Basin Resilience to Extreme Events Social Systems:
Taking Stock

Christopher Koliba, Ph.D.

Social Systems Team Leader

All Hands Meeting

June 4, 2019

BREE Basin Resilience to Extreme Events in the Lake Champlain Basin

National Science Foundation NSF EPS 1101317

Vermont EPSCoR

Overarching Research Question for Social Systems:

- *How do governance networks, institutional rules, macro-economic indices and resource allocation decisions respond to extreme events, and how can this knowledge be used to design public policies and governance networks that enhance resilience across the Lake Champlain Basin?*

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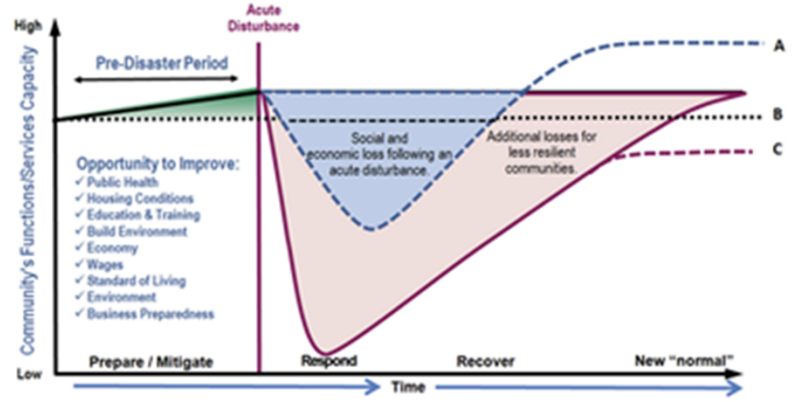
Defining Community Resilience

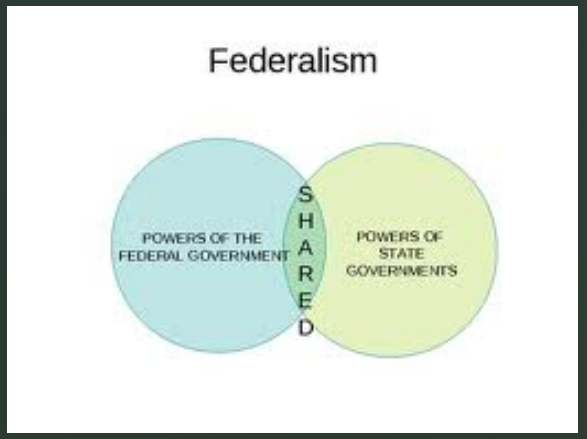
Resilience – The ability to anticipate risk, limit impact, and bounce back rapidly in the face of turbulent change.



Ability to quickly return citizens to work, reopen businesses, and restore other essential services needed for a full and swift economic recovery, as a result of pre-disaster mitigation activities.

Model: Dr. Mary Ellen Hynes, DHS (2001); Blair Rose, ORNL; CARRI 2008

Contemporary watershed governance approaches employed in our Basin:



- Pragmatic federalism (Gerlak, 2006)

  (1) emphasizes collaborative partnerships,

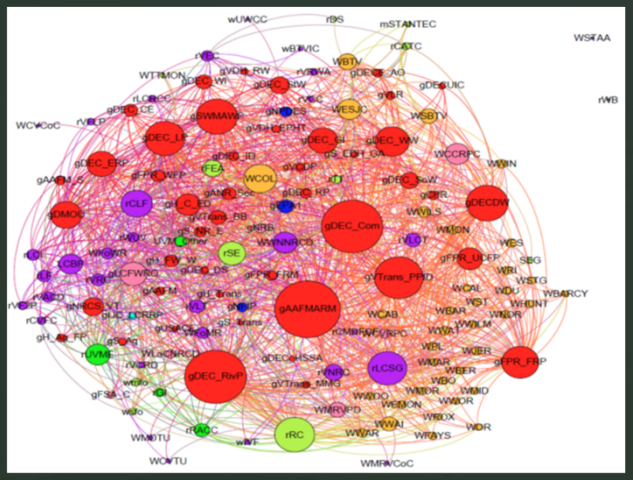
  (2) relies on adaptable management strategies, and

  (3) is problem and process oriented.

  - Gerlak, A. K. (2006). Federalism and US water policy: Lessons for the twenty-first century. *Publius*, 231-257.

Contemporary watershed governance approaches employed in our Basin:

- Polycentricity (Ostrom, 2010; Koontz et al., 2015; Berardo and Lubell, 2016).
  - Ostrom, E. (2010). Beyond markets and states: polycentric governance of complex economic systems. *Transnational Corporations Review*, *2*(2), 1-12.
  - Berardo, R., & Lubell, M. (2016). Understanding What Shapes a Polycentric Governance System. *Public Administration Review*, *76*(5), 738-751.



