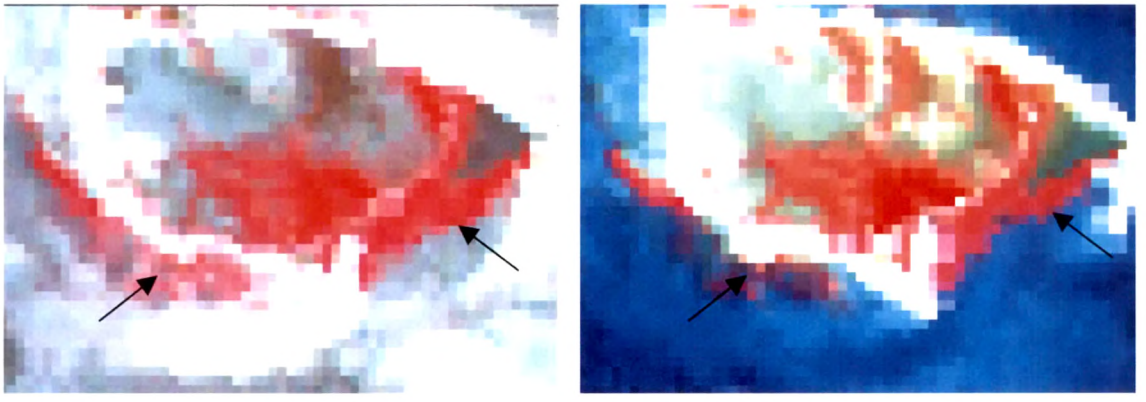
CHAPTER 8: MANGROVE HABITAT MAPPING AND COMMUNITY ZONATION

Habitat maps are very important in understanding the spatial distribution of various communities in an area. They give us an idea of the interaction of different communities that makeup the ecosystem.

8.1 MANGROVE HABITAT MAPS

The habitat maps were classified to the third level of classification. At this level the major habitats in the region could be identified. To understand the effect of tides on mangrove habitat it was decided to use low as well as high tide data to prepare mangrove habitat maps. Figure 8.1 displays satellite imagery of low and high tides for Pirotan Island. The arrows in the November 1999 satellite data indicated the region where a change in the mangrove vegetation seems to have occurred. However, this change was not due to any decrease in the vegetation but was observed on account of the submergence of low mangroves during high tide. The low tide as well as the high tide images which were classified using



March 2000 November 1999

Fig. 8.1 Effect of tide on the depiction of mangrove vegetation on satellite

unsupervised classification using 50 classes have been represented in plate 8.1, The resultant maps were analysed for similar changes all over the study area. It was observed that due to the effect of high tide the mangroves at the fringe of the creeks were not classified correctly and in some cases the mangroves at the

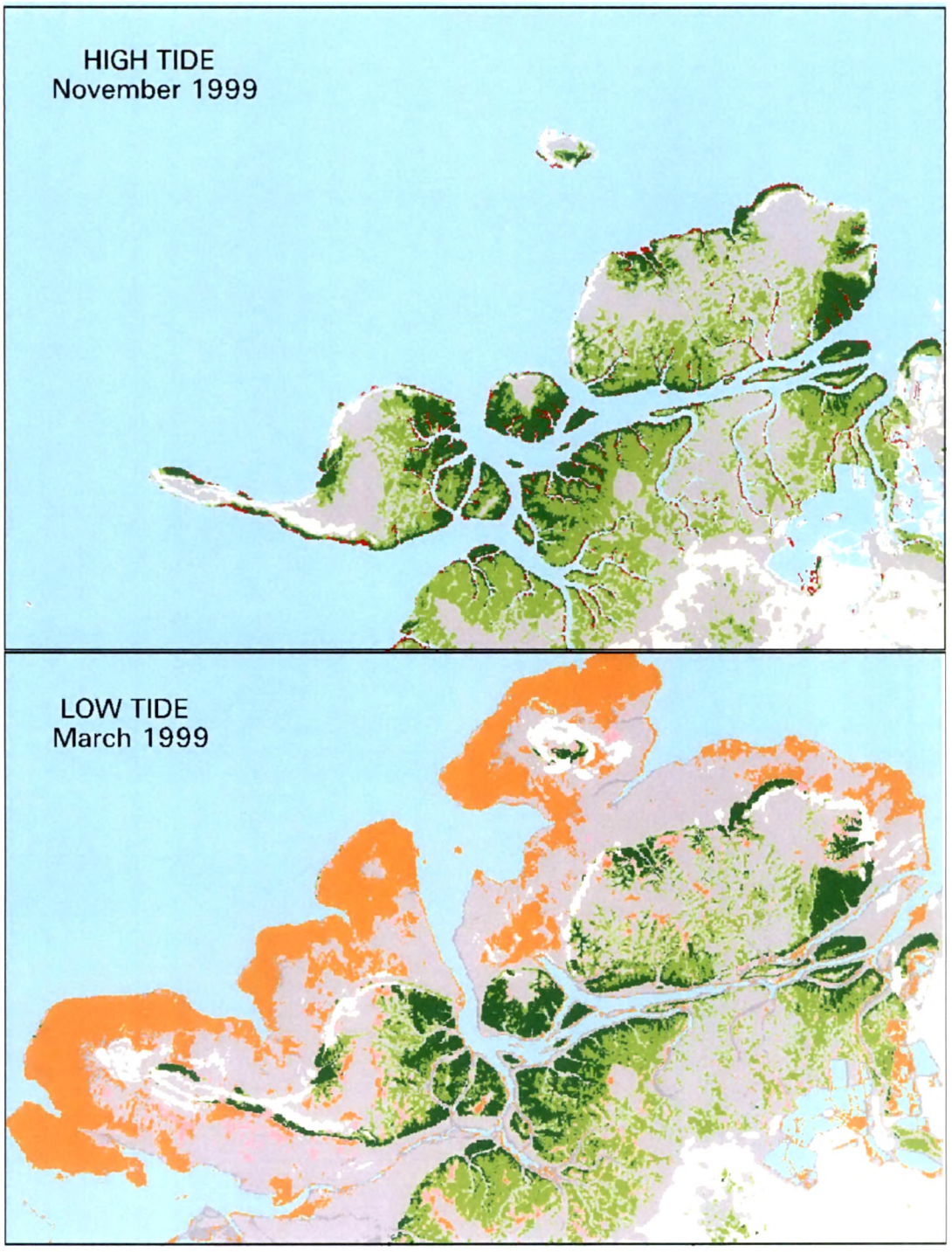


Plate 8.1 Effect of tide on the classification of Mangrove Vegetation

fringe were wrongly classified as water. It was also noticed that several classes were getting merged in the high tide image e.g. sparse mangroves and algae. It was therefore decided to use only low tide data for further analysis. However, high tide data of 1st March 1999 has been used for analysis because low tide data for the period was not available and this data was of importance as it gave an indication of a large loss of mangrove vegetation in the region. Fig. 8.2 explains the importance of the SWIR band in the community zonation of mangroves. It shows all the four bands and the arrows indicate the region where the different communities can be distinctly differentiated in the SWIR band. Bahuguna and Nayak (2000) and Blasco (1998) have also mentioned the importance of the MIR band in mangrove studies. In the presents study the SWIR data of all the dates were having a few diagonal strips cutting the mangrove areas resulting in some data loss. However, due to its important role in community zonation it was used despite of its poor quality as well as coarser spatial resolution (70.5 m).

