An adaptive agent-based model of network governance

BREE all-hands 2018-06-12

Patrick Bitterman
Postdoctoral Associate, Vermont EPSCoR
Postdoctoral Fellow, Gund Institute for Environment

patrick.bitterman@uvm.edu
www.patrickbitterman.com
@pjbitterman

Driving questions

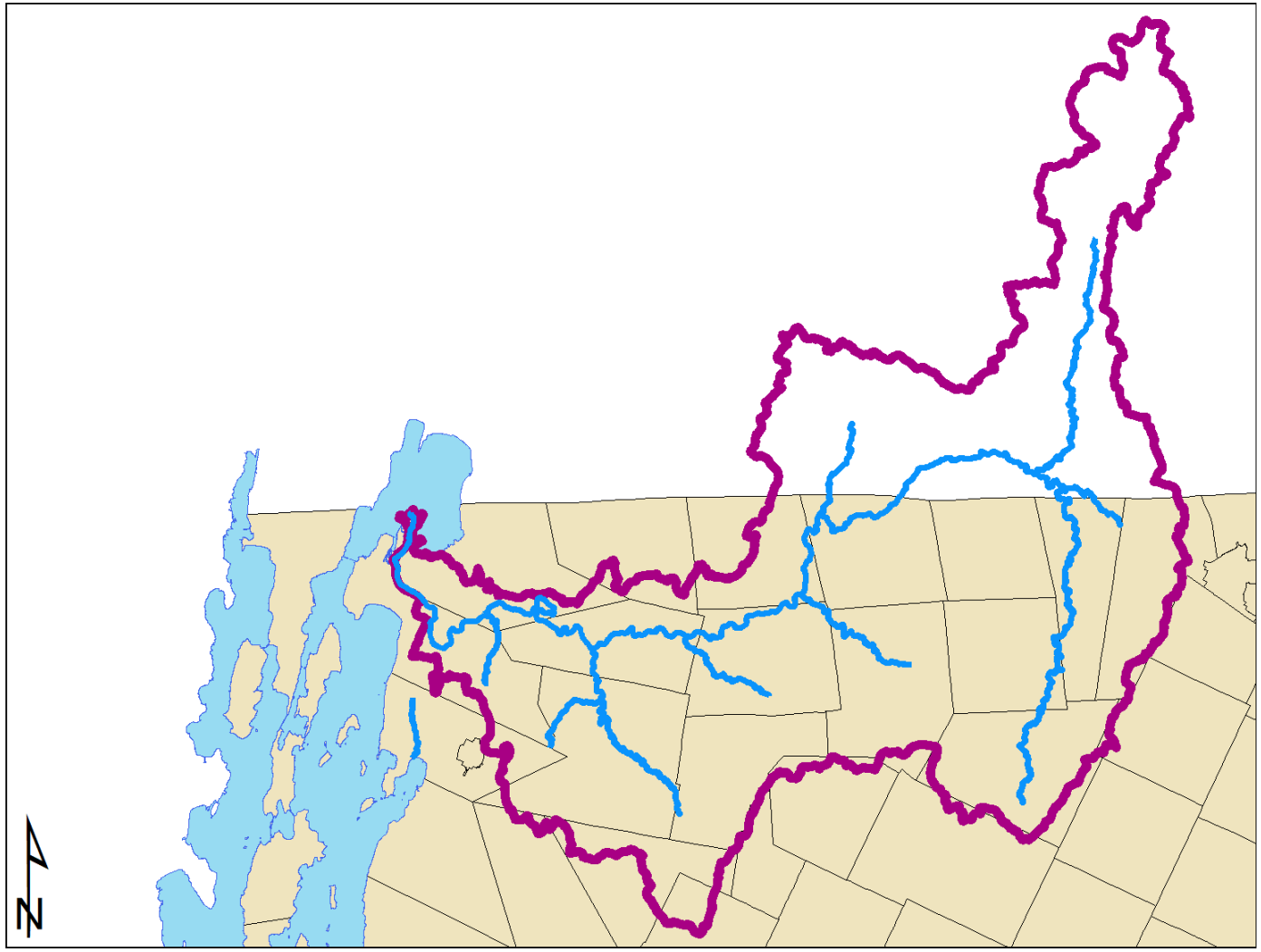
1. How does the structure of governance networks & institutional rules affect adaptability & resilience?

2. How do governance processes respond to environmental change that may be uncertain, slow, or smaller than expected?

3. What if…
   - *alternative rules/regulations were put in place?*
   - *we increased the capacity of local organizations?*
   - *we altered funding structures?*
   - *aligned spatial and temporal lags between social and environmental processes?*

Modeling challenges

- spatial and temporal lags and mismatches
  - admin./env. units
  - cause and effect
  - expectations and env. processes
- social actors manage both social and environmental systems
- diverse set of social actors and processes at various scales



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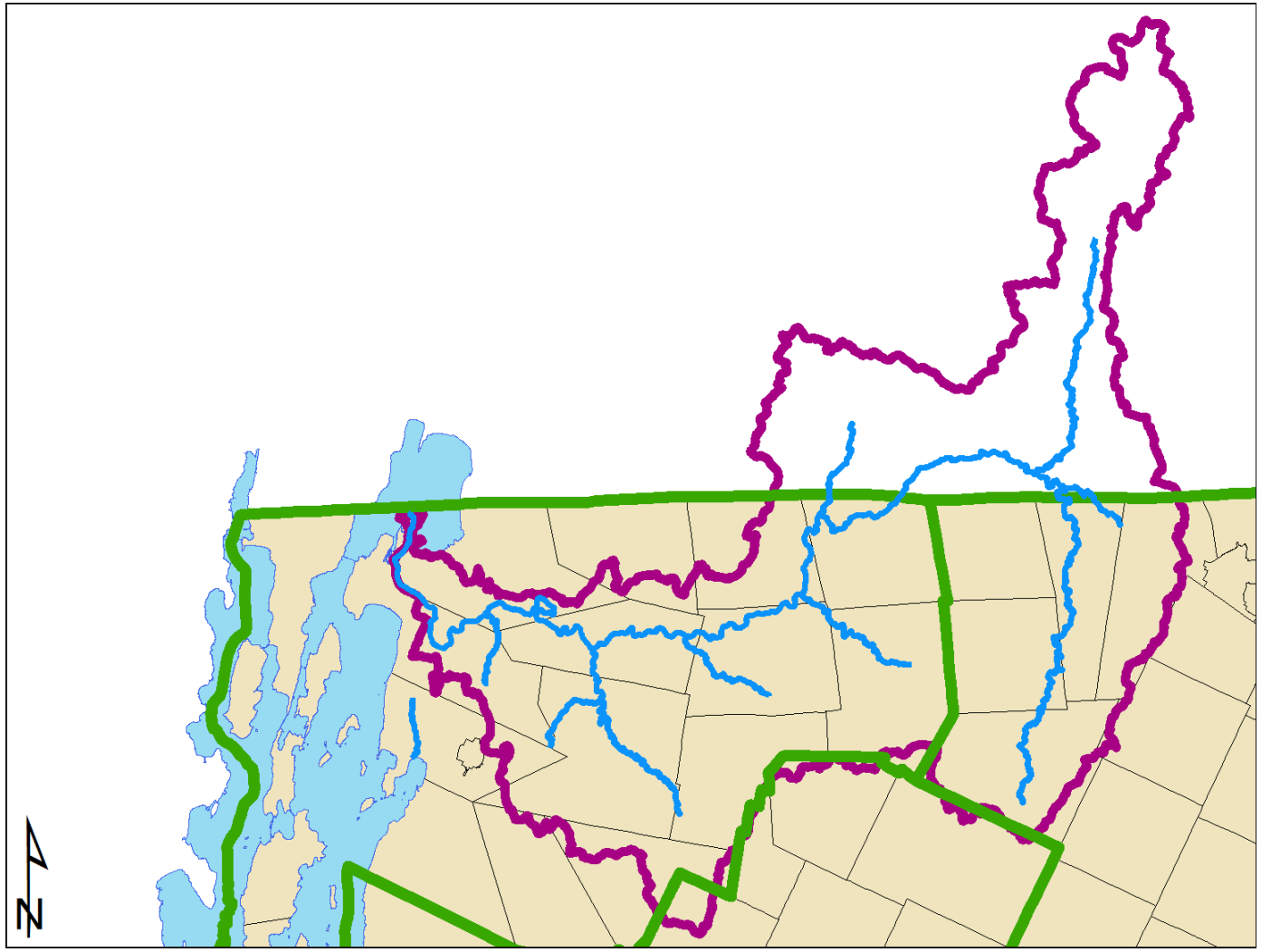

