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POTENTIAL SITE SELECTION FOR MANGROVE PLANTATION ALONG THE KACHCHH DISTRICT, GUJARAT, INDIA USING REMOTE SENSING AND GIS TECHNIQUES

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ABSTRACT

The awareness of mangroves restoration and plantation has increased worldwide. Hence, identify suitable sites for the mangrove plantation is the foremost task of coastal zone manager. The aim of present study is to identify suitable sites for mangrove plantation along the Kachchh coast, Gujarat, India. Four variables, namely (a) coastal land use and land cover, (b) coastal geomorphology, (c) significant wave height, (d) mean tidal ranges were analyzed to find out the suitable mangrove plantation sites. The study found that the coastal segment which was the most suitable mangrove plantation sites in between Tahera village in Lakpat taluk to Sindhodi Mot in Abadasa taluk, because it was sheltered coast and less wave action, moderate tidal range and existence of creeks mangroves. The total mudflat of Kachchh district was 2168.2 sq. km out of which Kori creek region was 1144.49 sq. km i.e. 52.79 % of the total mudflats area. Kori creek region recorded highest area of inter-tidal mudflats (970.55 sq. km). Lowest area of inter-tidal mudflats is found on Mandvi taluk which is 13.09 sq. km of the total inter-tidal mudflats areas.

Keys Words: *Mangroves, Land Use and Land Cover, Geomorphology, Tide, Wave*

INTRODUCTION

The restoration and plantation of mangroves have received a lot of attention worldwide. The awareness regarding the ecological and economic importance of mangroves has grown through the years. As a result, numerous countries are engaged to restore this valuable resource, as reflected by an increasing number of publications and workshops dedicated to this subject (e.g. Khemmark, 1995; Field, 1996). The coastline of Gujarat is about 1600 km (GOI, 1985) which is the longest coastline of India and Kachchh district is the largest district (<http://www.census2011.co.in>) and longest coastline among the coastal district of Gujarat. Gujarat has the second largest mangrove cover (1046 sq. km) of the country (4639 sq. km) (FSI, 2009). The mangrove cover of the state is distributed over four regions viz. Kori creeks (74.1%), Gulf of Kachchh (15.2%), Saurashtra (10.1%) and South Gujarat (0.6%), covering 11 coastal districts, is unevenly distributed over these four regions (FSI, 2009). There are a substantial number of plantation and restoration projects in Gujarat in which mangroves are planted on intertidal mudflats. Over 130 sq km of inter-tidal mudflats has been afforested by the Gujarat Forest department from first five year plan till year 1998-99 (Singh, 2004). Gujarat's environment and forests department are aiming to bring an additional area of 120 sq km along the state's coastline under mangrove cover by the end of the financial year 2011-12 (The Hindu, 2011). This will increase the mangrove cover in Gujarat from the present 1,080 sq km to 1,200 sq. km.

In the above context, mangrove plantation is taking a great attention in Gujarat. It is very difficult to generalize about the selection of a planting site as it will depend on local conditions and the mangrove species to be planted. The planting of mangrove cannot be done in every blank spot or empty mudflats. The successful of afforestation of mangroves is mainly dependent on where the plantation would be done. So, the suitable site selection for mangroves plantation is very crucial. The objectives for mangrove plantation programmed vary widely from case to case, including for commercial forestry purposes, restoring fisheries habitat, shoreline protection, sustainable multiple community use purposes and ecological restoration (Field, 1996). Irrespective of the objectives, for site selection of mangrove plantation, a numerous site characteristics should be considered including the stability of the site, rate of

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siltation, soil characteristics, degree of exposure to waves and tidal currents, amplitude of tidal inundation, height of water table, the availability of freshwater, presence of pests, availability of propagules, signs of natural regeneration etc. (Field, 1996). The aim of the present work is to identify suitable sites for mangroves plantation along the Kachchh coast using remote sensing and geographical information system (GIS) techniques.

