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IRS-1A Applications for Coastal and Marine Resources

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ABSTRACT: *The data from IRS-1A satellite have been found very useful in the study of coastal zone and marine resources. Important applications are in mapping of the tidal wetlands, coastal land forms, suspended sediments, understanding the processes of estuarine dynamics, shoreline changes, generation of coastal currents, internal waves, degradation/improvement in mangroves and coral reefs. Significant results of these studies are outlined in this paper.*

INTRODUCTION

The capability of satellite remote sensing to provide synoptic, repetitive and multispectral data has proved to be very useful in the inventory and monitoring of coastal features, such as tidal wetlands[1], coastal landforms, potential aquaculture sites, mangroves, estuary-dynamics/shoreline-changes[2-3], and off-shore aspects like suspended sediment dynamics and coastal currents[4], near-shore bathymetry, internal waves, etc. The IRS-1A data has been found to be useful in the study of the above coastal aspects. It also has potential towards marine resource applications by providing chlorophyll/primary productivity estimate and extent and spread of oil slicks. The spectral response of the different features in the coastal and off-shore region is indicated in figure 1.

COASTAL WETLAND/LAND FORM AND SHORELINE CHANGE MAPPING

Mapping of the entire Indian coast at 1:250,000 scale is in progress using IRS data. The objectives of the project include mapping of shoreline changes within the accuracy of 2–3 pixels and the classification of coastal zone with an accuracy of over 85 per cent. The planimetric accuracy of shoreline change maps is kept at 0.4–1.0 mm on 1:250,000 scale. The significant findings of the work could be summarised as follows:

On the Gujarat coast, depositional processes are predominant in the Gulf of Khambhat except in the Mahi estuary. The south Gujarat coast is experiencing erosion at several places.

Figure 1a. IRS-1A LISS-II image of a part of the Kerala coast (near Aleppey).

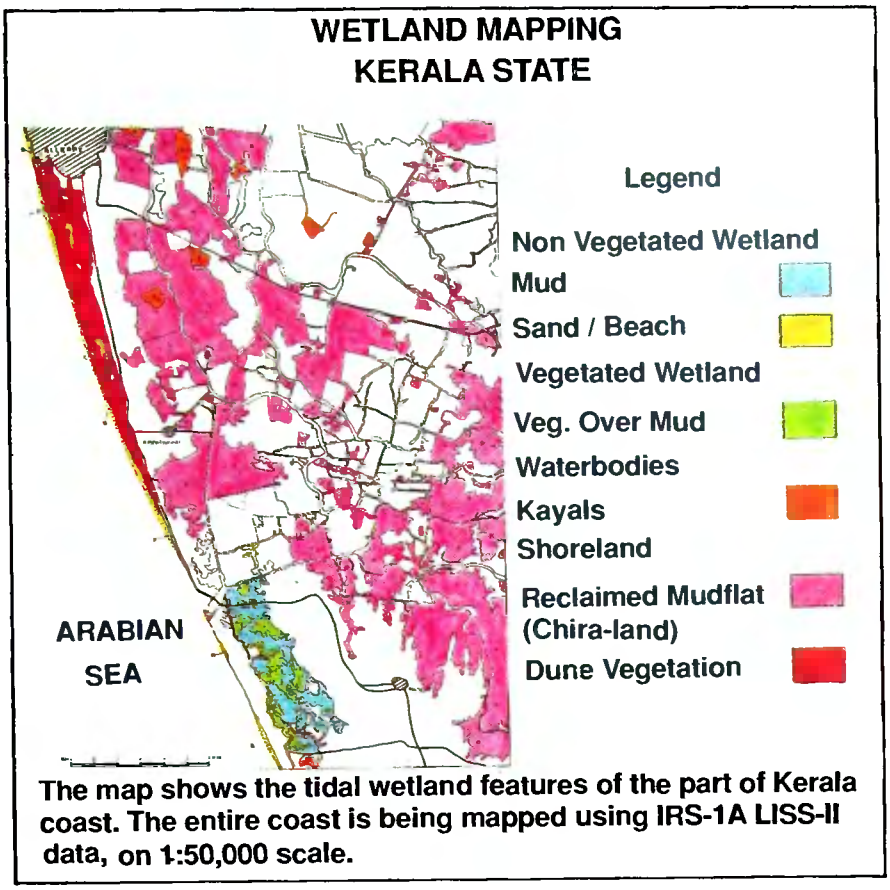

Figure 1b. Coastal wetland map corresponding to IRS-1A image.

