**Jobos Bay Water Resources II**

*Using Earth Observations to Analyze Coastal Changes, Mangrove Extent, and Water Quality in Southern Puerto Rico*

**Project Team**

***Project Team:***

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**Project Overview**

***Project Synopsis:***

The effects of climate change, including sea level rise and increased frequency of high intensity storms, and the development of natural areas impact coastal ecosystems in southern Puerto Rico. In order to understand the effects of these factors on mangrove forests and water quality in Jobos Bay, the team analyzed changes in mangrove area, mapped watershed land use land cover, and derived Jobos Bay water quality values from satellite data. By mapping these environmental conditions, the team aimed to inform the Jobos Bay National Estuarine Research Reserve’s (JBNERR) coastal protection efforts.

***Abstract:***

High-intensity storms and coastal development negatively impact the ecosystems of Jobos Bay, Puerto Rico, by causing reductions in mangrove forests and degradation of water quality. These changes compromise the ecosystem services, economic value, and cultural significance that Jobos Bay provides to the community. In collaboration with the Jobos Bay National Estuarine Research Reserve (JBNERR), a NASA DEVELOP team used Earth observations to investigate water quality, watershed land use land cover (LULC), and the impact of Hurricanes Maria and Irma on this mangrove forest area. The team examined mangrove extent using imagery from Landsat 8 Operational Land Imager (OLI), WorldView-2 WV110, and WorldView-3 WV110. Imagery from Sentinel-2 MultiSpectral Instrument (MSI) was used to map watershed LULC. Landsat 8 OLI and Sentinel-2 MSI data were analyzed to investigate water quality in Jobos Bay. Analysis of current watershed LULC produced a map that is similar to ground-truth imagery. Reduction in mangrove extent was observed following the 2017 hurricane events and extent increased over the following years. This information will improve JBNERR’s understanding of the impacts of development and weather events on Jobos Bay, as well as inform future shoreline management decisions that ensure continued quality of the ecosystem.

***Key Terms:***

satellite remote sensing, Landsat 8, Sentinel-2, water quality, mangroves, ORCAA, land use land cover change

***National Application Area Addressed:*** Water Resources

***Study Location:*** Jobos Bay National Estuarine Research Reserve, Guayama & Salinas, PR

***Study Period:*** January2017 to March 2022

***Community Concerns:***

* Puerto Rico is vulnerable to sea level rise and strong storms because of its location near the equator. The island was recently impacted by Hurricanes Irma and Maria in 2017, and Puerto Rico is still recovering from the effects of those storms.
* Mangrove forests prevent erosion, minimize flooding, and create vital habitats. Intense storms and human development impact mangrove forests, reducing their functional role in providing these services to communities surrounding Jobos Bay.
* Jobos Bay is important to the surrounding community because it provides cultural, ecological, educational, and recreational services. It is vulnerable to negative effects from climate change, including intense storms and sea level rise.
* Water quality in Jobos Bay may be impacted by changing land use, such as mangrove forest clearances, increased agriculture, and urbanization. Degradation of water quality affects ecosystem health and local community access.
* Land cover in Jobos Bay National Estuarine Research Reserve (JBNERR) and the surrounding areas has changed due to encroaching development and increased agricultural use, which could lead to changes in ecosystem health and water quality.
* There is still little data on the extent of the effects of strong storms and land use land cover (LULC) change in Jobos Bay, providing a barrier to decision-making regarding ecological protection and predictions of ecosystem resilience.

***Project Objectives:***

* Analyze LULC in JBNERR and the surrounding watersheds
* Comparewater quality measurements to satellite water quality data
* Analyze mangrove cover before and after the 2017 hurricanes as well as recovery up to 2021
* Differentiate mangrove forests from other terrestrial vegetation

***Previous Term:***

2021 Summer LaRC – Jobos Bay Water Resources I

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Jobos Bay National Estuarine Research Reserve** | Aitza E. Pabón Valentín, Director; Angel Dieppa, Research and Monitoring Coordinator; Milton Muñoz Hincapié, Stewardship Coordinator | End User | Yes |

***Decision-Making Practices & Policies:***

The JBNERR is managed by the Puerto Rico Department of National and Environmental Resources and the NOAA Office of Coastal Management. JBNERR is protected by the National Estuarine Research Reserve System and works with NOAA for funding and national guidance of conservation and management. JBNERR works towards advancements in coastal protection efforts by conducting water-quality monitoring, hands-on public education experience, and coastal stewardship, as well as initiating long-term field-based research and the utilization of remote sensing technologies and drone imagery. They currently utilize drone imagery and Earth observations in addition to *in situ* field collections to inform their decision-making.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 8 OLI**  | Mangroves, turbidity | The dataset was used to classify changes in mangrove health and extent over time in relation to landscape changes from Hurricane Maria and Irma and to capture water quality parameters.  |
| **Sentinel-2 MSI**  | Land cover, Color Dissolved Organic Matter (CDOM), Chlorophyll-a (Chl-a), turbidity  | The land cover imagery was used to create LULC classification maps. Meanwhile, water quality data was used for validity comparison between satellite imagery and *in situ* field measurements from the University of Puerto Rico. |
| **WorldView-2 WV110** | Mangroves | The imagery was used for validation of mangrove map accuracy assessment. |
| **WorldView-3 WV110** | Mangroves | The imagery was used for validation of mangrove map accuracy assessments. |

***Ancillary Datasets:***

* University of Puerto Rico,Mayagüez campus *in situ* data for CDOM, Chl-a, and turbidity – Data collected in the study area for satellite data comparison to inform accuracy
* JBNERR, Jobos Bay Shapefile – Shapefiles delineating various classified areas of the bay, including mangrove forests, for identifying changes in density
* Esri 2020 Land Cover – Used as a visual comparison to our 2021 LULC classification for validation of land cover change from 2020 to 2021

***Modeling:***

* ORCAA (POC: Hayley Pippin, NASA DEVELOP National Program) – Calculate chlorophyll-a and turbidity for the water quality parameters

***Software & Scripting:***

* Google Earth Engine API – Access and process satellite imagery to analyze land cover, mangrove extent, and water quality parameters
* Esri ArcGIS Pro 2.9 – Map and analyze mangrove changes before and after Hurricane Maria
* Google Earth Pro 7.3.4.8248 – Validate modeled mangrove extent and land use land cover classifications

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used**  | **Partner Benefit & Use** | **Software Release Category** |
| **Maps of Mangrove Change and Recovery after Hurricanes Maria**  | Landsat 8 OLI,WorldView-2 WV110WorldView-3 WV110 | These maps will inform planning and management decisions by providing partners with a better understanding of storm impacts and mangrove recovery time. This enhanced analysis of mangrove extent will aid partners in visualizing trends in mangrove density and further inform future management decisions. | N/A |
| **LULC Map 2021** | Sentinel-2 MSI | LULC maps will provide JBNERR with an understanding of changes occurring around the watershed that impact the Jobos Bay ecosystem. | N/A |

***Product Benefit to End User:***

In an area that is extremely susceptible to hurricanes, such as Jobos Bay, conservation and restoration efforts for the mangrove population are extremely vital. The final product will provide data on mangrove changes that will assist the researchers at JBNERR in future planning. The utility and visualizations of our project will not only benefit JBNERR in their decision making and planning, but the products will also reach a wider audience with the StoryMap and poster. The product benefit extends from the project partners to local communities and the general public by visualizing the importance of sustainability in vulnerable coastal shorelines as well as changes in mangrove health. JBNERR and local communities will utilize the analyzed data to create informed decisions to pinpoint critical areas of restoration.

**References:**

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