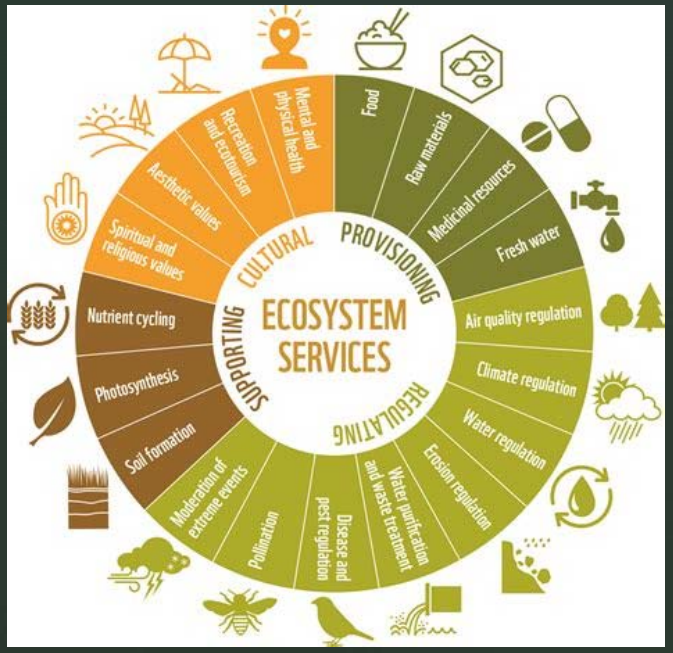
- Contemporary watershed governance approaches employed in our Basin:

Integrated water resource management (IWRM) framework

Main IWRM Features:

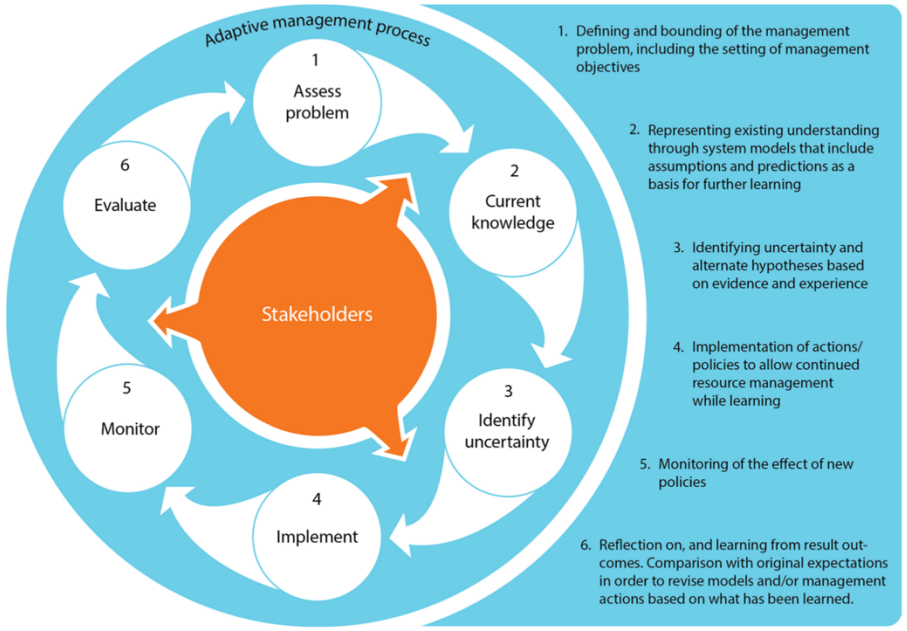
1)local water needs
2)hydraulic control
3)water pollution
4)ecological function

Lubell and Edelenbos, 2013.



Adaptive Management Process: Using science to manage and govern segments of society

Fig. 1. The adaptive management process (based on Walters [1986:9] and Holling [1978:20]). Stakeholder participation is considered central to the process and to achievement of successful natural resource management.



Rist, L., A. Felton, L. Samuelsson, C. Sandström, and O. Rosvall. 2013. A new paradigm for adaptive management. *Ecology and Society* **18**(4): 63. http://dx.doi.org/10.5751/ES-06183-180463

Purpose of the BREE Policy and Technical Advisory Committee (PTAC):

- To provide **technical advice** regarding model development, calibration and validation, including possible access to datasets that may be used in the process.
- To provide input regarding the **communication of research findings** and uncertainty associated with them.
- To provide **advice about possible scenarios** to be generated and tested from the BREE Integrated Assessment Model (IAM), as well as the land use, hydrology, climate, governance and economic models that are to be wrapped into it.
- To provide advice about the **development of actionable, decision-support tools to inform water quality** in the face of changing frequencies and intensities of extreme events in the study areas.

Policy and Technical Advisory Committee (PTAC) Roles

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Basin Resilience to Extreme Events
in the Lake Champlain Basin

VERMONT
AGENCY OF AGRICULTURE, FOOD & MARKETS

Lake Champlain Basin Program

VERMONT
AGENCY OF NATURAL RESOURCES
Department of Environmental Conservation

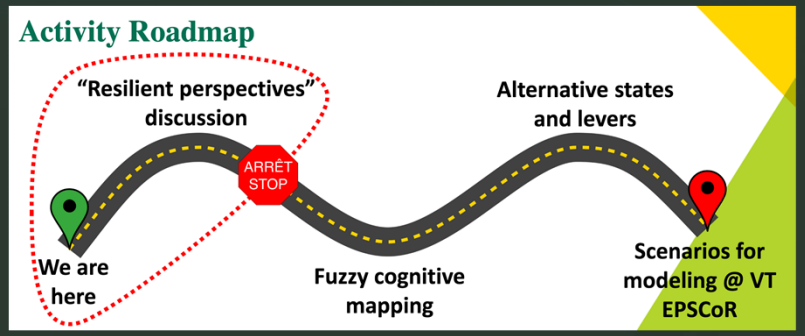
NRCS
Natural Resources Conservation Service

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

ECHO LAKE AQUARIUM AND SCIENCE CENTER

FRIENDS OF NORTHERN LAKE CHAMPLAIN

LAKE CHAMPLAIN COMMITTEE



Forum to Advance Science and Policy Recommendations on Lake Champlain Water Quality