- The Karnataka coast is marked by spectacular spits. Specific mapping of coastal Karnataka has brought out categories, such as non-vegetated wetlands, vegetated wetlands, waterbodies of different turbidity levels, land forms such as paleoflats, paleochannel, beach ridges and normal land use categories.
- The Kerala coast is marked by extensive backwaters. Erosion was noticed at Kasargod, Calicut, Kochi, while deposition was observed at Mahe and Aleppey.
- On the Tamil Nadu coast, fringing and patch reefs were marked near Rameswaram. Erosion is noticed north of Madras while deposition was noticed at Point Calimere and Nagapattinam.
- In Andhra Pradesh, tidal flats and mangroves are reducing in extent because of reclamation. The spits at the Godavari, the Krishna delta and Kakinada are growing and the Pulicat lake is shrinking. The erosion is noticed near Machalipatnam and north of Vishakhapatnam.
- On the Orissa coast, mangroves cover about 200 sq km area. Mangroves have been removed near Karanjmal and near Paradip port. The area of the Chilka lagoon has changed from 871 to 790 sq km between 1973 and 1986. This is mainly due to sedimentation in the lake.
- In the Kavaratti and Agatti Islands of the Lakshadweep archipelago, the area mapped under seagrass is 0.92 and 1.96 sq km, respectively[6]. The eroded areas and sites for live corals were mapped.
- The total reef area of 1050 sq km in Andaman & Nicobar Islands is found to be fringing type. Mangroves are present along tidal inlets, lagoons and bays and cover about 770 sq.km.

Coastal wetland mapping in the scale of 1:50,000 has been taken up on the Kerala and the Tamil Nadu coasts. These maps will provide information up to level-III, and can be used for planning conservation measures at the district level (Figures 2a and 2b).

Thematic maps of coral reefs are being prepared using IRS-1A LISS-II data for the Gulf of Kachchh, Gulf of Mannar, Lakshadweep Islands and Andamans and Nicobar Islands (Figure 3).

CHANGE DETECTION STUDIES

IRS data in conjunction with other resources satellite data were found to be extremely useful for monitoring degradation in mangroves and erosion along the coast. In the Marine National Park, situated in the Gulf of Kachchh, a study using IRS

