REMOTE SENSING FOR CORAL MAPPING AND MONITORING OF CORAL BLEACHING IN COASTAL WATERS OF VIETNAM

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Abstract

Coral reef is one of marine habitats have high primary production   but also is high sensitive. Due to comfortable conditions in humid tropical region, coral reef in coastal waters of Vietnam sea develop very well with their distribution stretch along from North to South areas. During the past several decades, coral reefs in many parts of the world have been subjected to a series of   bleaching events, including some coral reef areas in coastal waters of Vietnam.   This paper introduce some experiences on the coral mapping in coastal area of Vietnam and also design a plan for monitoring coral bleaching by remote sensing techniques.

Keywords: Coral mapping, early warning system, coral bleaching.

I.   INTRODUCTION

Vietnam lie in humid tropical area with coastal habitats such as coral reef, sea grass bed, mangrove forest, etc,… develop very well. Coral reefs in Vietnam distribute along coastal areas from North to South as well as in offshore waters (Spratly and Paracell Archipelagos) - figure 1 . Due to importance aspect of this habitats, many projects on the coral mapping   have been carried out   in coastal area of Vietnam (Ninh Thuan, Khanh Hoa, Phu Quoc,   Da Nang, Quang Nam,…) but   the assessment   of   natural disasters that effect to coral reef is still few. Effect of global warming and Elnino   is reasons causing coral bleaching   in   Con Dao , Phu Quoc islands in July 1998 (V S Tuan 2002) as well as Con Dao island during October 2005 (T. P. H Son – 2005) have been discussed in some papers but   how do we monitor and detect   the coral bleaching   in coastal waters of Vietnam sea is opened. The aim of this papers will present some experiences on the coral mapping in coastal waters of Vietnam and design a plan for monitoring the coral bleaching by remote sensing techniques.
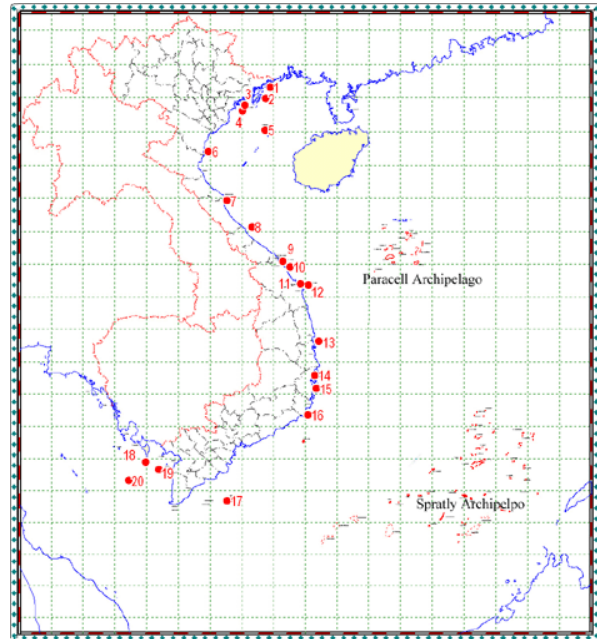

Figure 1 : Distribution of coral reefs in coastal areas and offshore seas of Vietnam.

II. SOME EXPERIENCE   ON   THE CORAL MAPPING IN COASTAL WATER OF   VIETNAM SEA:

In the recent time, some projects on the coral mapping have been carried out in coastal waters of Vietnam such as in Ninh Thuan province (T. P. H Son 2004),   Danang province ((T.P. H. Son 2005), Phu Quoc Island (2006), Khanh Hoa province   (T.P. H. Son 2007), etc,…   These results are premises for detail studies on coral reef distribution in coastal waters of Vietnam sea   as well as help for detecting of the coral bleaching in near future.

