Published on: 1st May 2012

MONITORING THE IMPACT OF ANTHROPOGENIC ACTIVITIES ON THE COASTAL ECOSYSTEM USING REMOTE SENSING SATELLITE DATA

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ABSTRACT:

The Coastal Zone in most countries including India is under severe and increasing pressure due to rapid urbanization, pollution, tourism development, over exploitation of coastal resources (especially biological resources) and continued development in hazard prone areas. With development in economy and world trade, sea route is the most economical and viable for goods transport. In addition to population pressure, fishing, recreational activities, coast has become the dumping ground for sewage, various pollutants and hazardous materials. In such circumstances, it becomes of paramount importance to make judicious use of resources of coastal zone and make development in sustainable manner. Environmentally effective coastal zone management depends upon accurate and comprehensive scientific data on which policy decisions can be based. Scientific data on coastal wetlands/landform/land use, coastal processes and water quality of near shore waters is needed. Remote sensing data because of its repetitive, multispectral and synoptic nature have proved to be extremely useful in providing information on various components of the coastal environment (Nayak 1977, Chauhan *et al.,* 2004b).

The Gujarat state is situated at the western part of India and having the largest shoreline of about 1600 km in all maritime states. The shoreline of the Gulf of Kachchh (the study-area for the present exercise) is marked by extensive mudflats and is highly indented with a number of cliff and rocky islands. At many places coral reefs can be observed. This area also produces salt at very large scale. In absence of many riverine systems, fluvial discharge is very negligible and mainly dominated by the marine processes. In the wake of developmental activities, this ecosystem has certain impact on it. To observe this impact, remote sensing data spanning 20 years (1980 to current), were used. Landuse maps of these areas were prepared using these data and change in various categories like, mangroves, corals; mudflats were measured to find out the impact of various anthropogenic activities. It was observed that mangroves have reduced and coral reef has got degraded in this region during the span of the present study. Large stretches of mudflats have also been converted for industrial infrastructure development. The result of the present study show that Remote sensing data along with GIS should be used for the monitoring of

developmental activities so that they can be done in sustainable manner with minimum impact on coastal ecosystems.

KEY WORD: *Coastal Zone, Ecosystem, Anthropogenic Activities, Mangrove, Coral reef.*

INTRODUCTION:

Coastal Zone is the interface delineated between the land and sea water. It includes coastal waters, tidal wetlands and shore lands influenced by marine waters. Its components can include river deltas, coastal plains, wetlands, beaches and dunes, reefs, mangrove forests, lagoons and other coastal features. India has a long coastline of 7516.6 km including its island territories (GOI, 1985). It is a site of extraordinary release of natural energy. The coastal zone is important because it houses several economically important ecosystems like Mangroves, Coral Reefs, Sea weeds etc. Coastal Zone in India is receiving an increasing importance in view of its high productivity, rich ecosystem and its growing use (Nayak *et al.,* 1992). There is an intense pressure to develop coastal areas in view of dense population (Nayak *et al*., 1992). The Coastal Zone is under constant pressure and stress due to many bio-physical (cyclones, tsunamis, floods etc.) and socio-economic (industry development, recreational activities, sewage dumping etc.) activities. These activities leave a negative impact on the Coastal Ecosystems (Mangroves, Coral Reefs, etc.). Looking at the importance of the Coastal Zone and harm caused to it, the judicious use of resources of coastal zone and development in sustainable manner is highly appreciable. Scientific Data and Satellite Data together work out for the betterment of this zone resulting in country's all round growth.

Main objective of the present work was to study the major effects of the anthropogenic activities carried out on the highly fragile coastal zone. The anthropogenic activities carried out here, cause a major damage to the ecosystems like, mangroves, corals, sea weeds, etc. which, in natural form, protect us from tsunamis, cyclones, floods etc.

STUDY AREA:

The study area for the present work is the Gulf of Kutchh on the coast of Gujarat state in India. Gujarat is the state having the longest coastline in India. The Coastal Zone of Gujarat is divided into 4 parts *viz; Gulf of Kachchh, Saurashtra coast, Gulf of Khambhat and South Gujarat coast.* Out of these, the present study area - Gulf of Kachchh, occupies the major part of the coastal zone which lies between 22^{o} to 23^{o} N latitude and 69^{o} to 70^{o} E longitude. It is marked by extensive mudflats and is highly indented with a number of cliff and rocky islands. This coastal part also shows a major occupancy of coastal ecosystems like coral reefs and mangroves. Apart from this salt production is carried out on a large scale.

Our present area of interest *i.e* Gulf of Kachchh, has an extensive coast line which includes highly productive and biologically diverse ecosystems (mangroves, corals, sea weeds, etc.) that offer crucial

nursery habitats for many reasons. It is under constant pressure and severe change due to the major anthropogenic activities like Urbanization, Pollution, Tourism development, over exploitation of coastal resources (especially biological resources) and continued development in hazard prone areas.