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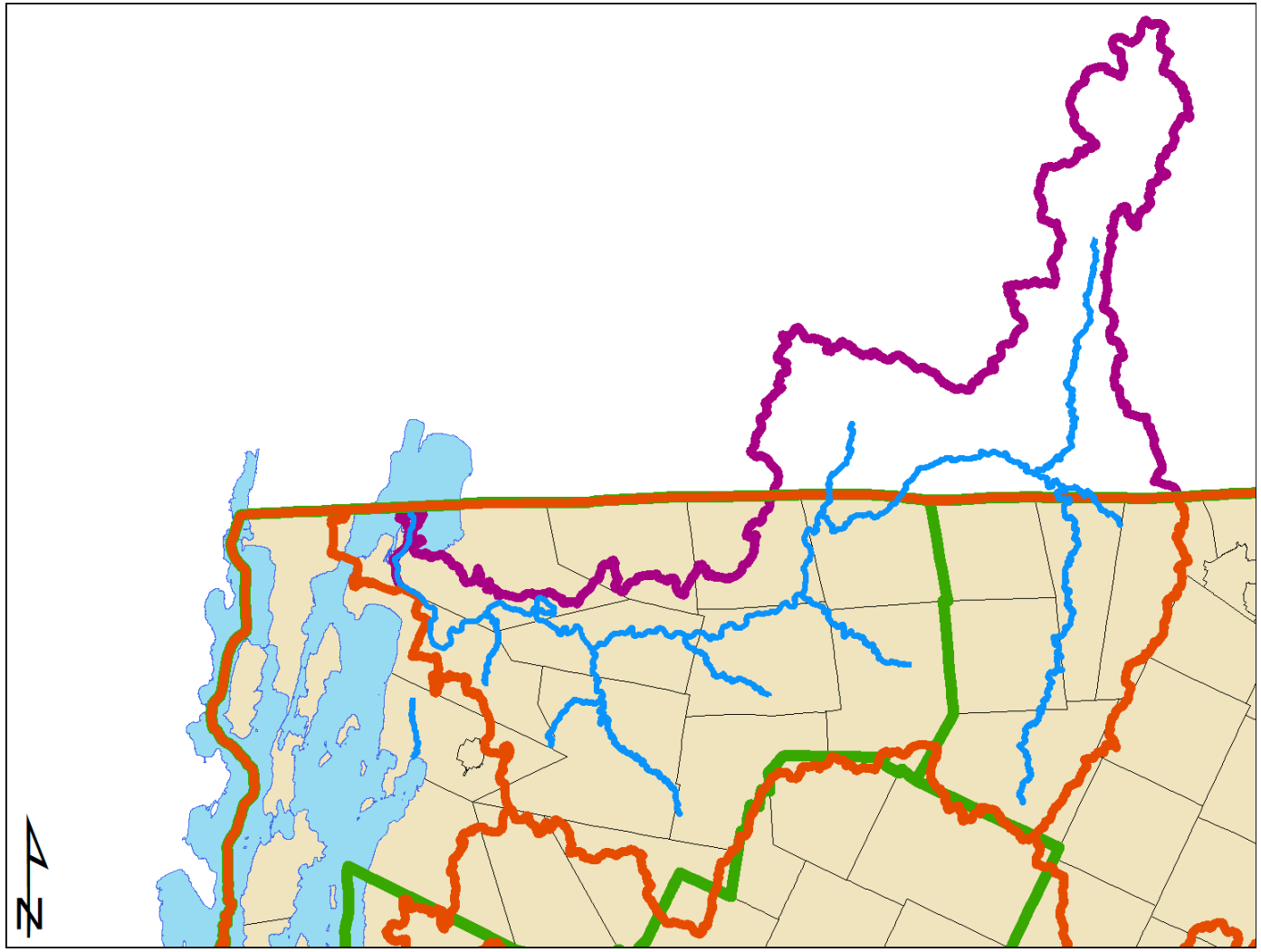
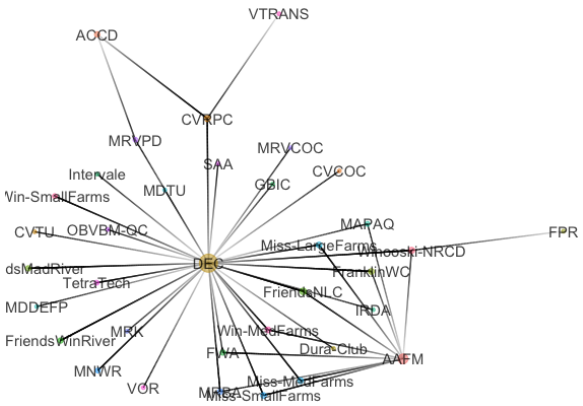


