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# OPERATIONAL USE OF RADARSAT AND OPTICAL DATA FOR COASTAL LAND COVER MAPPING

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**KEY WORDS :** Multi – sensor, Data Fusion, Coastal Land Cover

**ABSTRACT :** Multi – sensor data of Radarsat and Landsat – 5 TM Bands 4 and 5 were acquired on September 26, 2000 and June 26, 1997 for a test site of Thailand 's Ban Don Bay. The data display a large amount of information by color differences. It can be seen that these are not only meaningful in terms of land cover type differences but also provide topographic information. The result demonstrates how multi – sensor can be used to map coastal land cover of the largest Birdfoot delta area. Mangrove forest in red is excellently separated from yellowish green of mixed orchard. Pink to cyan color, in flood plain area are covered with paddy field. Within this area, where the deposites are older, many growing rubber trees are in greenish yellow. On Radarsat image, aquaculture activities can be easily detected such as shrimp farming and fish farming due to their dark tones of water surface resulting from low or no radar return and high contrast with bright tone, of both shrimp dikes and various shapes of fish trap.

## INTRODUCTION

An operational earth observation, optical sensors have proven an efficient tool for many applications. Imagery acquired by them offer various wavelengths and reveal specific information about ground features. In somecase, the information derived from optical sensor is ambiguous, especially among classes with standing tree or flooded vegetation. The development of SAR system has lead to increase interest and can be merged to opitical sensor for gaining more information. Coastal land cover mapping also needs multi-sensor data to extract a specific information. Vegetation with standing water under canopies and aquaculture features have been clearly seen on SAR image, resulting in very bright. Because, this situation is caused by double bounc of the radar from the tree to water surface under the canopies and back towards to sensor as well as the radar from the tree itself. As for the aquaculture features, the phenomenon is resulted by coner reflector effect from aquaculture features and water interactions. To create an operational approach, the idea of fusing radar with optical data was carried out by using RADARSAT-1 and LANDSAT-5 TM data. This fusion data can be provided many different land cover categories and could be considered as operational use for mapping. Consequently, this fusion product can be distributed to user who has limitted time working. It is an easy choice for user to make decisions inwhich each technique performs best.

## OBJECTIVE

To create an operational fusion data for mapping coastal land cover

## TEST SITE

Test site located approximately between latitude 9° 06' – 9° 27' N and longitude 99° 06' – 99° 27' E. It covered the Gulf coastal plain in southern Thailand from Ban Don Bay in Surat Thani province southward to the largest Tapi river run across the Gulf coastal plain. The dominent physiography is a Bird's foot delta which is formed by sediment of a river where it flows into the gulf. Generally the shoreline is covered with mud flats and mangrove forest. Off the coast, there are a lot of aquaculture features for fish and shell farming. Beyond shoreline to south ward, paddy field is commonly seen on flood plain, while rubber and oil palm plantations are grown on undulating or hilly area.

## REMOTELY SENSED DATA AND OTHER DATA

### Satellite Data

RADARSAT-1 and LANDSAT-5 TM were selected as input. LANDSAT-5 TM was acquired on June 26, 1997 and RADARSAT-1 C-band HH was taken on September 26, 2000.

### Field Information

Ground truth data was collected after two mouths RADARSAT acquisition date. Many land cover classes were observed.

### Other Related Information

Topographic maps which were produced by the Royal Thai Survey Department and an existing land use map from Land Development Department at a scale 1:50,000 were used for supporting image identification.

## LIMITATION, CONCEPT AND METHODOLOGY

### Limitation of SAR data

Usually, radar data has been provided in digital form and unusual data format.

Generally, radar data is contained only one frequency or one polarization, that mean data will be presented in black and white and difficult to identify coastal land cover classes

Note that, mangrove forest and mixed orchard components along the coast which they are the main vegetation, could not be easily separated using LANDSAT data alone. Because the spectral reflectance for mangrove and mixed orchard in swamp area were similar in either low tide and high tide stages. While, SAR data concept, a multiple interaction between vegetation and water, and complex dielectric constant are mainly considered. SAR sensor will exhibit strong backscatter from mangrove forest or other flooded vegetation standing water under canopies.