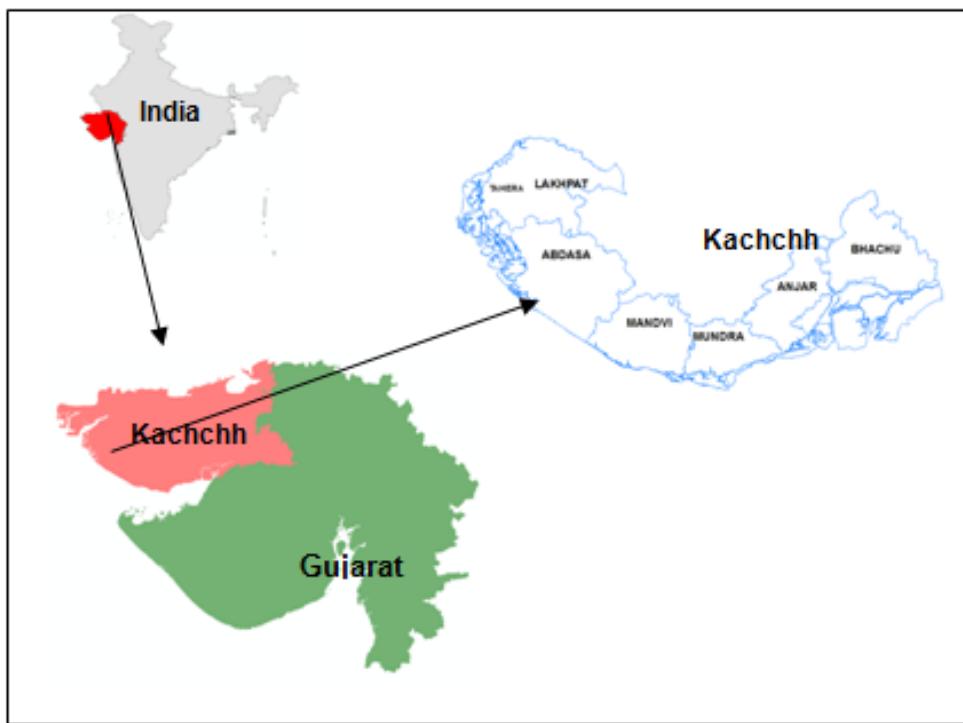


Figure 1: Shows the study area

Study Areas

The geographical location of Kachchh district (figure 1) is between $22^{\circ}44'08''$ to $24^{\circ}41'30''$ N and $68^{\circ}7'23''$ to $71^{\circ}04'45''$ E and it is surrounded by the Arabian Sea in the west, the Gulf of Kachchh in south and southeast, Greater Rann of Kachchh in north and Little Rann of Kachchh in northeast. Kori creek lies in between the north-western edge of the Kachchh district and the border with Pakistan. Kachchh falls in the arid zone and has a tropical monsoon climate. The average maximum (summer) and minimum (winter) temperature is 39°C to 45°C and 4.6°C respectively. All along the coast of Kachchh district, very few rivers drain into the Gulf and they carry only a small quantity of freshwater (except during monsoon). The rivers of kachchh like the Khari, Madh, tera, Rudramata etc are short in length. The average annual rainfall is 626 mm and the evapo-transpiration rate per year is 2.25meter (www.cspc.org.in). The district is also famous for ecologically important Banni grasslands with their seasonal marshy wetlands which form the outer belt of the Rann of Kutch. According to the 2011 census Kutch District has a population of 2,090,313. (<http://www.census2011.co.in/district.php>). There are seven coastal taluk in the Kachchh district namely Lakhpat, Rapar, Bhachau, Anjar, Abdasa, Mandvi and Mundra. The present study covered six coastal taluk (except Rapar) and Kori creeks regions.

MATERIALS AND METHODS

The main tasks for evaluation mangrove plantation site are emphasized on choosing several parameters that suitable for mangroves plantation. The parameters selected for the present study were coastal land use and land cover, coastal geomorphology, significant wave height (m) and mean tidal range (m). Coastal

