

# Applications of the Multi-Spectral Satellite Data from IRS-P6 LISS-III and IRS-P4 OCM to Decipher Submerged Coral Beds Around Andaman Islands

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**Abstract:** The coral reef of Andaman Sea is one of the least explored regions of the Indian Ocean. The coral reefs are the tropical fauna forming the important eco-system in the tropical ocean. The coral reefs grow in the suitable climatic conditions. The coral reef systems of Andaman region are unique from ecological perspective. The reefs found around Andaman region are fringing type of reef. Most of this reef is found in the shallow depths especially in the photic zone along the coast. There are even reef banks exist along some ridges in the offshore region away from the coast. Some areas are remaining unmapped due to isolated from the coast. The satellite data can able to detect the signatures of the submerged reef banks. Multi-spectral bands of IRS series P6 LISS-III and P4 OCM satellite data deciphering the information about submerged reef bank in Andaman Sea. The shorter wavelength from OCM spectral band3 (480-500 nm) and LISS III band1 (520-590 nm) were found useful in mapping submerged reef bank. The spectral signatures of these areas are similar to the mapped/observed submerged reef banks. The depths of these areas are from 25-70 meters observed based on the NHO charts and GEBCO bathymetric data. The current study brought out the possible areas of the submerged reef banks in the environs of the Andaman Island.

**Keywords:** Multi-spectral, submerged reef, Andaman etc.

## Introduction:

The coral reefs are the tropical fauna forming the important eco-system in the tropical ocean. The coral reefs grow in the suitable climatic conditions. These are mainly found along the coastal areas as fringing reefs, table reef, atoll and barrier reefs etc. Most of this reef is found in the shallow depths especially in the photic zone. There are even deep seas corals also exist in the higher depths. There are several works have been carried out on the coral reef mapping and monitoring using the remote sensing techniques (Bahuguna et al. 2008; Deshmukh et al. 2005; Kumaraguru et al 2003; Ninsawat et al. 2003; Palandro et al. 2003; Lugo-Fernández et al 2010; Purkis and Riegl 2005). The satellite data can able to detect the signatures of the submerged

reef banks. IRS Linear Imaging multi-spectral Sensor (LISS) data extensively used to study geomorphology of coral reefs (Nayak and Bahuguna, 1998). Indian Remote Sensing Satellite (IRS-P4) Ocean Color Monitor (OCM) is useful in detecting the submerged reef banks as deep as 50-60 meters (Chauhan and Nayak, 2005). Very few such works were carried out in identifying and mapping the submerged coral banks in the Indian waters. This work focuses on the sensor capability of the detection of the coral banks in the Andaman sea.

## Study Area:

Study area is a part of the Andaman Sea around the coordinate 93° 31'E longitude and 11° 8'N latitude. This area falls on the

long ridge starting from the great Nicobar up to the east off Middle Andaman. Tillachang Island of the Nicobar group of islands is also falls on the same ridge.

### **Methodology:**

The digital data of the IRS-P6 LISS-III data from path and IRS-P4 OCM FCC were analysed and observed to see the presence of the coral reef in the area. The signatures in the individual bands also observed. The spectral profiles are taken at location A in the current study area and at location B at northeast of Little Andaman is known reef area (Nayak and Bahuguna, 1997). Concurrently the bathymetric analysis also carried out in this area using General Bathymetric Chart of the Ocean (GEBCO).

