**NASA DEVELOP National Program**

**** NASA Langley Research Center

*Summer 2017*

**Short Title: Miami Beach Water Resources**

**Subtitle:** Assessing the Feasibility of Using NASA Earth Observations to Monitor Trends in Runoff and Storm Water Discharge of the Biscayne Bay

**VPS Title:** Stormwater, Salinity, and Seagrass: Remote Sensing in Florida’s Biscayne Bay

**Project Team**

**Project Team:**

Pamela Kanu (Project Lead), psknasadev@gmail.com

Danielle Quick

Randolph Colby

**Advisor:**

Dr. Kenton Ross (NASA Langley Research Center)

**Project Overview**

**80-100 Word Objectives Overview:**

The objective of this project was to use remote sensing techniques to produce annual water clarity and water quality trend maps from 1995 to 2016 for Biscayne Bay, the 270 mi2 shallow estuary south of Miami Beach. These maps will help project partners at the Public Works Department of the City of Miami Beach in making decisions regarding stormwater management to avoid impacts on Submerged Aquatic Vegetation (SAV) in the Bay. This project used NASA Earth observations in addition to *in situ* data provided by the City of Miami Beach Public Works Department.

**Abstract:**

Submerged Aquatic Vegetation (SAV) is an important component of coastal ecosystems, and is vulnerable to increased turbidity in the water column. It provides stability and protection to sediment deposits, and offers food and shelter to economically valuable species of marine life. Recent urban development and population growth in the Miami area have resulted in an increase in stormwater discharge connected to changing water quality in Biscayne Bay. The project used Earth observation data from a suite of sensors including Landsat 8 OLI, Landsat 7 ETM+, Landsat 5 TM, and Sentinel-2 MSI in conjunction with *in situ* water quality monitoring data. Turbidity and chlorophyll-a concentration data were used to develop a tool to view both historic and current water quality parameters in Biscayne Bay. The results of this project will assist the City of Miami Beach Public Works Department in decision making and predicting future water quality trends in Biscayne Bay and the surrounding area.

**Keywords:**

Landsat, Sentinel, turbidity, SAV, stormwater

**Partner Organizations:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| City of Miami Beach, Public Works Department | Francisco D’Elia, GIS Analyst | End User | No |

**Community Concerns:**

* Urban development in recent years has led to increased stormwater runoff.
* Sea level rise and land subsidence is increasing anti-flood pumping requirements for Miami Beach.
* Stormwater runoff from urban areas increases turbidity and can rapidly change salinity of the Bay.
* Submerged Aquatic Vegetation (SAV) is important to economically-important species and water quality, and is threatened by increased turbidity and variable salinity.
* Water quality decreases by both stormwater runoff and increased sediment resuspension due to reduced SAV.
* In the late 1980’s through early 1990’s, nearby Florida Bay lost over 4,000 ha of seagrass due to salinity issues.

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

The Miami Beach government currently monitors and assesses water quality in the areas surrounding Miami Beach to quantify and monitor runoff and stormwater discharge from the canals and pumping stations throughout the region. This information is used to determine how best to mitigate the impact of new floodwater pumping, as well as which pollutant sources are most damaging to Biscayne Bay. This allows the Public Works Department to more efficiently target their efforts to keep Biscayne Bay healthy.

**Decision Support Tools & Benefits:**

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software**  **Release** |
| Annual Water Clarity Maps | Landsat 5 TM,  Landsat 7 ETM+,  Landsat 8 OLI, and Sentinel-2 MSI | Annual water clarity maps will be used to create a Normalized Difference Turbidity Index to assess water clarity and correlate with *in situ* data. Annual maps would allow the historical water clarity of Biscayne Bay to be connected to events in the surrounding area, enhancing prediction of future event effects. | I |
| Trend Maps of Water Quality Parameters | Landsat 5 TM,  Landsat 7 ETM+,  Landsat 8 OLI, and Sentinel-2 MSI (annual temporal and spatial averages) | Trend maps of water quality parameters will be used to show historical trends in chlorophyll-a, turbidity, ADG and other water quality parameters. Trend maps would allow the past water quality of Biscayne Bay to be connected to events in the surrounding area, enhancing prediction of future event effects. | I |
| Biscayne Bay Water Quality Web Map Application | Landsat 5 TM,  Landsat 7 ETM+,  Landsat 8 OLI, and Sentinel-2 MSI | Annual water clarity maps and trend maps of water quality parameters displayed via web map application provide greater clarity and visibility to the citizens of Miami Beach. | III |

**Project Benefit to End User**:

This analysis will help the City of Miami Beach Public Works Department understand historical and current impacts to water quality by identifying long-term trends in Biscayne Bay, allowing them to base their current practices on the impact of past decisions and how they affect SAV. This project may be used by the surrounding regions to help predict the pollution areas causing the destruction of SAV. The methods produced by this project will allow the Public Works Department to continue using Earth observations to monitor water quality over a greater spatial and temporal extent than the data currently in use.

**Project Details**

**Applied Sciences National Application Addressed:** Water Resources

**Study Area** Biscayne Bay, FL

**Study Period:** January 1995 – December 2016

**Earth Observations & Parameters:**

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| Landsat 5 TM | Normalized Difference Turbidity Index (NDTI) | Landsat 5 will be used to generate maps identifying areas of high and low water clarity and where suitable SAV habitat can be found near Miami Beach. |
| Landsat 7 ETM+ | Normalized Difference Turbidity Index (NDTI) | Landsat 7 will be used to generate maps identifying areas of high and low water clarity and where suitable SAV habitat can be found near Miami Beach. |
| Landsat 8 OLI | Normalized Difference Turbidity Index (NDTI) | Landsat 8 will be used to generate maps identifying areas of high and low water clarity and where suitable SAV habitat can be found near Miami Beach. |
| Sentinel-2 MSI | Chlorophyll-a, Turbidity | Sentinel-2 data will be used for a higher resolution comparison to Landsat results and to produce maps identifying chlorophyll-a concentration. |

**Ancillary Datasets Utilized:**

* City of Miami Beach, Public Works Department, bathymetry – water depth
* City of Miami Beach, Public Works Department, *in situ* water quality data – turbidity, chlorophyll-a, total suspended sediment

**Software Utilized:**

* ACOLITE – atmospheric corrections for Sentinel-2 and Landsat 8 OLI data
* Python – scripting to batch process data
* Esri ArcGIS – raster manipulation and analysis, image enhancement, and map creation

**Project Handoff Package**

**Transition Plan:**

Deliverables will be handed off to Francisco D’Elia at the end of the term through a video conference. The end products will either be showcased at the meeting or delivered by email.

*Software Release Plan:* A web map will be delivered at the end of the term to the partner for visualizing the trend and water quality analysis. Since this web map includes processing of data, it will undergo software release prior to delivery. Francisco was made aware of the possible delay in delivery.

*Project Continuation Plan:* The first term of this project will produce trend and annual water quality maps using Landsat 8 OLI, Sentinel-2 MSI, Aqua MODIS, Landsat 5 TM, and Landsat 7 ETM+, in addition to *in situ* data provided by the City of Miami Beach Public Works Department. The second term will focus on updating the trend maps, producing finer resolution Aqua MODIS data using SeaDAS, creating tutorials and methodology overviews so that the City of Miami Beach can continue project analysis in the future.

**Team POC:** Pamela Kanu, psknasadev@gmail.com

**Software Release POC**: Pamela Kanu, psknasadev@gmail.com

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

**Handoff Package:**

* Annual Water Clarity Maps
* Trend Maps of Water Quality Parameters
* Map Package – MXD, File Geodatabase with Analysis and Charting Data