Human Impacts to Coastal Ecosystems in Puerto Rico (HICE-PR):

A remote sensing, hydrologic, ecologic, and socio-economic assessment with management implications.

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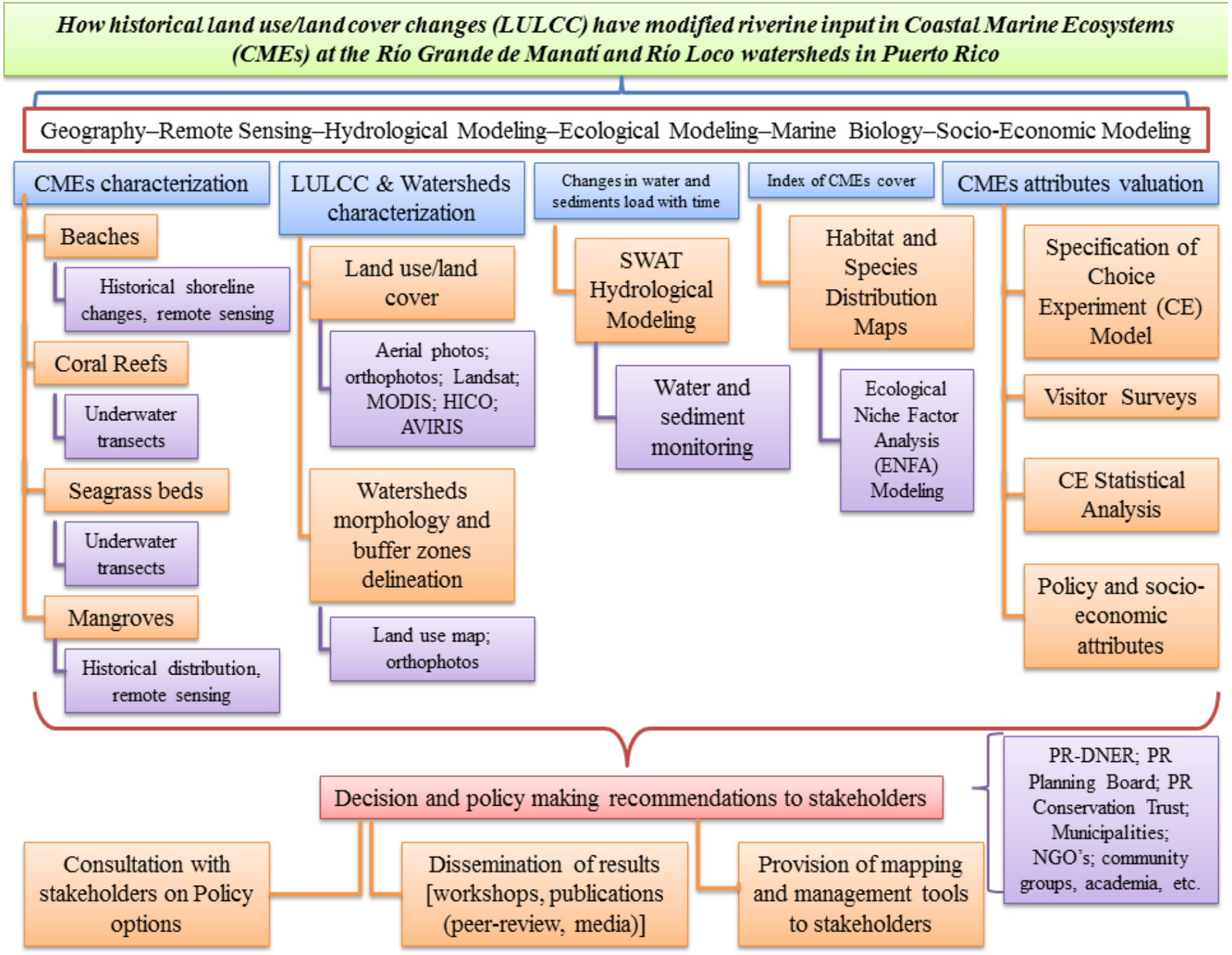
HICE-PR

