STUDY ON THE COASTAL VEGETATION AND LAND-USE CHANGES OF THE COASTAL TALUKAS OF BHARUCH DISTRICT

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Summary

Coasts are one of the most dynamic parts of the earth's surface. The coastal zone is a broad transitional area in which terrestrial environments influence marine environments and in which marine environments influence terrestrial environments (Carter, 1988). This mixture of the two different environments produces unique landforms and ecological systems. The coastal areas are rich with diverse species, habitat types, and nutrients and thus act as home to a wealth of natural resources (WRI, 2000). Besides this, coasts provide employment, recreation and tourism, waterborne commerce, energy and mineral production. Thus, it also sustains economic wealth. The prosperity of the coast has acted as a driving force for the migration of population to the coastal area (Bookman *et al.*, 1999). This has led to rapid urbanization and industrialization of coastal areas and resulting in tremendous pressure on the coastal ecosystems. Hence, scientific data on coastal wetlands, land use, landforms, shorelines and water quality are required periodically to ensure an environmentally effective coastal zone management practices.

A proper understanding of the land use and land cover of an area is first requirement for any planning activity. The term land use explains how the land is used while land cover referred to what covers the surface of the earth. The land use and land cover pattern of a region is the outcome of natural and socio-economic factors and their utilization by man in time and space. Land use planning is the result of a reasonable compromise between the environmental potential (measured in terms of the availability of natural resources) and the social demand (measured in terms of the requirements of goods and services by specific human communities). The change in land use / land cover is a major issue in global environment change and has become more significant along the coastal area and especially in rapidly developing countries of the world. Now a days, the major problem of changing land use is the irreversible transformations in the quality of resources, which limit future options for biodiversity conservation, arable agriculture and other land uses based on the natural resources (O'Connor and Kuyler, 2009). These changes in the land use and land cover have directly or indirectly affected biodiversity (Sala *et al.*, 2000), species richness (Kivinen *et al.*, 2007), primary productivity (Feng *et al.*, 2007), soil organic carbon (Yadav and Malanson 2008), soil erosion (Ni and Li 2003), hydrologic regimes (Shih, 1996; He *et al.*, 2008) and local as well as regional climate (Chase *et al.*, 2000).

A major impact of the change in land use is alteration in the composition of plant communities of an area (Ojima *et al.*, 1994). This is due to fragmentation of landscape, removal and introduction of species, change in nutrient cycles and water path-ways. These indirect changes in the vegetation composition may lead to extinction of many vulnerable species of flora and fauna of the coastal area (Davenport and Davenport, 2006). Thus, there is need of studying vegetation, making their inventory and conserving them either in in-vivo or in-vitro form. In coastal areas, the vegetation is represented by a characteristic group of plants which possess peculiar features and distributed on a relief very much influenced by the coastal biosphere (Rao and Sastry, 1972). Along the coastal area, the topography plays a very important role in terms of controlling the frequency, duration and extent of tidal flooding and substrate controls soil moisture and availability of nutrients required for the growth of vegetation. These variables together have a significant influence on soil salinity and water logging, both of which have a direct effect on plant physiology and therefore on the distribution of species. Thus, the study of the coastal vegetation also requires information on the various coastal land forms that are shaped and influenced by various coastal processes operating in the area.

In the present study various aspects of coast such as its floral diversity, land use land cover changes, geomorphology and sediment characteristics were studied for selected coastal talukas of Bharuch district of Gujarat State. Bharuch is located in the south central Gujarat and is situated between 72° 45' E to 73° 15' E longitude and 21° 30' to 22° 00' N latitude. It covers total area of 6527 sq.km and its total population is 1550822 with population density 238 per km (Anon, 2011b). The district consists of eight talukas namely Jambusar, Amod, Vagra, Bharuch, Jhagadia, Ankleshvar, Hansot and Valia and total 663 villages. Out of these Jambusar, Vagra and Hansot are the coastal talukas that have been selected for this study.

Keeping the significance of coast and its various aspects in mind, the following objectives were framed for the present study.

1. Mapping land use land cover changes of the coastal talukas of Bharuch District
2. Studying the diversity of coastal vegetation
3. Monitoring mangrove of the coastal talukas
4. Physico-chemical analysis of coastal sediments
5. Preparation of coastal geomorphological map

6. Identifying main drivers of the changes

To accomplish this work, the methodology was broadly divided in to geospatial analysis, field surveys and lab analysis.

1. Geospatial analysis involved the use of remote sensing data and geographic information system (GIS). Remotely sensed satellite data over a period of 34 years was used to prepare land use land cover and geomorphological maps. In addition to this topographic sheets surveyed during 1970's were used as base maps to understand the land use land cover categories. GIS was used to carry out the change detection study specifically for mangrove and industrial categories.
2. Field surveys: This involved the study of coastal vegetation, collection of sediments and accuracy assessment of thematic maps.
    a. The diversity of the coastal vegetation was studied through extensive field survey. An inventory of the coastal vegetation and land vegetation present adjacent to the coast (within 500m area from high water line) was made for all three talukas. The phytosociology of mangrove vegetation was studied using the point-centred quarter method (PCQM).
    b. Coastal sediments were collected from open (barren) mudflat area and mangrove as well as salt marsh vegetated mudflats of the study area.
    c. Accuracy of the thematic maps was estimated using stratified random sampling strategy. In this all the possible points were visited on ground and error matrix was generated to calculate accuracy.
3. Lab work: This involved identification of plants and analysis of the sediments. The various physico-chemical parameters studied for the sediments were grain size, pH, electrical conductivity, salinity and soil organic carbon.