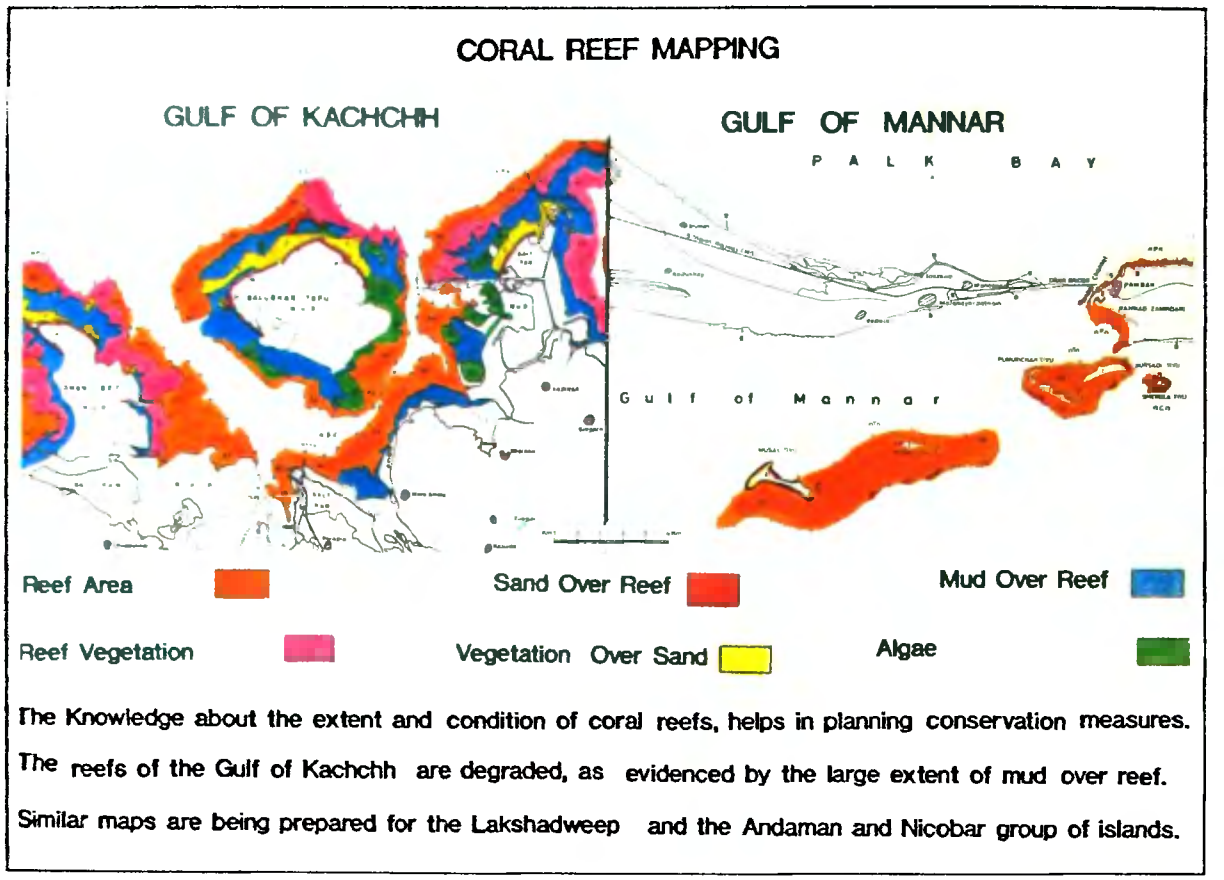

Figure 2. Coral reef maps for parts of Gulf of Kachchh and Gulf of Mannar prepared using IRS LISS-II data.

data of 1988, (along with past satellite data) showed positive changes in the area under mangroves and coral reefs as a result of the Government policy to restore the degrading environment. IRS data also provided information on various levels of turbidity of coastal water, which is useful towards understanding degradation of coral reefs.

In studying the changes along the Mahi estuary on which the Dhuvaran Thermal Power Station is situated in the Gulf of Khambhat, IRS LISS-II data was found quite useful in mapping channel boundary, flood-plain steps, terraces, cliffs, mudflats, eroded area, oxbow lake, paleo-meanders and reclaimed mudflats. This map was used to understand effects of engineering structures on the estuary[2] . The planimetric accuracy of the shoreline change maps improved to 40 m with IRS, compared to 200 m with Landsat, MSS.

Coastal Land Use Mapping for Brackish Water Aquaculture Development

IRS LISS-II data are being utilised for producing

Figure 3. FCC of LISS-I (Bands 2, 3, 4 histogram equalised; May 4, 1988) of the Pirotan Island and Environs showing various wetland categories (1-Turbid Water, 2-Coral Reef, 3-Sand, 4- Mangroves, 5-Mudflats, 6-Salt Pan, 7-Agricultural area).

coastal land use maps on 1:50,000 scale as an aid towards selection of aquaculture sites in West Bengal, Orissa and Andhra Pradesh. Various wetland features, such as mudflat/tidal flat, mangroves, marsh, salt pans, aquaculture ponds indicate the presence of brackish water. Land use information of the nearby areas is also useful in judging the quality of coastal waters.

Offshore studies

Suspended sediment analysis is another important application of IRS data. Along the west coast of India, this has shown coastal fronts, especially near the Southern coastline. The fronts are generally parallel to the coast except near river mouths, indicating the effect of fresh water influx[4] (Figure 4). Other off–shore studies have included bathymetric estimation and dynamic processes, such as coastal currents and internal waves. Internal waves at the interface of the upper mixed layer with the deeper ocean layer have surface expressions which have been discerned in the IRS image of the Bay of Bengal. The interaction of bathymetry with internal waves can be studied therefrom.

Marine resource and pollution

Although the IRS spectral channels and bandwidths are not as good as the data from Coastal Zone Colour Scanner (CZCS), primary productivity and chlorophyll mapping has been attempted from IRS data. An accuracy in pigment retrieval of about 60 per cent is achievable with IRS LISS-II data as compared to Landsat TM data.