May 8, 2019

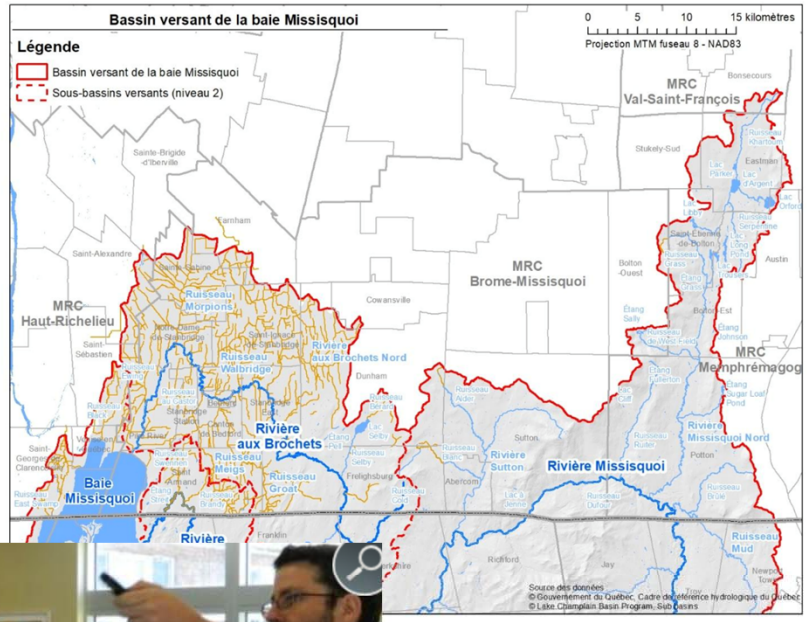

Eric Howe, Program Director Lake Champlain Basin Program


Question and Answer session with the BREE Presenters


Scott Turnbull, Vermont EPSCoR BREE Software Engineer


Breck Bowden, PhD, Vermont EPSCoR BREE

Research and Data in Missisquoi Bay Basin - Québec

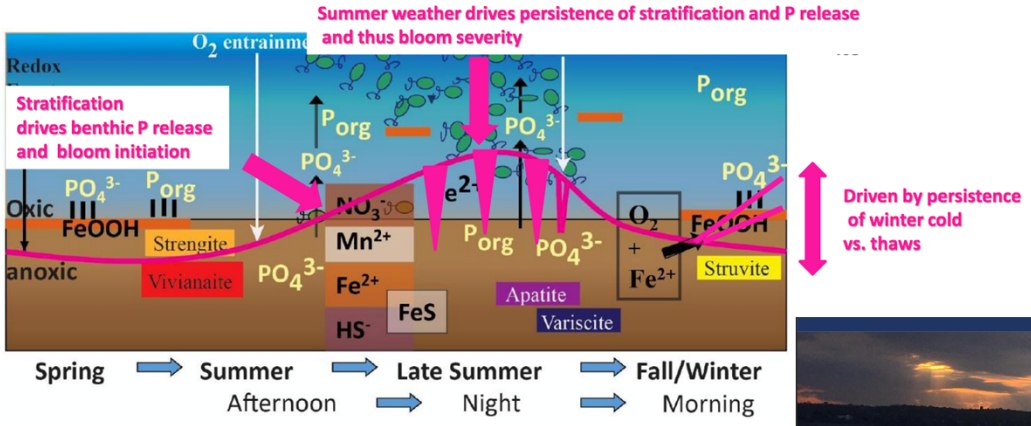


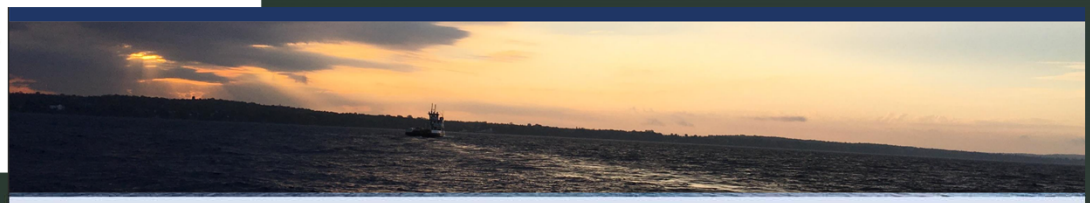
General data on MBB Québec

- Waterways data
  - Latest = GRHQ, 2018; Excluding ditches, many small waterways missing
  - LIDAR coverage: Montérégie 2013, Estrie to come; high resolution LIDAR waterways and ditches for MRCBM only
  - « Verbalized » waterways: MRCBM, MRCHR. For Ag drainage and maintenance.
- Hydrology
  - 4 river stations (Direction expertise hydrique)
  - 1 Missisquoi Bay station (Environnement Canada)


Frederic Chouinard, Organisme de bassin versant de la baie Missisquoi

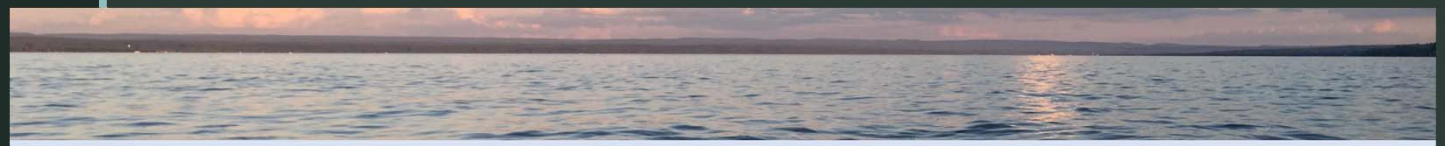
Drivers of Internal P Loading in Missisquoi Bay : Revised Conceptual Model