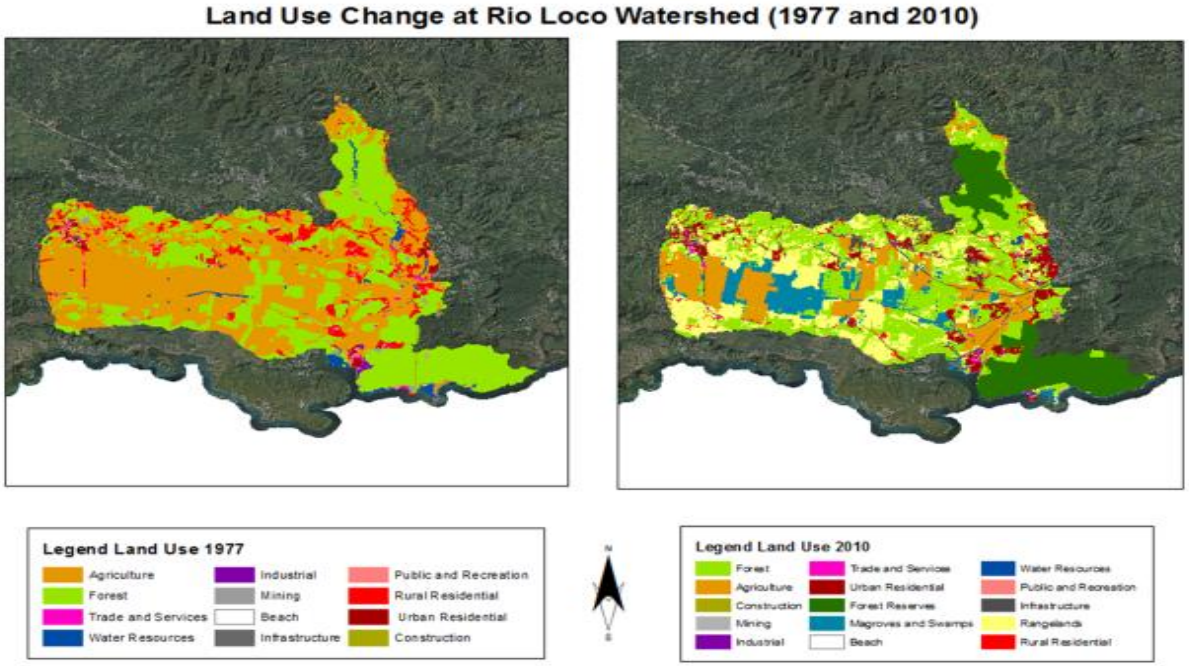
NASA IDS Grant: NNX14AJ23G

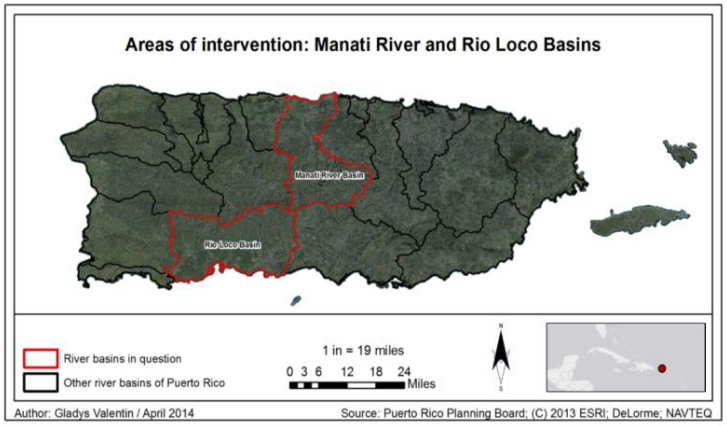
Main Goals

- 1)To conduct an interdisciplinary study using sound mapping technologies and hydrological modeling to infer how anthropogenic activities related to land cover/land use changes (LCLUC) have modified riverine inputs into the coastal and marine ecosystems (CMEs) associated with two priority watersheds in the north (Manatí) and south (Guánica) coasts of Puerto Rico
- 2) To combine outputs from field measurements within CMEs, ecological modeling and economic valuation methods to assess degradation of CMEs associated with the selected watersheds
- 3) To demonstrate the use of these remote sensing and modeling tools to stakeholders (local agencies, managers, community) via workshops allowing for technology transfer and collaboration


How historical land use/land cover changes (LULCC) have modified riverine input in Coastal Marine Ecosystems (CMEs) at the Río Grande de Manatí and Río Loco watersheds in Puerto Rico
Geography–Remote Sensing–Hydrological Modeling–Ecological Modeling–Marine Biology–Socio-Economic Modeling
CMEs characterization
Beaches
Historical shoreline changes, remote sensing
Coral Reefs
Underwater transects
Seagrass beds
Underwater transects
Mangroves
Historical distribution, remote sensing
LULCC & Watersheds characterization
Land use/land cover
Aerial photos; orthophotos; Landsat; MODIS; HICO; AVIRIS
Watersheds morphology and buffer zones delineation
Land use map; orthophotos
Changes in water and sediments load with time
SWAT Hydrological Modeling
Water and sediment monitoring
Index of CMEs cover
Habitat and Species Distribution Maps
Ecological Niche Factor Analysis (ENFA) Modeling
CMEs attributes valuation
Specification of Choice Experiment (CE) Model
Visitor Surveys
CE Statistical Analysis
Policy and socio-economic attributes
Decision and policy making recommendations to stakeholders
PR-DNER; PR Planning Board; PR Conservation Trust; Municipalities; NGO's; community groups, academia, etc.
Consultation with stakeholders on Policy options
Dissemination of results [workshops, publications (peer-review, media)]
Provision of mapping and management tools to stakeholders

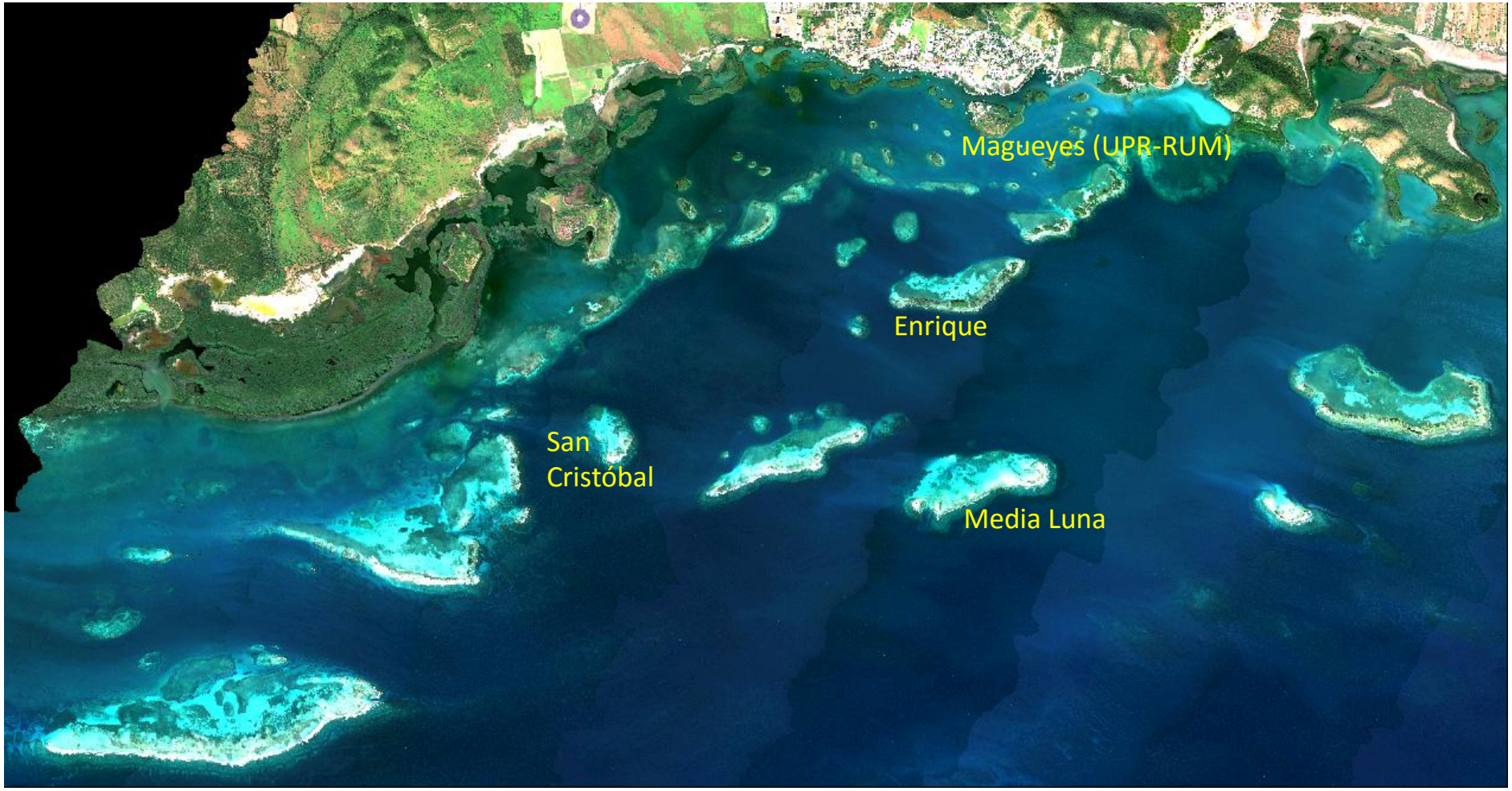
Guánica and La Parguera (southwest PR)





