ADDRESSING CLIMATE CHANGE EFFECTS IN GREAT LAKES – ST. LAWRENCE RIVER WATER LEVEL REGULATION

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Outline

- Review context regarding Great Lakes water level regulation
- Introduce Adaptive Management framework and discuss the role of the GLAM Committee regarding:
  - Hydroclimate Science
  - Evaluating Benefits and Impacts
  - Decision Support
- Discuss potential benefits of approach for managing Great Lakes-St. Lawrence River water levels and flows under uncertain future conditions
Ability to alter lake levels through the Regulation Plans is limited and is dominated by changes in water supply which could be exacerbated by climate changes.
Past Response to Fluctuating Water Levels

Lakes Michigan/Huron Water Levels (IGLD 1985)

1964-73

1977-83

1986-93

2000-06

2007-12

Water Level (m) (IGLD 1985)

1964 - 73

1977 - 83

1986 - 93

2000 - 06

2007 - 12

Long Term Monthly Average (1918-2013)

Measured Water Level
Adaptive Management for Water Levels and Flows

- Uncertainties in science and models
- Uncertainty due to climate changes
- Two most recent IJC Studies recommended **Adaptive Management** as a planning approach that links drivers to outcomes

Photo courtesy of Port of Montreal
Adaptive Management (AM)

Is an idea almost universally supported in theory

- **Make a decision** based on best evidence
  - **Monitor** key outcomes from the decision
  - **Challenge** the decision if the outcomes aren’t as expected
- **Make necessary adjustments**
On January 16, 2015 the IJC established the bi-national **Great Lakes-St. Lawrence River Adaptive Management (GLAM) Committee** for on-going review of lake regulation plans.

GLAM reports to all three Great Lakes Boards of Control.

### Canada
- Environment and Climate Change Canada (ECCC)
- Fisheries and Oceans Canada (DFO)
- Ontario Ministry of Natural Resources and Forestry (OMNRF)
- Quebec Ministry of Sustainable Development, Environment and Climate Change
- The Nature Conservancy (Michigan)

### U.S.
- U.S. Army Corps of Engineers (USACE)
- National Oceanic and Atmospheric Administration (NOAA)
- U.S. Environmental Protection Agency (U.S. EPA)
- New York Department of Environmental Conservation (NYDEC)
IJC Directive to GLAM Committee

Provide information to the Boards related to:

- The effectiveness of existing regulation plans in managing water levels and flows;
- Whether the system is changing over time and whether regulation plans should be adapted in response to those changes;
- Other issues raised by the Boards.

To support these outcomes, GLAM undertakes tasks to:

1. Verify models based on real world observations
2. Assess changes in water supplies
3. Track changes to the Great Lakes-St. Lawrence River system and impacts
4. Assess whether the regulation plan(s) can be improved
Plan Objectives

- Net benefits (economic and ecosystem)
- No disproportionate losses (balance between interests and upstream/downstream)
- Robustness under a range of conditions

Decision Support

Evaluating Benefits and Impacts

Hydroclimate Science

Plan Formulation

Routing Model

Net Basin Supplies

Hydrologic and Hydraulic (H&H) Conditions
Plan
Performance
Decision
Criteria

Evaluation Models

Water Levels & Flows
Routing Model

Plan Objectives
• Net benefits (economic and ecosystem)
• No disproportionate losses (balance between interests and upstream/downstream)

Regulation
Rules

• Regulation Plans
  – (Lake Superior and Lake Ontario Outflows)

Regulation of Lake Superior
Outflows at Sault Ste. Marie on St. Marys River

Regulation of Lake Ontario
outflows at Moses-Saunders
Dam on the St. Lawrence
River

Regulation Rules

Net Basin Supplies

Hydrologic and Hydraulic (H&H) Conditions

 Regulation Rules

Net Basin Supplies

Hydrologic and Hydraulic (H&H) Conditions
Net Basin Supplies
- Precipitation (weather stations and analyses)
- Runoff (flow, water level gauges and runoff analyses)
- Over-lake evaporation stations network

The Hydrologic Cycle

NBS = precip. on lake - evaporation on lake + runoff from land + groundwater from land
Hydrologic and Hydraulic Conditions

- Connecting Channel Conveyance
- Water Levels & Flows
  - Routing Model
  - Plan Objectives
    - Net benefits (economic and ecosystem)
    - No disproportionate losses (balance between interests and upstream/downstream)

