

# An adaptive agent-based model of network governance

BREE PTAC Meeting  
2018-05-24

**Patrick Bitterman**

Postdoctoral Associate, Vermont EPSCoR

Postdoctoral Fellow, Gund Institute for Environment

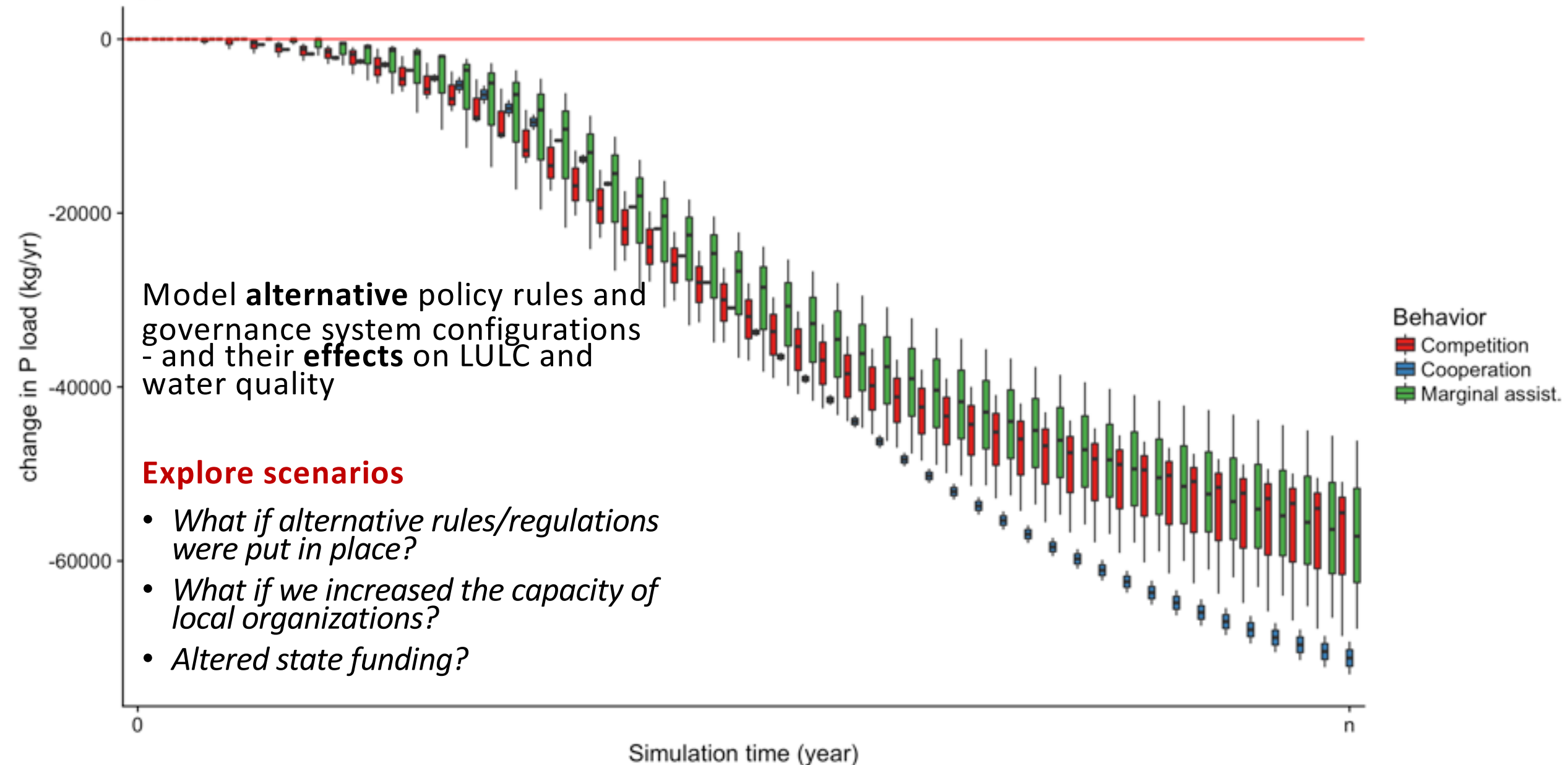
[patrick.bitterman@uvm.edu](mailto:patrick.bitterman@uvm.edu)

[www.patrickbitterman.com](http://www.patrickbitterman.com)

