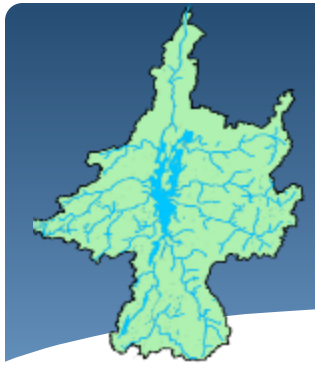
IJC Lake Champlain – Richelieu River Flood Study

Fisk Point – Isle La Motte, VT; Lake Champlain Basin Program

Presentation to the VTCAC

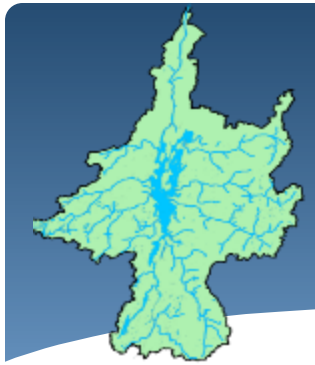
Mae Kate Campbell, US Study Manager

2021-05-12



The IJC commissioned this study, which has several areas of focus

- Causes and impacts of past floods
- Floodplain best management practices
- Flood adaptation strategies
- Advance binational flood forecasting
- Potential flood management and mitigation measures
- Social and political perception to measures

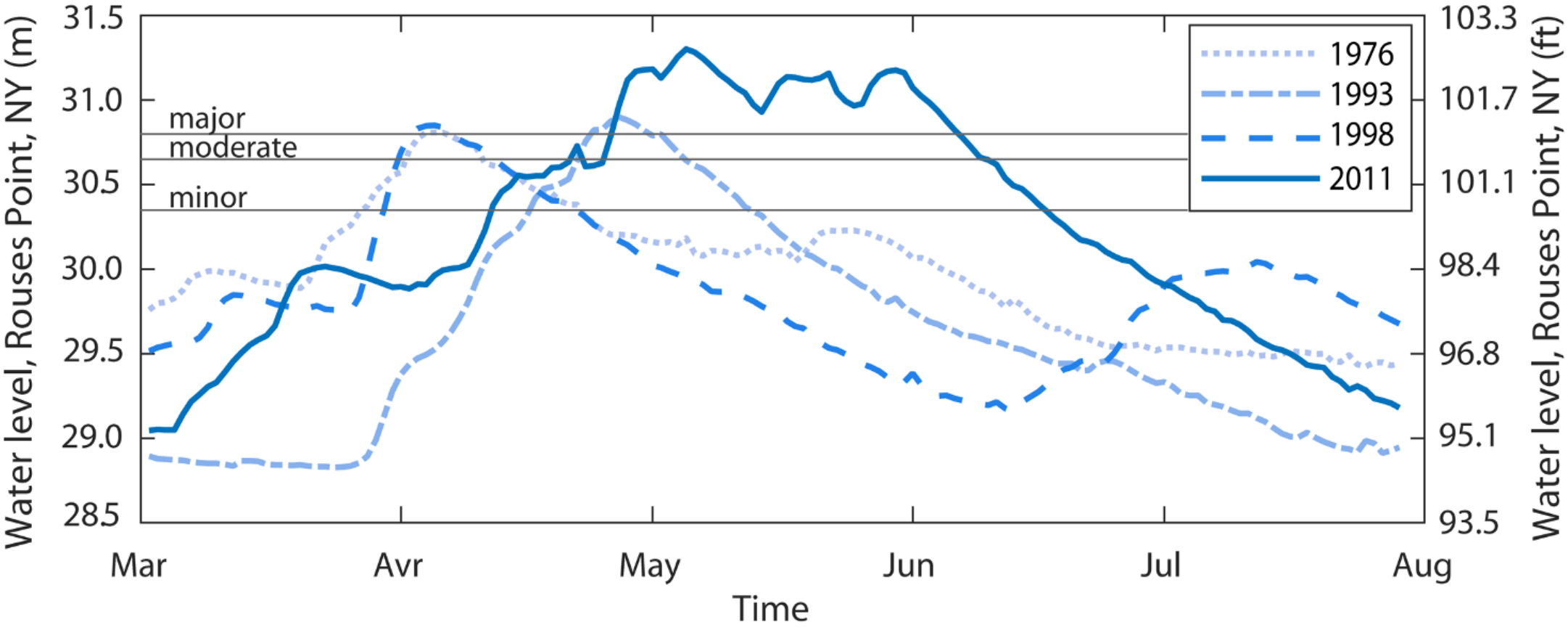


LCRR Basin Overview

- 23,899 km^2 (9,227 mi^2)
  - 84% in the United States
  - 16% in Canada

- The Saint-Jean Shoal (red star) is the hydraulic control for Lake Champlain and the upper Richelieu River and determines water levels upstream.
- The Chambly Canal (purple circle)

Flooding is an ongoing issue in the basin



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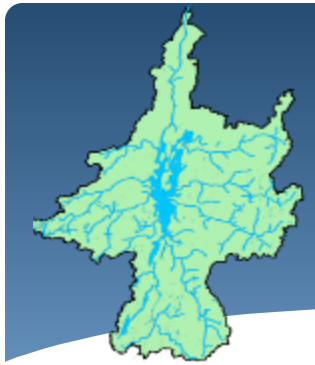
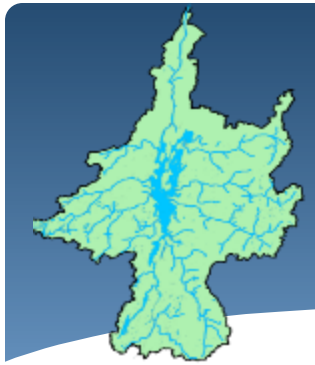


Study explores a range of flood mitigation solutions to reduce flood levels and build resiliency

- **Goal 1: Reduce high water levels and limit flooding impacts**
  - Reduce river levels with structural solutions
  - Impede water inflows to the lake by enhancing wetlands or storing water
- **Goal 2: Reduce flooding vulnerability and build flood resiliency**
  - Enhance flood response capabilities
  - Improve floodplain management

