Climate Change and Adaptation in the Great Lakes

Photo credit: Alan Amati

Project Summary
Emerging Issues Work Group
of the Great Lakes Water Quality Board
January 2017

Great Lakes Water Quality Board Emerging Issues Work Group

Climate Change and Adaptation in the Great Lakes

Project Summary

As outlined in the Great Lakes Water Quality Agreement (Agreement), the International Joint Commission is served in an advisory capacity by the Great Lakes Water Quality Board (WQB). The WQB includes an Emerging Issues Work Group that has identified the growing impact of climate change on the Great Lakes as a priority issue.

The Board last examined the impacts of climate change in 2003 with its report, *Climate Change and Water Quality in the Great Lakes Basin,* in which it advised the Commission that there is a need for the development and implementation of an adaptation strategy. An understanding of the roles and actions that U.S. and Canadian jurisdictions are currently undertaking to support adaptive capacity and the identification of potential gaps in the regulatory and policy framework related to addressing climate change impacts would be useful tools in the development of such a strategy.

This summary presents recommendations from the Emerging Issues Work Group on the topic of climate change adaptation and resilience as it relates to the goals of the Great Lakes Water Quality Agreement. The recommendations are based on three products or activities undertaken by the Work Group:

- A commissioned report titled "Climate Change and Adaptation in the Great Lakes Basin."
  This report provides an analysis of jurisdictional actions in Canada and the United States from local to federal and identifies gaps that may leave water quality vulnerable to climate change impacts. The report also makes valuable recommendations that the Work Group has further considered and refined. (The summary section of the report can in found in Appendix 1. The full report is on file at the Great Lakes Regional Office (GLRO).)

- An expert review of the commissioned report.
  The Work Group solicited comments on the report by climate change experts from academia, government and industry. The respondents were asked to pay particular attention to the strength and weaknesses of the jurisdictional analysis and the identified gaps. The participants were also asked to comment on and critique the recommendations provided in the report.

- A workshop on climate change adaptation and resilience in the Great Lakes.
  A communications consultant was chosen by the Work Group to conduct a workshop that took place in Windsor, Ontario on July 12 – 13, 2016. Participants at the workshop included many of the experts involved in reviewing the Work Group's commissioned report. The workshop consisted of presentations and group discussions designed to develop potential key elements of a binational approach to climate change adaptation and resilience, as well as to identify challenges and considerations in implementing such an approach. Key elements identified by participants included:

  - A common vision recognizing the importance of the Great Lakes and the impacts of

climate change on the region;

- A coordinating mechanism that might include a staffed coordinating network of existing and new networks (a "network of networks");
- An accountability framework to be built into the approach and adaptive management to be incorporated as a measurement of success;
- Mechanisms to aggregate and share Great Lakes specific research as well as incorporate traditional ecological knowledge.

The summary table from the workshop report can be found in Appendix II. Here, too, the full workshop report submitted by the workshop facilitator is on file at GLRO.

The report and the expert workshop affirmed that a changing climate is already influencing Great Lakes water quality and further changes will likely have significant impacts on the Great Lakes and water quality in the lakes and their tributaries. Examples of impacts that are already occurring include the well- documented trend of increased water temperature in Lake Superior and the recent catastrophic flooding events in northern Wisconsin. While various communities as well as state/provincial and federal agencies are engaging in some aspects of adaptation planning and implementation, and are implementing strategies to enhance ecological resilience in the region, there is no coordinated regional perspective, approach or strategy. The report and the workshop participants concluded that a coordinated binational approach is needed to protect Great Lakes water quality to the extent possible in a rapidly changing climate. Moreover, they concluded that current regulatory frameworks are insufficient to address this challenge.