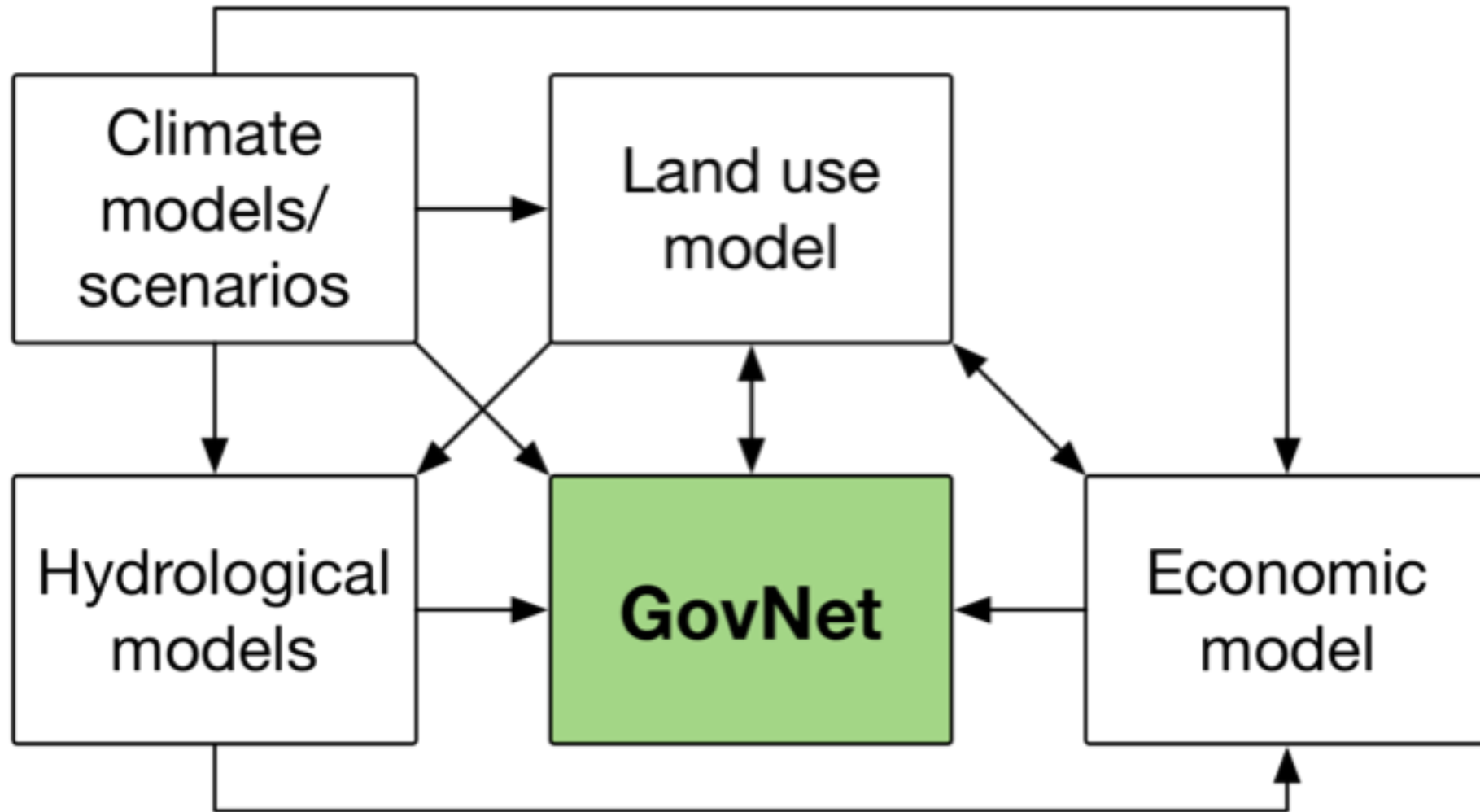
 @pjbitterman

# Change in loads to Lake Champlain by Agent