**NASA DEVELOP National Program**

**2024 Summer Project Proposal**

**PUP – Florida Gulf Coast University**

**Big Cypress Water Resources**

*Using Earth observations to assess Water Quality characteristics to Determine Operational Best practices in Big Cypress Preserve, FL*

**Project Overview**

***Project Synopsis*:** Embarking on a treasure hunt-style investigation in partnership with the Seminole Tribe and Florida Gulf Coast University, this study aims to discern and address chronic water quality problems affecting the canals, wetlands, and open water bodies of the northern precinct of Big Cypress Park, situated within the Everglades ecosystem. Harnessing the capabilities of Landsat 8 Operational Land Imager (OLI), Landsat 9 OLI-2, Sentinel-2 Multispectral Instrument (MSI), and Sentinel-3 Ocean Land Cover Instrument (OLCI), this project will examine water quality metrics such as chlorophyll-a concentrations, turbidity levels, surface temperature differentials, and cyanobacterial growth patterns from 2013 to 2024. Remote sensing analyses will be complemented with *in situ* datasets. This project hopes to inform management decisions (canal operations, wetland conservation, etc.) in the preserve.

***Study Location:*** Northern Big Cypress Preserve, FL

***Study Period:*** 2013 –2024

***Advisor(s):*** Dr. Rachel Rotz (Florida Gulf Coast University) rrotz@fgcu.edu; Dr. Barry Rosen (Florida Gulf Coast University) brosen@fgcu.edu; Ahmed Elshall (Florida Gulf Coast University) aelshall@fgcu.edu; Dhruvkumar Bhatt (Florida Gulf Coast University) dbhatt@fgcu.edu

**Partner Overview**

***Partner Organization(s):***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** | **Sector** |
| **Seminole Tribe of Florida** | Jed Redwine, Ecologist | End User | Tribal |

***End User Overview***

***End User’s Current Decision-Making Process & Capacity to use Earth Observations:***This project is set to impact the decision-making process around the management of canals and adjacent vegetation throughout the Big Cypress Region. Historically, the Federal Government has taken responsibility for this type of management via the Bureau of Indian Affairs. However, the Seminole Tribe has spent many years building up their infrastructure management capacity, practices, and procedures. Currently the partner organization doesn’t use Earth observations (EO) to inform management decisions, but they do use GIS and have the capacity to utilize EO data. The current decision-making process utilizes *in situ* sampling coupled with manager approval. Partners are hopeful that this project sparks a change in this process by incorporating EO data in a systematic, actionable, and scalable way. By increasing their EO use capacity, Ppartners will ultimately be able to optimize canal operations and best management practices with the best available data, and hopefully scale the methodology to apply to other Indigenous groups.

**Earth Observations Overview**

***Earth Observations:***

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| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** |  Normalized Difference Turbidity Index (NDTI) | This sensor will be used to quantify water quality characteristics across the Big Cypress Preserve. |
| **Landsat 8 TIRS** | Land Surface Temperature (LST) | This sensor will help find the LST of the study area. |
| **Landsat 9 OLI-2** | NDTI | This sensor will be used to quantify water quality characteristics across the Big Cypress Preserve. |
| **Landsat 9 TIRS-2** | LST | This sensor will help find the LST of the study area. |
| **Sentinel-2 MSI** | Colored Dissolved Organic Matter (CDOM), NDTI, Normalized Difference Chlorophyll Index (NDCI)  | This sensor will be used to quantify water quality characteristics across the Big Cypress Preserve. |
| **Sentinel-3 OLCI** | Cyanobacteria | This sensor will be used to identify Cyanobacteria using the 620 nm band. |
| **Dove PlanetScope** | NDTI | This sensor will showcase Turbidity a high 1 m resolution.  |
| **Maxar Worldview-3** | NDCI, Cyanobacteria | This sensor will help identify water quality characteristics Cyanobacteria at 2-3 m resolution using its multispectral bands. |

***Ancillary Datasets:***

* Seminole Tribe: Water Quality Samples (WQS) – validate chl-a, turbidity, and Cyanobacteria data acquired from Earth observations
* Environmental Protection Agency: Water Quality Framework (WQF) – validate chl-a, turbidity, Cyanobacteria, and Temperature data acquired from Earth observations
* South Florida Water Management District: DBHYDRO - validate chl-a, turbidity, Cyanobacteria, and Temperature data acquired from Earth observations
* National Park Service: Big Cypress National Preserve Small Scale Data - validate chl-a, turbidity, Cyanobacteria, and Temperature data acquired from Earth observations
* Florida Hydrologic Unit Code (HUC) Basins – Enable analyses to be conducted at the subwatershed level
* Florida National Hydrography Dataset (NHD) – showcase the location of current water bodies
* Landsat Dynamic Surface Water Extent (DSWE) – Landsat DSWE will show water presence as a baseline of comparison with the remotely sensed data.

