Ocean Color Data Applications for Water Quality in Coastal Areas

William J Hernandez, Ph.D.
Post Doctoral Researcher
CCNY-NOAA CREST
UPRM

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Water Quality

Land based sources of pollution (LBSP) are a major threat to corals:

- Cause disease and mortality
- Disrupt critical ecological reef functions that impede growth and reproduction and larval settlement.

Innovations in Monitoring and Assessment.

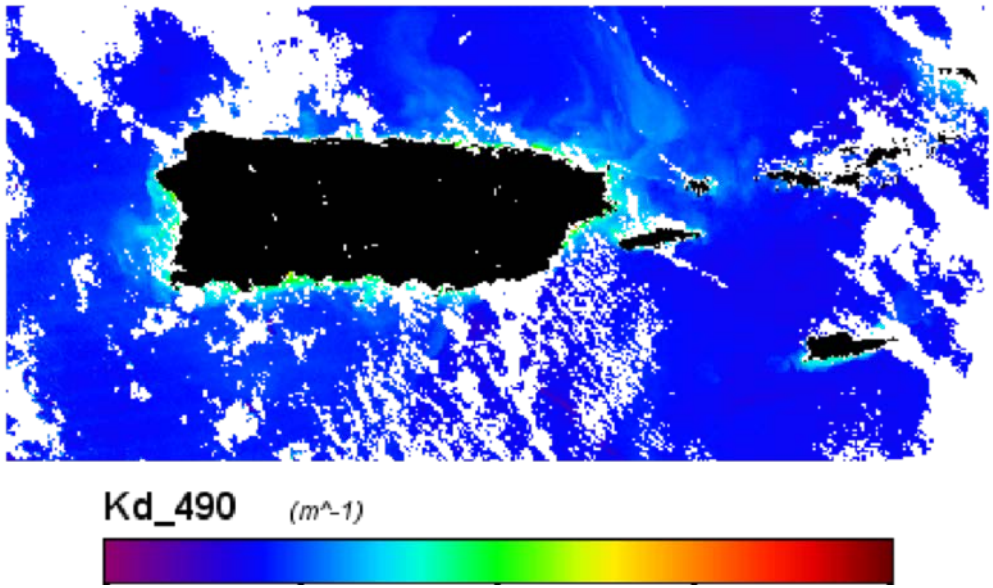
- Connecting Coasts, Estuaries, and Freshwater Ecosystems.
- Identifying and Assessing Emerging Risks.
- Measuring Effectiveness of Water Management Actions.

Honokahua Bay, West Maui. Credit: Bill Rathfon.

Guanica Bay, Puerto Rico Credit: NOAA

VIIRS

- **Chlorophyll-*a* (Chl-*a*)**
  - Monitoring phytoplankton biomass.
  - Nutrient status (*i.e.* **productivity**).
  - Index of water quality.
- **Kd(490)**
  - Diffuse attenuation coefficient at 490nm.
  - **Turbidity** (measure of the total organic and inorganic matter held in solution and suspension).
  - Index of water quality.



VIIRS Kd(490) product image for Puerto Rico and the USVI after a precipitation event (August 26, 2014).

Why use VIIRS for Water Quality?

- The color of coastal water is related to water quality.
- Satellite ocean color data provide a synoptic view of water quality.
- Continuous monitoring
- Ocean color tools that managers and stakeholders can use to:
  - Track water quality near their reefs
  - Evaluate effect in the coastal water due to changes in the watershed. (“Ridge to Reef”).

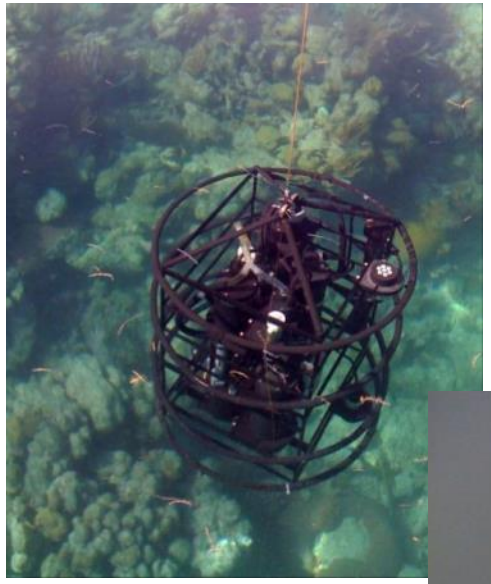


Image credit: Bio-optical oceanography Lab, UPRM

Study Area

U.S. Coral Reef Task Force priority watershed sites:

- Ka’anapali (West Maui, Hawai'i)
- Faga'alu (American Samoa)
- Guánica Bay (Puerto Rico).