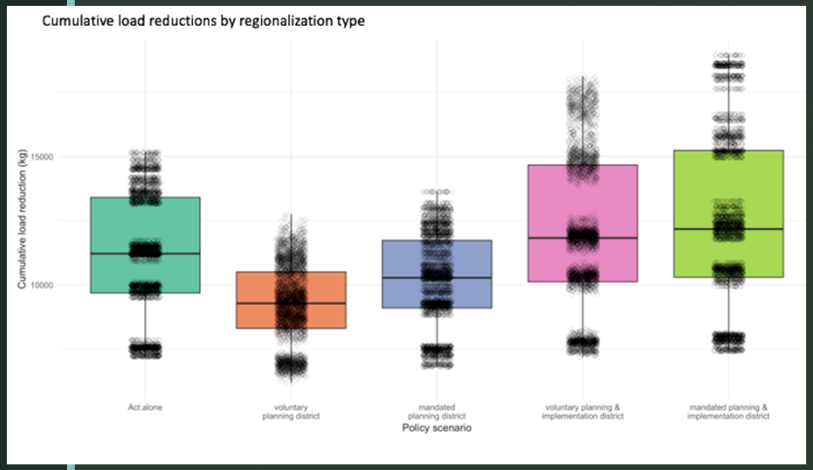
4. Address the impacts of legacy phosphorus

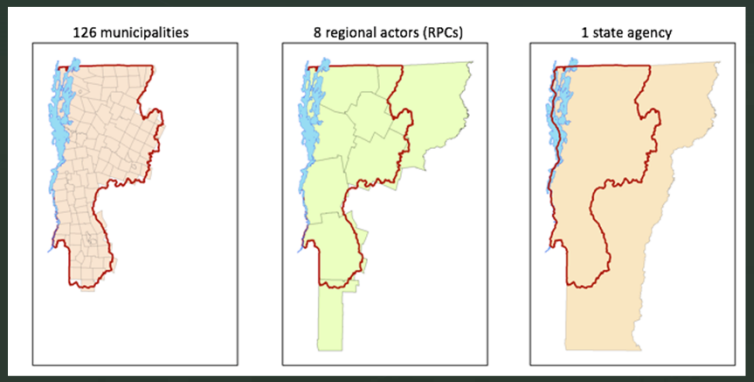
- Develop and implement management techniques for phosphorus in Missisquoi Bay sediment,
- Support programs that enhance river geomorphic function and reduce river bank erosion, and
- **Consider in-lake and in-river solutions that reduce the bioavailability of legacy phosphorus.**

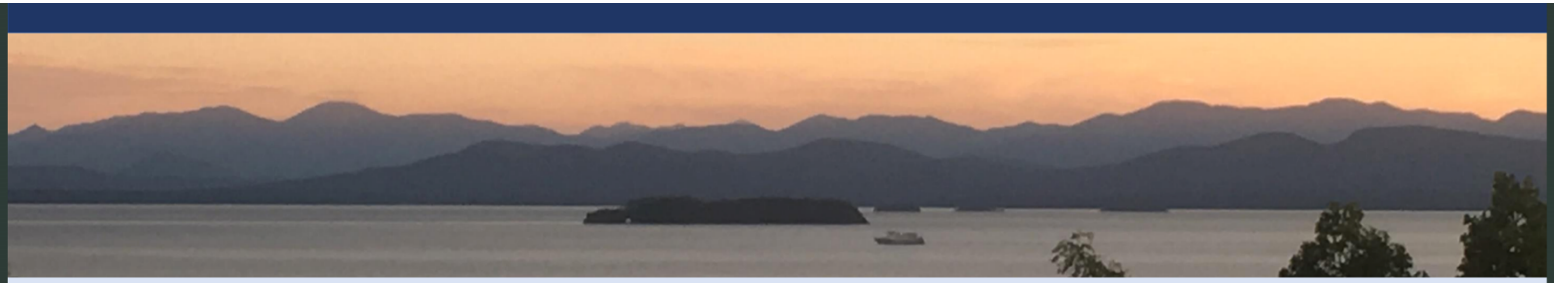


6. Examine and optimize the current system for regulation and distribution of clean water funding

- When possible, harmonize regulations and policies among jurisdictions across the watershed, and
- Carefully consider the efficiency of the current system for distributing federal, state, and other funds to nutrient reduction programs, specifically:
  - Determine whether the current staffing levels and organization at state, federal, and municipal agencies is optimally effective,
  - Increase funding for nutrient-reduction research applicable to the Lake Champlain Basin, and
  - **Consider relatively high cost pilot projects that may yield high phosphorus reductions per dollar invested.**

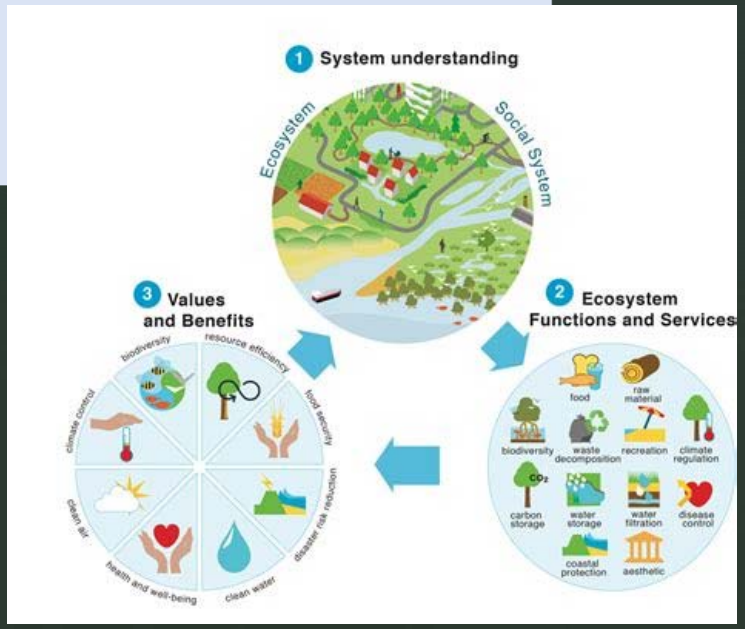






5. Prioritize nature-based solutions to reduce nutrient pollution

- **Increase the protection, enhancement, and reconnection of natural nutrient storage in floodplains and wetlands.**



