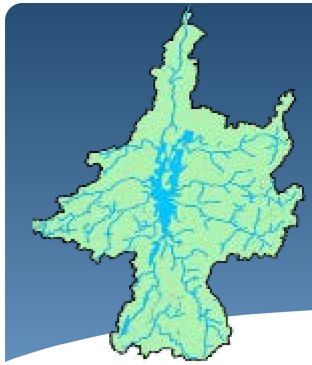
How the Lake Champlain Richelieu River study is assessing Climate Change

Technical Webinar

Wednesday, December 2, 2020

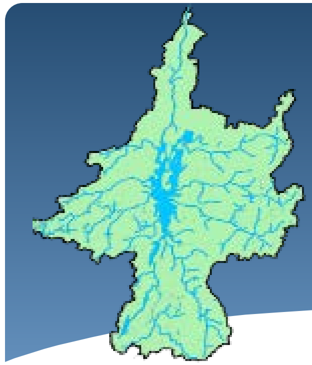
10-11 AM in English

2-3 PM en français



Overview

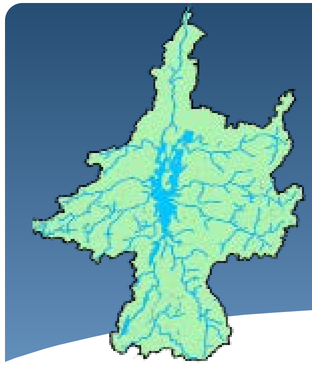
- Why climate change is so important in planning our responses to floods
- Decision scaling – it connects climatology and policy making
- 360° views. Four teams, four different angles on the future



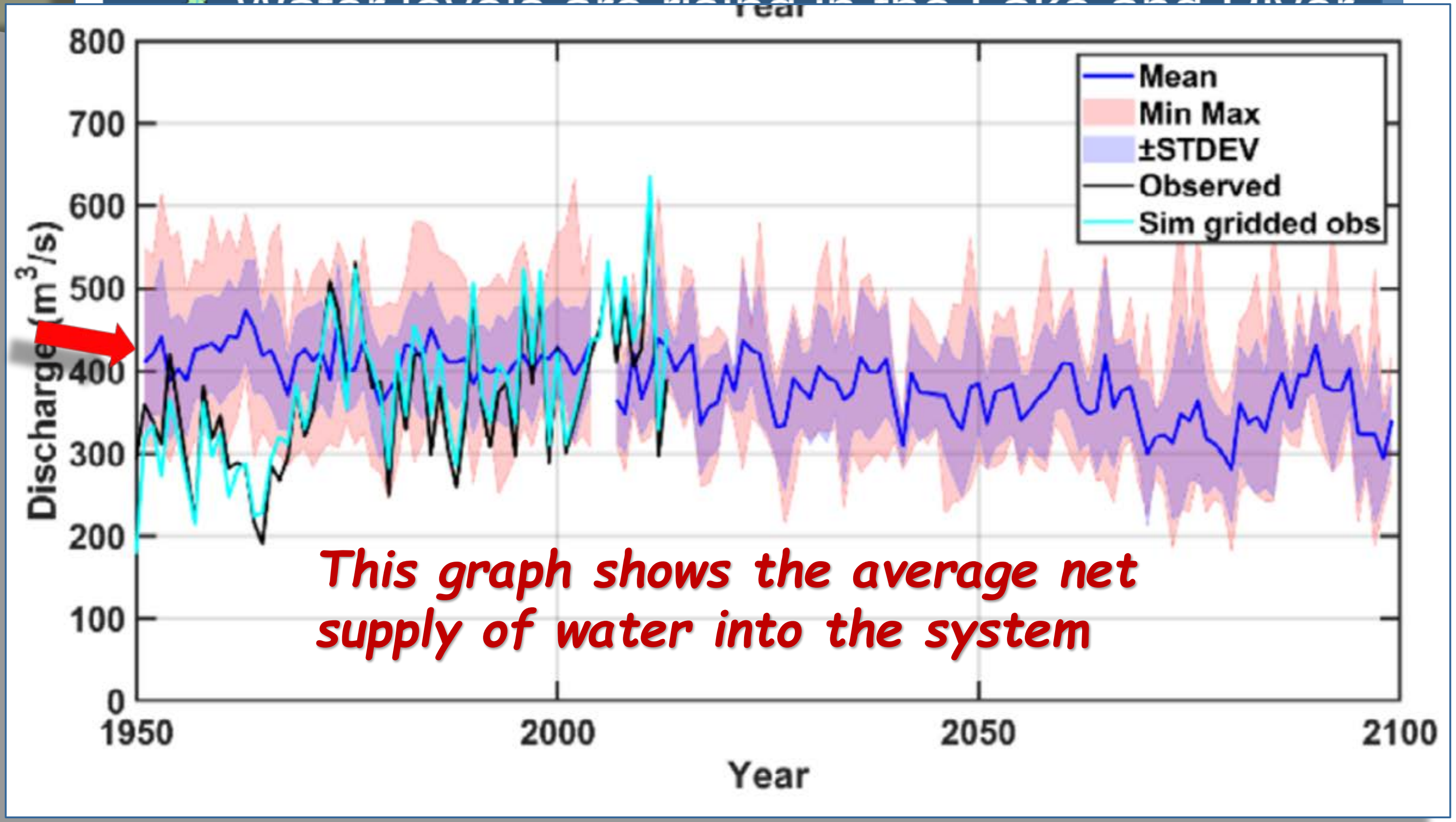
Why climate change is so important in planning our responses to floods