Results:

The present study depicts substantial change in mangrove cover as well as in land use land cover for all three coastal talukas. A summary of findings of present study are mentioned below.

1. Bharuch district showed an overall increase in the mangrove cover over the study period. It now has the largest extent of mangroves in Gujarat after Kachchh and Jamnagar district.

2. Mangrove phytosociological studies and the values of complexity index depict the young age of mangroves of present study area as well as the anthropogenic influence on it.
3. 110 species belonging to 88 genera and 37 families are being reported from coastal area of Bharuch district. This list included one species of true mangrove, five species of mangrove associates, seven species of salt marsh vegetation, three species of sand strand vegetation and ninety four species of land adjoining plants. The inventory indicates few new records and presence of several rare, endemic and indigenous plants from this study area.
4. The land use land cover of Jambusar, Vagra, Aliabet and Hansot showed substantial changes. The categories such as built-up and canal showed an increasing trend whereas coastal mudflats and agricultural land were the major categories showing decreasing trend over a period. Among three coastal talukas, Vagra has witnessed the highest increase in built-up land followed by Jambusar and Hansot. Endorsement of various schemes for development of various industries in Vagra taluka was the major reason for increase in industrialization and subsequent increase in habitation category.
5. Agriculture land was the major category with high areal extent throughout time series. This category showed an overall reduction in its area extent. Conversion of this category to habitation, industrial area, barren land or to scrub categories was the reason for its reduction.
6. Mudflat category showed considerable variation in its areal extent. Growth of mangrove on the inter-tidal mudflat area was the major reason for the reduction in the extent of barren mudflat area. The areal extent of the barren high-tidal mudflat indicated considerable reduction. Conversion of this area partly to salt-marsh vegetated mudflat or largely to the sea based industries such as saltpan or oil based or aquaculture were the main reasons for its reduction.
7. Saltpan was the dominating coastal wetland industry that covered the maximum area of coastal wetlands to the north of Naramda River. South of it, the aquaculture was the major industry. The major land based industries that were found in the present study area were brick kilns, oil wells and several chemical and petro-chemical based industries.

8. The presence of oil and natural gas in the study area had led the development of large number of oil wells. Their numbers were highest in Vagra followed by Jambusar and Hansot talukas.
9. The strategic location of Vagra has promoted the growth of port based industries and development of several SEZs, PCPIR and the passing of DMIC in vicinity of this study area were the impetus for such large-scale industrialization of this area.

    Thus, development of various industries across the different talukas was the major driver responsible for the observed land use land cover changes.
10. The land use land cover study depicts substantial increase and expansion of the canal network for all three talukas. This would improve not only agricultural activity but also attract industries especially to the water deficit areas such as Jambusar.
11. With the industrialization, the study area also showed an improvement in transport, health and education sectors.
12. The geomorphological study depicts much variation in the land forms observed in the north of Narmada River as well as to its southern region. The northern block was characterized by wider mud flat area, high cliffs whereas the southern block showed sandy ridges and relatively narrow mudflat area.
13. The analysis of coastal sediments showed the dominance of finer sediments. The sediments collected from mangrove and salt marsh vegetated area showed the presence of finer sediment as compared to open areas. This highlights the role of mangrove as well as the salt marsh vegetation as 'sediment binders'.
14. The organic carbon content of the sediments from mangrove and salt marsh vegetated mudflat areas have revealed little variation. The young age of mangrove stand could be reason for this observed variation. This also highlights the important role played by salt marsh vegetation in carbon sequestration and storage.
15. The statistical analysis of grain size suggested that the coarser particle size and their negative skewness nature of sediments indicate the deposition of sediments under the high energy conditions. The high energy conditions prevailing in several locations along the coast can be confirmed by the absence of vegetation and washed out mangroves at these locations.

16. Several locations in Jambusar and Vagra witnessed severe erosion. This has resulted in the loss of economically important infrastructure such as metaled roads, oil wells and parts of industrial areas. The construction of sea wall at several places to protect various man-made features further supplements the severity of erosion. The inland migration by the fishing community at Kaladara also indicates the socio-economic implications of erosion.
17. The plantation of mangrove to the south of Motimor bet has lower the rate of erosion in this area and proved its important role as a 'biosheild' or 'green wall'. This emphasizes the need to carry out mangrove plantation activity at erosional site to create a natural wall to protect various natural as well as manmade features. This will not only be cost effective but also provides huge ecological and economical benefits to the coastal community.