Behavior

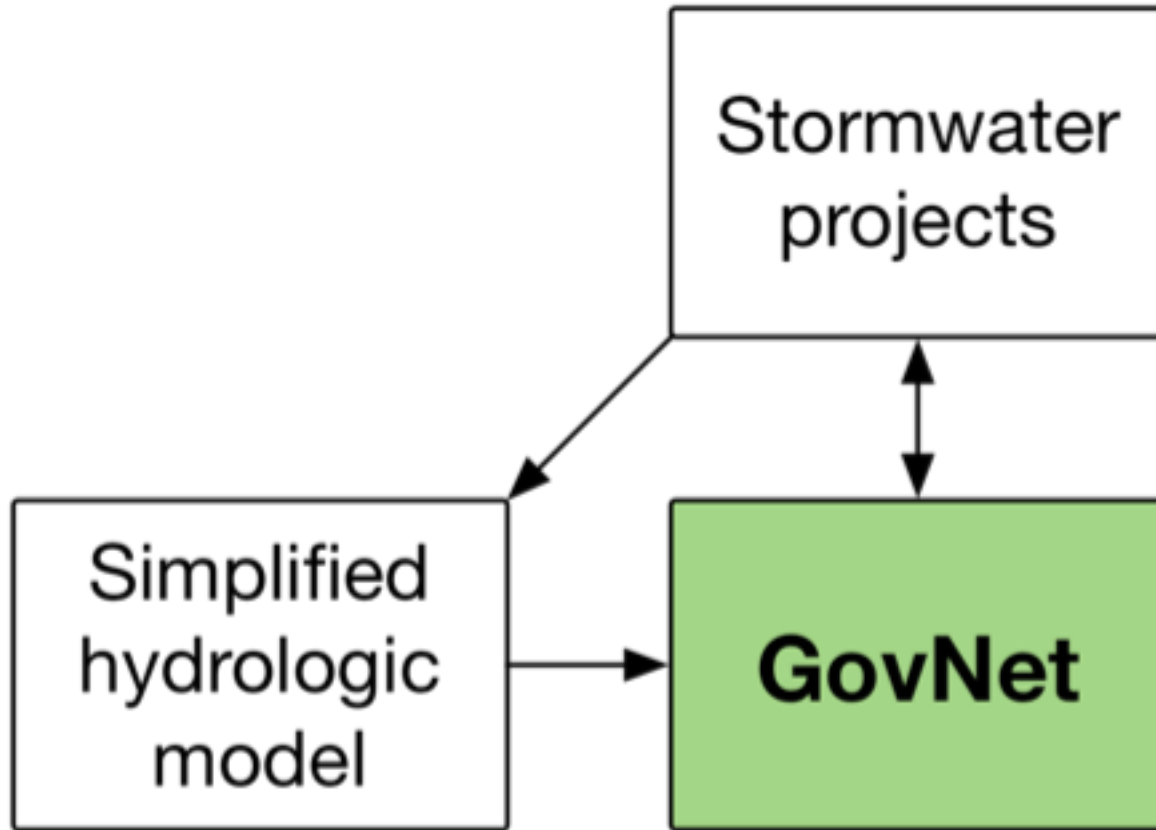
Kg/year vs. baseline



# A view of the IAM



# A