WHAT CAN BE LEARNED FROM STRUCTURAL INTERVENTION IN THE OTHER GREAT LAKES?

By Heather Sargeant

Lake Ontario and Superior have structures and regimes to manage water level variability; Georgian Bay as part of Lake Michigan-Huron does not. More extreme variability in water levels due to climate change is a costly problem that future generations are facing. Here are some important learnings on water variability, the benefits of water levels management and the pitfalls that need to be avoided.

GREAT LAKES WATER LEVEL VARIABILITY IS NATURAL AND GOOD

Fluctuations are an important part of helping maintain wetlands biodiversity and ecological services. Ups and downs are therefore critical to the health of lake ecosystems, including aiding in water quality so important for drinking.

While the Lakes' water levels fluctuate in all kinds of different time spans, GBF looks **at seasonal (one-year) fluctuations** of Great Lakes water levels and **water level variability over long periods** of time spanning decades.

Seasonal or annual behaviour

While peak times vary by Lake, typically higher water levels start during the spring and early summer, and lower water levels happen during the remainder of the year. Based on the monthly average water levels, the magnitudes of unregulated seasonal fluctuations are relatively small, averaging about 1.3 ft. (0.40 m) on Lakes Superior and Michigan-Huron, about 1.6 ft. (0.49 m) on Lake Erie, and about 2.0 ft. (0.61 m) on Lake Ontario (Great Lakes Commission, 2003).[1]

Variability, a historical perspective

These Great Lakes examples provide a general sense of the greater scale of lake level change over time.

- **Lake Michigan-Huron**
  Michigan-Huron has as a wide range of water-level fluctuations in recorded history, with a difference of 6.3 ft. (1.93 m). A maximum of 582.35 ft. or 177.50 m (GLWLD) in October 1986 and a minimum of 576.02 ft or 175.57 m in January 2013.[2]
- **Lake Ontario**
  Prior to regulation in 1956, levels ranged from a maximum of 248.56 ft. or 75.76 m in June 1952 to a minimum of 241.93 ft. or 73.74 m (GLWLD) in December 1934, a total of 6.6 ft. (2.02 m).[3]
- **Lake Superior**
  Pre-regulation data spans only 55 years, and the 3.6 ft (1.10 m) range from 603.2 ft. or 183.97 m (August 1876) to 599.6 ft. or 182.90 m (February 1866).[4]

NEW EXTREME VARIABILITY FROM CLIMATE CHANGE CAN BE REDUCED BY STRUCTURAL INTERVENTION

A short explanation of the interventions

Lake Superior water level regulation began in 1921 accounting for the needs of navigation, hydropower and landowners. Outflows are set with many interests considered upstream and downstream. Control structures such as gates, locks and power canals cross the St. Mary's rapids which, is where Lake Superior outflows to Lake Michigan-Huron (and thereby Georgian Bay).[5]

Lake Ontario was subjected to various projects undertaken between 1825 and 1905 to facilitate navigation, but current water regulation began in 1956 mostly as a response to US shoreline property owners concerned about flooding they experienced in the early '50s, with hydropower and navigation being highly considered. Built between 1954 and 1958, the principal control structure is the Moses-Saunders Dam that crosses the St. Lawrence River between Cornwall, Ontario and Massena, New York.[6]

High and low extremes are costly for a variety of stakeholders on the Great Lakes including property owners, shipping, recreational boating and fishing, hydroelectric power generators and users and more. For instance, an IJC Study Board found that regulation "reduced the damages due to fluctuating water levels on Lake Ontario shoreline properties by about 60%".[8]

Since Lake Michigan-Huron does not have structures in place that can help mitigate the extreme highs and extreme lows, stakeholders on these Lakes are vulnerable to damages and high costs that result from extreme variability in water levels. GBF helped fund the Council of Great Lakes Region "Low Water Blues" report that details plausible future costs over the next 35 years at about $18.82 billion USD if nothing is done.[9]

The good, the bad, and the ugly of reduced fluctuations in Lakes Ontario and Superior