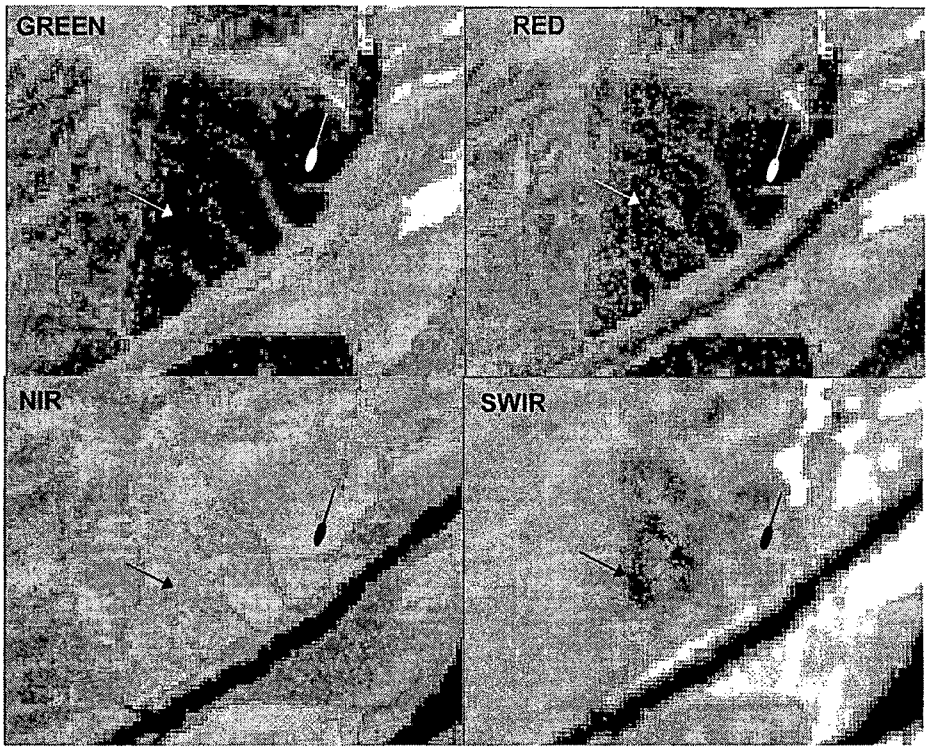


Fig 8.2 Importance of SWIR band in the community zonation of Mangroves. The pointed arrow indicates Ceriops while the oval arrow indicates Avicennia patch

8.1.1 Selection of proper methodology for Mangrove Habitat Map Generation

Several image analysis techniques were employed to get the desired categories. The major analysis techniques used and the major remarks of their classification into mangrove habitat maps have been summarized in table 8.1.

Accuracy Assessment

The first criterion in the accuracy assessment of all the different enhancement as well as analysis techniques was the differentiation of all the required classes in the map. It was observed that the unsupervised classification procedure in almost all the classes did not fulfill this criterion and were thus eliminated. From the table it can be seen that two techniques (highlighted in table 8.1) gave the best results. These two methods were selected and their accuracy was assessed. The results have been represented in table 8.2. It was seen that supervised classification of the band ratioed image gave the best result and this method was subsequently used to classify the images of all the dates.

Table 8.2 Accuracy assessment of Mangrove Habitat Maps

Method	Overall Accuracy	Kappa Coefficient
Supervised Classification of four basic bands	84.20	0.8278
Supervised classification of band ratioed image	90.8	0.8901

8.1.2 Mangrove Habitat Maps

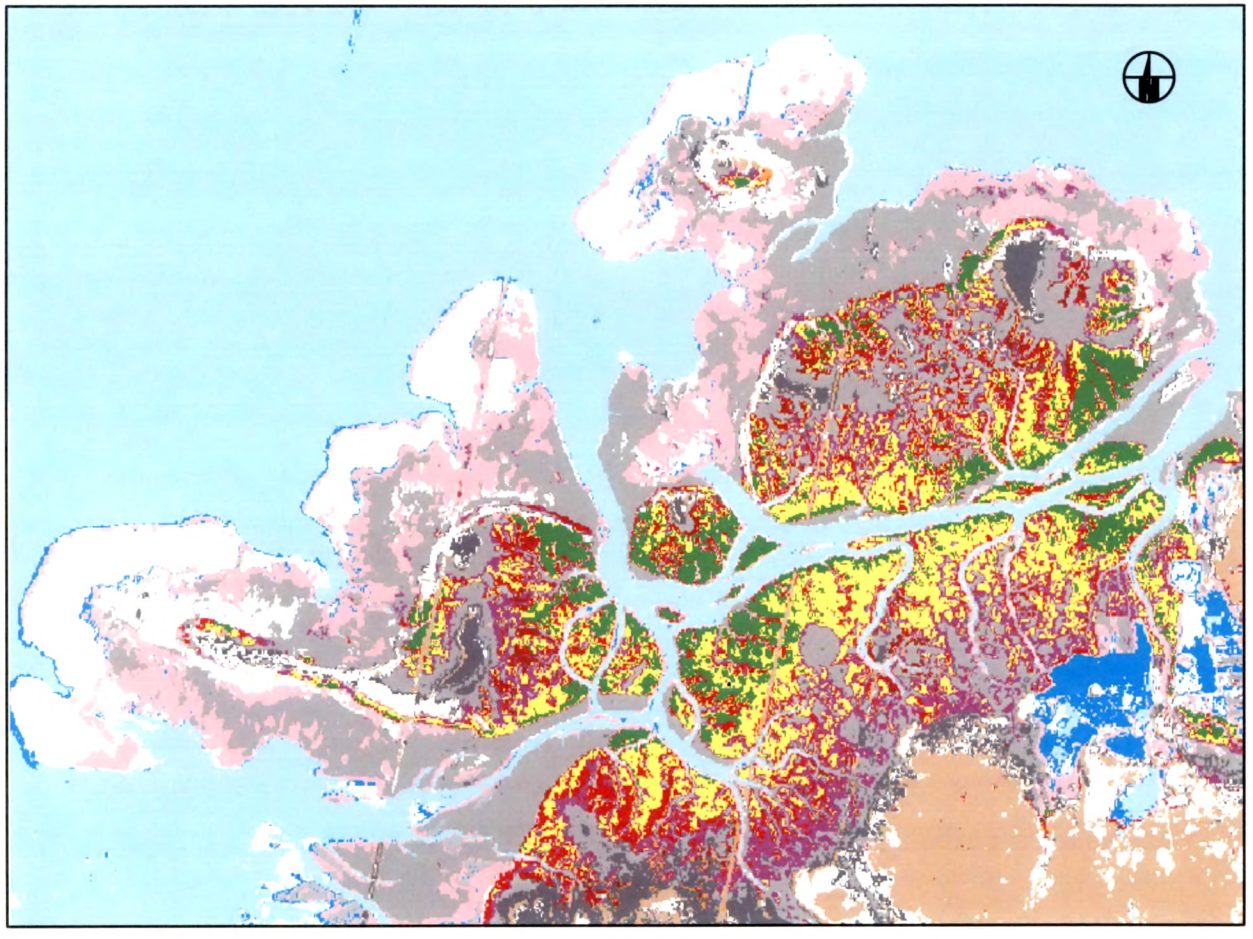
The mangrove vegetation in the region is characterized by low height (reaching a maximum of 5 m of some islands. Several categories were used to describe the different habitats found in the area as has been enumerated in the classification system given in table 6.4 earlier. The mangrove habitat maps of three (October 1998, March 1999 and January 2001) of the four selected dates have been given as plates 8.2 to 8.4 respectively. The categories that were used in the habitat mapping have been described below

Table 8.1 Major remarks for the different image analysis processes for the generation of habitat/zonation maps

Sr. No.	Image Analysis technique	Classification	Major Remarks
1.	Bo enhancements Only Radiance converted images	Unsupervised	• Merging between several categories. • Few categories e.g. sand vegetation not distinct. • Due to its turbidity and different depths, maximum number of classes were of water
		Supervised	• Most categories separated • Partial Merging between back mangrove and sparse mangrove • Sparse components of different communities show some merging.
2.	Haze Reduction	Unsupervised	• Increase in number of very small polygons • Merging between a large number of categories especially marsh and sparse mangroves
		Supervised	• Increase in number of very small polygons leading to a much cluttered map.
3.	Principle Component Analysis (First 3 components)	Unsupervised	• Merging between several categories. • Due to its turbidity and different depths, maximum number of classes were of water
		Supervised	• Overlapping classes • The resultant map appears cluttered. • Clear demarcation between island vegetation and mangroves. • Standing dead mangroves and high tidal mudflats not separable
4.	Vegetation Index $\frac{NIR}{\mathrm{Red}}$	Unsupervised	• Merging between several categories. • Several categories not being differentiated
		Supervised	• Merging between categories • Dense vegetation of all kinds getting merged.