simpler model

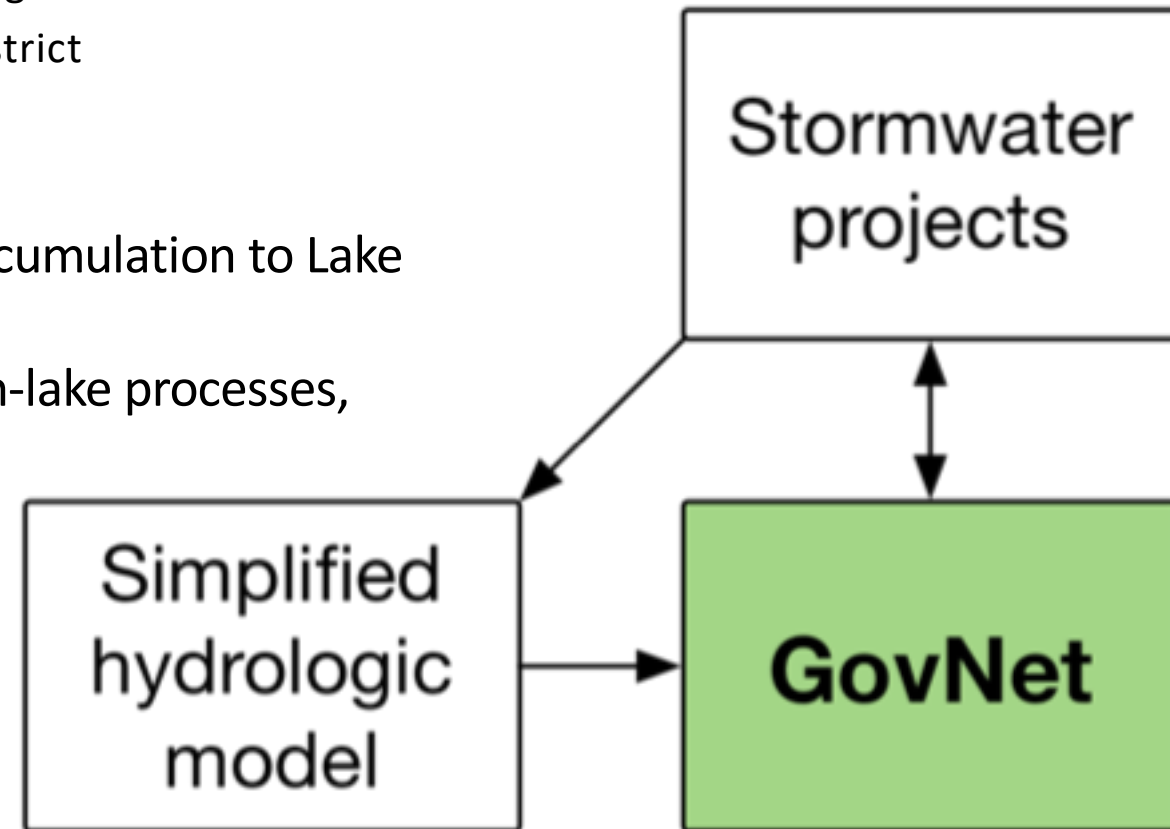
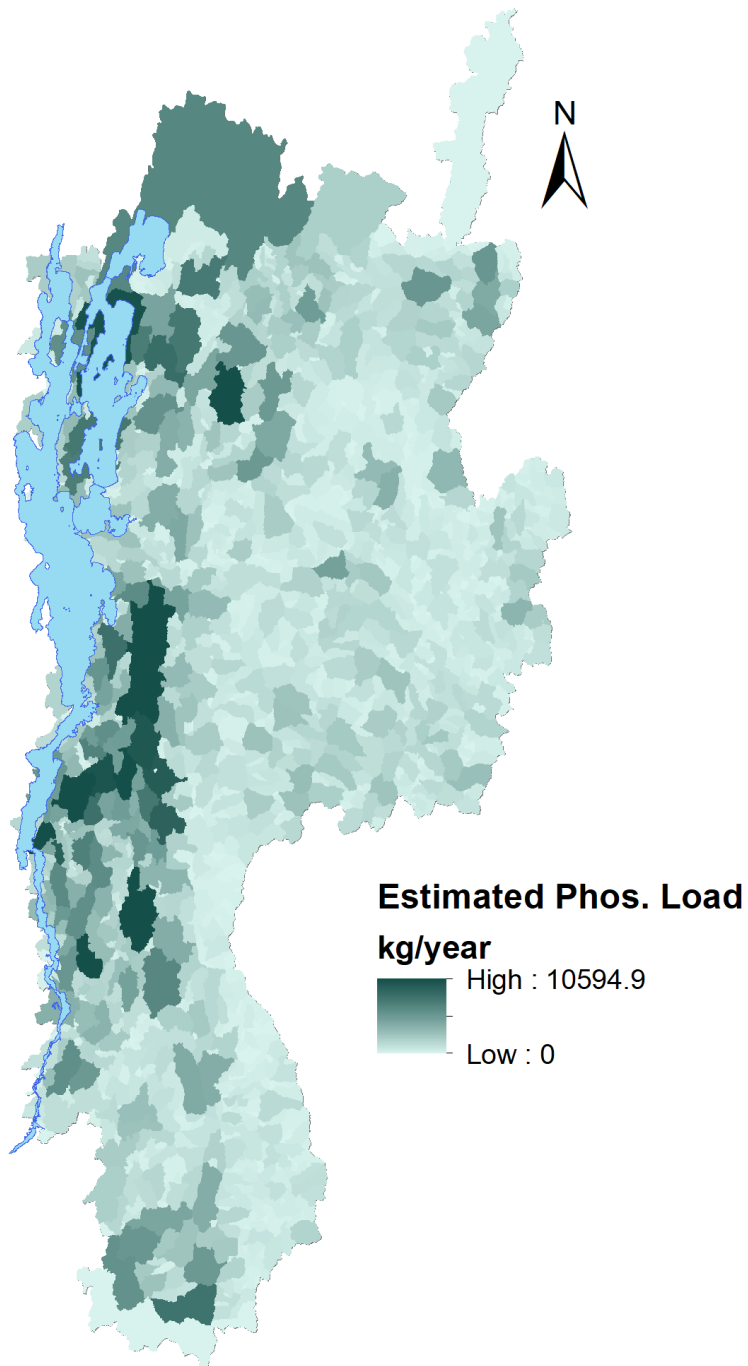


