



Abstract

The quantitative characterization of the submerged biotopes of Enrique Reef, southwestern Puerto Rico, requires atmospheric and water column corrections of satellite data before performing classification algorithms. The Lyzenga (1978) method was used for deriving three depth-invariant bands based on the visible bands of IKONOS imagery. The spectral reflectance properties of corals, seagrasses, gorgonians, sponges, sand and other benthic components were obtained *in situ* by a GER 1500 spectroradiometer and used to create a coral reef spectral library. The spectral properties of the submerged biotopes provide a measure of the variability of these targets, the degree to which they could be spectrally separated using multispectral or hyperspectral imagery, and the condition of these communities for change detection due to bleaching, diseases, hurricanes, and other natural or anthropogenic impacts.

State of the Art

This work took advantage of new instrumentation and sampling techniques for the development of well-calibrated spectral libraries required for hyperspectral unmixing algorithms. The GER-1500 spectroradiometer in an underwater housing used in conjunction with a Spectralon calibrated standard, allowed us to obtain accurate *in situ* radiometric measurements to derive the percent reflectance of the various coral reef benthic components. The high spectral resolution field data was used with high spatial resolution IKONOS imagery for addressing the unique spatial/spectral requirements of coral reef ecosystems.

Significance

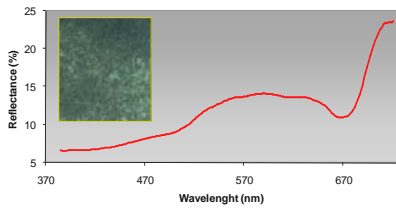
The characterization of tropical submerged biotopes is required to assess the condition of these communities due to bleaching, disease, hurricanes, and other natural or anthropogenic impacts. Monitoring the condition of coral reefs is important due to the increasing degradation of these ecosystems and the expected impacts of global climate change.

Technical Approach

An IKONOS image of La Parguera, Puerto Rico, from February 19, 2006 was used (Fig 1). We used the Lyzenga (1978) method to derive three depth-invariant bands based on the visible bands of the IKONOS imagery. Two different types of supervised classifications were used to evaluate the best technique: minimum distance algorithm and spectral pixel distribution (Figs. 2a-2d).

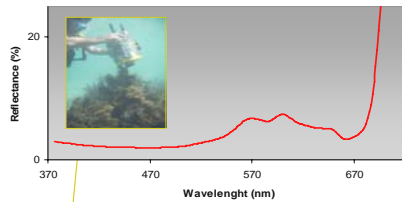
The spectral reflectance properties of corals, seagrasses, gorgonians, sponges, sand and other benthic components were obtained *in situ* by a GER 1500 spectroradiometer and used to create a coral reef spectral library. Three measurements of radiance per target were taken as well as from a standard reflectance panel. Although both shadow and full sunlight measurements were obtained, only the sunlit spectra is presented.

Thalassia Reflectance

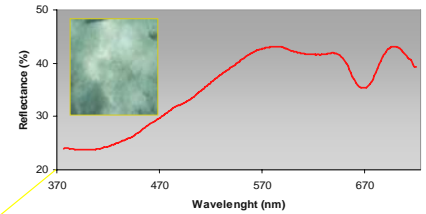


Accomplishments

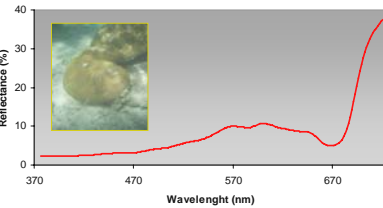
Gorgonian Reflectance



Sand Reflectance



Diploria clivosa Reflectance



Dyctiota Reflectance

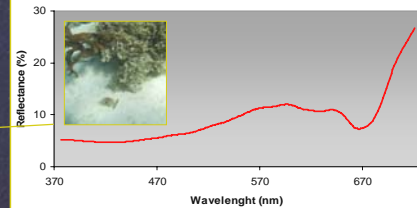


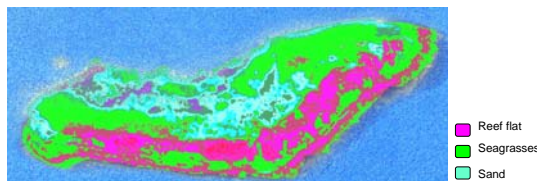
Figure 1: IKONOS image of Enrique Reef, La Parguera.

Conclusions

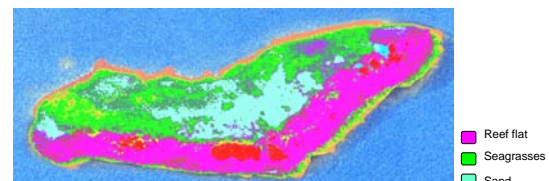
• *Dyctiota* (macroalgae), *Diploria clivosa* and the gorgonians show similar reflectance curves due to the zooxanthellae (unicellular algae) present in corals and gorgonians. Sand have the highest reflectance as expected. The seagrass (*Thalassia*) spectral curve has a broader green reflectance peak that is also characteristic of terrestrial vegetation.

• A comparison between the two classification algorithms showed that some benthic categories were better separated than others. For example, Figure 2a was best at separating sand and seagrasses. Figure 2b show a good differentiation between reef flat and seagrasses.

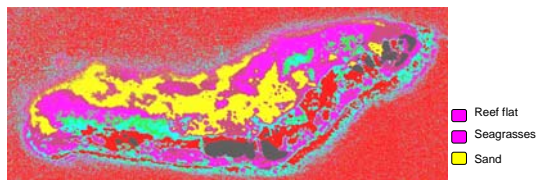
Three Level Diagram



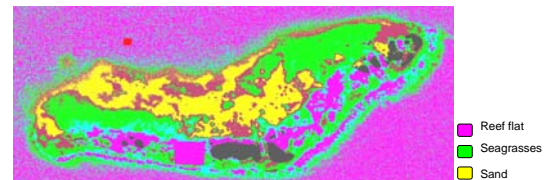
2a) Classification with pixel distribution between B1B2 on a depth invariant image



2b) Classification with pixel distribution between B2B3 on a depth invariant image



2c) Classification with minimum distance algorithm on a depth invariant image with a noise class



2d) Classification with minimum distance algorithm on a depth invariant image without noise class

Plans

- Complete the acquisition of *in situ* data on habitat type, the spectral library and depth measurements with a GPS Trimble XRS to obtain submeter positional accuracies.
- Generate an accurate benthic map of the area.
- Utilize the spectral library in the spectral unmixing algorithms.

References

D. R. Lyzenga, "Passive Remote Sensing Techniques for Mapping Water Depth and Bottom Features," Appl. Opt. 17, 379 (1978).
Grant: EEC-9986821

Contacts

- Zayas-Santiago, Carmen C. (c_castula@hotmail.com)
- Rivero- Calle, Sara (sara_erasmus@yahoo.es)
- Gilbes-Santaella, Fernando (gilbes@cacique.uprm.edu)
- Armstrong, Roy (roy@cacique.uprm.edu)