Image credit: NOAA/NESDIS/STAR/CRW

Study Area

Guánica and La Parguera Area (Puerto Rico).

Water Quality Products from VIIRS

<u>Matching large rainfall events to satellite derived measurements.</u>

- **Chlorophyll-*a* (Chl-*a*)**
- **Kd(490)**

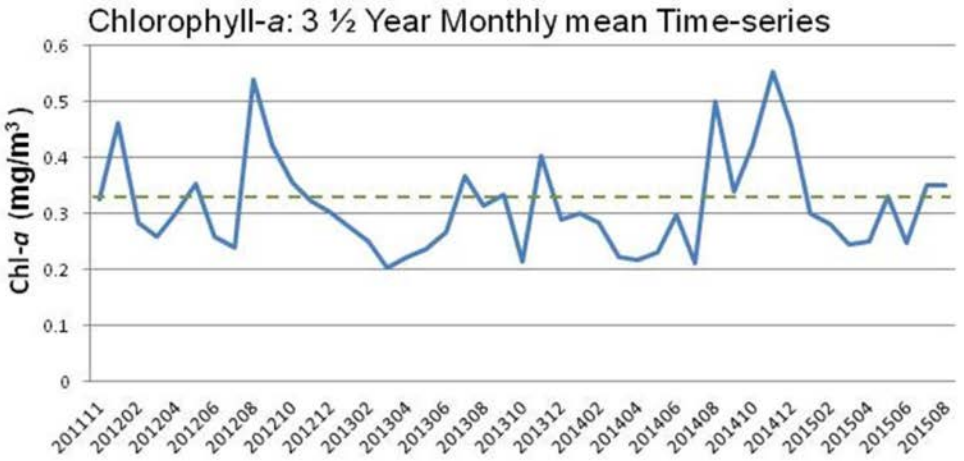
“Virtual Areas”

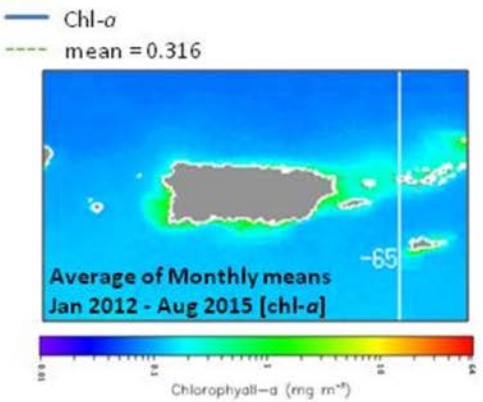
- Establishing virtual areas around watersheds will enable calculation of plume statistics such as:
  - Maximum and average levels of Chl-*a* and Kd(490)
  - Monthly climatologies
  - Variations from “normal” levels through time. (Anomalies).

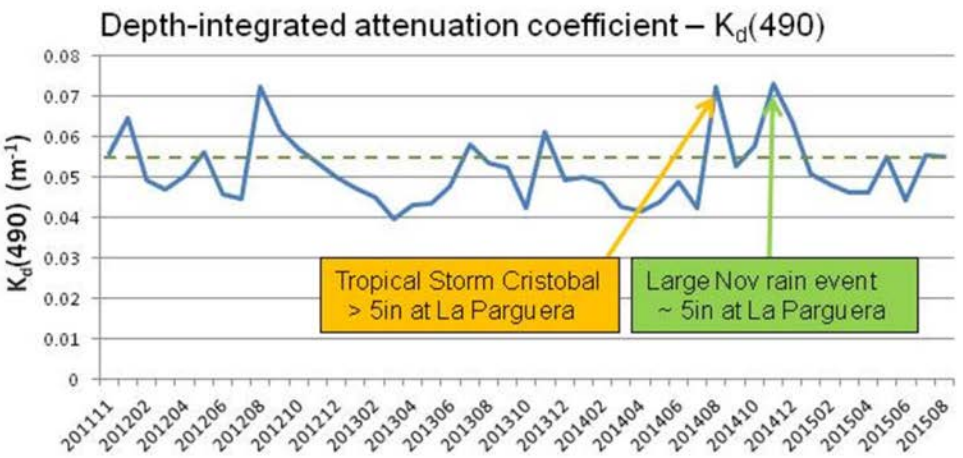
Results VIIRS (Monthly)

