CORAL REEF MAPPING USING LANDSAT THEMATIC MAPPER DATA

Nagarathinam V., Jayagobi K & Palanivelu R.
Institute of Remote Sensing, Anna University,
India. 600 025.
Commission Number VII

ABSTRACT:

Corals in the form of fringing reef occur in patches on the shallow continental shelf around the southern most part of the eastern coast of India. Systemmatic mapping is needed for the organised exploitation of the flora and fauna of this region and also for the preservation of this ecosystem. Landsat TM data is used for supervised classification and mapping. The results of such digital mapping are found to be satisfactory for effective inventory and environmental monitoring. Simple techniques such as band ratioing of different combinations and their use for this particular study are also dicussed.

INTRODUCTION:

The southern part of Tamil Nadu Coast between Tuticorin and Rameswaram abounds in coral growth due to favourable ecological factors. The reefs harbour a rich and varied coral flora and fauna of appreciable economic importance. These are commercially exploited being a major source of calcium carbonate. Coral quarrying and sea weed harvesting in the area need a careful inventorying and mapping. The use of digitally processed Landsat MSS images in thematic mapping of coral reefs has been demonstrated by Smith, et al(1975) and Bina et al.(1980). The main aim of this study is to develop techniques for extraction of bathymetric information from Landsat Thematic Mapper data and the results of the digital analysis for mapping the reef are presented in this paper. Band ratioing of different sets was attempted to delineate the categories. Bands 1,2,4,5 and 7 were used for this purpose.

STUDY AREA:

The study area comprises part of Gulf of Mannar which is a partially enclosed basin with Rameswaram promontory separating it from Palk Strait in the north. The sea basin is structurally a graben and it owes its origin to the breaking up of the Gondwana land and the subsequent drifting of Sri Lanka from the south eastern part of India (Katz,1978). The narrow continental shelf in this graben of regional subsidence has

provided the platform for the growth of corals. There are twenty off-shore islands between Tuticorin and Rameswaram ranging in length from a Km to seven Kms, aligned approximately along the 5 fathom line. They are low and sandy islands covered with grasses, shrubs and trees and are flanked by reefs. The terrestrial sand and coral sand consisting of coral debris mixed with comminuted grains of molluscan shell material, calcareous algae and foraminifera are heaped up on the reef platform forming reef islands. The ecological environment is conducive to the growth and proliferation of corals. The temperature of the water ranges between 260C and 320C and salinity from 32.12 to 35.56 parts per thousand. The average annual rainfall is 1235 mm. The tidal amplitudes vary from 50 cm to 75cm. The periodic reversal of the offshore currents provides plenty of plankton for the growth of corals.

METHODS:

The Landsat Thematic Mapper imagery(Scene ID: T51142054862250) was analyzed in VAX 11/780 computer for the test site - a group of islands in the fringing reefs lying to the south of Rameswaram promontory. This group called Krusadi islands with the predominant group of Pulli reef was selected because of the extensive reef area and accessibility for ground truth operations. Supervised mode of classification using maximum likelihood algorithm was attempted. Training sets were selected based on the field data. Observations were made using the Naval Hydrographic Chart. Spectral separability analysis were carried out to identify the best spectral bands for classification.Landsat TM Bands 1,2,3 and 4 were found to be suitable for the analysis of separability of pixels of different categories. Bands 5,6, and 7 were not much useful for classification purpose as the classes are spectrally very closer and overlapping.Depth variation was brought out although limited categories were selected for the classification. Two types of reef beds ie., exposed reef and submerged reef were identified based on the bathymetric informations obtained through the analysis. This study demonstrates the possibility of identifying underwater reef platforms at various depths. The simple band ratioing techniques with band 1, 5 and 7 were attempted to delineate the deeper, moderate and low depth zones. The same band ratioing were attempted with band 2 and 4 to delineate the categories found on the surface of the sea.