Recommendation 1: The Federal Governments of Canada and the United States should demonstrate global leadership by jointly developing, in cooperation with other governments and organizations across the Great Lakes basin, a Binational Approach to Climate Change Adaptation and Resilience in the Great Lakes. Such an approach would include a shared vision, coordinated action, creation of a network to share science, information and knowledge, including Métis, First Nations and Tribal traditional ecological knowledge if offered, and the commitment of adequate funding to carry out these objectives.

Action requested: The Water Quality Board asks that the IJC recommend to the Parties that they negotiate and develop a Binational Approach to coordinate and advance strategies that support climate change adaptation and increase ecological resilience in the Great Lakes ecosystem region, with a particular emphasis on safeguarding Great Lakes water quality.

Recommendation 2: Investments in research, information sharing and knowledge management are needed to carry out a Vulnerability Assessment, to engage stakeholders and rights holders, and to identify priorities for responsive actions in the Great Lakes region.

Action requested: The Water Quality Board further requests that the IJC urge the Parties to conduct a *Great Lakes Climate Change Impacts Vulnerability Assessment* as a first step in developing a regional approach. This assessment should address threats identified in the commissioned report noted above and the expert workshop and as summarized in the attached chart below.

The assessment should include due consideration of the vulnerabilities to the chemical, physical and biological integrity (including biodiversity) of the Great Lakes in the context of water quality, and the related potential vulnerabilities for Great Lakes coastal communities, commerce and public health at small enough geographic scales that can be of material use to communities and local decision makers.

Recommendation 3: The creation of a staff-supported *Network of Networks* (or augmentation of an existing network) to collect, aggregate and share information that can support climate adaptation response strategies at federal, regional, state/provincial, and local scales.

Action Requested: The Water Quality Board asks the IJC to request that the Parties establish (or augment) a Great Lakes regional climate adaptation and resilience network, supported by staffed coordination within the IJC or through another appropriate binational or regional coordinating body. Its function would be to build on and amplify the work of the many scientific, regulatory, and regional structures and activities already addressing some aspects of climate adaptation and resilience in the region and within federal agencies. The network hub could serve as the coordinating point for knowledge management, communications, and potential for technical resources that could support community-level strategies and actions.

CLIMATE PROJECTIONS AND LIKELY ENVIRONMENTAL IMPACTS IN THE GREAT LAKES REGION [1]

Climate-related Projections in the Great Lakes Region	Likely Environmental Impacts
Warmer air temperatures (esp. warmer nights; warmer winters: even *warmer* water temperatures)	• Less ice cover; less stratification and oxygen distribution in the lakes • More lake evaporation year-round (trending to lower lake levels) up by 25 percent since 1980 • More favorable conditions for algae and bacteria • Loss of habitat and/or increased stress for cool and cold-water fish • Increased likelihood of heatwaves and urban heat-island effects; heat-related illnesses • More warm weather pests, including invasive species • Stress on livestock and crops; reduced productivity • Loss of valued ecosystem services (flood buffers, water filtration, erosion stabilization, coastal habitat including nesting/nursery areas) from coastal erosion, damage to streamside habitat; loss of important populations • Challenges to coastal water infrastructure (drinking water intake and discharge disposal infrastructure not easily adaptable to high lake level variability) • Exposed contaminated areas from lower levels, dredging harbors to support shipping in low water years • Risks for coastal development during low water years and "hardening" shorelines
More precipitation and more extreme precipitation events	• Increased polluted runoff, especially from intense spring storms • Sediment and nutrient "flushes;" rapid increased loading in Great Lakes watersheds and the lakes themselves • Algal blooms, oxygen depletion, dead zones, cyanobacteria • Loss of safe drinking water supplies • Degraded wetlands and coastal habitat
More extreme swings between periods of drought and drench	• Loss of valued ecosystem services (flood buffers, water filtration, erosion stabilization, coastal habitat including nesting/nursery areas) from coastal erosion, damage to streamside habitat; loss of important populations • Challenges to coastal water infrastructure (drinking water intake and discharge disposal infrastructure not easily adaptable to high lake level variability) • Exposed contaminated areas from lower levels, dredging harbors to support shipping in low water years • Risks for coastal development during low water years and "hardening" shorelines
Increasing variability in lake levels	• Loss of valued ecosystem services (flood buffers, water filtration, erosion stabilization, coastal habitat including nesting/nursery areas) from coastal erosion, damage to streamside habitat; loss of important populations • Challenges to coastal water infrastructure (drinking water intake and discharge disposal infrastructure not easily adaptable to high lake level variability) • Exposed contaminated areas from lower levels, dredging harbors to support shipping in low water years • Risks for coastal development during low water years and "hardening" shorelines
Changes in vitality and distribution of cold-climate-dependent	• Changes in species range and relative abundance, especially for cool and cold-water fish • Likely range expansion for warm-weather invasive species, including diseases,