Sr. No.	Image Analysis technique	Classification	Major Remarks
5.	Normalized differential vegetation index - NDVI $\left(\frac{NIR - \mathrm{Re}d}{NIR + \mathrm{Re}d}\right)$	Unsupervised	• Merging between several categories. • Several categories not being differentiated • Dense and sparse mangrove clearly separated • Sparse mangroves getting merged with sand vegetation and island vegetation.
		Supervised	• Different communities not separated. • Merging between marsh, back mangrove and sparse mangroves • Intertidal mudflat and standing dead mangroves not differentiated. • Dense and sparse mangroves clearly separated
6.	Radiance converted image + NDVI	Unsupervised	• Merging between several categories.
		Supervised	• Good density separation but different communities not clearly separated.
7.	Radiance converted image $+\frac{NIR}{\mathrm{Re}d}+\frac{SWIR}{NIR}$	Unsupervised	• Merging between several categories.
		Supervised	• Most categories separated • Sparse and dense components differentiated • Different communities also separated. • Best separation among all procedures attempted
8.	Radiance converted image $+\frac{NIR}{\mathrm{Re}d}+\frac{SWIR}{NIR}+\frac{NIR}{SWIR}$	Unsupervised	• Merging between several categories.
		Supervised	• Major categories separated. • Merging between intertidal mudflat and standing dead mangroves. • Merging between marsh and back mangroves.

Methods selected for further mangrove habitat mapping have been highlighted



Legend

Class_Names

- Mangrove Dense
- Mangrove Sparse
- Mangrove Degraded
- Back Mangrove
- Marsh
- Standing Dead
- Algae
- Reef flat
- IMF
- HMF
- Land
- Sand