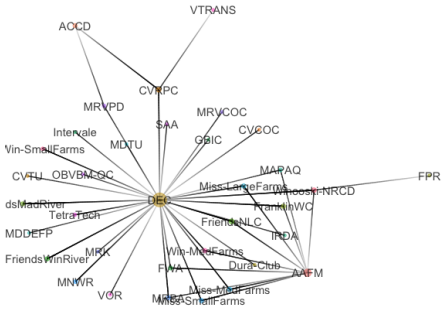
+ NY, QC, state, federal

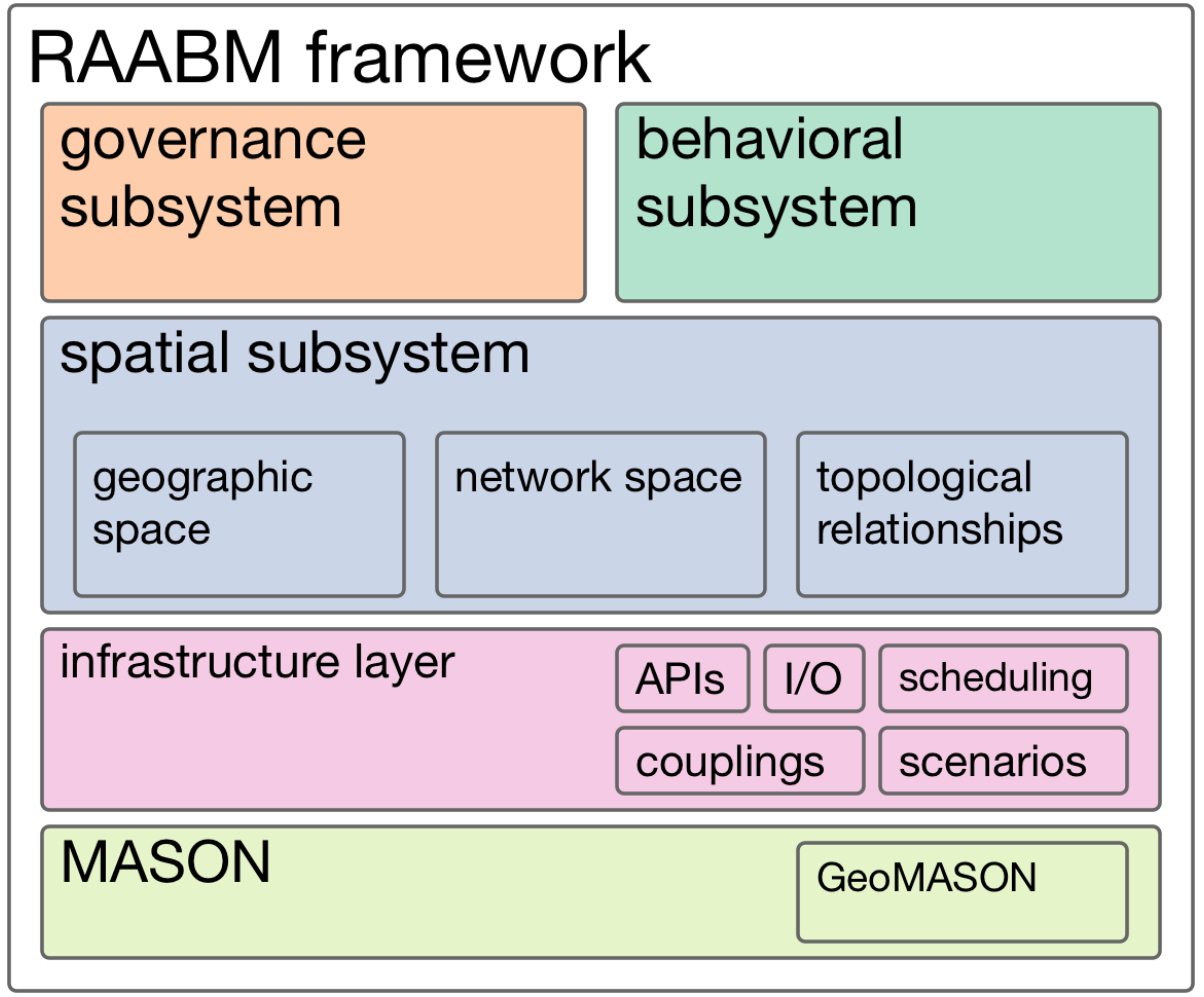


The Resilience & Adaptability Agent-Based Modeling Framework (RAABM)

Policy tools with:
- objectives
- targets
- conditions
- delivery system
- evaluation

SpatialFeature “Missisquoi Bay”





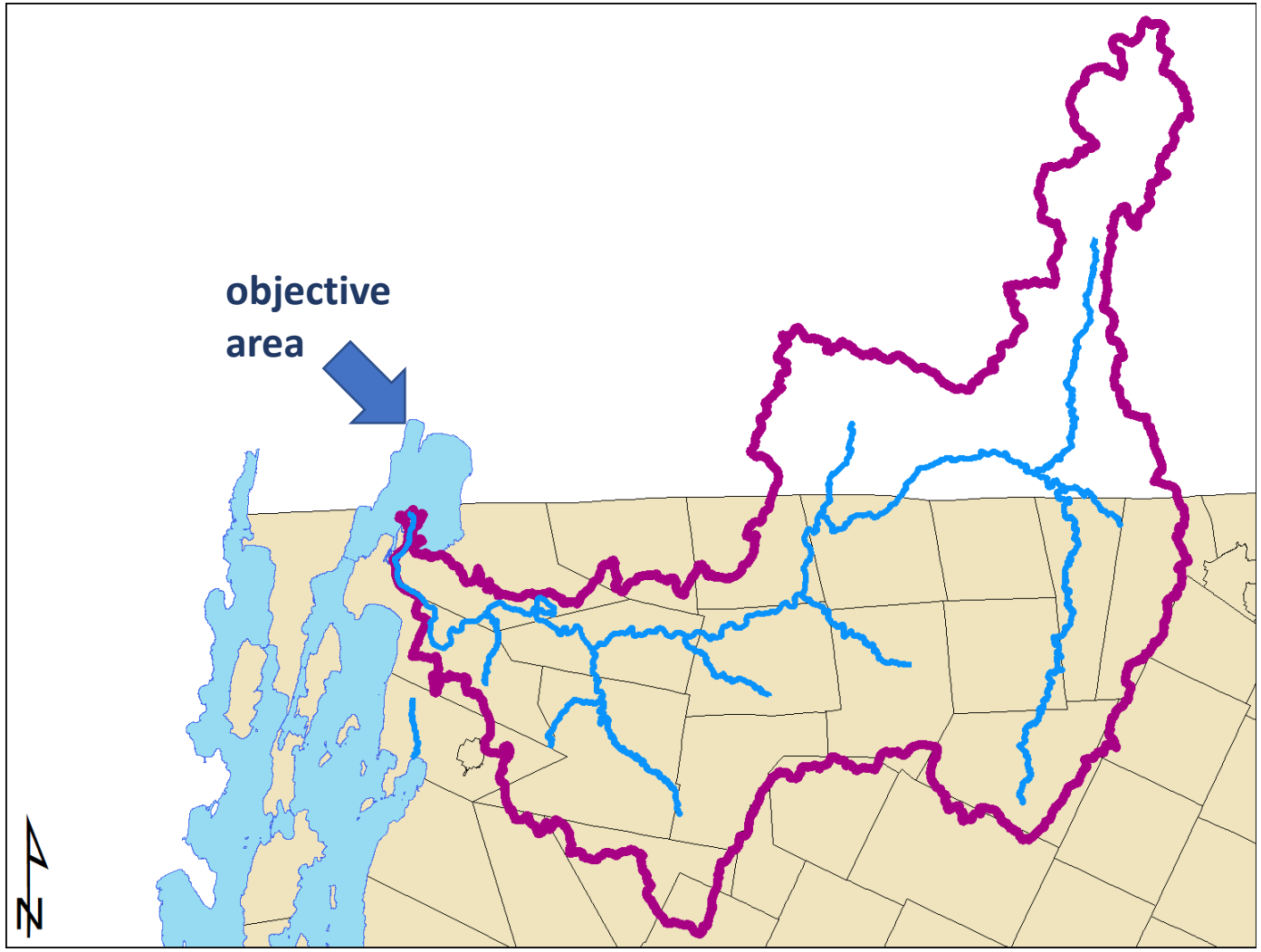
- alternative strategies
- learning
- knowledge diffusion

relationship.inside(Lake Champlain)
relationship.endpoint(Missisquoi River)
relationship.outlet(Missisquoi Watershed)

- diverse agent population
- scales to large n
- efficient
- interactive

What does the framework enable?