## CONCEPT

The combination of the near infrared and infrared bards on LANDSAT TM with RADARSAT greatly expands the spectral sensitivity range of the data set.

## METHODOCOGY

The simple image processing tools of data fusion are RADARSAT and LANDSAT TM band 4 and 5 data. Before entering the data into merging, a certain pre – processing is necessary. This includes speckle noise reduction on RADARSAT data and geometric correction. The specified speckle KUAN filter with 3 x 3 windows was applied. As for, image correction procedure, LANDSAT TM data was done first. About 38 homogeneous distributed ground control points (GCP) were defined to transform the image. The residuals of the GCPs are smaller than 1 pixel on x and y directions, The first order polynomial transformation with nearest neighbour method is applied and then resampling to 12.5 $m^2$ pixel sizes. Then, RADARSAT data has been spatially registered and use the same resampling method. Finally, a simple fusion method was done in order to access visually the value of multi – sensor, a color composite image was generated by assigning a color composite (RGB) to those different images. Red was assigned to RADARSAT, green to TM band 4 and blue to TM band 5. The color composite showed differences in the backscatter and reflectance of vegetation, soil and water units. In terms of color theory, It is relatively easy to understand the meaning of colors and understand the radar return signal.

## RESULT

The fused image was shown in figure 1. It provided a better interpretation capabilities for coastal land cover mapping. The variation in color composite indicated the difference in the backscatter and reflectant of vegetation units, Espectially, difference types of mangrove forest, Sonneratia alba specie which it is a pionier mangrove tree growing in sandy mud near the mouths of tidal rivers influence, the red color along the coast corresponding to Sonneratia specie. Sonneratia will provide a very high backscatter due to the nature of the canopy elements and leaf orientation. The greenish yellow color corresponding to Rhizophora species and mixed mangrove species. Rhizophora species which they are stronly associated with estuarine rivers with soft muds under tidal influence. Although, Rhizophora is a flooded mangrove forest, a factor of its camopy elements and leaf geometry are effect. A vertical branches and leafs have reduced radar backscatter for HH backscatter of RADARSAT. As well as, the yellowish green with coarse texture corresponding to mixed orchard. Aquacultural features appeared to be easy to detect from RADARSAT data. They have been clearly seen in difference shapes both V – shape and rectangular shape. Because of the result of corner reflector effect caused by regularly arranged from the bamboo poles of those features. Coastal land cover categories were derived from visual interpretation . The image interpretation keys used to identify includes tone, texture, pattern, shape and association. The coastal land cover types were investigated into 14 classes in table 1. Figure 2 showed visually interpreted coastal land cover identification and map.

