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Great Lakes Remote Sensing: Binational, Petascale, Wetlands and Habitats Change Mapping

History

This Sector Insight article is based on international cooperation and shared geospatial data – all without a major exchange of international funding. This approach for sharing data and resources, across an international border, can be applied to almost any large area or complex monitoring program – as demonstrated here.

The seeds for this project were planted in the 1990's by the Great Lakes Information Network or GLIN (https://www.glc.org/glin). Roger Gauthier, with the Great Lakes Commission, led a series of Regional Data eXchange (RDX) Conferences with the goal of fostering the exchange of geospatial data between Canada and the US.

In 2010, the author was granted a Radarsat-2 data grant from the Canadian Space Agency SOAR Program to investigate the use of satellite imagery for wetland mapping in collaboration with the University of Minnesota. This grant also reignited a collaboration with Dr. Brian Brisco with the Canada Centre for Remote Sensing (CCRS). In 2015, I was sent to Ottawa to renew collaborations that grew out of the Great Lakes Information Network.

Significance

The Great Lakes make up about 84% of North America's freshwater surface area and about 21% of the world's freshwater surface area. The total surface area of the Great Lakes Basin is about 244,106 square kilometers (93,971 square miles), which is about 0.2% of the Earth's total surface area of about 510.1 million square kilometers (196.9 million square miles). In the future, when the freshwater Greenland and polar ice caps melt into the saltwater oceans, the 21% of the planet's freshwater surface area increases to about 50%. Thus making the Great Lakes System an important freshwater resource to monitor for future generations.

Wetlands are one of the most dynamic and significant landscape features which help store and filter freshwater flowing into the Great Lakes. Due to human and climate actions, Great Lakes citizens and government leaders are observing rapid change in both interior and coastal wetland habitats around the Great Lakes Basin. Government, business and academic stakeholders are asking for rapid, seasonal views of the basin where they can take direct action to fix these problems.

Satellite and aerial images are essential tools used to track and observe wetland and associated habitat changes over time for large areas like the Great Lakes Basin. These images can come from a variety of optical, RADAR, lidar and SONAR sensors which now require petascale computing to ingest and process derived products due to the frequency of collection and the higher resolution of the sensors.

Glars Project

Starting in 2016, the University of Minnesota, Michigan Tech University, Minnesota Department of Natural Resources, SharedGeo.org, the Canada Centre for Remote Sensing and Environment and Climate Change Canada joined forces to develop a set of complex wetland and surface water mapping products led by the U.S. Fish & Wildlife Service and funded by the Great Lakes Restoration Initiative. With significant Blue Waters supercomputer support from the National Science Foundation, MAXAR commercial satellite imagery was accessed and processed via the National Geospatial-intelligence Agency (NGA) NextView Program. The team was able to process and create a variety of remote sensing demonstration products across pilot areas as well as the entire Great Lakes Basin.

For example, all available, stereo, sub-meter, MAXAR optical satellite imagery for the Great Lakes Basin were processed to create 2-meter surface vegetation elevation models as depicted in Figure 1.

The optical stereo satellite imagery were also classified for a variety of wetland derived products over a dozen pilot sites as depicted in Figure 2.

Figure 2 shows the pre- and post-herbicide treatment of Phragmites Australis (an invasive plant), from 2016 to 2017 near Saginaw, Michigan, using high-resolution MAXAR satellite imagery. The lower right map derived from the 7/19/2017 satellite image shows a dark purple triangular shaped area in the upper left portion of the map that was

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Figure 1.

missed with herbicide treatment from the previous year. This example illustrates how land managers can be more accurate with treating wetlands to help eradicate an invasive plant.

Figure 3, taken between Michigan and Ontario, northeast of Detroit, of monthly Radarsat-2 images were collected and processed from 2016 through 2021. The objective was to show the dynamic water level rise over this six-year period as well as the duration of water saturation which is defined as a hydroperiod. A variety of fish and wildlife habitats are linked to these saturation zones.

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Figure 2.

