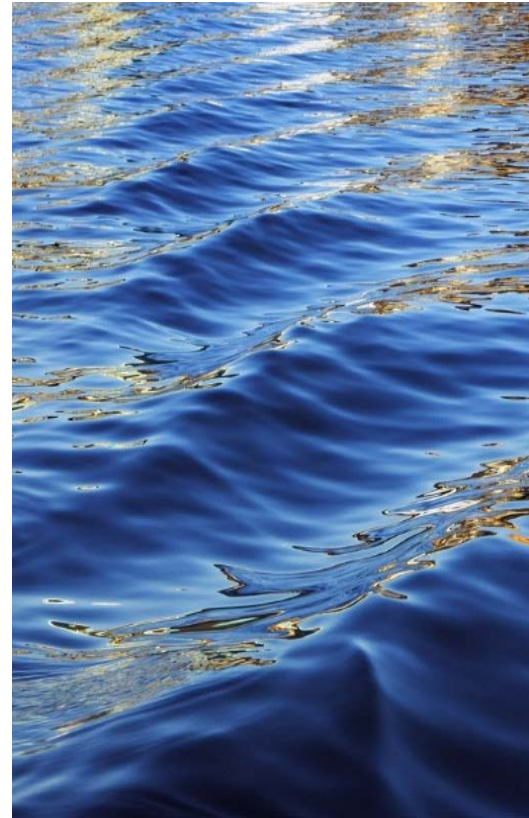


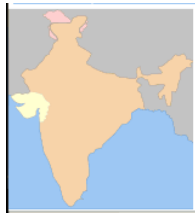


Sharing Lessons on Mangrove Restoration- Gujarat, India

By
C. N. Pandey & Richa Pandey

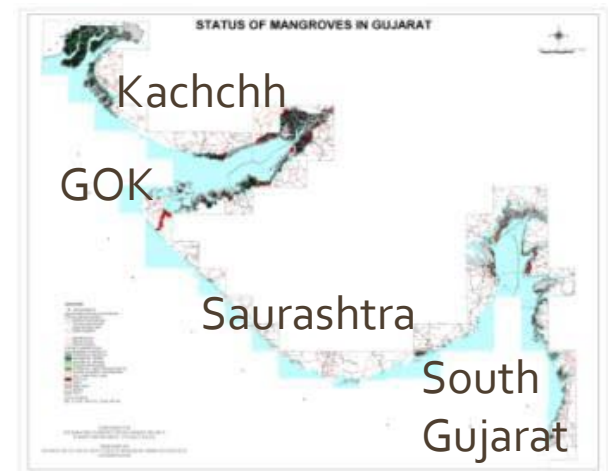


Mangroves in Gujarat



State has

- Longest coastline – 1650 Km – (20% of country)
- Largest area of coastal wetlands – about 66 % of country's coastal wetlands.
- Second largest mangrove cover of India – 1058 sq
- Despite second largest mangrove in the country, the state has a massive potential area for mangrove habitat development
- 15 mangrove species and more than 100 mangrove associates
- Four mangrove regions – Kachchh, Gulf of Kachchh, Saurashtra & South Gujarat



Four mangrove regions of Gujarat

Mangrove regions of Gujarat

Mangrove Region	Districts	Mangrove cover (km²)	% Dis.	Mangrove species	Fresh water inflow	Avg. annual rain fall
Kachchh	Kachchh (1)	778	73.53	1+3	Negligible	Up to 400
Gulf of Kachchh	Jamnagar and Rajkot districts & areas under MNP&S (2)	161	15.22	4	Marginal	400-800
Saurashtra	Amreli, Junagadh (2)	2	0.19	1	Marginal	400-800
South Gujarat	Bhavnagar, Ahmedabad, Anand, Vadodara, Bharuch, Surat, Navsari and Valsad (8)	117	11.06	15	Though Perennial rivers	Up to 2000
Total		1058	100%	15	NA	NA

Max. mangrove cover in Kachchh but max. diversity in South Gujarat

Relative Abundance of Mangrove Species in Gujarat

Abundant

1. *Avicennia marina*

Localized abundance

1. *Acanthus illicifolius*
2. *Aegiceras corniculatum*
3. *Ceriops tagal*
4. *Rhizophora mucronata*
5. *Sonneratia apetala*

Very rare at State level

1. *Avicennia alba*
2. *A. Officinalis*
3. *Bruguiera cylindrica*
4. *Bruguiera gymnorrhiza*
5. *Ceriops decandra*
6. *Excoecaria agallocha*
7. *Rhizophora apiculata*
8. *Lumnitzera racemosa*
9. *Kandelia candel*

Species diversity -15 species

Mangrove Plantations in Gujarat from 2003-11

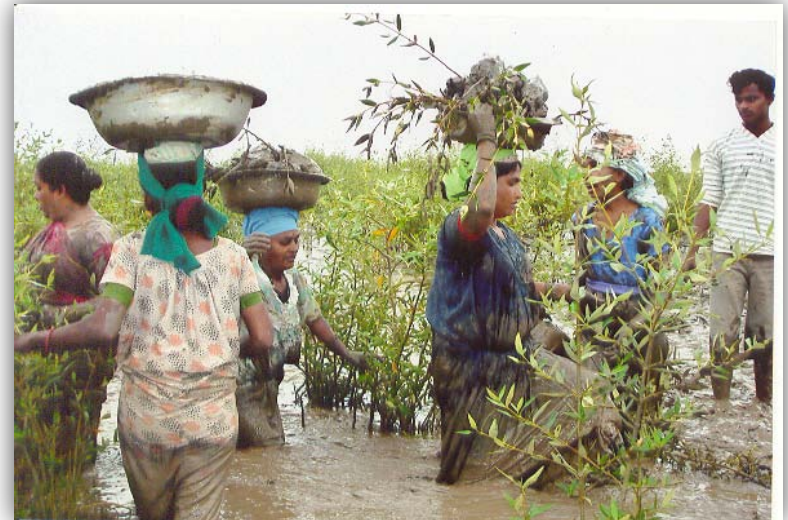
Year	Area (Hectares)					No. of Industries involved
	ICEF	PPP	GOG	GOI	Total	
2003-04	1250	0	0	0	1250	-
2004-05	560	0	0	0	560	-
2005-06	1101	0	0	0	1101	-
2006-07	1190	360	0	0	1550	3
2007-08	0	620	165	300	1085	6
2008-09	0	560	285	0	845	7
2009-10	0	900	965	0	1865	11
2010-11	0	1645	1100	3000	5815	13
Total	4101	4085	2515	3300	14071	



Of the total increase in mangrove cover of India during 2009-11, 50% is registered from Gujarat only

Mangrove afforestation programme in the state

- **Golden Goals (2010)- Mangroves:** Gov. of Gujarat has incorporated mangroves in its golden goals programme and has planned for raising **12000 ha (120 sq. km)** mangrove annually
- More than the total mangrove cover of many states!
- This has led to
 - Maximum increase in mangrove cover in the state
 - A remarkable mangrove conservation success story



Managerial Issues

1. Many Funding Agencies:

1. State fund,
2. Central Government fund (CSS),
3. World Bank aided ICZM
4. Disaster Management (for 2 yrs)
5. Green India Mission,
6. JICA funded GFDP
7. Private sector-Corporate social responsibility