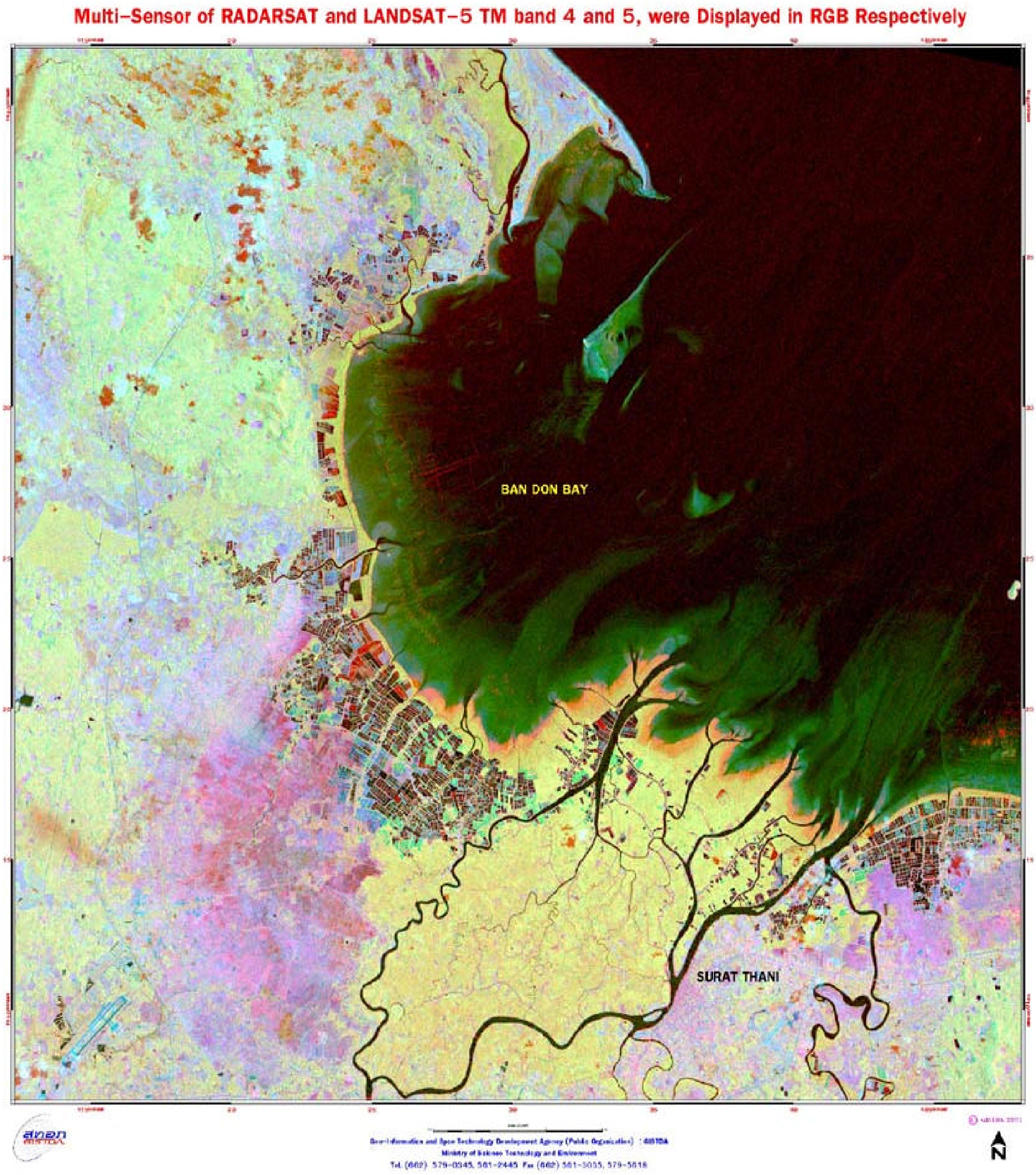


Figure 1 Multi – Sensor of RADARSAT-1 and LANDSAT-5 TM Band 4 and 5, Were Displayed in RGB Respectively.

