MONITORING SEDIMENT RESUSPENSION IN CORAL REEFS AND SEAGRASS BEDS WITH MODIS AND ASTER SENSORS

Gerardo Toro-Farmer[1*], Dale A. Kiefer[1], Burton Jones[1], Thaddeus Murdoch[2] & Anne Glasspool[2]

[1]University of Southern California * torofarm@usc.edu

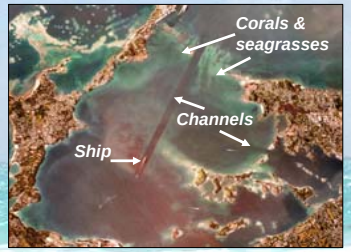
[2]Bermuda Zoological Society

Abstract

High concentrations of resuspended sediments reduce the survival of species inhabiting coral reefs and seagrass beds all around the world. We propose to demonstrate how MODIS moderate resolution and ASTER sensors can be applied to monitoring such threats in a case study of the Northern Lagoon of the Bermuda Island. This work will facilitate and improve future monitoring and management of coralline ecosystems in the study area, as well as in other coastal ecosystems.

The Problem

Navigation channels have been created to allow the access of large commercial and cruise ships from outside the reefs to ports located inside the lagoon. Ship traffic resuspend sediments which may then be transported to reefs and seagrass beds. Future governmental development plans in the area may include dredging the navigation channels to provide access to bigger cruise ships, and increasing the number of ferries crossing over seagrass beds and coral reefs.



Aerial picture (50cm resolution) showing some of the navigation channels in the area. (© 1997, 2006 The Bermuda Zoological Society)

A) Cruise ship that ran aground in June, 2006. B) Example of a scar left behind after removing the ship from the reef. (© 1997, 2006 The Bermuda Zoological Society)

Objectives

- use in-situ and satellite time series optical measurements to estimate the amount of material resuspended by navigation and the amount that reaches coral reefs and seagrass beds.
- estimate the ecological impacts of these resuspended materials.
- suggest a reliable, low cost, and low effort methodology for long term monitoring of these processes.

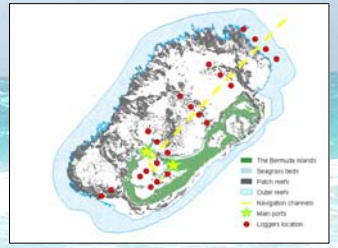
Study Area

The study will focus on the Bermuda Islands (32º N, 64º W) located in the Western North Atlantic. Although Bermuda is not considered part of the Caribbean, the Gulf Stream warms up the ocean near Bermuda, promoting the development of a variety of subtropical marine flora and fauna, including coral reefs, seagrass beds and mangroves (Smith 1998). An extensive lagoon lies between the north outer reefs and the islands containing a high diversity of corals distributed in patch reefs and seagrass beds (Smith 1998).

Landsat 7 ETM+ image of the Bermuda islands showing the location of the north lagoon. (Image credits: NASA/USGS)

Methods

Field optical measurements and remotely sensed imagery will be used to study spatial and temporal variations in the water column optical characteristics, as well as in the amount of suspended sediments along the navigation channels, and above reefs and seagrasses located at different distances from the navigation channels and between high and low traffic periods of cruise ships.



Coral reefs and seagrass beds locations. Red spots indicate planned in-situ stations.

Data collection:

***In-situ*:** water column IOPs and AOPs will be measured with a Hyperspectral ACS, and radiance and irradiance meters. Underwater light data loggers will be deployed in order to measure spatial-temporal changes in light intensity. The amount and size of suspended sediments will be estimated using a LISST particle size analyzer.

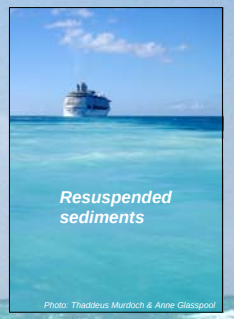
***Remotely sensed data*:** we intend to use images captured by three satellites part of the NASA's Earth Observing System (EOS): Terra, Aqua, and Landsat 7. Specifically, the sensors to be used are: MODIS (Terra and Aqua) with a spatial resolution of 250m (Band 1: 620 - 670 nm, and Band 2: 841 - 876 nm), ASTER (Terra) with a spatial resolution of 15m (Bands 1 to 3: 500 to 860 nm), and the 30m resolution Landsat 7 ETM+ sensor.

For calibration and comparison purposes, the set of satellite images downloaded must include day pass images captured by the satellite the same date the in-situ measurements are taken.

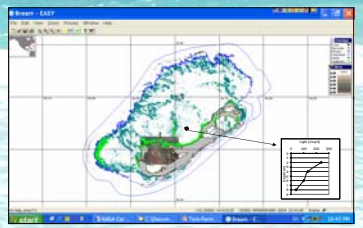
Data integration and analysis:

Data will be stored in geodatabases and analyzed with geostatistical tools. Regression analysis will be used for comparing TSS concentrations versus periods of low and high ships traffic. Absorption data at specific wavelengths will help us estimate CDOM concentrations as a result of resuspension events, and spectroradiometric measurements will be used for calculating remotely sensed reflectance (Rrs). Data from loggers will be processed and spatial-temporal false color images of light attenuation will be created. In-situ data will be imported into the EASy GIS software for later integration with remote sensed data.

Each satellite image from the time series will be digitally classified and geometric registration procedures will be employed to geo-locate the in-situ stations in the images. False color maps showing remote sensing reflectance at certain wavelengths will be created and values will be retrieved for comparisons with in-situ data.



Sediment resuspension produce by a cruise ship crossing the navigation channel (June, 2006).



Example of data visualization with the EASy GIS software

Acknowledgements

- NASA Headquarters under the Earth System Science Fellowship 2006
- Bermuda Biodiversity Project (BREAM) - Bermuda Zoological Society
- Bermuda Government Department of Conservation Services
- Wrigley Institute for Environmental Studies
- System Science Applications, Inc.

Reference

- Smith SR (1998) Bermuda. In: Kjerfve B (ed) CARICOMP – Caribbean coral reef, seagrass and mangrove sites. Coastal region and small island papers 3. UNESCO, Paris.