2. Major Plantation agencies:

1. Forest Department (Government schemes)
2. Gujarat Ecology Commission (CSR, ICZM)
3. Other Agencies (NGOs etc)

3. Monitoring is difficult

1. Remote localities
2. Dynamic intertidal conditions

4. High chances of duplication



Need to have long term systematic approach for mangrove development

Technical Issues: Mangrove plantation vs. Mangrove habitat development

- Requires technical information such as
 - Suitable mangrove species
 - Suitable sites (soil and inundation conditions)
- Demarcate suitable areas for development of mangrove habitats
- Incorporation of mangrove associates along with mangroves
- Need to prioritize the area based on their vulnerability against anthropogenic and natural pressures
- Ecological services/functions of monoculture mangrove plantations



Instead of plantation of few mangrove species, need to follow ecosystem approach

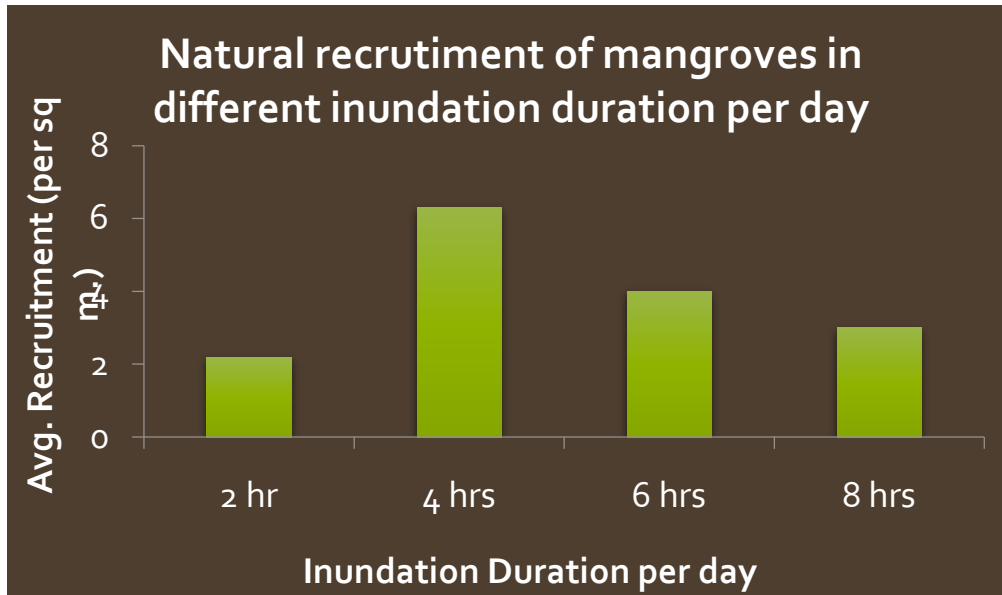
Research and Conservation Action in Gujarat

- Research inputs are being taken in overall conservation and management of mangroves

Research projects	Study Area	Significant results
Pollination Biology of three major mangrove species of Gujarat	Gulf of Kachchh	<i>Associated flora and fauna play significant role in reproductive success of mangroves</i>
Study of floristic and natural recruitment diversity of mangrove habitats of S. Gujarat	South Gujarat- Bhavnagar to Valsad	Recorded for the first time New mangrove habitats Mangrove species from the state Health of different mangrove habitats <i>Recommended mangrove species for various substrata and inundation conditions</i>
Estimation of carbon sequestration by mangroves of Gujarat	All mangrove habitats of state	<i>8.11 million ton carbon is stored in mangroves of Gujarat</i>

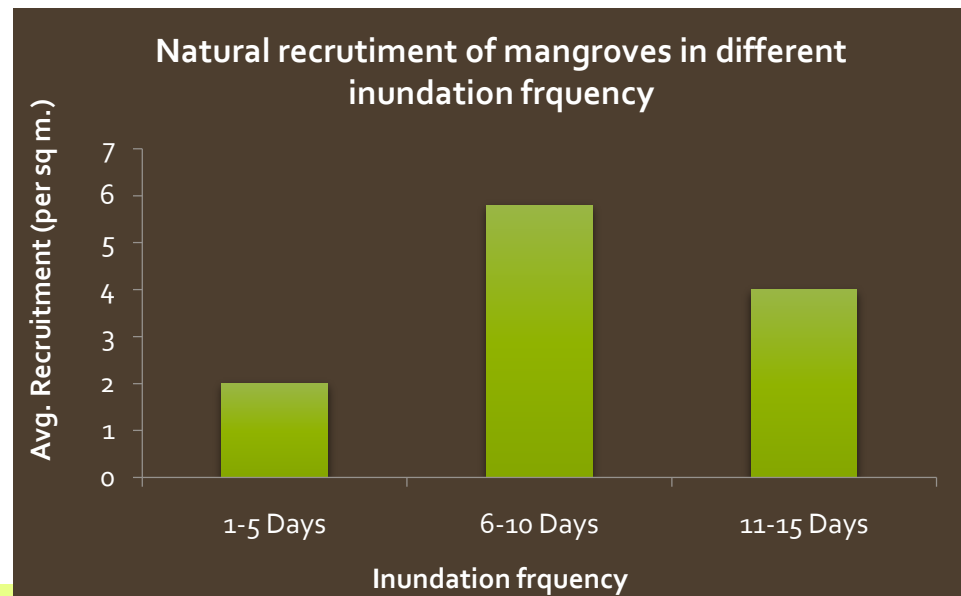
Substrata and inundation conditions preferred by mangroves of Gujarat is documented

Natural Recruitment of mangrove forests in different Inundation conditions



- **4 hours** per day -most suitable inundation duration for natural regeneration of mangrove.
- Any further increase in inundation duration results in a decrease in natural regeneration of mangroves.

- **6-10 days** (out of 15 day tidal cycle) most favorable for natural regeneration of mangroves.



Carbon sequestration by mangroves of Gujarat

Total carbon sequestered in mangrove forests (million ton)					
Zones	Particulars	Dense	Moderate	Sparse	All density classes
Kachchh	Soils	1.179	0.430	0.440	2.049
	Plants	1.180	0.344	0.220	1.744
	Total	2.360	0.774	0.660	3.793
Gulf of Kachchh	Soils	0.912	0.250	0.066	1.229
	Plants	0.190	0.021	0.005	0.215
	Total	1.102	0.271	0.071	1.443
Saurashtra	Soils	0.207	0.045	0.010	0.262
	Plants	0.023	0.003	0.001	0.026
	Total	0.230	0.048	0.010	0.288
South Gujarat	Soils	1.709	NA	0.626	2.335
	Plants	0.228	NA	0.029	0.257
	Total	1.937	0.000	0.655	2.592
All zones	Soils	4.008	0.725	1.141	5.874
	Plants	1.621	0.367	0.254	2.242
	Total	5.629	1.092	1.395	8.116

Of the total carbon sequestered by mangroves, 72% is by mangrove soil and 28% by mangrove plants

Mangrove cover vs. Carbon sequestration by mangrove regions

Mangrove Region	% Distribution of			
	Mangrove cover	Carb. Seq. by mangrove plants	Carb. Seq. by mangrove soil	Carb. Seq. Mangrove forests
Kachchh	73.53	77.79	34.88	46.73
Gulf of Kachchh	15.22	9.59	20.92	17.78
Saurashtra	0.19	1.16	4.46	3.55
South Gujarat	11.06	11.46	39.75	31.94

South Gujarat with about 11% of total mangrove cover has stored 32% of the total carbon sequestered in the mangrove of the state