species–both aquatic and terrestrial	crop pests, expanded ranges for zebra and quagga mussels • Changes in terrestrial tree and plant species along coastal areas and Great Lakes tributaries that will likely alter wildlife species distribution
Nutrient and invasive species challenges exacerbated	• Polluted runoff from extreme storms enriches nutrient and bacteria loadings into near-shore waters • Zebra and quagga mussels filter nearshore waters, increasing light penetration; • Sunlight penetration and warmer air temperatures warm the waters faster, deeper, and to higher temperatures • Sunlight and warm water supports growth of algae and other phytoplankton • With plenty of nutrients, warm water and sunlight, algae growth "explodes" • Massive blooms die off and use up dissolved oxygen=dead zones
Changes in seasonal wind directional (vector) patterns	• Reduced exchange between waters in bays with low oxygen levels and open lake waters; potential increase in dead zones, especially Green Bay, Western Lake Erie
Negative Synergies from multiple effects	• Polluted runoff from extreme storms enriches nutrient and bacteria loadings into near-shore waters • Zebra and quagga mussels filter near-shore waters, increasing light penetration • Sunlight penetration and warmer air temperatures warm the waters faster, deeper, and to higher temperatures • Sunlight and warm water supports growth of algae and other phytoplankton • With plenty of nutrients, warm water and sunlight, algae growth "explodes" • Massive blooms die off and use up dissolved oxygen=dead zones

[i] **Information in this table is summarized from the following sources:**

"Climate Change in the Great Lakes Region" summaries on temperature, precipitation, extreme precipitation, Great Lakes ice coverage, algal blooms, fish and wildlife, forests, lake levels, Great Lakes ice cover and agriculture, produced by the Great Lakes Integrated Sciences and Assessments Program (GLISA), a collaboration of the University of Michigan and Michigan State University. http://glisa.umich.edu/climate, accessed July 2016

"The Wisconsin Initiative on Climate Change Impacts" including its website summaries and report, *Wisconsin's Changing Climate: Impacts and Adaptation*. 2011. And the report from its, "Water Resources Working Group," accessed July, 2016, http://www.wicci.wisc.edu/water-resources-working-group.php.See also other resources on this site http://www.wicci.wisc.edu/ accessed July 2016.

Hanrahan, J. L., Kravtsov, S. V., and Roebber, P. J. (2010), "**Connecting past and present climate variability to the water levels of Lakes Michigan and Huron"** Geophysical Research Letters 37,L01701,doi: 10.1029/2009GL041707.

Val Klump, "**Green Bay Hypoxia: Biogeochemical Dynamics, Watershed Inputs, and Climate Change**" (presentation, Our Water World: The Nutrient Challenge, a Waters of Wisconsin Public Forum, Green Bay, WI, May 7, 2013).

US EPA, "**Understanding the Link Between Climate Change and Extreme Weather"** https://www3.epa.gov/climatechange/science/extreme-weather.html

Appendix I: Executive Summary from "Climate Change and Adaptation in the Great Lakes Basin," prepared for the Great Lakes Water Quality Board Emerging Issues Task Force, March 28, 2016 by Innovolve

The numbers are compelling: 20 percent of the world's surface fresh water by volume, providing drinking water to over 40 million Canadians and Americans, and contributing $180 billion to Canada-US trade on an annual basis. The Great Lakes Basin Ecosystem is an environmental, social and financial jewel. And climate change, among other stressors, is threatening its ability to continue to deliver these and other services to communities on both sides of the border.

