J. Terr. Mar. Res. Vol. 1(1) 2017:7-11.
Journal of Terrestrial and Marine Research

Waveland Scientific Publications
wavelandscientificpublications.com/journal-of-terrestrial-and-marine-research-jtmr/

ISSN:2456-7639

Research article

Identification of Mangroves Habitation in Tsunami Inundated areas using RISAT-1 Satellite Data

E. YUVARAJ[1*], K. DHARANIRAJAN[1], M. SAVURIRAJAN[2], J. BALASUBRAMANIUM[2], C. SANTHOSH KUMAR[2]

[1]Department of Disaster Management, Pondicherry University, Port Blair, India.
[2]Department of Ocean Studies and Marine Biology, Pondicherry University, Port Blair, India.

Abstract

A decade after 2004 Indian Ocean tsunami, studies on its impacts is still rolling. Apart from its negative impacts, there are fresh mangrove habitat formation was observed in tsunami affected areas of Andaman and Nicobar Islands. In this study, habitation of new mangroves area were delineated using the RISAT-1 SAR data in the South Andaman Island. Initially Pre and Post-tsunami landuse and landcover change map was prepared using multi-spectral images. The tsunami inundated areas were identified through prepared LULC map. While interpret this map with the processed SAR data it shows the presence of fresh habitation of mangroves in the inundated areas. The In-situ field survey confirmed the same. The study found that HV polarized image of RISAT-1 shows that the presence of mangrove vegetation in more accurately than HH. The result of field studies shows that SAR data can be used for mapping mangroves habitat in the tsunami inundated areas.

Keywords: Inundated area, Mangroves, RISAT-1, SAR, Tsunami

Introduction

Indian Ocean Tsunami results in enormous impacts on the coastal states of India; Andaman and Nicobar Islands (ANI) were affected drastically by the tsunami inundation impacts (Ramanamurthy et al. 2005). Mangroves are the most affected coastal ecosystem in this catastrophic event and its resulting sea water inundation (Roy and Krishnan, 2005). The impacts vary according to the geomorphology of mangroves of this Island (Yuvaraj et al. 2014a). Presently the rejuvenation of mangroves observed in many parts of the ANI (Das et al. 2014). Remote Sensing and GIS are the indispensible tools that playing an important role in monitoring these mangrove ecosystems (Singh et al. 2004).

Studies regarding the analysing of Indian mangrove ecosystems using SAR are less. For the region like ANI the cloud cover was prominent, because of rainfall for over 200 days in a year (Andrews and Jayaraj, 2005).This problem is addressed using Synthetic Aperture Radar (SAR) is an active form of remote sensing in which a microwave signal is used to detect the object even in the cloud covers areas (Heumann, 2011). This advantage of the SAR is used to mapping and monitoring the mangroves all the climatic conditions than other remote sensing techniques (Pereira et al. 2012).The backscatter values of RISAT image was used for classification of mangrove ecosystem (Chakraborty et al. 2013). The backscatter co-efficient of SAR can be used to quantify the relative biomass of the mangrove forest (Lucas et al. 2007). In this study an approach made for identify the restoration of mangroves in the Tsunami inundated areas of South Andaman Islands using SAR image.

Study area

Southern part of South Andaman Island was taken as study area stretching from 11°47’ N to 11°28’ N and 92°31’ E to 92°47’ E (Figure1). Indian Ocean mega tsunami and tectonic subsidence in 2004 devastate the low lying lands of South Andaman Island which also results to inundation of sea water in the coastal land cover features such as agriculture lands, plantation, settlements, sandy beaches, forest, mangroves, coral reefs and mudflats (Dharanirajan et al. 2007). These inundated areas of South Andaman Island was taken as study sites and monitored frequently using satellite images as well as *in-situ* field verifications.

Methodology

The fine resolution RISAT-1 SAR data coupled with LISS optical images were used in this study. The

Manuscript Information:

Received: 09 December 2016 / **Revised:** 27 December 2016 / **Accepted:** 29 December 2016 / **Published:** 31 December 2016 /
Corresponding Author: yuvaerd22@gmail.com

RISAT-1 image was acquired on 28 June 2013. Multi-spectral images of IRS 1D LISS III (1998) and (2005) were used for mapping LULC map. The high resolution sensor imgages such as LISS IV and RISAT-1 FRS-2 images were used for monitoring of inundated areas (Table 1).