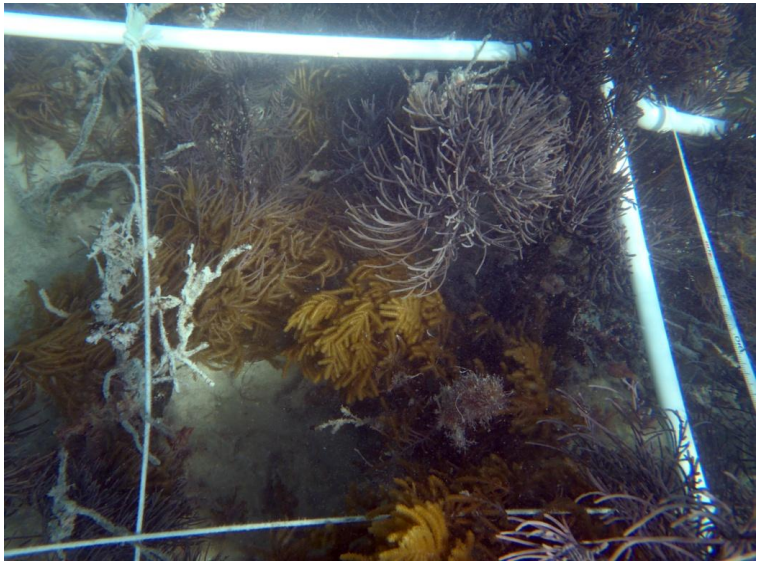
Guánica Study Sites – HICE-PR

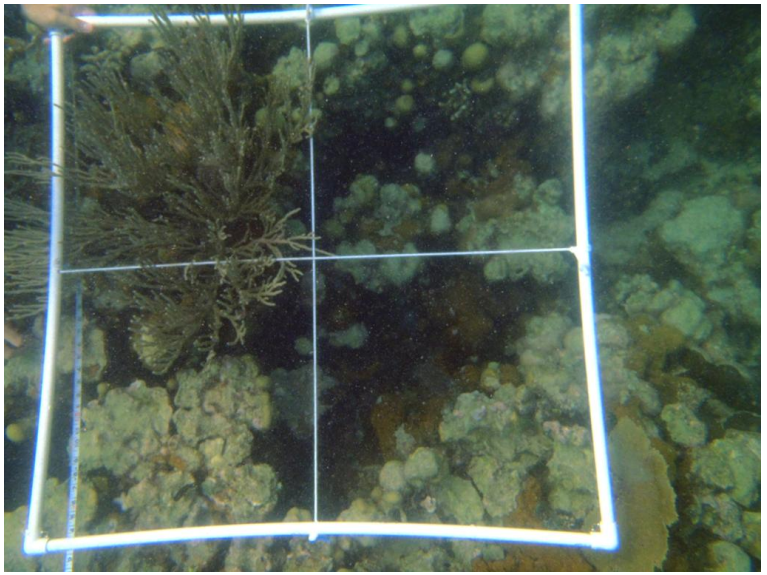
La Parguera Study Sites – HICE-PR



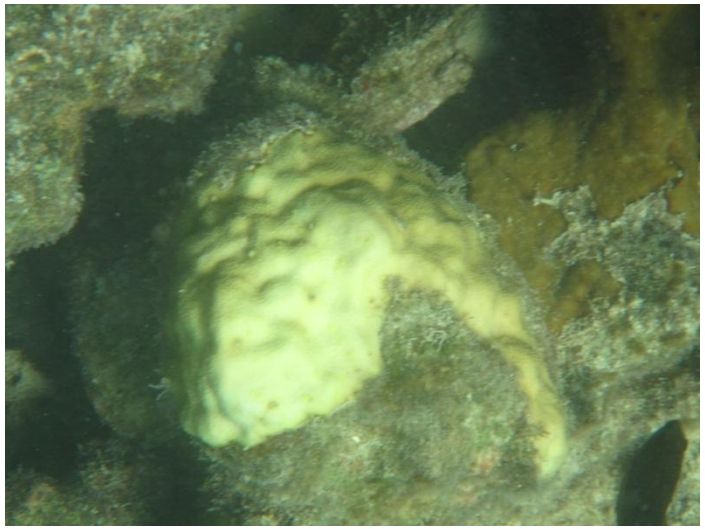
Present condition at La Parguera-Guánica

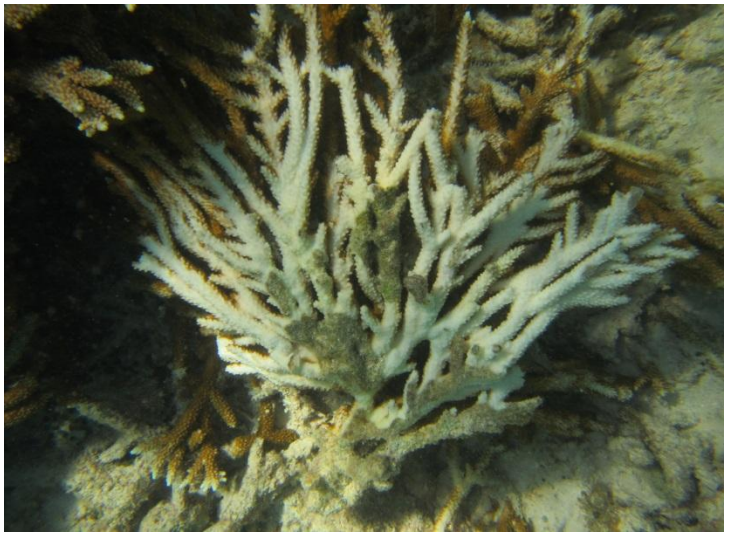
- **For back-reef areas (La Parguera and Guánica):**
  - Dominated by gorgonian plains
  - Average hard coral cover: 0.02-30%, with most sites ~11% cover
  - Significant cover of the encrusting sponge *Cliona*
  - Some reef zones show ~40% macroalgal cover, mostly *Dyctiota*
  - Dead coral colonies covered by turf or other algae: ~40% in most areas
  - Ongoing 2nd Yr of reef characterization (Oct-Nov 2015) show minor coverage of bleached colonies, mostly Acroporids

