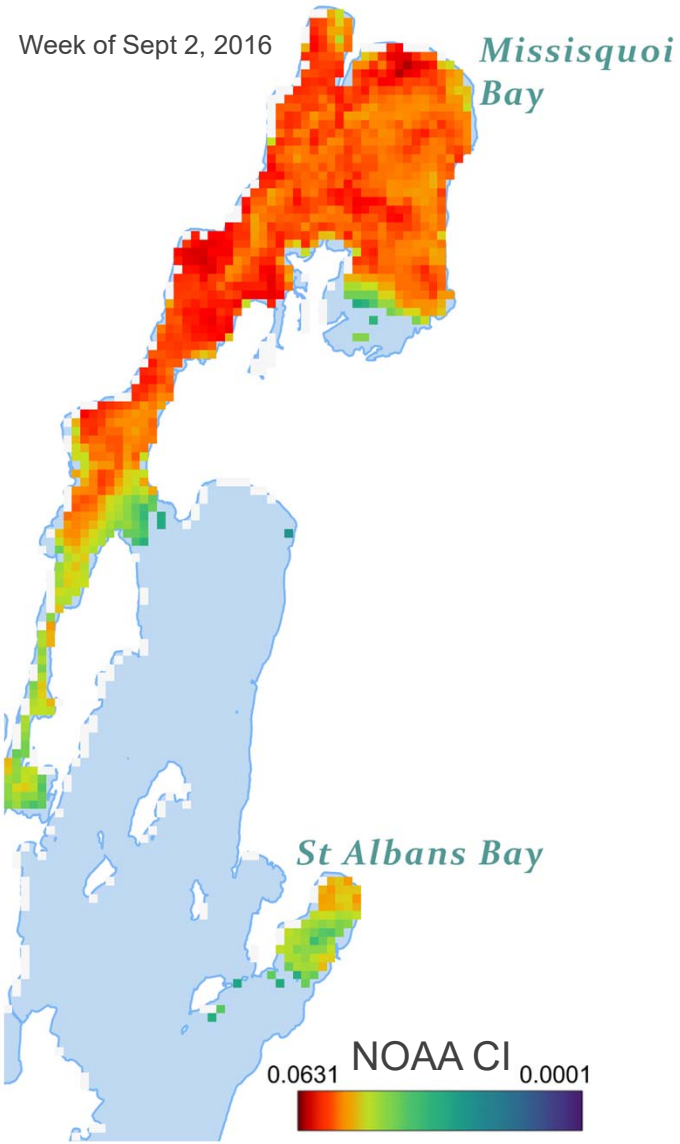


Modeling alternative water governance scenarios in the Lake Champlain Basin:

A multi-scale agent-based model of resource prioritization and collective action

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

June 4, 2019 // All Hands Meeting 2019

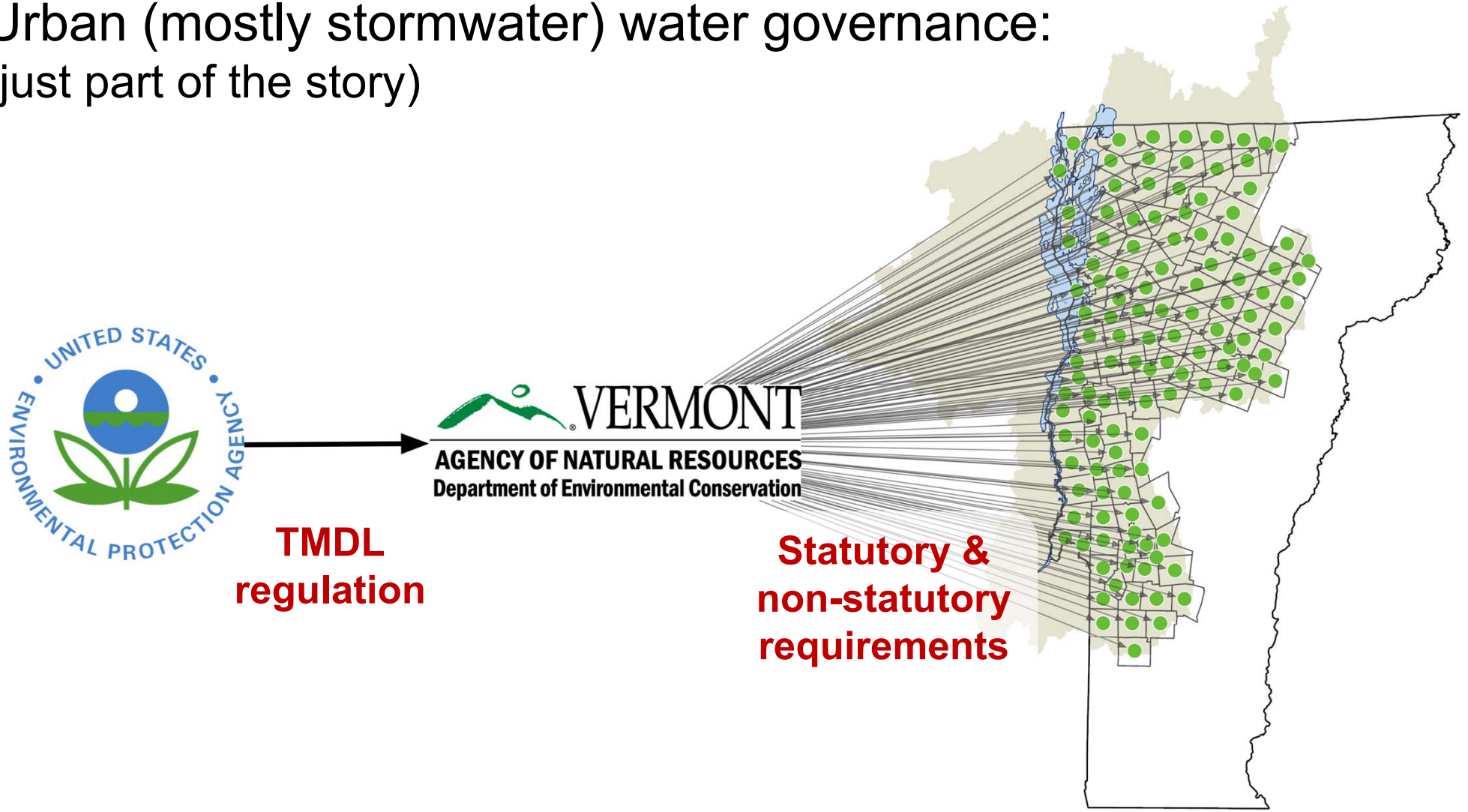
BREE Basin Resilience to Extreme Events in the Lake Champlain Basin

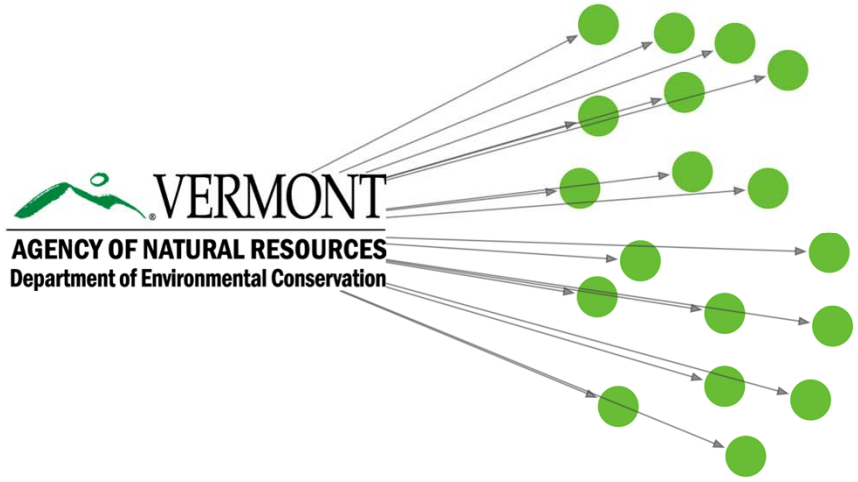
The University of Vermont

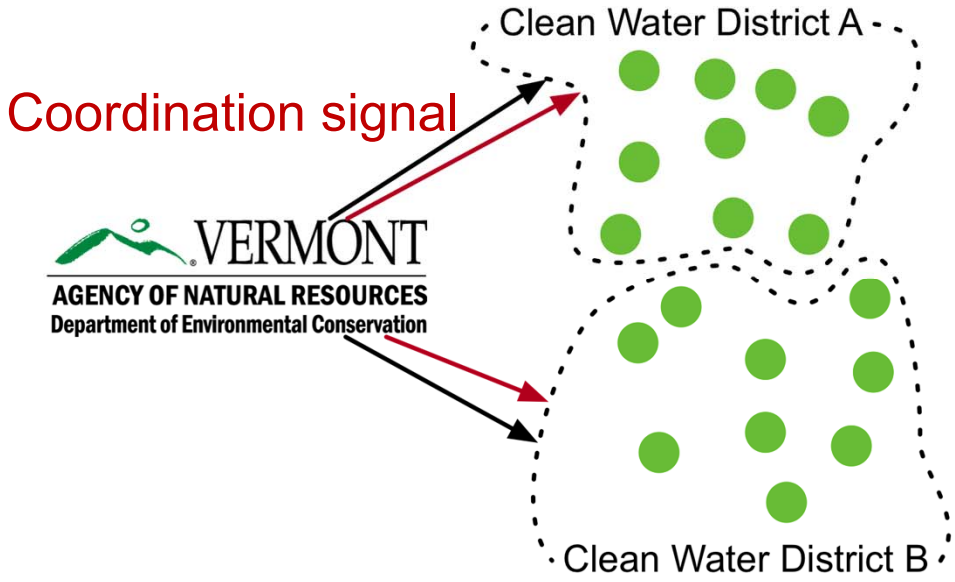
Main takeaways

- The efficacy of water quality-related municipal coordination in the LCB is a function of network **structure** and **function**
- Coordination schemes that regionalize **planning *and* implementation** are more effective in reducing phosphorus loads
- **Capacity** at state and municipal scales is more important than the amount of funding
- Phosphorus mitigation projects must become *much* more effective