Need of Systematic approach

1. **Better coordination** amongst agencies to avoid duplication and conflict
2. **Better planning for uniformity in technical** implementation such as choice of species, area treatment etc.
3. Improving **physical monitoring**
4. Combining **mangroves and mangrove associates** for better diversity in the line of natural zoning pattern
5. **Permanent identity** to each mangrove potential area

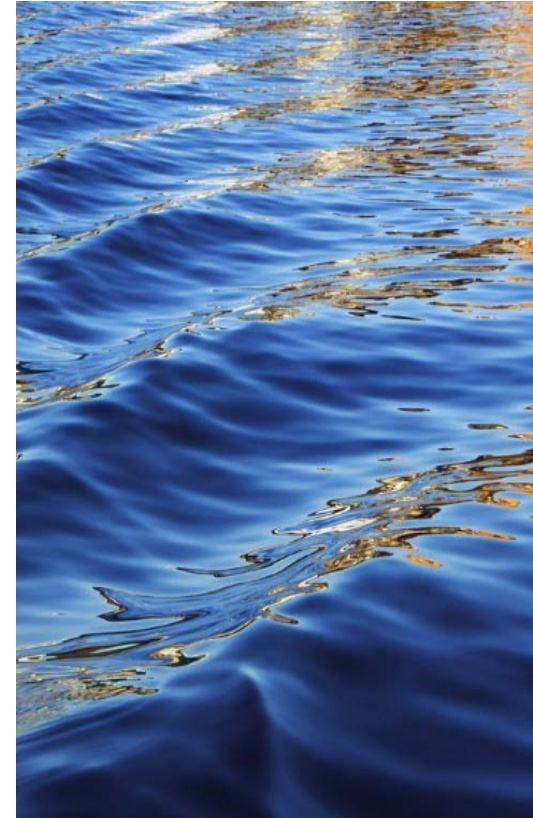
It has led to development of Mangrove Conservation Action Plan for the State

Mangrove Conservation Action Plan

Major activities

- **Identification and demarcation** of suitable areas for mangrove habitat development
- **Categorization** of such areas based on soil and inundation conditions
- Development of **monitoring system**
- **Ecosystem approach** (incorporation of mangrove associates)
- **Prioritization** of potential areas based on vulnerability against anthropogenic & natural pressures
- **Coordination** among different agencies

Led to Potential area mapping of coastal mudflats of the State



Potential Area Mapping of Gujarat

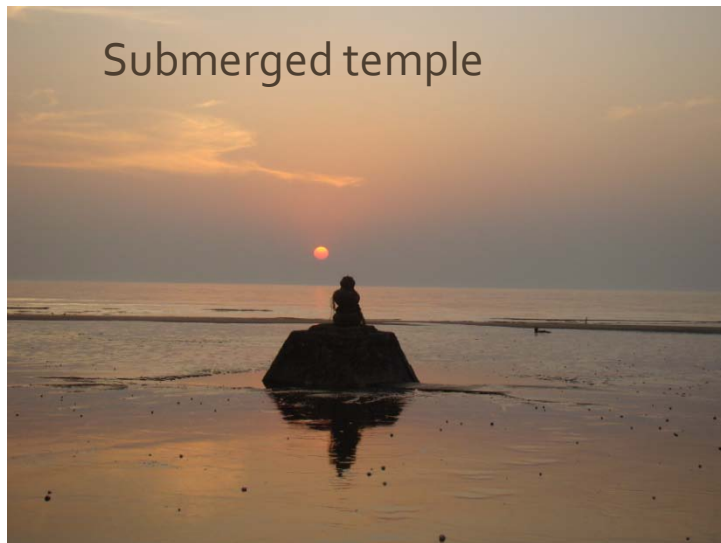
Development of Potential area maps of the state in phased manner

1. South Gujarat - Completed
2. Kachchh - Ongoing
3. Gulf of Kachchh - to be started after completion of Kachchh
4. Saurashtra - to be started after completion of Gulf of Kachchh

Criterion for selection of South Gujarat

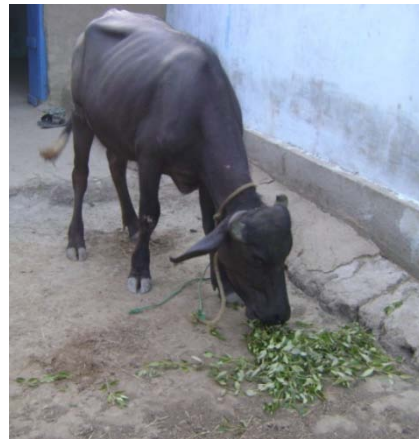
- Better fresh water inflow
- Maximum floristic diversity
- Direct dependence of community on mangrove habitats
- Involvement of local community in mangrove conservation is feasible
- Need for conservation of fragmented mangrove patches by development of mangrove habitats wherever possible
- Coastal erosion is alarming
- Many estuarine areas available
- Recently surveyed under the IUCN-MFF project

Coastal erosion in South Gujarat



Coastal erosion is very high in South Gujarat

Dependence of local communities coastal habitats of South Gujarat



Approach...

- Need for **conservation of fragmented mangrove** patches by development of contiguous mangrove habitats wherever possible
- **Alarming coastal erosion** needs to be addressed
- Many **estuarine areas available** indicating availability of suitable areas
- Recently surveyed under the IUCN-MFF project
- **Direct dependence of community on mangrove** habitats so involvement of local community in mangrove conservation is feasible

Approach...

Identification of mud flats using IRS LISS III

Developing enlarged map for each identified mudflat for ground verification. Collaborating ground details with google images