*How might alternative institutional rules affect water quality & related activities?*

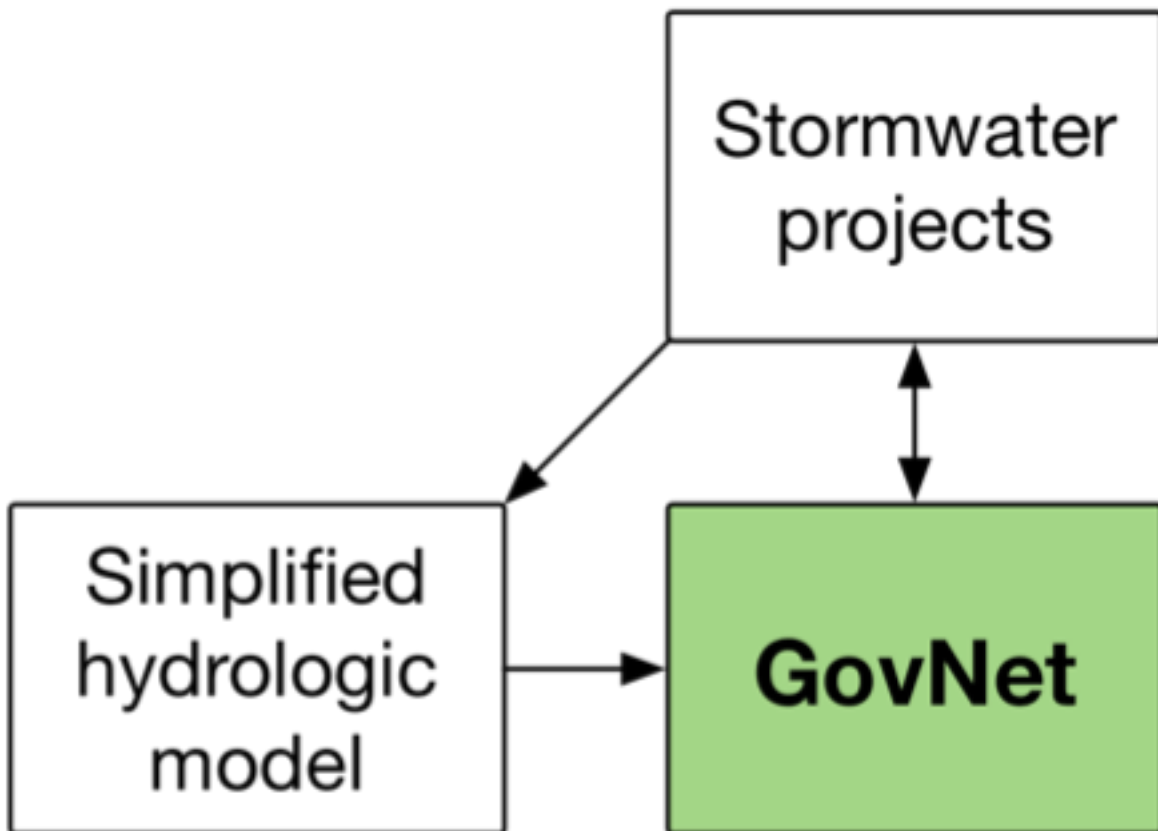
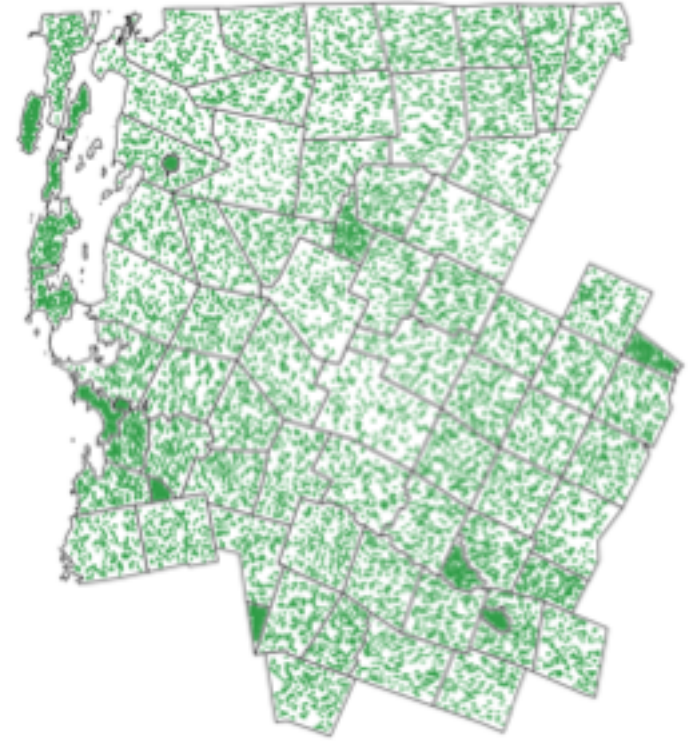
- Funding
- Capacity
- Alignment of environmental lags and policy creation/evaluation
- Restrictions & incentives on actor behavior

# A simplified hydrologic model

- EPA load estimates (NHDPlus)
- Rescaled to:
  - Municipality
  - Regional Planning Commission
  - Conservation district
  - Tactical basins
  - LCB (VT portion)
- Annualized load accumulation to Lake Champlain
- Excludes climate, in-lake processes, transport



# A simplified land use model



- Generic “clean water projects” (based on stormwater projects)
- Empirical parameterization
  - Est. load reductions
  - Est. implementation costs
- Excludes existing infrastructure, land rights, maintenance

# Four governance agent types

## Municipalities

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

(78)

## State agency

- Evaluate/grade planned projects
- Allocate funding to projects

## Regional actors

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

(5)

## Political (state)

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

# Alternative governance structures & institutional rules

## Pure cooperation

- Regional actors facilitate cooperation among munis 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



# Simulation dimensions

- 5 levels of clean water funding available (\$)
- 5 levels of capacity of **state agency agent** to fund, grade, and allocate funds (bandwidth)
- 5 different lag times between when a project is implemented and effects are realized
- 5 levels of project evaluation frequency by **political agent**
- 3 institutional rules & incentives
  - Municipal cooperation
  - Municipal competition for CWF \$
  - Municipal competition with marginal role for regional actors