**Decision Support Tool & End Product Overview**

***End Products:***

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| --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** |
| **Water Quality Timeseries (2013 – 2024)** | By understanding water quality trends over the last decade, partners will have data to aid in their water management decisions. | Landsat 8 OLI, Landsat 9 OLI-2, Sentinel-2 MSI, PlanetScope, Seminole Tribe WQS, EPA WQF, DBHYDRO, NPS Small Scale Data |
| **Harmful Algal Bloom Location Map** | This map will showcase areas most susceptible to HABs, enabling partners to adjust their HAB management approach accordingly. | Sentinel-3 OLCI, Landsat 8 OLI, Landsat 9 OLI-2, Sentinel-2 MSI, PlanetScope, Seminole Tribe WQS, EPA WQF, DBHYDRO, NPS Small Scale Data |
| **Cyanobacteria Time Series** | This time series will showcase the prevalence of cyanobacteria over the last decade (2013-2024). | Sentinel-3 OLCI, Maxar Worldview-3, Seminole Tribe WQS |
| **Temperature Differential Map**  | This map will showcase LST Differentials and provide partners insight into causes of water quality trends. | Landsat 8 TIRS; Landsat 9 TIRS-2; Correlation Analysis; EPA WQF, DBHYDRO, NPS Small Scale Data |
| **GIS Tutorial** | This product will show partners how to recreate the most successful methods (with the best EO data) of water quality monitoring in the region. | N/A |
| **Video** | The Video will document the project in a way that will showcase the partnership between the Seminole Tribe, NASA DEVELOP, and FGCU. | N/A (Partner Depending) |

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Summer 2024

***Similar Past DEVELOP Projects***:

* 2023 Summer (LaRC) – Lake Anna Water Resources: <https://appliedsciences.nasa.gov/what-we-do/projects/using-nasa-earth-observations-identify-algal-event-risk-factors-lake-anna-and>
* 2022 Summer (MSFC) – Lake Champlain Water Resources: <https://appliedsciences.nasa.gov/what-we-do/projects/using-nasa-earth-observations-identify-spatial-and-seasonal-trends-harmful>
* 2022 Fall (PUP) - Shoshone Water Resources I: <https://appliedsciences.nasa.gov/what-we-do/projects/assessing-sediment-inputs-shoshone-river-wyoming-determine-areas-protection-and>
* 2022 Fall (ARC) – San Diego Water Resources: [Monitoring Pollution Plumes due to Storm and Wastewater Runoff in the San Diego Bay and Tijuana River Estuary to Inform Water Quality Management | NASA Applied Sciences](https://appliedsciences.nasa.gov/what-we-do/projects/monitoring-pollution-plumes-due-storm-and-wastewater-runoff-san-diego-bay-and)

**Notes & References:**

***Notes*:** As partners are interested in overhauling their current methodology and scaling results, they are also interested in commercial data. They are specifically looking at adopting Planet data for continuous monitoring of the area. While this project can be done without Planet and Maxar data, it will be helpful to partners to ascertain the feasibility of incorporating these (and all) EO data into their practices.

Additionally, the specific area of a given analysis is variable depending on the EO platform utilized. Ideally this study is looking at waterways and wetlands on and near tribal lands. Thus, end products will have a range of scale from focused (a small canal cross section seen from high resolution commercial imagery) to encompassing (the whole Big Cypress area seen from Landsat and Sentinel platforms). Further, some sensors (e.g., PlanetScope and Maxar Worldview-3) will look at areas beyond the Big Cypress region to showcase data feasibility of use and scalability.

***References:***

Miller, R. L., McPherson, B. F., Sobczak, R., & Clark, C. (2004). Water Quality in Big Cypress National Preserve and Everglades National Park—Trends and Spatial Characteristics of Selected Constituents. US Department of the Interior. *Water Resources Investigations Report* 03-4249. <https://pubs.usgs.gov/wri/wri034249/wri03_4249_miller.pdf>