**NASA DEVELOP National Program**

**2024 Spring Project Proposal**

**California – Ames**

**Cali Urban Development**

*Using NASA Earth Observations to Assess Wetlands and Land Reclamation in Cali, Colombia*

**Project Overview**

***Project Synopsis*:**

Wetlands are vital for ecosystems and biodiversity but are threatened by urbanization and agricultural expansion. This project investigates the declination of wetlands in Cali, Colombia by developing a time series of wetland extent and land use classification with Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Landsat 9 OLI-2, Sentinel-2, and Planetscope data between 1992 and 2023. This project partners with Fundación Dinamizadores Ambientales who aim to preserve biodiversity and sustainability of the natural resources by understanding the historical distribution of wetlands and drivers of declinations. By providing up-to-date information on wetland distribution, land cover change, and land use change it will support evidence-based decision-making, enhance wetland conservation efforts, and contribute to the sustainable management of these critical ecosystems in the country.

***Study Location:*** Cali, Colombia

***Study Period:*** January 1992 – December 2023

***Advisors:*** Dr. Juan Torres-Pérez (NASA Ames Research Center) juan.l.torresperez@nasa.gov , Lisa Tanh (ESRI) ltanh@esri.com, Dr. Alexandra Christensen (NASA JPL) alexandra.l.christensen@jpl.nasa.gov

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** | **Sector** |
| **Fundación Dinamizadores Ambientales** | Sebastian Oyola, Project Coordinator | End User | International |
| **Departamento Administrativo de Gestión del Medio Ambiente (DAGMA)** | Franklin Castillo-Sanchez, Deputy Director of Environmental Quality. Viviana Huetio-Vergara, Environmental Engineer, Urban Environmental Assessment Group. Elidier Gómez, Director ( E) - 02 Octubre. Francy Restrepo Aparicio, Directora Dagma. Viviana María Sánchez Escobar, Líder grupo cambio climático. Monica Londoño. | End User | International |

***End User Overview***

***End User’s Current Decision-Making Process & Capacity to Use Earth Observations:***

The Departamento Administrativo de Gestión del Medio Ambiente (DAGMA) is the maximum authority in Cali, Colombia in charge of developing diverse programs directed at citizen participation and care of the environment. The Fundación Dinamizadores Ambientales (FDA) is a non-profit organization that has helped DAGMA for the past 10 years by providing educational and applied tools for the conservation of Cali’s natural resources. While both institutions have personnel trained in basic remote sensing and geographical information systems (GIS), neither has the tools, personnel, and resources to maintain a program on the use of remote sensing tools for resource management. This project will introduce the usage and methodologies of NASA Earth observations in the partner’s tool kit.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 5 TM** | Landcover | These data will be used between 1992 and 2012 tocalculate land-use change, create maps, anddevelop time series analyses. |
| **Landsat 7 ETM+** | Landcover | These data will be used between 1999 and 2021 tocalculate land-use change, create maps, anddevelop time series analyses. |
| **Landsat 8 OLI** | Landcover | These data will be used over the past 22 years tocalculate land-use change, create maps, anddevelop time series analyses. |
| **Landsat 9 OLI-2** | Landcover | These data will be used over the past 3 years tocalculate land-use change, create maps, anddevelop time series analyses. |
| **Sentinel-1 C-SAR** | Backscatter | This data will be utilized for inundation classification within the NASA DEVELOP’s Wetland Extent Tool (WET)  |
| **Sentinel-2 MSI** | Land cover | These data will be used over the past 6 years tocalculate land-use change, create maps, anddevelop time series analyses. Thess data are also in the primary input to the Dynamic World land cover dataset that will be used as a reference in selecting training polygons for classification. |
| **Suomi-NPP VIIRS** | Floodwater fraction | These data will be used to calculate floodwater fraction for validation of classification tool. |
| **PlanetScope** | Surface Reflectance | These data will be used over the past 8 years tocalculate land-use change, create maps,develop time series analyses, and delineate wetland extent |

***Ancillary Datasets:***

* USGS SRTM 90 m Digital Elevation Database – input data for the Wetland Intrinsic Potential tool

