

# COASTAL –GILBES’ GROUP REPORT

(Performance period: March 1, 2009 to August 31, 2009)

## RESEARCH COMPONENT

### RESEARCH PROJECT SUMMARY FOR THE REPORTING PERIOD ONLY

Project	Tasks	CREST Researcher	Students involved	NOAA and Other Collaborators
Project (2) Field measurements in coastal waters for algorithm testing/development and satellite validation.	<p>Compare to satellite water leaving products and atmosphere retrievals.</p> <p>Intercomparison of the below/above water signals with aircraft and satellite data as available.</p>	F. Gilbes	<p>Vilmaliz Rodriguez (M.S. Student)</p> <p>Natlee Hernández (M.S. Student)</p>	<p>Joaquín Trinanes (Acting NOAA CoastWatch Operations Manager for the Caribbean Regional Node)</p> <p>From UPRM: Eric Harmsen Roy Armstrong</p> <p>From CSU: Carlos Ramos-Scharrón</p>
Project (3) Improvement/ Development of algorithms for remote sensing of coastal waters.	<p>Analysis of optical field measurement together with Chl, TSS concentrations.</p> <p>Evolution and tuning of algorithm for Chl retrieval in PR coastal waters.</p> <p>Development of GIS database for land sea interactions in Mayaguez Bay.</p>	F. Gilbes	<p>Vilmaliz Rodriguez (M.S. Student)</p> <p>Natlee Hernández (M.S. Student)</p> <p>Alexis Cruz (B.S. Student graduated in May 2009, now M.S. Student)</p>	<p>Joaquín Trinanes (Acting NOAA CoastWatch Operations Manager for the Caribbean Regional Node)</p> <p>From UPRM: Eric Harmsen Luis Pérez-Alegría Roy Armstrong</p> <p>From CSU: Carlos Ramos-Scharrón</p>

**Thrust:** Remote Sensing of Coastal Waters

**Project 2:** Field measurements in coastal waters for algorithm testing/development and satellite validation

**Project 3:** Improvement/Development of algorithms for remote sensing of coastal waters

- **Relevance to NOAA's mission and the strategic plan:** This project is well in view with NOAA's vision and mission that establish a comprehensive understanding of the role of the oceans and coasts to meet our Nation's economic, social, and environmental needs. It is aligned with the new priorities for the 21st century presented in the NOAA's strategic plan and in regards of coastal and marine resources through an ecosystem approach to management. The research activities are helping to develop better and most cost-effective tools to monitor coastal processes.
- **Relevance to NOAA Line Office (i.e., National Weather Service, National Ocean Service) strategic plan:** This project provides critical support for NOAA's missions of the National Ocean Service by using and validating environmental satellite data. Especially, it is creating an important database of bio-optical properties from coastal waters affected by rivers discharge. These field data are crucial to develop improved algorithms for the estimation of water quality parameters in coastal waters.
- **Supervising PI or Co-Is:** Fernando Gilbes Santaella
- **Publications (during performance period):**
  - Journal Publications with Students:**
    - ❖ Rodríguez-Guzmán, V., F. Gilbes-Santaella (2009) Estimating Total Suspended Sediments in Tropical Open Bay Conditions using MODIS. In: Proceedings of the 8th WSEAS International Conference on Instrumentation, Measurement, Circuits and Systems, Hangzhou, China, May 20-22, 2009, pp 83-86.  
[http://gers.uprm.edu/pdfs/rodriguez\\_gilbes\\_09a.pdf](http://gers.uprm.edu/pdfs/rodriguez_gilbes_09a.pdf)
    - ❖ Rodríguez-Guzmán, V., F. Gilbes-Santaella (2009) Using MODIS 250 m Imagery to Estimate Total Suspended Sediment in a Tropical Open Bay. International Journal of Systems Applications, Engineering & Development. 3(1):36-44.  
[http://gers.uprm.edu/pdfs/rodriguez\\_gilbes\\_09b.pdf](http://gers.uprm.edu/pdfs/rodriguez_gilbes_09b.pdf)
  - On-line Publications:**
    - ❖ Cruz-Benitez, Alexis (2008) Spectral Effect of Minerals in Sediments of Mayagüez Bay, 34 pages.  
[http://gers.uprm.edu/pdfs/topico\\_alexis2.pdf](http://gers.uprm.edu/pdfs/topico_alexis2.pdf)
  - Books:**
    - ❖ Fernando Gilbes and students have continued working with their chapters for the peer-review book about the oceanography and remote sensing of Mayaguez Bay, including all the work sponsored by NOAA CREST. This book will be published

in collaboration with the Center for Hemispherical Cooperation (CoHemis) of UPRM and the University of Puerto Rico Press.