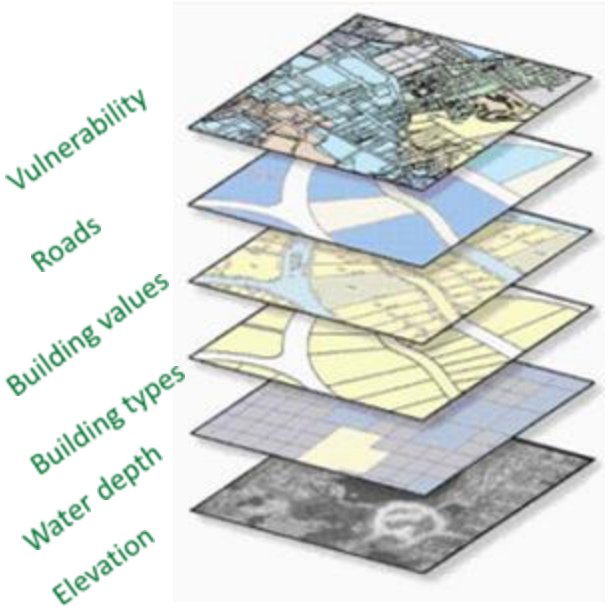
- Final recommendations will include results from all four areas of focus

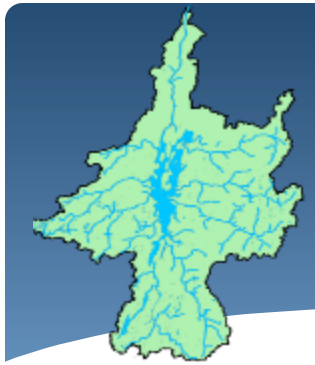


The impacts of mitigation measures will be evaluated using the ISEE system

- ISEE includes:
  - several spatio-temporal databases
  - water level time series and Performance Indicators simulated with computer models
- As water level peaks are reduced or vulnerable properties protected by mitigation measures, flood damages in affected grid points change
- Impacts can be presented by sector and/or regions (upstream, downstream) for a specific event or over a time series

***I**ntegrated **S**ocial – **E**conomic – **E**nvironmental*

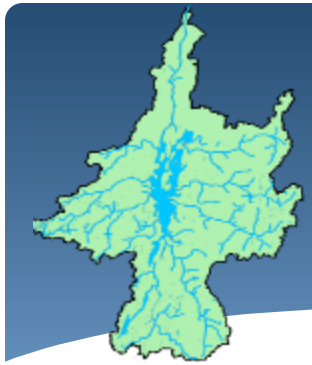




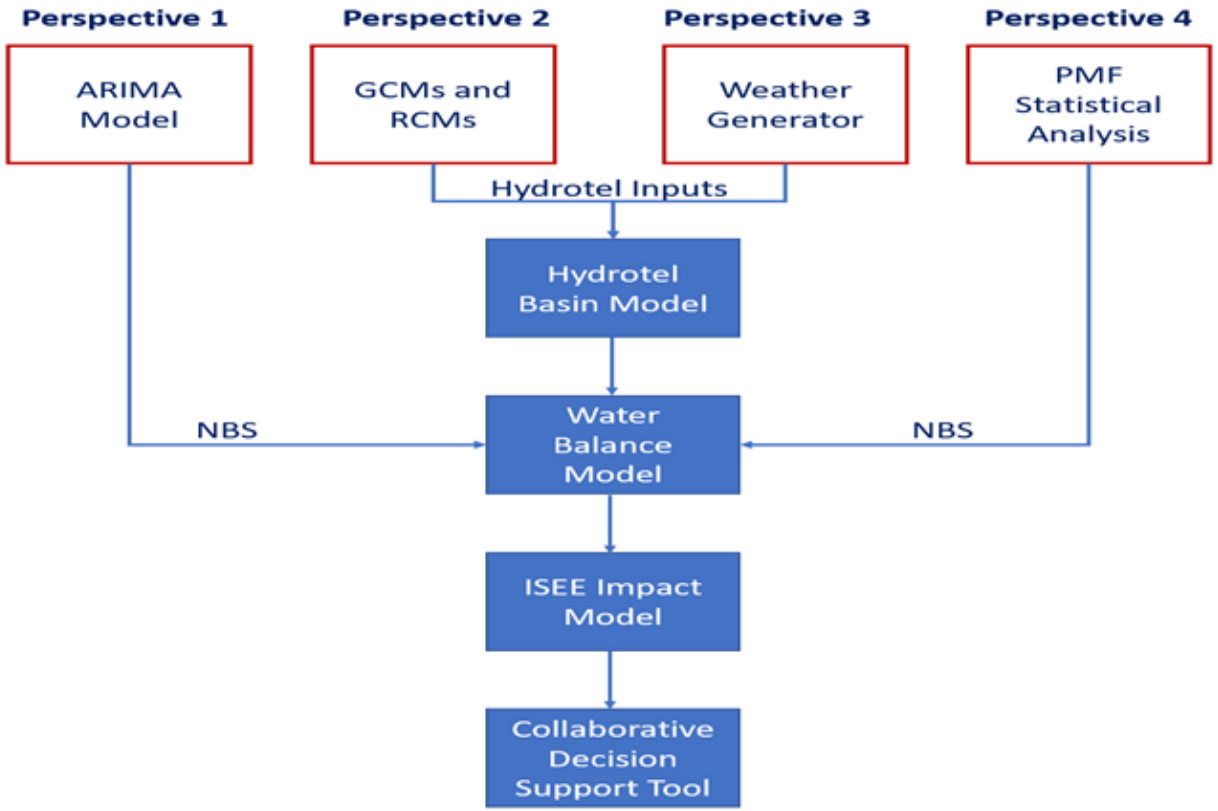
Study Board will consider seven criteria to assess proposed mitigation measures

Criteria	
1. Within study scope and mandate	5. Equitable and fair
2. Implementable	6. Environmental considerations
3. Technically viable	7. Robustness to climate change
4. Economically viable	

* Social and political acceptability will be an important consideration.



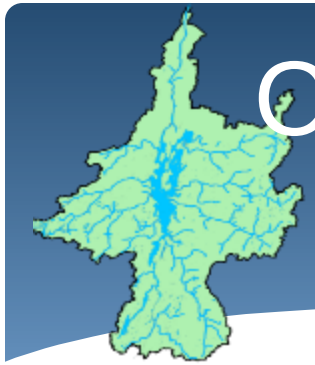
Looking at vulnerability to climate from four approaches



Four perspectives examined to determine future water supplies

1. Stochastic models
2. Climate models feeding a hydrological model
3. Stress test using different combinations of temperature and precipitation to power a hydrological model
4. Probable maximum flood (PMF) uses possible combinations of 3 variables: snow stock, temperature changes and precipitations

Results expected in the summer of 2021!