Preliminary recommendations - QCCSAG

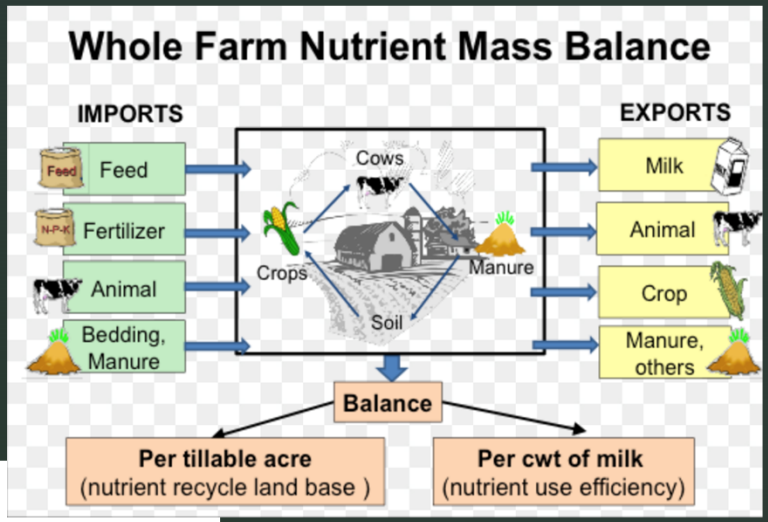
1 - Establish a dedicated, bi-national Task Force on Missisquoi Bay

- Task is to develop and implement plan to reach joint phosphorus reduction targets
- Long-term financing from Federal and Provincial/State levels
- «Special Status» for Missisquoi Bay to allow flexibility and innovation ?
  - Programs
  - Incentives
  - Regulation
- Composed of experts, government representatives and stakeholders from the watershed
- Includes a strong outreach component to inform and educate the population

Preliminary recommendations - QCCSAG

4 - Harmonize Water Quality Monitoring Programs

- There is a significant difference in estimated phosphorus loads by Vermont and Québec
- Water Quality Monitoring Program procedures (sampling) and reporting (streambank erosion ?) should be harmonized to avoid confusion



Knowledge gap

5 - Design a Cross-border Phosphorus Mass Balance Model

- Develop a Cross-border Model for phosphorus sources for the entire Watershed using the same methodology and include a complete mass balance of all phosphorus inputs and outputs
- The Model could make possible the development of reduction scenarios for the entire territory and to make cost-benefit analysis

7. Acknowledge and encourage the importance of watershed-scale collaboration, education, and outreach

- Encourage stakeholder engagement and commitment toward clean water and healthy ecosystems,
- Expand water quality education and outreach in the Basin, particularly to underserved communities and groups, and
- **Acknowledge the importance of watershed-scale cooperation, and facilitate collaborative opportunities between potential partners, including the United States and Canada, Vermont, New York, and Québec, and between local municipalities and watershed groups.**

THE CHAMPLAIN SEVEN-DIGGER-TIMES INDEPENDENT DAILY

Your only remaining consolidated news source for Lake Champlain Valley

FREE WEEKLY NEWS PRESS .NET

$10

All proceeds to rescuing Elon Musk from Mars
Bring him home!

Today: mostly sunny 81/58, Tomorrow: snow flurries 34/22

May 24, 2040

Population Increases Brings Problems for Water Quality

Write your headline here

1. Does the conceptual map need to change to fit your storyline? If so, how?	2. What are the primary factors that led to your storyline?	*Construction of Winooski dome remains on schedule despite tragic accident* ~~~~~~~~~~~~~~~~~~~~~~~~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~

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Like Champ Cyanobacteria is a Rare Sighting