- The Board's final report will include its finding on the risk of future flooding in the study area
- That risk has two components, water and land
- **Water**: climate change may influence the frequency and severity of high-water events
- And **Land:** Development and post-flood rebuilding policies in the floodplain can change the vulnerability to flooding
- The Board has studied both issues extensively and will report the connections between them in its findings and recommendations

What have we already said about the water part?

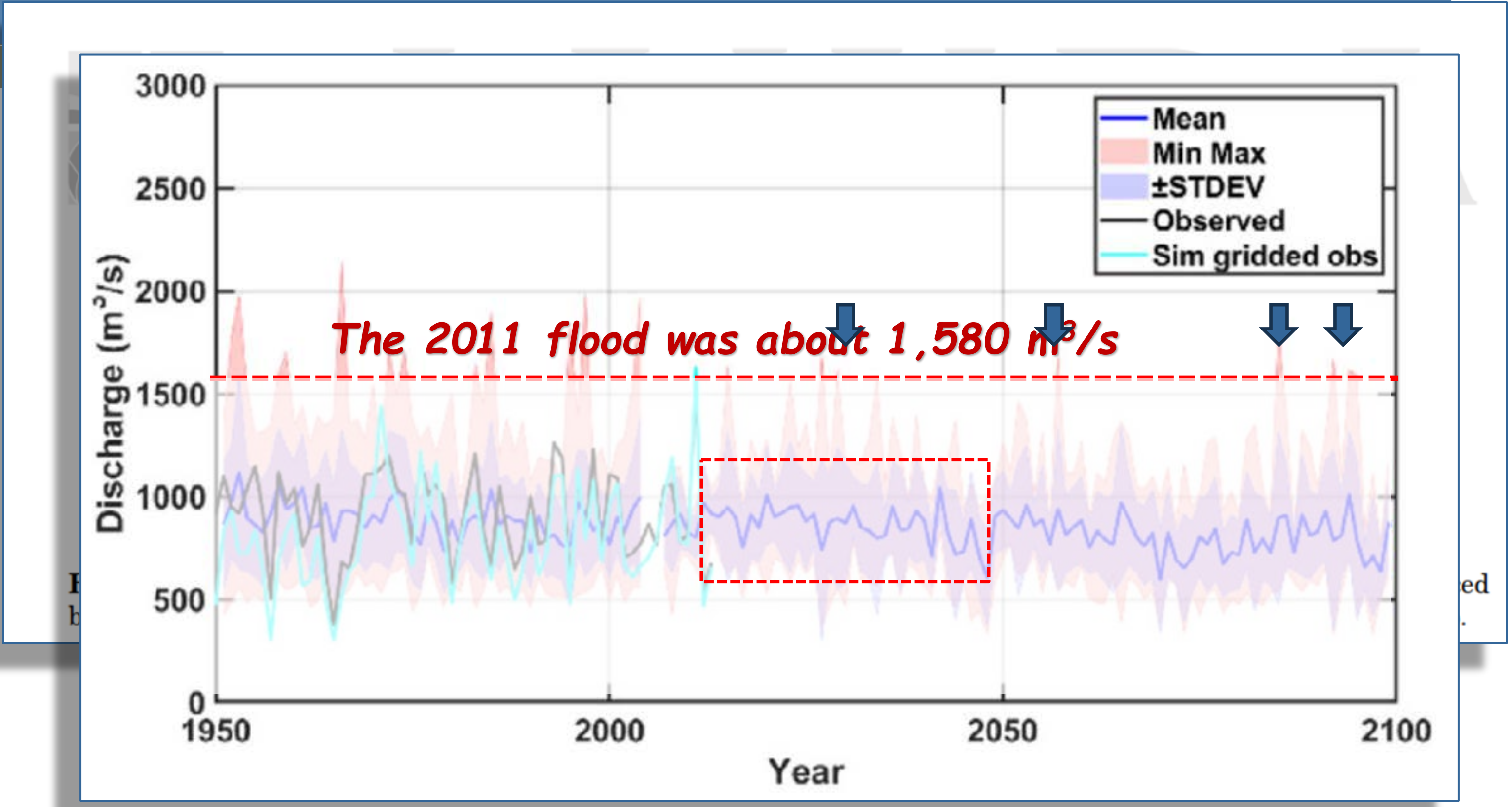


- November 2018: Average Annual Lake levels are trending up sharply, a foot since 1925
- Our climate change analysis indicates a decline in mean annual net basin supplies in the 21st century



Climate change study

- The analysis in a peer reviewed paper examined 186 scenarios of what can possibly happen based on climate simulations performed by several climate centers arounds the world and the Hydrotel model.
- The majority of those scenarios presented a slow decreasing trend of flood values in statistical terms.
- But a certain number of them showed oppositely an increasing trend
- Large floods continue to be possible in all scenarios from time to time. Only their probabilities are changing



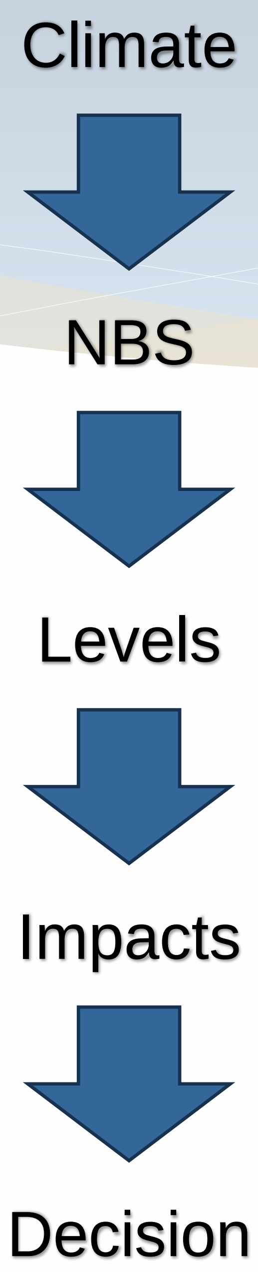
This graph shows the peak flow in the Richelieu River near St. Jean-sur-Richelieu

How do we decide what to do if the future is so uncertain