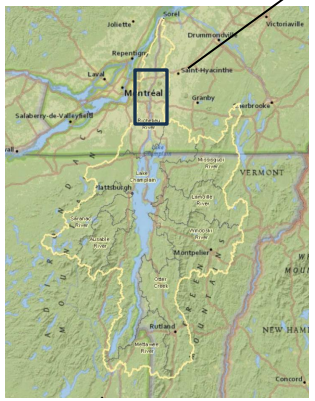


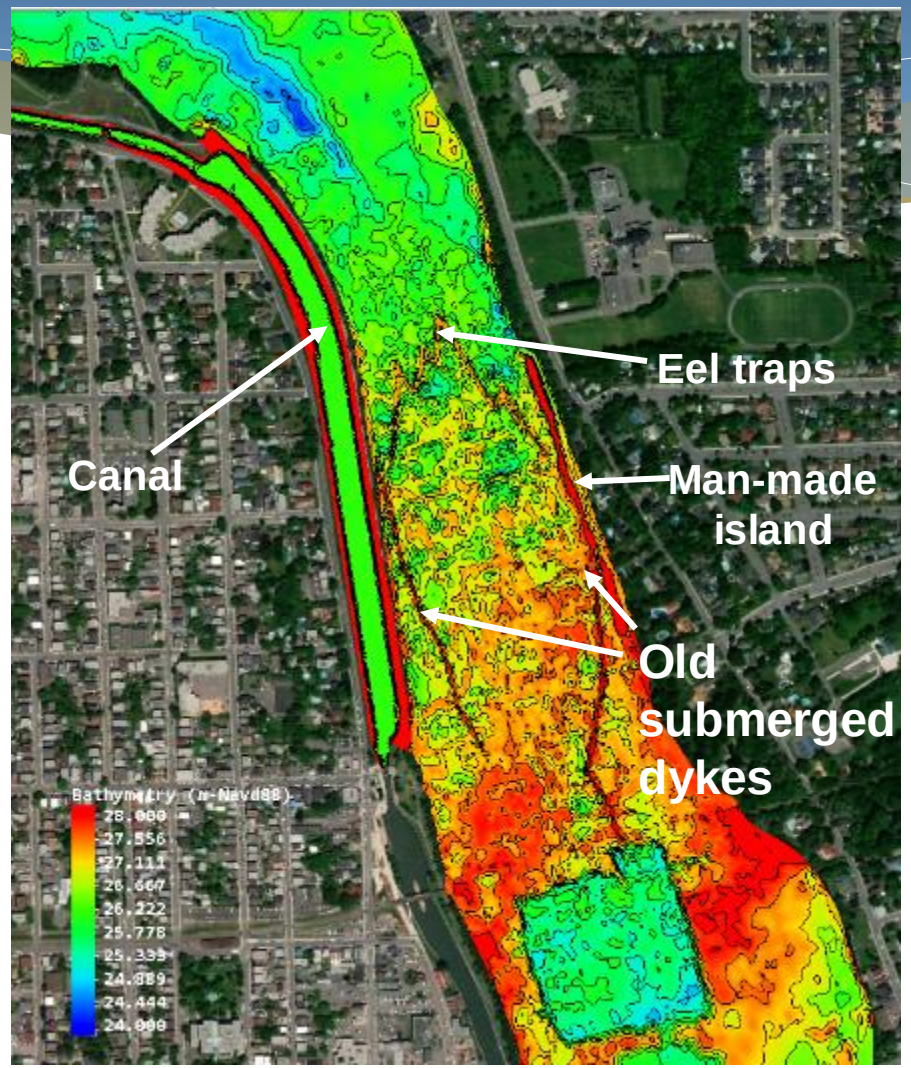
Climate Variability and Change Impact on Water Supplies

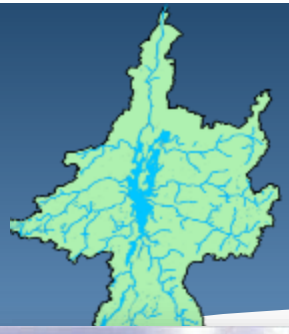
- Study suggests Lake Champlain and Richelieu River water levels may generally decline because of climate change.
- But the research also points to the plausibility of greater than 2011 floods.
- The Board links climate research to decisions, asking, what should we do if climate variability and change might affect water levels in different ways.

Human activity has affected water flow and levels

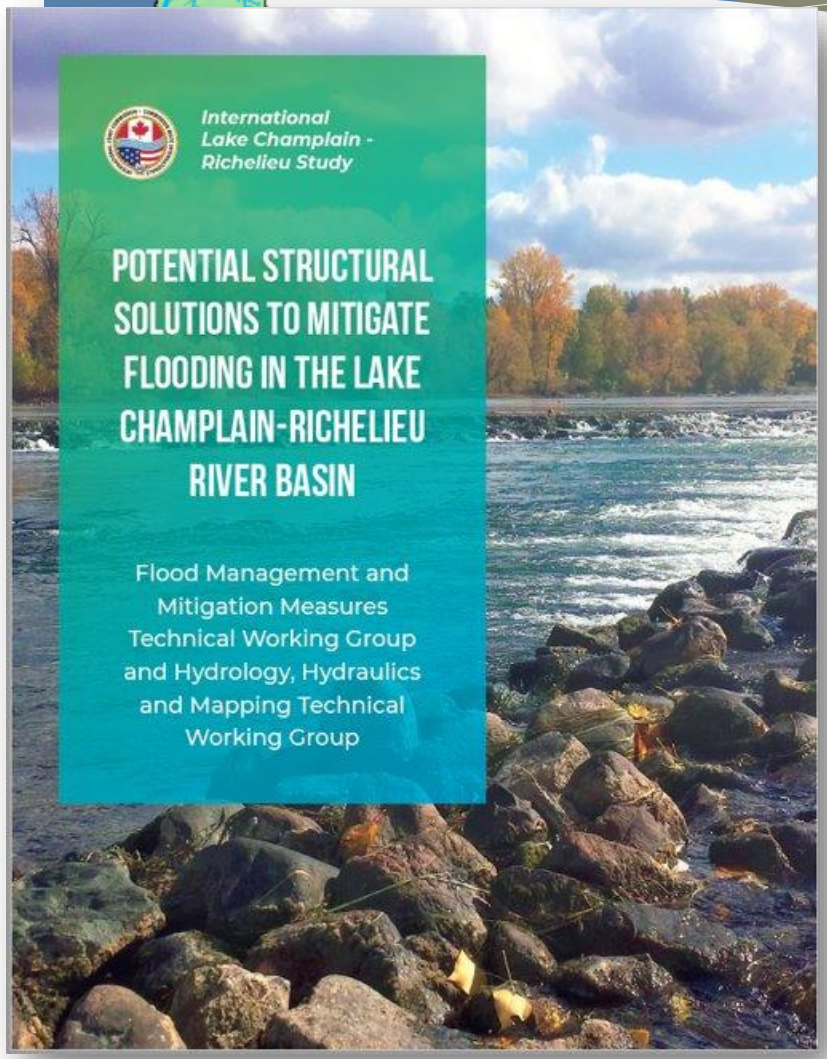
- Eel traps (1850)
- Submerged dykes for old mills (1860)
- Man-made islands, Iberville (1800)
- Bridges and bridge piers
- Chambly Canal widening, early 1970s
- Homes built in the floodplain