While there is a robust history of Canada-US cooperation on the Great Lakes dating back to decades, there are new complexities driving the need for increased cooperation and collaboration. Consider, for example, the varying degrees of jurisdictional authority across levels of government and aboriginal peoples in both countries, the increase of nongovernmental actors from civil society, academia and industry, as well as the cumulative nature of climate change impacts on water, and it becomes clear that concerted and coordinated action is a must. Together, these conditions afford the IJC an opportunity to build on its role as convener and advisor to governments.

Impacts

The Great Lakes Basin Ecosystem is complex. Water quality in the basin is dependent on many factors, some of them driven by natural processes and others by anthropogenic activities. Most of the impacts of climate change on water quality are indirect in nature. Climate change adds a compounding effect on already existing impacts in the Great Lakes basin related to human activities and land use.

Projected changes in the Great Lakes basin climate and physical characteristics of the Great Lakes, with associated impacts on water quality

Expected change in climate and in the physical characteristics of the Great Lakes	Effect on water quality
Increase in total annual precipitation and in the frequency and intensity of storm events	Intensified runoff, erosion, sedimentation, and nutrient loading in the Great Lakes and their tributaries
Potential droughts in certain areas; extreme swings between periods of flood and drought	Loss of water supply and habitat, with related stresses on the ecosystem resilience
Rising air temperature and associated increase in water temperature in the Great Lakes and tributaries	Loss of cold and cool-water fish habitat, increased evaporation, decreased dissolved oxygen, shift in species range, algal bloom
Climate-related vectors for invasive species.	Loss of biodiversity and habitat, new vectors for water-borne illnesses
Declining water level; larger fluctuations between high and low water levels	Loss of wetlands and fish habitat
Declining ice cover	Loss of whitefish spawning areas and loss of wetlands from erosion; changes in lake stratification and the timing of seasonal turnover, increasing the potential for oxygen depletion of bottom waters and nutrient regeneration
Combination of multiple stressors	Negative synergies and multiplier effects.

Potential impacts are varied, significant and cumulative. Addressing them requires not only solid, evidence-based policy, but also communication, coordination and collaboration across jurisdictions.

Gaps

The current study aims to identify capacity within existing policy frameworks of Great Lakes jurisdictions that can address these impacts. It also highlights significant policy gaps that may leave the Great Lakes water quality vulnerable to climate change impacts and make recommendations for building on the former and addressing the latter.

Indeed, the survey of policy instruments across the various Great Lakes jurisdictions yielded a rich array of regulation, tools and knowledge products either directly or indirectly addressing water quality in the basin. As an example, several provinces and states have some sort of climate adaptation or resilience plan in place. All have a water quality strategy in place and most have measures for addressing nonpoint sources of pollution such as agriculture and urban runoff.

Below is a summary of the gap analysis and key findings for different areas requiring attention.