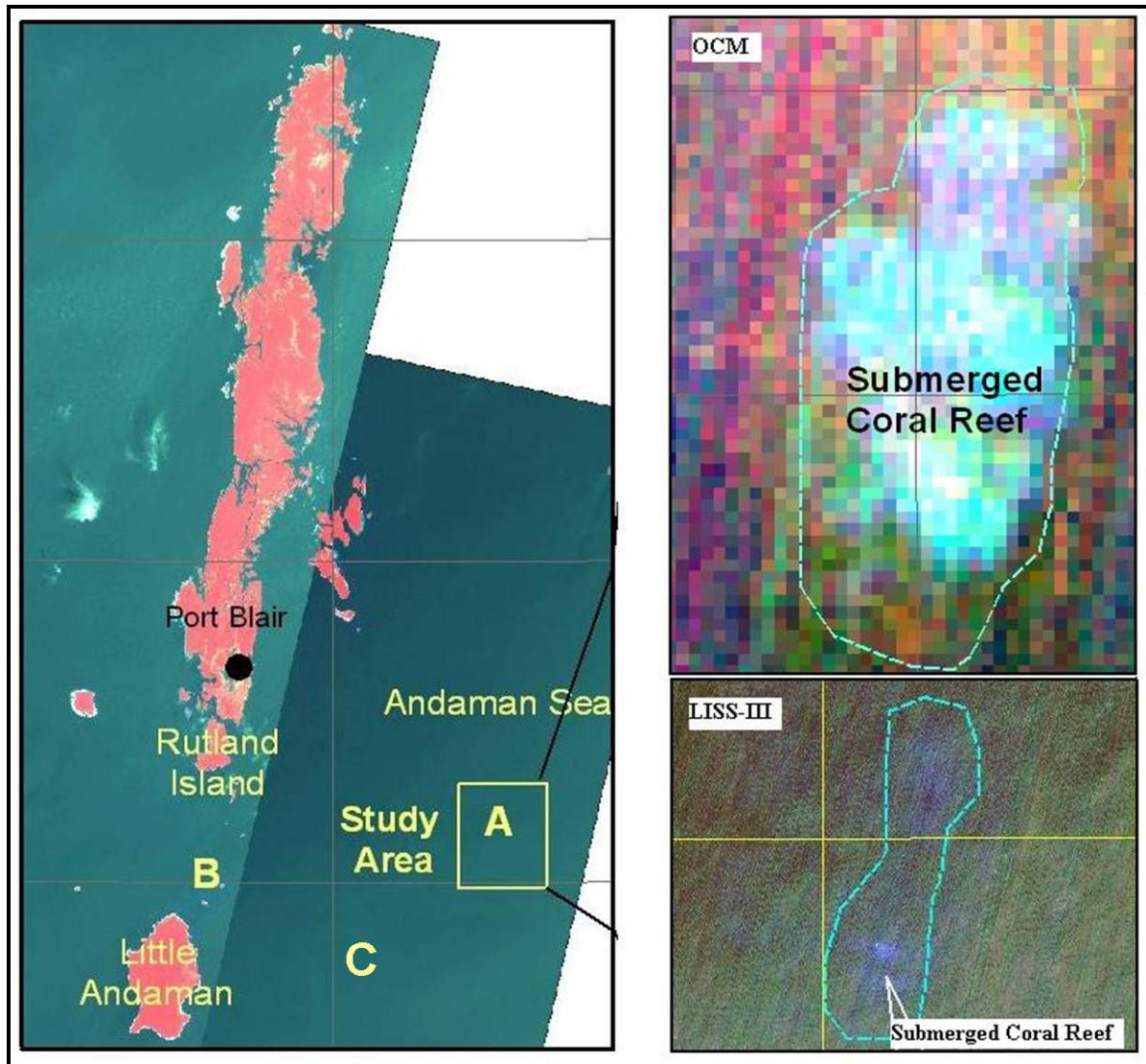
### **Results and Discussions:**

GEBCO 1 minute bathymetric data has been used analyze the depths in the study area. This data clearly indicate the reef banks are satiated at less than 100 meter depth. The depth profile from the Port Blair to location A also deciphers the presence of the ridge at location A at shallower depth. Depth in this area varies from 26-80 meters along the ridge which can be easily reachable for the optical sensors in the clear Andaman waters.