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land use and land cover maps (figure 3B) on 1: 25000 scales for the period of 2004-06 were prepared from IRS Resourcesat-1 LISS-IV data by visual image interpretation techniques. The study considered that the inter-tidal mudflats are the potential area for mangrove plantation but some of them will not be suitable. Inter-tidal mudflats of the study area were extracted from the land use land cover maps. The coastal geomorphologic feature desirable for the growth and regeneration of mangroves are coastal mudflats of estuaries, creeks, deltas etc. Coastal geomorphology map for the period of 2005 (figure 3C) on 1:50,000 scale was collected from National Natural Resource Management System (NNRMS) database and was analyzed. Mean tidal range and significant wave height data are critical factors in determining the survival of propagules and seedlings. These parameters also guides to luxurious growth and area extent of mangroves. Mudflats which were frequently inundated and protected from tidal action were found to facilitate growth and survival of mangrove transplants (Deshmukh and Karmakar, 1990). Mean tidal range (figure 3D) data was collected from the predicted tidal elevation along the Gujarat coast for the year 2006 using MIKE –CMAP model and it was analyzed. Significant wave height data (figure 3E) were collected from output of Spectral Wave (SW) model of MIKE-21 software. The methodology is shown in figure 2. The GIS software used in this study was Arc Map 9.1. Based on coastal configuration the entire Kachchh coast has been classified into different segments (figure 3A), each segment characterized coastal environment and put into GIS as a thematic layers. The suitable mangroves plantation site is identified by overlay analysis in GIS using inter-tidal mudflats and above the parameter attributes as thematic layers.

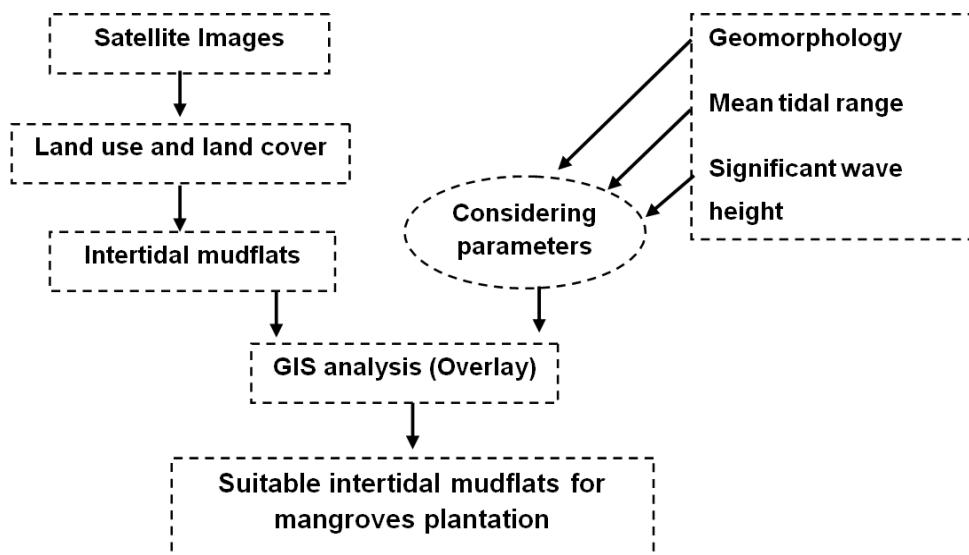


Figure 2: Shows the study methodology

Figure 3A Show the different segment of kachchh coast based on coastal configuration of the coast; Figure 3B show the land use and land cover map; Figure 3C show the geomorphology map; Figure3D show the station wise mean tidal range (M) and Figure3E show the station wise significant wave height (M) in the kachchh district