Urban (mostly stormwater) water governance:
(just part of the story)







EPA approves administration's clean water funding steps

By Elizabeth Gribkoff
Feb 12 2019 | one reader footnote

Senate's skepticism over clean water bill gives way to unanimous approval

By Elizabeth Gribkoff
Apr 2 2019 | 4 reader footnotes

vtdigger.com

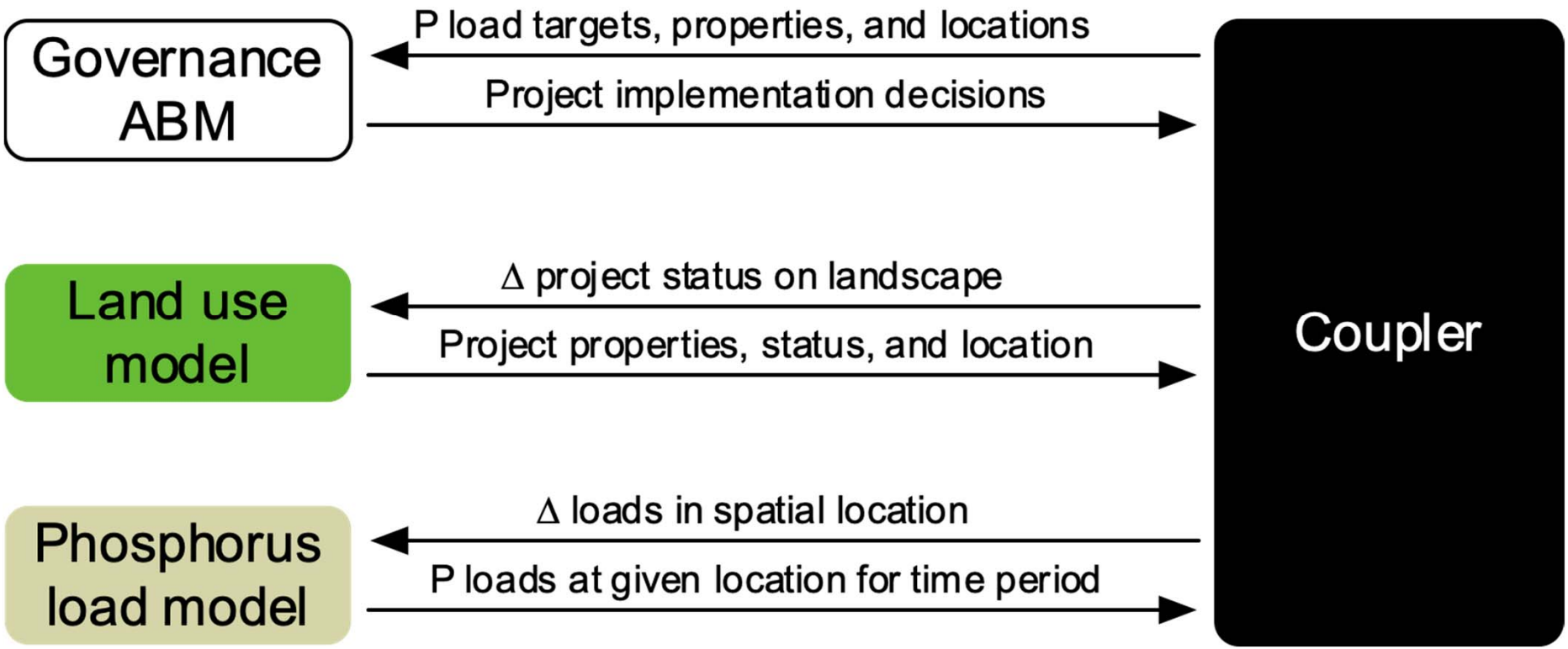
S.96

An act relating to the provision of water quality services

Sponsor(s)	Sen. Christopher Bray
	Sen. Virginia Lyons
	Sen. Rebecca Balint
	Sen. Robert Starr
Last Recorded Action	Senate 5/22/2019 - As passed by Senate and House

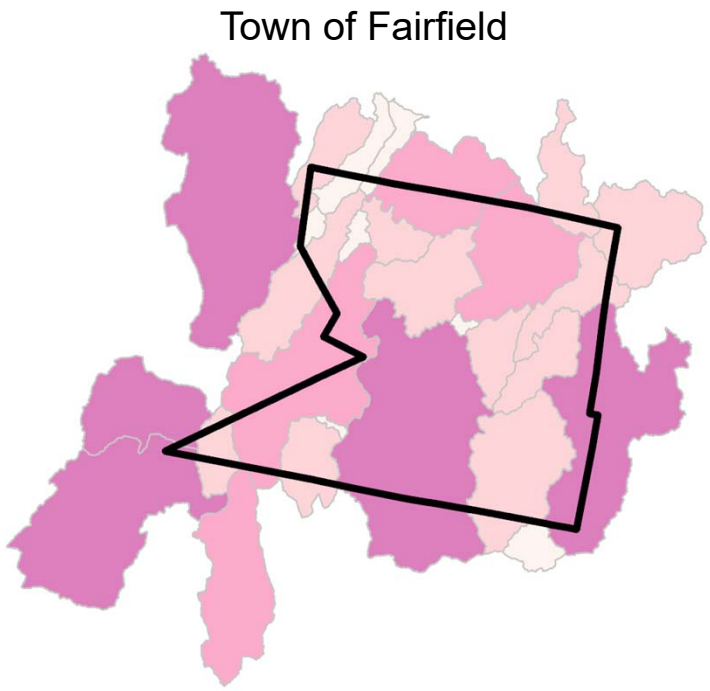
https://legislature.vermont.gov/bill/status/2020/S.96

A coupled model of clean water project prioritization

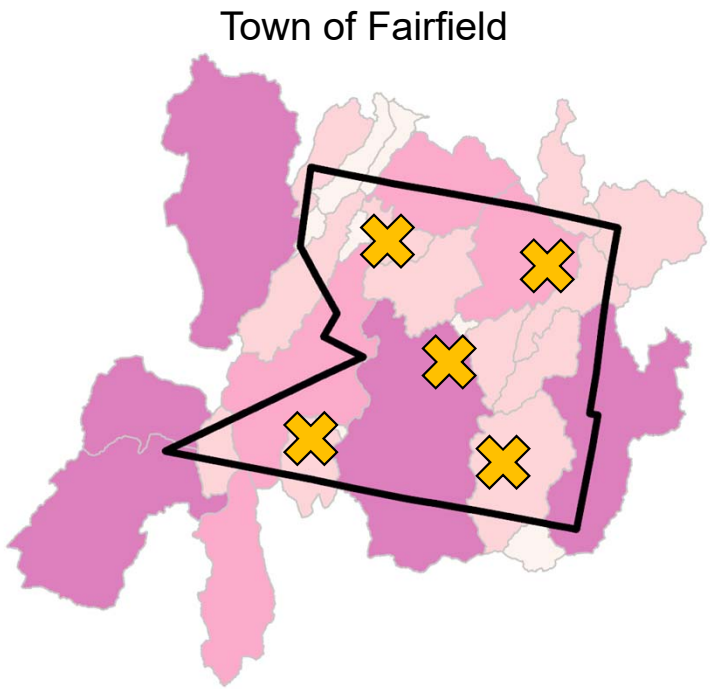


ABM: municipal project creation and prioritization

Behaviors:



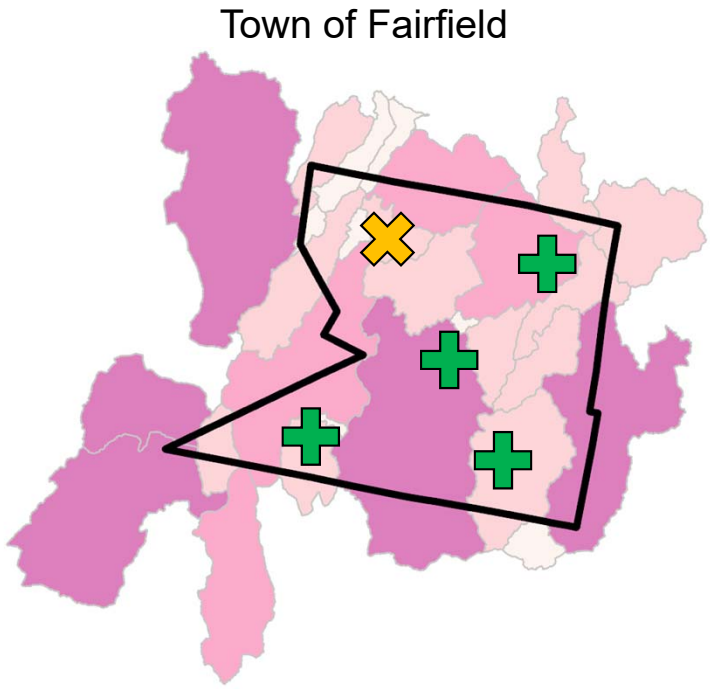
ABM: municipal project creation and prioritization