- In the early 21st century, it was commonplace to do climatological studies that provided a few specific future climate change scenarios
- The primary method is called “downscaling” in which global predictions were applied locally to adjust historical streamflow data up or down.
- But flood management alternatives were typically evaluated based on historic floods, so downscaling was used more to add insights than to directly shape policies.
- The “Decision scaling method” explicitly links the impacts from extreme climate, the plausibility of those scenarios, and policy making
- The LCRR study is using decision scaling.

Decision scaling vs. Downscaling

- Decision scaling includes two things beyond making best available science predictions
  1. Determines the breaking points – how much would climate have to change to cause the system to fail expected performance targets?
  2. Asks whether there are plausible climate projections that would cause those failures.
- In doing this, decision scaling expands on and inverts the downscaling process

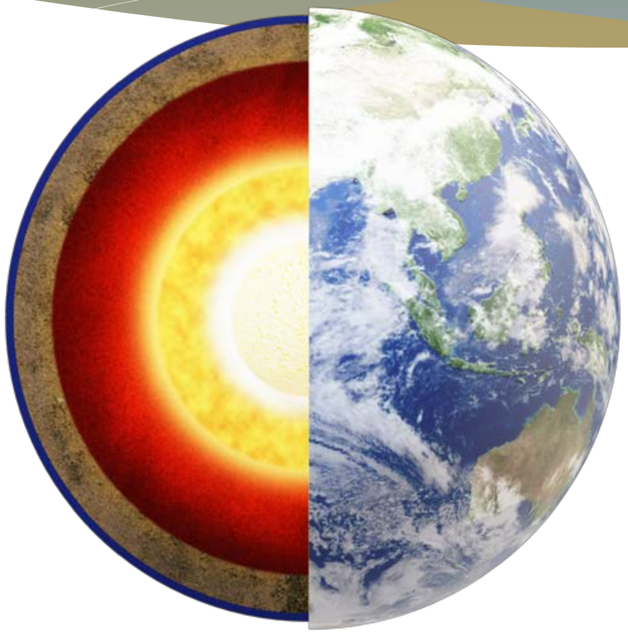


Breaking points

- Downscaling is a defensible method for estimating likely future net basin supplies
- This is like estimating the load a structure will likely have to withstand
- But if you're interested in whether the structure is safe, another approach is to load it until it breaks …
- And then ask, are breaking loads plausible?