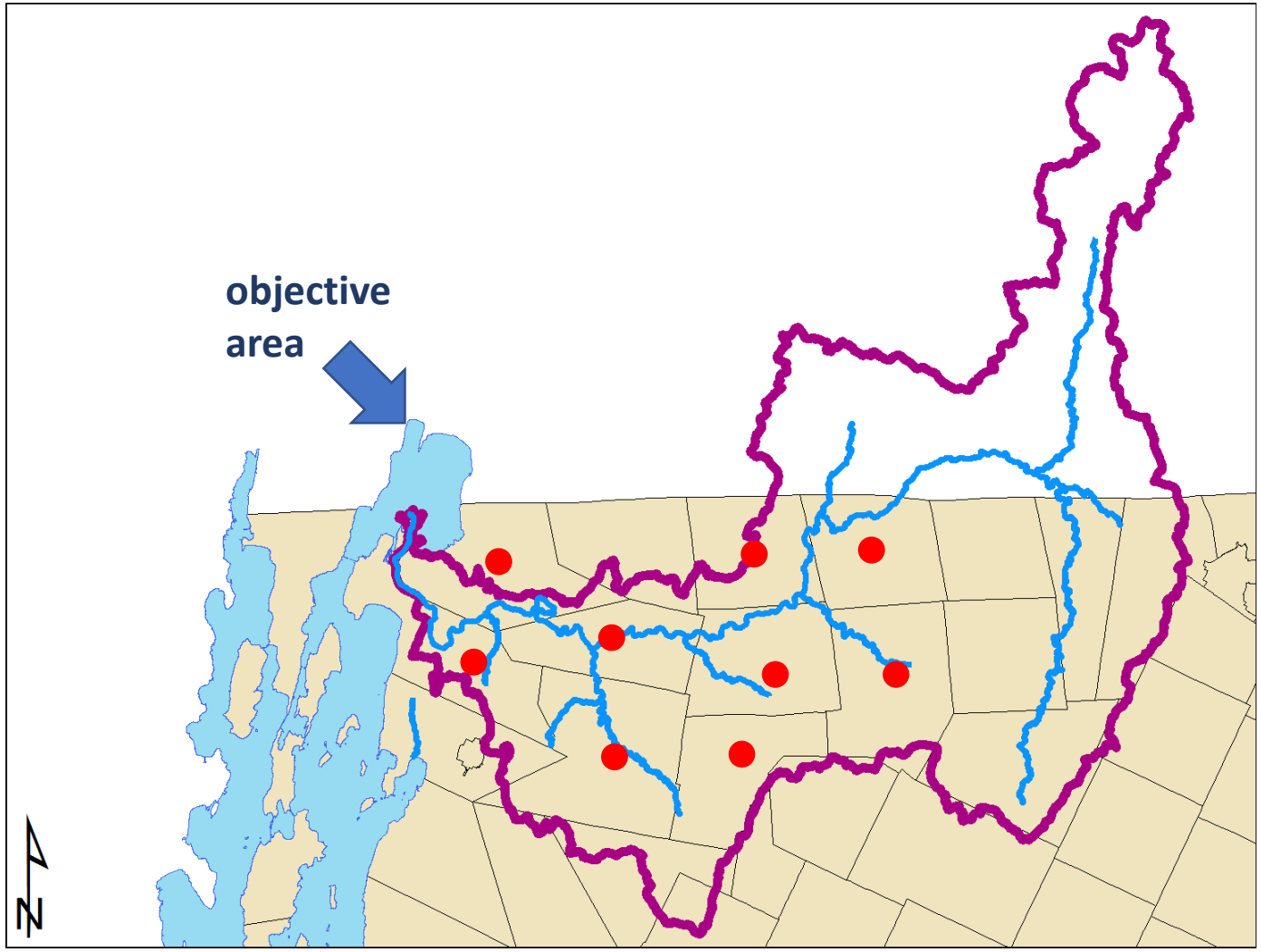
1. identify objective and objective area



What does the framework enable?

1. identify objective and objective area

2. identify eligible agents

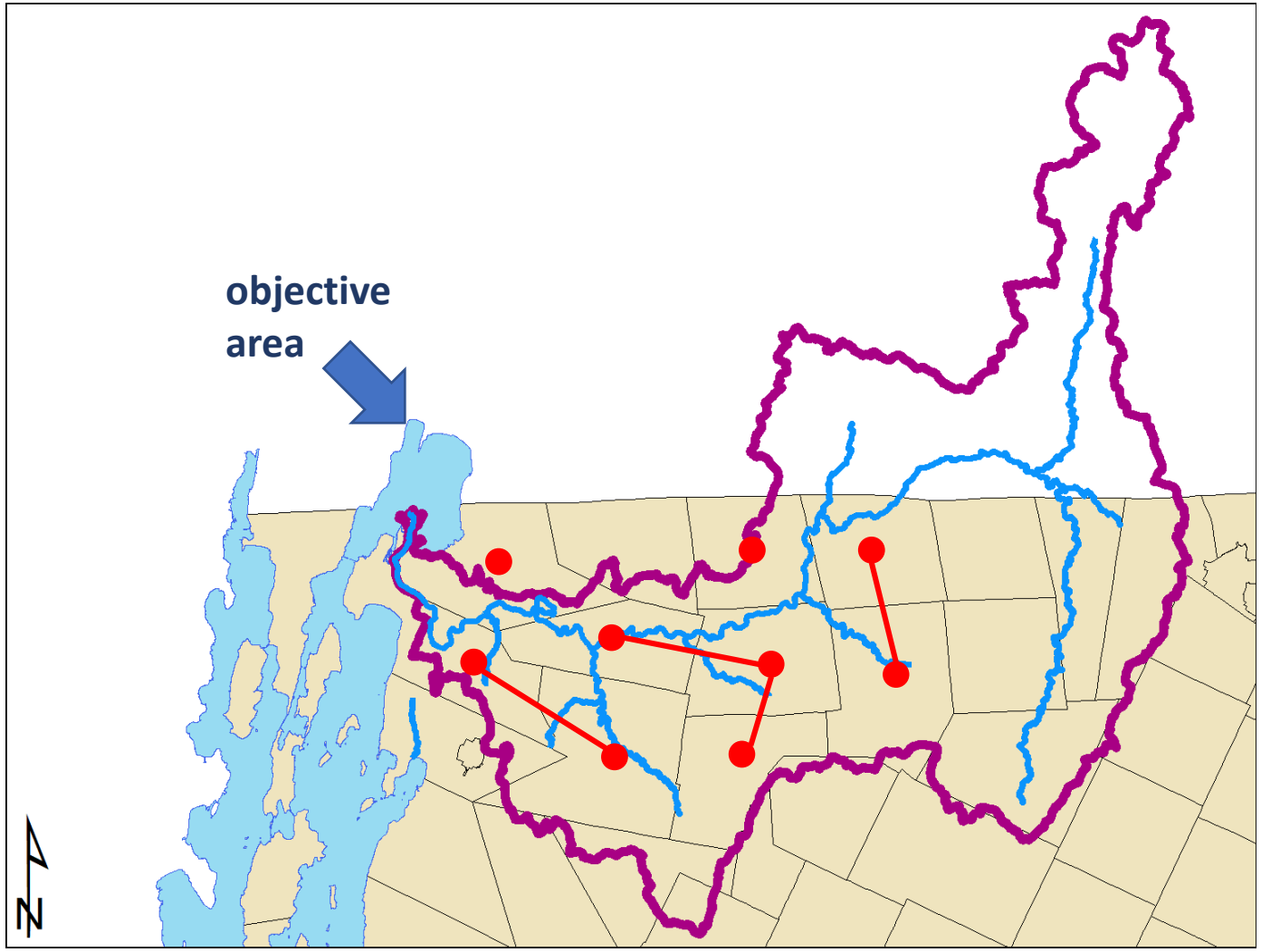


What does the framework enable?