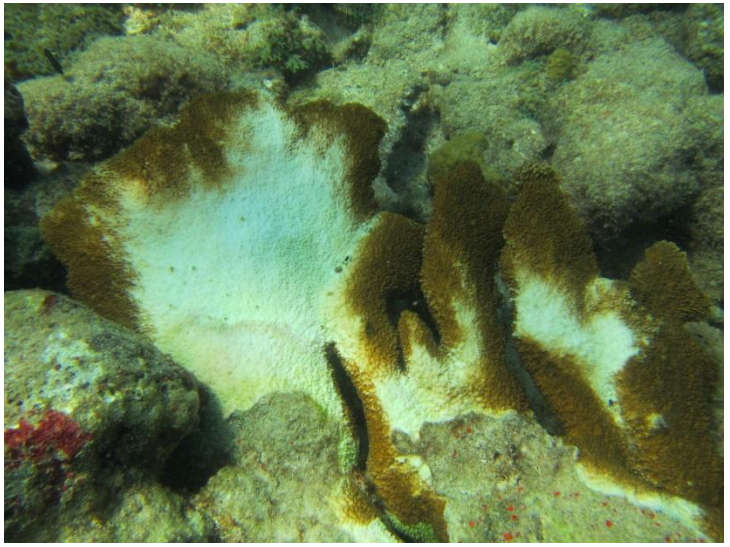




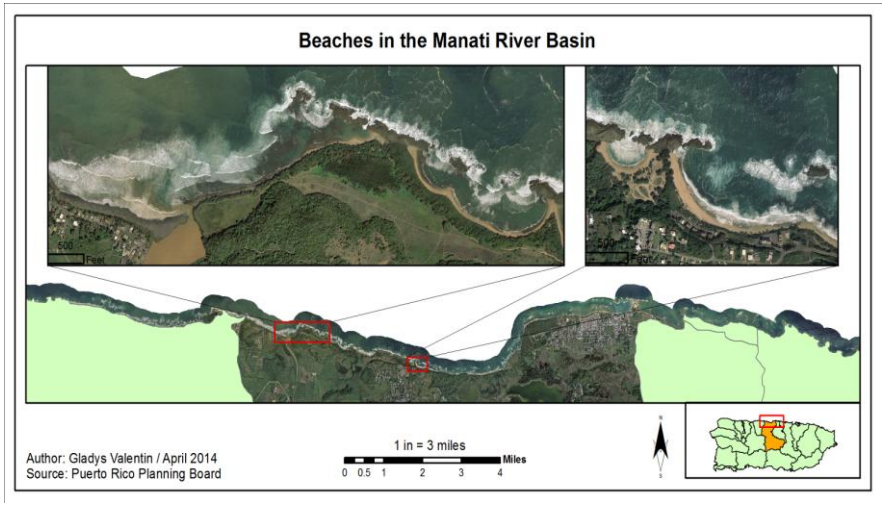
October 2015 – La Parguera

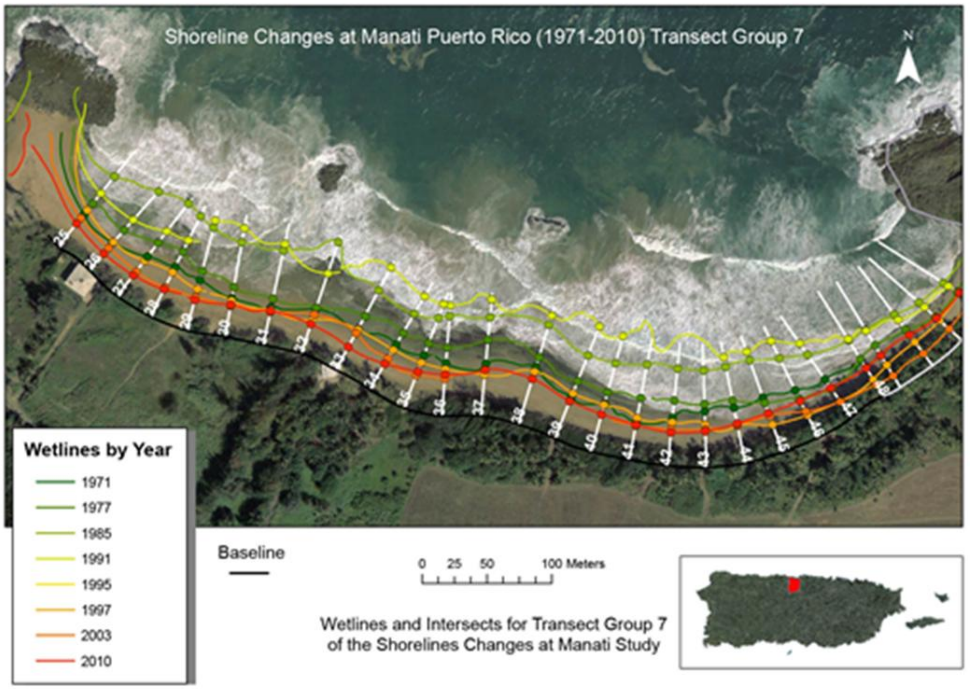




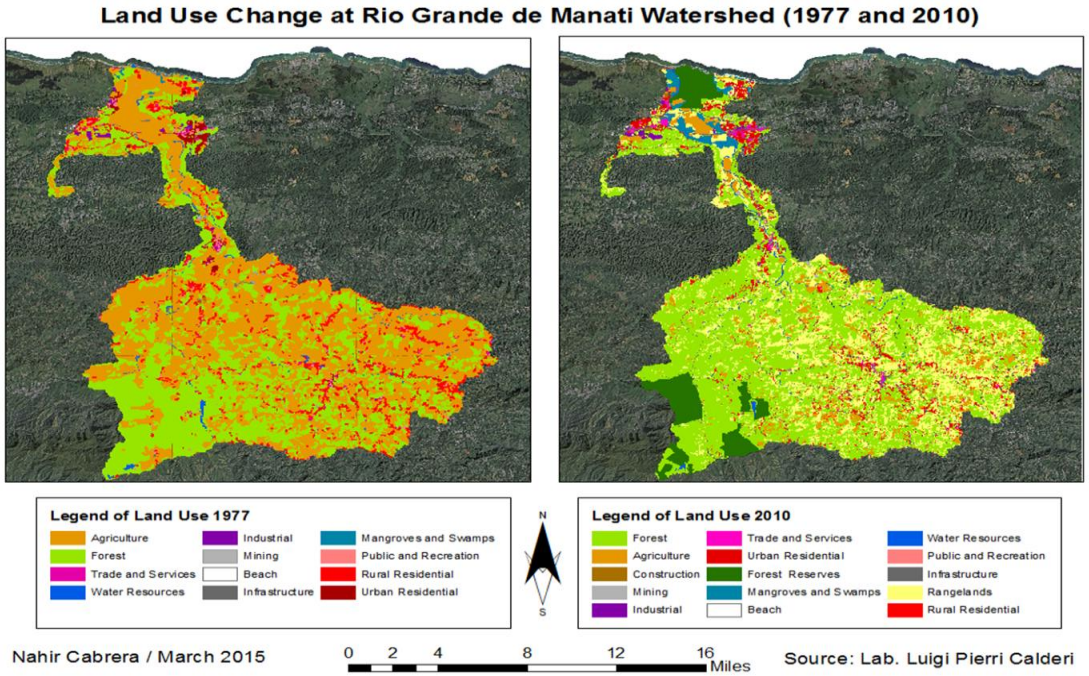


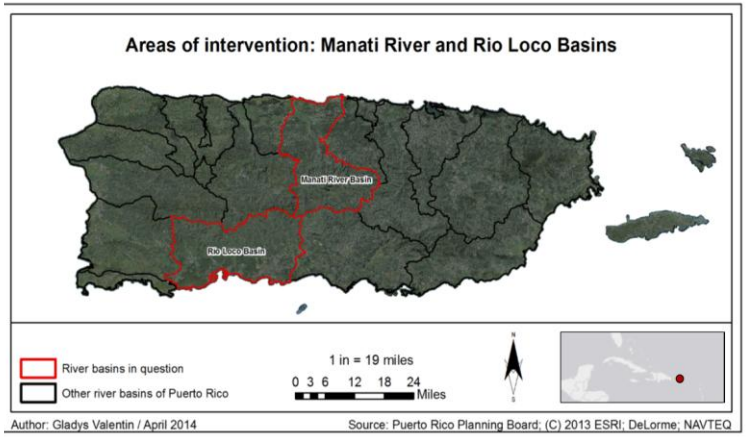
Manatí (north coast PR)



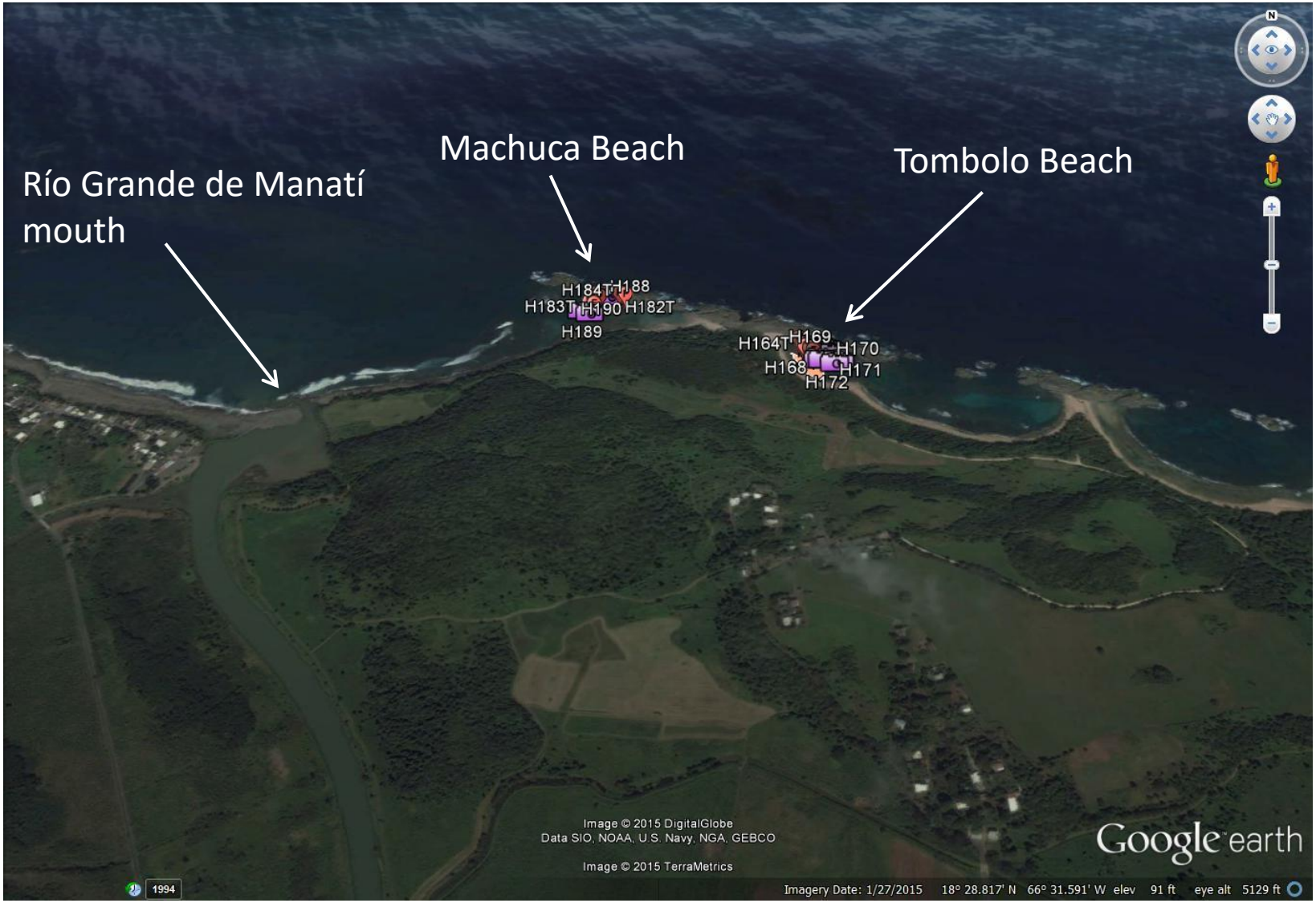


Map prepared by Orlando Santaella; Data displayed from Shoreline Study realized by Orlando Santaella, Nahir Cabrera Rios and Maritza Barreto 2014
stoss, E.A., Zichichi, J.L., and Ergul, Ayhan, 2009, Digital Shoreline Analysis System (DSAS) version 4.0—
extension for calculating shoreline change: U.S. Geological Survey Open-File Report 2008-1278.





