

REMOTE SENSING APPLICATIONS FOR COASTAL ZONE MANAGEMENT

L.V. Gangadhara Rao

National Institute of Oceanography, Dona Paula, Goa.

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The coastal zone represents an unique interface between the sea, land and air. India has a long coast line of about 7,500 km with the continental shelf (0 to 200 m depth) extending to about 4,50,000 sq. km. The coastal zone of India is highly productive with rich living and nonliving resources and is under pressure due to various developmental activities and intense urbanisation. The coastal ecosystems like mangroves and coral reefs are threatened due to pollution, siltation, erosion and ever increasing human settlements. In view of this, environmentally effective scientific management of our coastal zone assumes special significance. One of the prime prerequisites of coastal zone management is information on existing shoreline and wetland conditions and changes that may have occurred through time and space. For scientific management of coastal zone, accurate and comprehensive data on coastal geomorphological features, coastal wetlands and vegetation, coastal processes and water quality of nearshore waters are required.

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 wetlands and mangroves and coastal geomorphology, erosion/accretion, sediment transport. The satellites carry onboard sensors operating in different regions of the electromagnetic spectrum such as visible, near infrared, thermal and microwave. The spectral response curves for potential applications in coastal zone management are shown in Fig. 1. Satellites such as IRS, LANDSAT, SPOT with their synoptic and repetitive coverage provide valuable information on various aspects related to coastal zone. Certain dynamic features such as estuarine conditions, mud flats, sedimentation in river mouths, pollution could be monitored through the repetitive coverage from these satellites. The analysis of satellite data can provide information on various coastal zone features such as mangroves, wetland, saltpans, creeks, estuaries, lagoons, beaches etc. The remote sensing data can help in updating information on coastal zone landuse and characteristics.

Typical Coastal Applications

Coastal Morphology: The interaction between different elements like lithology, structure, climate etc., plays a vital role in the geomorphic evolution of the coast. The satellite

data have been found to be useful in identifying many geomorphic features. The various geomorphic features originating from (i) structural processes, (ii) denudation, (iii) fluvial processes and (iv) marine processes could be located using remote sensing data. The different spectral bands are sensitive to specific features.

Coastal Vegetation and Mangroves:

Information on coastal vegetation is important from the environmental and economic points of view. Remote sensing technique has been found to be useful in inventorying coastal vegetation. The visible and near-IR reflectance characteristics can be utilised to distinguish canopies. In-situ measurements using radiometry can be used in conjunction with satellite data to determine reflectance signatures with respect to vegetation canopies. IRS data, in conjunction with other satellite data were found to be extremely useful for monitoring degradation in mangroves.

Littoral Processes:

The littoral zone is defined as the zone extending from the shoreline to the tidal zone (generally up to a depth of 100 fathoms). The transport of sediments in this zone by waves and currents is of importance in coastal engineering applications and estimation of erosion and accretion rates along the shore. Under ideal conditions, the nearshore profiles can be utilised in determining longshore transport rates. In this respect the remotely sensed data have been found to be highly useful when used in conjunction with in-situ optical data, navigational charts and nearshore profiles with some accuracy. The presently available satellite sensors have been found to be useful in the study of coastal erosion and accretion and shoreline changes.

Sediment transport:

The main sources of suspended matter in sea water are river runoff, biological productivity and coastal erosion. The amount of suspended sediment load is an important factor in deciding the dynamics of the ocean bottom flow. Several studies have indicated that a good correlation exists between the visible and near-IR reflectance values of water bodies and the sediment load. The studies using satellite data indicate that a good inverse correlation exists between suspended sediment load and light penetration. The 0.6-0.7 μm band is found to give the sharpest definition of coastal waters of varying turbidity. However extensive atmospheric corrections have to be applied to the data to get more accurate results.

