TROPICAL CENTER FOR EARTH AND SPACE STUDIES
SPACE INFORMATION LABORATORY
GERS LAB
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The Geological and Environmental Remote Sensing Laboratory (GERS Lab) from the UPRM Department of Geology has been collaborating very closely with the Space Information Laboratory (SIL) during the past year. Such collaboration has included research projects with undergraduate and graduate students and use of the SIL resources for teaching purposes in remote sensing courses of the Department of Geology.

The main contribution during this past year is the research project summarized below. This project represents the master thesis of Gretchen Chiques, a graduate student of the Geology Department. This work was recently published in the proceedings of the 8th International Conference of Remote Sensing for Marine and Coastal Environments that was held in Halifax, Nova Scotia Canada, during May 17-19 of 2005. Also, this student will be defending her thesis during July 14 of 2005. After the defense we are planning to submit a scientific paper to a peer-review journal.

Spectral Characterization of Sandy Beaches in Western Puerto Rico

Remote sensing applications to beach system in Puerto Rico have been limited by low spatial resolution of the available images and lack of appropriate equipment for field validation. A GER-1500 spectroradiometer was used to collect reflectance measurements with a spectral range from 350 to 1050 nanometers in 15 sandy beaches in western Puerto Rico. Samples of the beaches were analyzed in the laboratory to determine the composition. Results indicate a change in magnitude in the reflectance curve compared with the composition. Higher magnitude correlated with more carbonate material concentration in the sand and lower magnitude correlated with higher concentration of dark mineral. The reflectance shows a change in the curve between 450 to 550 nanometers that is present in all 15 beaches. The spectral slope in that range was calculated and related to the composition. The results of the field reflectance measurements were compared to a high resolution (1m) of IKONOS satellite image. Using band math these images show a correlation between the field measurement and the satellite image. A methodology to obtain information about composition in sand beaches using remote sensing was developed. For the first time a spectral library of beach sand sediment for western Puerto Rico was created.

FIGURE 1: Example of IKONOS images for beaches in this study, the red squares indicates the area where reflectance measurements and sand samples were taken.

Field measurements and laboratory analyzes

Grain sand composition analyses show a correlation between the composition of the sand and the magnitude of the reflectance curve. High reflectance correlates very well with beaches of high carbonate concentration (80%-96%). The source of the carbonated material also affects the magnitude of the reflectance. Figure 2 shows the high magnitude in Playa Sucia, where the carbonate came from skeletal source (hard bodies parts of marine plants and animals). In Tamarindo west and Tamarindo east beaches the carbonate source is erosion of the outcrop. The geology of the area shows that this outcrop has been eroded by waves. However, Tamarindo west has finer material compare with Tamarindo east. Feldspars, dark minerals, and magnetite reduce the magnitude of the reflectance curve. The carbonate content in these cases decreases from 80% to 20%. Feldspars (silicate of calcium, sodium and potassium) are normally light dark and increased in several beaches from 12% to 59%. While dark minerals originated from igneous rock increased from 11-59%. The magnitude of the curves is affected by the lower carbonated content and high feldspar and dark mineral in the samples. In other beaches the dark mineral content represented more than 50% of the sample, 30% is feldspar and less than 10% is carbonate material. The other 10% are divided between quartz and magnetite minerals. Quartz and magnetite are present in most of the beaches in this study, but their concentrations are between 5-10% and they have low effect in the magnitude of the reflectance curve.

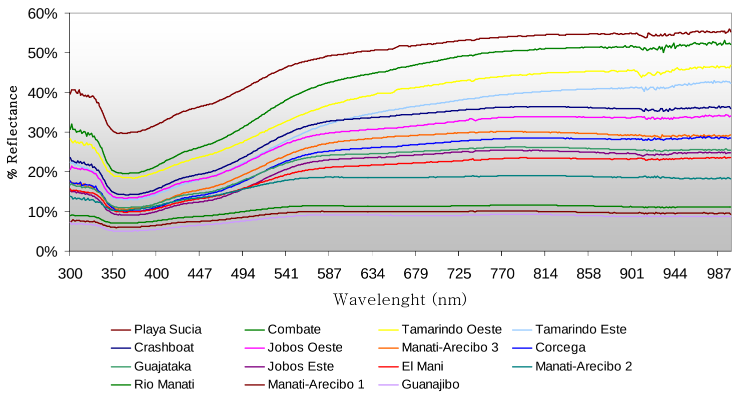

Figure 1: Reflectance curves for the 15 beaches of this study. The order of the legend corresponds to the magnitude in the reflectance. The legend is read from left to right

Satellite image analyzes

IKONOS images were calibrated radiometrically and the dark pixel substrate method was used for the atmospheric correction. Reflectance values collected with the GER-1500 spectroradiometer in the same wavelengths of the IKONOS bands were obtained. Band ratios were calculated with both datasets and plotted in order to determine their relationship. A clear trend between the maximum and minimum values of the ratios was found. This produced a good linear correlation between field and image data. The best fits were found for band ratios B1/B2, B2/B1, B3/B4, and B4/B3 (Figure 3).

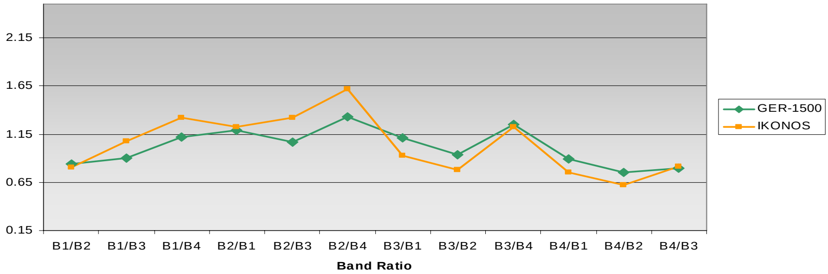

Figure 3: Comparison of the data obtained by the GER 1500 and the IKONOS images in Combate Beach. Other beaches showed the same trend.

Landsat-TM image was radiometrically calibrated and the atmospheric correction was performed using the Flash module of ENVI 3.6. The image was georeferenced with the IKONOS image. However, this image provided a low spatial resolution and it is less accurate than the other data. Only one pixel for almost every beach was available to compare. The pixels in most beaches were from wet sand and water. These two parameters affect the values and produce an inaccurate result. Figure 4 shows Landsat TM and IKONOS images, where the difference in the spatial resolution is clearly noticed.

Figure 4: Images of Landsat TM (top) and IKONOS (bottom) for Playa Sucia. IKONOS provide a better spatial resolution but it has a limited spectral resolution.