1. Depth Invariance Index method: Base on method of "Depth Invariance Index" some coral reef area in coastal waters of Vietnam have been detected (figure 2)
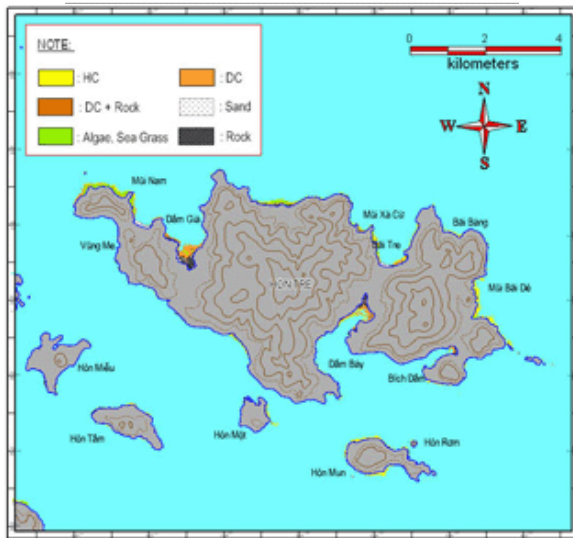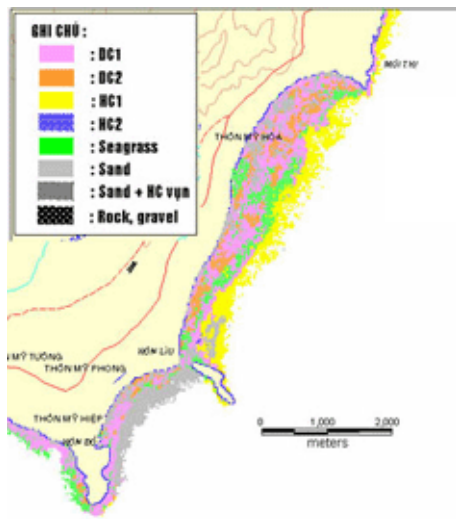
Figure 2: Coral reefs in coastal waters of Ninh Thuan province (upper) and Nhatrang Bay (under) have been detected by method of Depth Invariance Index

In order to process the distribution of coral reef, beside the geometry and radiation correction, some other importance steps need to deal with such as atmospheric correction and water column correction,…

The atmospheric correction have been deal with by method of " Dark Pixel subtraction" as well as 6S tool (referred from website ftp://kratmos.gsfc.nasa.gov/6S/), in which the second methods give better results. In this step we use a lot the parameters for processing such as gain and offset (or Lmin and Lmax), time and day of the image acquisition, sun elevation, ordinate of scene center (collect from Metadata file) as well as mean solar exoatmospheric spectral irradiance - ESUN for each spectral band.

In the water column correction, the choice of the sand areas in difference depth is the best important step.

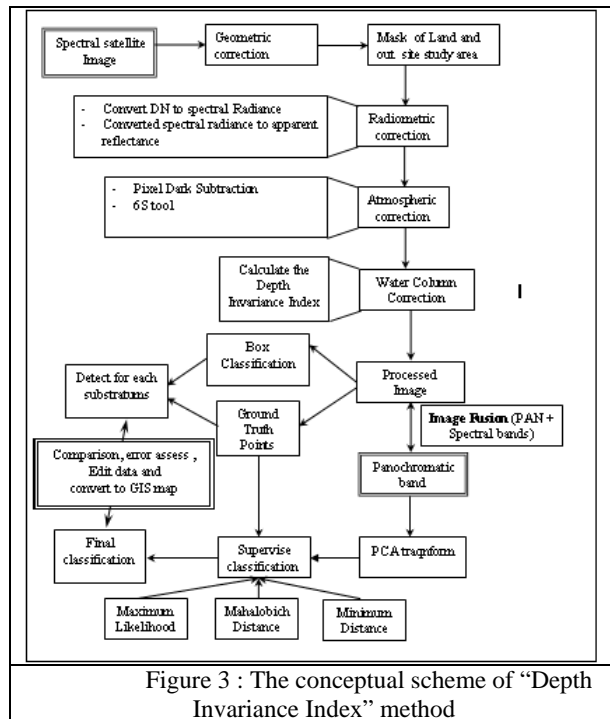The conceptual scheme of "Depth Invariance Index" method show in figure 3

Figure 3 : The conceptual scheme of "Depth Invariance Index" method

A test of using " Depth Invariance Index" for coral mapping from ALOS sensor (AVNIR2 - resolution 10 m) and PRISM - 2.5m with date 17 July 2007) have just carried out in islands in Nha Trang Bay. The results show that, AVNIR2 with spatial resolution 10 m with four spectral bands can detect well distribution of coral reef compare with Landsat ETM+, ASTER and SPOT 5 as well (figure 4 and figure 5)

2, Image Fusion Method : The fusion method combined images with high resolution (but monochromatic image) of aerial photographs with the multi-spectral bands of satellite image. This technique was performed through the Geometry correction (orthorectification) of aerial photograph and the satellite image that has same coordinates and projection. Combine (Merge) multi-spectral information of satellite image (low resolution) with spatial information of aerial photograph (high resolution) to create a new multi-spectral image that contains more information (both spectral and special resolution compare with initial images) .