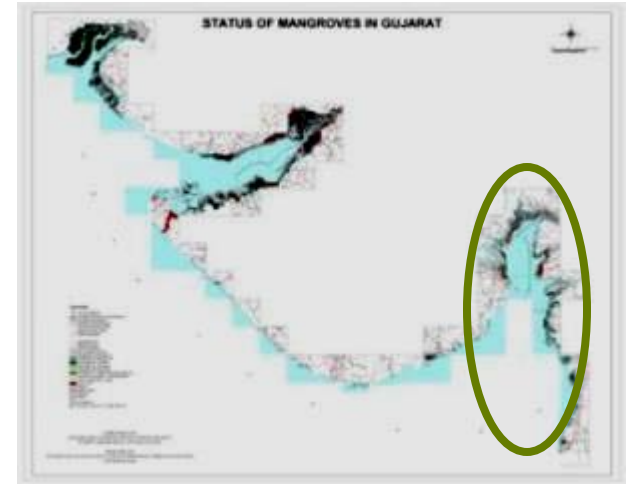
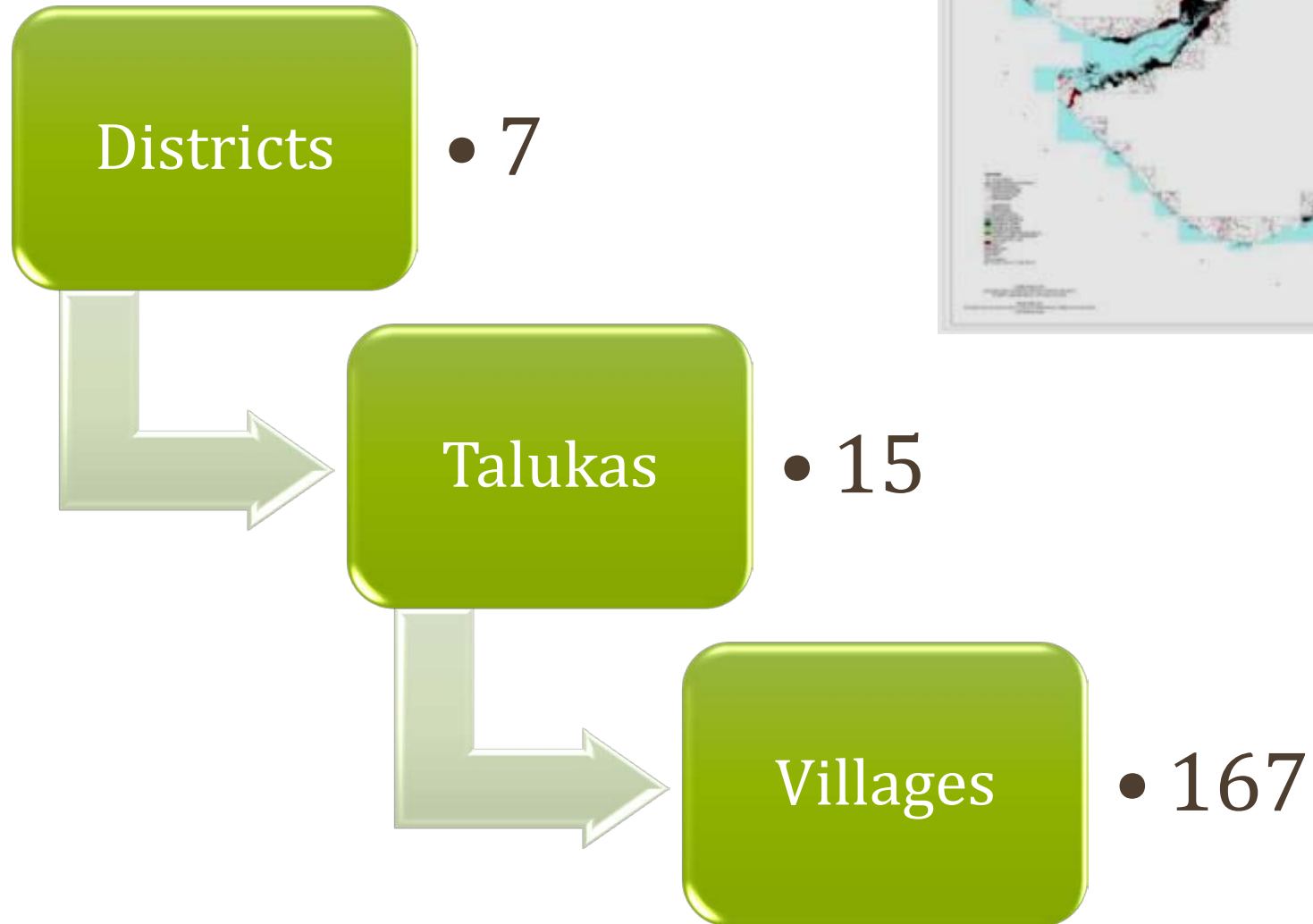
Ground truthing and collection of ground/local information

Zonation based on ground informations- Zones A, B and C and preparation of treatment map/plan for each zone

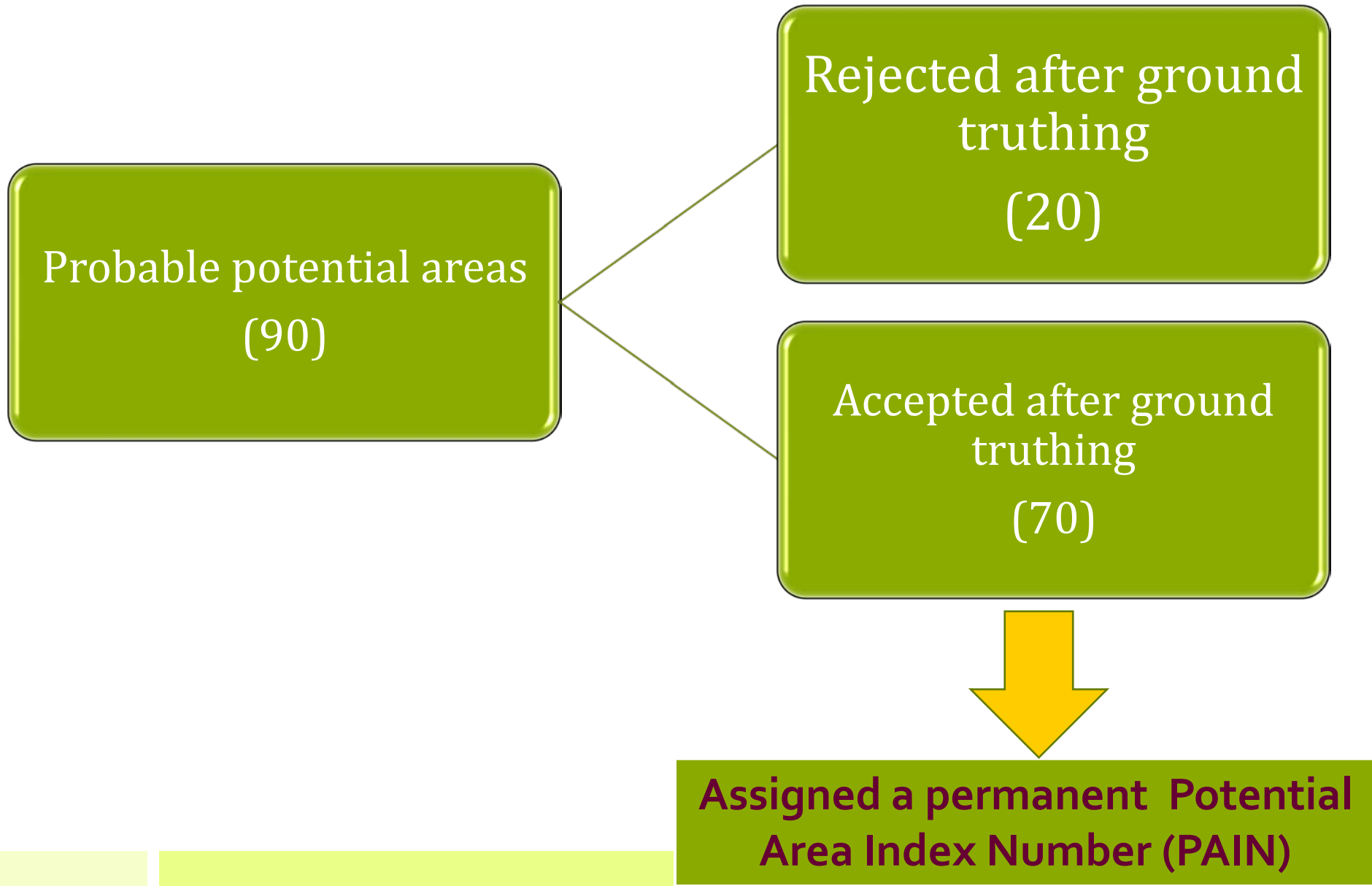
Prioritization of each potential area based on their vulnerability against natural and anthropogenic pressures

Area Covered

➤ Coastal area from Valsad to Bhavnagar



Finalising potential areas after ground truthing



Total no. of probable and actually available potential areas of South Gujarat

District	No. of Probable coastal areas (of more than 100ha)	No. of Potential Area available after GT
Valsad	12	6
Navsari	16	9
Surat	14	11
Bharuch	19	16
Anand	8	8
Ahmedabad	11	9
Bhavnagar	10	11
Total No.	90	70

Each potential area was divided into three types

Type A:

- Direct mangrove plantation is possible without any land treatment.
- These areas receives more than 6 days out of 15 days tidal cycle.
- Substratum – soft clayey and the salinity is low.
- Located generally located near/along the creeks.