Scale

5 0 Kilometers

1 : 125000

PLATE 8.2. MANGROVE HABITAT MAP 1998

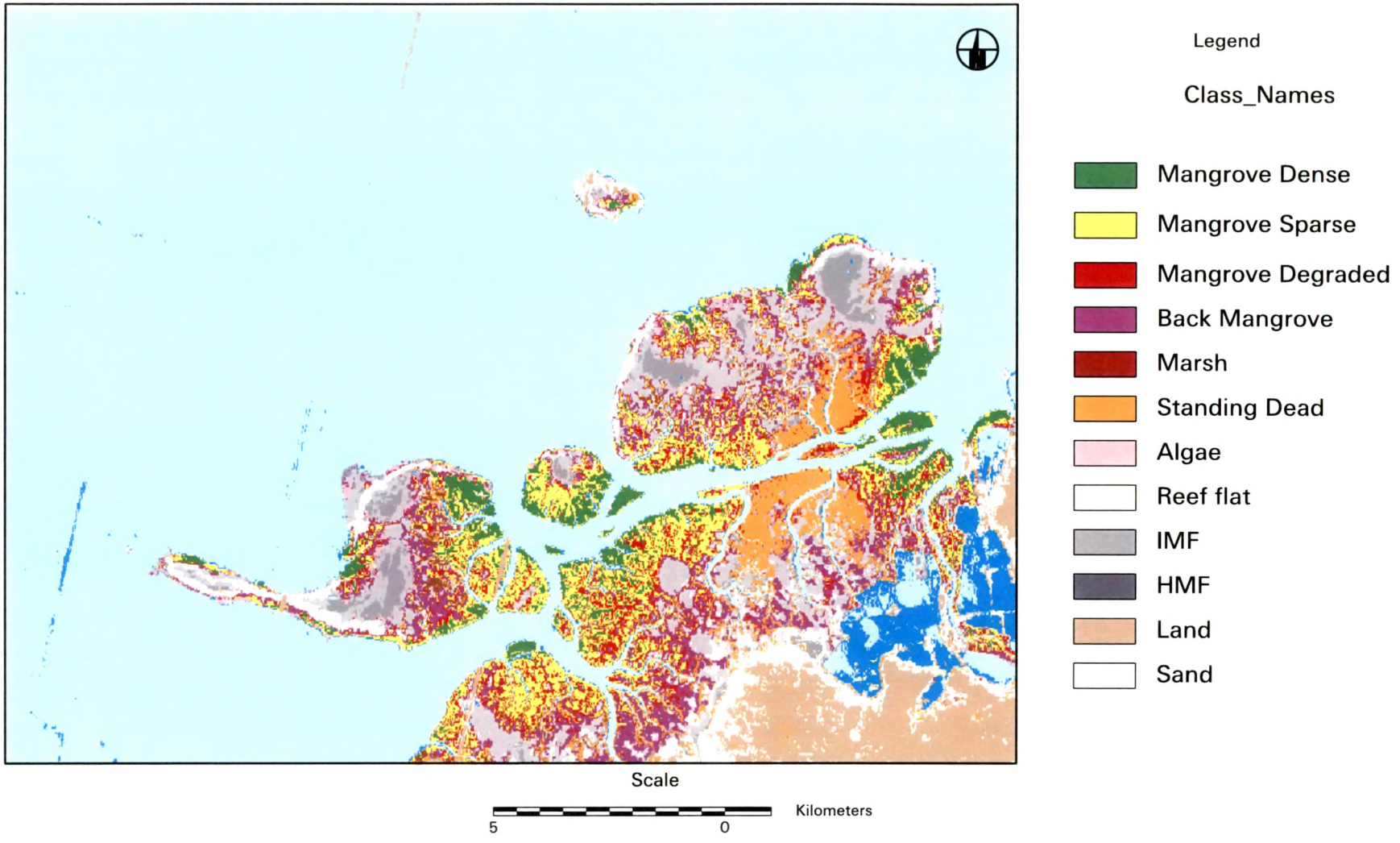


PLATE 8.3. MANGROVE HABITAT MAP 1999

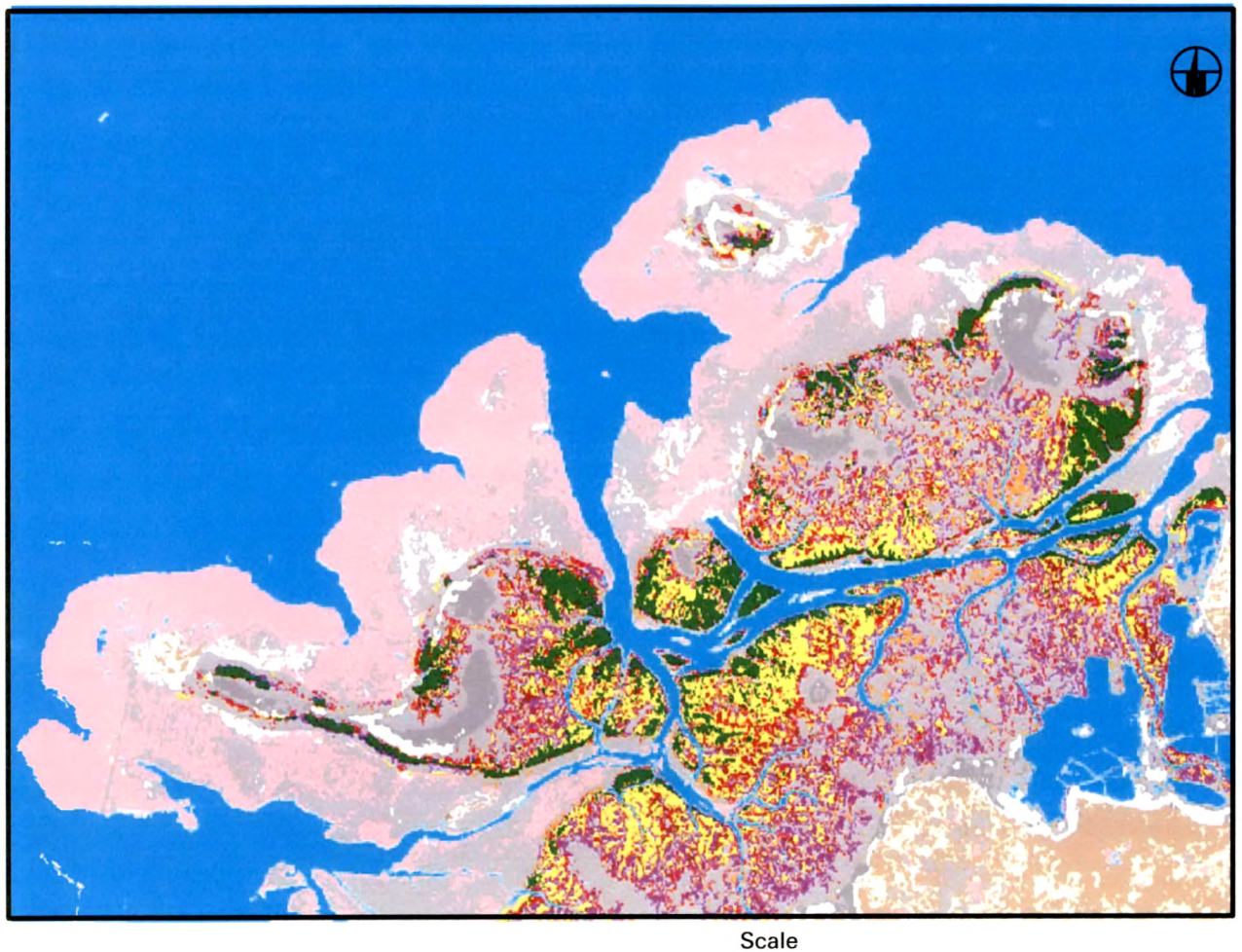


PLATE 8.4. MANGROVE HABITAT MAP 2001

Mangrove Dense

The mangroves vegetation in this category has more than 60 % canopy cover. In the habitat maps no distinction between species has been done and dense mangrove formations of all the species found in the area viz. *Avicennia, Rhizophora* and *Ceriops* fall under this category. The dense *Avicennia* mangroves are usually characteristic of the fringe areas of most islands and the fringe mainland mangroves. At most of these locations the height of the trees is 3 m at the fringe but about 30-100 m inland the height of the trees rapidly decreases to less than 2 m. Dense patches of *Ceriops* are found at several location in the study area and the canopy cover in most of the cases is more than 90%. Their growth in such dense formations makes it virtually impossible to pass through them without physically damaging the individual plants. Plate 8.5 depicts the dense mangroves found in the area.

Mangrove Sparse

The mangrove vegetation in this category has between 30-60 % canopy cover. This category is generally characterized by low vegetation. The height of the vegetation in this category is usually less than 2 m. It is mostly located in the region between the fringe mangrove and the back mangrove community. It is the largest mangrove habitat in the region. Plate 8.6 shows the sparse mangrove community in the region.

Back Mangrove

The back mangrove community is characterized by the presence of both mangrove species as well as salt marsh plants. The true mangrove species representative of the community is usually *Avicennia marina* var. *marina. A. alba* is also commonly found in this community. Within the mangrove plants various salt marsh plants like *Aleuropous, Suaeda, Sesuvium* etc can be found growing. The height of the mangrove plants is not more than 1 m while that of the salt marsh plants is usually less than 40 cm. Plate 8.7 shows the back mangrove community in the area.

Dense *Avicennia* mangroves (Chhad Is.)

Dense *Ceriops* (Dide ka bet)

Dense *Rhizophora* (Chiriya Tapu)

Plate 8.5 Dense Mangroves Habitat

Sparse *Avicennia* mangroves (Chhad Island)

Sparse Mangroves (Mainland fringing)

Mixed Sparse Mangroves (Chhad Is.)

Plate 8.6 Sparse Mangroves Habitat

Back mangrove community (Fringing Mainland opposite Baga beli Island)
A – *Ceriops,* B- *Avicennia*, C- *Suaeda*, D - *Aleuropus*

Back Mangrove (Fringing Mainland)
A - *Avicennia*, B - *Sesuvium*

Plate 8.7 The Back Mangrove Habitat

Standing Dead

This category came largely into existence due to an unexplained event (most probably an oil spill) in which a large tract of mangrove on the Jindra-Chhad island and the fringing mainland mangroves to its south were affected . The plants in this habitat had become compeletely defoliated and most of them after some time died while a few mangaged to regenerate. The most affected species was *Avicennia marina* followed by *Ceriops tagal*. The degraded and the standing dead community has been depicted in Plate 8.8

Degraded Mangrove

This habitat is characterized by very low densities. It has several dead plants adjoining living plants. They are usually found in the vicinity of human habitation or near creek margin which are frequented by fishermen. They are also found towards the landward margins where the mangroves have started to dry off.

Marsh

The marsh vegetation is located towards the landward margin of the mangrove vegetation. Low plants usually reaching a height of less than 40 cm characterize the category. The marsh plants found in the study area include three species of *Suaeda*, *Sesuvium portulacastrum*, *Salicornia brachiata* and Aeluropus lagopoides. *Suaeda* has been found to mainly occur in a dominant condition on most of the islands while on the fringing mainland mangroves the other three species have been found to dominate. Plate 8.9 shows the marsh habitat in the study area.

Sand Vegetation

All the larger islands in the study area are characterized by sandy beaches or patches on one or more of its periphery. These regions are characterized by several species such as *Salvadora, Ipomoea* etc. While individually the species do not form large patches suitable for mapping, together they make up sufficiently large patches at places where they can be mapped. Plate 8.10 shows the sand vegetation in the area.

Standing dead Mangroves (A) on Jindra Island. Towards the edge of the creek regenerating *Avicennia* plants (B) can be seen.

A close up view of standing dead mangroves at the mouth of Gusanga Creek

Plate 8.8 Standing Dead Mangroves

Suaeda marsh habitat (Dide ka Bet)

Suaeda marsh along creek
(Jindra Island)

Salicornia marsh
(Fringing Mainland)

Plate 8.9 Marsh Habitat of the study area

Fimbristylis sp on sand beach (Northeast Jindra)

Salvadora on sand (Dide ka bet)

Plate 8.10 Sand vegetation habitat of the study area

Other categories

The other wetland categories that have been mapped are water, reef area, algae, intertidal mudflat, high tidal mudflat, sand, saltpan, saline area, terrestrial vegetation and terrestrial area. As saltpans are mostly covered with water for most time they are difficult to separate during the classification process. They can however be easily corrected during contextual editing. A few of these wetland categories have been depicted on plate 8.11