Legal and Policy Framework	Information & Science	Implementation
• Comprehensive adaptation or resiliency plans are not consistently in place to drive action by jurisdictions • Adaptation is not routinely integrated into broader water strategies or into government planning initiatives • Policy addressing climate change adaptation and ensuing water quality considerations rely mostly on application of existing legislation which may be inadequate or insufficien. • There is no formal federal statute or regulatory requirement addressing agricultural runoff in the United States • Some policies, such as the U.S. Farm Bill, support markets and incentives that drive agricultural practices that increase nutrient pollution and sedimentation, both of which amplify negative impacts from intense precipitation and warming waters • Planning is advancing, but not at the rate necessary to address all key issues in a comprehensive manner (e.g., stormwater management, urban runoff, nutrients, shoreline erosion, loss of wetlands, etc.)	• Data and information gaps identified in all jurisdictions • Federal funding is conflicting with state and province project agendas in some cases (more prominent in US) • Converting data into policy-relevant information or recommendations remains a challenge • Lack of willingness to hear about issues from policy or decision makers • Knowledge gaps, inconsistencies and uncertainties within climate change research are prevalent and must inform priority setting for future work	• Lack of clear leadership or requirements to have adaptation plans • Municipalities are key actors, but do not have sufficient capacity • Competing policies and program objectives dilute efficacy of efforts • Coordination mechanisms are not worked into government planning • Coordination and collaboration across government agencies and with relevant external stakeholders is an ongoing challenge • Some states simply do not prioritize climate change adaptation on their agendas

Nongovernment Stakeholders

Like most of society's issues, it is clear that tackling the impacts of climate change in the Great Lakes basin under the current policy regimes will require updating those policies, addressing the gaps to introduce new ones and finding appropriate mechanisms to improve and facilitate their implementation. This needs to be a collective effort conducted with a plurality of perspective.

While national and sub-national governments are the primary actors in protecting water quality in the basin, it is imperative to recognize and engage the myriad stakeholder groups across the region, including research groups producing climate models, Tribes, Métis and First Nations, environmental organizations, industry, local governments, as well as recreational groups such as anglers. In this stakeholder mix, industry represents one of the most important voices. And this voice is broad, if not fragmented, covering everything from farmers to multinational industrial water users to water technology innovators. Harnessing the perspectives of these actors and ensuring policy is developed with them is a key ingredient in ensuring effective implementation and ultimately, protection of the waters they all share.

While by no means exhaustive, this report paints a picture of the stakeholder landscape across the basin with a view to building the argument for regular dialogue across jurisdictions and sectors in order to ensure sustainable shared value for all communities in the basin.

Recommendations

While several Great Lakes jurisdictions have developed climate adaptation plans, the lack of an integrated plan to deal with Great Lakes water issues is a significant gap in being able to mobilize action by sub-national jurisdictions and nongovernmental actors. There is a clear benefit in having leadership exercised by the two national governments to drive actions, especially over the longer term. Given the historical and institutional nature of collaborative planning between Canada and the United States on Great Lakes water quality, this is a natural and increasingly necessary step. The process of developing such an integrated plan would, in itself, prove a meaningful motivating signal across states, provinces, and communities.

It is recommended that the IJC formally ask the two national governments to jointly develop a Great Lakes Climate Adaptation and Resilience Plan.

The integrated climate adaptation plan for the Great Lakes Basin Ecosystem should be supported by the following four pillars:

- *Leadership* at top levels to advance the importance of the issue, enable policy frameworks and foster coordination/collaboration mechanisms to be established.
- *Coordination/collaboration* of activities which need to occur between governments, within governments, and with stakeholders.
- *Data and information* to drive the development of policy frameworks and program actions needed to confront the core issues.
- *Resource and capacity* weaknesses need to be addressed within jurisdictions to act on identified issues now and to undertake more complex future ones.

As mentioned above, we encourage the IJC to leverage its 'convening' power and broad-based international authority and expertise to table these topics with governments and stakeholders. It needs to consider how to make the problem clear and understandable to governments and stakeholders in order to animate action by them. Finally, given the incredible stakeholder landscape across the basin, the IJC needs to create constellations of networks within this landscape to prod action that is coordinated and strategic.

Specific actions are recommended under each pillar of the proposed integrated plan:

Leadership

- Ensure that the next iteration of the *Great Lakes Water Quality Agreement* is developed in the context of observed climate change and give a more explicit and practical focus on climate change impacts, adaptation, and resilience allowing for more effective action by governments.
- Engage the IJC during the drafting process to ensure meaningful consultation and engagement.
- Fund an ongoing, dedicated climate change impacts and water resources research program of original academic and policy research to build knowledge and capacity in this area for future action.