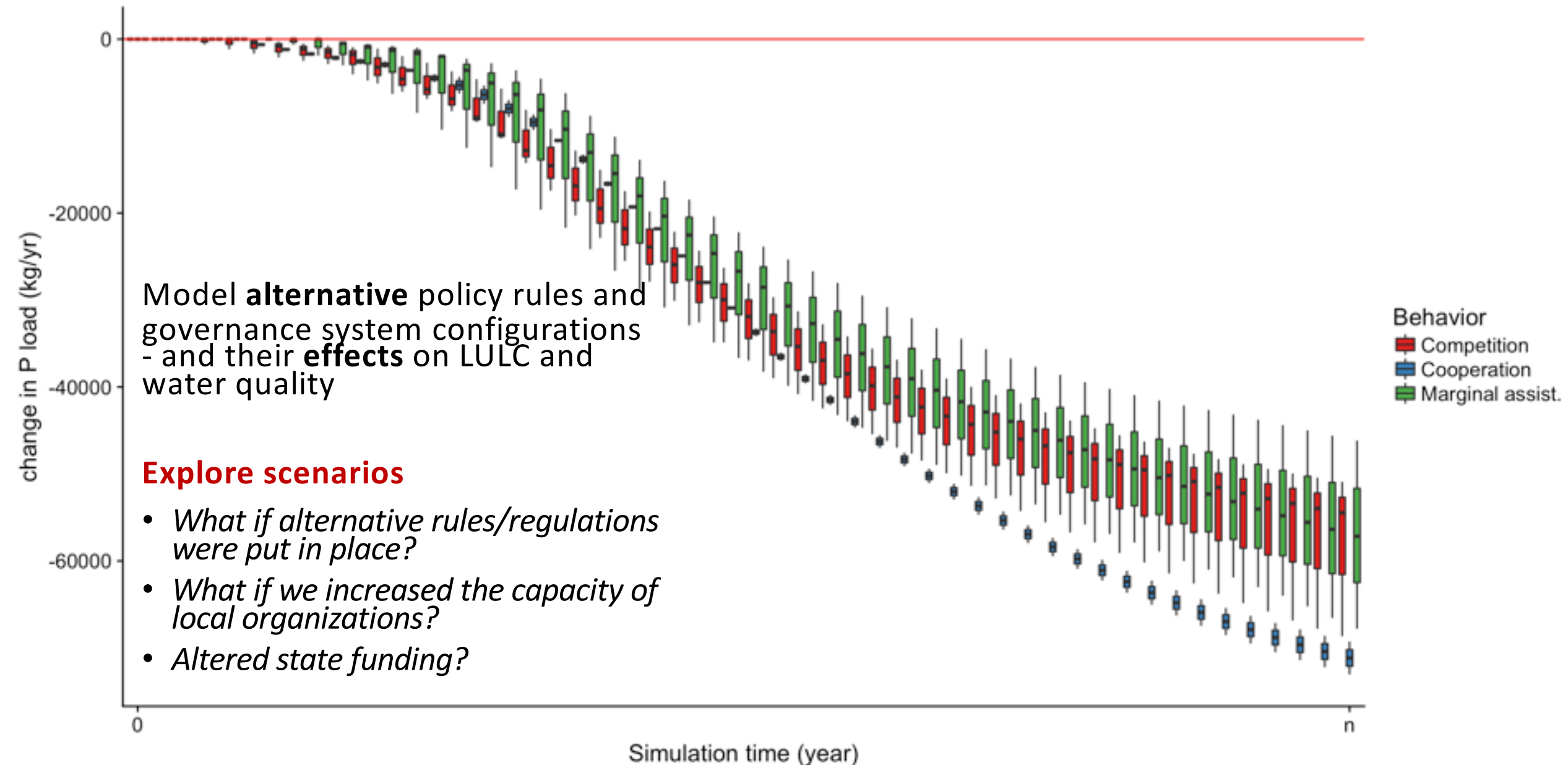
$$\prod_{i=1}^6 x_i = 18,750 \text{ scenarios}$$