Behaviors:

1. Identify clean water projects

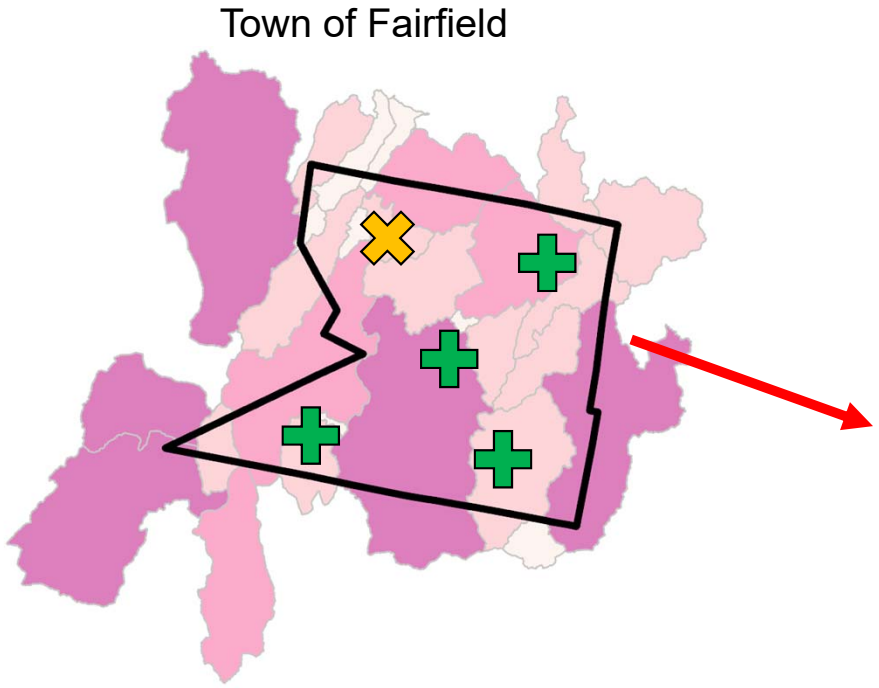
ABM: municipal project creation and prioritization



Behaviors:

1. Identify clean water projects
2. Plan clean water projects

ABM: municipal project creation and prioritization



Behaviors:

1. Identify clean water projects
2. Plan clean water projects
3. **Apply for funding (from state)**

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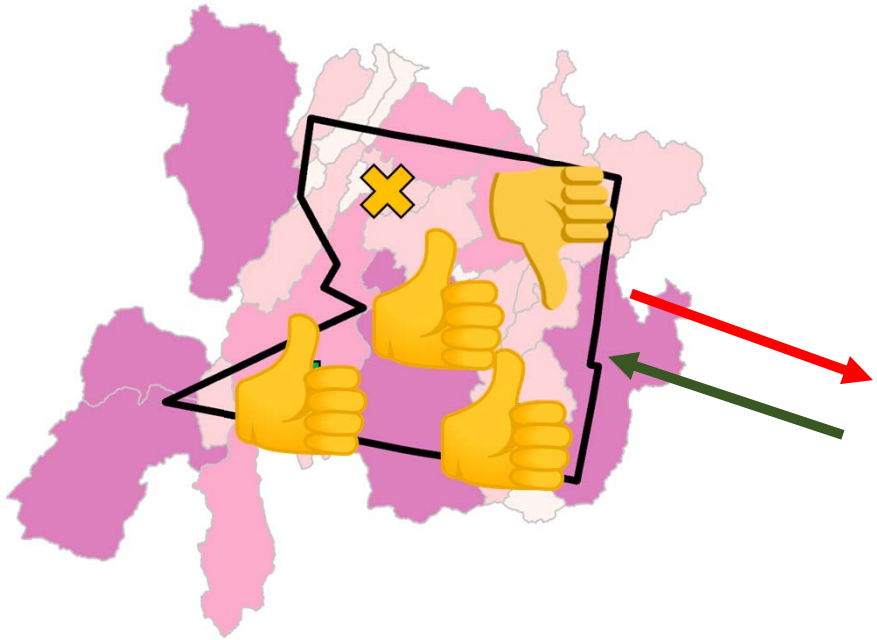
ABM: municipal project creation and prioritization

Town of Fairfield



Behaviors:

1. Identify clean water projects
2. Plan clean water projects
3. **Apply for funding (from state)**

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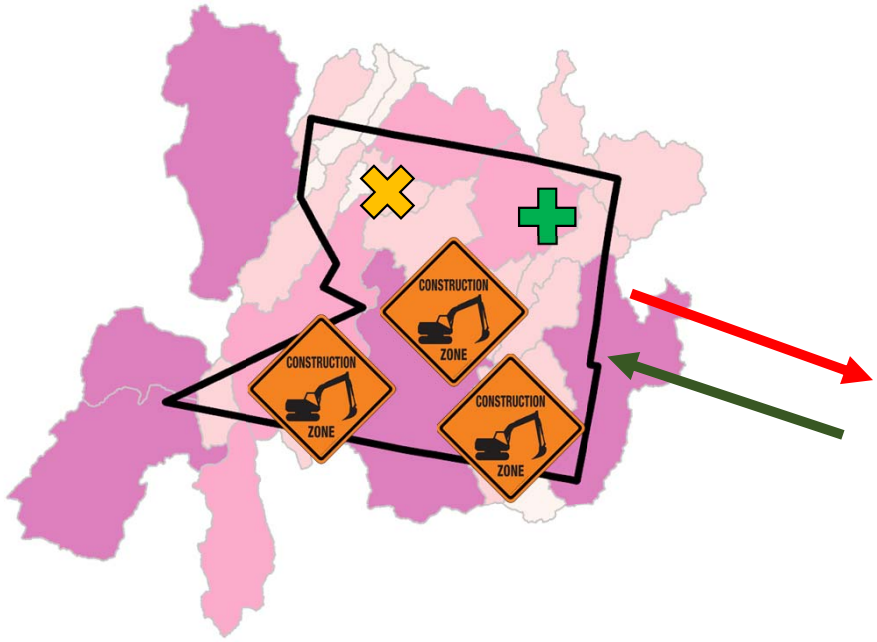
Department of Environmental Conservation

- **Priorities**
- **Constraints**
  - Available funding ($)
  - Human resources (throughput)

ABM: municipal project creation and prioritization

Town of Fairfield



Behaviors:

1. Identify clean water projects
2. Plan clean water projects
3. **Apply for funding (from state)**
4. Implement/build clean water projects

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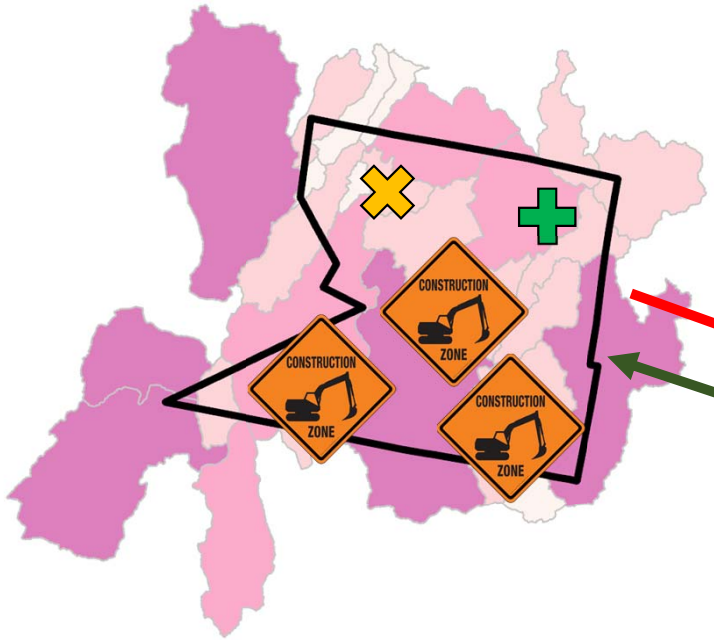
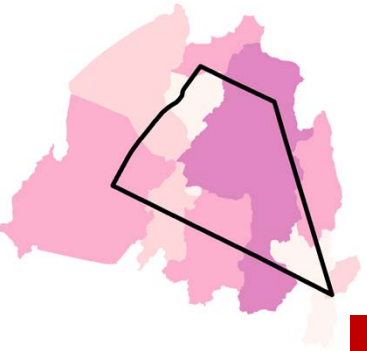
ABM: municipal project creation and prioritization

Town of Fairfield





Town of Georgia

Behaviors:

1. Identify clean water projects
2. Plan clean water projects
3. **Apply for funding (from state)**
4. Implement/build clean water projects