By this method, some coral reefs in deep waters (25m and more) in coastal water of Ninh Thuan have been detected (figure 6)

3, Using spectral aerial photograph: Base on data set of aerial photograph (21 scenes) in Phu Quoc Islands , we detected detail coastal habitats in this region. Due to high resolution (0.4m) of aerial photograph and their

deeper water penetration we can detect easily underwater habitats . Combine with a lot ground truth data , we can digitize all of substratum directly in screen and convert to GIS map. Some results show in figure 7   However, this method need high cost and   not that don't exist data in all of Vietnam territorial.
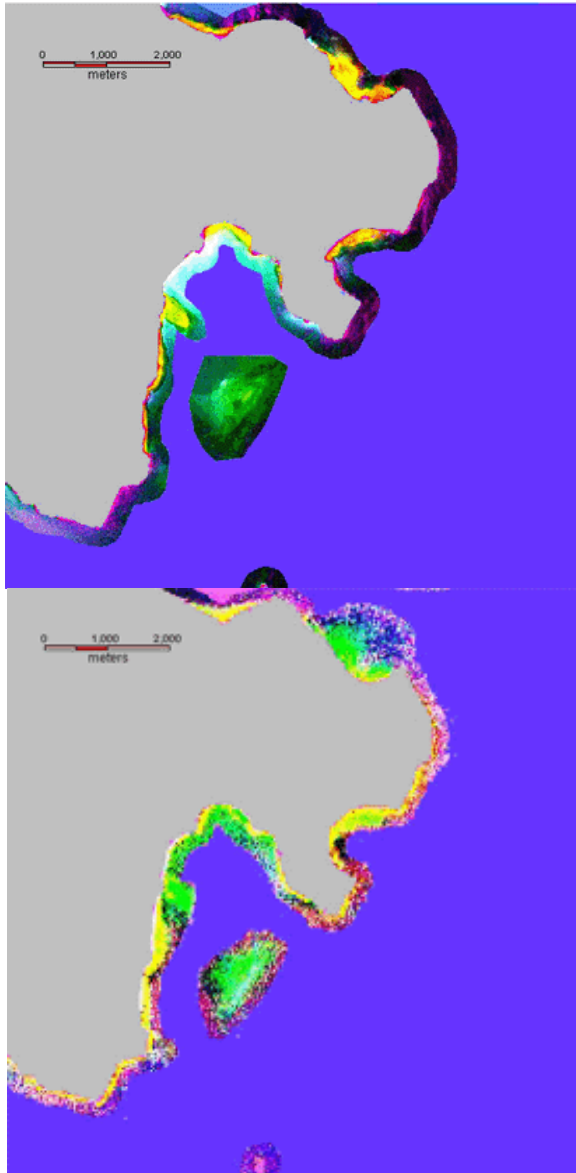

Figure 4: Comparison between results obtain from AVNIR2 (left) and Landsat ETM + (right) in coral reef in Ninh Van (shallow water 5 – 7m) , show that AVNIR2 give better results
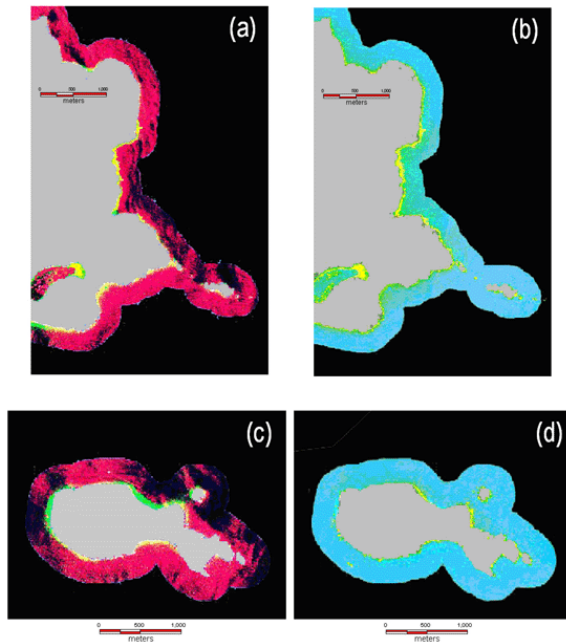