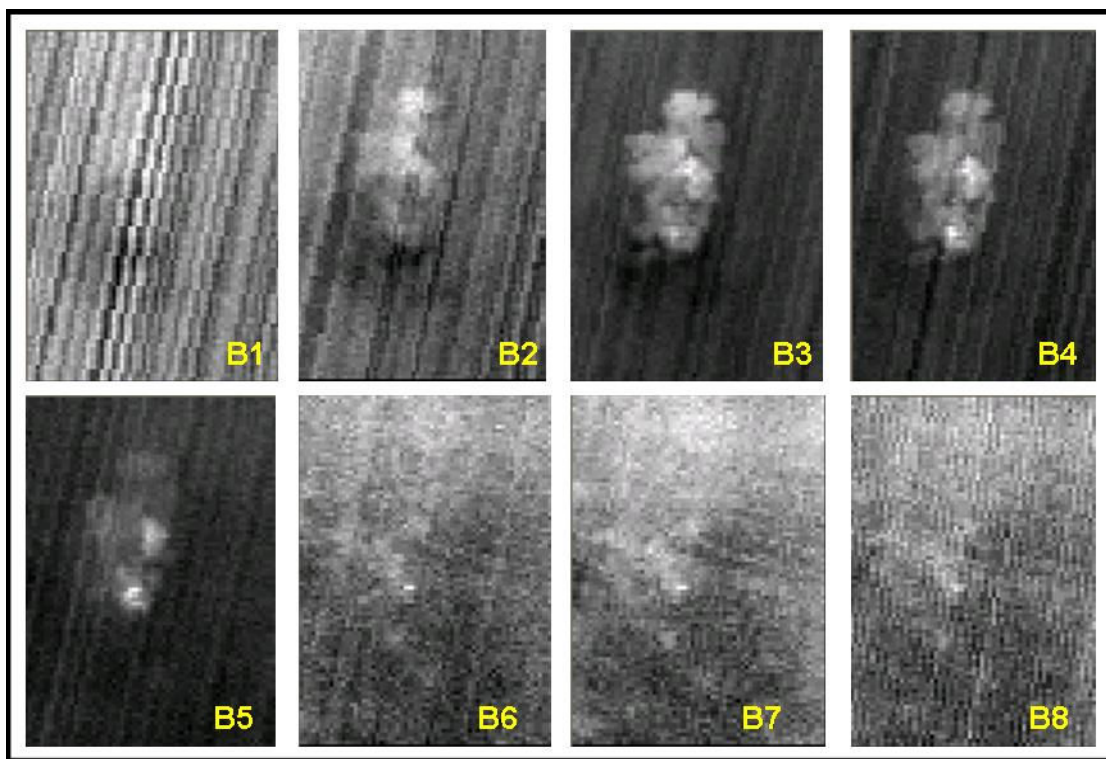
### **Spectral Signatures of the Submerged Reef:**

The signatures in the IRS-P4 OCM FCC with band combination 8, 5, and 3 in Figure 1 clearly depict the reflectance coming from the bottom which is similar to submerged reef observed in the other known areas. The spectral profiles are calculated for the