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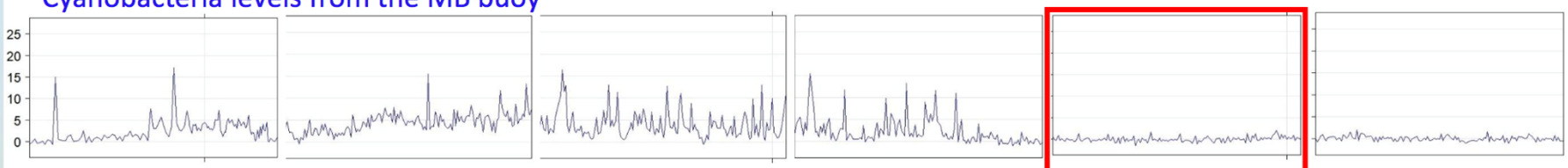
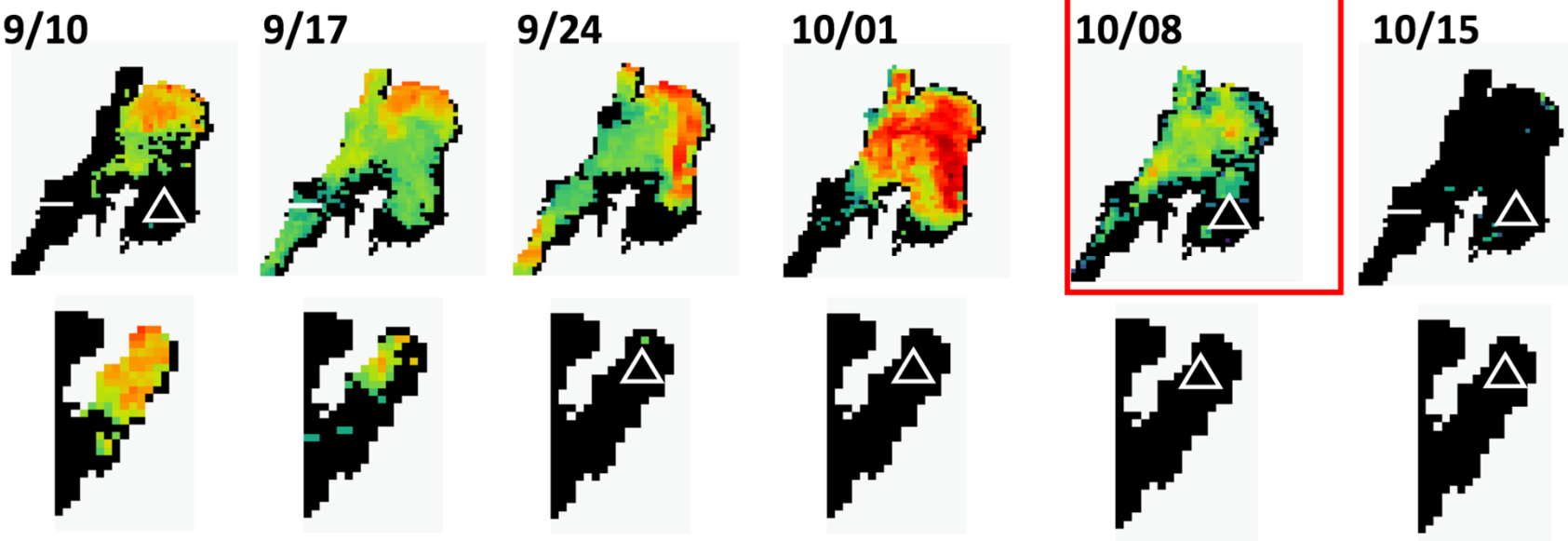
May 24, 2040

”Lake Champlain Becomes the Next Lake Erie?”

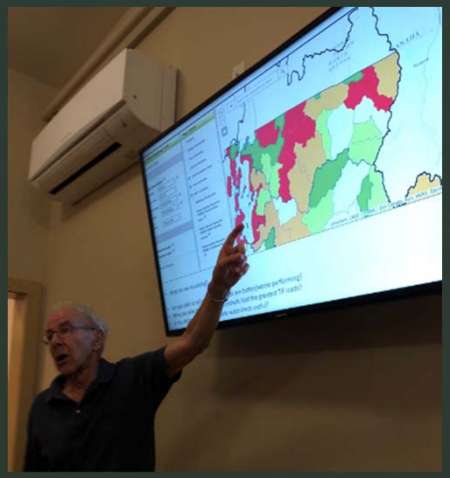
2017 bloom was late and persisted into October in MB but shut down late September in St. AB

Cyanobacteria levels from the MB buoy





Citizen Advisory Committees use of decision support tools



September 2018,
focus group

Major Policy Impacts for BREE (Thus far)…

- Placing legacy nutrients and internal loading impacts the HAB problems in shallow bays…
- Ensuring that climate change impacts of extreme events are considered in future mitigation measures…
- Highlighting the importance of interjurisdictional coordination for planning and implementation of clean water projects…
- Integration of satellite imagery into early warning systems…

Overarching Research Question for Social Systems:

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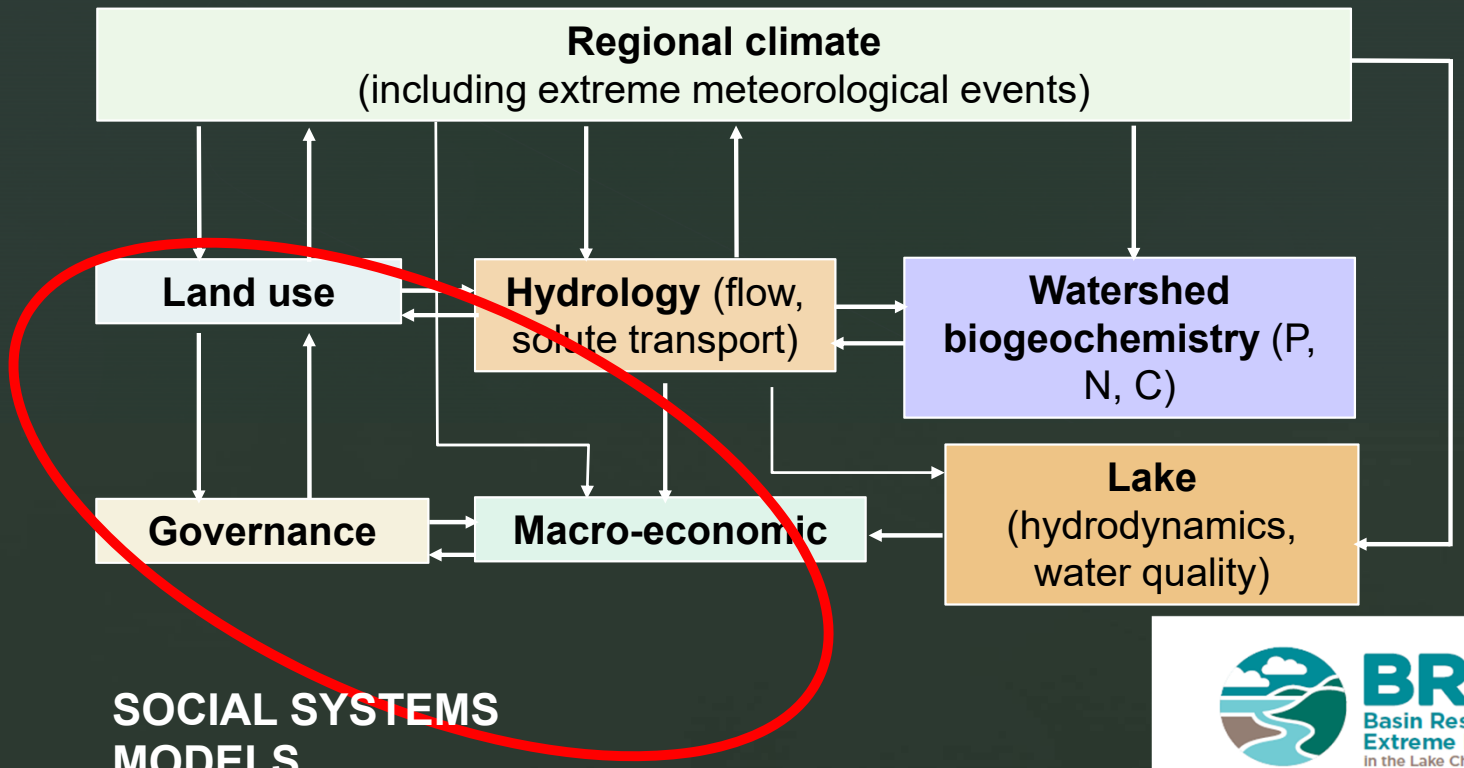
Major Features of the BREE Integrated Assessment Model



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BREE Social Systems Key Concepts:

- **Agents**
  - LAND USERS: farmers, urban residents, rural/forest land owners,
  - GOVERNANCE ACTORS: town managers, watershed managers, policy makers, governments, nonprofits, firms
  - ECONOMIC ACTORS: consumers, owners…
- Agent **rules & behaviors**
  - Rational -> boundedly rational-> non-rational
- Agent **ties**
  - to each other
  - to the land
  - to markets

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in the Lake Champlain Basin

Economic model

Beneficial to water quality

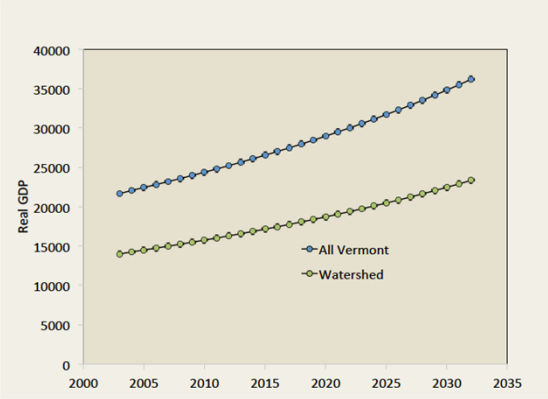


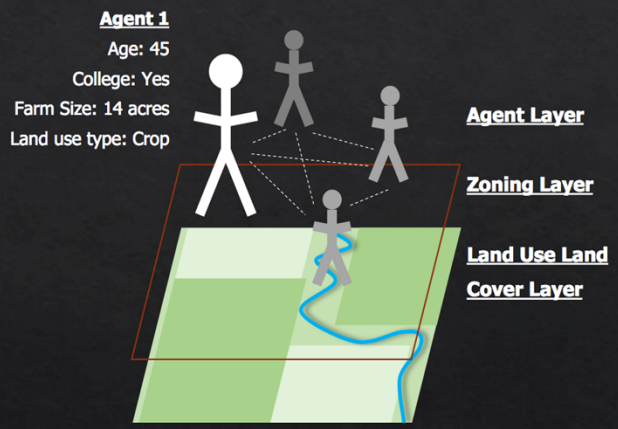
Table: Change in mean P^1 loading and GDP

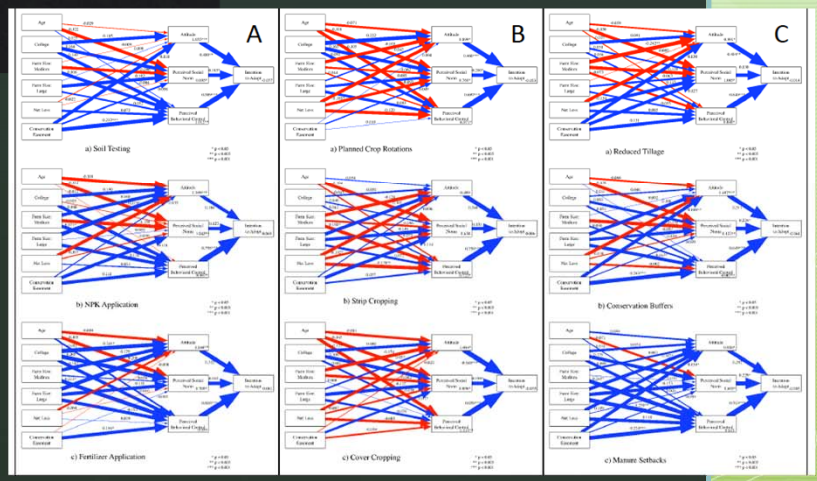
Tax	Mean P	GDP
1	-0.00002	0
3	-0.00006	0
25	-0.00460	0
100	-0.01780	0

Notes: 1. Percent. All improvements fall over time.