1. identify objective and objective area

2. identify eligible agents

3. model agent-agent and agent-environment relationships



What does the framework enable?

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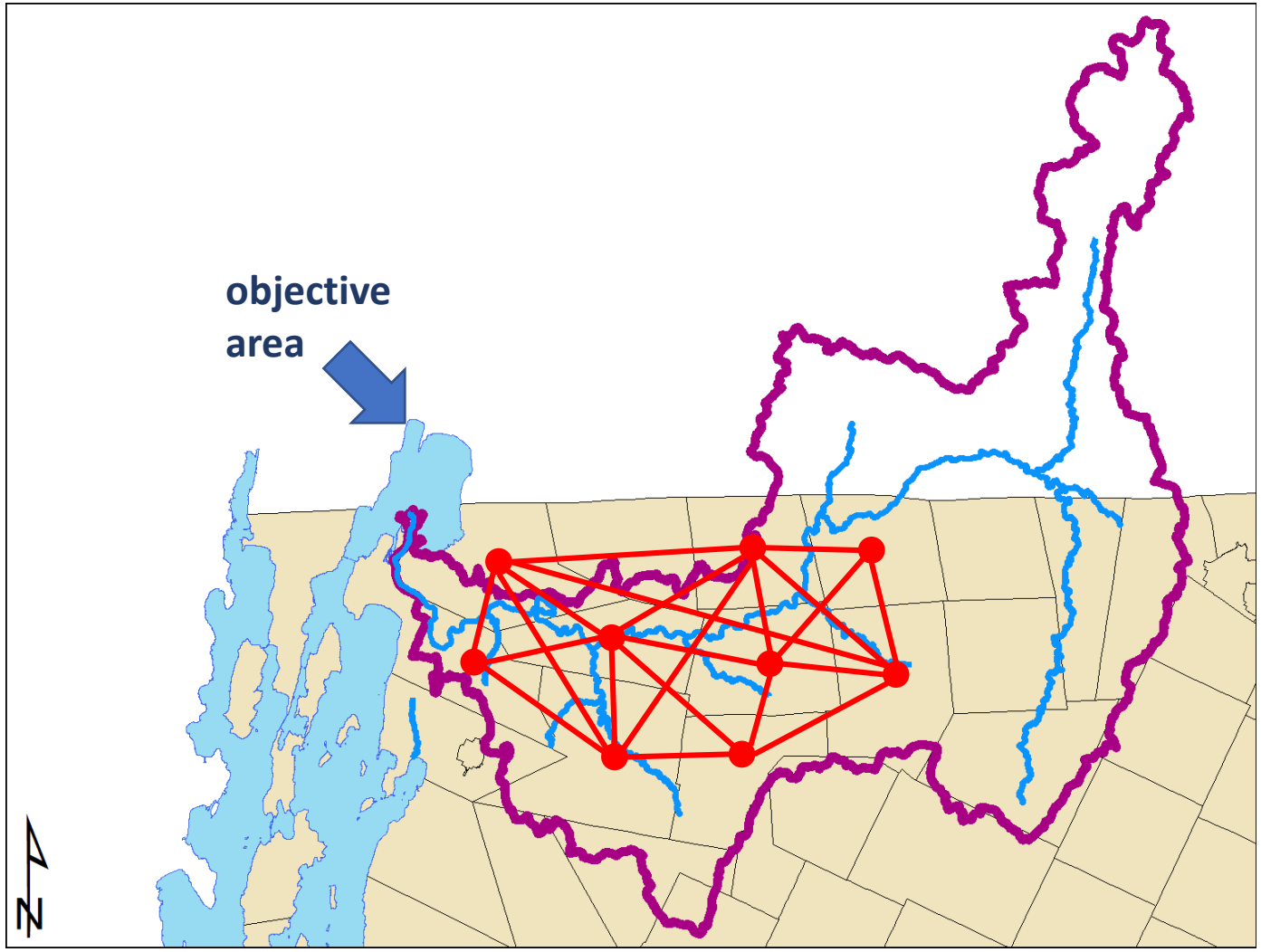
3. model agent-agent and agent-environment relationships

4. model alternative relationships created by new policy tools



What does the framework enable?

