**NASA DEVELOP National Program**

**Spring 2016 Project Proposal**

**NASA Goddard Space Flight Center**

**Great Lakes Ecological Forecasting**

Quantifying the Current and Future Extent of *Phragmites australis* in the Great Lakes Basin Using NASA Earth Observations

**Project Overview**

***Objective:*** To utilize NASA Earth observations to quantify the extent of *Phragmites australis* invasion in the Great Lakes Basin and identify areas at high risk of invasion.

***Community Concern:*** *Phragmites australis*, also known as the common reed, is an aggressive invasive freshwater or brackish-tidal wetland perennial grass. Phragmites easily outcompetes native plant species due to its ability to reproduce through seeds or underground rhizome clones. There is a native variety of Phragmites in the Great Lakes watershed; however, native Phragmites are rare and occur in healthy, mixed-wetland plant communities, whereas invasive Phragmites will grow in monotypic stands. Phragmites can grow up to 15 ft. tall with up to 60 stems per sq. ft., displacing native marsh vegetation. Dense monotypic stands of Phragmites create unsuitable habitat for native fish or wildlife, increase fire risk, and increase elevation of the landscape. Once Phragmites are introduced in an area they are difficult to remove. Traditional methods of removal include mowing and burning and do not work unless you can remove the entire plant, which requires costly, heavy machinery. Active land management is currently the best practice for preventing Phragmites from invading a region. Identifying the areas at highest risk for invasion by creating a time series of the proliferation of Phragmites would be helpful for land managers to ensure Phragmites do not become a problem in their region.

***National Application Area Addressed:*** Ecological Forecasting

***Study Location:*** Great Lakes Basin, United States (MN, WI, MI, IL, IN, OH, PA, NY) and Canada (Ontario, Quebec)

***Study Period:*** June 1985 – June 2020

***Advisor(s):*** TBD

***Source of Project Idea:*** This project idea came from continued conversations with the Great Lakes and St. Lawrence Cities Initiative, who continue to provide a strong partnership.

**Partner Overview**

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

Great Lakes and St. Lawrence Cities Initiative (GLSLCI) (End User and Boundary Organization; POC: Laura Bretheim, Program Assistant)

Michigan Tech Research Institute (Collaborator; POC: Laura Bourgeau-Chavez, Research Staff)

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

The GLSLCI does not currently involve remote sensing in their management decisions for the entire Great Lakes Basin, nor do they have a strong understanding of the extent of *Phragmites australis* for this region. The Cities Initiative also lacks understanding of how Phragmites extent will change in the future. They recognize the issues that Phragmites pose but would like to understand where to focus management areas of highest priority based on current extent and future projections. Current policies are carried out through an intergovernmental collaborative across cities, municipalities, states, and provinces. The Great Lakes Phragmites Collaborative was established to facilitate communication among stakeholders across the region and serve as a resource center for information on Phragmites biology, management, and research. Current policies to eradicate *Phragmites australis* involve the use of herbicides, mowing, prescribed burning, flooding, tarping, and grazing.

***NASA Earth Observations Capacity:***

Great Lakes and St Lawrence Cities Initiative – The GLSLCI is familiar with NASA Earth observations but has not used them to address invasive *Phragmites australis*.

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

Great Lakes and St. Lawrence Cities Initiative – The GLSLCI will distribute results to the mayors and decision makers in the areas surrounding the Great Lakes Basin.

Michigan Tech Research Institute – The research institute is familiar with *Phragmites australis* mapping in the Great Lakes Basin and has produced some maps of the region. They will provide methodological assistance and ancillary data. They are familiar with the Landsat platform but no other NASA Earth observations. Previously, they mapped Phragmites using costly Phased Array type-L-band Synthetic Aperture Radar (PALSAR) data and they did not complete the entire basin. Expanding the study area to include neglected areas as well as developing a methodology that would not incorporate PALSAR would be beneficial to the region. In addition, Phragmites forecasting was only completed for the United States border with the Great Lakes.