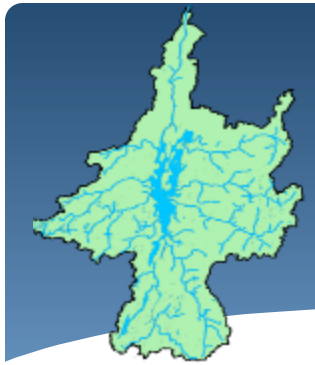




To reduce water levels, six possible structural alternatives have been investigated



1. Remove human-placed artifacts at Saint-Jean shoal to remove obsolete man-made structures
2. Divert water through the Chambly Canal during floods
3. Combine parts of 1 and 2
4. Install a fixed submerged weir 11 km (6.8 miles) upstream from Saint-Jean-sur-Richelieu
5. Install an inflatable weir at the same upstream location
6. Install an inflatable weir at Saint-Jean Shoal

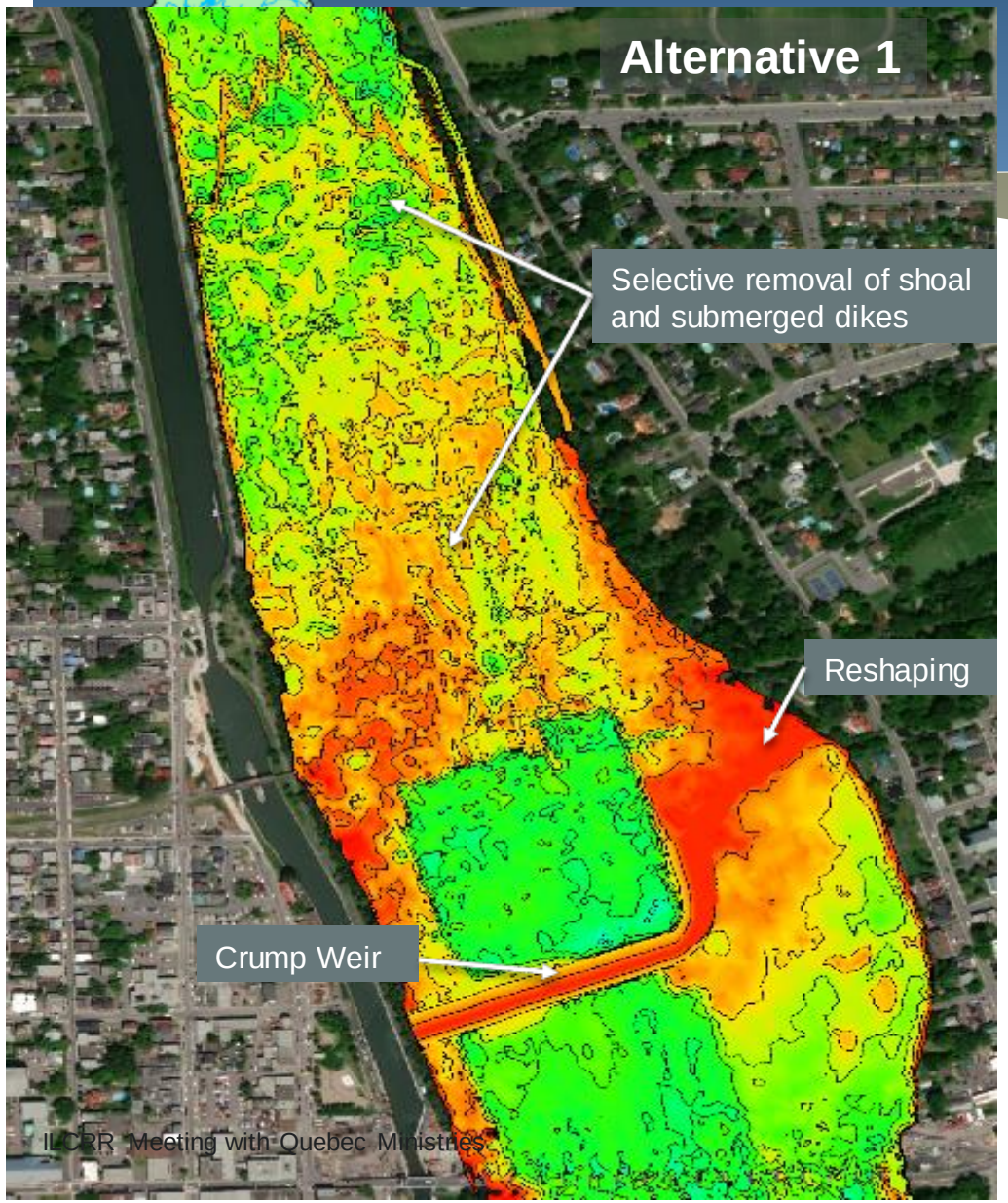


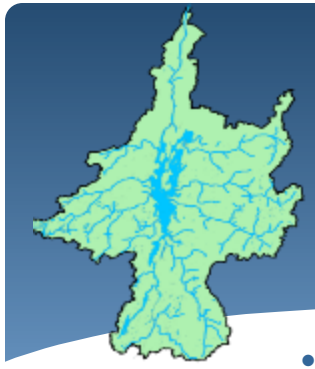
To reduce water levels, six possible structural alternatives have been investigated

- Study Board requested further analyses be focused on:
  - Using the Chambly Canal to route additional flow,
  - Modifications to Saint-Jean-sur-Richelieu Shoal to increase the river's conveyance.

- Three additional alternatives were developed and being assessed:
  - Alternative 1: Removal of human artifacts on the shoal and construction of a crump weir,
  - Alternative 2: Optimized Chambly Canal diversion (not cost-effective),
  - Alternative 3: Alternative1 with modest Chambly Canal diversion.

