BASELINE MAPPING OF THE PHILIPPINE-SABAH TURTLE ISLANDS USING SPOT SATELLITE IMAGERY

Abigail Joy A. Ramos
World Wildlife Fund – Philippines
aramos@wwf-phil.org.ph

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ABSTRACT

Essential for the effective management of a marine habitat is the availability of accurate and current baseline information representing the general characteristics of the habitat's various ecosystems. The Turtle Islands, located in the Sulu Sea is regarded as one of the remaining major nesting population of green turtles in the ASEAN region. Active coastal processes characterize these islands as well as a small number of human populations whose land and marine-based activities have exerted pressure on the region's remaining resources. Critical information regarding the existing coastal and land resources, bottom cover characteristics, as well as an in depth understanding of the existing threats would facilitate in the efficient implementation of conservation activities in the region.

With the onset of satellite technology, coastal and habitat mapping of the area was carried out for the purpose of providing the baseline information necessary for effective management. Various remote sensing techniques were adopted leveling of with an image enhancement procedure using the RGBI technique. This RGB (Red/Green/Blue) to ISH (Intensity/Saturation/Hue) transformation was adopted to clearly delineate the extent of the boundaries of existing land and marine based features. ISOCLASS unsupervised classification was selected to interpret the various land cover and land use activities, and to determine the geographic extent and health conditions of coral reef covers within the protected area. Finally, to measure the extent of the turtle's nesting area, an automated scheme designed to detect the existing shoreline of each islands will be adopted. To facilitate data processing, adequate ground truth information on the existing coastal zone features as well as the distribution of the various resources were gathered from the region.

1   INTRODUCTION

On nine small islands located within the Sulu Sea, rare species of turtles have found a haven to nest and breed. Aside from the turtle habitats, these islands support a large variety of marine fauna and flora such as corals and various fishes and several species of birds (*WWF, 1998*). These islands have been declared as the Turtle Islands Heritage Protected Area, the world's first transfrontier protected area for sea turtles, and stands as the only remaining major nesting population of green turtles in the ASEAN region. Due to the remoteness and sheer sizes of these islands, one of the severe limitations in working in this part of the region is the lack of sufficient baseline information for the protection of the habitat. The only existing map of the region is a 1:50,000 scale topographic map, which is not sufficient enough to provide for basic biophysical information about the region. Various active coastal processes and multiple land-based activities characterize the islands and such baseline information is important in complementing the conservation initiatives being done by both countries today.

With the application of satellite technology, the use of satellite imagery in coastal and habitat mapping is very efficient in defining a clearer understanding of the processes that occur in the area. Information on the various land cover features as well as an accurate idea of the geographic extent of bottom coral cover, along side with a general classification of the different underwater features would provide for sufficient information about the uniqueness of the coastal environment. Furthermore, nesting and hatchery sites are located on the shores or beach area, thus a clear delineation of its extent would help in the proper zonation of human settlements, as well as in the understanding of the active coastal processes that occur along the shorelands. Threats such as coastal erosion, sedimentation and siltation particularly from Sabah region during the Southwest monsoon (October to March), that affect the quality and status of coral reef structures can also be seen as well.

In view of this concern, the utilization of SPOT satellite imagery and the application of various remote-sensing techniques will be employed to (1) interpret the various land cover classes; (2) identify the general zonational patterns of the coral reefs area and the dominant benthic communities present; and (3) perform a robust system for shoreline detection develop by the Center for Space and Remote Sensing Research in China Taipei in order to estimate the extent of nesting and

hatching area of the turtles. And lastly, to determine the extent of sedimentation and siltation due to land based activities in Sabah, Malaysia.

Preliminary processing would involve the RGBI technique, which takes the Red-Green-Blue image and sharpens it by replacing Intensity with data from the Panchromatic image, then transforming back to RGB formula. This would enhance the existing image for a more accurate visual interpretation and serve as input to further image processing. The ISOCLASS unsupervised classification has been adopted for both land and bottom cover characteristics, in order to present a general yet accurate idea of the features present in the area.

Finally, despite some limitations, the application of remote sensing on coral reef studies particularly in the utilization of SPOT data is adequate for providing baseline information on the location of the reefs, their general zonational patterns, and the dominant benthic communities found in these islands.

2   MATERIALS AND METHODS

2.1   STUDY AREA

The Turtle Islands is located at the southwestern tip of the Philippines, lying adjacent to the international treaty limits that specify the boundary between Malaysia and the Philippines. It is about 1,000-km southwest of Philippine capital, Manila and 40 km north of Sandakan, Sabah, Malaysia. These islands cover a total land area equivalent to about 320 hectares, supporting a small number of populations particularly among the islands belonging to the Philippine archipelago. Thus land-based activities should be taken into account in the proper management of the coastal and land resources. Baguan Island, Philippines and the three Malaysia group of islands have been declared as a marine turtle sanctuary. Appropriate laws and policies have been implemented with regards to fishing practices and in regulating sustainable economic activities in the region.