1. identify objective and objective area

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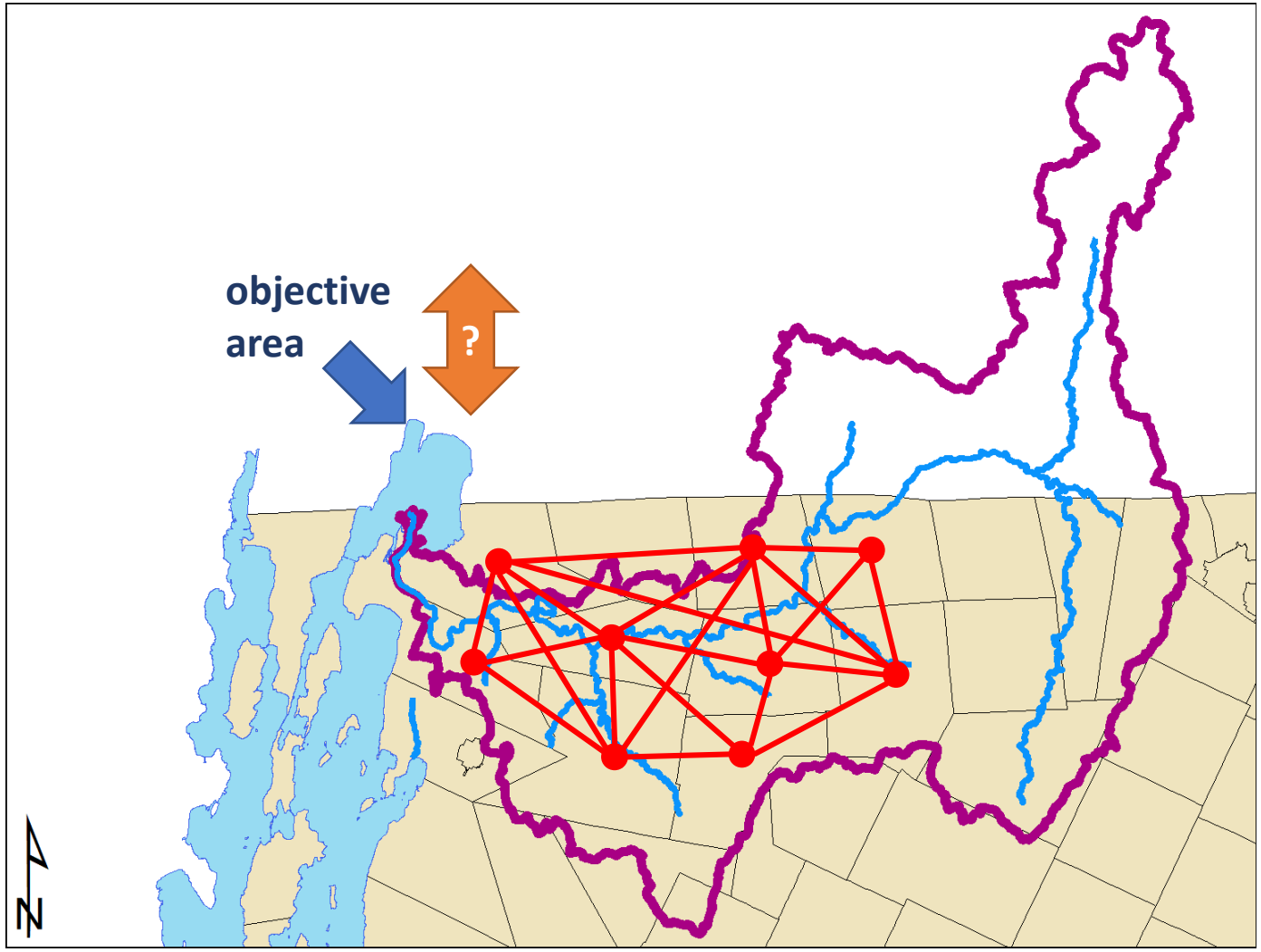
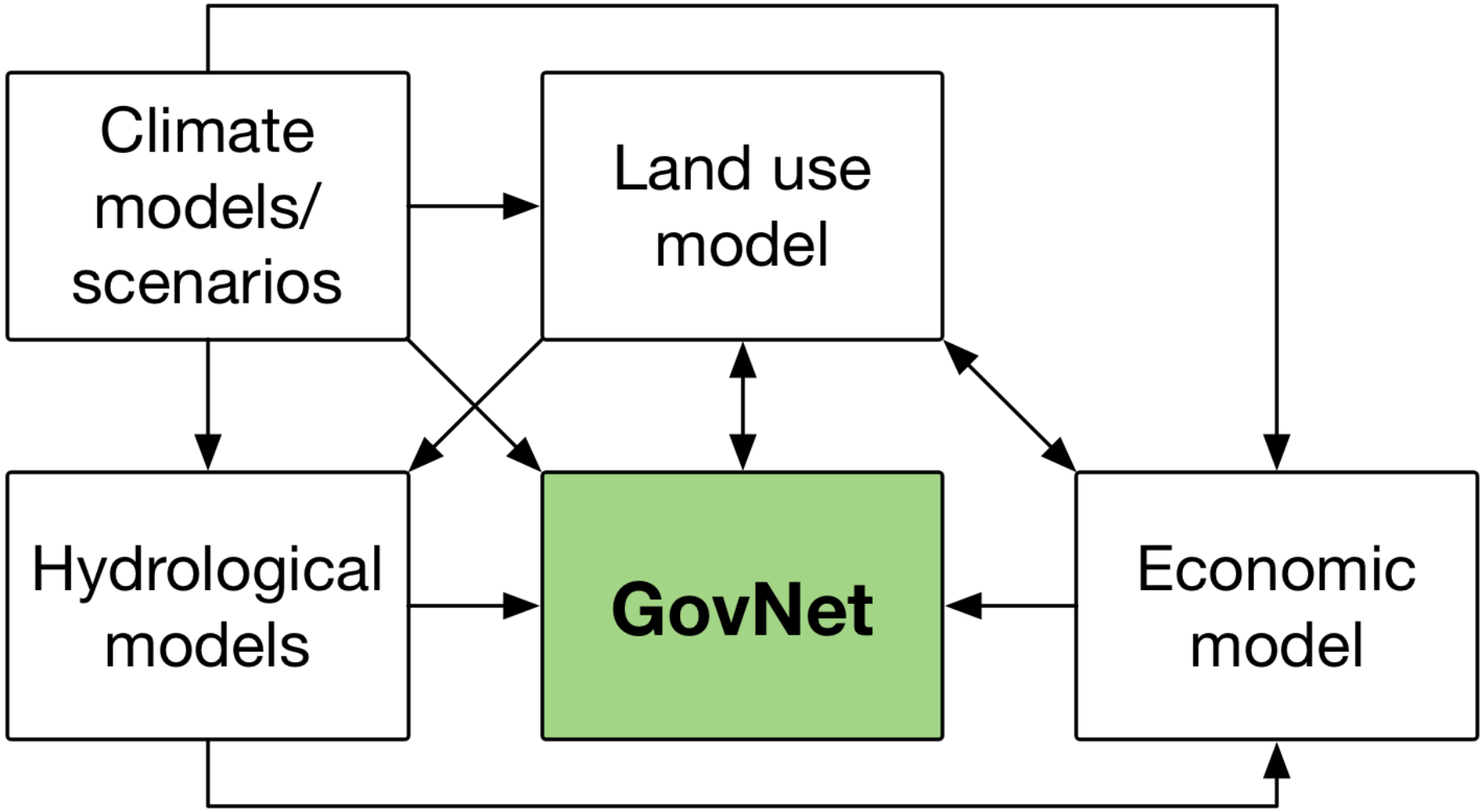
3. model agent-agent and agent-environment relationships

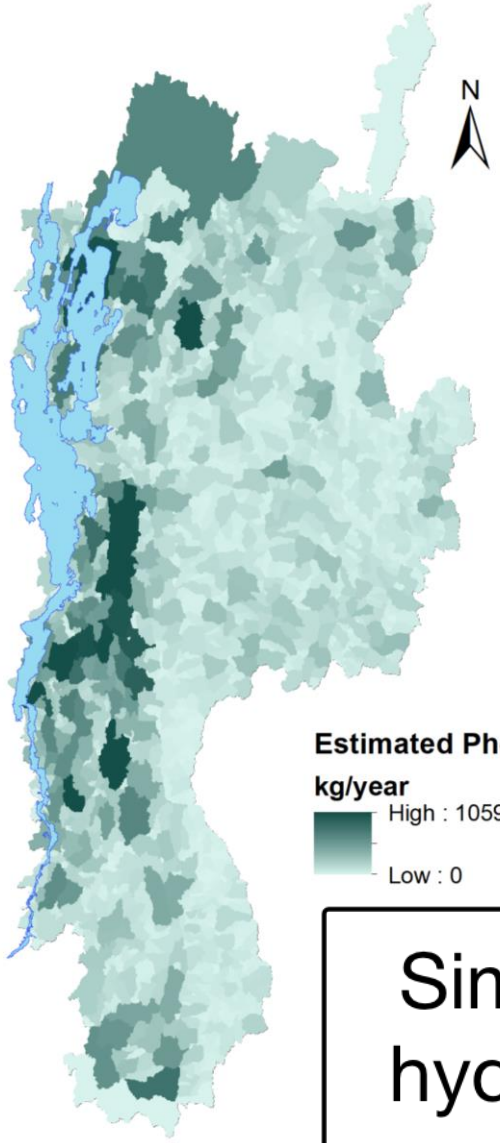
4. model alternative relationships created by new policy tools