Promising Theme 1 Structural Solutions





Preliminary Results for Promising Alternatives

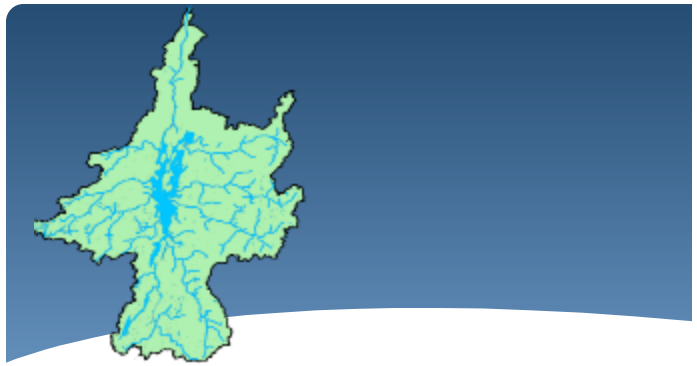
- For an event like 2011
  - Flow → 1477 m^3/s

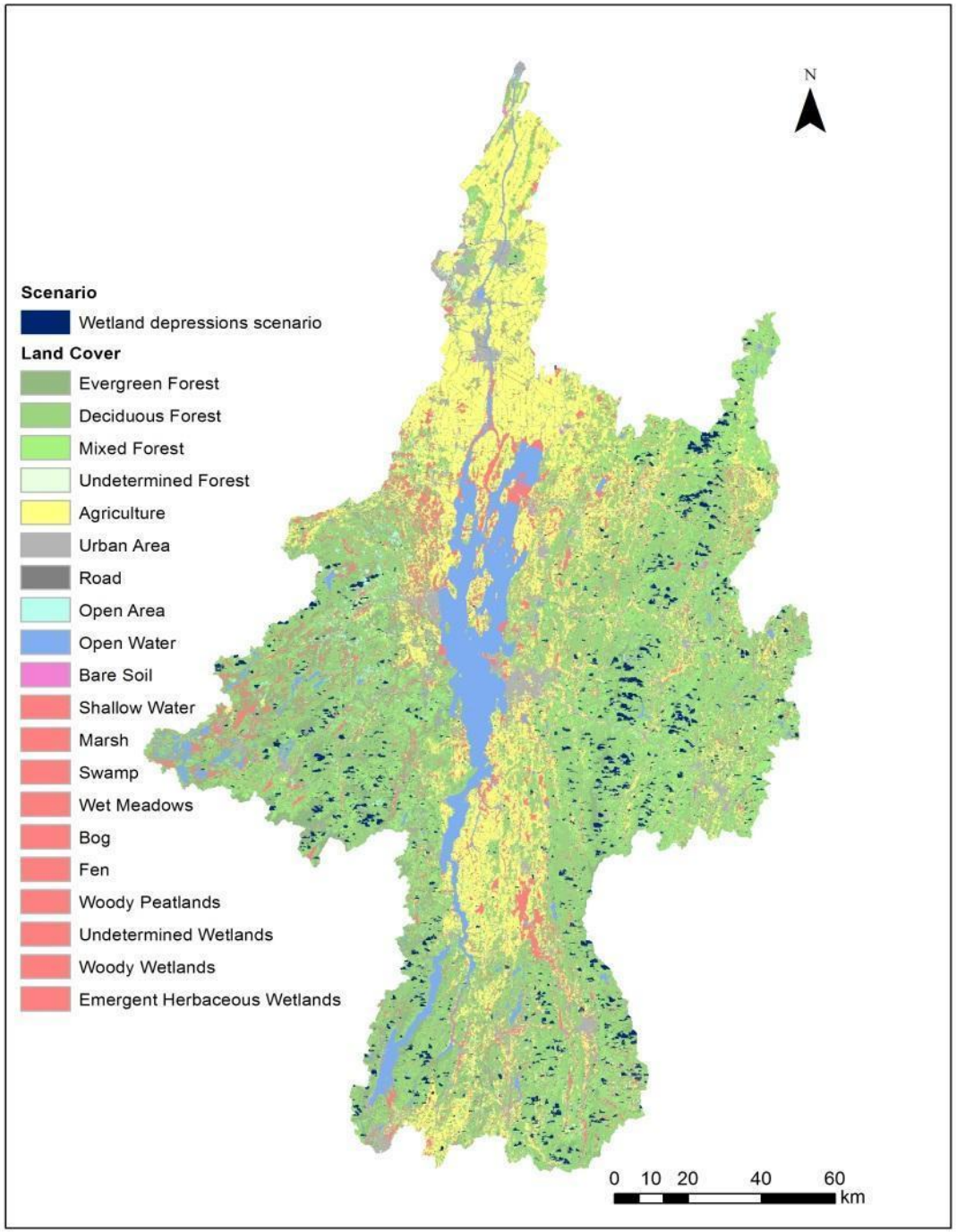
Alternative 1: Selective Removal of Artifacts and Crump Weir (Cost - $8 M)

- At Saint-Jean-sur-Richelieu Marina → Relief of **15.0** cm
- At Lake Champlain → Relief of **10.4** cm
- Preliminary Benefit-Cost Ratio → **≈3.0**

- **Alternative 3: Alternative 1 with Modest Chambly Canal Diversion (Cost - $21 M)**
  - Flow through diversion → 80 m^3/s
  - At Saint-Jean-sur-Richelieu Marina → Relief of **19.2** cm
  - At Lake Champlain → Relief of **12.4** cm
  - Preliminary Benefit-Cost Ratio → **≈1.2**

- For low flow events like 1964 (for both options)
  - Flow → 59 m^3/s
  - Lake Champlain water levels → Raises by 10 to 34 cm





