

**MAPPING THE COASTAL ZONE
BY INTEGRATING RADAR AND OPTICAL DATA
IN THE SOUTH BALI ISLAND**

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ABSTRACT

The use of remote sensing technology for mapping and monitoring resources has become useful. The large area coverage, spatial information, repeats coverage and timeliness have all been recognized as advantages of using the remote sensing approach. This technology has evolved to include SAR sensors, which offer additional advantages of all weather, day or night data collection capability as well as synergism between SAR data and optical data.

In this study used Radarsat Fine Beam Mode, which was acquired in March 1999 and Landsat TM, was acquired in August 1997. Topographic Map 1:50,000 from aerial photography in 1981/1982 used to geometrically correct the two images. From classification result, in the coastal zone of South Bali were identified eight type of land cover: open water, mangroves, coconut plantation, built up area, paddy field, reclamation area, Port Benoa and Ngurah Rai Airport. Quantitative evaluation of the accuracy of each classification was considered to be an essential component of image analysis.

INTRODUCTION

Recently, remote sensing technology has been an efficient and helpful tool to mapping and monitor resources in a large area. It has become well developed since the launch of ERTS-1 (renamed Landsat) in the early 1970s. The main problem in mapping and monitoring resources areas is cloudy condition. The best instrument to do this is Synthetic Aperture Radar (SAR) sensors, which offer additional advantages of an all-weather, day or night data collection. (Brown, et al, 1996; Tetuko, et al, 2001).

In Indonesia space based remote sensing technology and its applications entered in conjunction with the initiation of Landsat program too, in 1972. Considering the

country's position as the world's largest archipelagos state with more than 1700 islands stretching 5100 km from far east to west along the equator, its intentions of utilizing this technology for inventory, exploitation and monitoring of its natural resources is very high. As commonly found in the developing countries, where the availability of natural resource data are very limited, Indonesia requires much efforts on preparing natural resources quick data, accurately and with a high degree reliability. These conditions can only be met by applying remote sensing technology, which allows providing real time data, multitemporal, multispectral and in continuous manner (Soesilo, 1994). Radar imagery, which can be acquired through clouds or at night, is ideal for the tropical country like Indonesia. All the Indonesia optic images that acquired in ten years between 1974-1984 reported that 3 percent from those images have cloud cover between 0-10 percent (Murni, 1997). So, for the land cover mapping at the primary level and sometimes at secondary or higher level of classification is quite effective with SAR data and the need to update land cover or land use maps too.

In this study, it also would like to revision of the previous map about the coastal zone in South Bali. Bali has long been developed as a tourist resort, spread along the beach. However, on the other side of the beach, there is a mangrove forest exist there (Saraswati & Rahardjo, 1999; 1998). The mangrove forest is help protecting the coastal areas from erosion (Tanaka, 1994). As a tourist resort, there is a reclamation project, which changed over the land cover. This project destroyed the area of mangrove forest, but for the local people is very useful. The island is now being connected to the main island (Bali).

METHODOLOGY

Scene Info

The Radarsat and Landsat TM are used to support this study. The Radarsat image was Fine beam mode 4, it was acquired in March, 13, 1999. Landsat TM was acquired in August 20, 1997. Besides those images, a topographic maps scale of 1:50.000 from aerial photography in 1981/1982 has also been used (BAKOSURTANAL, 1992).

Image Processing

In this study, the image analysis has been used PCI EASI/PACE version 6.2 software package. First, doing some correction activities such as radiometric and geometric correction. The program is Antenna Pattern Correction (APC), to correct radiometric distortions and remove artificial brightening. The correction is performed by APC is based upon a least-squares polynomial function to estimate the mean grey level at each pixel location in the input image. By using a polynomial, a smooth correction can be defined (Anon, 1997; Richards, 1995). Calibrated Radarsat data used

to correct for both effects of differing illumination across the swath and the processor induced scaling and offsets and to calibrated radar backscatter. The images were registered with the 2nd polynomial order and resampling with nearest neighbour assignment and the Root Mean Square (RMS) should below 1 (Lillesand & Kiefer, 1994 ; Schowengerdt, 1997). Ground control points collected from topographic maps and the RMS were $x = 0.00$ and $y = 0.00$.

In the enhancement process, tried to give the radar image some filters. Filtering is available by using such kinds of Enhanced Lee Filter, Kuan Filter, Gamma Map Filter, Enhanced Frost Filter and Median Filter with the different windows. After that, the Radarsat image was converted from 16 bit to 8 bit using a linier stretch, divided into 256 classes. Data fusion between Radarsat image and Landsat TM referred to the process of created a new colour image by fusing the colour component of one input image with the intensity component of another input image (Schott, 1997). This was used the red, green, blue (RGB) to intensity, hue, saturation (IHS) transformation on the Landsat TM with the following bands $R=TM5$, $G=TM4$ and $B=TM3$ (Cavalcanti, et al, 1998). In this paper tried to use Brovey transform, is a formula based process that works by dividing the band to display in a given colour by the sum of all the colour layers (RGB) and then multiplying by the intensity layer from Radarsat data (Anon, 1997). The classification has been done by unsupervised classification with K-means classifier (Schowengerdt, 1997; Latifovic et al, 1999).