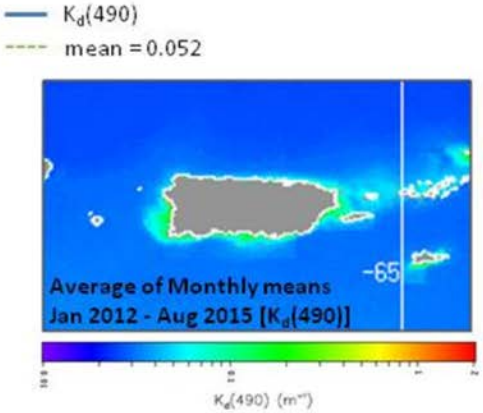
10 km around Point A (17.92347 °N, 66.90108 °W)

Target Site: Guánica watershed discharge site, Puerto Rico





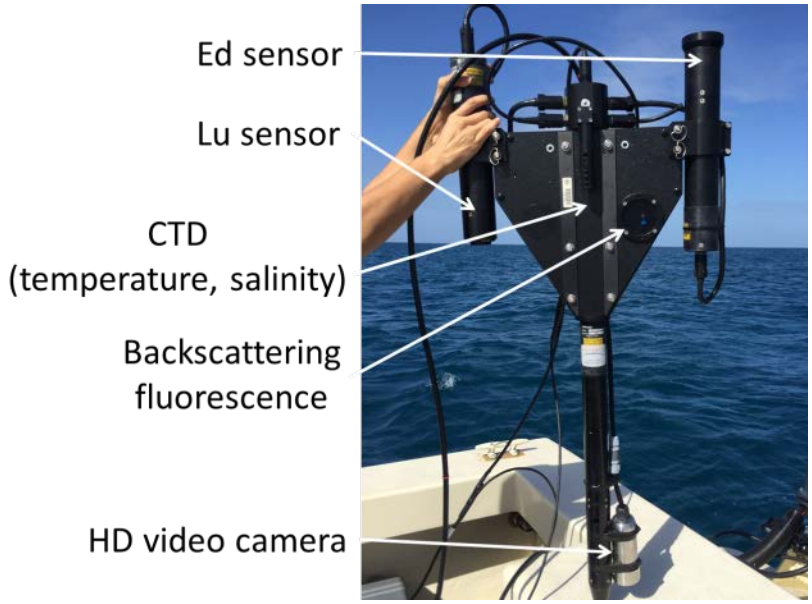




Images credit: NOAA/NESDIS/STAR/CRW

Field Sampling

- Simultaneous with Landsat 8 OLI image capture
- Instruments
  - **Satlantic Hyperpro Profiling radiometer (Lu, Ed, Rrs, Lw, Kd)**
  - GER 1500 Spectro-radiometer (Lw, Ed, Rrs)
  - SolarLight Datalogging Radiometer (PAR)
  - Hydroscat-6 (backscattering, flourescense)
  - YSI EXO (CHL, TSS, CDOM, CTD)
  - Water quality samples
    - CHL, TSS, CDOM