METHODOLOGY:

Multispectral Data (LANDSAT TM, LISS III and Awifs) was used for the present study of monitoring the activities on coastal ecosystems. SOI topographic maps surveyed in the year 1965 of index numbers 41F7-6, 41F11 and 41F15 were used for the area selection. These topographic maps were geo referenced with the polynomial model, polyconic projection keeping the Spheroid and Datum as Everest. The RMS value was kept as low as 0.5. This geo referencing was carried out with the help of ERDAS software 9.0 package.

Similarly the satellite data of Landsat TM (dated 13th May 1991), LISS III data (dated 10th January 1999, 10th December 2000, 4th April 2001 and 1st October 2002) and Awifs data (dated 30th December 2006 and 7th March 2007) used for the present study were also geometrically corrected and geo referenced. All the digital data were geo corrected and geo referenced with the ERDAS software 9.0 packages keeping the RMS error below 0.5.

After proper geo referencing of the toposheets and digital data, the features on them were delineated according to the shape, size, colour, tone, texture. This is called the on line digitization of the images. Different vector polygons, which were created by the online digitization, were then classified according to the classification system. The SAC –ISRO, developed the classification system.

As the classification of the vector polygons were done, color coding was completed. Area calculation statistics was carried out lastly by the formula generated. The sum of the similar class values was then noted. These values were then multiplied by the constant (K) 0.0529 for the final results showing the total area in hectares.

RESULTS AND DISCUSSION:

The present study has shown very clear results in mapping of various coastal features like algal ridges, corals, mangroves, salt pans, as well as building structures, agriculture, habitation, etc. using remote sensing satellite data. The result shows that anthropogenic activities in the coastal area are changing the demography of the region. It was evident from the data calculations that there is change in the area of habitation and industry of the regions covered by toposheets 41 F7, 41 F11 and 41 F 15; and that, it is industrial development, which propels the habitation. Table 1 shows the overall area calculations of various coastal ecosystems and features as covered by toposheet 41 F15. As there is not much industrial activity in the area covered by 41 F7, the habitation change is very slow compared to the areas covered by 41 F11 and 41 F 15 (Fig.2). It is also observed that industrial development takes place, either on the

agricultural land or on mudflats. Also, after development of the industry, the ecology of the area gets disturbed. It can be observed in toposheet 41 F15 that the industrial area which was 3.9 hectares in 1966-67, steadily increased from about 44 hectares in 1999 to about 74 hectares in 2007. This may have led to tremendous anthropogenic pressure on the mangroves and other coastal ecosystems. The mangroves are seen to be either reduced or degraded. Very dense Mangroves have decreased from 16 hectares in 1966-67 to about 6hecteres in 2000 and degraded even further to 3 hectares in 2001. Only after the mangrove afforestation programme, they increased to 6 and 8 hectares in 2006 and 2007, respectively. The area of salt pans has increased over the entire period of mapping, showing considerable anthropogenic pressure. Also, other factors like, building of port/harbor/jetty, etc. have increased, thus adding to anthropogenic pressure on the mangroves and corals. The coral reef area has decreased drastically from about 21 hectares in 2001 to about 5.6 hectares in 2007.

CONCLUSION:

Remote sensing data helps to study and monitor various coastal features like, mangrove, coral, mudflats, etc. Landuse maps of these areas are prepared using these data and change in various categories like, mangrove, coral, are measured. This helps us to find out the impact of various anthropogenic activities on these fragile coastal ecosystems. Through the present study, it can be observed that mangroves have reduced and coral reef has got degraded in this region. Large stretches of mudflats have got converted for industries. Thus it can be concluded that Remote sensing data, along with GIS should be used for monitoring the developmental activities to be done in sustainable manner with minimum impact on coastal ecosystem. Not only that, remote sensing and GIS can help to identify places and spots for mangrove afforestation, salt pan formation and making industrial buildings so as to have judicious use of all natural resources.

ACKNOWLEDGEMENT

We express our sincerest thankfulness to Dr.B.K.Jain – Principal, M.G. Sc. Institute and the Ahmedabad Education Society, for their help and support throughout the work and always.

Our profound sense of gratitude to Dr.Ajai, Group Director, MESG, Space Applications Centre, for his encouragement, valuable counsel and constructive criticism throughout our work.

We are also thankful to Shri R.M.Dwivedi, Head, MCED, SAC, Ahmedabad, for providing all the necessary help during the work.

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Table: 1 Area-wise Comparison of various Coastal Ecosystems/ Features