Figure 5: Comparison between processed results obtain from AVNIR2 (left) and Landsat ETM + (right) in Tre and Mun Island   (deep water of   12 – 15m) , show that AVNIR2 (a) and (c) give better results   compare with SPOT5 (b) and (d)
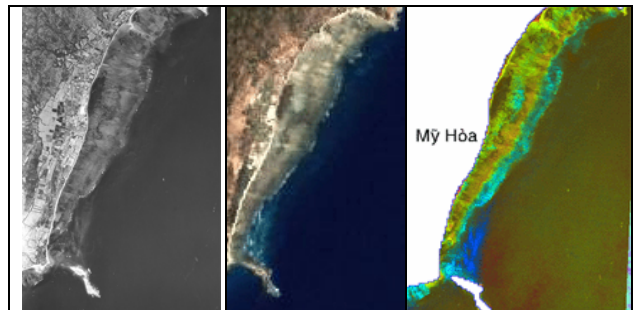

Figure 6: Fusion method for enhancing the coral reef in coastal water of Ninh Thuan (aerial photograph - 2m resolution (left), Color composite of Landsat ETM+ - 30m resolution (Mid) and   merged result (right)
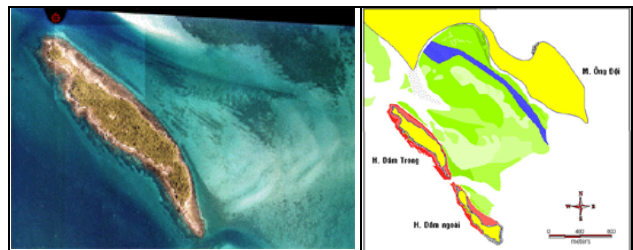

Figure 7: Aerial photograph take Dam Trong Island (left and processed GIS map (right) obtain from this image sourc show the seagrass bed with difference cover levels (gree color) and coral reef (red color) as well as navigatio channel (blue color).

We hope that existed experience from above mention results will be premises for detecting the coral bleaching in some coastal areas of Vietam sea by ALOS imagery. The first, some areas have been chosen for detecting such as Con dao Island during July 1998 and October 2005, and Phu Quoc Island during July 1998.

III) Using ocean color imagery for monitoring of the coral bleaching: One of main reason causing the mass coral bleaching is global warming . We can detect and monitoring this parameters easily. Monitoring of SST from earth-orbiting infrared radiometers has had a wide impact on oceanographic science. We can use difference imagery source for detecting Sea Surface Temperature such as AVHRR, Seawifs and MODIS. In present time NOAA/NESDIS proposed a method for monitoring and early warning of the coral bleaching by SST. Some parameters have been used as : SST anomaly, Hot spot and Degree Heating Week (DHW) . The methodology for calculation of these parameters show clearly in papers of Strong. A. E and other (1996, 1997, 2000).

We hope that, base on this remote sensing techniques with some improves in concrete condition in Vietnam sea and combine with ALOS imagery for detecting mass coral bleaching. The first, some areas have been chosen for testing such as Con dao Island during July 1998 and October 2005, and Phu Quoc Island during July 1998.

The early warning system of coral bleaching will be created in South East Asia in the near future.

REFERENCE :

1. T.P.H.Son, V.S.Tuan, L.V.Khin. 2005 : Application of Remote Sensing and GIS for coral reef mapping in the coastal waters of Ninh Thuan Province (Vietnam) - in the 8th International Conference on Remote Sensing for Marine and Coastal Environments at 17-18 May 2005 in Halifax – Canada.
2. Tong Phuoc Hoang Son and Phan Minh Thu 2005 : Some pre-analysis techniques of remote sensing images for land-used in Mekong delta .- The international geoinformatic Journal – March/2005 - pages 25 – 29 .
3. T.P.H.Son and others 2005 : Application of Remote Sensing and GIS for coral reef mapping in the coastal waters of Phu Quoc Island – Report of UNEP project 2006
4. T.P.H.Son and others 2007 : Application of Remote Sensing and GIS for coral reef mapping in the coastal waters of Khanh Hoa province – Report of national project 2007
5. Strong, A. E., E. Kearns and Gjovig, K. K., 2000: Sea Surface Temperature Signals from Satellites - An Update. *Geophys. Res. Lett, 27*(11): 1667-1670 (June 1, 2000).
6. Strong, A. E. and C. Duda, 1997: New AVHRR product - Coral Reef HotSpots.
7. Strong, A. E., C. S. Barrientos, C. Duda and John Sapper, 1996: Improved Satellite Techniques for Monitoring Coral Reef Bleaching.