…decide to engage in coordination

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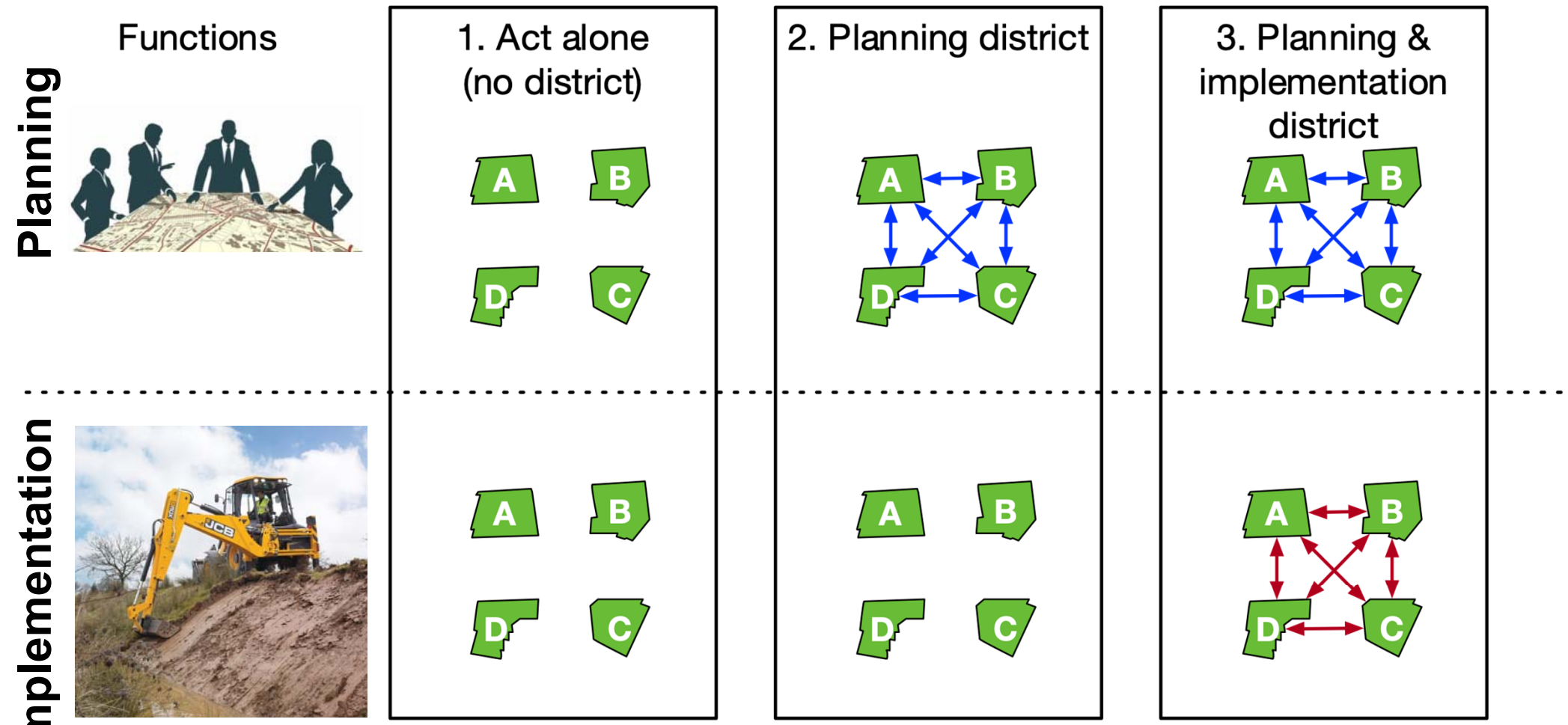
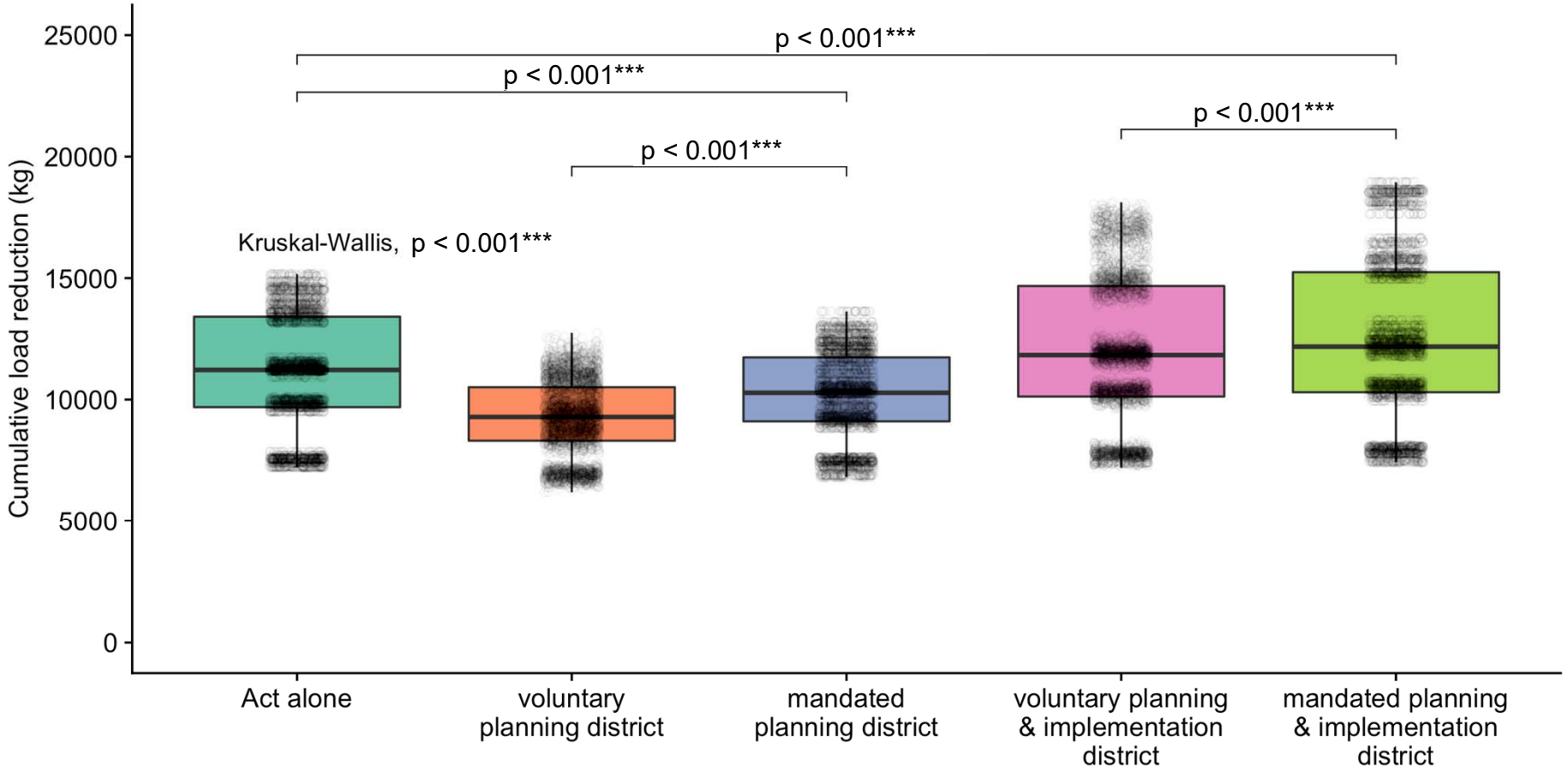
How might clean water districts function (as multiplex networks)?



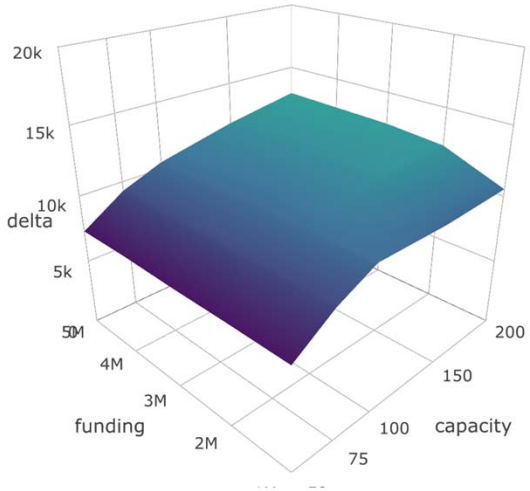
Simulation scenarios

Lever of change	Parameter	Values
How much money should the state spend?	Allocated funds	1, 2, 3, 4, and 5 million USD
How many human resources are necessary?	State agent capacity (throughput)	50, 75, 100, 150, and 200 projects/year
Scale and scope of coordination	Policy rules	1. Municipalities act alone 2. Voluntary **planning district** 3. Mandated **planning district** 4. Voluntary **planning and implementation district** 5. Mandated **planning and implementation district**

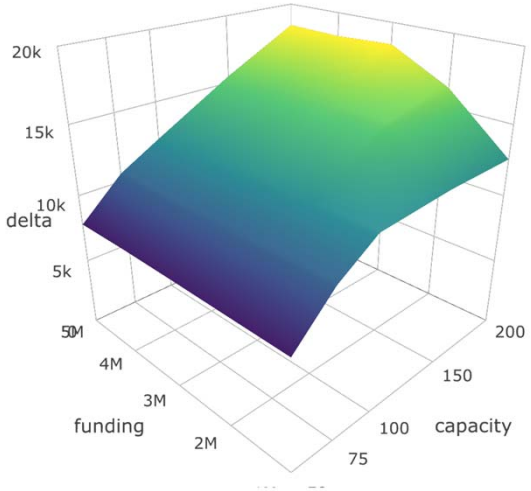
Levers of change: regionalization policy

