**NASA DEVELOP National Program**

**Georgia – Athens**

****

*Project Summary – Fall 2017*

**Miami Beach Urban Development**

*Utilizing NASA Earth Observations to Assess Sea Level Rise and Develop Optimal Green Infrastructure Plans to Restore Mangrove Habitat and Enhance Coastal Resiliency*

**VPS Title:** Greening the 305: Mapping Ecological Resilience in Miami Beach

**Project Team**

***Project Team*:**

Maria Luisa Escobar Pardo (Project Lead), mlescobarpardo@gmail.com

Christopher Cameron

Abhishek Kumar

Sonia Linton

David Rickless

Navid Hashemi Tonekaboni

Sam Weber

***Advisors & Mentors*:**

Dr. Rosanna Rivero (University of Georgia, College of Environment and Design)

Dr. Marguerite Madden (University of Georgia, Department of Geography)

**Project Overview**

***Project Synopsis*:** This project aimed to provide the Miami Beach Public Works Department with a better understanding of how green infrastructure can improve coastal resiliency and local ecosystems. The goal of this DEVELOP project was to examine historic and current sea-level conditions in addition to mangrove habitat suitability in Biscayne Bay and adjacent cities. The team worked to create a vegetation time series, along with historical mangrove health maps and post Hurricane Irma coastal damage assessments, to enhance habitat restoration efforts. These end-products will assist management in evaluating changing conditions across the Biscayne Bay area and provide decision makers with additional information to assess restoration plans.

***Abstract*:**

In response to projected sea level rise and extreme weather events, Miami Beach and other urban areas surrounding Biscayne Bay are developing adaptive strategies to mitigate the effects of changing environmental conditions. Because the local economy, especially the tourism industry, is intricately tied to coastal resources, city officials are involved with on-going efforts to reduce storm damage and monitor shoreline conditions. Some important considerations for these adaptive strategies include water drainage capacity, green infrastructure, and maintenance of natural wetland ecosystems, particularly mangrove forests. This NASA DEVELOP project employed Earth observations to assess historical trends in urban vegetation density, post Hurricane Irma coastal damage, and the current extent and health of mangrove ecosystems in protected areas. The goal of this project was to enhance the wetland monitoring and shoreline management programs led by local organizations, such as the City of Miami Beach Public Works Department. The results of this project will be incorporated into a mangrove habitat suitability analysis that will aid the ecological management and land use planning efforts led by the City of Miami Beach Public Works Department to improve coastal resiliency.

**Keywords:**

Coastal wetlands, sea level rise, green infrastructure, living shorelines, Miami, mangroves, Landsat, Biscayne Bay

***National Application Areas Addressed:*** Urban Development, Water Resources

***Study Location:*** Miami-Dade County, FL

***Study Period:*** March 1984 – September 2017

***Community Concern:***

* Cities surrounding Biscayne Bay have increased their storm water drainage capacity and pump stations as adaptive strategies to mitigate effects associated with changing sea level conditions.
* Predicted changes in shoreline could significantly impact the economies (primarily the tourist industry) of The City of Miami Beach and others in Biscayne Bay.
* Extreme weather events, such as hurricanes, pose major threats to coastal communities surrounding Biscayne Bay.

***Project Objectives:***

* Examine changes in shoreline land use and position across Miami-Dade County from 1984 to 2017
* Map changes in historic vegetation extent from 1984 to 2017 using Landsat 5 and 8 data
* Analyze green space distributions from 1984 to 2017 for major urban areas in Miami-Dade County
* Assess health and distribution of coastal wetlands, specifically mangroves, in the study area

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **City of Miami Beach, Public Works Department** | Francisco D’Elia, GIS Analyst | End User | Yes |

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

The Miami Beach government monitors and assesses water quality in the areas surrounding Miami Beach to quantify and monitor runoff and storm water discharge from the canals and pumping stations in the region. As pumping requirements increase with expected sea level rise and subsidence, in addition to a growing population and urban development, there are concerns that water quality will no longer support aquatic biodiversity and healthy ecosystems.