RESULTS AND DISCUSSIONS:

Five classes have been identified including the two types of reef categories. (Figure I). Because of the limited information regarding the sunken reef at greater depths, ground truth verification was carried out only for the reef exposed

above sea level and that lying within a depth of 3 metres to 10 metres (Pillai,1982). Diving to a greater depth and more sophisticated equipments are needed to assess the extent of the submerged reef(Mahadevan and Nayar, 1974). In the absence of these informations, only correlation with depth was done using the hydrographic chart which depicts bathymetric details in fathoms obtained through sounding operations. Submerged reefs are marked as fowl grounds in this chart. The digital analysis of the imagery pertaining to the study area has revealed two more zones of different depths apart from the two reefs already described. By superimposing the digital output on to the hydrographic chart, the depth variation with these zones has been confirmed. The drifting sea weeds that abound in this area have appeared distinctly in a different colour. Mean, and standard deviation of each class for Landsat TM bands are given in Table I. Figure II gives the spectral seperability between the classes in various combinations of Landsat TM bands. Bands 1,2,3 and 4 in different combinations have given good separability and these bands are considered for classification. Reef mapping is done based on the identification of ocean depth variation. With the water penetration capability of the TM channels, combined with the improved resolution, such simple operations as contrast stretching was found to be adequate to bring out various depths. A simple ratioing between bands 1 and 5 gives the qualitative depth variation with enhaced surface information. Ratioing of band 1 by 7 gives very clearly the offshore bars and vegetation within islands adjoining the reefs. Ratioing of band 4 by 3 gives the sea surface information and it was possible to distinguish clearly the reef and sea weeds.

CONCLUSIONS:

The feasibility of using the Landsat TM data for the reef mapping and delineation of bathymetric details have been demonstrated in this paper. Sandy islands with coralline rocks and the reef platforms have distinct spectral signatures. Other categories such as sea weed areas, submerged reefs along with the details of their extent and depth of occurence and also identification of predominant types of corals can be done with various combination and ratioing of bands.Band ratioing of 1 and 7 & 1 and 5 were found suitable to delineate the depth variations and also to delineate the surface features such as weeds and reefs. The coral reef mapping with high accuracy using Landsat TM data is confirmed in this study.

REFERENCES:

1. Bina Ricardo T., Wolfgang Zacher, Kent Carpenter, Robert Jara and Jose B.Lim, "Coral Reef mapping using Landsat Data:Follow up studies, Report, National Resources Management Centre, Philippines, 1980.

2. Katz M.B., "Sri Lanka in Gondwanaland and the evolution of the Indian Ocean", Geological Magazine Vol 115, No 4, 1978.

3. Mahadevan S, and Nagappan Nayar K., "Ecology of Pearl Oysters and Chank beds", Central Marine Fisheries Research Institute Bulletin 25,1974.

4. Pillai Gopinadha C.S., "Coral Resources of India with special reference to Palk Bay and Gulf of Mannar" The Proceedings of the Symposium on Living Resources of the Seas around India, Cochin, 1972.

5. Smith E.V., R.H.Rogers and L.E.Reed, "Thematic Mapping of coral reefs using Landsat data", Proceedings of 10th International Symposium on Remote Sensing of Environment, Vol 1; 1975.

TABLE I

	CLASS	Landsat Thematic Mapper Bands 1	2	3	4	5	7
I	Marshy	77	30	26	85	48	12
II		1.88	1.25	1.04	2.79	3.68	3.48
I	Vegetation	93	44	49	62	86	39
II		3.4	3.1	6.2	4.8	7.3	5.4
I	Sea	80	28	15	7	5	3
II		1.7	1.03	0.92	0.61	1.14	0.9
I	Sunken Reef	92	36	25	8.3	4.1	2.7
II		2.9	2.39	3.3	1.31	0.92	0.9
I	Exposed Reef	109	47	37	10	4	2
II		2.4	1.61	2.1	0.92	0.99	0.94
I	Sand	135	75	98	88	142	82
II		7.5	6.7	10.1	11	14.0	13.0