***Modeling:***

* DEVELOP WET Tool (POC: Mitch Porter, Cultural Site Research and Management Foundation and Bruce Chapman, NASA Jet Propulision Laboratory) – wetland change analysis and monitoring
* Wetland Intrinsic Potential Tool (POC: Meghan Halabisky, University of Washington) – mapping wetland intrinsic potential through machine learning and remote sensing datasets

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |
| --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** |
| **GIS Tutorial** | A tutorial created by the project team will provide partners with the ability to create a GEE-based toolthat performs land use changeanalyses and produces timeseriesgraphs and charts. The partners will use these maps for strategic urban planning because wetlands have been drastically reduced in the past two decades. | Calculated land use changefrom Landsat 5 TM, 7 ETM+, 8 OLI, 9 OLI-2, and true color composites from PlanetScope will all be utilized within Google EarthEngine. |
| **Wetland Extent Time Series** | Static maps depicting wetland extent throughout time. The partners will use these maps for strategic urban planning because wetlands have been drastically reduced in the past two decades. | Time series of wetland extent maps analyzed in Google Earth Engine with Sentinel-1 C-SAR, Sentinel-2 MSI, and Suomi-NPP VIIRS datasets. |
| **Land use/Land cover change maps** | Static maps calculating land-use/land cover change will allow partners to further understand which areas havechanged the most over the last 31years.  | Calculated land-use changefrom Landsat 5 TM, 7 ETM+, 8 OLI, and 9 OLI-2 and PlanetScope will be used to understand how human development andinfrastructure has increased overthe past 31 years within thestudy area. |

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: (2024 Spring) to (2024 Summer)

***Multi-Term Objectives:***

* **Term 1:** 2024 Spring (ARC) – Cali Urban Development
	+ This term will create a time series of wetland extent and land use and land cover to investigate drivers of wetland loss. This will include a ~30 years land use/land cover change analysis. A code tutorial of the methodologies will be transferred to the partners to increase their capacity to use NASA Earth observations.
* **Term 2 (2024 Summer):** 2024 Summer (ARC) – Cali Urban Development II
	+ This term would investigate the Urban Heat Island (UHI) effect for communities of Cali, Colombia while using the wetlands as a rural reference. The team will utilize NASA DEVELOP’S URBAN HEAT EXPOSURE ASSESSMENT TEMPE (UHEAT) to understand the UHI effect before and after wetland loss related to urban development. A tutorial on the methodologies will be transferred to the partners to increase their capacity to use NASA Earth observations and understand the heat disparity for communities.

***Similar Past DEVELOP Projects***:

* 2013 Spring (MSFC) – Utilizing NASA Earth Observations to Analyze Wetland Gain and Loss in Threatened Wetland Areas in South Carolina: <https://www.devpedia.developexchange.com/dp/index.php?title=South_Carolina_Ecological_Forecasting_MSFC_Spring_2013>
* 2014 Summer (SCC) – Louisiana Ecological Forecasting: <https://www.devpedia.developexchange.com/dp/index.php?title=Louisiana_Ecological_Forecasting_SSC_Summer_2014>
* 2014 Fall (JPL) – Gulf Coast Ecological Forecasting: <https://develop.larc.nasa.gov/2014/fall/GulfCoastEcologicalForecasting.html>
* 2017 Summer (MSFC) – Rwanda Ecological Forecasting: <https://appliedsciences.nasa.gov/what-we-do/projects/utilizing_nasa_earth_observations_to_classify_wetland_extent_in_rwanda_in_support_of_united_nations_sustainable_development_goals>
* 2019 Spring (JPL) – Alaska Ecological Forecasting II: <https://appliedsciences.nasa.gov/what-we-do/projects/semi_automated_mapping_of_alaskan_wetland_inundation_by_integrating_synthetic_aperture_radar_and_optical_satellite_imagery>
* 2020 Spring (JPL) – Great Lakes Water Resources II: <https://develop.larc.nasa.gov/2020/spring/GreatLakesWaterII.html>
* 2021 Summer (ARC) – Maya Forest Water Resources: https://develop.larc.nasa.gov/2021/summer/MayaForestWater.html
* 2021 Summer (AZ) – Hawaii Island Climate: <https://appliedsciences.nasa.gov/what-we-do/projects/utilizing-earth-observations-delineate-wetland-extents-model-sea-level-rise>
* 2021 Fall (ARC) – Maya Forest Water Resources II: https://appliedsciences.nasa.gov/what-we-do/projects/mapping-inundation-below-forest-canopy-maya-tri-national-forest
* 2023 Spring (JPL) – WET Water Resources: https://appliedsciences.nasa.gov/what-we-do/projects/google-earth-engine-python-api-tool-automate-wetland-extent-mapping-using-radar
* 2023 Spring (ARC) – Maldives Climate II: https://appliedsciences.nasa.gov/what-we-do/projects/evaluating-potential-impacts-sea-level-rise-human-development-and-coastal