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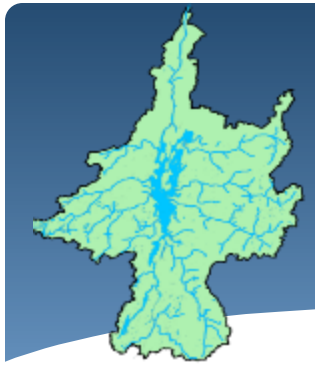
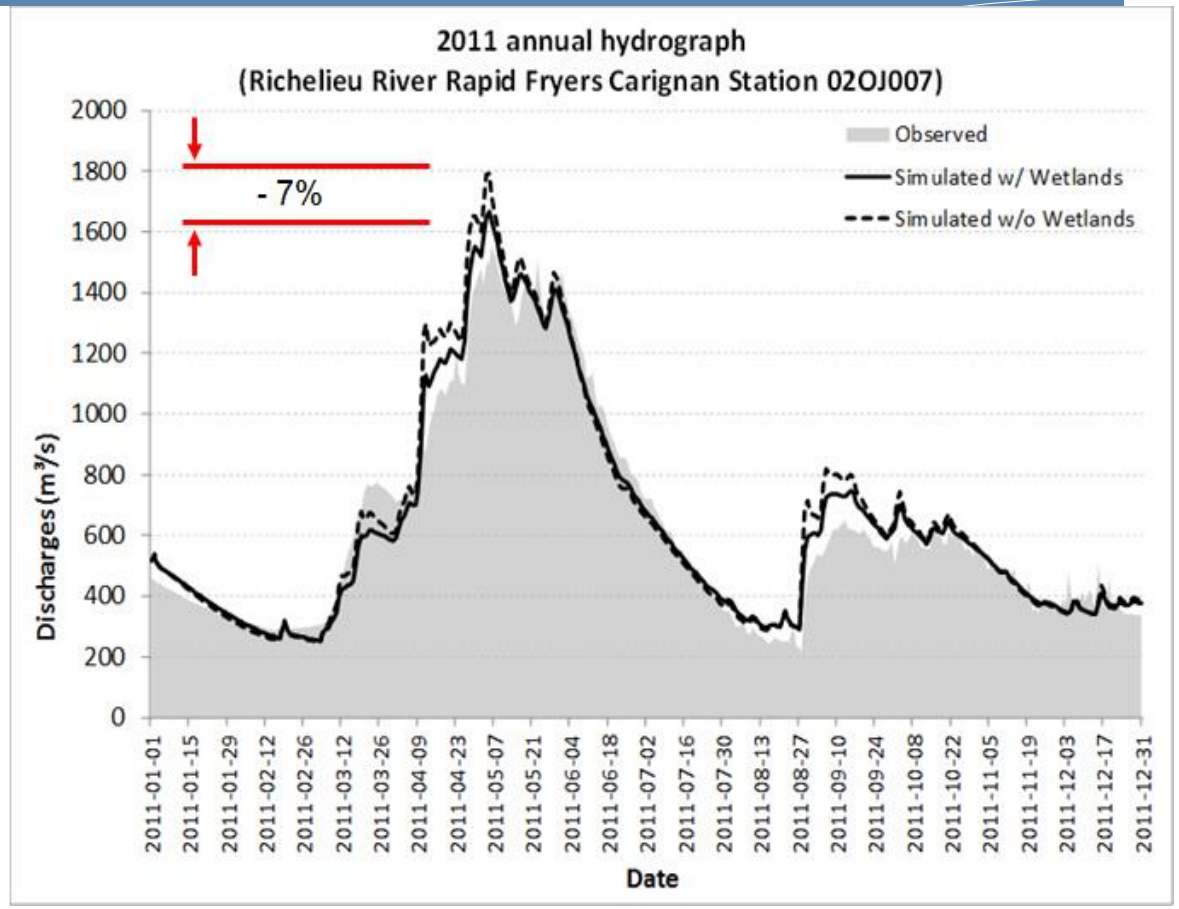


Enhancing wetlands in upland locations is unlikely to reduce Lake or Richelieu River flooding

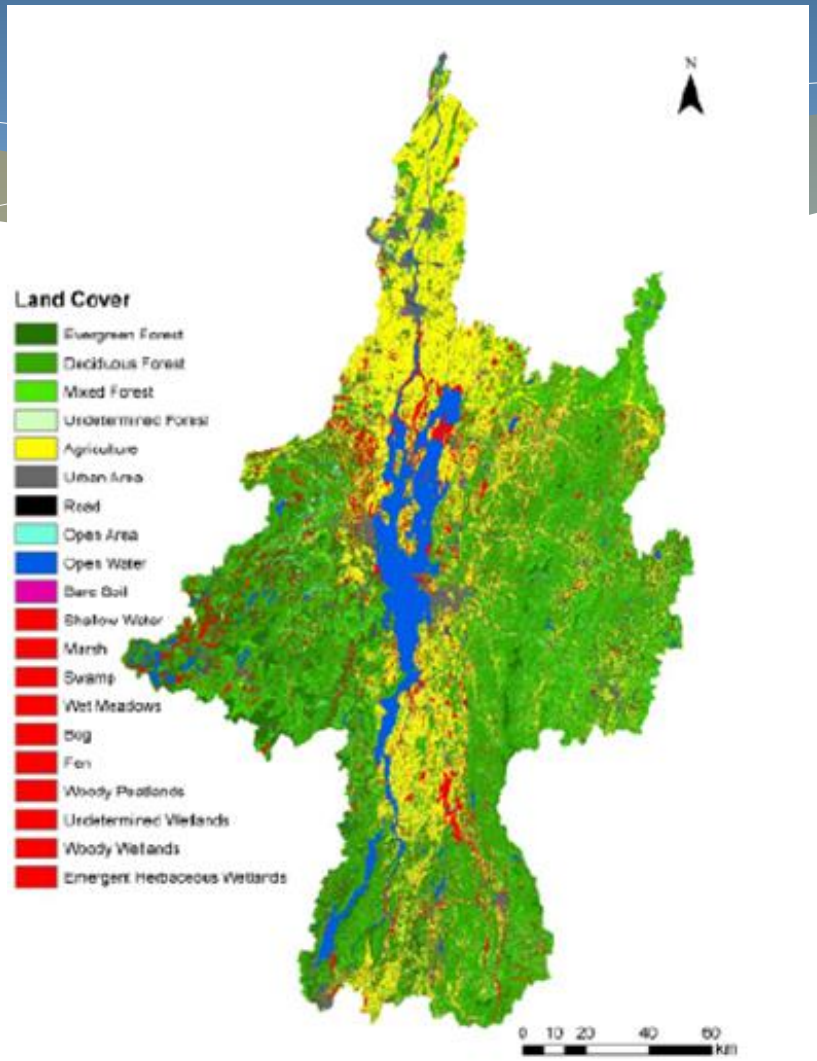
- Existing wetlands, particularly on the US side, have helped to provide some flood relief on the 2011 peak flood on the Lake and Richelieu River and relief at local tributary levels.
- Analyses done by the Study determined that an area three quarters the size of Lake Champlain would be required for upland storage to produce a comparable flood relief as proposed for the Alternative 1 structural solutions.
- A preliminary Benefit-Cost Ratio (< 0.01) suggests that this is not a cost- effective mitigative measure for basin-level flood relief.