Manatí PR – north coast



Benthic photos from past field observations at Manatí (2010)

Photo: Maritza Barreto

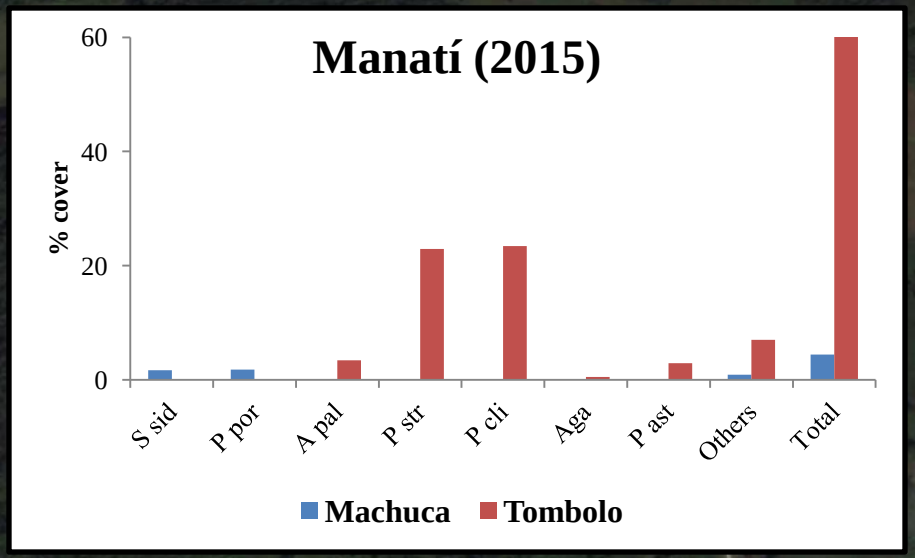
River mouth after a rain event (2014)

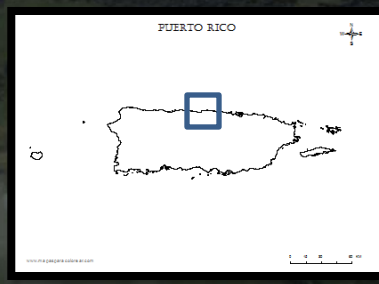
River plume (10/23/2015)