8.1.3 Area Statistics

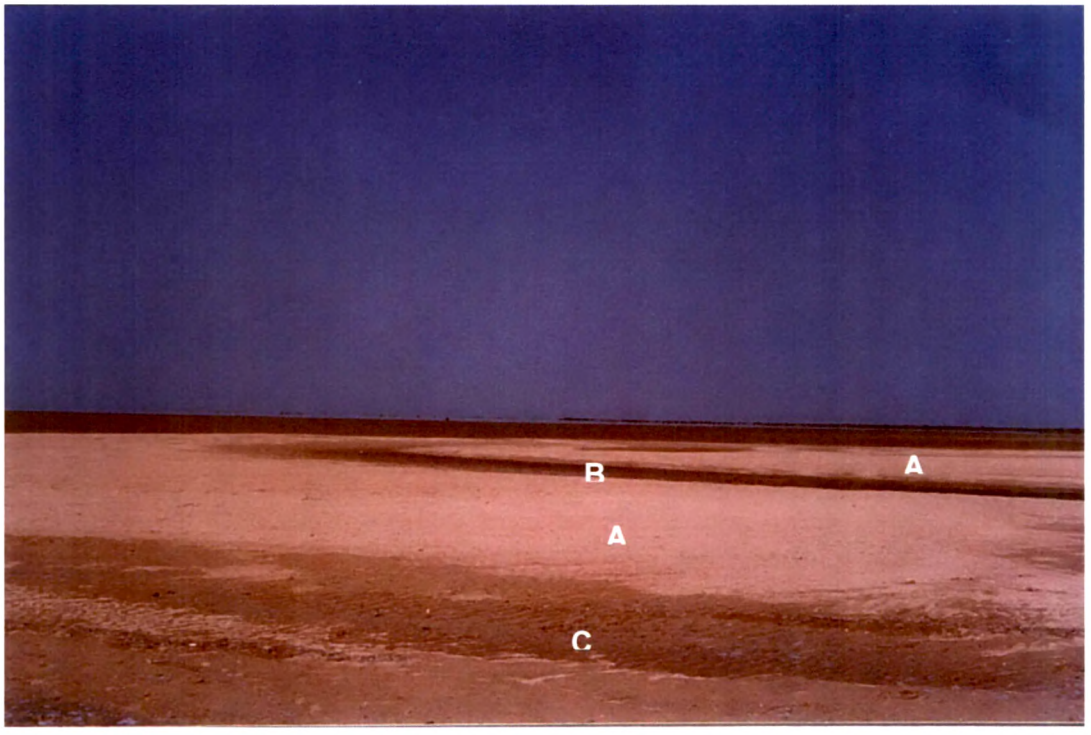
The area statistics of all the mangrove categories in the habitat maps have been given in table 8.3 below. It can be clearly seen that the mangroves of the study area are under stress and a gradual decline in the mangrove cover can be noticed. Fig 8.3 shows the trend in the mangrove cover of the study area. The major characteristics of the mangrove habitat mapping are enumerated after the table below

Table 8.3 Area statistics for Mangrove Habitat Maps

Sr. No.	Category	Area (ha)			
		Oct 1998	Mar 1999	Mar 2000	Jan 2001
1.	Mangrove Dense	1149	624	886	914
2.	Mangrove Sparse	3277	2752	3138	2653
3.	Mangrove Degraded	679	738	480	505
4.	Back Mangrove	1065	1110	912	1022
5.	Standing Dead	61	857	434	310
6.	Marsh	405	415	452	490
	Total	6636	6496	5983	5894

- The major cause for the decline in mangrove cover has been the severe defoliation event prior to March 1999, which decreased the live mangrove cover severely.
- The standing dead mangroves are gradually decreasing in extent after March 1999 due to their conversion into either mudflat or into degraded mangroves.

Intertidal Mudflat on Mainland



High tidal Mudflat (Dide ka Bet)
(A- Salt encrusted High tidal mudflat, B-Plant Debris, C – wet High tidal mudflat

Plate 8.11 Other habitats of the study area

- The dense mangrove cover is seen to be increasing and has reached 914 ha in January 2001.
- The extent of the marsh community is increasing gradually and is the highest in January 2001 at 490 ha.

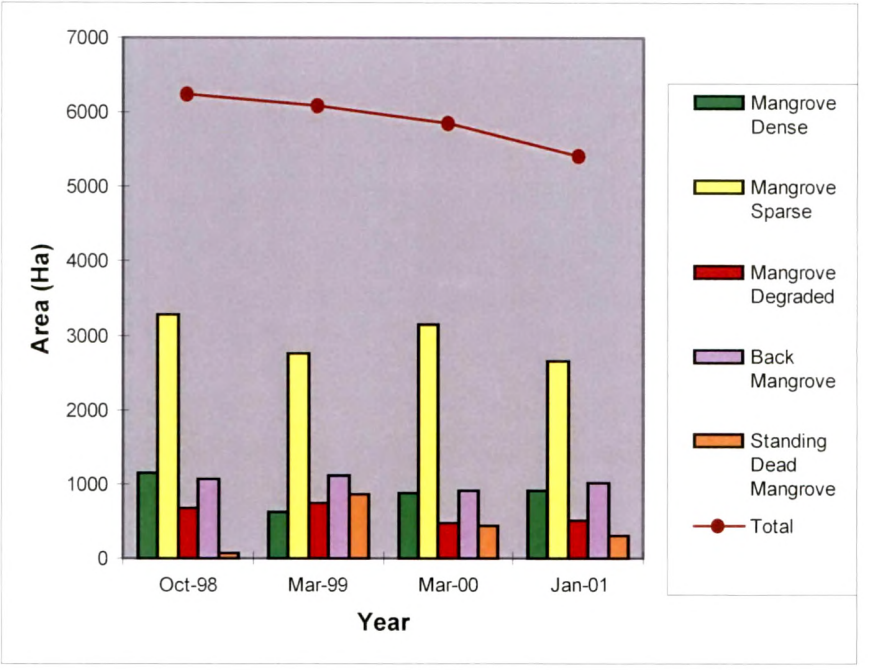


Fig. 8.3 Change in Mangrove habitat over the study period

8.2 MANGROVE COMMUNITY MAPPING

Mangrove community maps are an important input in the management of any mangrove forested area. Knowledge about the distribution and extent of various communities can immensely help in their efficient management.

As the main emphasis in mangrove community mapping is to map the mangrove communities, the adjoining reef area and the terrestrial area were masked out as the algae present on the mud in the reef area and the terrestrial vegetation were interfering in the classification.

Seven species of mangroves were found in the area. It was earlier aimed to prepare a mangrove species zonation map of the area but the similarity in spectral behavior among the species of the same genus led to a mangrove zonation map based on genera rather then species. Four mangrove genera had

been located in the present study. Among these *Aegiceras* was found scattered among the other mangrove species and did not form large homogenous patches that are characteristic of major elements of a mangrove habitat (Tomlinson, 1986). These small and scattered patches could not be mapped, as the spatial resolution of the sensor used in the present study was 24 m. This species was mostly located in the mixed mangrove area and was mostly found in areas where the height of the neighboring plants was not more than 2.5 m. *Ceriops* and *Rhizophora* are the other genera found in the area. They grow in large and almost homogenous patches at several regions of the study area. They have different growth forms and occupy differing microhabitats in the area show similar spectral behaviour in the LISS III sensor. Thus it was not possible to separate them spectrally. It was therefore decided to map both the genera under one singe class. The class was named the *Ceriops-Rhizophora* community, as *Ceriops* was the more dominant species. Improved resolution may help in separating them into distinct patches.

8.2.1 The Mangrove Communities of the Study area

The dominant mangrove communities in the study area have been described in detail below.

Avicennia Community

This is the largest community in the study area and is usually composed of one or more species of *Avicennia*. This community is universally found in all the regions of the study area. The dense community has a canopy cover of more than 60% while the sparse component has a cover between 30-60 %, The plants in the dense component usually reaches a height of about 3 m towards the fringe of the islands and towards the interior they have a height of about 2 m. The plants in the spaser component do not have a height of more than 2 m and in most cases the height is usually below 1.5 m. The sparse community is the largest community in the study area occupying more than 46% of the total mangrove cover of the area. Large patches of both dense and sparse component are present on Dideka Munde Ka bet, JIndra-chhad and on the fringing mainland mangroves.

***Ceriops-Rhizophora* Community**

The *Ceriops* and the *Rhizophora* plants grow in different environmental settings. They are rarely found growing together. In the dense component the *Ceriops* plants grow very close to another and reach a height of up to 2 m. They usually grow behind the fringing mangrove of the creek on slightly firmer soil. The Rhizophora plants on the other hand grow adjoining creeks and on very soft soil. It is difficult to move among the *Rhizophora* plants due to its arching stilt roots. Individual plants reach a height of more than 3.5 m. The sparse component is usually found associated with its dense counterpart and mostly fringing it. The sparse component has several *Avicennia* plants growing along with it but the composition of *Ceriops* plants is always more than 60 %. Large patches of the dense component are found on Dide-ka bet, Bhains bid and in the Kanakiya region of JIndra Is. While Dide ka Munde Ka bet is home to large sparse components of the community.