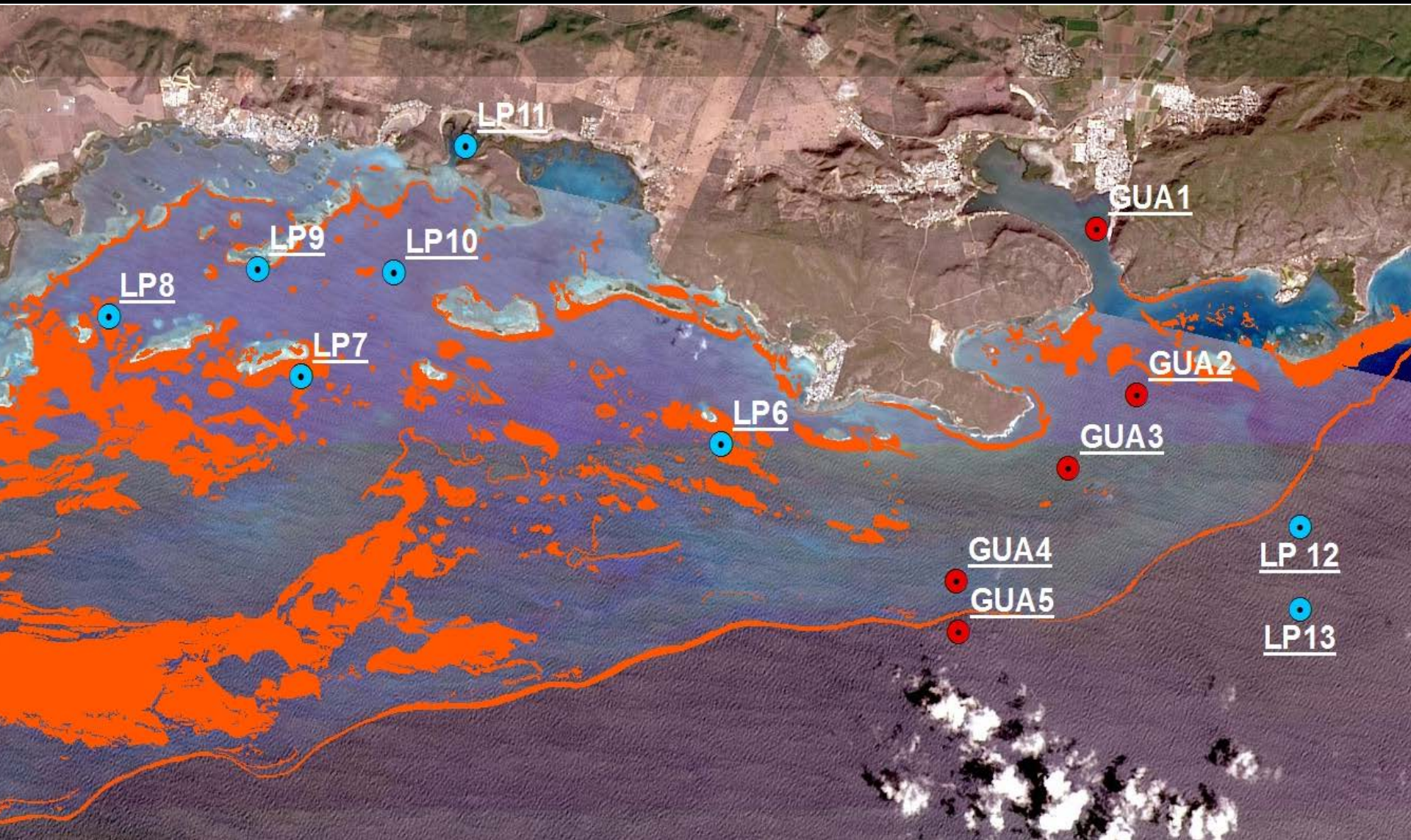


Hydroscat-6

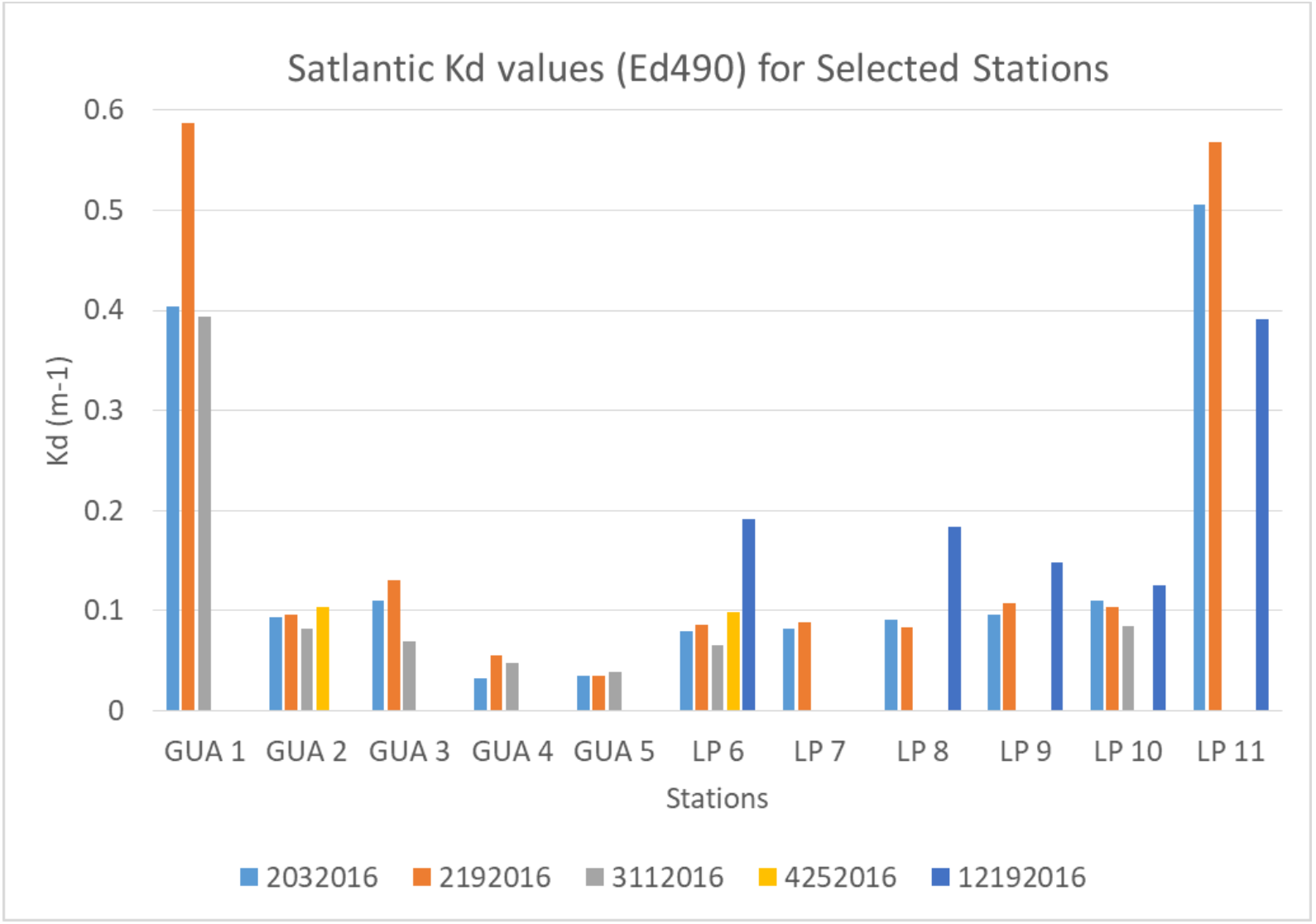
GER1500

YSI EXO

Field Sampling

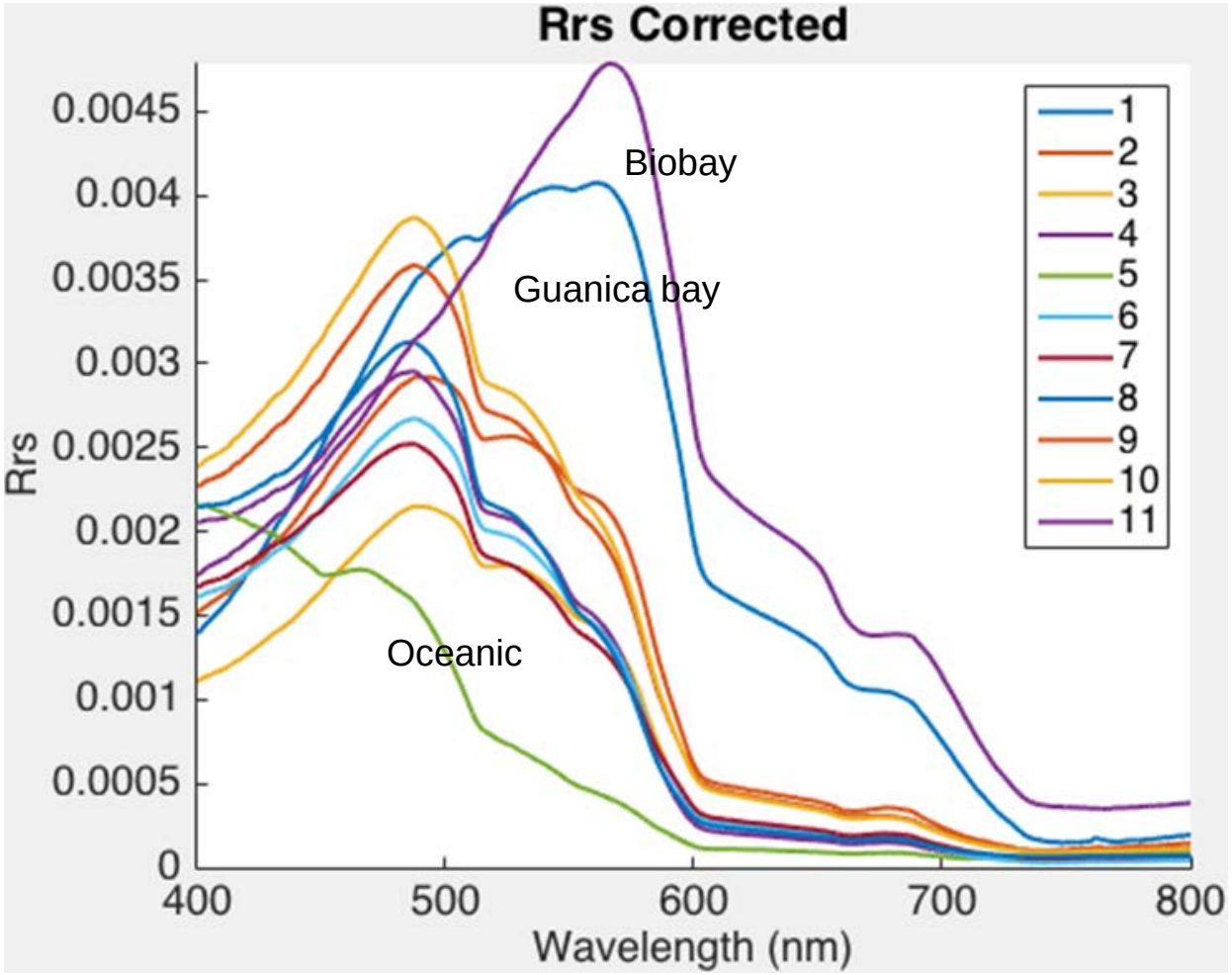


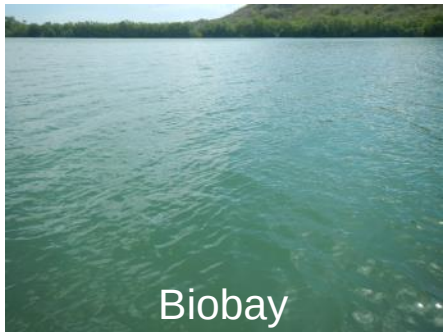
