**NASA DEVELOP National Program**

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NASA Langley Research Center

**Fall 2014**

**Great Lakes Climate**

*Monitoring the Impacts of Climate Change and Decreasing Water Levels on Wetlands in the Great Lakes Region of North America*

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**Applied Sciences National Applications Addressed:**

Climate & Ecological Forecasting

**Study Area:** This study focused on an area along the northeastern section of Lake Huron, specifically the Georgian Bay area in Ontario, Canada.

**Study Period:** May 1987 and June 2013

**Partners/Collaborators**

Great Lakes and St. Lawrence Cities Initiative (David Ullrich)

Georgian Bay Forever (David Sweetnam)

Ontario Ministry of Natural Resources and Forestry (Mike Robertson)

**Word Blurb**

This study updated land cover classifications for coastal areas surrounding the Georgian Bay area off of Lake Huron. Land cover maps showing the changes in coastal wetlands extent were produced. This visualization highlights the impact of fluctuating lake water levels on the diverse ecosystem.  With the changing climate, the future of wetlands in the region is currently unknown. Fully understanding how wetlands have responded to lake level fluctuations in the past will help policy-makers prepare for future changes.

**Community Concerns**

* The Great Lakes and Georgian Bay water levels have been below the long-term average for over a decade.
* Georgian Bay coastal wetlands are some of the most diverse wetlands in the Great Lakes Basin and the below average lake water level trend may pose a risk to them.
* The economy of cities that gain revenue from fisheries and tourism rely on healthy coastal wetlands.

**Current Management Practices & Policies**

This project reaches across different Canadian federal, provincial, and local government jurisdictions that have taken individual and combined efforts to address the status of wetlands in the Great Lakes basin.  In Canada, and specifically Ontario, where the Georgian Bay is located, there is no specific legislation protecting wetlands; although there is some indirect coverage through conservation acts. Also, some wetlands are protected through policies and agreements, but these accords are not acknowledged as law. A number of natural heritage protection measures and planned upcoming legislation may provide wetlands with future protection, but currently, detrimental policies remain in effect, including allowing the drainage of wetlands for agricultural use.

**Abstract**

Wetlands are considered to be some of the most productive and diverse ecosystems on Earth. The Laurentian Great Lakes region of North America includes diverse types of coastal wetlands (e.g., swamps and marshes) that support numerous flora and fauna species. Studies of this ecosystem are very important for ecological communities and economic industries, which benefit from fisheries and tourism. The effects of climate change, such as variations in temperature, precipitation, and evaporation, could impact the water level of the Great Lakes, and therefore, the development and survival of coastal wetlands in this area. An updated land cover classification was developed, using a Random Forest classification method, to evaluate and monitor changes in the wetlands around Georgian Bay. NASA Earth Observations System (EOS) data from Landsat 5 Thematic Mapper (TM) and Landsat 8 Operational Land Imager (OLI) were used to classify land cover from 1987 and 2013. To improve the accuracy of the maps, resultant land cover classifications were validated with ground truth data. Additionally, TOPEX/Poseidon Jason-1 and Ocean Surface Topography Mission (OSTM)/Jason-2 radar altimeters and *in-situ* water gauges data served as a resource for tracking water levels over time to compare these fluctuations with wetlands. The methodology to create land cover classification maps showing the changes in coastal wetland health and extent offers a more cost-effective approach to monitoring wetlands in the region.

**Decision Support Tools**

* An updated methodology for classification of land cover for the coastal regions surrounding the Georgian Bay in Ontario, Canada
* A change detection map showing variations in the health and extent of coastal wetlands between May 1987 and June 2013

**Benefit to End-User:**

* Georgian Bay area classified maps and the associated wetlands extent change detection map can be used to inform regional decision makers of wetland health trends and influence conservation policy decisions.
* Maps displaying the change in study area wetland extent can be used to educate the general public on the importance of wetland conservation.
* Graphs of Lake Huron water level trends coinciding with the period of the wetland study provide local and regional decision makers with recent data to inform environmental and economic policies affecting the region.

**Earth Observations & Parameters**

* Landsat 5 TM: Land Cover
* Landsat 8 OLI: Land Cover
* TOPEX/Poseidon Jason-1: Lake Water Levels
* OSTM/Jason-2 : Lake Water Levels

**Future Applicable NASA Missions**

N/A

**Models Utilized**

Random Forest Classification Model

**Ancillary Datasets Utilized**

* Georgian Bay Forever – Parry Sound station *in-situ* water levels
* Ontario Ministry of Natural Resources and Forestry – land cover
* Canada Department of Fisheries and Oceans – lake water levels
* Google Earth imagery – training site selection aid

**Software Utilized**

* ArcGIS 10.2.2 - Raster Manipulation/Analysis, Spatial Analyst Classification tools
* Python scripting – Imagery Digital Numbers to Reflectance conversion
* R programming – Dr. Ned Horning’s and Dr. Martin Wegmann’s Random Forest Land Cover classification script for Landsat Imagery
* Microsoft EXCEL – Water Level graphs
* ERDAS Imagine – Accuracy assessment