Mixed Dense Community

This community is composed of several mangrove species, but the composition of no single species reaches more than 60 %. *Aegiceras* has mostly been located as a member of such a community. Locations where the canopy cover is more than 60% falls under the dense component and the sparse component has a canopy cover between 30-60%. Dide ka bet, Jindra-Chhad and the fringing mainland mangroves have large patches of the dense component while the largest patch of the sparse component is located on Jindra-Chhad Island.

Other categories

The other categories are similar to the categories found in the mangrove habitat map.

8.2.3 The mangrove community zonation map and its accuracy

Mangrove community zonation maps were prepared using the two methods viz. radiance converted only and radiance converted with band ratios, that have been outlined earlier in table 8.1. As has been described earlier in the methodology chapter only the March 2000 image was analysed for community zonation. The

maps produced by the two methods were subjected to accuracy assessment using 125 computer-generated random points. The points were selected using stratified random sampling were the water class was eliminated. The points generated were then visited in the field and the resultant error matrix was generated. The error matrix for both the methods has been given in fig 8.4 and fig 8.5 respectively. The users and producers accuracy for all the classes and the overall accuracy and the kappa coefficient had been presented in table 8.4. It is seen that there is very little difference in the accuracy using both the methods, however, the second method involving band ratioing was selected because it gave more classes. Also the class 'standing dead mangroves' could not be separated completely from high tidal mudflat in the first method. An important point to be kept in mind was that the maps were prepared using the March 2000 data while the fieldwork for accuracy assessment was conducted in Apirl-May 2001. This time frame between the two dates could also have been one of the reasons for the error points obtained during the accuracy assessment.

METHOD 1

		REFERENCE															
SATELLITE DERIVED DATA		AvD	CrD	MxD	AvS	CrS	MxS	BM	DgM	SD	Mar	Hmf	Imf	Sa	TA	SP	Total
	AvD	14															14
	CrD		3	1													4
	MxD			7													7
	AvS				17		1	1									19
	CrS					2											2
	MxS						6										6
	BM				1			12	2								15
	DgM							1	7	1							9
	SD									0							0
	Mar										9						9
	Hmf									1		7					8
	Imf				1						1		21				23
	Sa													4			4
	Ta														3		3
	SP															2	2
	Total	14	3	8	19	2	7	14	9	2	10	7	21	4	3	2	125
TOTAL POINTS: 125									NO. OF FAILURES: 11								

Fig 8.5 Error Matrix for mangrove community map using method 1

METHOD 2

		REFERENCE															
SATELLITE DERIVED DATA		AvD	CrD	MxD	AvS	CrS	MxS	BM	DgM	SD	Mar	Hmf	Imf	Sa	TA	SP	**Total**
	AvD	10															10
	CrD		7														7
	MxD		1	8													9
	AvS				17		1										18
	CrS					3	1										4
	MxS						9										9
	BM							11			1						12
	DgM								3	1							4
	SD								1	5		1					7
	Mar										6						6
	Hmf									1		7					8
	Imf							1		1			16				18
	Sa													8			8
	Ta														1		1
	SP															4	4
	Total	10	8	8	17	3	11	12	4	8	7	8	16	8	1	4	125
TOTAL POINTS: 125									**NO. OF FAILURES: 10**								

Fig 8.5 Error Matrix for mangrove community map using method 2

Abbreviations used in the error matrix

1.	AvD	*Avicennia* Dense
2.	CrD	*Ceriops-Rhizophora* Dense
3.	MxD	Mixed Dense
4.	AvS	*Avicennia* sparse
5.	CrS	*Ceriops-Rhizophora* Sparse
6.	MxS	Mixed Sparse
7.	TrM	Back Mangroves
8.	DgM	Degraded Mangroves
9.	SD	Standing Dead Mangroges
10.	Mar	Marsh
11.	Hmf	High tidal Mudflat
12.	Imf	Inter tidal Mudflat
13.	Sa	Saline Area
14.	Ta	Land Area
15.	SP	Salt Pan

Table 8.4 Accuracy statistics for Mangrove Community Maps

Sr. No.	Category	Accuracy for Method 1		Accuracy for Method 2	
		Users %	Producers %	Users %	Producers %
1.	Avicennia Dense	100.00	100.00	100.00	100.00
2.	Ceriops-Rhizophora Dense	75.00	100.00	100.00	87.50
3.	Mixed Dense	100.00	87.50	88.89	100.00
4.	Avicennia Sparse	89.47	89.47	94.44	100.00
5.	Ceriops-Rhizophora Sparse	100.00	100.00	75.00	100.00
6.	Mixed Spare	100.00	85.71	100.00	81.82
7.	Back Mang	80.00	85.71	91.67	91.67
8.	Degraded Mangrove	77.78	77.78	75.00	75.00
9.	Standing Dead	-	0	71.43	62.50
10.	Marsh	100.00	90.00	100.00	85.71
11.	High-tidal Mudflat	87.50	100.00	87.50	87.50
12.	Inter-tidal Mudflat	91.30	100.00	88.89	100.00
13.	Sand	100.00	100.00	100.00	100.00.
14.	Terrestrial Area	100.00	100.00	100.00	100.00
15.	Salt Pan	100.00	100.00	100.00	100.00
	Over All	91.2		92	
	Kappa	0.9016		0.9143	
	Accuracy (85% confidence level)	87.9		88.9	

The classification accuracy of the map was estimated to be 87.9 % and 88.9 % at 85 % confidence level for method one and two respectively.

8.2.3 Area statistics

The mangrove community map has been depicted in Plate 8.12. The area statistics of the major communities have been given in table 8.5. The values have been rounded off to the nearest hectare.

The area statistics substantiate the fact that mangrove forests of the study area are dominated by a single genus *Avicennia.* The pure *Avicennia* communities (including both dense and sparse components) account for approximately 55 % of the mangrove cover of the area. The back mangrove community occupying 16.5 % of the area also has *Avicennia marina* var. *acutissima* as its dominant species. Thus approximately 71% of the mangrove cover is dominated by *Avicennia* genus. In addition to this the mixed communities of which *Avicennia* is