Tombolo Reef

Machuca Reef

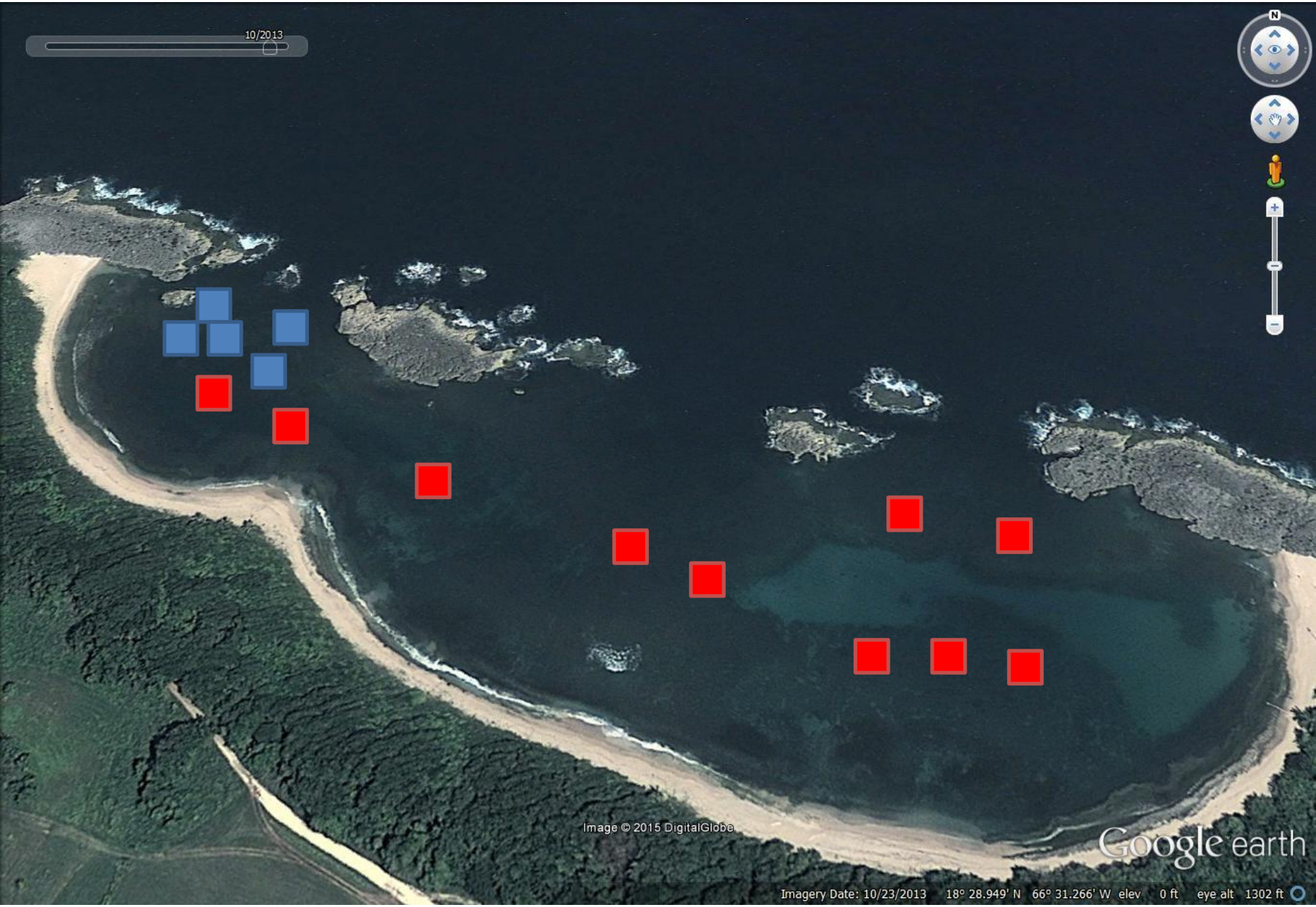
Río Grande de Manatí mouth

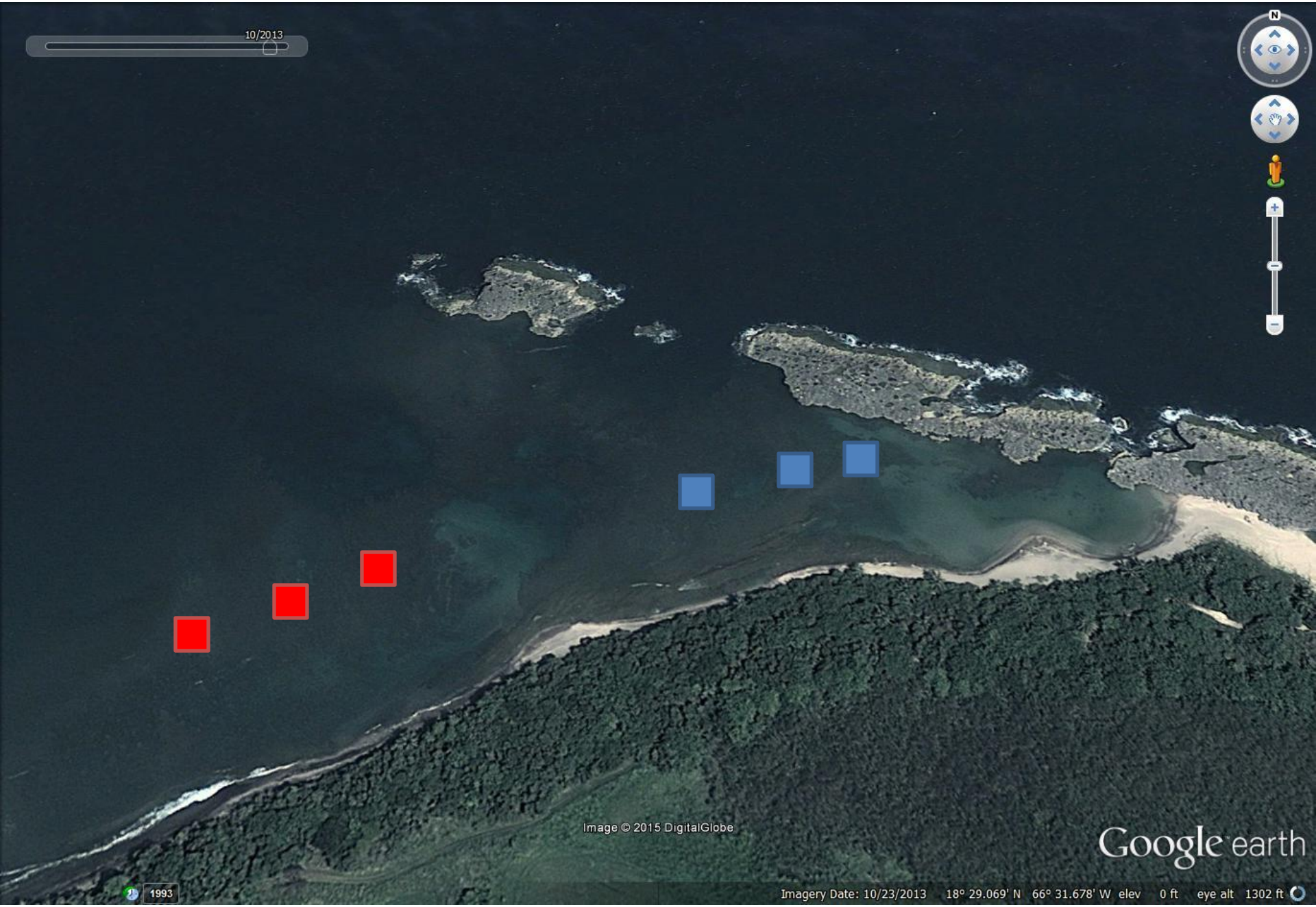




Tombolo Beach at Manatí

April 28, 2015


10/2013
Image © 2015 DigitalGlobe
Google earth
Imagery Date: 10/23/2013 18° 28.949' N 66° 31.266' W elev 0 ft eye alt 1302 ft


10/2013
Image © 2015 DigitalGlobe
Google earth
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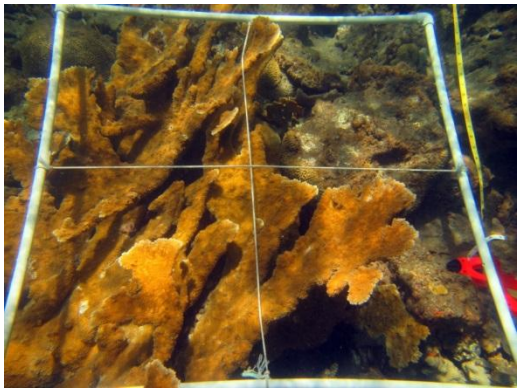
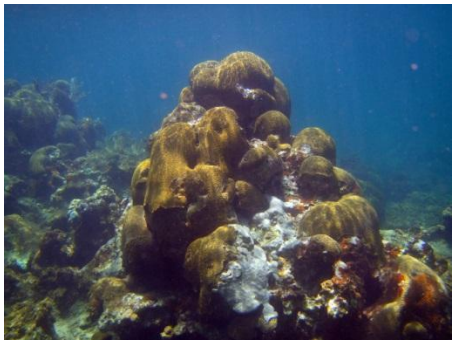
Imagery Date: 10/23/2013 18° 29.069' N 66° 31.678' W elev 0 ft eye alt 1302 ft

Present condition at Tombolo Beach (Manatí)

Summary:

- Relatively shallow depth (0-4m); high waves most of the year
- High hard coral cover: 28-60%; average = 35%
- Mostly dominated by *Acropora palmata* and *Pseudodiploria* sp. (*P. clivosa* and *P. strigosa*)
- Other species include *Orbicella annularis*, *Porites astreoides*, fire corals (*Millepora* sp.), and sea fans (*Gorgonia* sp.)
- High cover of turf algae on dead coral surfaces
- Extremely low % of diseased colonies, mostly gorgonians

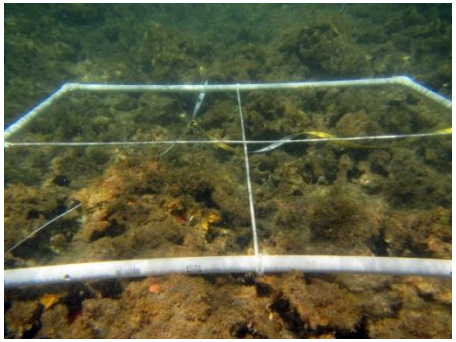


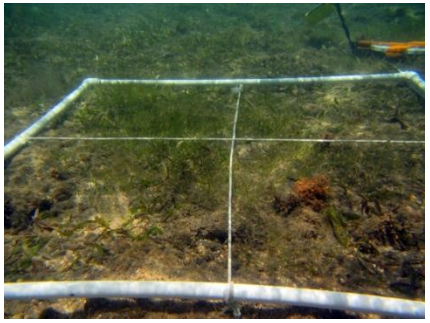


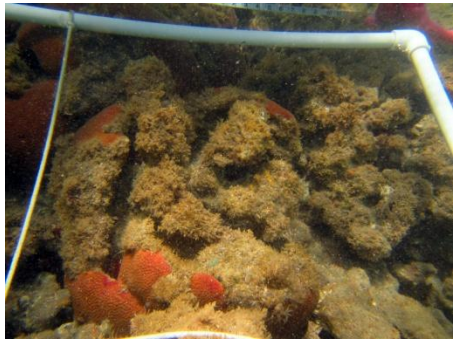
Present condition at Machuca Beach (Manatí)