# Preliminary results

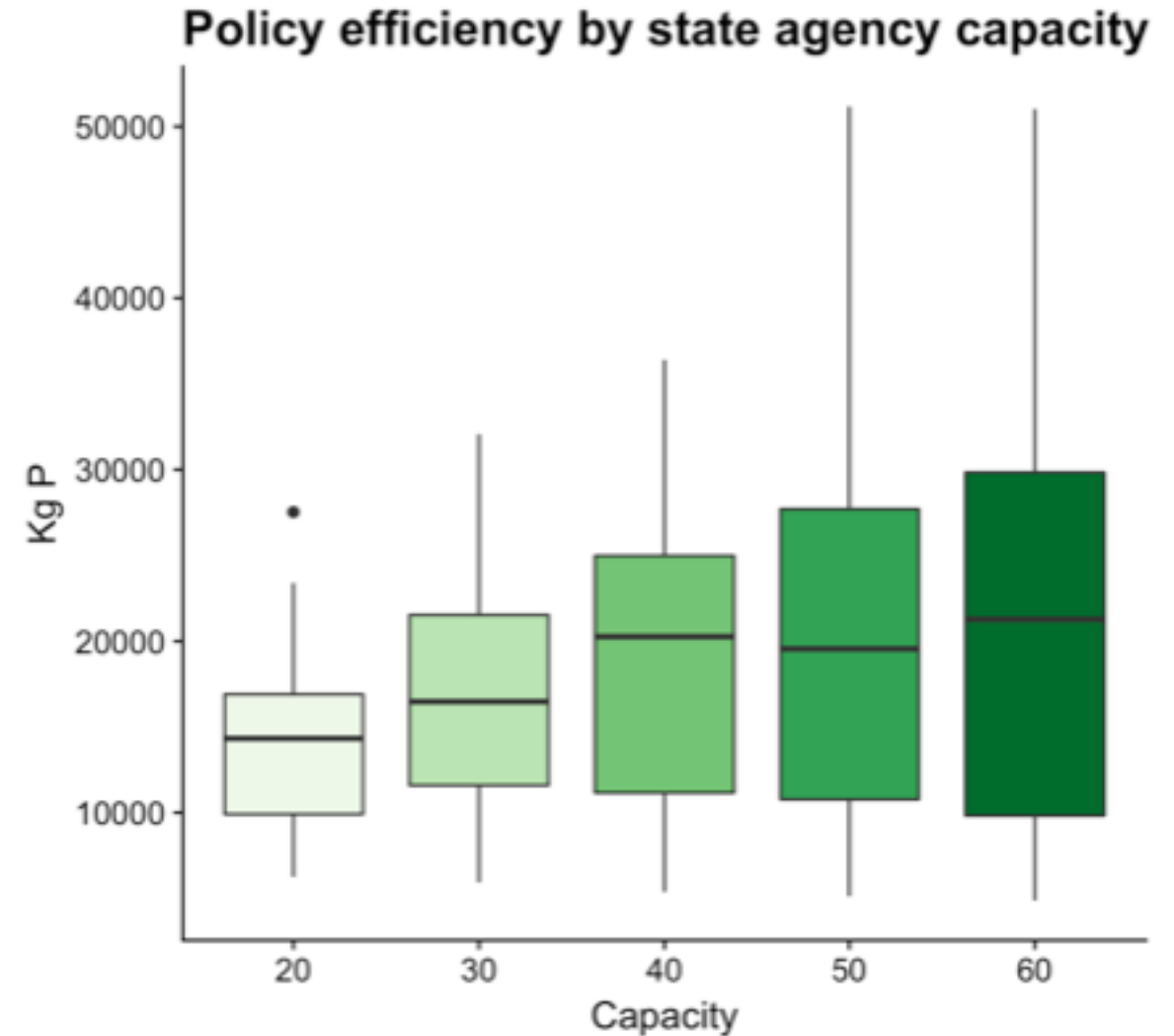
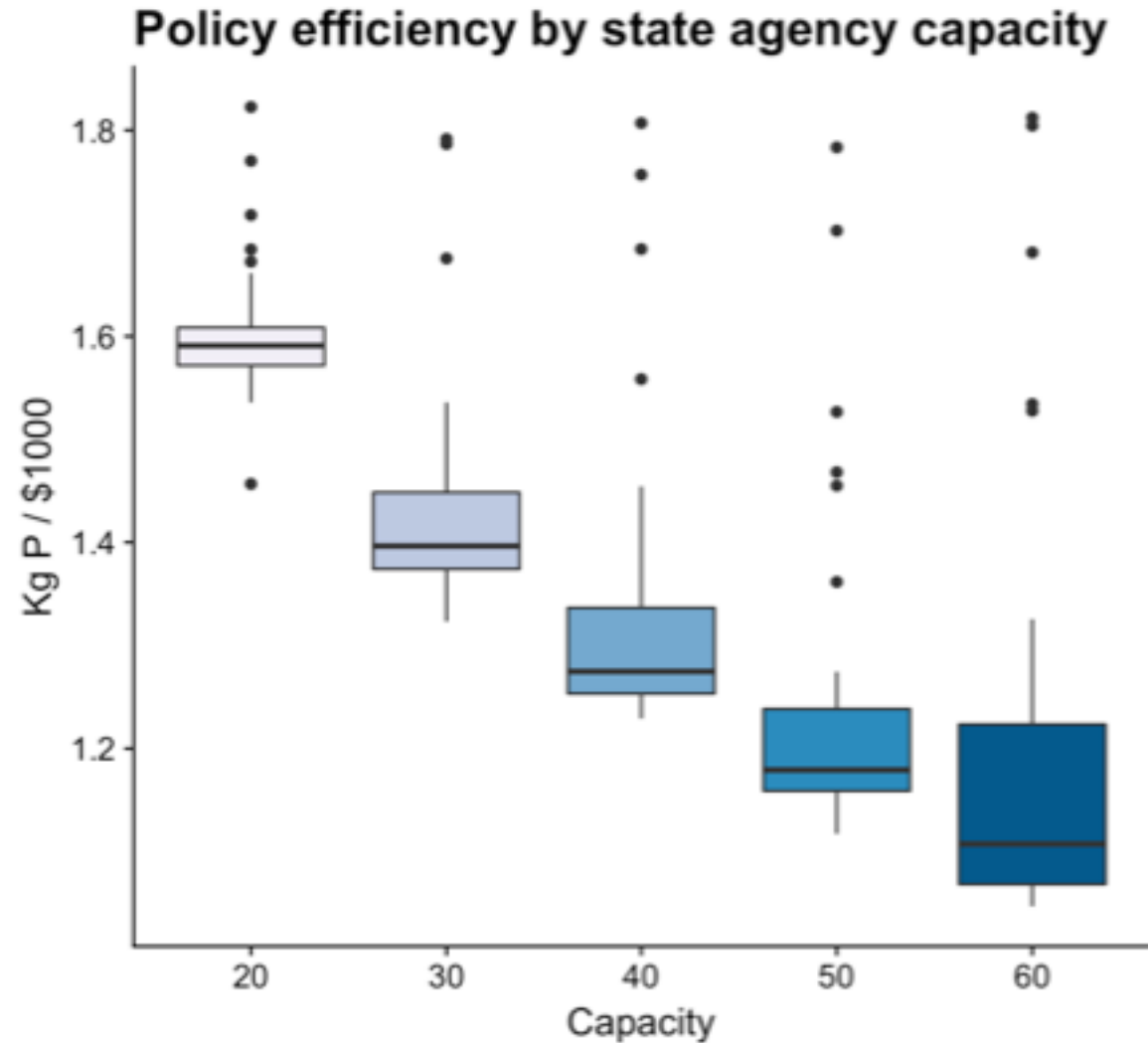
(vs. a baseline simulation)