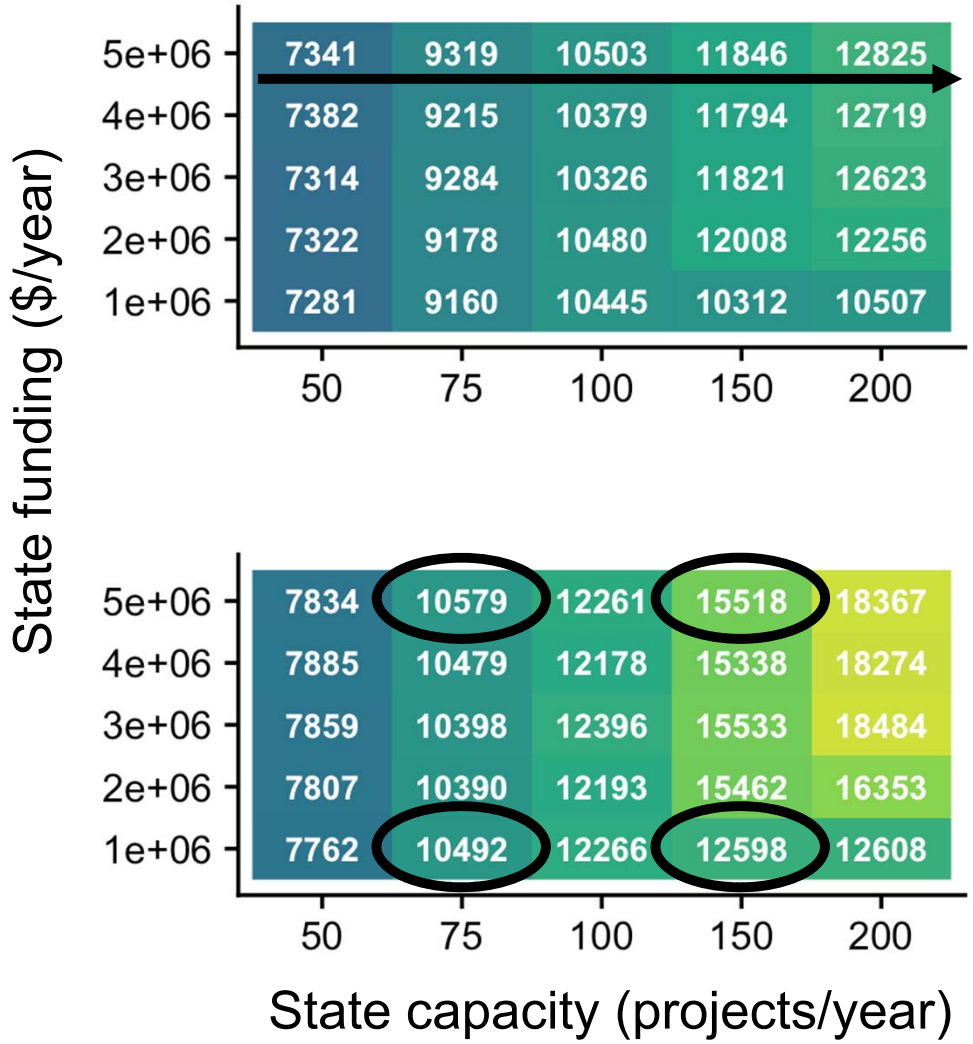


Planning only district

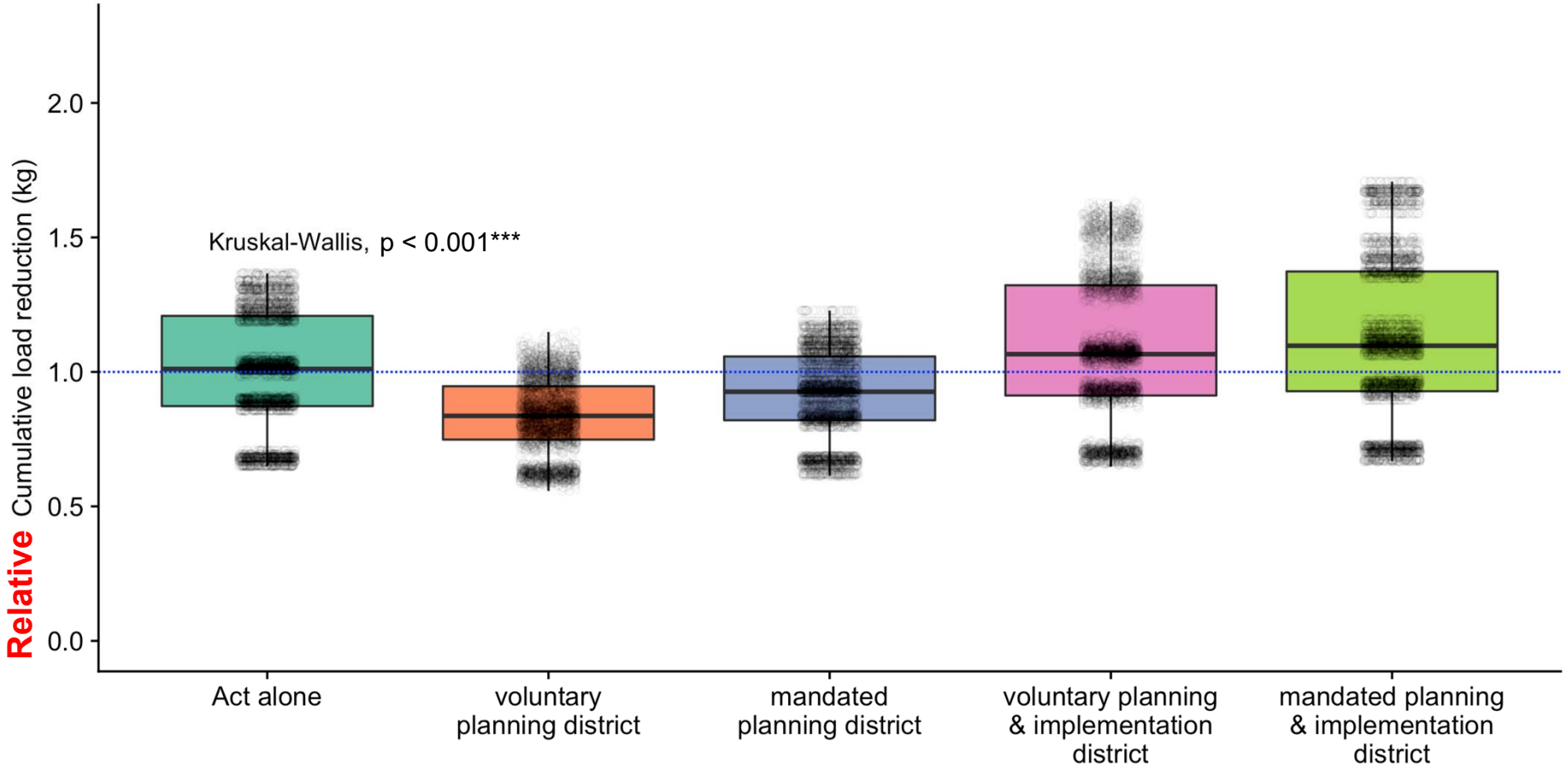


Planning & implementation district

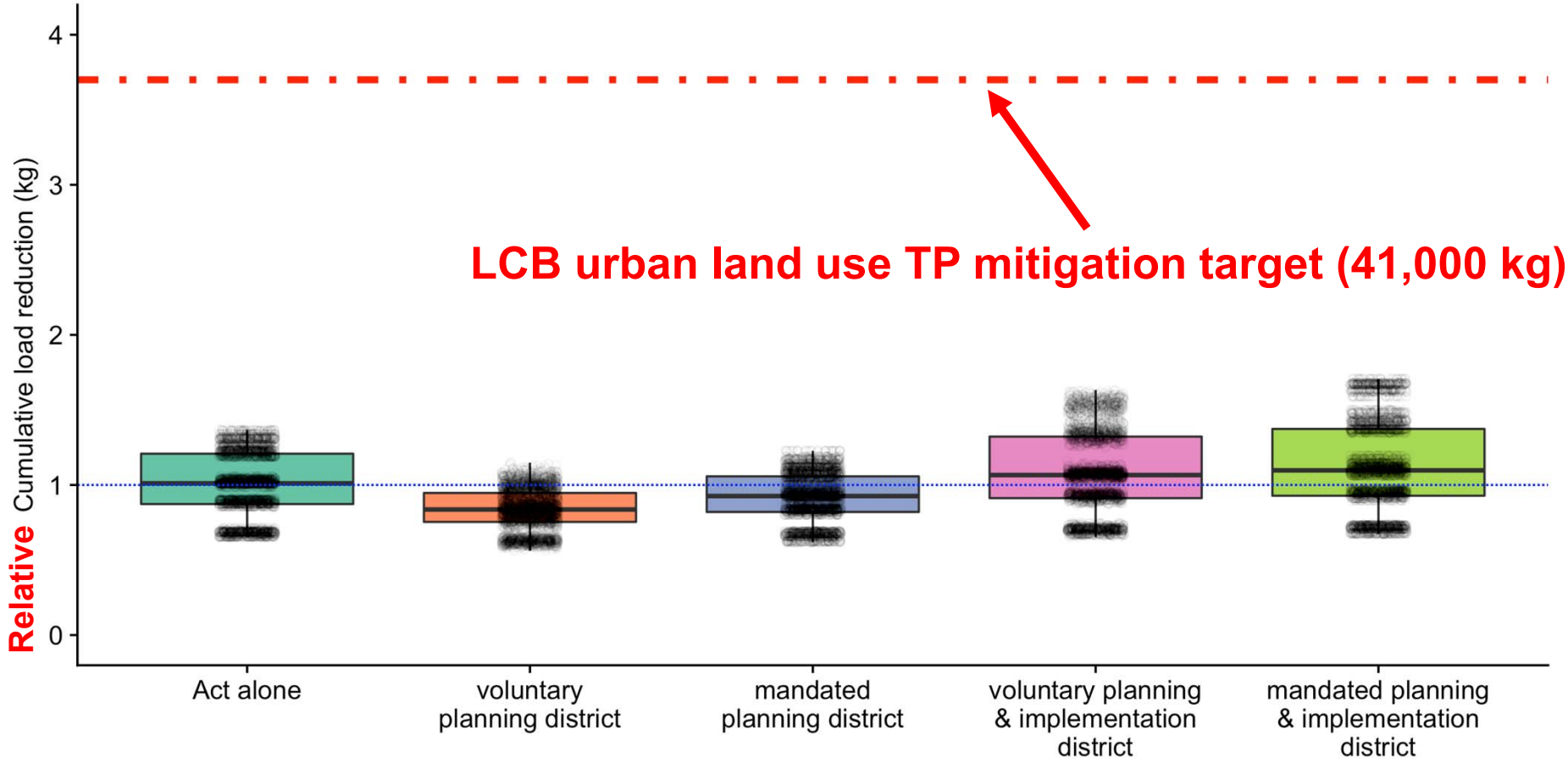




Levers of change: regionalization policy



Levers of change: regionalization policy



Conclusions

- The efficacy of networked collaboration in the LCB is a function of network **structure** and **function**
- Water districts that regionalize planning *and* implementation are more effective in reducing phosphorus loads than other configurations
- **Capacity** at state and municipal scales is more important than the amount of funding
- Regardless of policy, phosphorus mitigation projects in Vermont must become *much* more effective

Thank you!