- **Dollar amount of funds leveraged with CREST funds (during performance period):**

Project Title	Sponsoring Agency	PI/Co-PI/Recipient/Group	Dollars	Start Date	End Date
Study of Benthic Habitats Using Hyperspectral Remote Sensing	NSF-CenSSIS	PI: Miguel Velez Co-PI: Fernando Gilbes among others	\$50,000	March 2000	February 2010
Developing a protocol to use remote sensing as a cost effective tool to monitor contamination of mangrove wetlands	University of Puerto Rico Sea Grant College	PI: Johannes Schelekens Co-PI: Fernando Gilbes	\$30,000	June 2006	December 2009

- **Ongoing, New or Revised?:** Ongoing
- **Staff:** None
- **Students PhD:** None
- **Students MS:** Vilmaliz Rodriguez and Nathlee Hernández, UPRM-Dep. Of Geology
- **Students Undergraduate:** Alexis Cruz, UPRM-Department of Geology (this student worked in a NOAA CREST related topic, but he was not directly funded by the project)
- **NOAA Collaborators:** A site-specific algorithm has been developed and tested to estimate Total Suspended Sediments (TSS) in Mayaguez Bay. This algorithm is being incorporated in NOAA-NESDIS system as a “testing product” of TSS for Puerto Rico in collaboration with Joaquin Trinanes, Acting NOAA CoastWatch Operations Manager for the Caribbean Regional Node.
- **Other Collaborators:** Eric Harmsen (UPRM-Department of Agricultural Engineering), Carlos Ramos-Scharrón (Department of Geosciences, Colorado State University), and Roy Armstrong (UPRM-Department of Marine Sciences).
- **Operational Impact:** The on-going project aims to develop the appropriate techniques to use ocean color sensors to monitor the conditions of coastal environments. Estimates of Chlorophyll and Suspended Sediments from space can be used as proxy for the quality of coastal waters. Continuous monitoring of such parameters with satellite sensors will help to better understand and manage our coastal environments.
- **Status of the project with respect to the goals/objectives and benchmarks previously identified:** Processing of field data collected in Mayaguez Bay over the past eight years was continued. A third version of a site-specific algorithm for the estimation of Total Suspended Sediments in Puerto Rica coastal waters has been developed and its implementation as “testing product of the NOAA CoastWatch program is underway. Remote sensing reflectance measurements obtained with the GER-1500

spectroradiometer are being used to estimate these parameters and compared with MODIS data. Several experiments were conducted to better understand the effect of suspended sediments on the remote sensing reflectance. Additional biogeo-optical data have been incorporated in GERSVIEW (the on-line GIS-database of the GERS Lab) for further analyses and comparisons with satellite data. Good progress has been obtained in all proposed tasks.

### **Tasks (For year III as per the Milestone Chart)**

#### **Task: Compare to satellite water leaving products and atmosphere retrievals**

Evaluation of MODIS data continues to fine-tuning the algorithm to estimate total suspended sediments (TSS). Two image processing methods, based on two image analysis packages predefined routines (i.e. ENVI and SeaDAS), were evaluated and compared in order to determine the most suitable method for this purpose. Developed algorithms were evaluated by applying resultant equations to two MODIS images from which in situ data were available. Analyses with the GIS based model continued to estimate sediment load to the Mayagüez bay and compare it with same estimations derived from MODIS data. This model is based on the Revised Universal Soil Loss Equation (RUSLE), which requires to spatially defining a series of factors that promotes soil erosion. Basic information, such as Land Use, soil series and annual precipitation, was used to define these factors. New results confirmed that the resultant values are reasonable when compare to previous studies and their spatial distribution responded to known characteristics of the area. This work is part of Vilmaliz Rodriguez master theses.