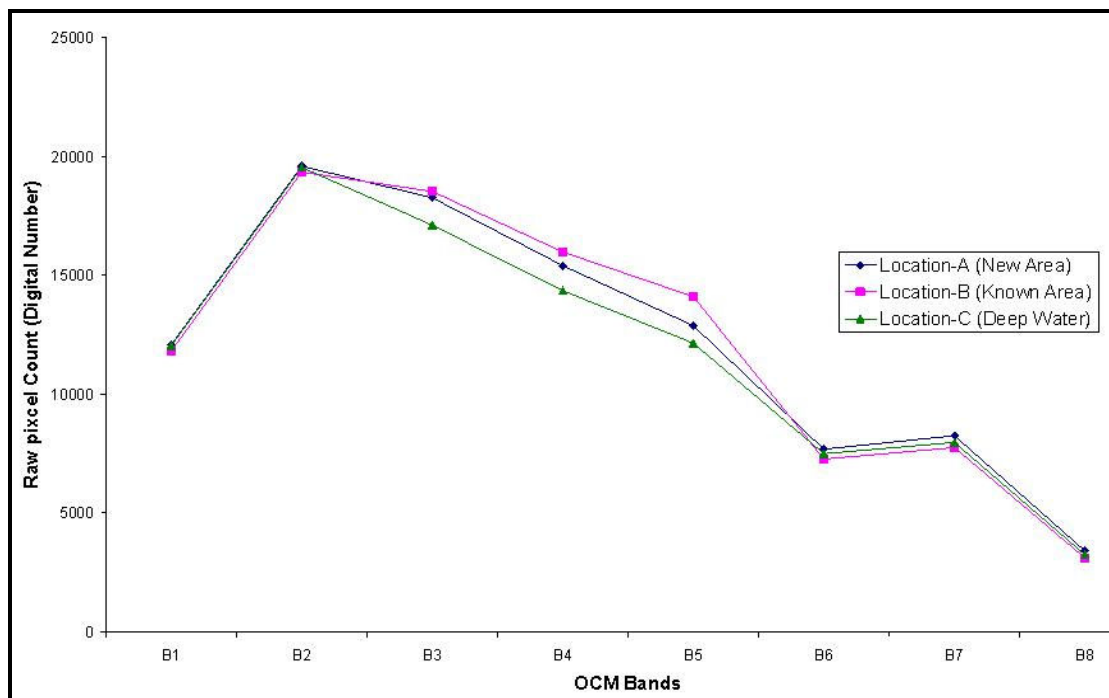
submerged reef area at location A, location B is at northeast of Little Andaman is known reef area (Nayak and Bahuguna, 1997) and at location C for the deep water. Signatures of the submerged coral reef observed in different bands (Figure 2) deciphers the bands 2, 3, 4 and 5 recorded the signal of the submerged reef. The band 3 picked up strong signature; the same has been reported by Chauhan and Nayak, 2005. The spectral profile (Figure 3) of the submerged reef taken in the study area and known area depicts the same trend. The spectral curves depict that submerged reef distinctly separated in bands 3, 4 and 5 when compared with the deep water signature. There is slight between the signatures of the submerged reef probably due to the difference in the overlaying water column in these two areas. The signatures in the IRS-P6 LISS-III FCC with band combination 3, 2, and 1 in Figure 1 depict the reflectance of the submerged reef which is similar to other known areas. The spectral profiles are calculated in the study area at location A and location B. Signatures of the submerged coral reef observed in different bands (Figure 4) deciphers the band 1 recorded the signal of the submerged reef. The spectral profile (Figure 5) of the submerged reef taken at the locations A, B and C as marked on Figure1 depicts the same trend. The curves depict that submerged reef distinctly separated in bands 1 when compared with the deep water signature. There is slight between the signatures of the submerged reef probably due to the difference in the overlaying water column in these two areas



**Figure 1:** IRS-P4 OCM FCC (B853) acquired on February 21, 2001 and -P6 LISS-III FCC (B321) acquired on February 06, 2006 were Depict Submerged Reef off Southeast off Rutland Island in the Andaman Sea.