***Project Benefit to End User***:

These end products will contribute to resilience studies being conducted by officials at the Miami Beach Public Works Department, specifically those related to the use of mangrove ecosystems as green infrastructure. The outputs of this project will enhance ongoing storm surge modeling and help expand current studies conducted by officials in Miami Beach and other neighboring cities. Decisions about prioritizing certain areas of interest in relation to sea level rise and coastal resiliency will be enhanced by the methods and analysis conducted during this project.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 5 TM** | Vegetation and shoreline extent | Landsat 5 data from 1984 to 2013 were used in vegetation mapping and time series analysis. Images were used to examine mangrove health and estimate past extent. Additionally, these data were used to assess historic changes in shoreline conditions. |
| **Landsat 8 OLI** | Vegetation and shoreline extent | Imagery from 2013 to September 2017 were used in vegetation mapping and time series analysis. Landsat 8 images were used to quantify mangrove health and estimate habitat extent. Additionally, these data assisted in identifying recent changes in shoreline conditions. |
| **PlanetScope** | Coastal damage assessment and shoreline change | PlanetScope data for two dates (September 7, 2017 and September 12, 2017) were used to determine post hurricane coastal damage and vegetation loss along the shoreline in Miami Beach. |
| **Terra MODIS** | Vegetation health and extent indices | Terra MODIS data from February 18, 2000 to September 22, 2017 were used to analyze historical GPP values as a proxy for mangrove health. |

***Ancillary Datasets:***

City of Miami Beach, Public Works Department Bathymetry – underwater terrain and shoreline features

City of Miami Beach, Public Works Department LiDAR –high resolution terrain and vegetation structure data

USDA National Agriculture Imagery Program – high resolution aerial photography of urban areas in Miami- Dade County

USGS Digital Orthophoto Quadrangles – historic aerial photography of urban areas in Miami-Dade County

USGS National Elevation Dataset – high resolution elevation data for Miami-Dade County

Miami-Dade County GIS Open Data – study area boundary shapefile

***Software & Scripting:***

Esri ArcGIS 10.2 – image processing and mosaicking, map creation, and hotspot analysis

Google Earth Engine API – creation of time series animations and mapping of mangrove health and extent

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Irma Coastal Damage Assessment Maps** | PlanetScope | This product will provide officials at the City of Miami Beach Public Works Department with information regarding changes in shoreline and sea level conditions in the Biscayne Bay area as a result of Hurricane Irma. | N/A |
| **Historic Vegetation Maps** | N/A | Vegetation maps will give officials at the City of Miami Beach Public Works Department information about the historic range of vegetation and changes in vegetation extent in the Biscayne Bay area. | N/A |
| **Mangrove Health and Extent Time Series** | Landsat 5 TM, Landsat 8 OLI, Terra MODIS | The mangrove health and extent time series will enable the project partners to identify historic trends in mangrove health and examine how these correlate with extreme weather events. | N/A |

**Project Handoff Package**

**Transition Plan:**

The team conducted a virtual hand-off to share end products and results to the Miami Beach Public Works Department at the end of the term.

*Project Continuation Plan*: The Miami Beach Urban Development project is expected to continue for a second term during the spring of 2018 at the Georgia – Athens node. The materials expected to be completed during this first term of the project include: a) shoreline change time series and analysis, b) historic vegetation maps, and c) historic mangrove extent maps. The end products handed off to our project partner at the end of the first term will serve as inputs for a mangrove habitat suitability analysis that will be created during the second term of this project.

**Team POC:** Maria Luisa Escobar Pardo, mlescobarpardo@gmail.com

**Partner POC**: Francisco D’Elia, franciscodelia@miamibeachfl.gov

**Handoff Package:**

* Irma Coastal Damage Assessment Maps
* Historic Urban Vegetation Density Maps
* Mangrove Health and Extent Time Series
* Final Draft Deliverables
* Project Video

**References:**

Costanza, R., Pérez-Maqueo, O., Martinez, M. L., Sutton, P., Anderson, S. J., & Mulder, K. (2008). The value of coastal wetlands for hurricane protection. *Ambio, 37*(4), 241-248.

Diamond, J. M., & Heinen, J. T. (2016). Conserving rare plants in locally-protected urban forest fragments: A case study from Miami-Dade County, Florida. *Urban Forestry & Urban Greening*, *20*, 1-11.

Wdowinski, S., Bray, R., Kirtman, B. P., & Wu, Z. (2016). Increasing flooding hazard in coastal communities due to rising sea level: Case study of Miami Beach, Florida. *Ocean and Coastal Management*, *126,* 1-8.