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

The team will communicate with the partners during bi-weekly telecons as well as email updates as needed. The team will transition results to the partners through a video conference where results are shared and discussed. The results generated by the team will be used to inform decisions regarding Phragmites control and removal. The project will be presented at the Great Lakes & St. Lawrence Cities Initiative Annual Meeting & Conference where decision makers from the US and Canada will have the opportunity to view the results and applications of NASA data.

***End-User Benefit:***

This project will allow communities in the Great Lakes Basin to respond to and prevent further invasion of Phragmites by locating the current extent of this invasive aquatic species, forecast the future extent, and guide policy makers to implement best management practices for targeted funding to support an invasive Phragmites program.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform** | **Sensor** | **Geophysical Parameter** |
| **Landsat 5,7,8** | Thematic Mapper(TM), Enhanced Thematic Mapper + (ETM+), Operational Land Imager (OLI) | Land use/ land cover change |
| **Shuttle Radar Topography Mission (SRTM)** |  | Digital Elevation Model |
| **Earth Observing-1 (EO-1)** | Hyperion | Vegetation indices  |
| **Sentinel-1** | Synthetic Aperture Radar (SAR) C-band | Monitoring forested wetland hydrology  |

***NASA Earth Observations Use:***

Landsat 5,7,8, TM, ETM+, OLI – used to complete land cover classifications highlighting areas of *Phragmites australis*

SRTM – used to determine the elevation of the landscape to aid in land cover classification

EO-1, Hyperion – used to complete land cover classifications and highlight areas of *Phragmites australis*

Sentinel-1, SAR — used to monitor the hydrology in areas impacted by *Phragmites australis*

***Models:***

TerrSet Land Change Modeler (POC: Dr. James Toledano, Clark Labs)

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

|  |  |  |
| --- | --- | --- |
| **Proposed End Products** | **Decision to be Impacted** | **Current Partner Tool/Method** |
| Land Use / Cover Time Series and Current Phragmites Extent Maps | Current Phragmites mitigation areas  | Anecdotal evidence describing the spread  |
| Forecasted Phragmites Extent Maps  | Areas to focus Phragmites prevention | None |

*Time Series of Current Phragmites Extent Maps* – Landsat 5, 7, 8 and EO-1 will be used to create land/water cover classification maps highlighting current Phragmites extent.

*Forecasted Phragmites Extent Maps* – the outputs from the land cover classification time series will be used to forecast Phragmites extent into the future using TerrSet’s Land Change Modeler.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Spring 2016

***Previous Related DEVELOP Work:***

Summer 2013 (LaRC) – Great Dismal Swamp Ecological Forecasting: Utilizing NASA Earth Observations and Orthoimagery to Locate Invasive *Phragmites australis* Reed Grass to Support U.S. Fish and Wildlife Service Invasive Species Eradication

Spring 2015 (MCHD) – Mississippi Water Resources I & II: Mapping Extent and Modeling Land Use of Critical and Endangered Watersheds to Assist Restoration and Conservation Planning using NASA Earth Observations

**Project Needs/Requests**

***Participants Requested:*** 4

***Software & Scripting:***

ArcGIS – land cover classification, raster manipulation/analysis, image enhancement and map creation

ERDAS Imagine – raster manipulation/ analysis, land classification

TerrSet – forecast modeling of change

R – Statistical analysis

**Notes & References:**

***References:***

Bourgeau-Chavez, L., Endres, S., Battaglia, M., Miller ME., Banda, E., Laubach Z., Higman, P., Chow-Fraser, P., and Marcaccio, J. 2015. Development of a Bi-National Great Lakes Coastal Weltand and Land Use Map Using Three-Season PALSAR and Landsat Imagery. Remote Sensing 7 (7): 8655-8682, doi: 10.3390/rs70708655

Pengra, BW., Johnston, CA., and Loveland TR. 2007. Mapping an invasive plant, Phragmites australis, in coastal wetlands using the EO-1 Hyperion hyperspectral sensor. Remote Sensing of Environment 108: 74-81.

<http://www.mtri.org/coastal_wetland_mapping.html>

<http://geodjango.mtri.org/coastal-wetlands/>

<http://cida.usgs.gov/glri/phragmites>