Coordination and Collaboration

- Organize a forum with municipalities and state and provincial governments to foster greater collaboration and coordination with key municipal actors in addressing storm water runoff and other related climate impacts. Consider utilizing or leveraging the Great Lakes and St. Lawrence Cities Initiatives in this activity.
- Use existing governance mechanisms (or create new ones) to ensure that climate change strategies are integrated into watershed management plans.
- Enhance engagement with private industry on both sides of the border relying on Great Lakes water to:
  - Leverage their knowledge and expertise on climate impact solutions;
  - Foster greater awareness by governments of the impacts of climate change on industry and business and of the fact that industry does not operate on the same timeframes than governments.

Data and Information

- Develop and publish a short, easy-to-follow climate change impacts report on the Great Lakes focused on IJC mandate area to 'tell the story' publicly of the importance of this issue and give a focus to 'asks' of government and others. Illustrate this with pictures, diagrams, and timelines to make the problem clear and easily understood.
- Examine state of storm water infrastructure in region and prioritize investment in its modernization and renewal.
- Update flood mapping for vulnerable zones.

Resources and Capacity

- Encourage all governments to develop broader, integrated climate change plans that highlight Great Lakes water quality issues.
- Present the case to governments for the need to invest in climate-resilient infrastructure to address runoff issues from severe precipitation brought about by climate changing weather patterns via specific research and case studies. This needs to occur at the national, sub-national, and municipal levels to capture all possible initiatives and areas of responsibility.
- Analyze how the *U.S. Farm Bill* can be utilized more effectively to increase resilience and better support climate adaptation.
- Protect/restore/create wetlands to improve water quality reduce erosion and mitigate water level fluctuations – in the U.S., the *Agricultural Conservation Easement Program* under the *Farm Bill* could be used to this effect, as well as Section 404 of the *Clean Water Act*.

APPENDIX II – Executive Summary from "Climate Change Adaptation and Resilience in the Great Lakes" Workshop Report

The Emerging Issues Work Group (EIWG or the Work Group) of the International Joint Commission's (IJC) Great Lakes Water Quality Board (WQB) convened a workshop on July 12-13, 2016 in Windsor, Ontario, Canada. The purpose of the workshop was to draw on the knowledge and experience of 25-30 experts to explore and more fully develop a recommendation that the WQB may present to the IJC for consideration: Namely that the IJC advise Canada and the United States to demonstrate global leadership by jointly developing a Binational Approach to Climate Change Adaptation and Resilience in the Great Lakes.

The workshop consisted of presentations and group discussions designed to develop potential key elements of a binational approach to climate change adaptation and resilience, as well as to identify challenges and considerations in implementing such an approach. The following table provides a summary of the key elements, as co-created by the workshop participants, of a binational approach to climate change adaptation and resilience in the Great Lakes for the IJC to consider.

Summary of Key Elements of a Binational Approach to Climate Change Adaptation and Resilience in the Great Lakes for the IJC to Consider	
 **Shared Vision**	• Common vision • Clear call to immediate action • Local and Indigenous engagement is critical • Open declaration to be signed • Messaging should be positive and inclusive
 **Coordinated Action**	• A staffed, coordinated, binational network • Collect, aggregate, and share science and best practices • Framing documents to establish priorities • Funding and capacity
 **Accountability**	• Vulnerability assessment • Baseline data • Accountability will depend on the model used • Adaptive management
 **Science / Info / Knowledge**	• Aggregate and share research • Incorporate traditional ecological knowledge • Expand the GLWQA Annex 9 to include adaption • Legal tools needed • Species and habitats at risk are a key knowledge gap
 **Implementation Considerations**	• Shared vision is fundamental to implementation • Sector specific implementation is needed • Tools include: recognition, certification, and incentives • Challenges include: adapting lessons learned across borders, coordinating across sectors and nations