Regulation Rules

Net Basin Supplies

Hydrologic and Hydraulic (H&H) Conditions

- Hydrologic Criteria
  - Performance Indicator (PI) Metric
  - H & H Results

- Other H&H Conditions
  - Conveyance
    - Diversions
  - Hydrologic and Hydraulic Conditions
    - Connecting Channel
    - Conveyance
    - St. Marys River
    - St. Clair River
    - Detroit River
    - Niagara River
    - St. Lawrence River
    - Long Lac-Ogoki
    - Chicago Welland Canal
    - Lake Ice Conditions
    - Inputs from Key Tributaries

Simulate water levels by:

- altering Plan rules (Plan Formulation)

Or alter NBS:

- Stochastic supplies
- Stochastic extremes
- Climate Change models

Non-regulated Plan 2014

Routing Model

Regulation Rules

Net Basin Supplies

Hydrologic and Hydraulic (H&H) Conditions
Performance Indicators (PI’s)

• Are metrics that relate outcomes with a water level or flow condition.
• Were developed for a range of ecological and socio-economic parameters.
• Represent the foundation for the development of impact evaluation models.
Coastal Zone Property
First Floor Flooding; Erosion; and Shore Protection Damage/disproportionate loss

Ecosystems
Wetlands; Muskrat; Fish; and Birds, habitat and diversity

Municipal and Industrial Water Uses
Infrastructure costs

Hydropower
Hydropower Production and stability and predictability of water levels

Recreational Boating
Willingness to pay/ Marina accessibility

Commercial Navigation
Costs of transportation/benefits

Flood and Erosion Prediction System

Integrated Ecological Response Model

Shared Vision Model

Performance Indicator (PI) Metric

Water Levels & Flows

Routing Model

Regulation Rules

Net Basin Supplies

Hydrologic and Hydraulic (H&H) Conditions
### Plan Performance Decision Criteria

- **Evaluation Models**
  - Water Levels & Flows
  - Routing Model
  - Plan Objectives
  - Net benefits (economic and ecosystem)
  - No disproportionate losses (balance between interests and upstream/downstream)

### Hydrologic and Hydraulic (H&H) Conditions

- **Performance Indicator (PI)**
- **Metric**
- **PI Scores**

### Evaluation Results

- **H & H**

<table>
<thead>
<tr>
<th>Performance Indicator (PI)</th>
<th>Metric</th>
<th>H &amp; H PI Scores</th>
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<tbody>
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<td>Hydrologic Conditions</td>
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<td>Economic Impacts</td>
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<td>Lower St. Lawrence River Flooding</td>
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<td>Virginia Rail reproductive index</td>
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<td>Muskrat house density, drowned river mouth wetlands</td>
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<td>Wetlands fish - abundance index</td>
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<td>Golden Shiner - suitable feeding habitat area</td>
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<td>Least Bittern reproductive index</td>
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<tr>
<td>H &amp; H Evaluation Results</td>
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*The graph above shows all months' levels; the user selected elevation (75 meters) is shown as a red dash crossing the Plan 2014 line (blue) at the 75% point, meaning that about 25% of levels in all months are above 75 meters.*
Plan Objectives

- Net benefits (economic and ecosystem)
- No disproportionate losses (balance between interests and upstream/downstream)
- Robust under a range of conditions

Plan
Ranking
Decision
Criteria
Evaluation Models
Water Levels & Flows
Routing Model
Regulation Rules (Plan Formulation)
Net Basin Supplies
Hydrologic and Hydraulic (H&H) Conditions

Decision Support
Evaluating Benefits and Impacts
Hydroclimate Science
<table>
<thead>
<tr>
<th>SCREENING FACTORS</th>
<th>Priority 1</th>
<th>Priority 2</th>
<th>Priority 3</th>
<th>Priority 4</th>
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<th>Show Stopper</th>
<th>Think It’s a Show Stopper</th>
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<td>Improve the Environment overall</td>
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**Conditions**

- Net benefits (economic and ecosystem)
- No disproportionate losses (balance between interests and upstream/downstream)
Plan Objectives

- Net benefits (economic and ecosystem)
- No disproportionate losses (balance between interests and upstream/downstream)
- Robust under a range of conditions
Collaboration is Essential

• Cross border, multi-jurisdictional
  – Work with the three Great Lakes Boards of Control to engage stakeholders and seek AM collaborators
Moving Forward

- The GLAM Committee will be implementing a long-term strategy to improve hydroclimate science and evaluation strategies to support regulation plan evaluation.

- The AM framework provides a forward looking strategy for assessing regulation plans given uncertain future conditions.

- Successful implementation will require strong collaboration amongst many partner agencies and stakeholders.
Questions?