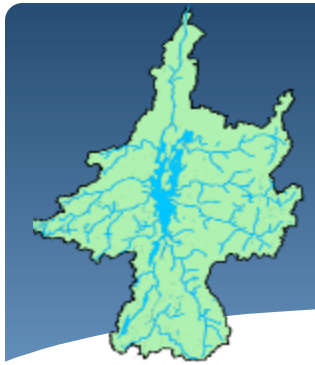


Study's Model/Database Development

- It is recognized that upland storage can provide many benefits: such as reducing tributary flooding and local impacts; improving water quality through trapping nutrients and other contaminants; and providing essential aquatic habitat.

- A high-resolution tool and databases (developed by INRS-ETE) covering the complete LCRR basin can be used to determine targeted upland storage projects.

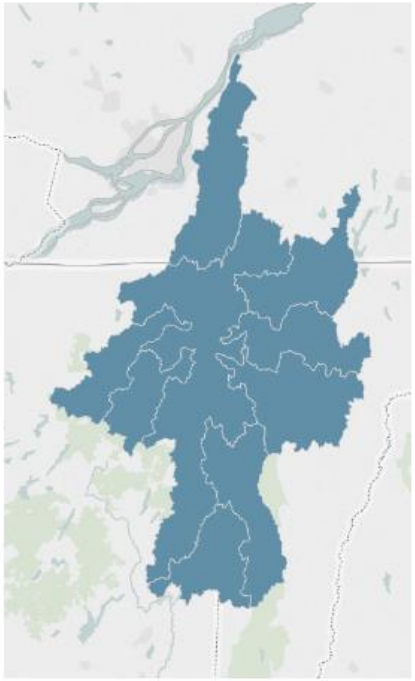




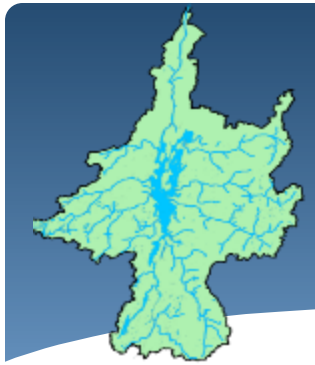
Improving flood prediction and emergency preparedness capabilities

A Comparison of the State Hazard Mitigation Plans of New York and Vermont

US SPE Task 8 Deliverable: Shannon Thayer, Emma Spett, Chris Koliba, Curt Gervich



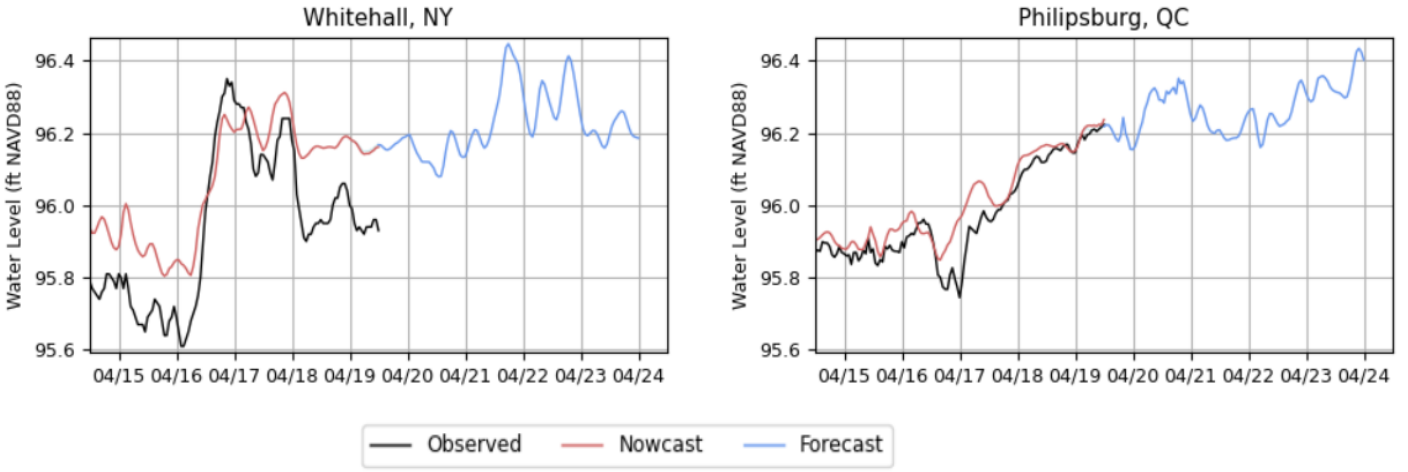
- Will make recommendations to implement an operational, real-time forecasting and flood inundation mapping system
- Surveyed the public regarding risks
- Analyzing hazard mitigation plans
- Researching early warning systems
- Conducted targeted interviews with US emergency responders and planners in Vermont and New York

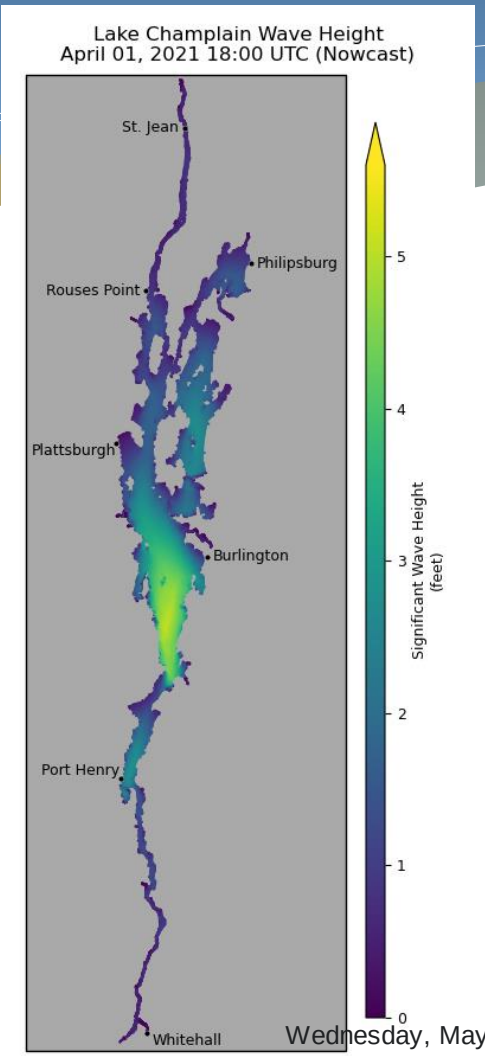


Social acceptability and political feasibility of flood mitigation measures were assessed in the US