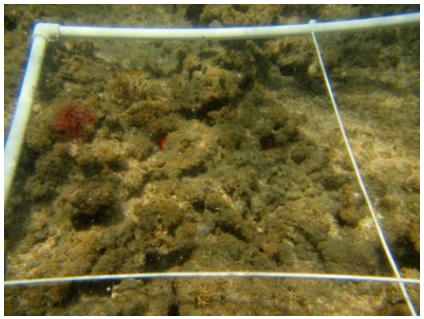
Summary:

- Very shallow site (<2m depth); high waves most of the year
- Close to the Río Grande de Manatí mouth
- Coral cover: <5%
- Site shows the structure of a relict or old reef (bioeroded dead coral colonies now covered by algae)
- Dominant algae: *Dictyota*, *Padina* and turf









Tombolo Beach: April 2015

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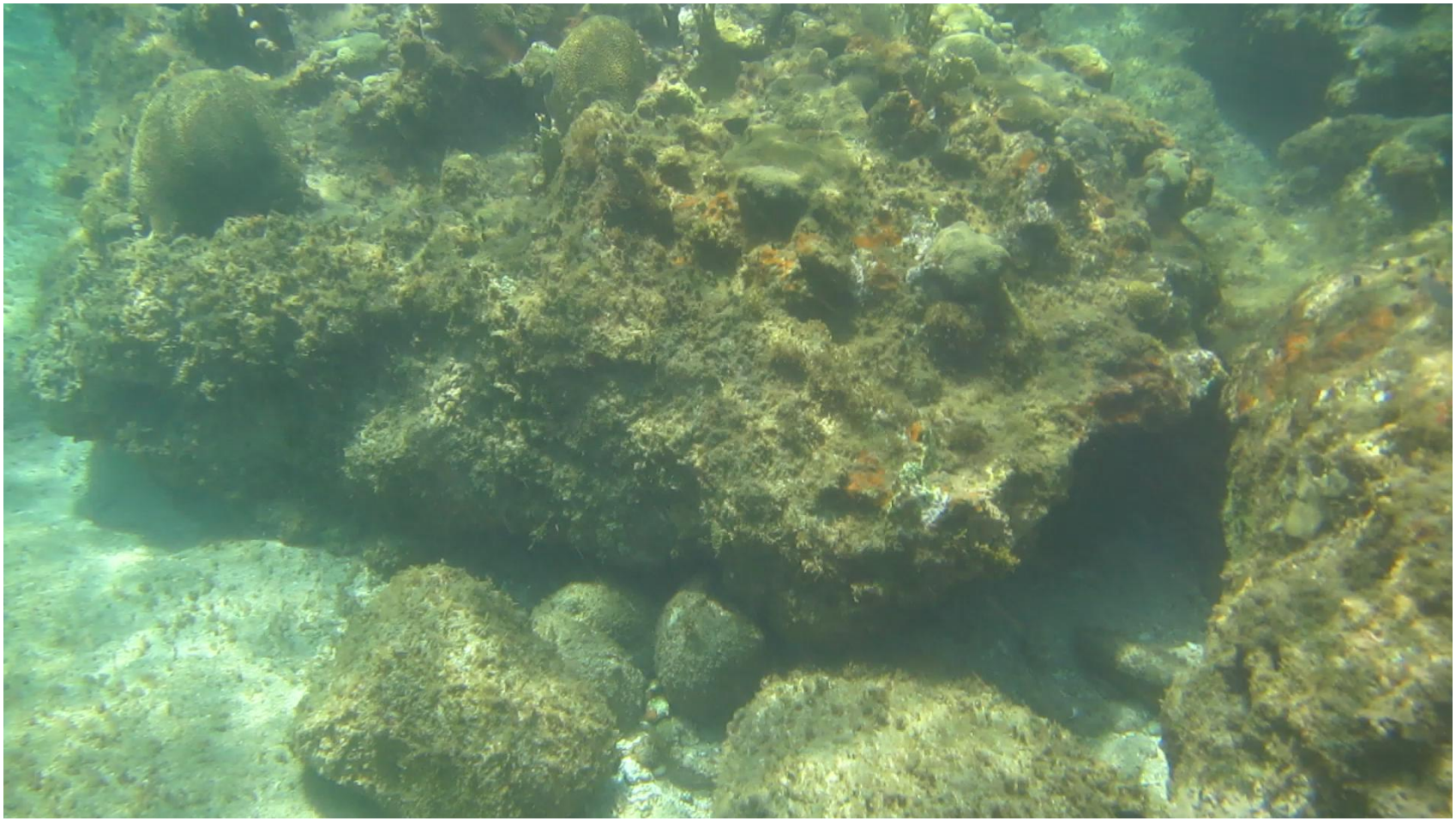

Beach geomorphology and spectral analysis of beach components

- Side project of HICE-PR (Irma Caraballo's PhD Thesis)
- Spectral characterization of beach components from the vegetation line to the swash zone
- Sediments show river influence (dominance of magnetite and terrigenous near river mouth)
- Found remanents of a relict reef in the swash zone intermingled with beach rock and eolianite


Thank you!

NASA and the US Coral Reef Task Force

New Projects

- **USVI: Experimental Program to Stimulate Competitive Research (EPSCoR): Remote sensing of Coral Reef Biodiversity and Water Quality – January 2016, 3 years**
- **Florida: CORAL airborne mission, late March/Early April**
- **Guam: CORAL airborne mission, May**
- **Hawai'i:**
  - **HyspIRI airborne missions Oct/Nov (Jan 2017?)**
  - **CORAL airborne mission Nov/Dec**

Earth Venture: COral Reef Airborne Laboratory (CORAL): Pacific and Atlantic Caribbean campaign of **low altitude NSF GV flights** with PRISM (hyperspectral) instrument to study reef condition and biogeophysical forcing, 5 years

HyspIRI: A single campaign of **high altitude ER-2 flights in 2016 to the Hawaiian Islands, extending from the Big Island of Hawaii to Kure Atoll**, with AVIRIS-Classic and MASTER instruments aboard, 1 year project