Kd 490


Satlantic Kd values (Ed490) for Selected Stations
Kd (m-1)
0.6
0.5
0.4
0.3
0.2
0.1
0
GUA 1
GUA 2
GUA 3
GUA 4
GUA 5
LP 6
LP 7
LP 8
LP 9
LP 10
LP 11
Stations
2032016
2192016
3112016
4252016
12192016

Field Sampling - Rrs

GER1500 surface remote sensing reflectance



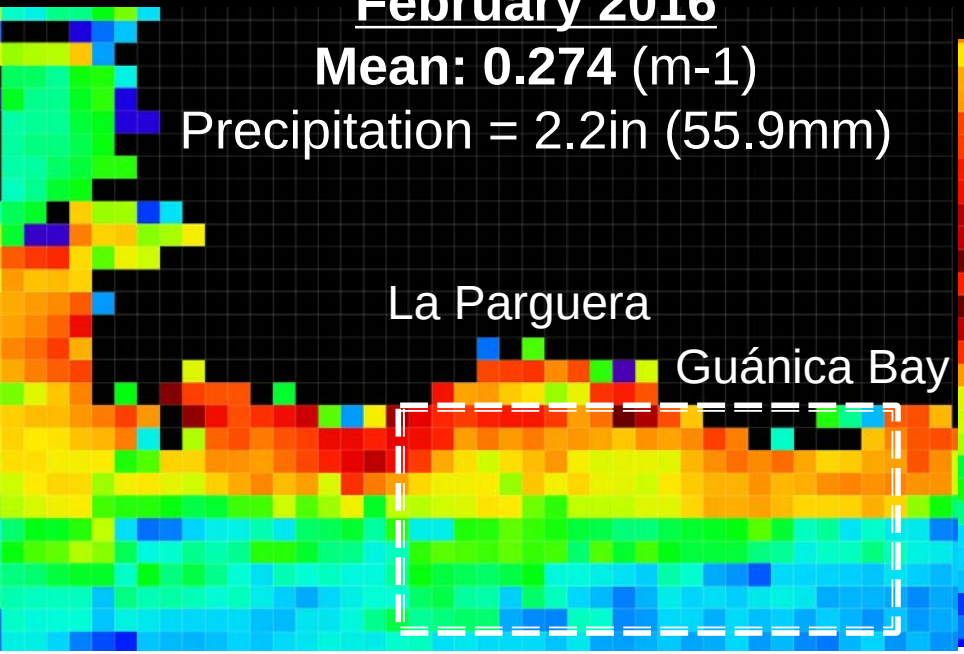


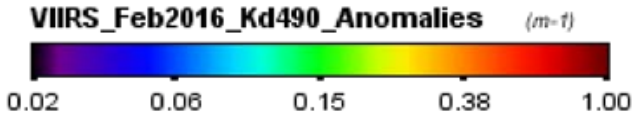
VIIRS Monthly Anomalies Kd(490)