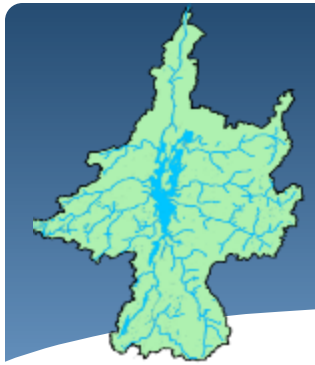
- More concerns expressed about tributary flooding than lakeshore flooding
- Political entities desire improved flood predication capabilities and communications
- Public risk perceptions are correlated with flooding experience
- However, most households had taken no action to reduce risk even if high flooding risk perceived
- TV, radio and word of mouth via neighbors are primary sources of flood hazard information for residents
- Hazard Mitigation Plan analysis: lakeshore flooding not a concern at any level of gov't; focus of plans is on maintenance of infrastructure (e.g., roads, bridges)

Flood Forecasting and Inundation Mapping System





- The Study is incorporating wind, wave, and ice observations to improve forecasting on Lake Champlain.
- An experimental 5-day water level forecast has been developed.
- An experimental 30-day forecast is under development.
- A flood mapping component is being explored.



Theme 4: Floodplain Management

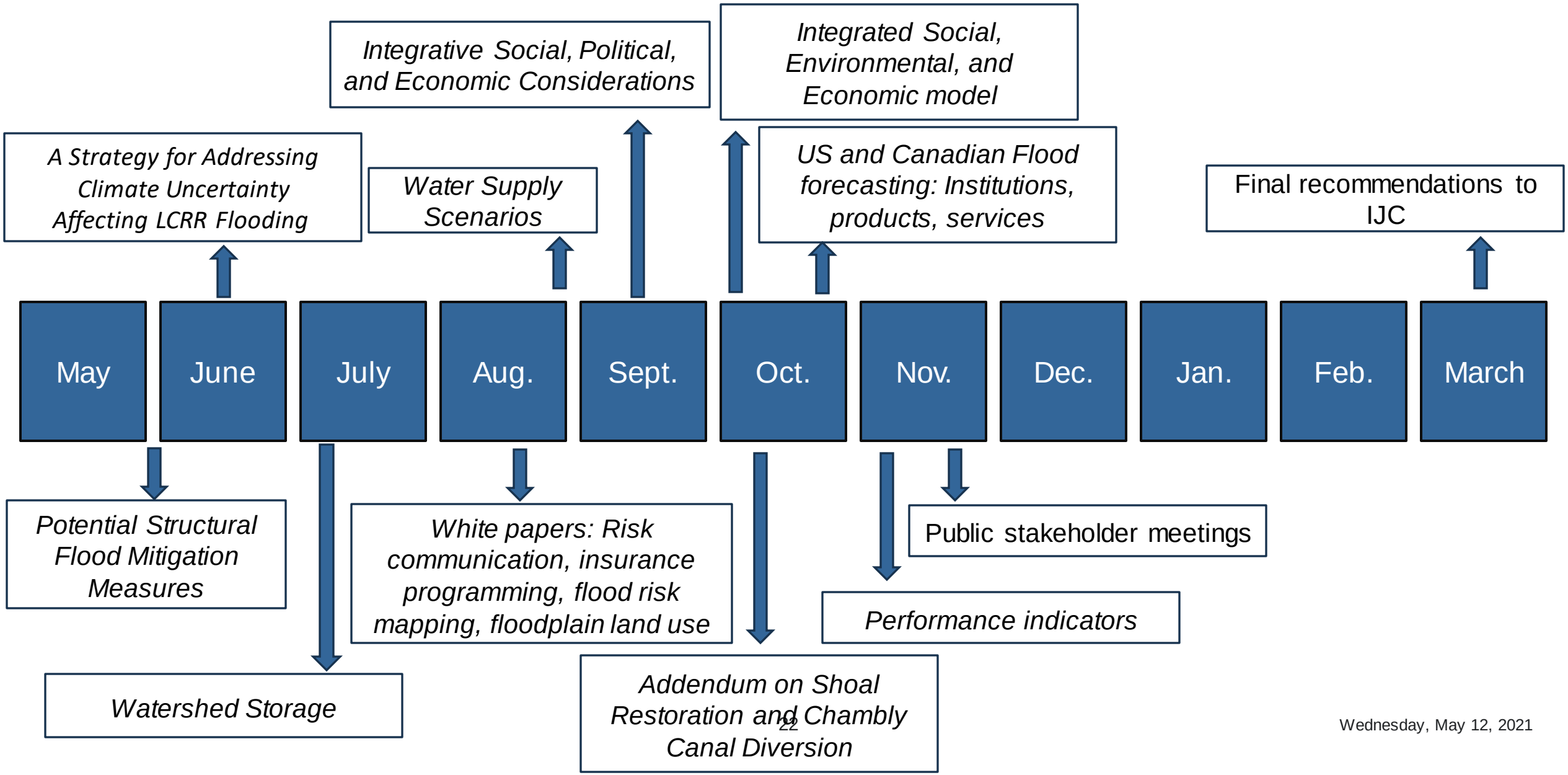
The following four White Papers are at various stages of completion:

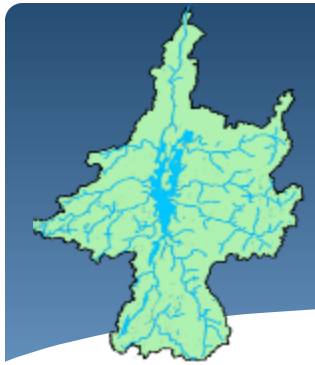
1. Flood risk mapping (Ouranos lead).
2. Better communication of flood risks (U. of Waterloo - Dr. Dan Henstra).
3. Floodplain occupancy management (Ouranos lead)
4. Development of flood insurance programs (U.S. National Academies of Science - Dr. Len Shabman)

The Study is researching best management practices for these four different, but interrelated topics of floodplain management.

The knowledge gained from this work will be applied to the LCRR basin setting and used to provide different perspectives to the governments on potential best floodplain management practices.

Timeline through the end of the Study





Thank you!

- Stay up to date with progress of the LCRR Study at: www.ijc.org/lcrr