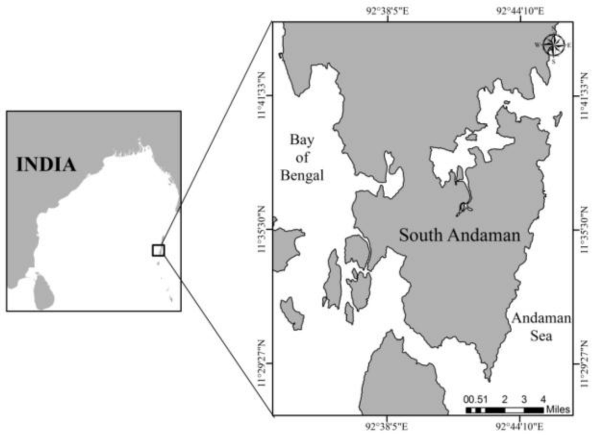

Fig.1. Study area of South Andaman Island

The RISAT-1 SAR data rectified using geo-corrected LISS-IV image and geometric accuracy was maintained with in a pixel. A 3×3 enhanced-Frost filter was applied for speckle attenuation (Rodrigues and Souza-Filho, 2011). Coastal Landuse and Land cover features were mapped using visual interpretation techniques (SAC, 1991). Apart from the classification techniques which are more complicated for this island scenario the features are identifed and digitized onscreen (Yuvaraj et al. 2014b). Tsunami Inundated areas were delineated and are monitored continuously using LISS IV satellite images and RISAT backscattered images. The backscatter co-efficient was calculated using formula given by NRSC (Rao, S. S.,et al., 2014)

$$\sigma_0(dB)=20\log_{10}(DN_p)-K_{dB}+10\log_{10}(\sin(i_p)/\sin(I_{center}))$$ ---------- (Eqn.1)

Radiometric calibration requires four inputs

DN_p : (Image pixel value), K_{dB} : Calibration Constant in dB, i_p : Incident angle for pixel position, I_{center} : Incident angle at the scene center. Backscattering coefficient images were filtered using a median filter with 3*3 window size.

Result and Discussion

By comparing the pre and post tsunami landuse and land cover maps the inundated areas of were identified. It shows the areas of Dollygunj, Sippighat, Mithakhari, Govindapuram, Saithankahri, Chidyatapu, Wandoor, Port Mount and Tirur are affected by tsunami inundation (Figure 2). Coastal flat lands and low-lying areas where plantation and vegetation activities are practised are the areas which were affected by this catastrophic event. The total inundated area of South Andaman covers around 772 ha. The area is continuously monitored using satellite images and field survey.

The RGB of SAR image is made from dual polarisation data by considering Red-HH, Green-HV, Blue -HH. When comparing all the images of figure 3, RGB shows the inundated area, whereas HH images shows more speckles which includes mangroves, dune grasses and mudflats and these feature cannot able to delineate. But the HV image shows clear delineation of inundated areas and mangroves (Figure.3C). This is due to volumetric scattering in vegetative area (i.e Mangroves) has exhibit higher backscattering coefficient than specular reflection in sea water inundated area.

Table 1. Details of Satellite images used for the study

S.No	Satellite	Year	Resolution	Sensors
1	IRS 1D	1998	23.5 metre	LISS III
2	IRS 1D	1998	23.5 metre	LISS III
3	IRS P6	2009	5.6 metre	LISS IV
4	IRS R2	2013	5.6 metre	LISS IV
5	RISAT	2013	6 metre	SAR