Three expert teams provide four perspectives

1. Stress tests – what if we built a weather generator that created various weather scenarios representative of a range of future warming and precipitation increases?
2. Statistical – what can we learn about extremes from historical data and trends?
3. Probably Maximum Flood – what if we stitched together heavy winter snowfall, cold springs and torrential spring rains?
4. Climate model driven simulations of future net basin supplies



Decision scaling team, perspective 1

Casey Brown

Professor of Civil and Environmental Engineering
Consortium Institution:
University of Massachusetts
Education:
Ph.D.: Environmental Engineering Science, Harvard University, Cambridge, MA, 2004
M.S.: Environmental Engineering, University of Massachusetts Amherst, Amherst, MA, 1994
B.S.: Civil Engineering, University of Notre Dame, Notre Dame, IN, 1993

Baptiste Francois

PhD: Earth and Environment - University of Grenoble-Alpes, Grenoble (France), 2010-2013
Thesis: Optimal management of multi-purpose reservoir and climate change.
Models, projections and uncertainties (in French)
Master Degree: Atmospheric Science and Hydrology - University of Joseph-Fourier – Grenoble, France, 2007-2009

Bachelor Degree: Physics and Chemistry Applied to the Environment - University of Toulon – Toulon, France, 2004-2007

Casey Brown originated the concept of decision scaling and has applied it with the IJC and globally with the World Bank, Rand Corporation and Rockefeller Foundation

Baptiste Francois Ph.D. thesis in Grenoble, France was closely related to Professor Brown's work, optimal management of a storage lake given the uncertainties of climate change.

They will create plausible future climate change scenarios using their stress testing for the basin and then ask, how many global models predict the changes in precipitation and temperature that create these stresses?

They will also help integrate the insights of the other two team into the Board's findings and recommendations

Statistical team, perspectives 2 and 3

Taha Ouarda

Professor at the Chemical and Environmental Engineering Department at Masdar Institute, and Head of the Institute Center for Water and Environment (iWATER). His specialization is in statistical hydrometeorology, environmental modeling, and risk analysis.

Taesam Lee

Professor of Civil and Environmental Engineering
Consortium Institution:
Gyeongsang National University

Education:
Ph.D.: Civil and Environmental Engineering, Colorado State University, 2009
M.S.: Civil Engineerning, University of Seoul, 2001
B.S.: Chosun University, South Korea, 1999

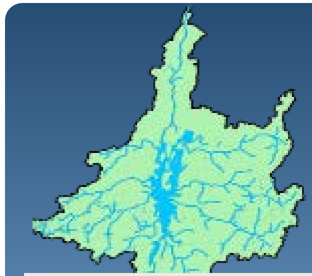
Taha Ouarda Head of the Institute Center for Water and Environment in Quebec City. His specialization is statistical hydrometeorology. He earned his Ph.D. at Colorado State University, world renown for this type of analyses. He's worked with IJC analyzing trend change points in Great Lakes water levels and has produced stochastic times series for inflows to the Great Lakes.

Taesam Lee is a professor of civil engineering at Gyeongsang National University in Jinju, South Korea. He also earned his Ph.D. at Colorado State and is the lead author of many peer reviewed papers related to this work.

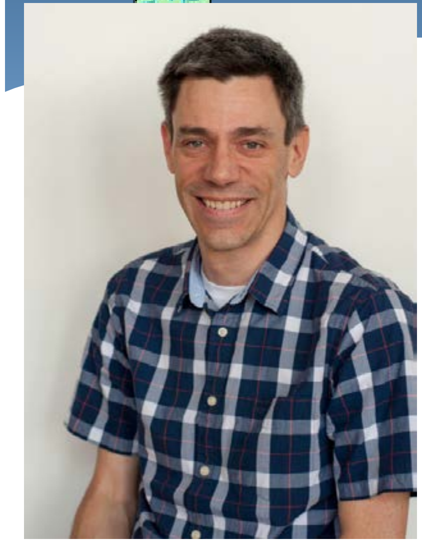
Taha and Taesam are working on the second and third perspectives for our study

They will generate stochastic net basin supply datasets that produce statistically plausible floods greater than 2011.

Taha will also create what is called a "Probable Maximum Flood", something that is common for river flood evaluations but a new idea for lakes.



Modeling team – Perspective 4



Phillipe Lucas-Picher

Simon Lachance-Cloutier

Phillipe is a Senior climate scientist at CNRM/Météo-France and **Simon** is part of Centre d'Expertise Hydrique du Québec within the Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs. He he worked on the hydroclimatic Atlas of southern Quebec (versions 2013, 2015, 2018 and 2021, the last soon to be published)

They are the lead authors of the peer reviewed climate research papers for this study and will use the Hydrotel model they calibrated for generating NBS to Lake Champlain from climate model outputs for processing the stress tests and other work from the decision scaling team.