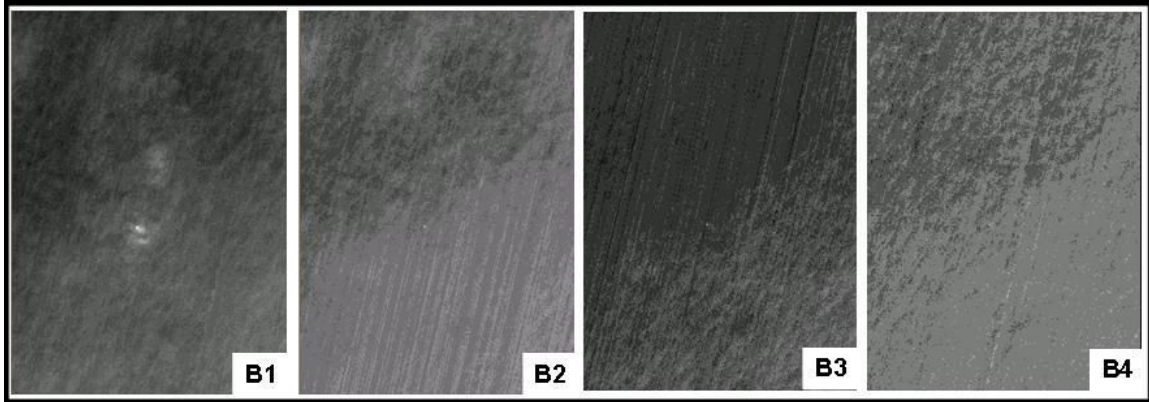


**Figure 2:** Signature of the Submerged Coral Reef as observed in IRS-P4, OCM Bands (B1-8). Bands 2, 3, 4 and 5 depicting the signature of the submerged reef, Band 3 gives the Strong Signature.

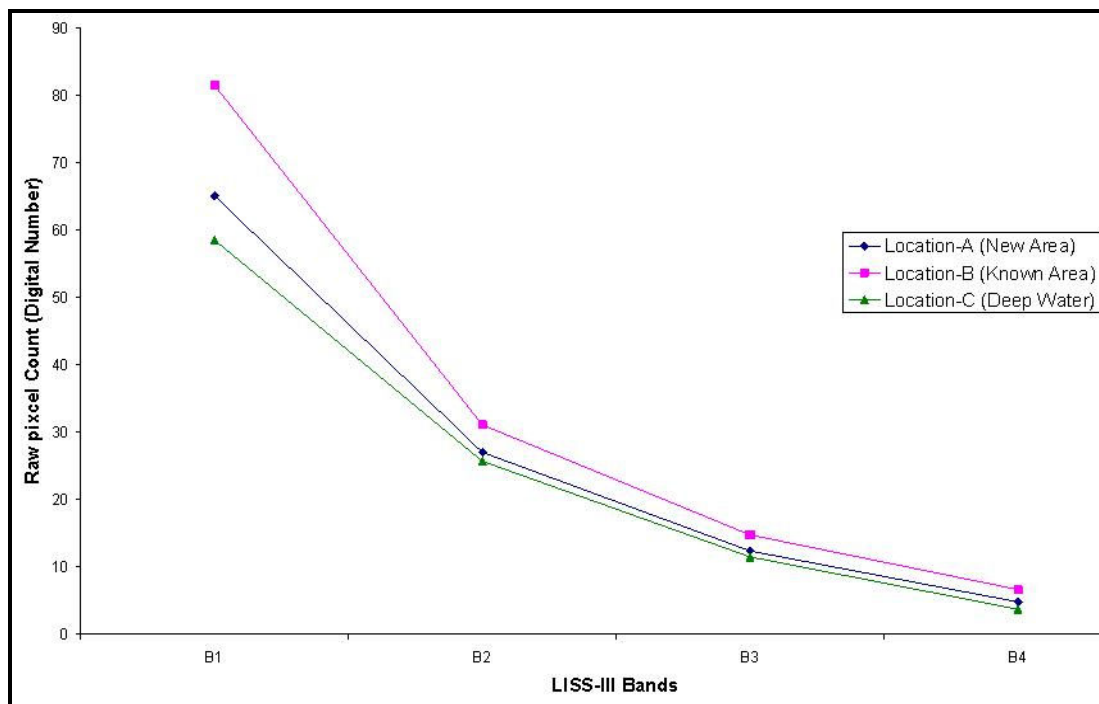


**Figure 3:** Graph Depicting the Pixel Values in the OCM at the Location A and B as Marked in Figure 1. Green Line Measured at the Deep Water.





**Figure 4:** Signature of the Submerged Coral Reef as observed in IRS-P6, LISS-III Bands (B1-4). The Band 1 Recorded the Signature of the Submerged Reef.