**References:**

Halabisky, M., Miller, D., Stewart, A. J., Lorigan, D., Brasel, T., & Moskal, L. M. (2022). The Wetland Intrinsic Potential tool: Mapping wetland intrinsic potential through machine learning of multi-scale remote sensing proxies of wetland indicators. *EGUsphere*, 1-19.

Ocampo-Marulanda, C., Carvajal-Escobar, Y., Perafán-Cabrera, A., & Restrepo-Jiménez, L. M. (2021). Desiccation of wetlands and their influence on the regional climate. Case Study: Ciénaga de Aguablanca, Cali, Colombia. *Tropical Conservation Science*, *14*, 19400829211007075.

Vilardy, S. P., González, J. A., Martín-López, B., & Montes, C. (2011). Relationships between hydrological regime and ecosystem services supply in a Caribbean coastal wetland: A social-ecological approach. *Hydrological Sciences Journal*, *56*(8), 1423-1435.

Zapata-Caldas, E., Calcagni, F., Baró, F., & Langemeyer, J. (2022). Using crowdsourced imagery to assess cultural ecosystem services in data-scarce urban contexts: The case of the metropolitan area of Cali, Colombia. *Ecosystem Services*, *56*, 101445.

Pre-Term Notes:

* DAGMA
* Diego – biologist. Coordinator for project.
* Tatiana Meza – biologist from National Park. DAGMA team.
* Maria Sanchez – supply leader.
* Robert Diaz – Government and climate change grup
* Monica London – Ecosystem coordinator and coordinator for project management
* Sebastian Oyola – Environmental engineer. Organization in Cali that has always worked on environmental conservation and education. Focused on giving job opportunities to people in neighborhoods to work and have benefits from environmental conservation. Met Juan five months ago. Idea with research project in Cali about the wetlands. With DAGMA team so they can articulate and learn how to work together.
* Project 1 = land use/land cover change and wetlands.
* Projects are based on remote sensing data. Utilizing different datasets from different satellites. We can’t go to the field to validate it. We have to rely on what’s available from reference papers or data that the partners can facilitate. Any data that validates our satellite data is always welcome.
* We expect bi-weekly meetings and may possibly ask for things like this.
* There is some validating data for wetlands for mangroves. Search that data now.
* In this month, they are transitioning governments. They are wondering if there is any action to be done now.
* Send what information is needed. Create an agreement.
* Already map for 2016 and 2018 for parts of the city that could be made available for the second term.
* We can incorporate Sentinel data for later years of Landsat series. We will use GEE free online tool so they can do it on their own.
* To validate information, they have a drone for vegetation.
* Participate with community to host environmental school and have people in the community know what the technology is and how they can take care of the environment. Sebastian is working on permit from DAGMA , environmental authorative of the city, to get permission to work in the wetlands. Big project in the field with the people.
* There will be a change in the government. They want to do a document that could explain what our project will be and what their participation will be and how they can give support. A letter that documents that we will keep data sensitive. One page just like Great Plans. DEVELOP will do a 2 term project in Cali which will run between x amount of time on these two projects. In communication with DAGMA, they agreed on providing field support, x, y, z. 5 hours of meeting time. Aside from data, we ask them to fill out pre-project partner form.