- **Good**
  Some extremes are moderated. For example, "unregulated Lakes Michigan-Huron and Erie had extremely high water-level peaks in 1929, 1952, 1973, 1986, and 1997, as well as extreme lows bottoming out in 1926, 1934, 1964, 2003 (with new records set in 2012 and 2013). Some of those extreme levels, especially the lows, were muted in Lakes Superior and Ontario after regulation began."[7]
- **Bad**
  Environmental concerns were not part of the initial criteria when regulation and structures were put into place in Lake Superior and Lake Ontario so many decades ago.
  Additionally, structures were built on the historical record of hydrology prior to 1954 and not on changing hydrology brought about by climate change.
- **Ugly**
  This has been particularly devastating to Lake Ontario, where the variability has been so limited that it has led to the degradation of more than 26 thousand hectares of wetlands.
  Despite a general desire to address and fix the issues in the last 20 years, and after several proposals and millions of dollars spent, the economic trade-off to return to a regime with more natural variation, has so far met with too much opposition.[10]

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AVOIDING MISTAKES WHILE PROTECTING THE FUTURE

✓ **Variability maintained**

AECOM's proposals for **Lake Michigan-Huron** (and by extension Georgian Bay) include retaining variability within historical norms.

✓ **Taking the edges off**

The huge surface area of Lake Michigan-Huron makes it extra susceptible to climate change impacts like increased evaporation and flashier storm systems. The technology being proposed would mitigate future extreme highs and lows that result from climate change and that without intervention would be extremely costly. The proposals have considered up-to-date technology that was not available in other Great Lakes examinations of structural interventions.

✓ **Consultation–bringing stakeholders together**

AECOM and GBF continue to garner widespread support by giving careful consideration to the factual feedback and expertise of multiple stakeholders with different interests in lake levels.

What are the solutions for Lake Michigan-Huron?

On pages 6 and 7, read about AECOM's report on structural options providing protection to future generations from more extreme water level variability in Lake Huron-Michigan and Georgian Bay.

[1] Douglas A. Wilcox, Todd A. Thompson, Robert K. Booth, and J.R. Nicholas. Lake-Level Variability and Water Availability in the Great Lakes http://pubs.usgs.gov/circ/2007/1311/pdf/circ1311_web.pdf. Page 5 and 6

[2] *Final 2015. And Long-Term (1918-2015) Mean, Max, & Min. Monthly Mean Water Levels* (Based on Gage Networks) (feet, IGLD85). (2016, May 11). Detroit District of the United States Army Corps of Engineers. Retrieved from http://www.lre.usace.army.mil/Portals/69/docs/GreatLakesInfo/docs/WaterLevels/LTA-GLWL-English_2015.pdf. The metres are from the Great Lakes Water Level Dashboard: http://www.glerl.noaa.gov/data/dashboard/GLWLD.html. NOAA.

[3] *Final 2015. And Long-Term (1918-2015) Mean, Max, & Min. Monthly Mean Water Levels* (Based on Gage Networks) (feet, IGLD85). (2016, May 11). Detroit District of the United States Army Corps of Engineers. Retrieved from http://www.lre.usace.army.mil/Portals/69/docs/GreatLakesInfo/docs/WaterLevels/LTA-GLWL-English_2015.pdf. The metres are from the Great Lakes Water Level Dashboard: http://www.glerl noaa.gov/data/dashboard/GLWLD.html. NOAA. Also, some verbiage from:

[4] Douglas A. Wilcox, Todd A. Thompson, Robert K. Booth, and J.R. Nicholas. Lake-Level Variability and Water Availability in the Great Lakes. http://pubs.usgs.gov/circ/2007/1311/pdf/circ1311_web.pdf. Page 6

[5] http://www.ijc.org/en_/Great_Lakes_Water_Quantity and Wikipedia.