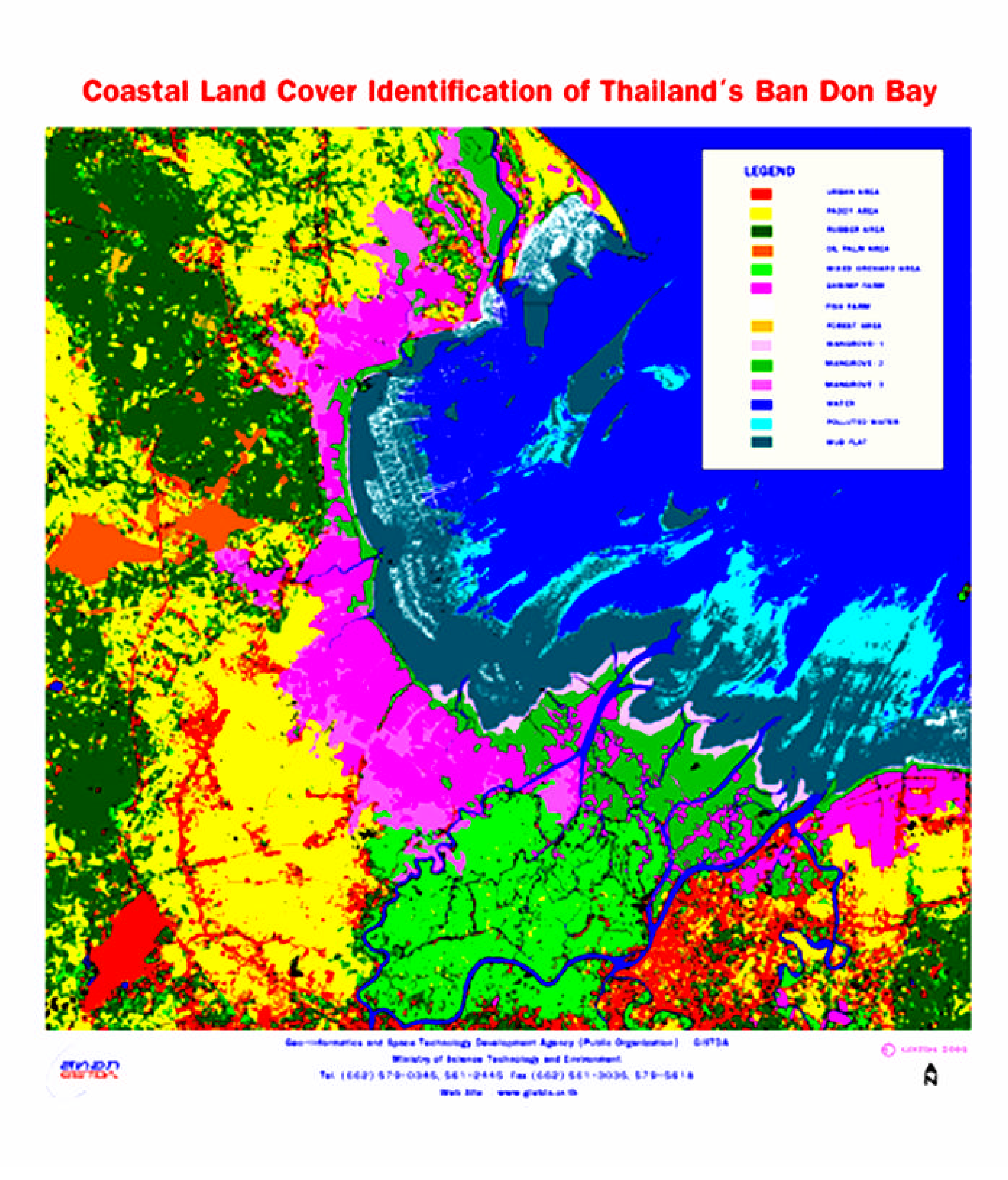


Figure 2  Visually Interpreted Coastal Land Cover Map of Thailand’s Ban Don Bay.

| No | Class | Description | Color | Area km$^2$) |
|---|---|---|---|---|
| 1. | Urban | City and Village includes pavement | Red | 81.35 |
| 2. | Paddy | Paddy Area | Yellow | 212.37 |
| 3. | Rubber | Rubber Plantation | Dark Green | 195.85 |
| 4. | Oil Palm | Oil palm Plantation | Orange | 14.05 |
| 5. | Mixed Orchard | Mixed Orchard | Light Green | 73.25 |
| 6. | Shrimp Farms | Shrimp Farms | Magenta | 73.90 |
| 7. | Fish Farm | Fish Farms | White | 11.58 |
| 8. | Forest | Forest Area | Powder Orange | 1.43 |
| 9. | Mangrove 1 | Mangrove (Sonneratia Alba Species) | Powder Pink | 8.47 |
| 10. | Mangrove 2 | Mangrove (Rhizophora Species and Mixed species | Green | 43.68 |
| 11. | Mangrove 3 | Disturbed Mangrove Forest | Pink | 38.85 |
| 12. | Water_1 | Water bodies | Blue | 328.82 |
| 13. | Water_2 | Polluted Water | Cyan | 39.89 |
| 14. | Mud Flat | Mud Flat | Greenish Blue | 123.23 |
| | | | Total Area | 1246.72 |

Table 1 Coastal Land Cover Identication of Thailand’s Ban Don Bay

**CONCLUSION**

The best identification of coastal land cover type with data fusion of operational earth observation of RADARSAT-1 C – band HH image and LANDSAT-5 TM is achieved by visual interpretation using backscatter and reflectant in term of tone and color, texture, pattern, shape and association. In addition, to understanding of local cultural practices, knownledge of topography and ground information are essential to make a good coastal land cover map.

The fused image is very useful tool for map updating. However, a precise data registration and SAR data filtering should be carefully processed in order to retain the identification accuracy of map.

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