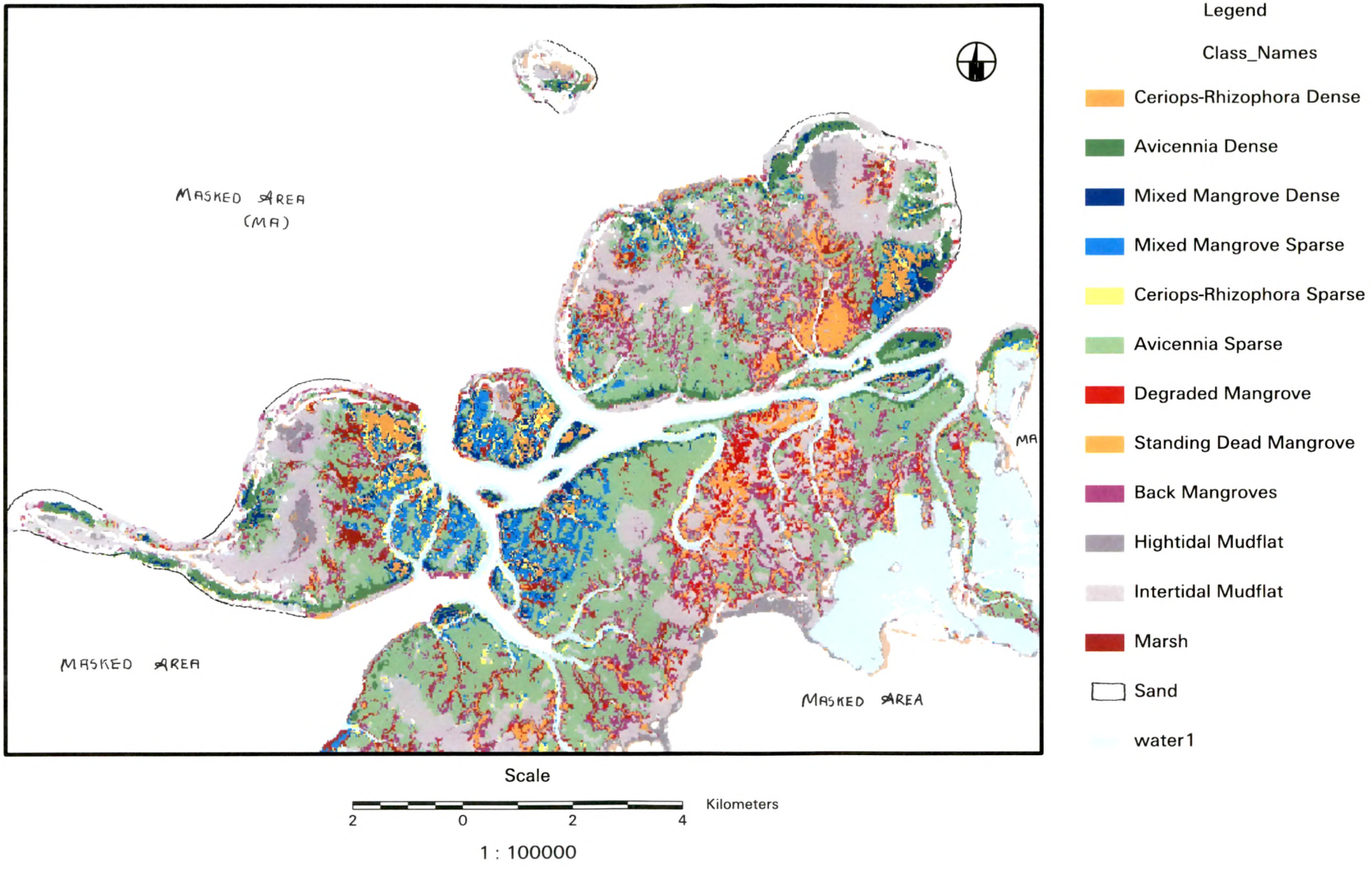


Plate 8.12 Mangrove Zonation Map 2000

one of the components occupies an additional 11.9 % of the mangrove cover. Taking this into consideration 83 % of the mangrove community in the area has *Avicennia* as its component. Only one community i.e. the *Avicennia* sparse community represents more than 46 % of the total mangrove area. The dense and sparse *Ceriops-Rhizophora* communities together cover a mere 5.9 % of the total mangrove vegetation of the area. The percentage composition of the different communities have been graphically depicted in fig. 8.5

Table 8.5 Extent of major mangrove communities in the study area

Sr. No.	Category	Area (Ha)
1.	*Avicennia* Dense	473
2.	*Ceriops-Rhizophora* Dense	173
3.	Mixed Dense	240
4.	*Avicennia* Sparse	2559
5.	*Ceriops-Rhizophora* Sparse	158
6.	Mixed Spare	421
7.	Back Mangroves	912
8.	Degraded Mangroves	160
9.	Standing Dead Mangroves	434
	Sub-total	**5531**
10.	Marsh Vegetation	453
	Total	**5984**

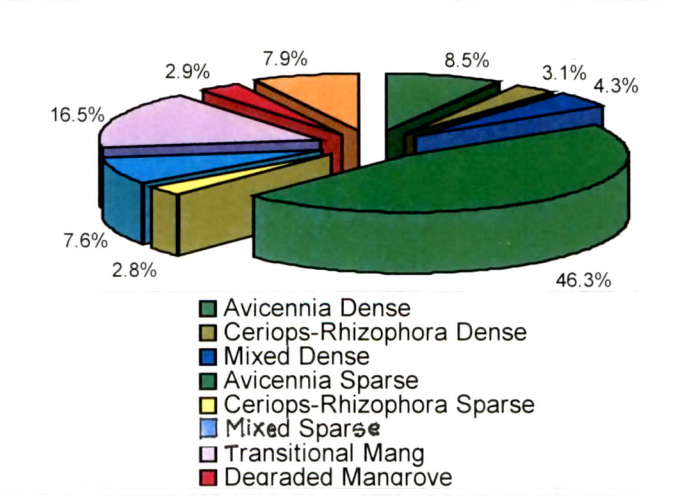


Fig 8.5 Percentage Composition of Different Mangrove Communities of the study area

8.2.4 Mangrove community distribution over different regions

The different mangrove communities are not distributed evenly over all the islands and the fringing mainland mangroves. Different islands show large variation in their community composition. For the sake of comparison the study area has been divided into the following three regions

1. Large Islands – Jindra Chhad and Dide ka- Mude Ka bet
2. Small islands – Pathe Pir Ka Bela, Chiriya tapu, Bhains bid, Pirotan and other smaller islands (Amudi Bela, Baga beli, Baga belan etc.)
3. Fringing Mainland

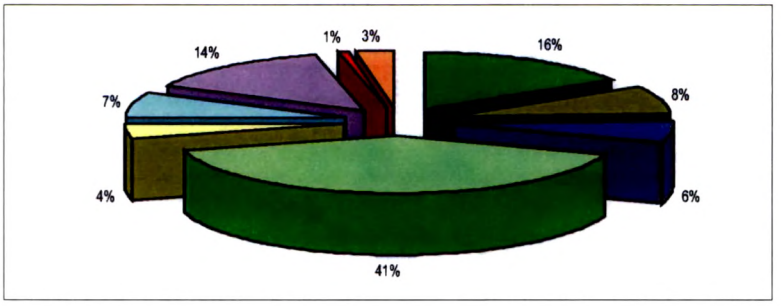
The area statistics for the different communities on major islands and regions has been given in table 8.6, while their percentage compositions have been graphically depicted in plates 8.13 to 8.15. The major characteristics have been enumerated below,

- The highest percentage composition (60.3%) of dense mangroves is located on the smaller islands (viz, Amudi Bela, Bada Beli, Baga belan, etc.) while the lowest (6.1 %) is located on the fringing mainland mangroves.
- More than 56% of Pirotan Island's mangrove vegetation is composed of dense mangroves.
- Bhains bid has a mixture of mangrove communities. Here any single community does not occupy more than 28 % of the area. The *Ceriops-Rhizophora* community covers approximately 24 % of the island's mangrove vegetation and is the largest percentage composition for the community in an area, among all regions of the study area. On the other hand, the proportion of this community is a mere 3.1% on the fringing mainland mangroves.
- Area-wise Jindra-Chhad has the largest area for the *Ceriops-Rhizophora* community at 72 ha.
- More than 40 % of the mangrove vegetation on the Islands of Bhains bid, Chiriya tapu and Pathe Pir ka bela are composed of mixed mangroves with the highest (48%) found on Pathe Pir ka bela. These islands represent the region with the highest species diversity in the area.

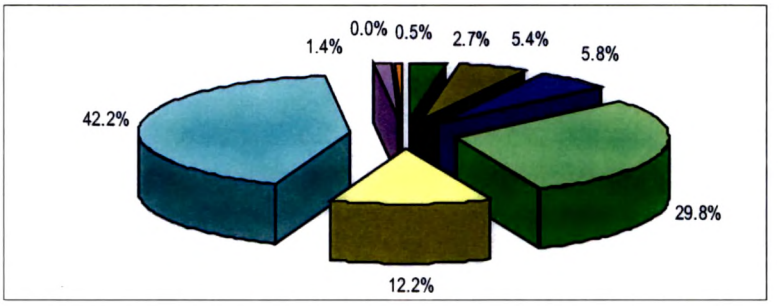
- The community is also found in good measure (approx 24%) on the other smaller island. On all the other regions except Dide ka- Munde ka bet it composes of less than 10 % of all mangroves.
- The largest back mangrove community (912 ha) is found on the fringing mainland mangroves but its highest composition (20.2%) is found on Jindra-Chhad.
- The fringing mainland mangrove also has the largest marsh vegetation area at 200 ha

Table 8.6 Extent of Major mangrove communities on different regions of the study area