[6] Wikipedia, and International Joint Commission (2014). Lake Ontario St. Lawrence River Plan 201: Protecting against extreme water levels, restoring wetlands and preparing for climate change http://www.ijc.org/files/tinymce/uploaded/LOSLR/IJC_LOSR_EN_Web.pdf

[7] Douglas A. Wilcox, Todd A. Thompson, Robert K. Booth, and J.R. Nicholas. Lake-Level Variability and Water Availability in the Great Lakes. http://pubs.usgs.gov/circ/2007/1311/pdf/circ1311_web.pdf Page 6

[8] International Joint Commission (2014). Lake Ontario St. Lawrence River Plan 201: Protecting against extreme water levels, restoring wetlands and preparing for climate change. http://www.ijc.org/files/tinymce/uploaded/LOSLR/IJC_LOSR_EN_Web.pdf Page 13

[9] Rob Dorling, Reuven Shlozberg and Peter S. Spiro, Jun 25 2014. Low Water Blues. http://georgianbayforever.org/wp-content/uploads/2015/10/low-water-blues-exec-sum.pdf

[10] Wikipedia, and International Joint Commission (2014). Lake Ontario St. Lawrence River Plan 201: Protecting against extreme water levels, restoring wetlands and preparing for climate change http://www.ijc.org/files/tinymce/uploaded/LOSLR/IJC_LOSR_EN_Web.pdf

WATER LEVEL EXTREMES

There is a developing confluence of support to undertake work that will address water level extremes beyond historical norms in the Upper Great Lakes. This effort would focus on helping promote healthy ecosystems while protecting the economic interests of the region. Please read this timeline of events and turn to page 6 and 7 to read a summary of proposed solutions.

Water Level Extremes: Lake Michigan-Huron and Georgian Bay

1850s to 1960s	Dredging and historic mining create the loss of 53 cm to Lake Michigan-Huron.
1971 to 1989	Long period of high water.
1986	Highest recorded water at 177.50 m (Great Lakes Water Dashboard).
1987 to 2009	Long term declines due to climate change (9 to 17 cm), erosion of the St. Clair River (7 to 14 cm), glacial Isostatic adjustment (4 to 5 cm).
2013	Lowest recorded water level at 175.57 m.
2014	Highest July outflow into Lake Michigan-Huron from Lake Superior through the St. Mary's River since 1951.
2013 to 2015	Fastest rise of water in Lake Michigan-Huron.

Progress on Water Level Extremes: Finding the Cause, Finding Solutions

2005	The Georgian Bay Association* commissioned W.F. Baird and Associates to undertake a study of the St. Clair River and its contribution to the low water levels on Lake Michigan-Huron. The results of that report were useful to the International Joint Commission (IJC), and government subsequently expanded the IJC's reference to include the St. Clair River in its $17-million Upper Great Lakes Study.
2009	The final Report on Upper Great Lakes Water Levels to the IJC affirms there is merit in additional lake level control structures.
2012	The International Upper Great Lakes Study is released. It acknowledges the need for a detailed examination of additional lake level control structures and their possible contribution towards mitigating both the historic impacts of previously authorized project work and the ongoing and increasing impacts of climate change on the system.
2013	The IJC provided non-unanimous advice to governments that included the examination of structural options to address water levels but it was noted by Commissioner Pollack to be missing the significant climate change perspective.
2014	$18.8 billion cost to doing nothing about water level extremes. Findings in a GBF, Council of the Great Lakes and Mowat Centre report, "Low Water Blues."
	Proposed regulation 2014 to include healthy water level fluctuations within the historic ranges that promotes healthy ecosystems and protects the economic interests of the Region, which have evolved within those regimes. Without new tools to address the significant "out of band" impacts of climate change, there will be no adaptive management within the upper-middle Great Lakes. There will only be reactive adaptation.
2015	GBF supported NASA DEVELOP study shows a ten percent wetland loss in Southern Georgian Bay with prolonged low water levels, a four percent net loss.
	GBF retains global engineering firm AECOM to identify the most viable options and locations for extreme water level management.
Summer 2016	GBF and AECOM report, "Providing Structural Solutions for Adaptive Management in the Great Lakes: Creating Climate Resilience" is reviewed by key stakeholders and decision makers including the IJC. See a summary on page 6.

* The W.F. Baird and Associates report was funded through the GBA Foundation, which later became Georgian Bay Forever.