**Figure 5:** Graph Depicting the Pixel Values in the LISS-III at the Location A, B and C as Marked in Figure1, Green Line is the Signature of the Deep Water.

The qualitative and quantitative investigations on the spectral signatures carried out using OCM and LISS-III indicate the presence of the submerged reef bank. However, the stronger signatures picked up in the OCM due to the finer spectral resolution and the spectral channels with narrow band width.

### Conclusions:

The investigations on spectral signatures carried out in the present study using OCM

and LISS-III clearly suggest that the presence of the submerged coral reef in the study area. The bathymetric studies using GEBCO also complement to confirm the existence of the submerged reef bank in this area. It is also concluded that the OCM spectrally overtakes LISS-III in demarcating the submerged reef banks. The OCM bands 3, 4 and 5 are useful bands to identify the submerged reefs. The results of this study are useful in mapping the submerged reef areas in the offshore regions. This will also

help in the declaration of the extents of Exclusive Economic Zones (EEZs) of the country.

### References:

- [1] Chauhan, P. and Nayak, S., Detection of the Submerged reef banks in the Lakshadweep Sea using IRS-P4 OCM satellite data. *Curr. Sci.*, 2005, 89, 3, 527-560.
- [2] Nayak, S. and Bahuguna, A. 1998. Coral reefs of the Indian coast, Scientific Report, Space Applications Centre, Ahmedabad.
- [3] Nayak, S. and Bahuguna, A., Coral Reef Atlas of India. 1997, SAC/RSA/RSAG/DOD-COS/OD/13/97, Space Applications Centre.
- [4] Bahuguna, A., Nayak, S., and Roy, D. 2008. Impact of the tsunami and earthquake of 26th December 2004 on the vital coastal ecosystems of the Andaman and Nicobar Islands assessed using RESOURCESAT AWiFS data, *International Journal of applied Observation and Geoinformation*, 10, 229-237.
- [5] Deshmukh, B., Bahuguna, A., Nayak, S., Dhargalkar, V. K. and Jagtap, T. G. 2005. Eco-geomorphological Zonation of the Bangaram Reef, Lakshadweep, *Journal of the Indian Society of Remote Sensing*, Vol. 33, No. 1, 2005.
- [6] Kumaraguru, A.K., Jayakumar, K. and Ramakritinan, C.M. (2003) Coral bleaching 2002 in the palk Bay, aoutheast coast of India, *Current Science*, 85(12), 1787-1793.
- [7] Sarawut Ninsawat, Nitin Kumar Tripathi, Michiro Kusanagi, Frederic Borne and Kathe Jensen (2003) Mapping Coral Reefs of Phi Phi Island Using Remote Sensing and GIS for Integrated Coastal Zone Management, *Proceedings of the Regional Conference on DIGITAL GMS, AIT, Thailand*
- [8] Ninsawat, S., Tripathi, N. K., Kusanagi, M., Borne, F. and Jensen, K. 2003. Mapping Coral Reefs of Phi Phi Island Using Remote Sensing and GIS for Integrated Coastal Zone Management, *Proceedings of the Regional Conference on DIGITAL GMS, AIT, Thailand*
- [9] Palandro, D., Andréfouët, S., Muller-Karger, F. E., Dustan, P., Hu, C. and Hallock, P. 2003. Detection of changes in coral reef communities using Landsat-5 TM

and Landsat-7 ETM+ data. *Can. J. Remote Sensing*, 29 (2), 201-209.

- [10] Lugo-Fernández, A. and Gravois, M. 2010. Understanding impacts of tropical storms and hurricanes on submerged bank reefs and coral communities in the northwestern Gulf of Mexico, *Continental Shelf Research*, doi:10.1016/j.csr.2010.03.014

- [11] Purkis, S. J. and Riegl, B. 2005. Spatial and temporal dynamics of Arabian Gulf coral assemblages quantified from remote-sensing and in situ monitoring data. *Mar Ecol. Prog. Ser.*, 287, 99-113.