#### **Task: Intercomparison of below/above water signals with aircraft and satellite data as available.**

As discussed in previous reports, we have found that characteristics of the sediments, like composition and grain size distribution, have important implications in the optical properties of the water. We continue addressing this issue as demonstrated in the work by undergraduate student Alexis Cruz and recent-hired graduate student Natlee Hernandez. Both students compared reflectance measurements with sediments composition. Four different techniques for mineral composition were evaluated and tested: X-Ray Diffraction (XRD), Spectroscopy, Inductively coupled plasma mass spectroscopy (ICP-MS), and Scanning Electron Microscope (SEM). The data collected by these techniques are now being analyzed and next report will have a more comprehensive results and conclusions about the effect of mineral composition in the spectral response of suspended sediments.

#### **Task: Analysis of optical field measurement together with Chl, TSS concentrations**

This task is focused on the spectral response of minerals in suspended sediments of Mayaguez Bay. Rio Añasco, Yagüez and Guanajibo are the three major rivers that affect the sedimentation of Mayaguez Bay. Each river had three stations (Dentro, Boca and Playa) to obtain sediments and compare the spectral slope of total suspended sediments (TSS) and without organic matter. Water samples were collected in September 21 and September 26, 2008. A laboratory procedure was developed to obtain pure minerals from the sediments and take out the organic material, which can affect the Remote Sensing Reflectance (Rrs). Rrs was obtained using the GER-1500 spectroradiometer. Differences in the spectral slope were found along the study sites demonstrating that mineral composition play an important role in the development of future

remote sensing techniques for estimations of suspended sediments. More details of this task can be found in Alexis Cruz report ([http://gers.uprm.edu/pdfs/topico\\_alexis2.pdf](http://gers.uprm.edu/pdfs/topico_alexis2.pdf)).

### **Task: Evolution and tuning of algorithm for Chl retrieval in PR coastal waters**

After several years working with this task and based on the results presented in the dissertation of Marcos Rosado ([http://gers.uprm.edu/pdfs/thesis2\\_marcos.pdf](http://gers.uprm.edu/pdfs/thesis2_marcos.pdf)) it has been demonstrated that the estimation of chlorophyll a (Chl-a) using current ocean color sensors is impossible for Mayaguez Bay. Neither SeaWiFS nor MODIS are capable to generate reliable estimates of Chl-a because of their spatial resolutions and corresponding bio-optical algorithms. The diverse efforts for developing a site-specific algorithm for estimation of Chl-a has also been unsuccessful because the lack of good quality images and the strong effect of coastal processes over the optical signal detected by these remote sensors. Therefore, it has been decided to stop working with this task and get focus on improving the estimation of suspended sediments by ocean color sensors. This has a larger potential of success. Based on this decision future reports will not include a narrative of this task.

### **Task: Development of GIS database for land sea interactions in Mayaguez Bay**

Quality control of all data collected in Mayaguez Bay was continued during the reported period. In addition, new analyses of the collected radiometric data were started. This data set was not included during the first round of processing because the nature of processing and quality control is more complicated and requires particular attention. Transfer of knowledge between Ramon Lopez (Ph.D. student graduated in Dec 08) and Natlee Hernandez (new M.S. student) continued in order to further development of GERSVIEW.

### **Future Tasks (From the Milestones)**

Efforts for developing site-specific algorithms for suspended sediments will continue. Other optical data are being organized and they are getting ready for the GIS databases. Very soon they will be exported to ArcIMS and be published in the web. This activity will allow people to access and manipulate the data via internet for better understanding of land-sea interactions in Mayaguez Bay. Natlee Hernandez (new M.S. student), will continue working with this important aspect of the project. Another publication by Vilmaliz Rodriguez will be submitted to a peer-review journal before the end of the year. She will also defend her master thesis. The PI and other students will continue working with the chapters of the Mayaguez Bay book.

**Appendix: The following links include publications related with work of this report period.**

[http://gers.uprm.edu/pdfs/rodriguez\\_gilbes\\_09a.pdf](http://gers.uprm.edu/pdfs/rodriguez_gilbes_09a.pdf)

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[http://gers.uprm.edu/pdfs/thesis2\\_marcos.pdf](http://gers.uprm.edu/pdfs/thesis2_marcos.pdf)