NSF OIA Award #1556770: Lake Champlain Basin Resilience to Extreme Events

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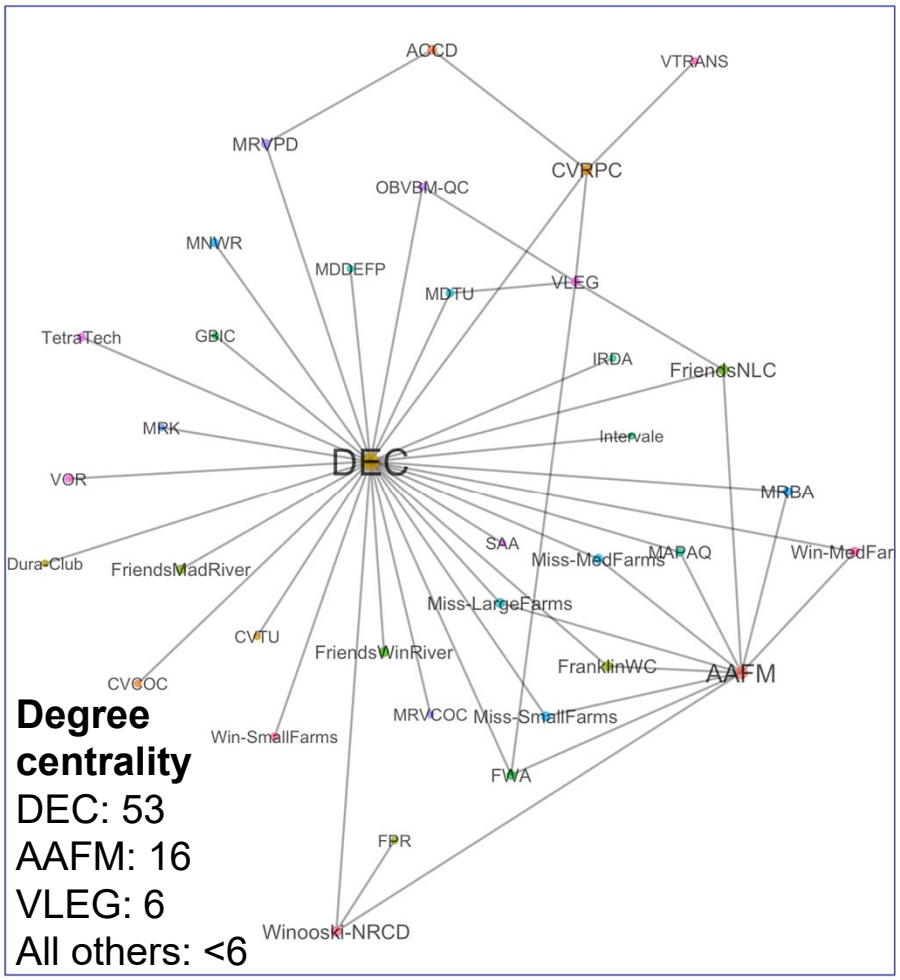
Limitations & future work

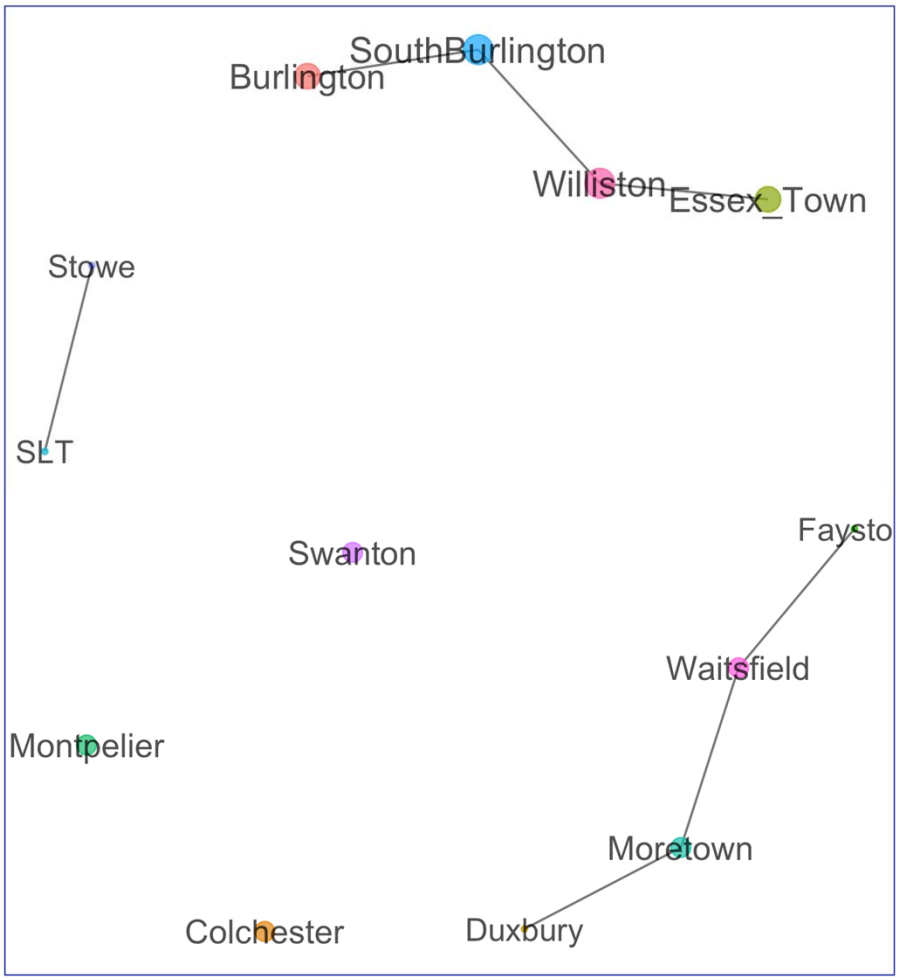
- TP loads are not the only driver of behavior
- Power, politics, and path dependencies influence prioritization (and aren't modeled)

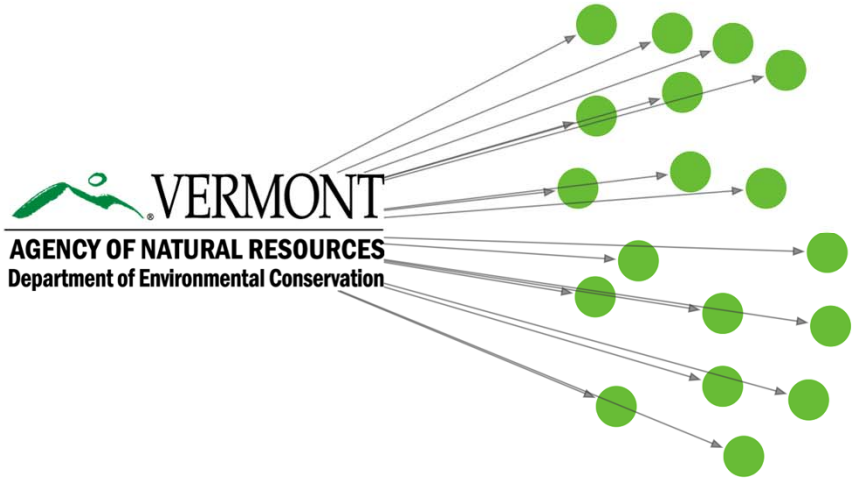
- Ongoing relationship with Vermont DEC to better understand scope of new rules & flexibility
- More than just a scaling exercise: "serious games" with new districts to better understand how they prioritize projects
- Extending to agricultural governance

Cross-scale Information Sharing and Project Coordination



Municipal Project Coordination (Missisquoi and Winooski watersheds)