February 2016

Mean: 0.274 (m-1)

Precipitation = 2.2in (55.9mm)

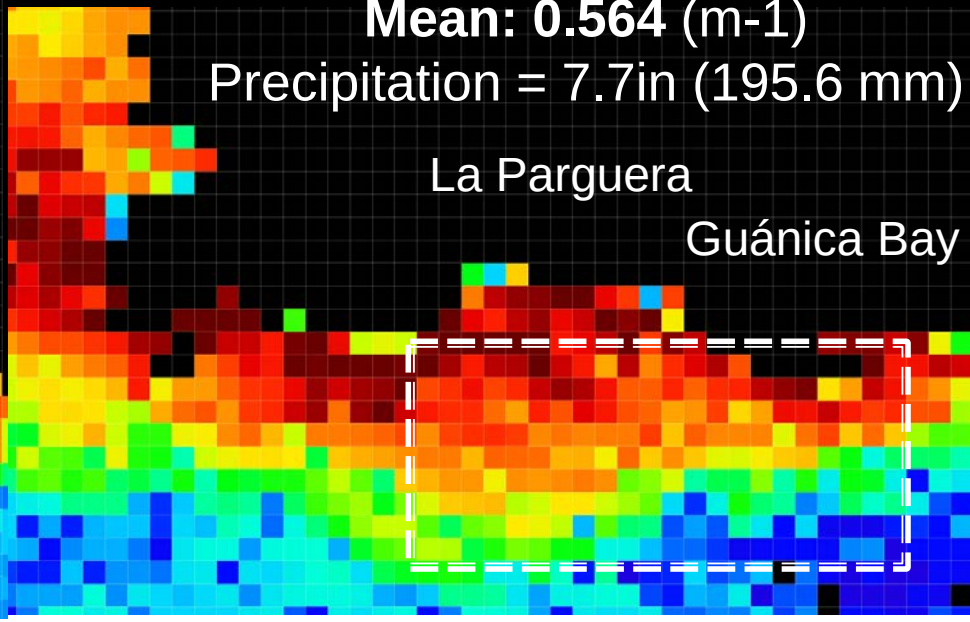


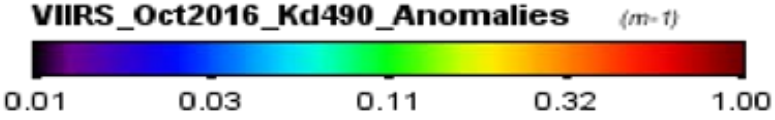


October 2016

Mean: 0.564 (m-1)

Precipitation = 7.7in (195.6 mm)





High Resolution Sensors

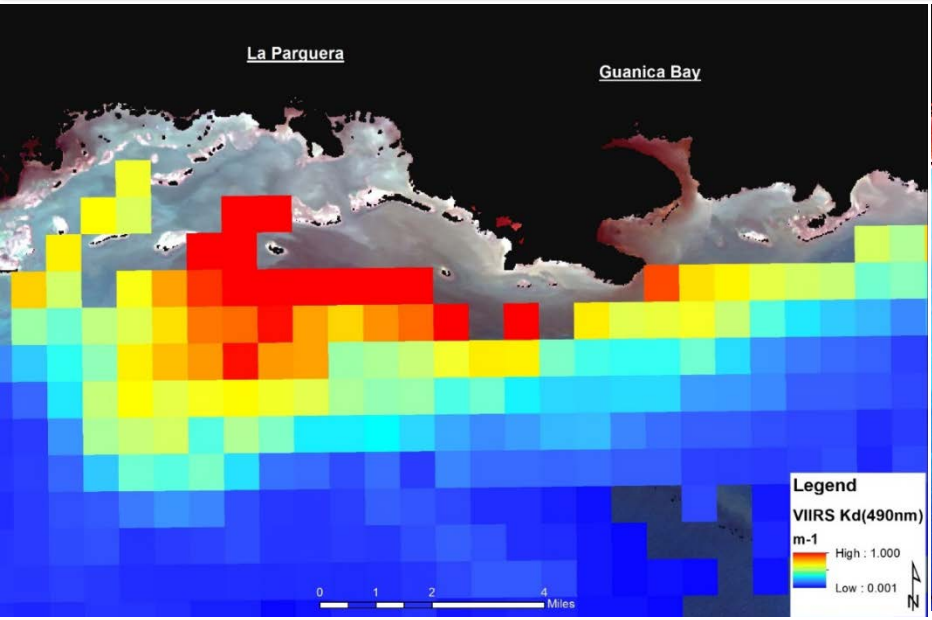
Landsat 8 Operational Land Imager (OLI)