JAWRA
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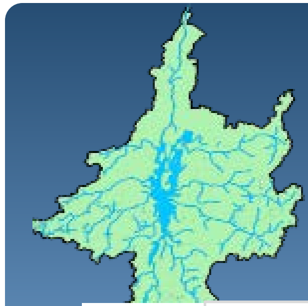
AMERICAN WATER RESOURCES ASSOCIATION

Will Evolving Climate Conditions Increase the Risk of Floods of the Large U.S.-Canada Transboundary Richelieu River Basin?

Philippe Lucas-Picher , Simon Lachance-Cloutier , Richard Arsenault , Annie Poulin , Simon Ricard , Richard Turcotte , and François Brissette

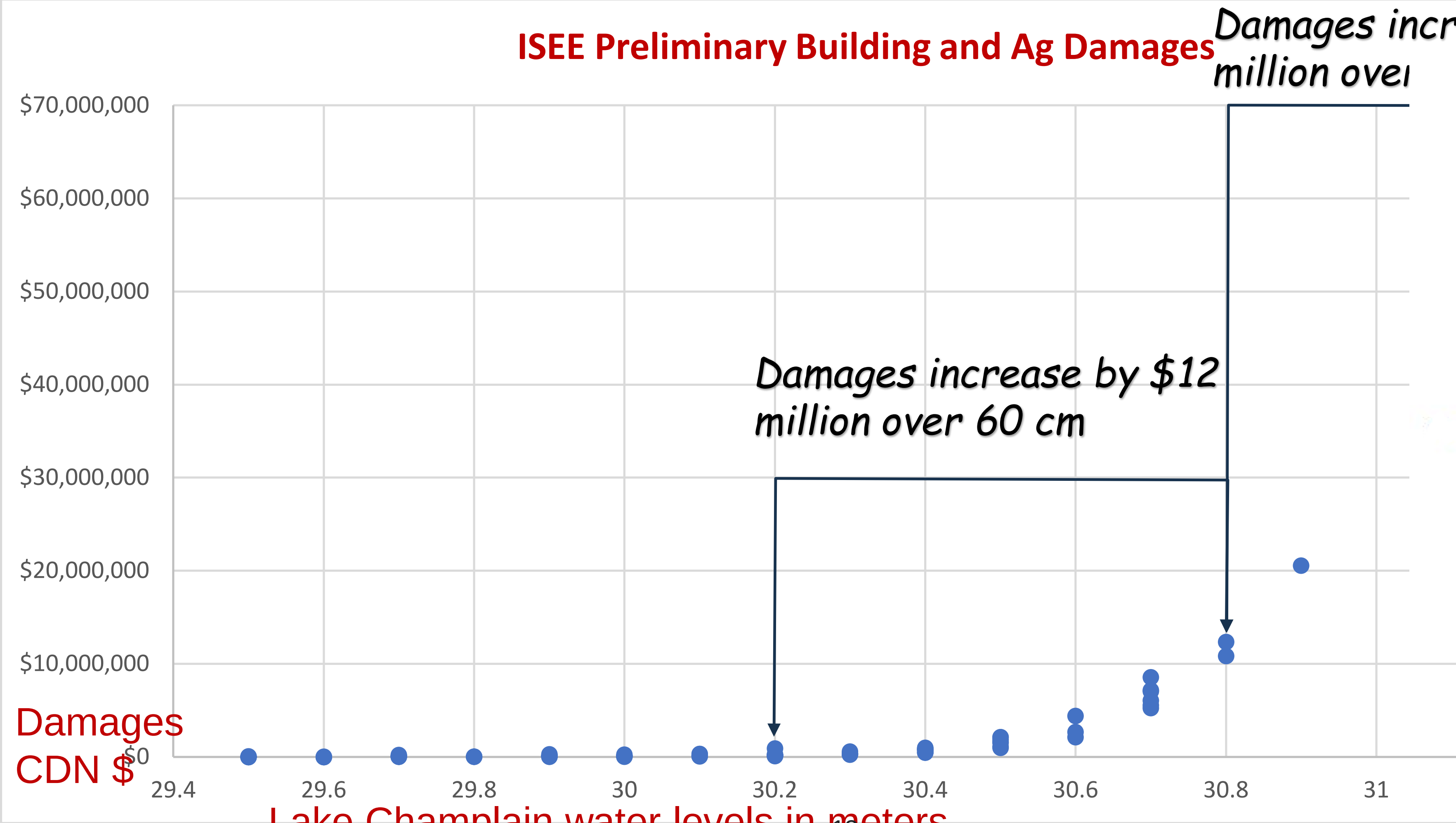
Research Impact Statement: The flood risk of the Richelieu River simulated with a hydrological model forced by three ensembles of climate simulations should decrease with time, especially for the high emission scenario.