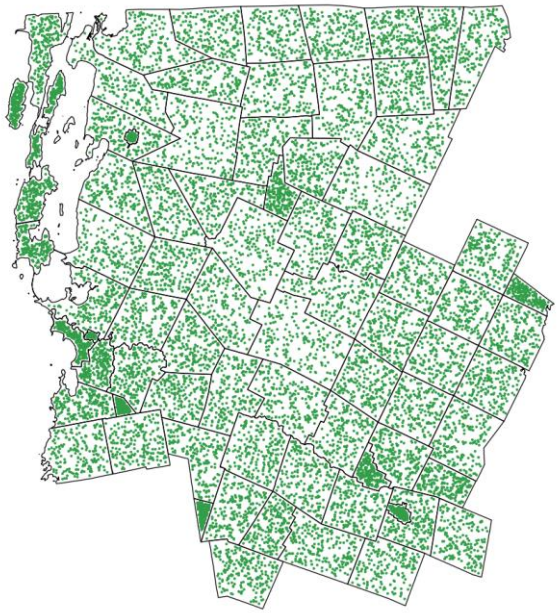
5. model environmental impact



A view of the IAM







Stormwater projects

Simplified hydrologic model

GovNet

Four governance agent types

Municipalities (78)

- Plan projects in their jurisdiction
- Cooperate or compete for project funding
- Implement (build) local projects

State agency

- Evaluate/grade planned projects
- Allocate funding to projects

Regional actors (5)

- Facilitate muni cooperation
- Lend supplemental planning capacity
- Supplement project evaluation

Political (state)

- Allocate clean water $
- Evaluate water quality program
- Adjust (cut) clean water $

Alternative institutional rules (and scenarios)

Pure cooperation

- Regional actors facilitate cooperation among municipalities in their regions
- Municipalities pool resources
- State agent prioritizes reductions / $ at basin scale

Pure competition

- Municipalities compete for clean water funds
- State agent operates as FIFO with limited optimization

Competition with regional actors working at the margins and semi-independently

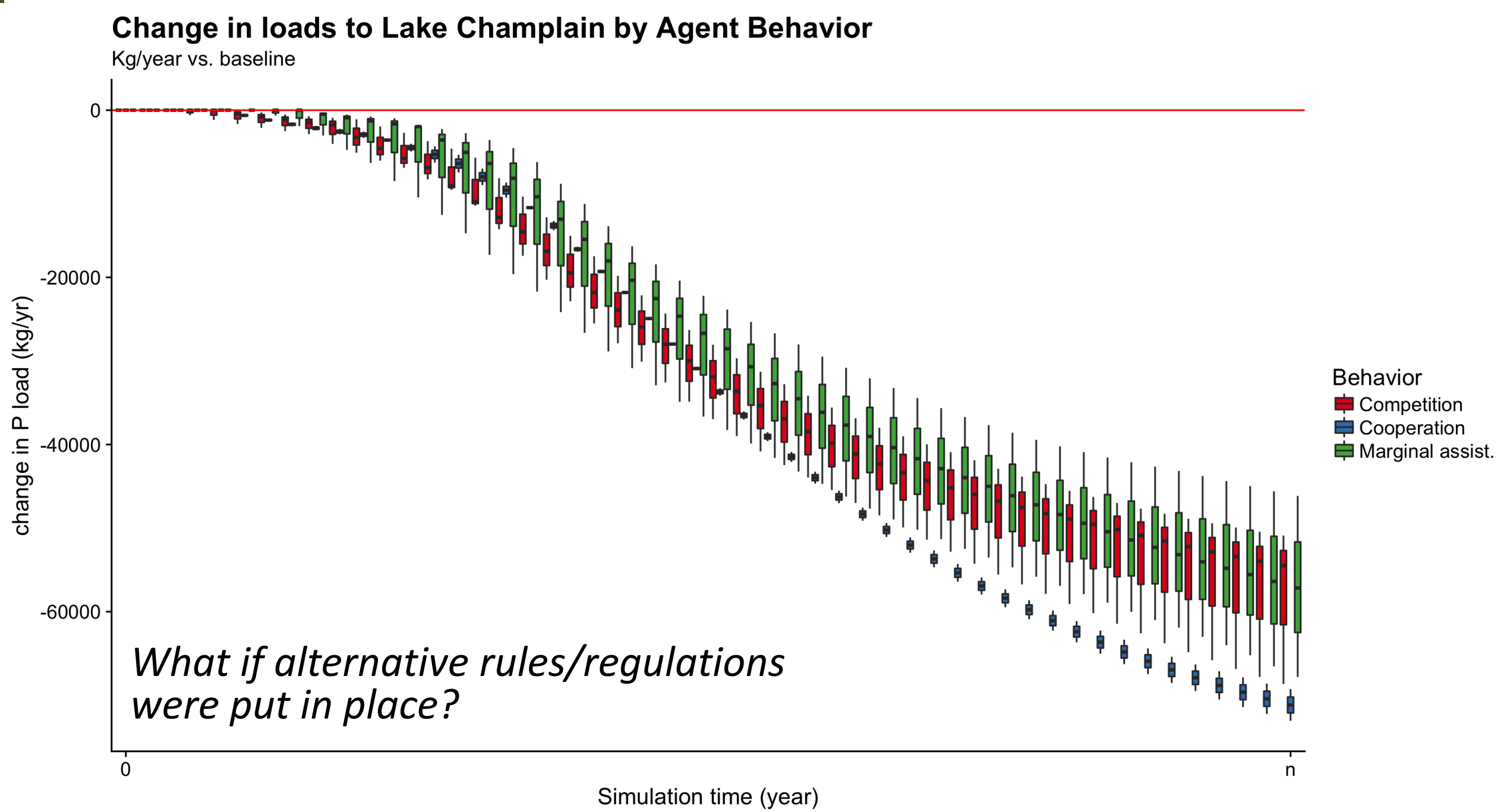
- Regional actors share their capacity to plan and evaluate
- State agent operates as FIFO within regional networks