2.2   DATA COLLECTION

SPOT HRV multispectral and panchromatic images of the area were both taken last May 15, 1999 at 20m and 10m resolutions, respectively. These were processed to level 1B basic preprocessing level, incorporating radiometric and geometric corrections. Ground truth survey was done during the last week of August of the same year. The survey involved the gathering of ground control points using a Global Positioning Systems unit, as well as the verification of existing land cover and land use patterns of each island.

2.3   METHODOLOGY

Geometric corrections were performed on both the multispectral and panchromatic images using a known point registration based on the identifiable features in the image that have known coordinate locations.

2.3.1   LAND USE CLASSIFICATION

To improve visual interpretation, a RGB to ISH transformation was performed to enhance the image while combining the panchromatic image to the three bands and retransforming ISH to RGB to produce high resolution pseudo color synthetic images. The pseudo color images were further enhanced with the linear enhancement method and smoothed by a 3x3 matrix operation to reduce noise. Finally, to define the boundaries more sharply, an edge sharpening method was adopted with a 5x5 matrix. From then, an accurate interpretation of the land features can be achieved which would serve as input to further image processing. Finally, the ISOCLASS unsupervised classification method was applied to the image to extract the various land cover classes present in the area and for which area statistics are generated.

2.3.2   BOTTOM COVER CLASSIFICATION

As satellite imagery has significant limitations in the accuracy and precision in mapping out coral reef systems, SPOT data was utilized to map the geographic extent of the reef areas as well as determine the ecosystem's health condition. Only the first two wavebands were used since the third band is completely attenuated in the water column and is therefore not useful for submerged feature detection.

Previous analysis has shown that principal components analysis enables reduction of the data set to "representative " spectra for each of the broad bottom type categories defined: healthy coral, bleached coral, algae-covered surfaces, rubble, sea grass and sandy areas. For this study, after sufficient visual interpretation through the RGBI technique, ISOCLASS unsupervised classification has been adopted and the general statistics for the classified bottom features have been calculated.

2.3.3   SHORELINE DETECTION

In order to delineate the shoreline for each island, the automated scheme developed by the Center for Space and Remote Sensing Research in Taipei on shoreline detection will be adopted. After the RGB to ISH transformation was performed, an ISOCLASS unsupervised classification method was applied to classify the saturation image into 3 clusters. Accordingly, the cluster that has the mean in the middle can be identified as the potential tideland areas, the maximum mean cluster as sea areas and the minimum mean as land areas. Subsequently, a refinement procedure will be used to remove misclassified pixel areas as potential tideland after which, the refined image will be clustered according to potential tideland areas. The extracted edge of the tideland can be then identified as the shoreline. This can be achieved by applying the HUE information for refinement.

2.3   RESULTS AND DISCUSSION

The existing land cover and land use pattern of the area was generally classified into agricultural/seasonal crops, wooded area, open areas with settlements, predominantly coconut plantations, secondary growth forest, grass/scrubland and finally, the beach area or sandy area. The classification was verified through a ground truth survey conducted August of the same year and changes in the coastal as well as the land use patterns were observed and taken into account.

Bottom coral cover is generally presented as predominantly sand with patches of corals, algae-covered corals and rocks, submerged sand in shallow waters, sea grass areas and sand areas containing rubbles particularly along areas close to the coastline. It was observe that the water column effect on the classification is apparent as depth increases. An algorithm to remove the water-column effects may need to be adopted to produce more accurate results.

In classifying the marine-based features present in the area, siltation / sedimentation has been observed at different depth levels originating from Sabah, Malaysia. This points out a concern in defining threats areas and the extent of which are harmful to the marine environment particularly the coral reef ecosystems. A general classification of the siltation event was presented based on the water depth level ranging from shallow to deep waters.

Finally, the importance of identifying the extent of the beach area in each island would define the zone for nesting and potential hatchery sites of the turtles. This would also help in studies regarding the encroachment of human settlements along the coast. Furthermore, due to the active costal processes, changes brought about by erosion or the rise in sea level can be monitored from time to time.

2.4.1   Refining the Classification

The initial classification for both land and bottom cover characteristics will be subject for further refinement procedures using the existing classification cluster centers as the starting points for the new calculations. After the ground truth survey to verify the thematic classes, a supervised classification technique is being considered for a more accurate representation of both land and water-based features.

To provide for a higher resolution image, SPOT HRV multispectral and panchromatic level 1B images will be resampled at 10m resolution. This will be achieved by combining the P band with data from bands XS1 and XS2 to produce enhanced XP1 and XP2 data. XS3 band from the multispectral data will be resampled at 10m by duplication.

3.0   CONCLUSION

One cannot undermine the potentials of using SPOT satellite imagery (multispectral and panchromatic) in providing baseline information critical in decision making processes and in the formulation of management strategies for any marine

ecosystem. The adoption of various classification techniques and the shoreline detection scheme is useful in identifying predominant reef features and its geographic extent, land cover classes as well as land use patterns and finally, delineation of the extent of the coastal habitat of marine turtles. Though sufficient enough, the methods used and applied to enhance classification techniques are subject to further refinement procedures in order to come up with more accurate representations of the divisions of spectral zones based on their reflectance values on both land and water.

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