Type B

- Mangrove plantation is possible after land treatment
- They receive inundation 4-6 days out of 15 days tidal cycle.
- Substratum is relatively harder.
- They have creeks in the nearby areas.

Type C

- Mangrove plantation is not possible because these areas are elevated and do not receive regular tidal waters (0 to 3 days of 15 day cycle).
- Substratum – harder.
- Mangrove associates many be planted in such areas.

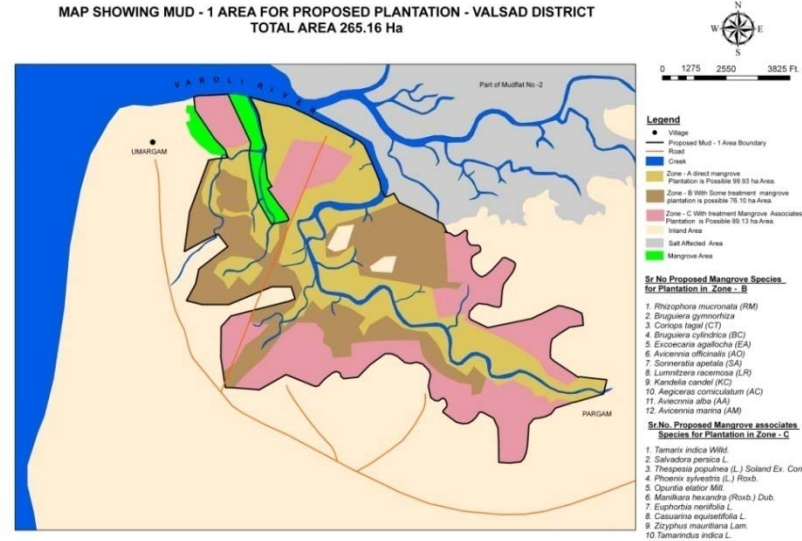
Results-District wise details of Potential areas

Districts	Potential Area (ha) in different zones			
	A	B	C	Total
Valsad	785.61	705.18	153.40	1644.19
Navsari	490.96	4833.88	2980.65	8305.49
Surat	1512.94	4489.81	567.69	6570.44
Bharuch	8410.04	5895.29	879.66	15184.99
Anand	4283.00	9976.50	3591.49	17850.99
Ahmedabad	756.59	7310.06	12827.97	20894.62
Bhavnagar	4541.92	5526.28	541.22	10609.42
Total	20781.06	38737.00	21542.08	81060.14

Total mangrove cover of state -1058 sq km.
Identified more than 810 sq km area available for mangrove afforestation
spread over seven coastal districts

Information provided in the final map for each Potential Area (PA)

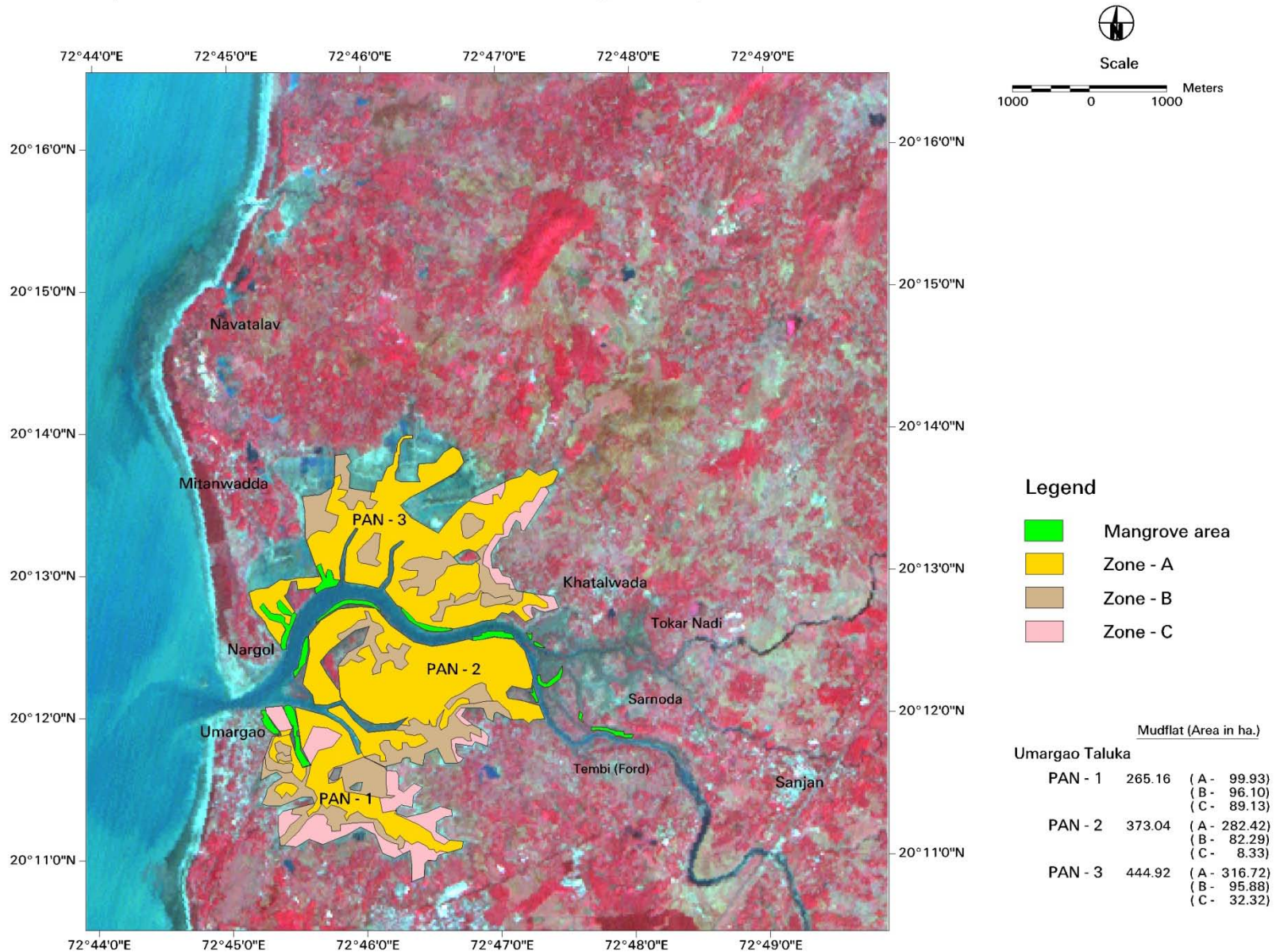
- Its location viz. Nearby village with GPS points
- Nearest approach road/route/landmark
- Total available area
- Its categorization into different categories viz. A, B and C
 - Area available under category A, B and C
- Inundation condition viz. No. of creeks
- Proposed species for plantation in different category of land
- Nearby mangrove habitat, if any



Developed treatment plan for every potential area with recommendation about plantation model and plant species