Nearshore Bathymetry:

Another important aspect of physiography of the coast is the study of river mouths and sediment transport near the coast. Satellite data have been found to be sensitive to turbidity of coastal waters and hence useful towards study of estuarine siltation and formation of mudflats. The interaction of the waves and the beach causes changes in the beach profile from time to time affecting the nearshore bathymetry. With a knowledge of the sediment load in the surface layers, it is possible to correlate satellite radiance values with ocean depth as indicated by studies using optical data from satellites. Another approach is to use the data from Synthetic Aperture Radar which is sensitive to land-ocean features.

Marine Fisheries:

Our continental shelf is endowed with vast fishery resources. The data from ocean colour radiometer like CZCS, was found to be extremely useful for assessing primary productivity and mapping chlorophyll concentration. This together with information on sea surface temperature available from sensors like AVHRR will greatly help in locating potential fishing zones in our shelf region.

Oil Pollution:

The damping of surface waves by an oil slick creates a smoother and therefore darker patch in the satellite image. For example, the Gulf Oil Slick (Feb. 1991) has been detected using IRS imagery. Airborne remote sensing is very useful for oil spill monitoring and surveillance in coastal seas.

REFERENCES

Gangadhara Rao, L.V. and V.R. Rao (1981) Studies in the Indian Continental Shelf - Application of Remote Sensing data. Proceedings of an EAR Sel-ESA Symposium, Voss, Norway, 19-20 May, 1981 (ESA SP-167, July 1981).

Shailesh Nayak and B. Manikiam (1992) IRS-IA Applications for Coastal Zone Management. National Resources Management - a new perspective. ISRO, Bangalore, pp. 181-189.

Space Applications Centre, ISRO (1992) Remote Sensing Applications Mission - Coastal Environment. Scientific Note RSAM/SAC/COM/SN/11/92 SAC, Ahmedabad. 114.

Deekshatulu, B.L. and George Joseph (1991) Science of Remote Sensing. Current Science, Vol. 61, Nos. 3&4, 129-135.

Fondekar, S.P. and L.V. Gangadhara Rao (1991) Remote Sensing of Oil Slicks. Current Science, Vol. 60, No. 11, 636-639.

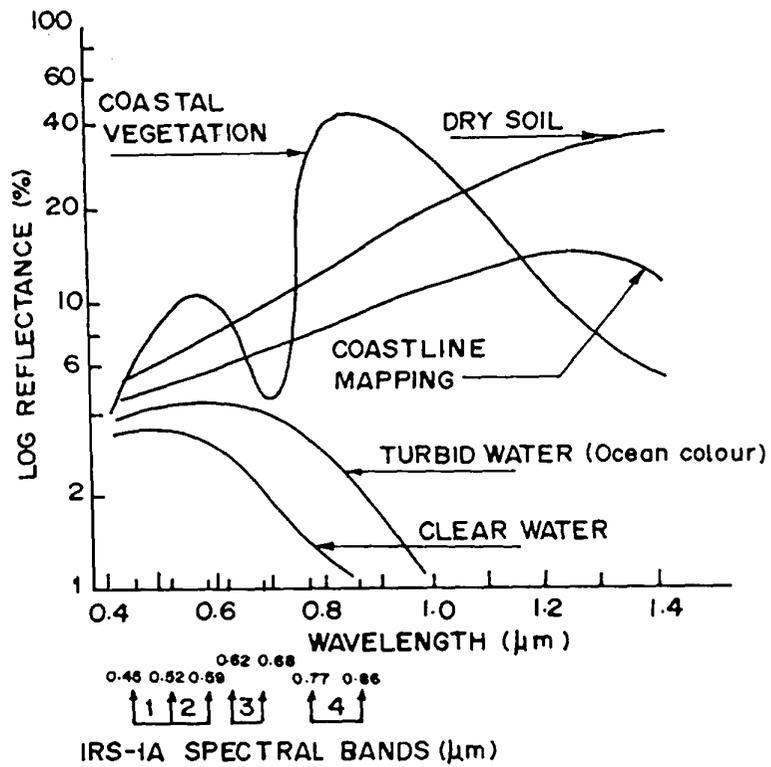


Fig. 1. Spectral Response Curves