Sr. No.	Classification	41 F 15 (Toposheet 1966-67)	L3 99	L3 2000	L3 2001	AWiFS 06	AWiFS 07
1	Agriculture	518.2814	90.51351	508.9608	489.4127	466.99	471.3584
2	Creek	0.314075	9.265362	15.09206	5.219849	6.60754	8.632087
3	Pond/Lake	0.130052	1.685549	1.568642	2.826088	0.596172	3.257197
4	Habitation	1.252664	2.095614	1.810376	3.596262	1.522053	
5	Industrial Area	3.903863	44.6446	46.78679	47.53769	72.44315	73.33462
6	Waste Dumping			0.76544	1.607739		
7	Salt Pans	10.62139	12.31586	12.60869	13.58569	14.53179	14.25673
8	Seawall/Embankment		0.115684	0.604523	0.357816		
9	Iner-tidal	5.128307	28.76867	14.01348	39.99146	17.32637	67.95436
10	High-tidal	33.88345	26.55127	28.6868	32.1198	17.86219	25.70678
11	Very dense mangrove	16.11065	2.561787	6.058283	3.181211	6.873453	8.446331
12	Dense Mangrove		3.286873	6.617269	10.18341	7.799238	1.629817
13	Sparse Mangrove		5.560155	0.644207	1.252931	2.531134	8.291485
14	Reservoir/tank	19.20709	11.09145	9.113861	9.010886	22.98456	12.13018
15	Pot/ Harbour/Jetty	0.209856	1.232406	1.350534	1.225376	1.925035	1.240732
16	Dense Algae		30.491		9.303897		9.249971
17	Fringing Coral Reef		18.24742		21.24526		5.661121
18	Algal ridge						2.263706

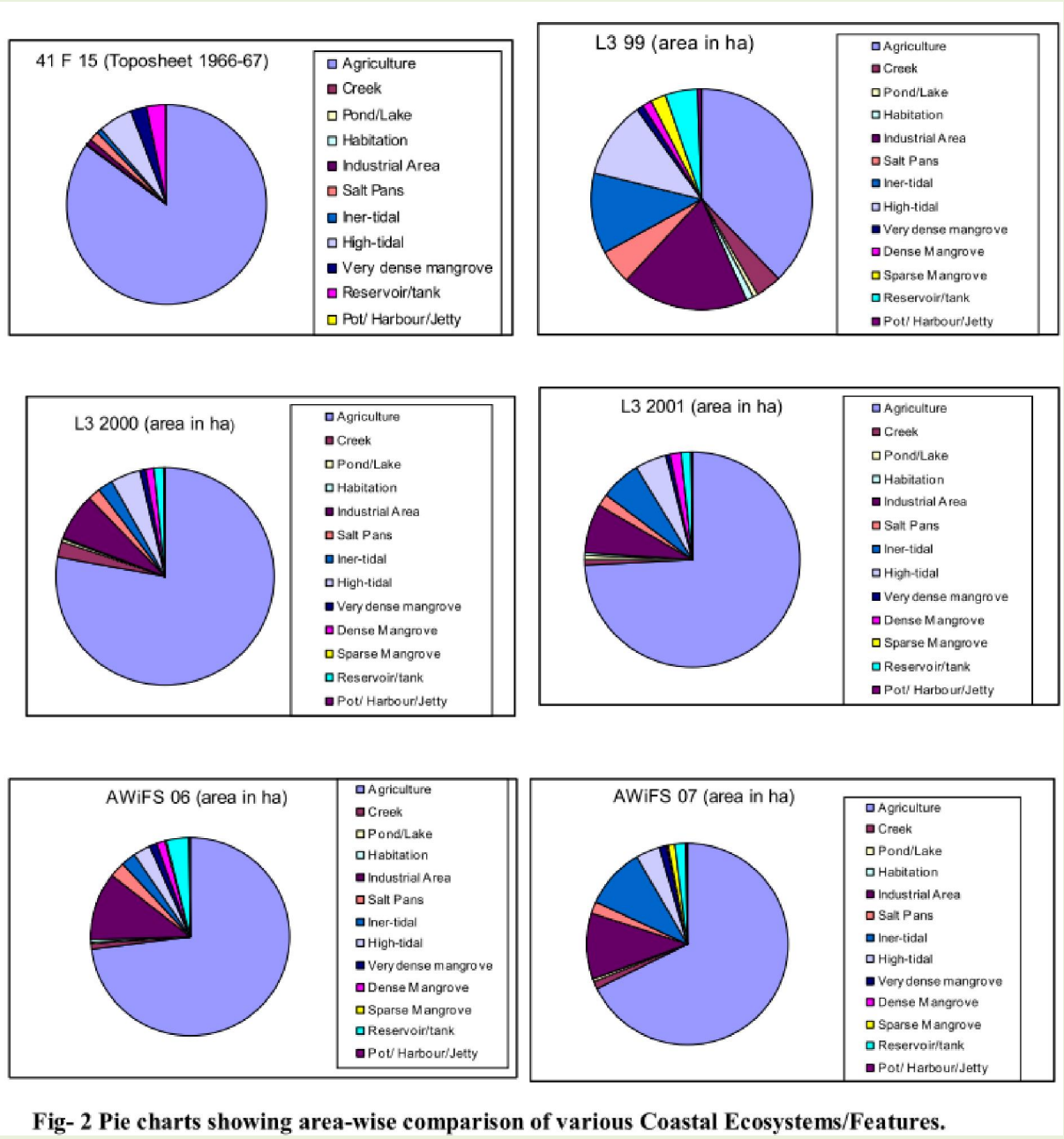

Fig- 2 Pie charts showing area-wise comparison of various Coastal Ecosystems/Features.