Clean water $

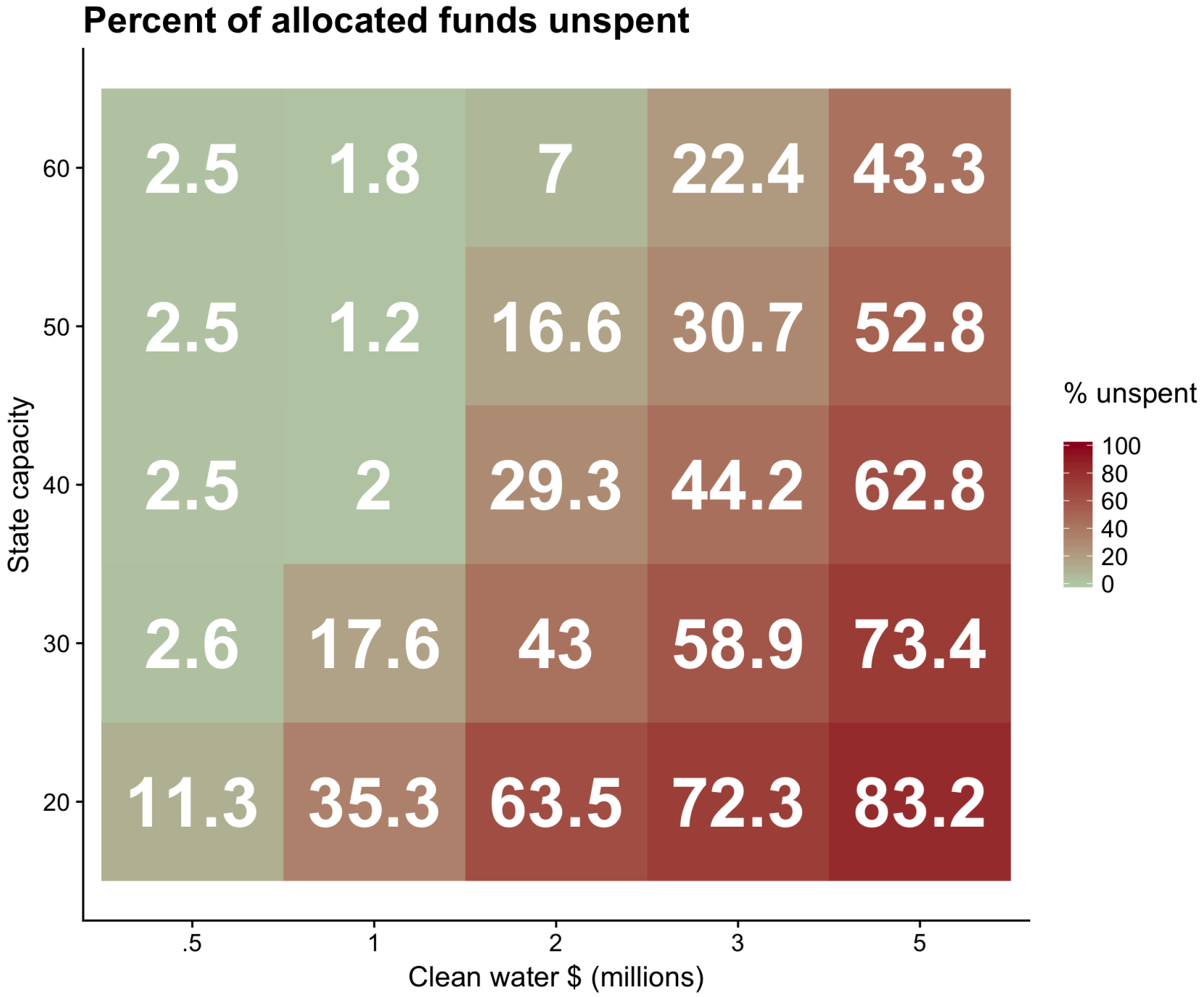
State agent capacity

Environmental lags

Frequency of project evaluation


Change in loads to Lake Champlain by Agent Behavior
Kg/year vs. baseline
0
-20000
-40000
-60000
change in P load (kg/yr)
0
n
Simulation time (year)
Behavior
Competition
Cooperation
Marginal assist.
What if alternative rules/regulations were put in place?

Without sufficient capacity, allocated funds can go unspent

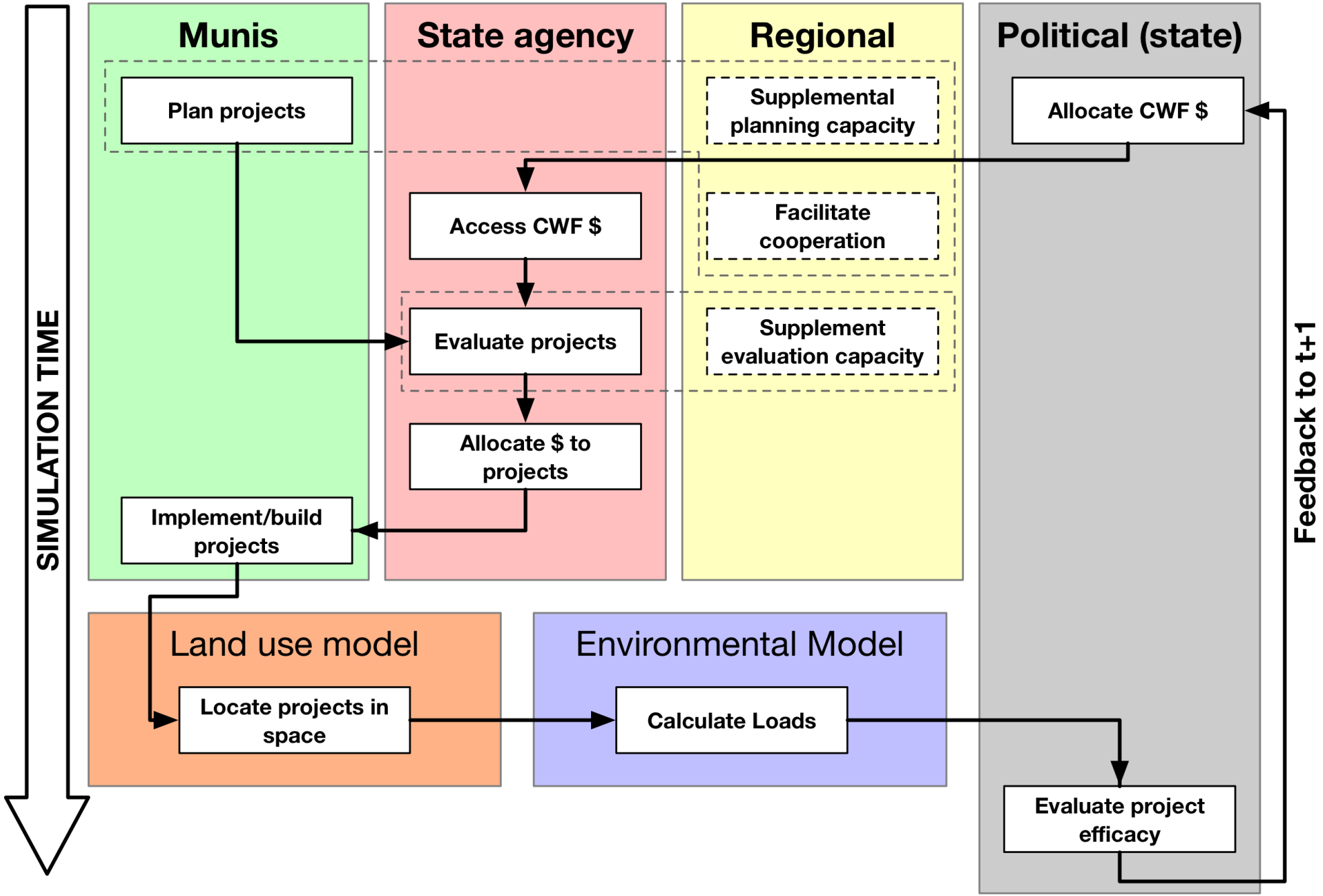


Conclusions and future work

- Developed a spatially-explicit S-E governance framework and model
- Modeling how changes to adaptability and resilience result from multiple, complex, and interacting processes
- Need adaptive institutions & policies to manage lags and mismatches

- Collecting data on resources, rules, and relationships
- Institutional network refinement via document analysis
- Further development of capacity & funding models (e.g., cost share)


Thank you


Munis
State agency
Regional
Political (state)
Plan projects
Supplemental planning capacity
Allocate CWF $
Access CWF $
Facilitate cooperation
Evaluate projects
Supplement evaluation capacity
Allocate $ to projects
Implement/build projects
SIMULATION TIME
Feedback to t+1
Land use model
Environmental Model
Locate projects in space
Calculate Loads
Evaluate project efficacy

Governance networks

"…interorganizational networks comprised of multiple actors, often spanning sectors and scale, working together to influence the creation, implementation, and monitoring of public policies." (Koliba et al. 2011)