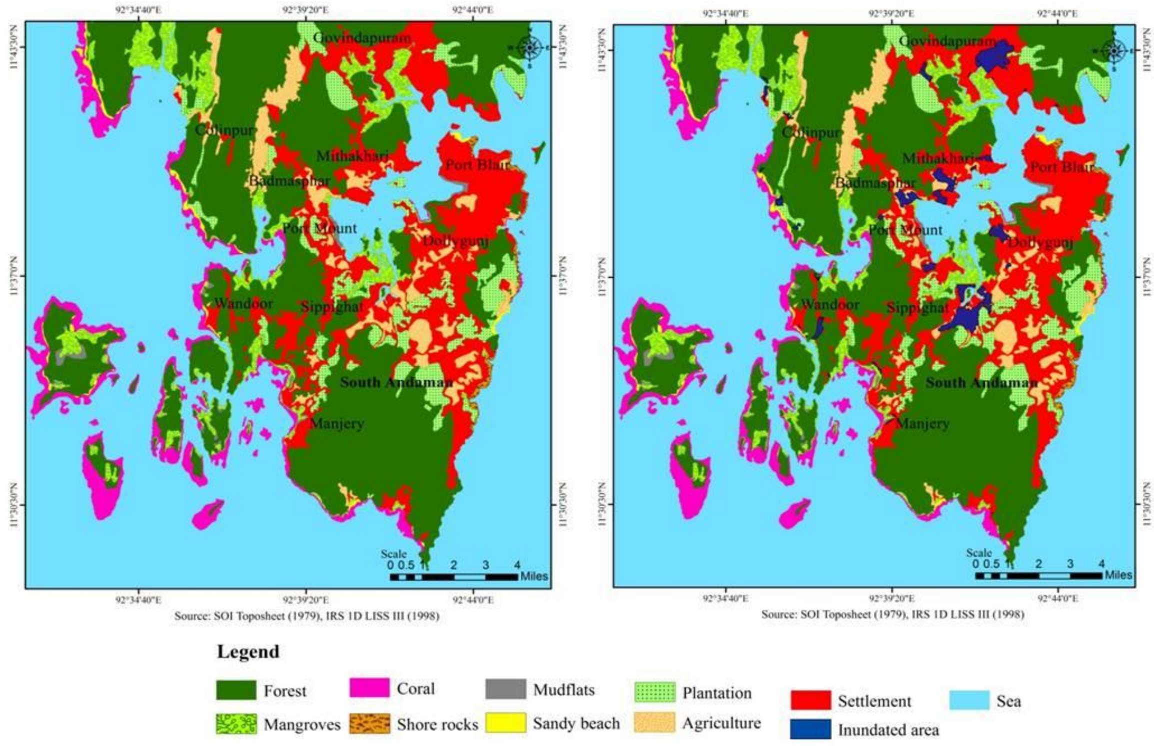

Fig. 2. Pre and post tsunami Landuse and Land cover map of the study area

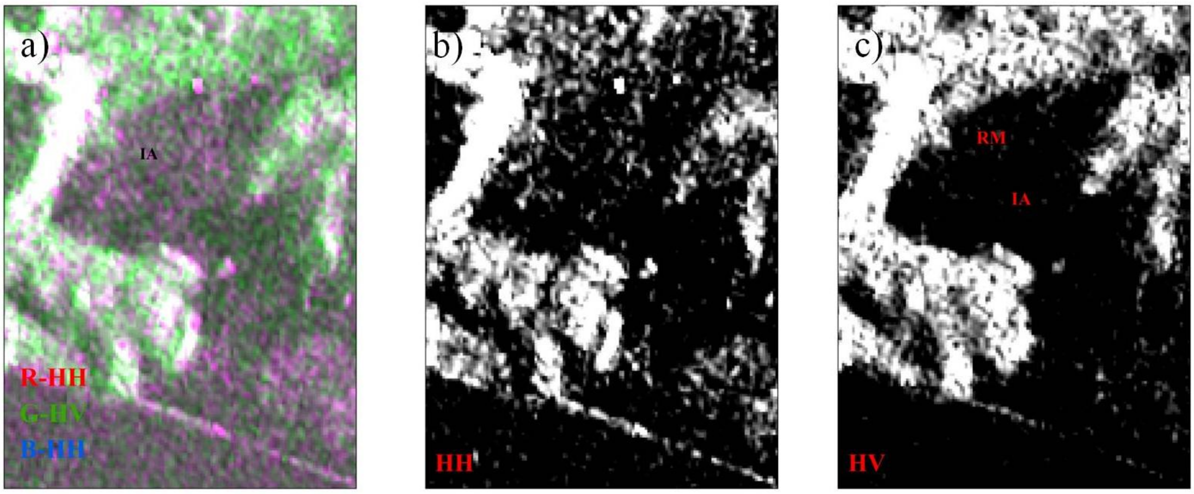

Fig. 3. a) RGB of the SAR image (HH, HV, HH) Shows the inundated area (IA) of Mithakhari **b)** It is difficult to delineate backscatters from mudflats and mangroves in the inundated area of HH image **c)** In HV image inundate area (IA) was clearly delineated with coarse spots.