We are workir



The Land side: why climate change and extreme events are so important

Clima



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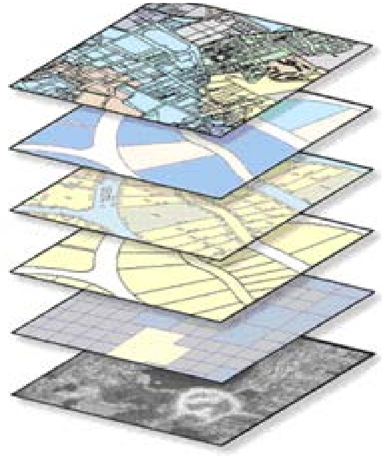
Model



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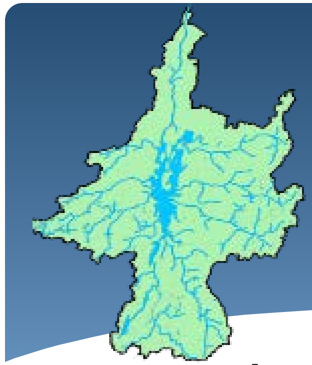
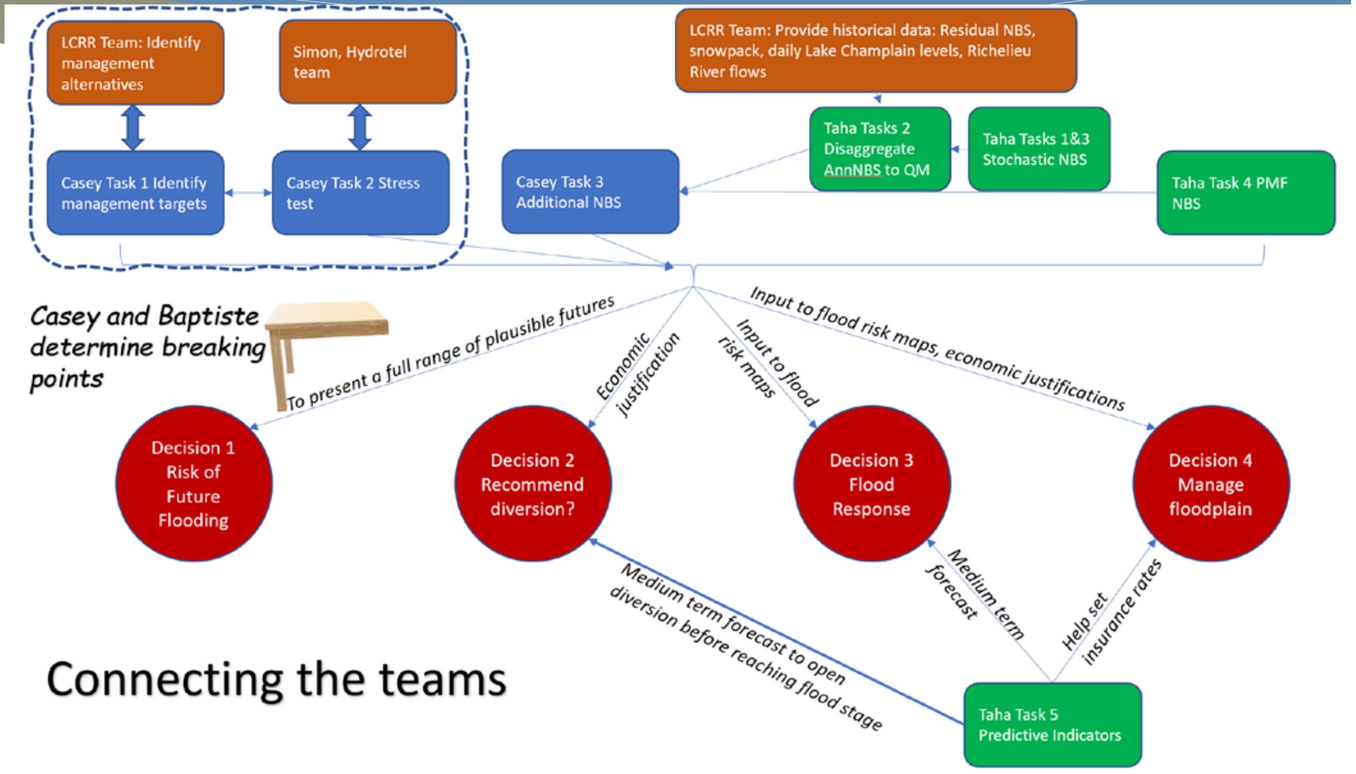
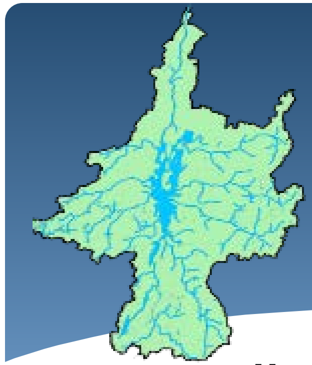