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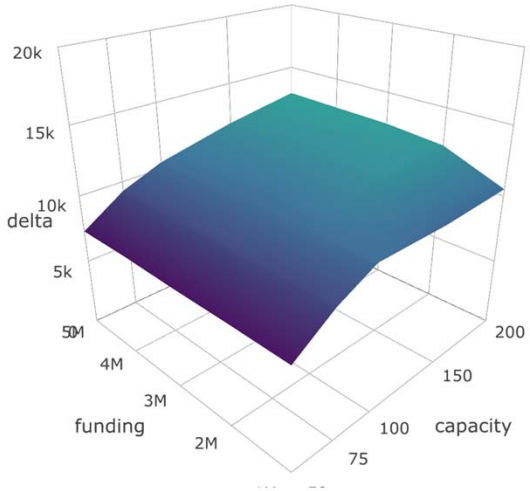
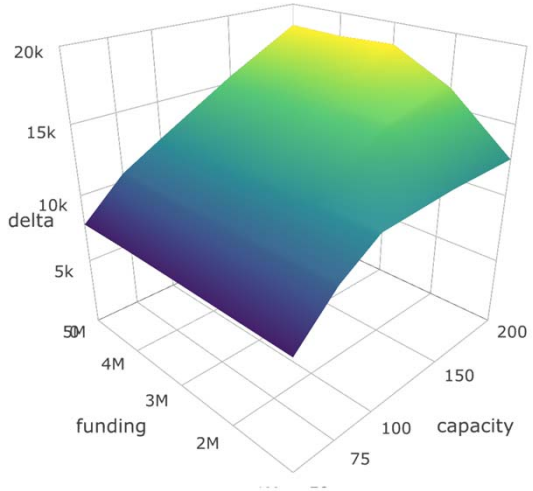
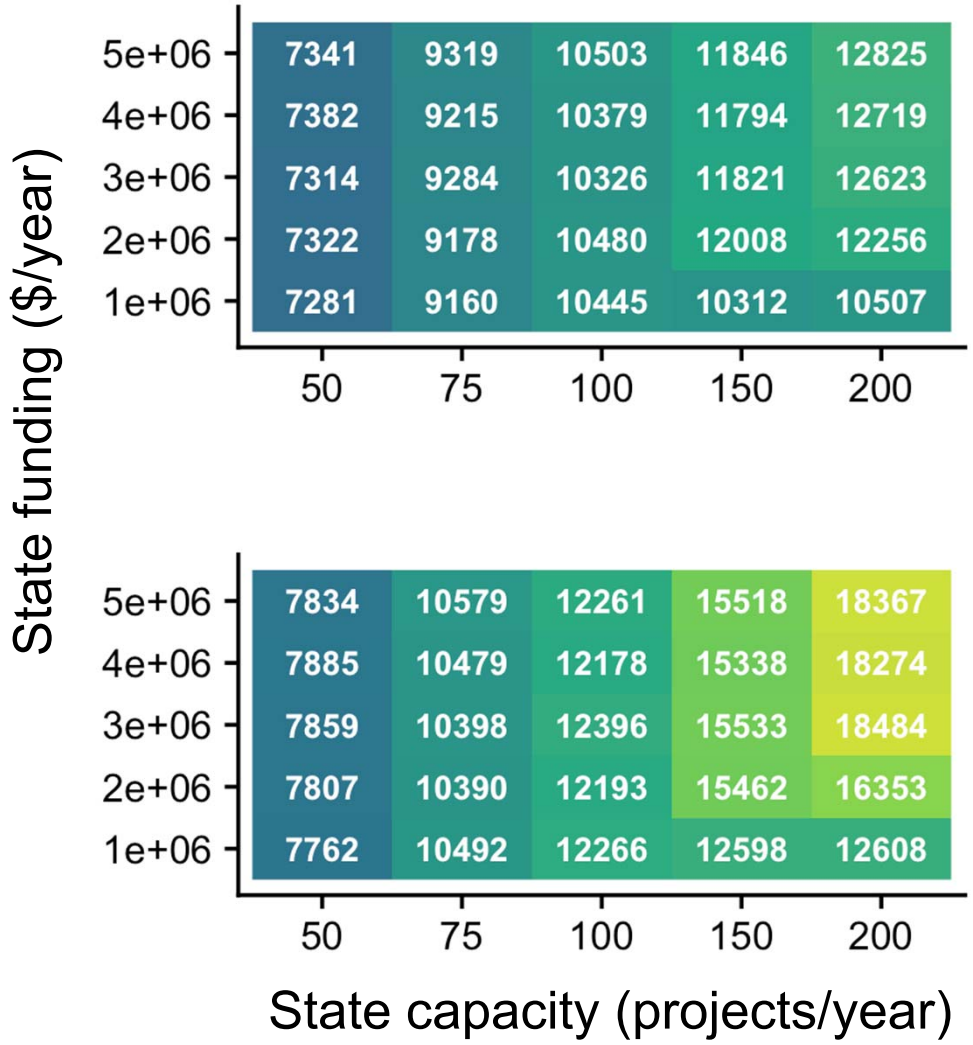
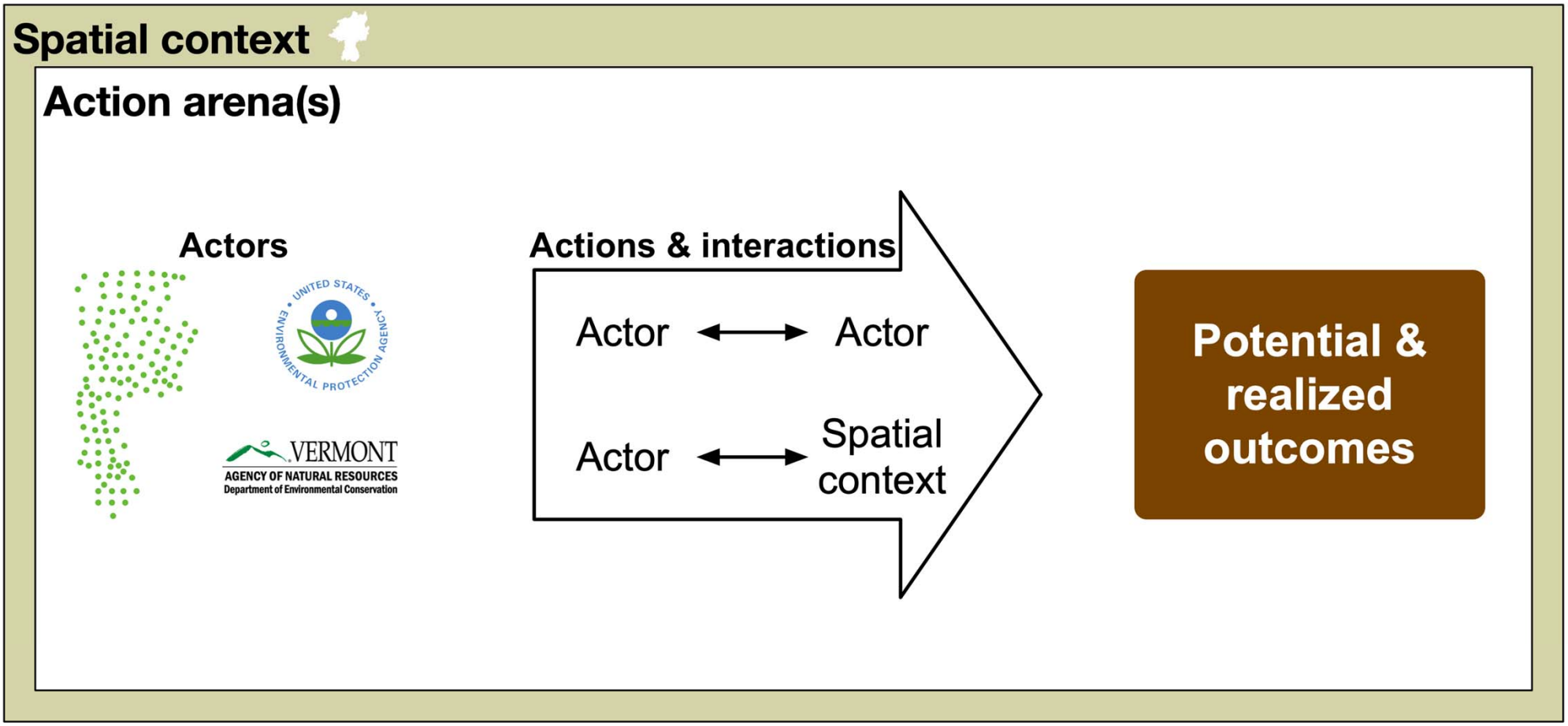
Planning only district