The HV polarized image of RISAT-1 clearly shows the formation of vegetation habitat in the areas of Mithakari (Figure 4). Backscatter co-efficient of the vegetation shows near similar values of the existing mangroves of the island. So the field visit were conducted for identify the vegetation. The field survey confirms that the vegetation was mangroves (Figure 5). Mangrove vegetation in the image were delineated and the area covered by the fresh habitation was estimated based on the pixel coverage. The fresh habitation of mangrove is occupied around 2.48 ha in the parts of inundated area. Species such as *Avicennia marina, Rhizophora apiculata* and *R. mucronata* are observed during the field visit. This shows salt tolerant capacity of mangroves that adapt to the saline environment than any other trees (Hogarth, 2010). Various salt tolerant capabilities such as breathing root system and salt excreting leaves etc. (Naskar and Mandal, 1999) leads mangroves to establishing its ecosystem in the tsunami inundated areas of South Andaman Island. The rejuvenation in the newly formed intertidal areas were also due to changes in coastal geomorphology (Das et al, 2014).

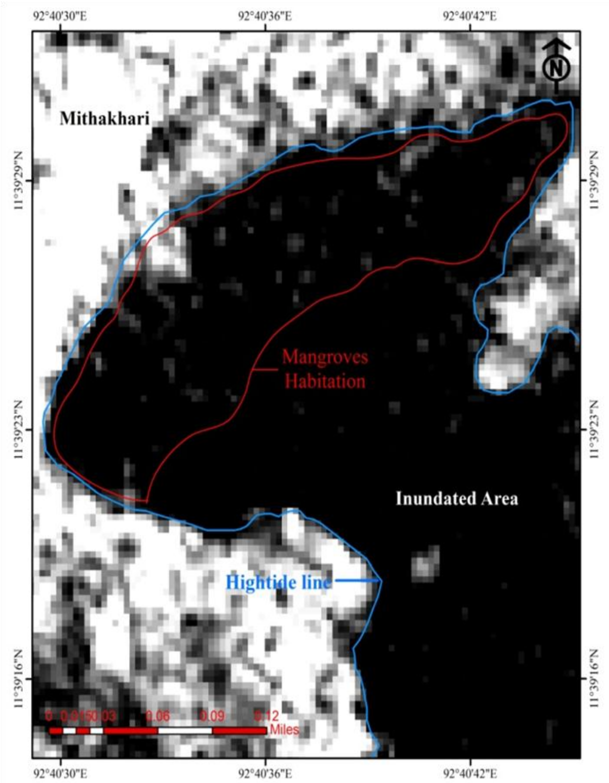

Fig. 4. HV image of RISAT-1 shows the fresh mangrove habitation in tsunami inundated area of Mithakhari.

Fig. 5. Field photo showing fresh mangrove habitation in inundated area of Mithakhari.

SAR images showing significant application in monitoring the mangrove ecosystem (Pereira et al. 2012). The data from the C-band could be used to provide quantitative information of mangroves (Kovacs et al. 2006). Cross-polarized radar (HV or VH) returns result from multiple reflections within the vegetation volume used to delineate the mangrove vegetation from its surrounding environment (Chakraborty et al. 2013). Thus, the HV polarization of C-Band RISAT image shows the clear delineation of mangrove vegetation in the inundated area.

Conclusion

The inundated areas of South Andaman were identified using pre and post tsunami landuse and landcover map. These inundated areas are continuously monitored using satellite images. SAR images used to identify and delineate the fresh habitation of mangroves in the tsunami inundated areas. This is due to higher backscatter from volumetric scattering of the mangroves when compare to the adjacent inundated sea water. Among the dual polarized images of RISAT-1, HV polarisation shows the mangrove vegetation clearly which used for the delineation of mangrove vegetation from its adjacent environments. This study concludes that high resolution cross polarized microwave images provide wide application in monitoring these newly forming marine ecosystems. This study recommends that it is in need to monitor the fresh habitation of mangrove for the better ecosystem management and conservation measures.

