ABSTRACT

The coral reefs characterise an ecosystem of high biological diversity, having the greatest number of species of any marine ecosystem. Livelihood of many millions of people is dependent on this unique ecosystem as a considerable proportion of their food and earning is from the productivity of coral reef. The increasing human population and their activities, coastal and shelf geomorphologic changes and the activities of physical oceanographic features like monsoons, waves, ocean currents and tides have caused degradation of coral reefs all over the world. The recent estimates on areal extent of coral reefs indicate that there is about 1270 sq. km area of coral reef resources in India. Regular mapping and monitoring of coral reefs are sought for sustainable utilization of these resources.

In this context, the present study "Management of coral reefs in Gulf of Mannar using remote sensing and GIS techniques – with reference to coastal geomorphology and landuse" has been taken up.

For mapping of coastal geomorphology, IRS LISS-III imagery and GIS software have been used. Visual interpretation of satellite data was adopted for this mapping, using Survey of India toposheet as the base.

For shoreline change mapping, Survey of India toposheet (1969) and IRS LISS-III (1998) data were utilised and the sites where shoreline changes such as coastal and island erosion/accretion occurred and their influence on coral reef degradation were identified. Multidate bathymetry data along with GIS and ERDAS software were used for mapping shelf morphology and its changes.

IRS LISS-II (1988) and IRS LISS-III (1998) satellite data were used for landuse/landcover mapping. Change detection studies were carried out in a GIS environment and the influence of landuse/landcover changes on coral reef degradation was studied. To map the landuse/landcover, visual interpretation technique was used with collateral data from Survey of India toposheets.

The IRS LISS-II (1988) and IRS LISS-III (1998) satellite data with GIS and ERDAS software were used for mapping coral reef, change detection and demarcation of coral reef zonations. Various enhancement techniques and classification methods like K-Means classification, Maximum Likelihood Classification (MLC) and Principal Component Analysis (PCA) were used to identify the best suitable techniques to map coral reef. Both, digital analysis of satellite data using ERDAS imagine system and visual interpretation techniques were used to map the coral reef area together with collateral data from Survey of India toposheet.

Using visual interpretation of IRS LISS-III image, various coastal geomorphic features like, beach, spit, beach ridges, swales, mudflats, back

swamp, sand dune complex, teri dune complex, natural levee, flood plain, deltaic plain, strand lines etc were mapped along Gulf of Mannar coast. All the geomorphic features particularly beach ridges, strandlines and swales and backwater system indicate various stages of sea level.

The analysis of multidate shoreline map showed that 4.34 sq.km of the coast has been eroded and 23.49 sq.km of the coast has accreded in Gulf of Mannar over a period of thirty years (1969-1998). This study indicates that the migration of the coastline is towards the seaward side and is very active in Gulf of Mannar. The accretional nature or seaward migration of shoreline indicates that the Gulf of Mannar is undergoing progradation or the sea level falling.

The analysis of multidate shoreline map showed that 4.160 sq.km and 3.310 sq.km areas of islands in Gulf of Mannar have been eroded and accreded respectively over a period of thirty years (1969-1998).

The analysis of multidate bathymetry map indicated that the Gulf of Mannar seafloor is gradually rising due to sedimentation and tectonic upliftment or sea level fall. The calculation shows that the average rise in sea floor is about 0.021m/year of which 0.001m/year is due to sediment deposit and 0.02 m/year is due to the influence of tectonics.

Visual interpretation of 1988 IRS LISS-II and 1998 IRS LISS-III imageries showed that 539.86 sq.kms of cropland has been reduced to 417.66 sq.km, 50.17 sq.km of fallow land has increased to 52.56 sq.km, 185.56 sq.km

of agricultural plantation has increased to 192.57 sq.km, 115.29 sq.km of forest plantation has increased to 145.02 sq.km, 243.48 sq.km of scrub land has increased to 294.02 sq.km, 39.28 sq.km of sandy area has been reduced to 36.80 sq.km, 70.84 sq.kms of tank has increased to 74.85sq.km, 3.81sq.km of island vegetation has been reduced to 2.28 sq.km and 3.86 sq.km of natural forest has been reduced to 0.062 sq.km over a period of ten years (1988-1998). The validation of this result by ground truth confirmed that enormous growth of population and activities related to them have caused landuse/landcover changes. The multidate remote sensing data analysis indicates that 0.860 sq.km of mangroves, 0.375 sq.km of marsh vegetation and 1.840 sq.km of mudflat areas have increased over a period of ten years (1988-1998). The increase of land cover categories indicate that the study area is under going progradation or falling of sea level. Socio-economic studies indicate varying occupational structures of the coastal people in Gulf of Mannar and the activities were mainly related to fisheries, seaweed collection, shell collection, coral mining and agriculture.

Visual classification of 1988 IRS LISS-II and 1998 IRS LISS-III imagery showed that 25 sq.km of coral reef area in Gulf of Mannar has been lost over a period of ten years (1988-1998). The validation of this result by ground truth confirmed that in the study area eight main anthropogenic causes such as (i) over fishing and destructive fishing practices, (ii) seaweed collection, (iii) commercial shell collection, (iv) coral mining, (v) poor land use practices, (vi) coastal and urban development, (vii) harbour and dredging and

(viii) industrial development and pollution are mainly responsible for coral reef degradation. Four natural factors have also been identified in the study area as the cause of degradation of coral reefs. These are (i) sea level fall, (ii) northeast monsoon (iii) wave, tide, and ocean current and (iv) suspended sediment. The total coral reef area in Gulf of Mannar is estimated to be only 61.01sq.km; of this 67.2% are dead reefs, 19.6% living coral and 13.1% coral mining area. Digital classification of IRS LISS-III satellite data using principal component analysis technique with 3rd band (NIR) was found to be more suitable for coral reef zonation studies and species identification. Digital classification of IRS LISS-III data with principal component analysis technique also provides more classification accuracy than K-Means and maximum likelihood classification.