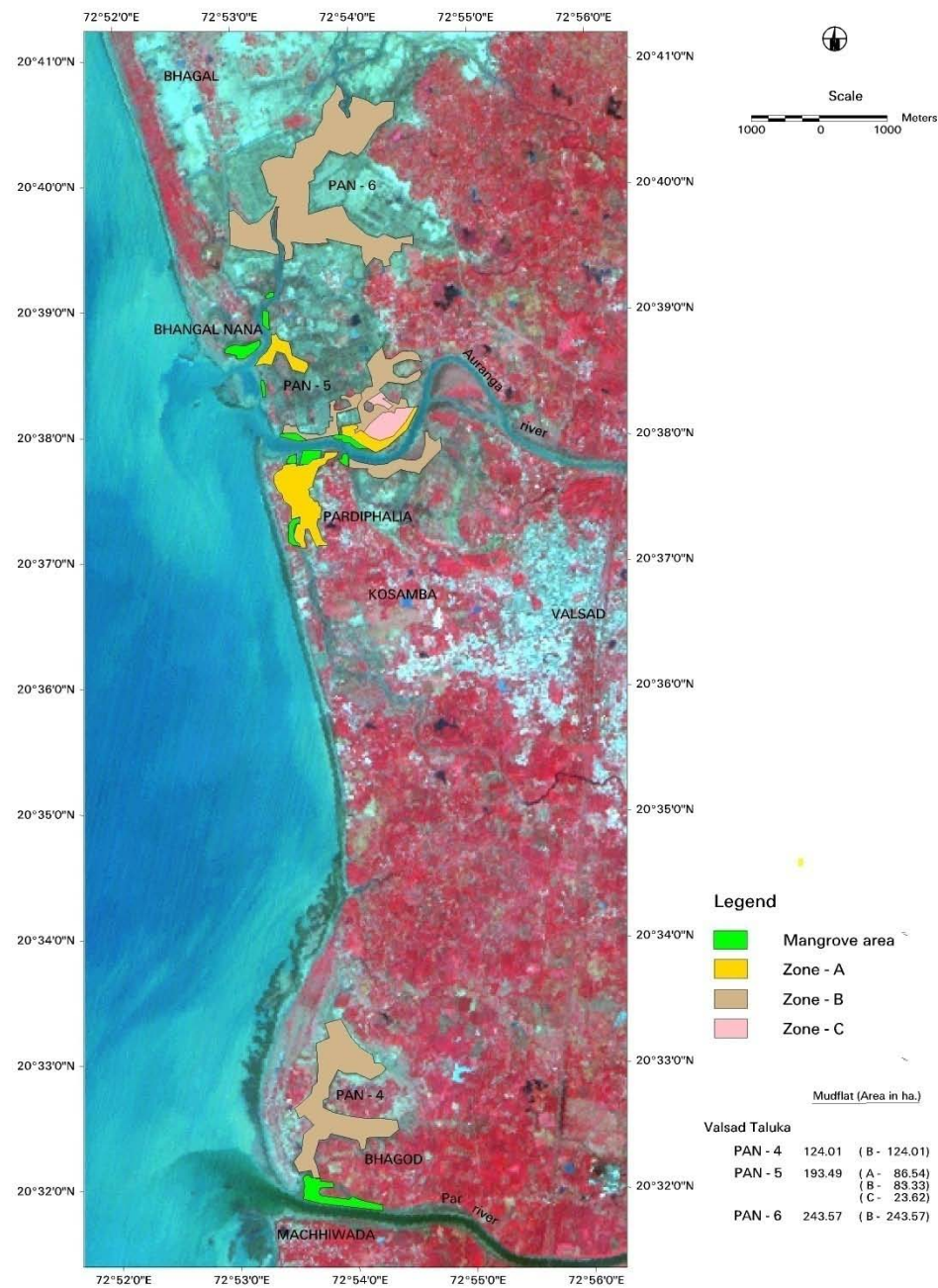
Distribution of potential area over the inter tidal areas

Map No. - 1 Potential area for Mangrove, part of Valsad District



Cont...

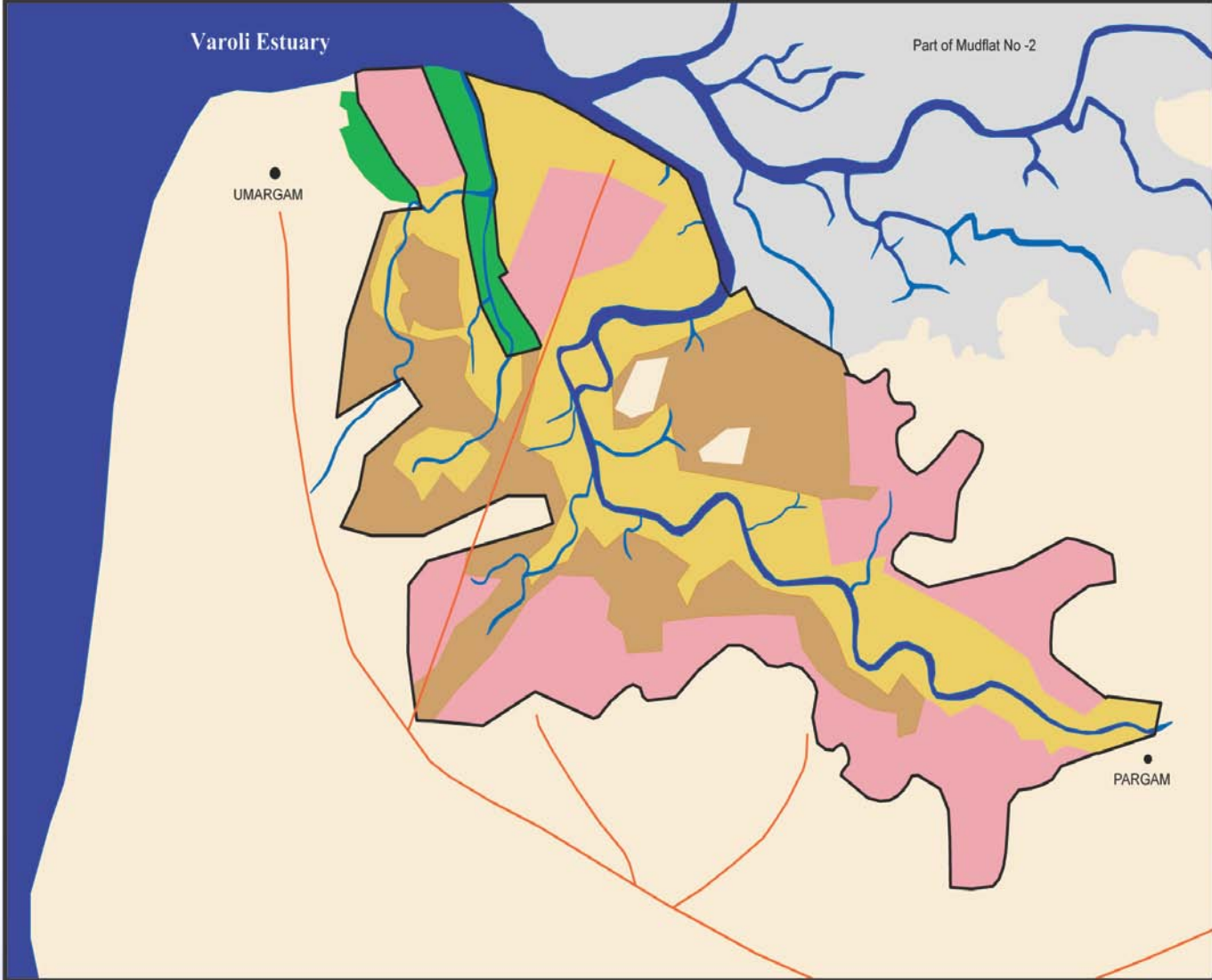
Map No - 2 Potential area for Mangrove, part of Valsad District