The damping of surface waves by an oil slick creates a smoother and therefore darker patch in the

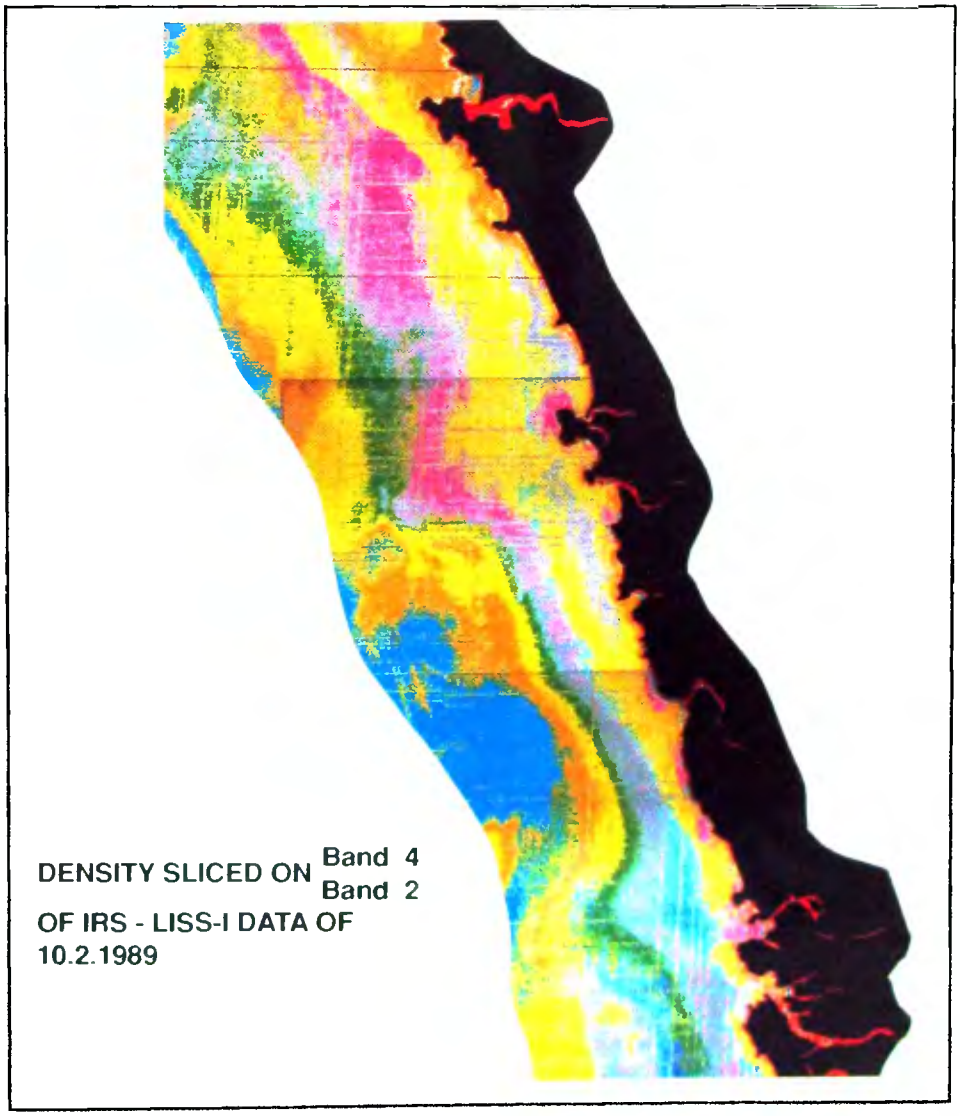

Figure 4. Coastal geometry and suspended sediment along Maharashtra (Ratnagiri) coast.

IRS image of an oceanic area. The recent Gulf oil slick (February–March 1991) has been detected using IRS imagery[5].

FUTURE SCENARIO

The planned satellite programmes in the near future indicate that microwave data will become available to the users. This will enhance the potential applications of remote sensing to ocean and marine studies by way of providing data on surface winds, waves, circulations, etc. Higher resolution data from the IRS-1C/1D satellites will help in the study of coastal changes and in identifying areas undergoing rapid changes due to large scale erosion. The future R&D will also include the development of suitable models for evaluation of the marine resources by combining physical, oceanographic and meteorological data from satellites.

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