I - Mean Value of the pixels
II - Standard deviation

Figure I

Figure II a

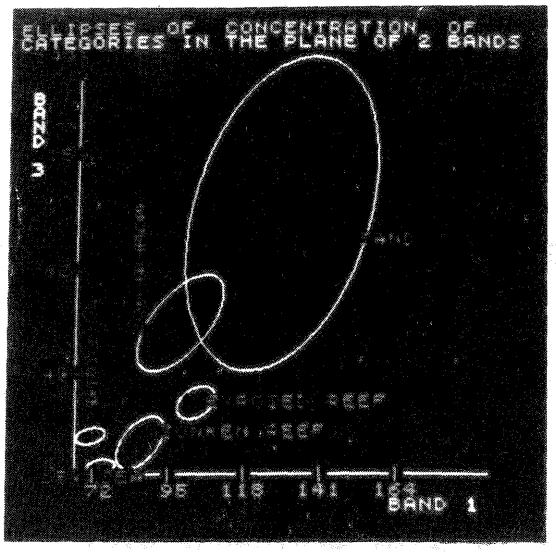

Figure II b

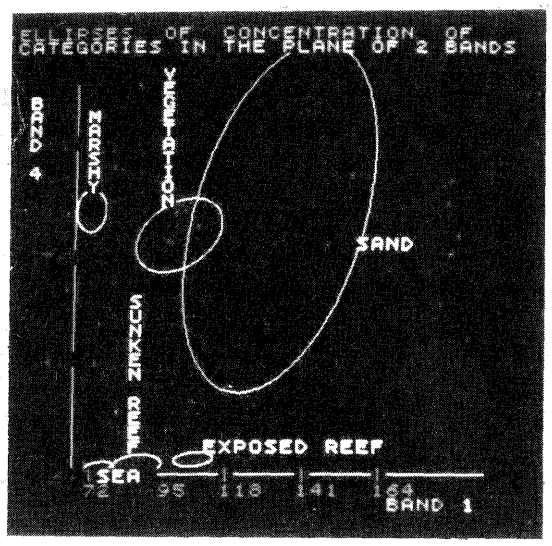

Figure II c

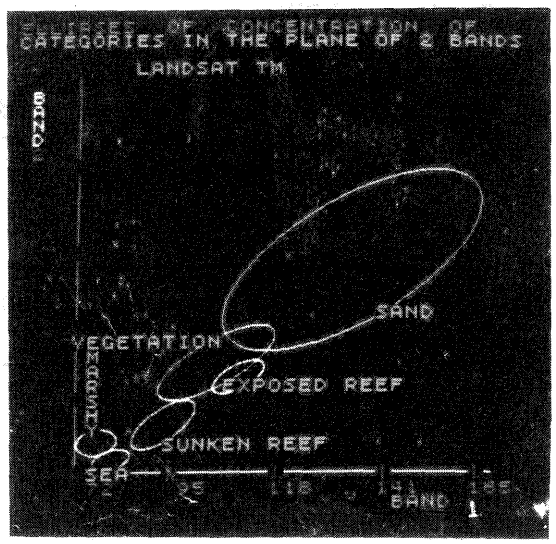
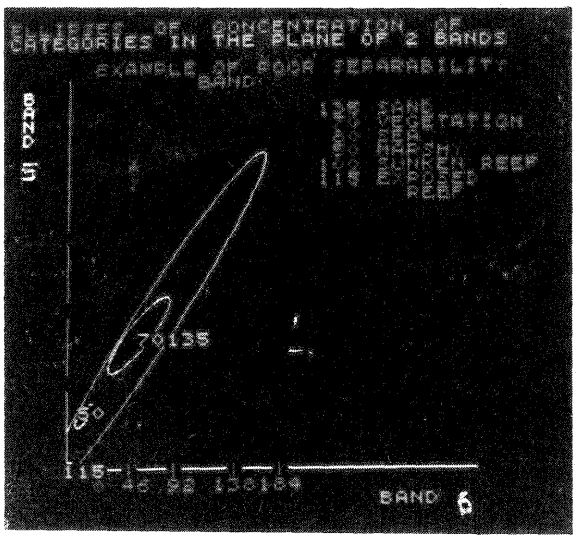
Figure II d