We've diagrammed the connections between the teams task by task

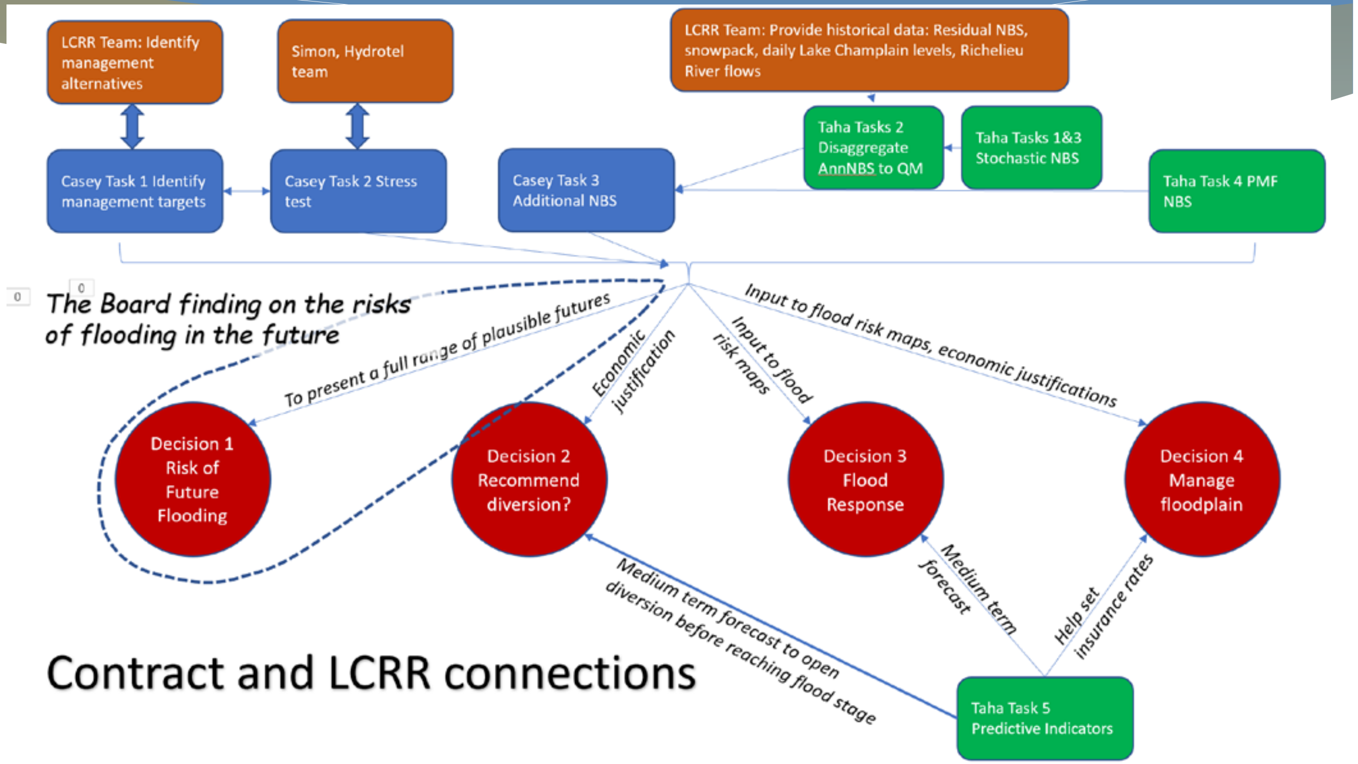
- The teams talk regularly and share findings as they occur
- These scientists also converse regularly with the study technical specialists which include NOAA and ECCC experts on these subjects