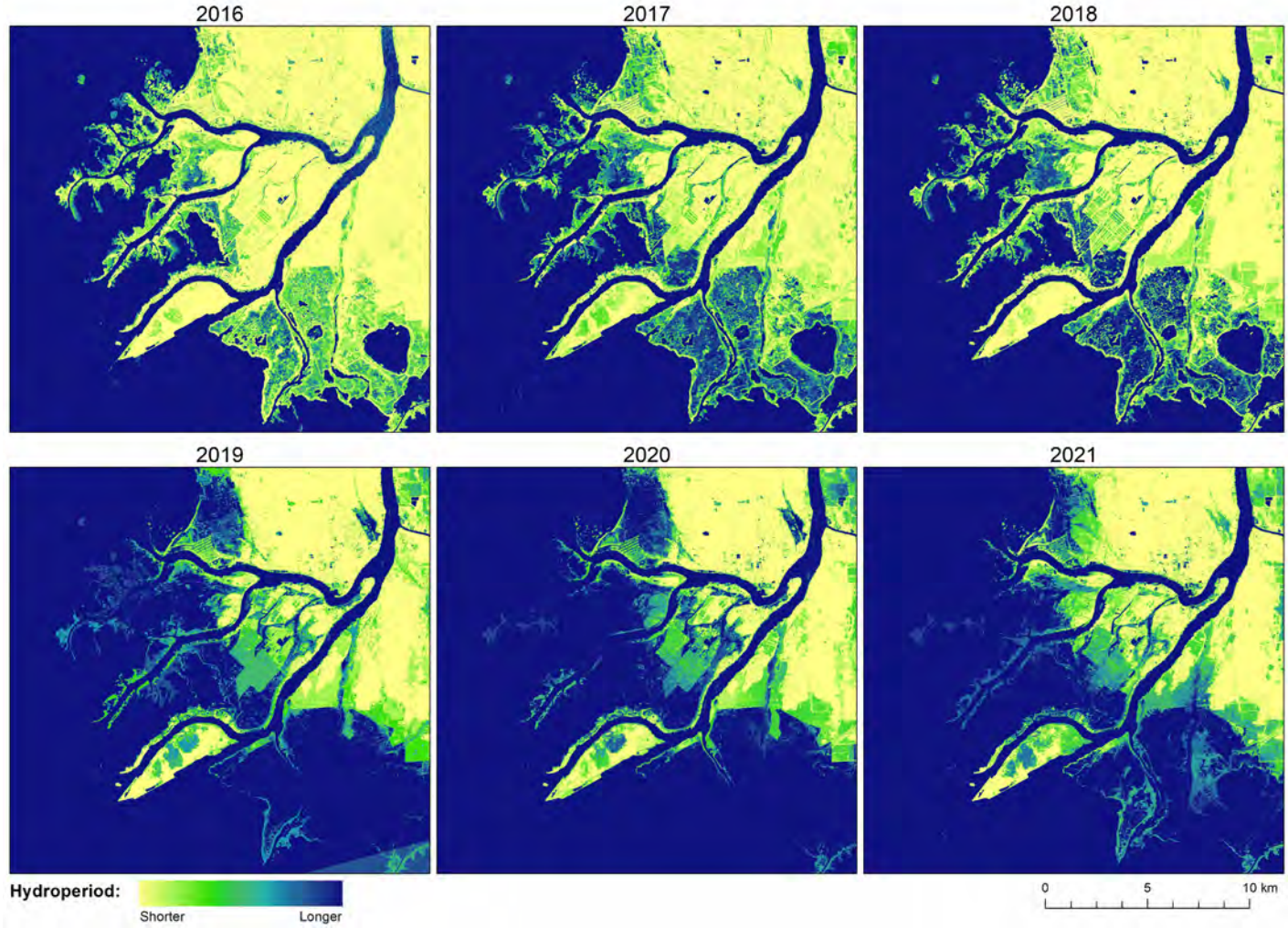

Figure 3.

What is the Future for Great Lakes Remote Sensing?

As a consequence of this project, the Great Lakes Alliance for Remote Sensing (GLARS) was formed to help further binational remote sensing of the Great Lakes and data distribution. The examples shown in this Sector Insight article can all be accessed at https://glars.org.

The Great Lakes Restoration Initiative funded this project to demonstrate the next generation tools from optical and radar imagery for submeter, high resolution, multi-temporal image products. The challenge for the future will be to develop this into a binational program to monitor and sustain the Great Lakes. Such an approach as this results in good, solid applications based on teamwork and cooperation rather than competition. Given the importance of the Great Lakes to Canada, the US, and the planet, it should be expected that this work will lead to an on-going, dedicated program.

Dedication

This column is dedicated to the late Dr. Brian Brisco, Canada Centre for Remote Sensing, Natural Resources Canada. Unfortunately, Brian passed away in September of 2022 after bravely battling illness for many years. Brian led the CCRS research and development for radar research and applications for surface and water features. His interest is not surprising since he was an avid muskie fisherman and duck hunter. Brian was the recipient of the Canadian Remote Sensing Society's Larry Morley Gold Medal Award in 2017.

Author

Brian Huberty is an ASPRS Certified Mapping Scientist who is currently assisting SharedGeo (a geospatial non-profit) with a variety of remote sensing projects. Over the last four decades, he has applied remote sensing and geospatial assessment technologies for the Minnesota Department of Natural Resources, USDA Forest Service, USDA Natural Resources Conservation Service, U.S. Geological Service and the U.S. Fish & Wildlife Service. Mr. Huberty has B.S. and M.S. degrees from the University of Minnesota, College of Natural Resources specializing in geospatial resource inventory systems. Brian has held leadership positions within ASPRS and ISPRS.