**NASA DEVELOP National Program**

**Spring 2016 Project Proposal**

**NASA JPL**

**Bolsa Chica Ecological Forecasting**

Tracking the Success of the Bolsa Chica Wetland Restoration Using NASA Earth Observations

**Project Overview**

***Objective:*** To assess changes in the Bolsa Chica, CA, Wetland and Ecological Reserve over time and provide monitoring capabilities for vegetation extent using AVIRIS, Landsat and UAVSAR datasets.

***Community Concern:***

A large portion of coastal wetlands within California have degraded over time due to human impact. These wetlands are home to an array of migratory birds and are nursery grounds for fish. The Bolsa Chica Ecological Reserve was one such wetland altered by human activity, starting in the 1890s, which continued until 1997, when the state purchased 880 acres from an oil company. The planning process to restore 550 acres of historic Bolsa Chica lowlands began in 2001 and finally in 2006, tidal flushing was fully restored within Bolsa Chica. Since the start of the restoration process, there have been few large-scale or quantitative analysis of the success of the restoration project. It is important to obtain a refined understanding of wetland restoration and inform managers where *in situ* devices should be placed, such as a staff plate or nitrate sensor.

***National Application Area(s) Addressed:*** Ecological Forecasting

***Study Location:*** Bolsa Chica Ecological Reserve and Wetland, Orange County, California

***Study Period:*** 1970 – 2015 (or whenever first image of the wetland is available)

***Advisors:*** Cedric Fichot (JPL)

***Source of Project Idea:***

Former DEVELOP Center Lead, Gwen Miller, met Joana Tavares, a teacher at Long Beach City College, and an employee of Amigos de Bolsa Chica, through a DEVELOP science adviser. After talking for some time about the Bolsa Chica wetland and the restoration process at the wetland, the Center Lead realized DEVELOP could help the Amigos de Bolsa Chica group through an analysis of how the wetland has changed overtime.

**Partner Overview**

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

Amigos de Bolsa Chica, (End-User/Boundary Organization; POC: Joana Tavares-Reager, Oceanographer & Environmental Communication Specialist

***End-User Current Decision Making Process:***

Currently there is no remote sensing analysis of the Bolsa Chica wetland and the large-scale changes within the wetland are relatively unknown. Amigos de Bolsa Chica collaborates with the CA Dept. of Fish and Wildlife (DFW) managers and the other Bolsa Chica NGOs on a number of projects aimed at improving public education, maintenance, and conservation of the wetlands. The organization functions as stewards of the wetlands offering support to the Ecological Reserve managers with information, volunteer work, and financial resources. The organization has access to some limited *in situ* vegetation extent assessments conducted in the past five years. The Current decision making process is based largely on information acquired by DFW personnel and volunteers on the ground, which limits a more complete and historically integrated management approach.

***NASA Earth Observations Capacity:***

Amigos de Bolsa Chica – The Amigos knows about the existence of NASA Earth observations but have not used them before. They have no experience with remote sensing.

***Collaborator & Boundary Organization Support:***

Amigos de Bolsa Chica – The organization will handout the brochure produced by the DEVELOP project, as well as show the DEVELOP virtual poster during their upcoming Science Symposium and other public events. The Amigos will also publicize these materials on their website and various social media outlets the organization uses to communicate with the community. The Amigos intend to hire a Curriculum Developer to adapt DEVELOP project results into lesson plans that can be used by Amigos docents during school group visits to the wetlands and by teachers in the classroom. The Amigos will also pass on any findings to the CA Department of Fish and Wildlife who manage the Bolsa Chica Ecological Reserve.

***Communication Plan & Transition Approach:***

The team will talk to the partners during the beginning, middle, and end of the term.

***End-User Benefit:***

The Amigos can use the information to better inform the public on the restoration success at Bolsa Chica. The end-user will use the information obtained from this study to better educate the public through outreach material and to decide the best methods to conduct *in situ* environmental measurements. The project will fill in a gap on how the wetland is performing and how it looks on a large scale. For example, it is not well known how the water level changes over time at the wetland. By utilizing UAVSAR, or another NASA sensor, the Amigos can be better informed on the changes in water extent with different tides and environmental conditions including rainfall.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform** | **Sensor** | **Geophysical Parameter** |
| **ER-2** | AVIRIS | Multi-spectral; vegetation indices, surface water extent |
| **Landsat (1-8)** | OLI and TMI | Multi-spectral; vegetation indices, surface water extent |
| **Gulfstream III** | UAVSAR – available at ASF | Change in water and vegetation extent |
| **ALOS-1 and RADARSAT-1** | SAR – available at ASF | Change in water and vegetation extent |
| **Sentinel-1** | SAR – available ESA/ASF | Change in water and vegetation extent |

***NASA Earth Observations Use:***

AVIRIS – High spatial resolution (4-15 meters), multispectral data with previous collections in the study region. The high spatial resolution gives a better idea of different types of vegetation throughout the wetland. AVIRIS data can be used to detect changes in water coverage. AVIRIS is also an underutilized sensor.