Sentinel 2A/B MultiSpectral Instrument (MSI)

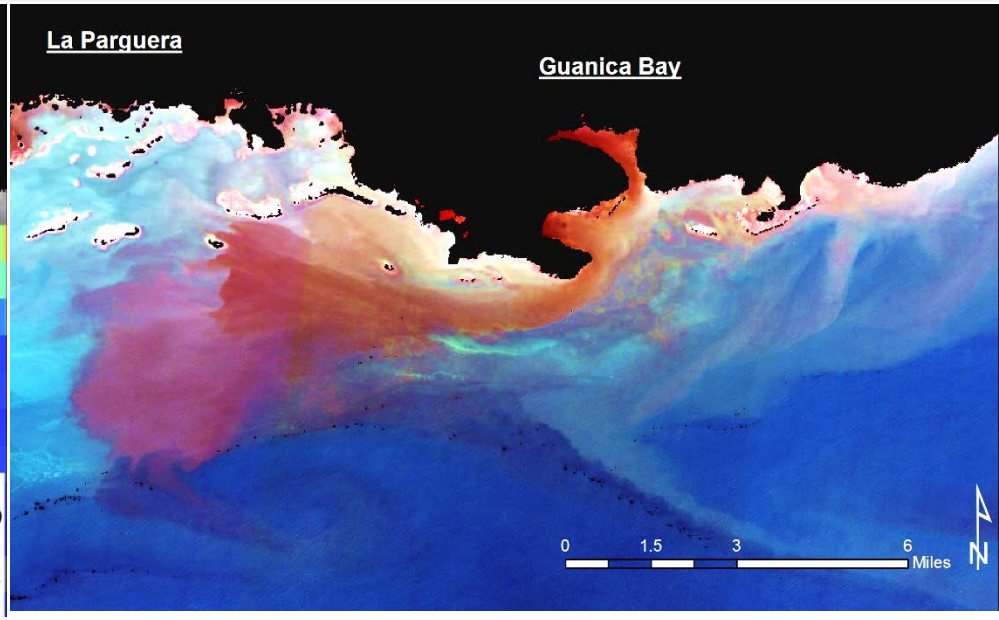
- Supplements VIIRS in very near shore with higher resolution
- Morning pass (~11:00am) less clouds.
- Water quality products can be obtained.
- Other products like benthic maps and land cover can created from imagery.

Sentinel-2 Guánica Bay
February 17, 2017

VIIRS / Landsat 8 Showcase



VIIRS image of turbidity, Kd (490 nm) wavelength (Level 2 Science Quality) averaged for November 11-13 at 750m.



Landsat 8 OLI False Color (3,2,1) image (with landmask) for November 12, 2014 showing plume from Guánica Bay

**6.0 inches precipitation event

Aerial/Drone Photos

Aerial photo of the Guánica Bay after a rain event of approximately 5.5 inches in late August 2014 (Photo credit: Protectores de Cuencas Inc.).

Next Steps…

- Continued data collection for PR and HI
  - Shared experiences for HI and PR.
- Web mapping application for watershed managers that can include:
  - Watershed layers
  - Benthic habitat/land cover maps.
  - Water quality from satellites (VIIRS, Landsat/Sentinel).
  - *In situ* water samples results.
  - Layers from watershed managers.

UPRM Sample

http://arcg.is/1QpyIL7

Collaborators

- NOAA
  - Alan E. Strong, NOAA/NESDIS/STAR, GST Inc.
  - Robert A. Warner, NOAA/NOS/NCCOS
  - Erick F. Geiger, NOAA/NESDIS/STAR, GST Inc.
  - C. Mark Eakin, NOAA/NESDIS/STAR.
  - Menghua Wang, NOAA/NESDIS/STAR.
- NGO/Universities
  - Protectores de Cuencas Inc.
  - West Maui Ridge 2 Reef
  - University of Hawaii Maui College
  - University of Puerto Rico Mayaguez

Bio-Optical Oceanography Laboratory Team Members

- Dr. Roy Armstrong -Director
- Dr. Yasmin Detres - Researcher
- Suhey Ortiz, Maria Cardona, Myrna Santiago, Jenniffer Perez, Omar Lopez -Graduate Students
- Luis Lugo - Staff

QUESTIONS?

Contact:
william.hernandez@upr.edu