RESULT

Image enhancement by using various filter, for Kuan Filter demonstrated the best result (see Table 1). Kuan filter smoothes the image data without removing edges sharp features in the image. The resulting filter has the same form as the Lee filter but with different weighting, it can be considered to be superior to the Lee Filter (Anon,1997). From the Table 1, showed parameters examined from images describe above and prove effectiveness of Kuan filter 3x3 that highly preserved mean and standard deviation, which means that information in filtered image, was not significant.

In the qualitative analysis of two data fusion methods showed that Brovey transform was produce better contrast and visualized more objects for visual interpretation compared with IHS transform. In IHS transform, the cloud cover (blue colour) from the TM data was clearly detected rather than in Brovey transform. Another object was built up area; in the Brovey transform was better contrast than in HIS transform. See also Figure 1.

Furthermore, in Serangan Island, there was a reclamation project for tourist resort. From the Landsat TM, which was acquired in August 1997, Serangan Island hasn't connected to the main island yet. Meanwhile from the Radarsat data (March, 1999), the island was already connected. The site of the reclamation area was very clearly in the Radarsat image than in TM image.

Table 1. Initial Statistic Extraction

No	Filter & Size	Minimum	Maximum	Mean	Std dev
1	Unprocessed	0	65535	5767.5	6688.3
2	Median 3x3	217	65535	5317.9	4754.5
3	Median 7x7	592	65535	5082.1	3884.4
4	Kuan 3x3	397	65535	5764.0	5102.7
5	Kuan 7x7	759	54428	5765.0	4586.6
6	Gamma Map 3x3	4	65535	6087.1	5655.8
7	Gamma Map 7x7	5	65535	6050.4	5816.9
8	Enhanced Lee 3x3	11	65535	6273.5	5879.8
9	Enhanced Lee 7x7	9	65535	6361.7	6073.8
10	Enhanced Frost 3x3	11	65535	6343.0	5831.7
11	Enhanced Frost 7x7	9	65535	6432.9	5991.9

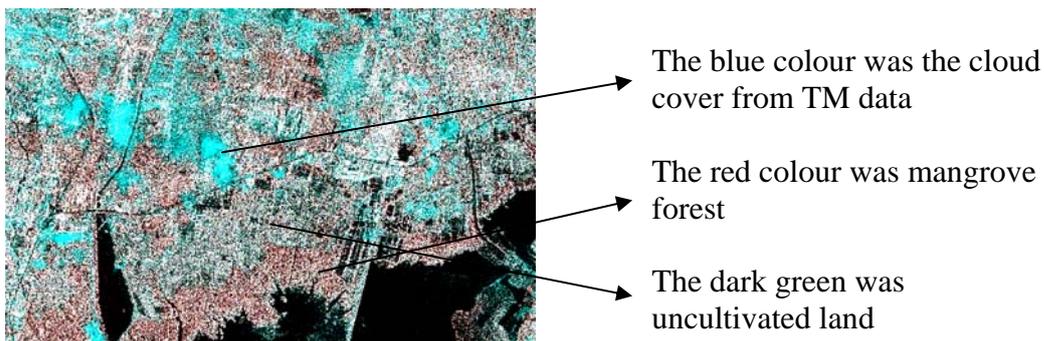


Figure 1. HIS transformation between Radarsat and Landsat TM data

In the Landsat TM, the foundation of the reclamation area (underwater) was clearly detected. However it was difficult to detect the boundary of the reclamation in the Landsat TM than in the Radarsat data. The area of reclamation from the classification image was about 57.19 ha.

The result of unsupervised classification in the coastal zone of South Bali were: Ngurah Rai Airport, Port of Benoa, open water, mangroves, coconut plantation, uncultivated land, built up area, reclamation area. Here was the description :

1. Ngurah Rai Airport was clearly differentiated by their rectilinear shape, size and dark grey tonal.
2. Port of Benoa was square shape and bright tonal

3. Open water was strait, fishpond and rivers, determined by the shape and the black tonal
4. Mangroves and coconut plantation have rather similar tonal. However mangroves have rather dark tonal, because coverage by water, and coconut plantation has less dark than mangroves and uncultivated was light grey tonal
5. Built up area was spotted on the image because of the white and shiny tone which contrasts with the grey tone of surrounding area
6. Reclamation area has bright tone than the main island.

SUMMARY

In the coastal zone of South Bali were identified the land cover consist of : Ngurah Rai Airport, Port of Benoa, open water, mangroves, coconut plantation, uncultivated land, built up area, and the reclamation area.

In the qualitative analysis of two data fusion methods showed that Brovey transform was produce better contrast and visualized more objects for visual interpretation compared with IHS transform.

Radarsat Fine Beam Mode data has a potential to identify the reclamation area than Landsat TM data. Filter Kuan is more effective to indicate whether the main island or the reclamation area. The reclamation area gives a benefit to the local people; they got more easily to go to the Bali Island. However the mangrove forest around that area was destroyed..

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