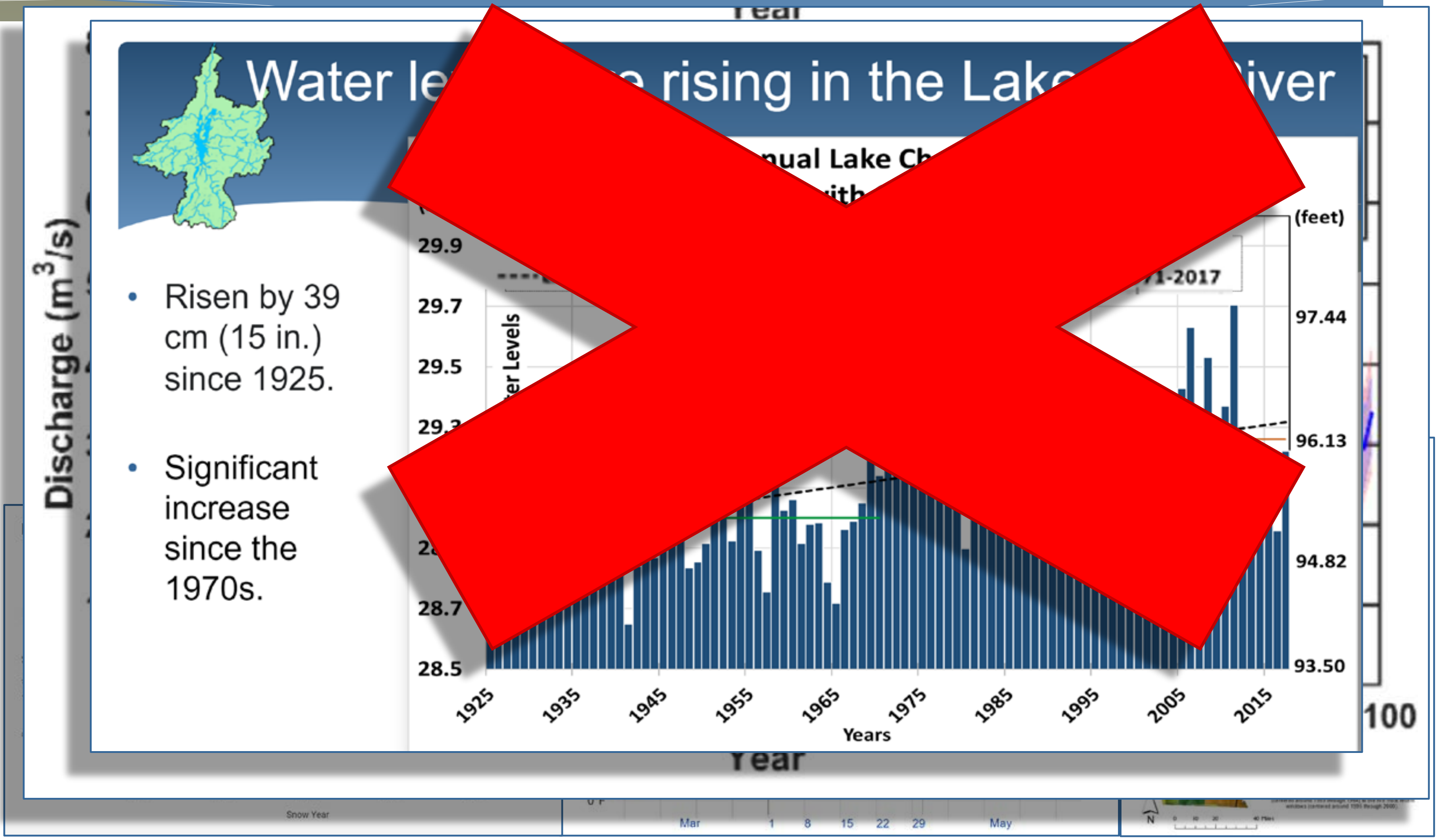
And the linkages to our economists and Board

- All the working scientists also exchange ideas with study economists
- They also converse regularly with the Study Directors and Study Board members expert on these issues



Risk of future flooding

- We don’t know yet where the research will lead, but here’s an educated guess:
- We reject the simple upward trend we showed at the beginning of the study, because it measures annual averages, not flooding
- We acknowledge that even if average NBS is heading down, we can’t discount the chance of a greater than 2011 flood
- Probable Maximum Flood research will provide a different perspective from stochastic and climate model projections
- We will ask, can we do something sensible to prepare for severe but unlikely floods?



Key Messages

- We have not reached firm conclusions on the impacts of climate change on Lake Champlain flooding
- We may conclude that over the long term there's a good chance of a general decline in water flowing into Lake Champlain (net basin supplies)
- But also allow that there is small but credible threat of floods much worse than 2011
- The Board might also
  - raise the issue of the impacts of future extreme low water conditions (boating, harmful algal blooms)
  - estimate the impacts of lake levels much higher than 2011
  - suggest planning for worst case scenarios.