Detailed maps of a few Potential Areas

Potential Area Index No.(PAIN): 1

Valsad District

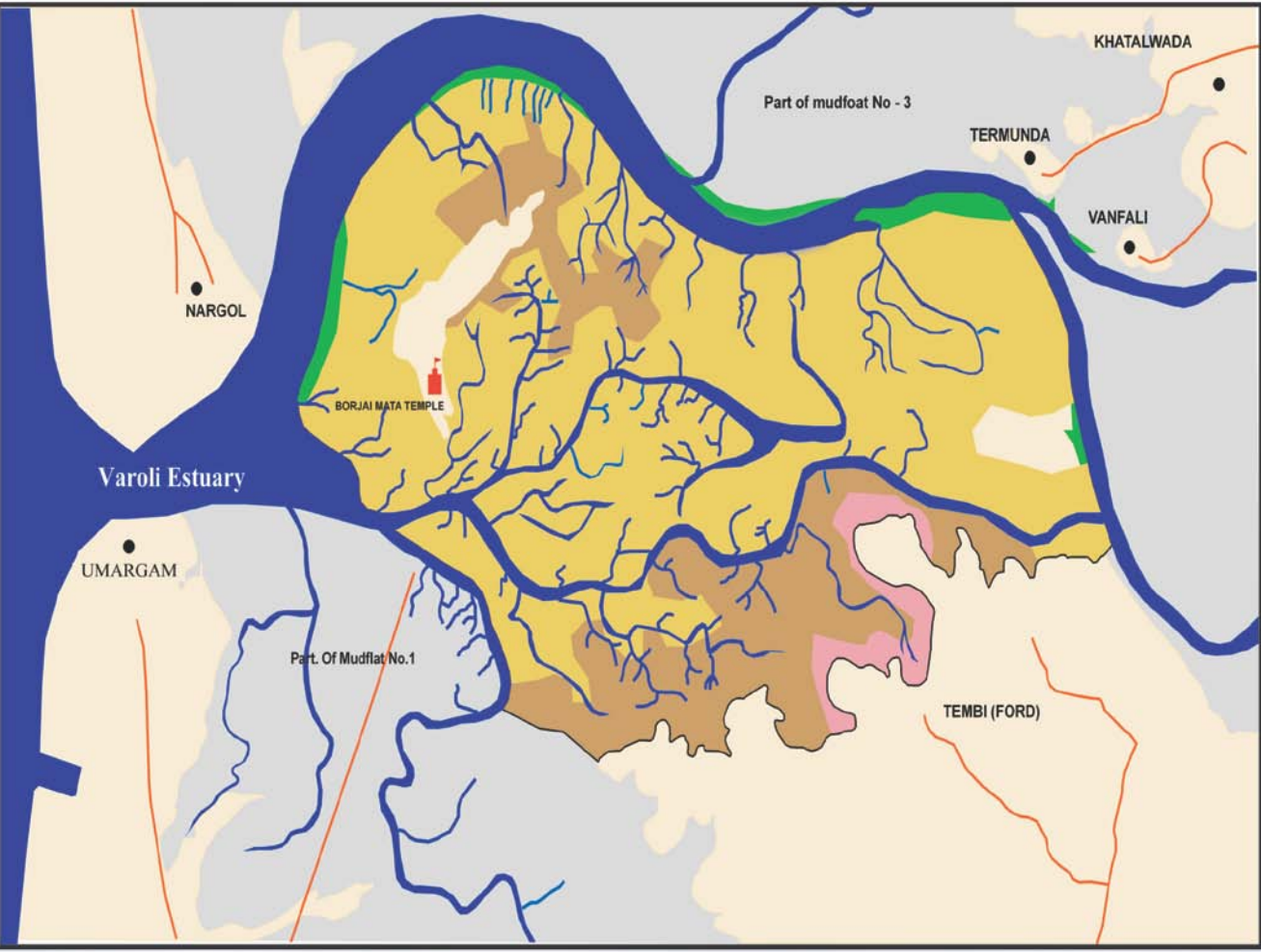


Legends

- Village/s
- Potential Area Boundary
- Road/s
- Creek/Water Body
- Zone A - 99.93 ha
- Zone B - 76.10 ha
- Zone C - 89.13 ha
- Non Potential Area/Human habitation/s
- Another Potential Area
- Mangrove Area

Potential Area Index No.(PAIN): 2

Valsad District

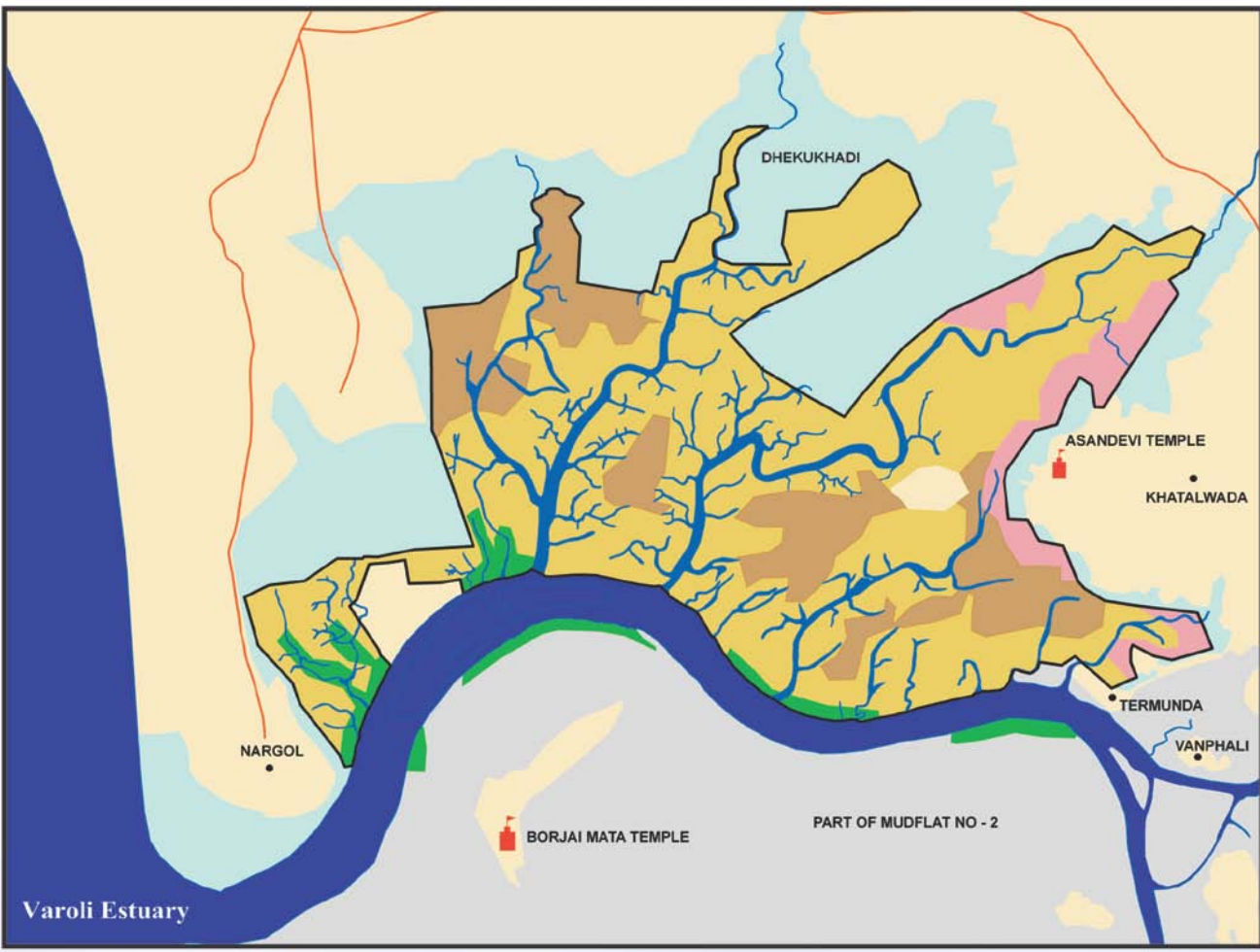


Legends

- Village/s
- Potential Area Boundary
- Road/s
- █ Creek/Water Body
- █ Zone A - 282.42 ha
- █ Zone B - 82.29 ha
- █ Zone C - 8.33 ha
- █ Non Potential Area/Human habitation/s
- █ Another Potential Area
- █ Mangrove Area