Landsat – High temporal resolution with a long dataset (data is available 1982 – present). The Landsat satellites provide the best resource to analyze the long-term changes within the wetland area due to the temporal scale. Landsat data can also be used to detect changes in water coverage.

UAVSAR – The high resolution of this instrument (~6 m) and different radar signatures over vegetation, bare earth and water, allow for a higher detailed analysis of changing landscape and wetland boundaries. UAVSAR can pick up changes in water coverage overtime and has annual data available from 2009-present within the study area.

ALOS-1 and RADARSAT-1 data of this area are available through the Alaska Satellite Facility. Both SAR sensors can provide valuable information to the project in a similar fashion as UAVSAR but with a longer time record. There may also be data available from Seasat SAR collected in 1978. More recent imagery may be available from Sentinel-1 SAR, openly available through the European Space Agency (ESA) and soon through ASF through a NASA/ESA agreement.

***Ancillary Datasets:***

Field surveys of plant species

Historical map from the 1970s obtained from aerial photography which distinguished the wetland extent that is available (Amigos)

Tide gauge data (NOAA) or stream gauge data (USGS).

Coastal Lidar Data

NOAA-C-CAP data

**Decision Support Tool & End-Product Overview**

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| --- | --- | --- |
| **Proposed End Products** | **Decision to be Impacted** | **Current Partner Tool/Method** |
| Satellite and aircraft imagery | Visual imagery showing change in wetland over time that can easily be understood by the general public | Historical aerial photography |
| Maps of changes in vegetation | How to more successfully monitor the wetland and direct educational program | *in situ* data |
| Maps of changes in water | How to more successfully monitor the wetland and direct educational program | *in situ* data |
| AGOL online map | Public outreach | *in situ* data |
| Video Documentary | Public outreach | On-site footage and datasets |

*Satellite and aircraft imagery* – Imagery to contrast changes over time.

Maps *of changes in Vegetation* – The Amigos can refer to the change maps to assist in determining future projects within the wetland. Changes in vegetation can help determine the usefulness of installing a staff plate and can be used by Amigos for outreach material for the general public.

*Map changes in water* - These maps can determine if there is a significant change in water elevation with different tidal cycles. This information can help determine the usefulness of installing a staff plate and can be used by Amigos for outreach material for the general public.

*AGOL on-line map* – An informative, interactive map of the Bolsa Chica wetlands that utilizes the dataset imagery that can be viewed and shared by the public. The intent of this product focuses on aiding the educational program that the Amigos de Bolsa Chica hosts. The implementation of Change Maps (described above) could be incorporated in the AGOL map to determine future projects within the wetland.

*Documentary Video* – A short, 5 to 8-minute video documentary that involves the history, human impact and current-day science at the Bolsa Chica Wetlands. The use of on-site footage and NASA datasets would benefit as a tool for public outreach in order to provide information on wetland restoration.

**Project Timeline & Previous Related Work**

***Project Timeline:*** Spring 2016

***Previous Related DEVELOP Work:***

Spring 2015 (JPL) – Los Angeles Water Resources: Monitoring Streamflow Regimes using NASA Sensor Data to Aid Classification-Based Decision Making for Streamwater Management in Los Angeles County

Spring 2015 (Langley) – Great Lakes Climate II: Monitoring the Impacts of Climate Change and Decreasing Water levels on Wetlands in the Great Lakes Region of North America

Spring 2015 (Fort Collins) – Arizona Ecological Forecasting: Coupling unmanned aerial systems with Landsat 8 imagery to refine, evaluate and compare risk assessments for invasive plants in the critical wetland habitat of Havasu National Wildlife Refuge

Spring 2005 (Stennis) – Louisiana Coastal and Water management: Utilizing Landsat Data to Monitor the Success of Various USACE Wetland Restoration Projects

**Project Needs/Requests**

***Participants Requested:*** 3-4

***Software & Scripting:***

ENVI - land classification of Landsat imagery, SAR mapping.

ArcGIS - land classification of Landsat imagery and change analysis

Python – creating header files for UAVSAR files and converting the files to dB

Google Earth Engine API for Landsat

TerrSet Land Change Modeler