Reference

1. Chakraborty, M., Panigrahy, S., Rajawat, AS., Kumar, R., Murthy, TVR., Haldar, D, and Kundu, S. (2013). Initial results using RISAT-1 C-band SAR data. Curr. Sci.104 (4): 490-501.
2. Das, AK., Jha, DK., Devi, MP., Sahu, BK., Vinithkumar, N. V, and Kirubagaran, R. (2014). Post tsunami mangrove evaluation in coastal vicinity of Andaman Islands, India. J. Coast. Con, 18(3): 249-255.
3. Heumann, BW. (2011). Satellite remote sensing of mangrove forests: Recent advances and future opportunities. Progress in Physical Geography, 35(1): 87-108.
4. Hogarth, P, and Hogarth, P. J. (2007). The biology of mangroves and seagrasses (No. 2nd Edition). Oxford University Press.
5. Kovacs, JM., Vandenberg, CV, and Flores-Verdugo, F. (2006). Assessing fine beam RADARSAT-1 backscatter from a white mangrove (Laguncularia racemosa (Gaertner)) canopy. Wetlands Ecol. Management, 14(5): 401-408.
6. Lucas, R. M., Mitchell, A. L., Rosenqvist, A., Proisy, C., Melius, A. and Ticehurst, C. (2007). The potential of L-band SAR for quantifying mangrove characteristics and change: case studies from the tropics. Aquatic conservation: Marine and Freshwater Ecosyst 17(3): 245-264.
7. Naskar, K. and Mandal, R. (1999). Ecology and biodiversity of Indian mangroves. Daya publishing house, Delhi.
8. Pereira, FRDS., Kampel, M, and Lignon, M. (2012). Mapping of mangrove forests on the southern coast of São Paulo , Brazil , using synthetic aperture radar data from ALOS / PALSAR. Geomatica, 3(7): 567–576.
9. Ramanamurthy MV., Sundaramoorthy, S., Pari Y. Ranga Rao, V., et al. (2005). Inundation of sea water in Andaman and Nicobar Islands and parts of Tamil Nadu coast during 2004 Sumatra tsunami. Curr. Sci. 88 (11): 1736-1740.
10. Rao, SS., Sahadevana, DK., Wadodkar, MR., Nagaraju, MSS., Chattaraj, S., Joseph, W, and Amminedu, E. (2014). Soil Moisture Model with Multi Angle and Multi Polarisation Risat-1 Data. ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences. 1:145-150.
11. Rodrigues, SWP, and Souza-Filho, P. W. M. (2011). Use of multi-sensor data to identify and map tropical coastal wetlands in the Amazon of Northern Brazil. Wetlands. 31(1):11-23.
12. Roy, SD, and George, G. Marine resources of islands: status and approaches for sustainable exploitation/ conservation with special emphasis to Andaman and Nicobar. (2010). Indian J. Ani. Sci, 80(4): 57–62.
13. SAC, (1991),'Manual for mapping of coastal wetlands/landforms and shoreline changes using satellite data', Space Application Centre (ISRO), Ahmedabad, India. Report No: IRS-UP/ SAC/ MCE/ TN/32/91, pp 28-38.
14. Singh, IJ., Singh, SK., Kushwaha, SPS., Ashutosh, S, and Singh, RK. (2004). Assessment and monitoring of estuarine mangrove forests of Goa using satellite remote sensing. J. Indian Soc. Rem. Sen, 32(2): 167-174.
15. Yuvaraj, E., Dharanirajan, K., Jayakumar, S. and Saravanan. (2014a). Geomorphic settings of mangrove ecosystem in South Andaman Island: A Geospatial Approach. J. Earth Syst. Sci, 123 (8):1819-1830.
16. Yuvaraj, E., Saravanan, and Dharanirajan, K. (2014b). Assessment of Landuse and Landcover changes in South Andaman Island using Remote Sensing and GIS. Int J. Geomatics Geosci, 5 (1): 171 -181.