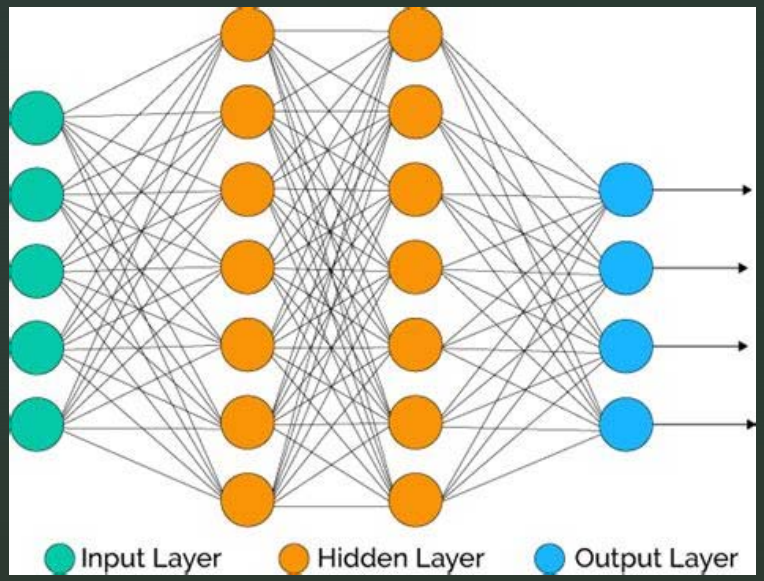
Land and Watershed

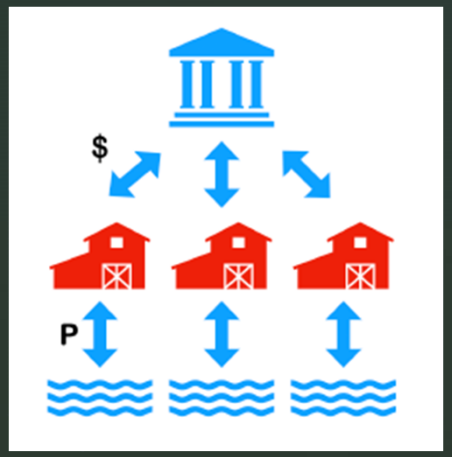
- Land owner nutrient best management practice adoption and motivation to adopt
  - Farmer, forester, residential, business, municipality
- Zoning regulations and maps
- Land Cover digital maps
  - 30m resolution, 16+ landuse classifications
  - In US: National Land Cover Database





Building the Deep Learning Capacity of Agents





THE MICRO / MACRO

CHALLENGE OF THE GOVERNANCE OF

COLLECTIVE RISK IN SOCIAL ECOLOGICAL SYSTEMS

- ***KEY CHALLENGE: To understand the relationship that individual human behavior at the micro scale has to the development of aggregated patterns at the macro scale of larger systems-level phenomena.***

- ***KEY OPPORTUNITY: The more aware that individual and institutional social actors are of the collective consequences of their actions, the more likely they are to behave in ways that protect the security of collective interests.***

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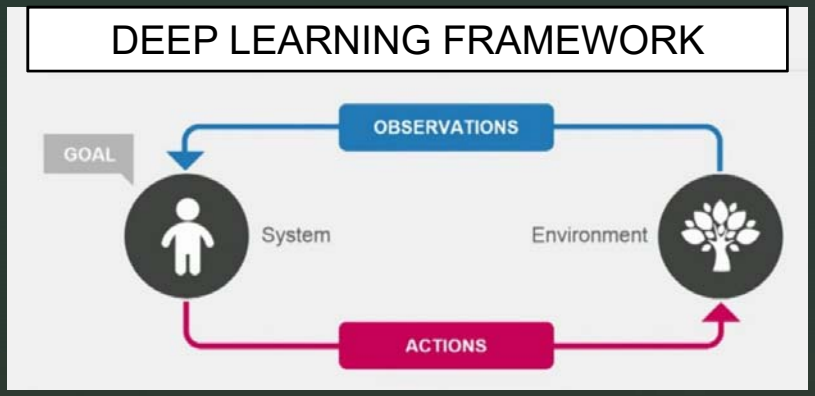
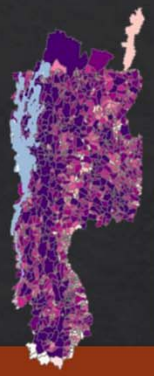
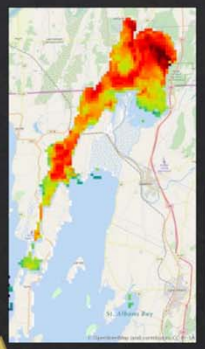


http://visteon.bg/2017/03/02/machine-learning-algorithms-autonomous-cars/



TP loads/targets

HABs



Problem(s) & objective(s)

Actors

Municipalities

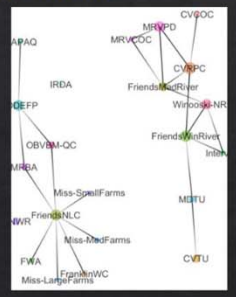
USDA

VERMONT AGENCY OF NATURAL RESOURCES

Regional water districts

Governance actors, capacity ($), policy tools, and network structure(s)

Networks



Governance

- CA/QC water quality regulations
- Programs, budgets, incentive spending, education, technical assistance
- Climate change/environmental quality beliefs
- TP & N estimates
- Agricultural productivity and profitability

Governance ABM (GovNET)

Multi-dimensional policy evaluation, prioritization, & decision-making