Potential Area Index No.(PAIN): 3

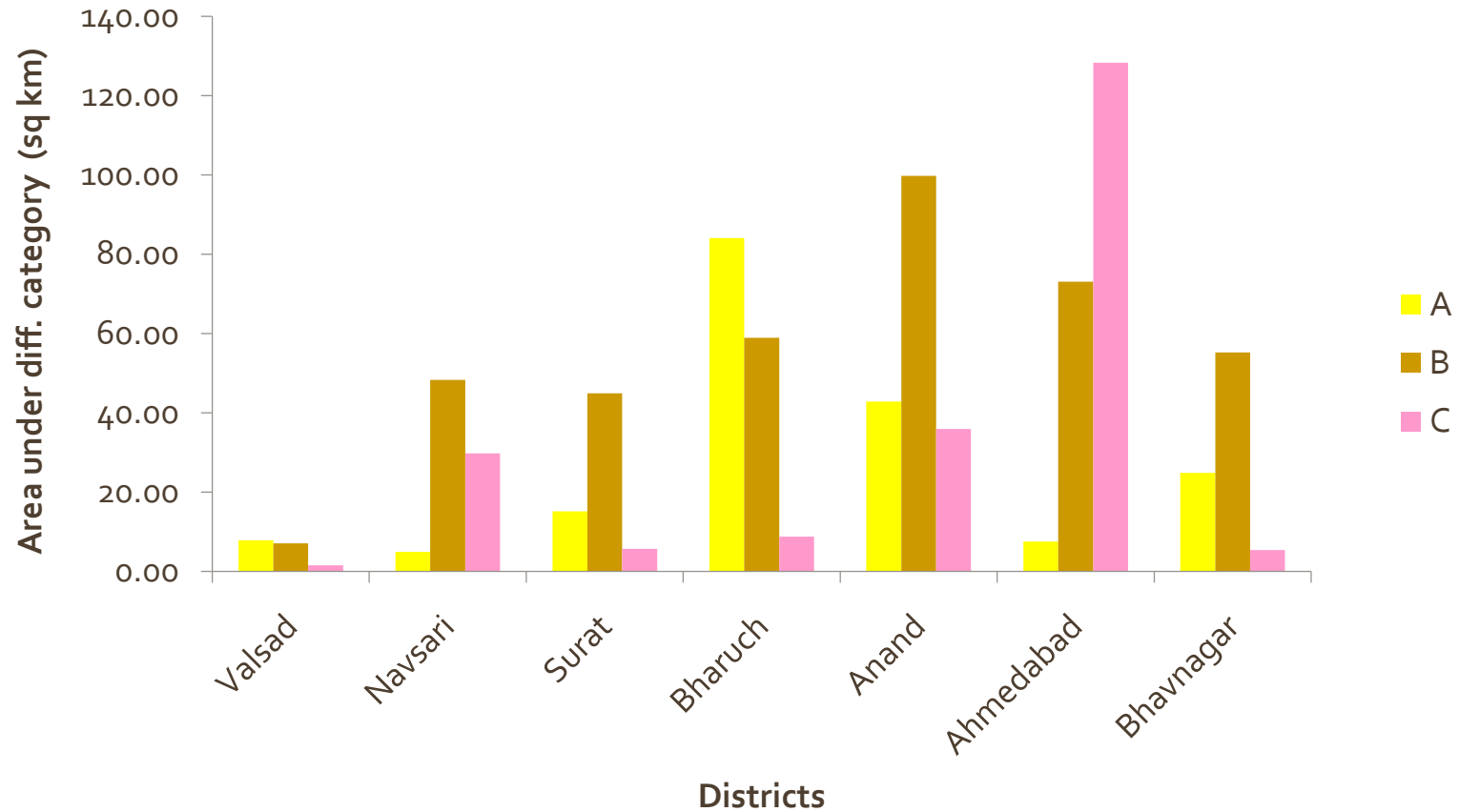
Valsad District



Legends

- Village/s
- Potential Area Boundary
- Road/s
- Creek/Water Body
- Zone A - 316.72 ha
- Zone B - 95.88 ha
- Zone C - 32.32 ha
- Non Potential Area/Human habitation/s
- Another Potential Area
- Mangrove Area
- Salt Affected Area

Total Potential area (sq km) of South Gujarat



Vulnerability assessment of the Potential Areas

- Anthropogenic pressures assessed in terms of **illicit tree felling, grazing, sand mining & pollution**
- Natural pressures assessed in terms of **susceptibility against soil erosion, proximity with the sea front, non availability of biological or mechanical shield**
- The opinions of local community and field staff also sought while deciding the vulnerability category for each potential area.

Districts	Total no. of potential areas	No. of potential areas vulnerable against					
		Anthropogenic pressures			Natural pressures		
		Most	Moderate	Least	Most	Moderate	Least
Valsad	6	1	3	2	Nil	Nil	6
Navsari	9	6	3	Nil	5	Nil	4
Surat	11	4	3	4	5	Nil	6
Bharuch	16	4	6	6	14	Nil	2
Anand	8	Nil	1	7	2	Nil	6
Ahmedabad	9	4	2	3	1	Nil	8
Bhavnagar	11	8	Nil	3	11	Nil	Nil

Information dissemination

- Presented to
 - The Government
 - Senior officials at head office
 - Divisional Staff
- Orientation of Division field staff about the plantation methods, selection of species etc.
- Shared the information with other agencies working in the same field

Major Achievements

- ***GREEN India Mission*** - Central Government - selected Potential Areas of One Districts (Bharuch) for mangrove habitat development
 - ***Only*** mangrove habitat development project selected under this scheme in the country
- One more proposal is being developed for funding under ***Green India Mission***
- Specific PAINs are being allotted for mangrove habitat development to various territorial Division of the state
- The information is being used by other agencies involved in mangrove plantations

Managerial benefits

- Monitoring of plantation works will be easy
- Chances of duplication of work will be less
- Chances of survival of plantations will be more
- Incorporation of suitable mangrove associates with mangrove species will enhance the biodiversity and in turn the function of ecosystem
- Prioritization of Potential areas against natural and anthropogenic pressures will be helpful in selection of area for plantation
- Selection of area as per the availability of budget is possible

Ecosystem approach is being used for conservation of mangrove ecosystem

Scope of involvement of local communities

Involvement of local community in the mangrove habitat development

- Human settlements are very close to mangrove areas and mudflats
- Direct dependence on mangrove habitats for fodder, grass and fuel wood is very high
- Local fisherman community belief mangrove positively influence the fish catch
- Easy to motivate and involve local community for mangrove habitat development
- Promotion of eco-tourism based on mangrove habitats

PPP mode is being promoted for mangrove plantation