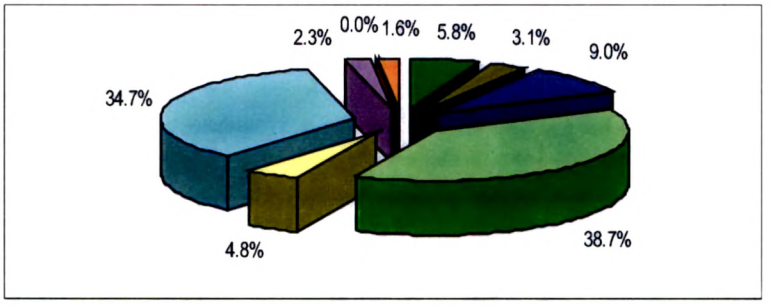
Sr. No.	Category	Area of Mangrove category in different regions of the study area (Ha)							
		Dide ka Munde ka	Pathe Pir Is	Chiriya Tapu	Bhains Bid	Pirotan Is.	Jindra-Chhad	Other Islands	Main-land
1.	*Avicennia* Dense	115	2.2	5.7	15	12.7	168.0	60.1	93.5
2.	*Ceriops-Rhizophora* Dense	57	4.4	3.0	28	0.6	47.8	9.0	22.3
3.	Mixed Dense	44	4.7	8.8	34	2.3	62.3	30.8	51.6
4.	*Avicennia* Sparse	290	24.2	37.7	36	5.0	611.0	37.3	1518.6
5.	*Ceriops-Rhizophora* Sparse	29	9.9	4.7	21	0.0	24.2	6.3	62.6
6.	Mixed Sparse	51	34.3	33.8	57	0.2	74.0	8.7	162.4
7.	Back Mangrove	101	1.1	2.2	2	5.2	296.8	8.4	492.9
8.	Degraded Mangrove	6	0.0	0.0	3	0.5	15.4	1.3	132.0
9.	Standing Dead	20	0.4	1.6	8	0.9	169.8	3.5	229.4
	Sub-total	713	81	98	204	27	1469	165	2772
10.	Marsh	86	5.2	4.0	19	0.2	129.8	5.9	199.9
	Total	799	86	102	223	28	1599	171	2974



Dide Ka Bet

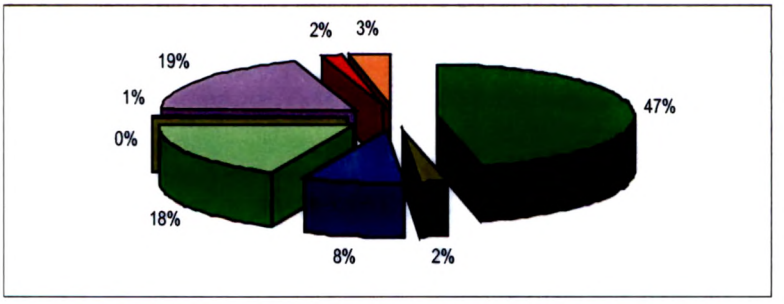


Pathe Pir Ka Bela

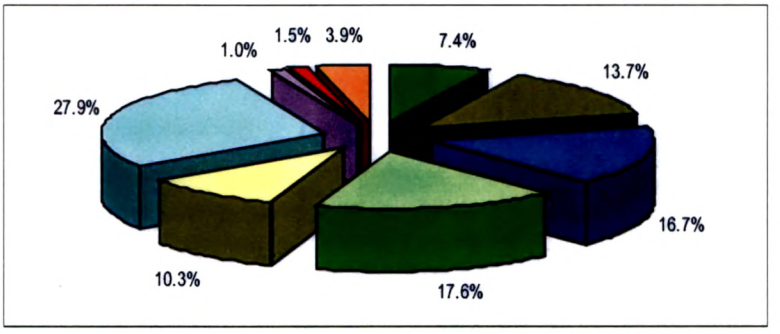


Chiriya Bela

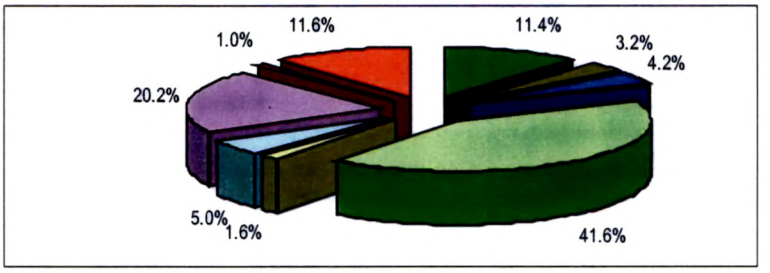
Plate 8.13 Composition of Mangrove Community in Different regions of the study area - I



Pirotan

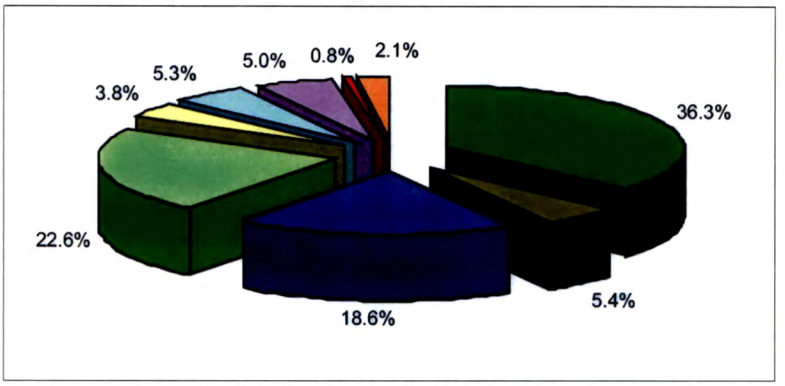


Bhains Bid

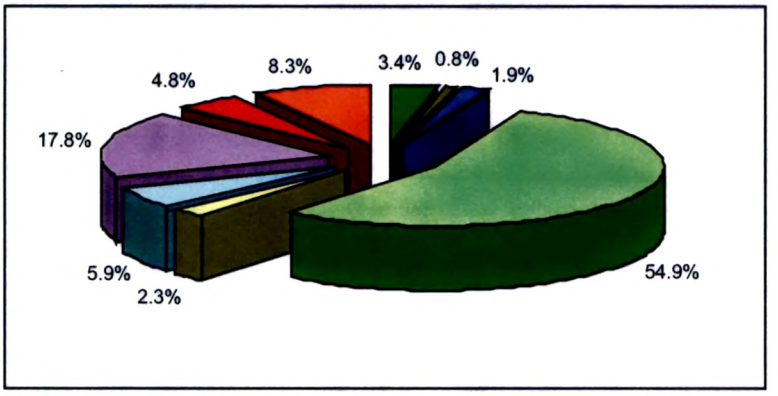


Jindra-Chhad

Plate 8.14 Composition of Mangrove Community in Different regions of the study area – II



Other Islands (Amudi bela, Baga beli etc)



Fringing Mainland Mangroves

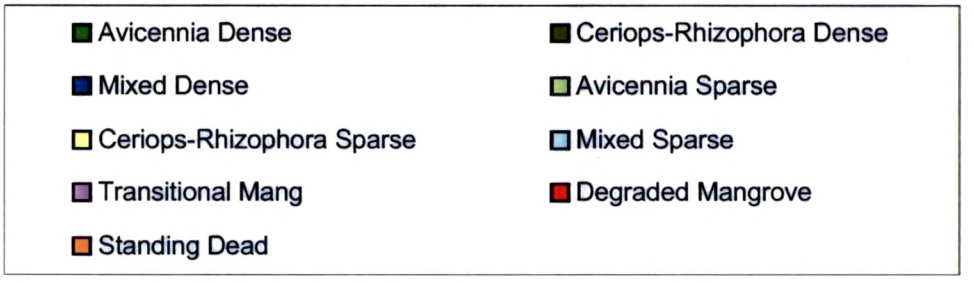


Plate 8.15 Composition of Mangrove Community in Different regions of the study area - III