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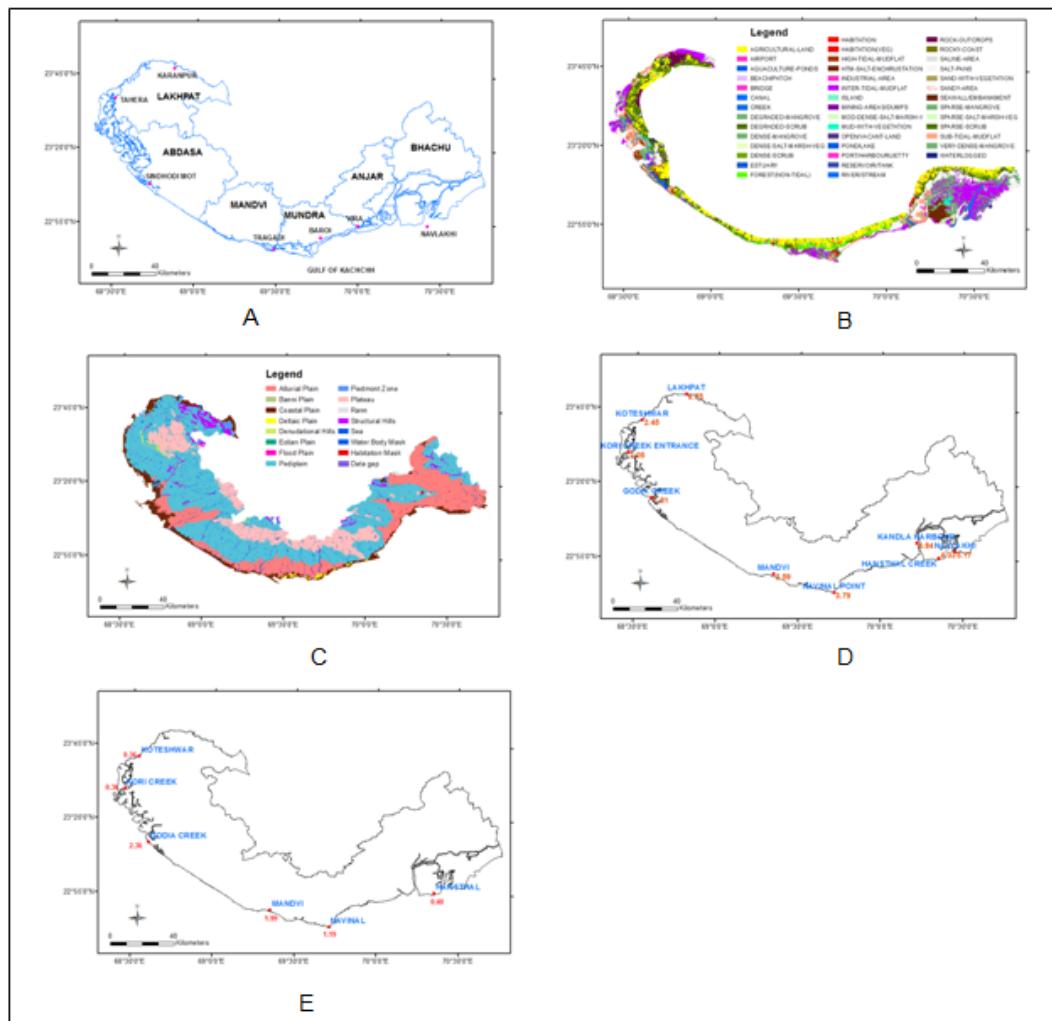


Figure 3A: Show the different segment of kachchh coast based on coastal configuration of the coast; **Figure 3B:** Show the land use and land cover map; **Figure 3C:** Show the geomorphology map; **Figure 3D:** show the station wise mean tidal range (M) and **Figure 3E:** show the station wise significant wave height (M) in the kachchh district

RESULTS AND DISCUSSION

The study found that the coastal segment which was most suitable mangrove plantation sites (figure4) in between Tahera village in Lakpat taluk to Sindhodi Mot in Abadasa taluk because it was sheltered coast and less wave action, moderate tidal range and turbidity and existence of creeks mangroves. The coastal segment between Tragadi to Vira was the second most suitable site for mangrove plantation because of moderate wave and tidal range and existence of creek mangroves. But the problem of this segment may be the water quality as there are many industries. The North West regions of Kachchh district (i.e., Kori creek region) had a large potential of mangrove plantation but it may not be suitable as it was inaccessible and high salinity guided by Indus river discharge fresh water supply. South east portion of the district near Kandla, Hanstal creeks there is large intertidal mudflat and sparse mangrove along the creeks and estuary but plantation may be restrict as high salinity often form salt incrustations and high tidal range. Inter-tidal mudflats area has large potential for mangrove plantation among the different classes of mudflats. Because the high tidal mudflats do not support any vegetation due to high salinity and high

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upper layer soil temperature during summer and sub-tidal mudflats, which get exposed only at the lowest of low tides, are not suitable for mangroves. Mud in this category of land is thin, loose and unstable too. After germination of seeds, root system does not remain stable. The taluk-wise distribution of mudflats classes are shown in table1. The total mudflat of Kachchh district is 1797.91 sq. km out of which Kori creek region had 774.2 sq. km i.e. 43.06 % of the total mudflats area