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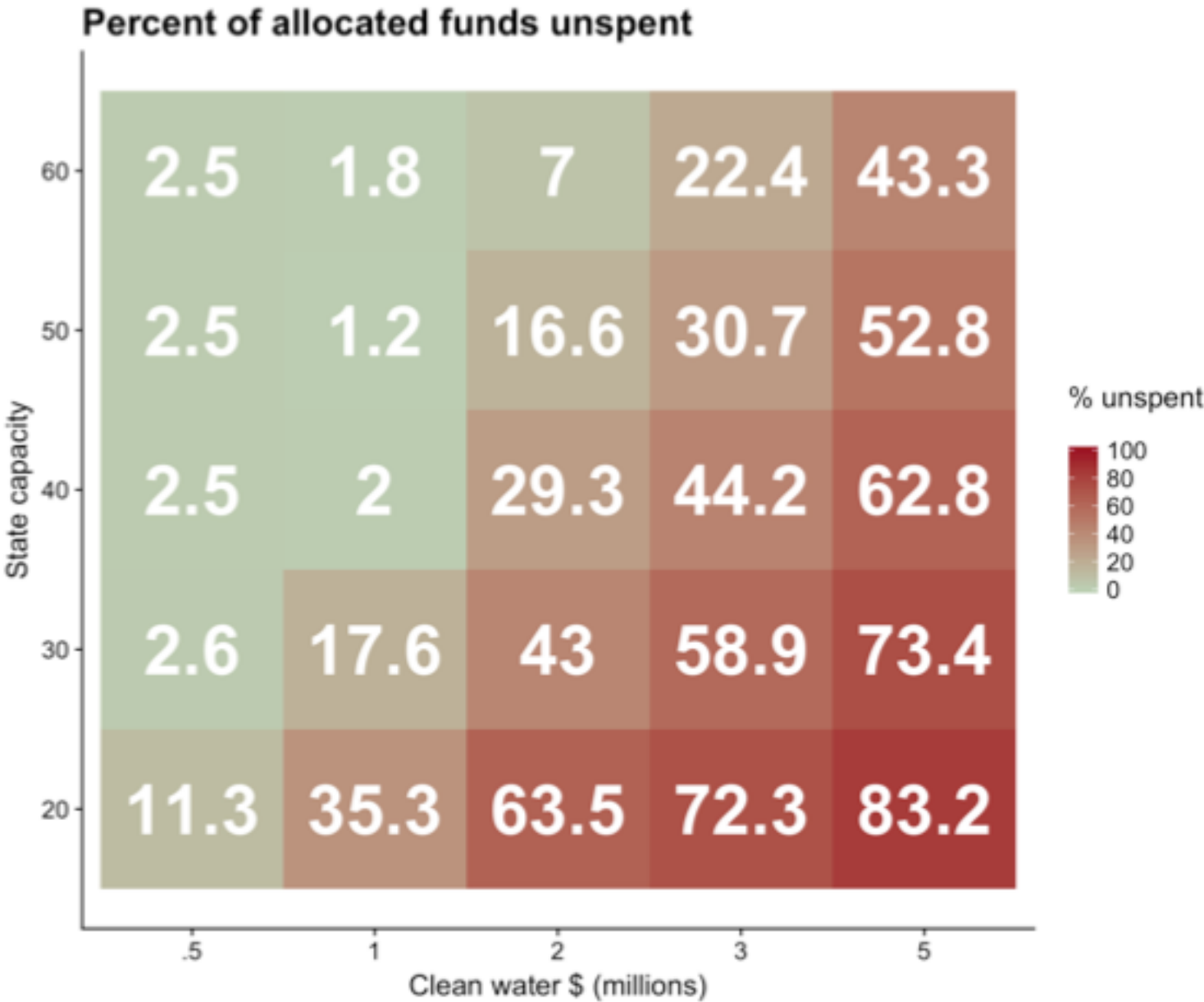
Kg/year vs. baseline



# But you also motivate what you measure...



Without sufficient capacity, allocated funds can go unspent



# Conclusions, future work, and data collection

- Capacity-building should go hand-in-hand with (or precede) direct allocations
  - Rules that incentivize *smart* cooperation can lead to improved results
  - Need adaptive institutions & policies to manage lags and mismatches
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- 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