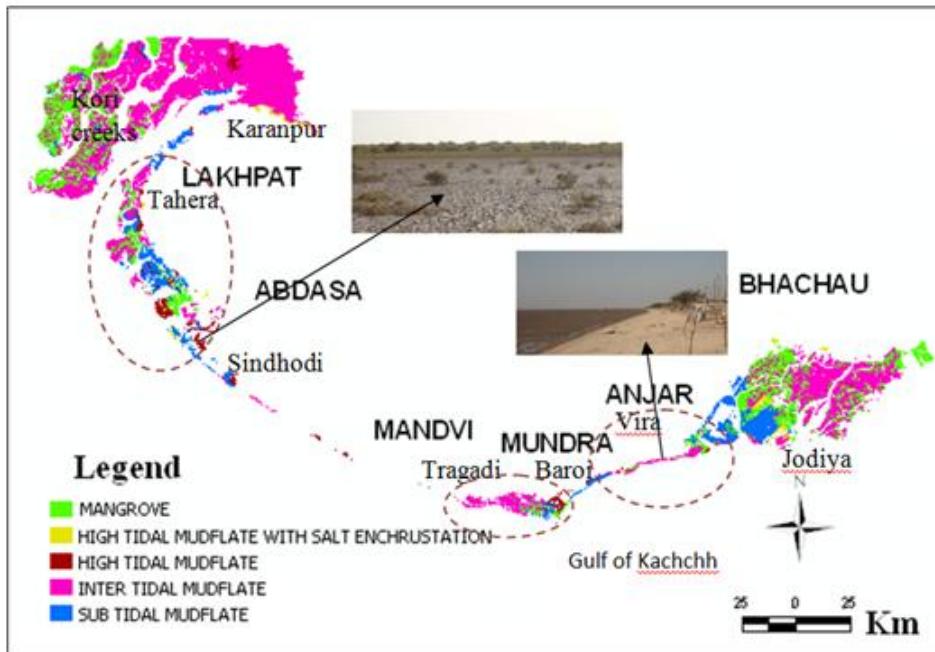


Figure 4: Shows the suitable sites for mangrove plantation along the study area

Table 1: Show the taluk-wise different classes of mudflats of the study area

Taluk Name	High-tidal Mudflat with salt incrustation area (sq km)	High-tidal mudflat area (sq km)	Inter-tidal Mudflats area (sq km)	Sub-tidal Mudflats area (sq km)	Total mudflats area (sq km)	% of total mudflats
Lakhpat	11.15	8.6	95.04	60.07	174.86	9.72
Abdasa	6.65	51.18	26.81	92.09	176.73	9.83
Mandvi		2.77	13.09	0.1	15.96	0.89
Mundra		18.05	58.14	23.25	99.44	5.53
Anjar		1.39	19.2	24.41	45	2.50
Bhachau	20.24	3.07	383.26	105.15	511.72	28.46
Kori Creeks	0.3	4.32	745.5	24.08	774.2	43.06
Total	38.34	89.38	1341.04	329.15	1797.91	
% of total mudflats	2.132476	4.971328	74.58883	18.30737		

Taluk which had the largest area of total mudflat is Bhachau which is 28.46 % of the total mudflats area. The lowest total mudflats area is found in Mandvi taluk which is 15.96 sq. km i.e. 0.89 % of the total mudflats area. The Kori creek region recorded highest area of inter-tidal mudflats (745.5 sq. km). Lowest

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area of inter-tidal mudflats is found in Mandvi taluk which is 13.09 sq. km of the total inter-tidal mudflats areas.

Conclusion

Mangroves plantation development is largely dependent not only the proper selection of site but also the selection of planting species and planting method. Kachchh district has a large inter-tidal mudflat which is the potential site for mangroves plantation but all these inter-tidal mudflats are not suitable. The purpose of this study was to provide a preliminary overview of the coastal segment which was suitable for mangroves plantation. The decision can be rapidly made to prevent initial planning of the area. The suitable sites for mangrove plantation are identified based on four variables: coastal land use and land cover, coastal geomorphology, mean tidal range and significant wave height. The significant variables leading to identify suitable plantation sites were land use and land cover and coastal geomorphology. The study suggested that number variables should be consider such as soil water, ground water and sea water salinity, soil pH etc for more accurate site selection. The study found that the major problems for mangrove plantation are high temperature and evapo-transpiration, low rainfall/ freshwater supply and high salinity. The study also demonstrates that the remote sensing derived variables and GIS techniques are highly useful for suitable site selection for mangroves plantation.

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