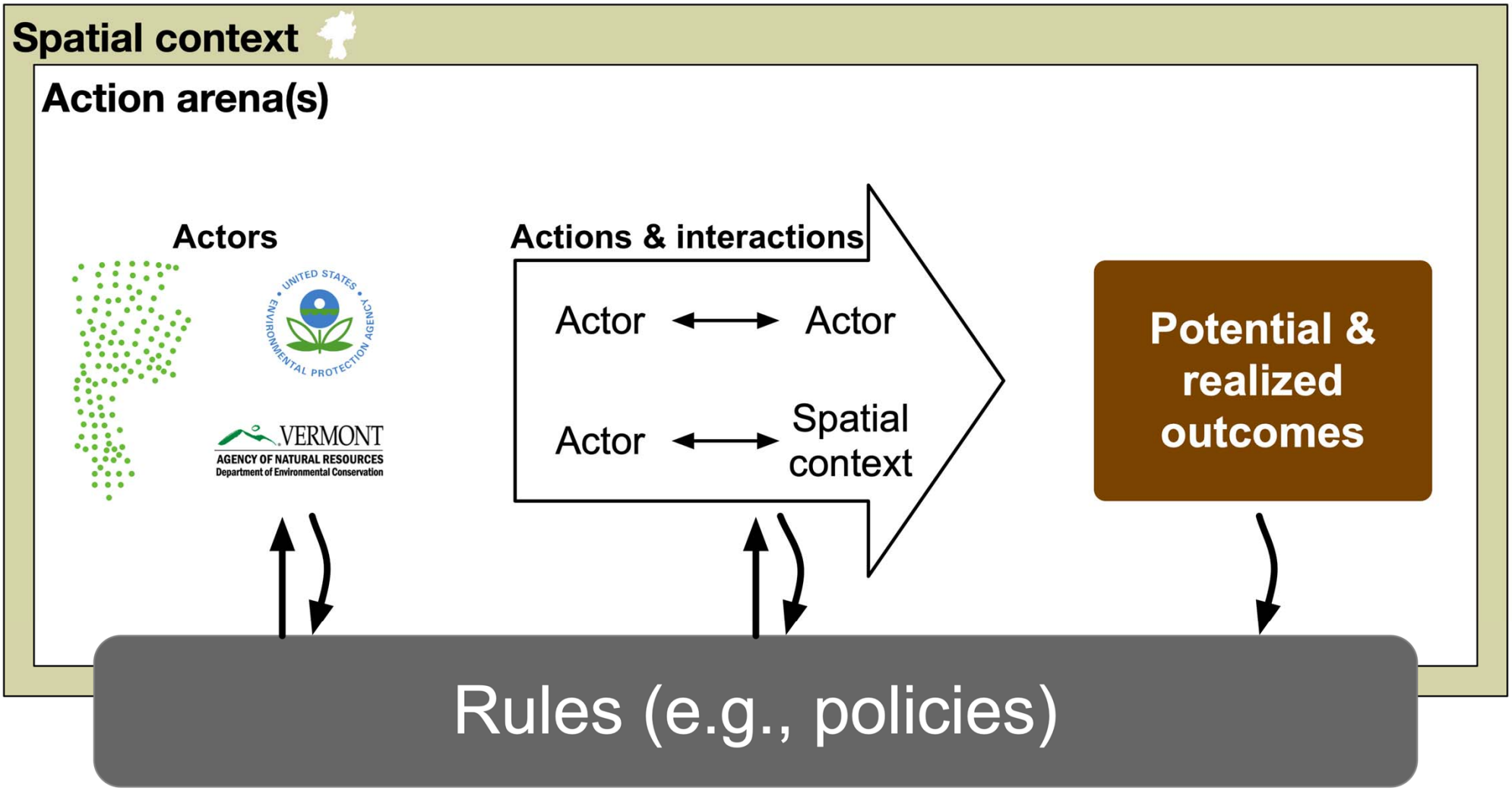
Planning & implementation district







Ostrom, E., 2009. *Understanding institutional diversity*. Princeton university press.



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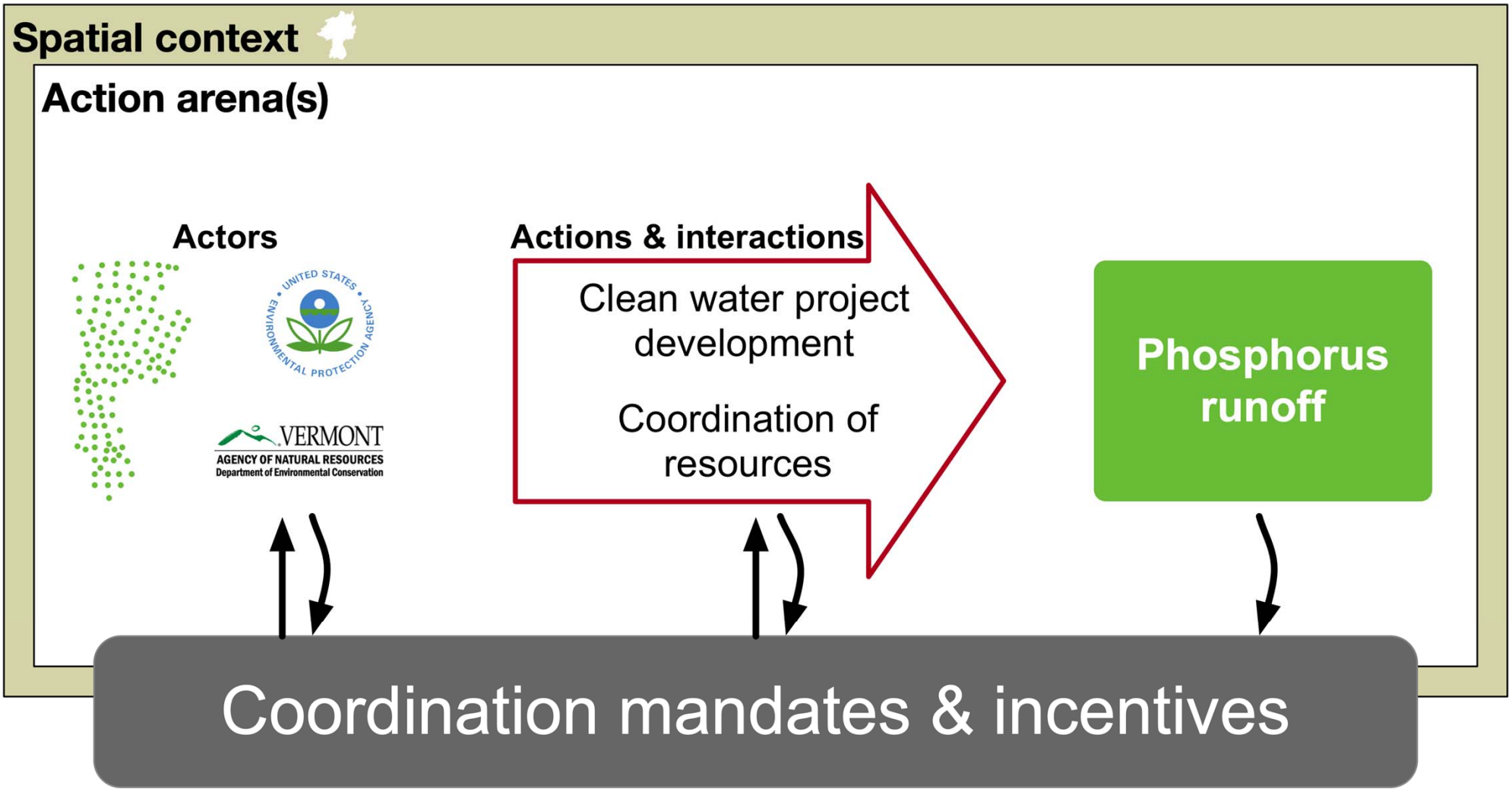

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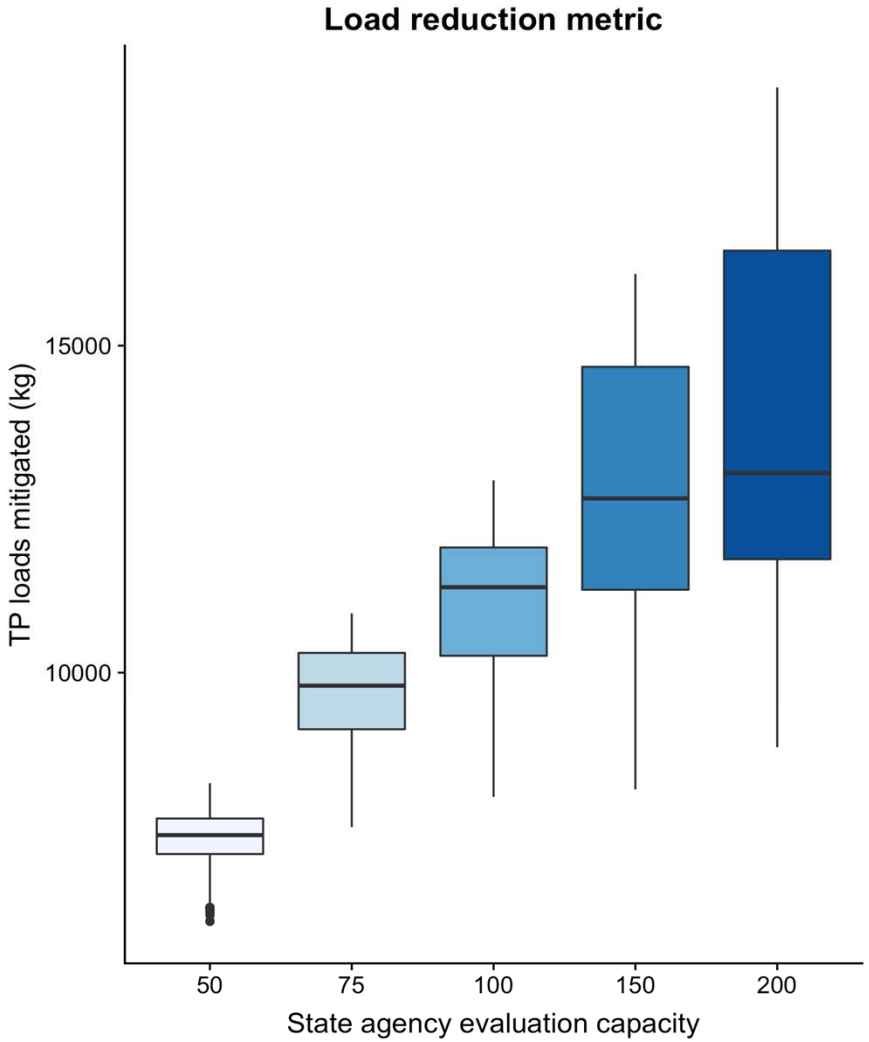
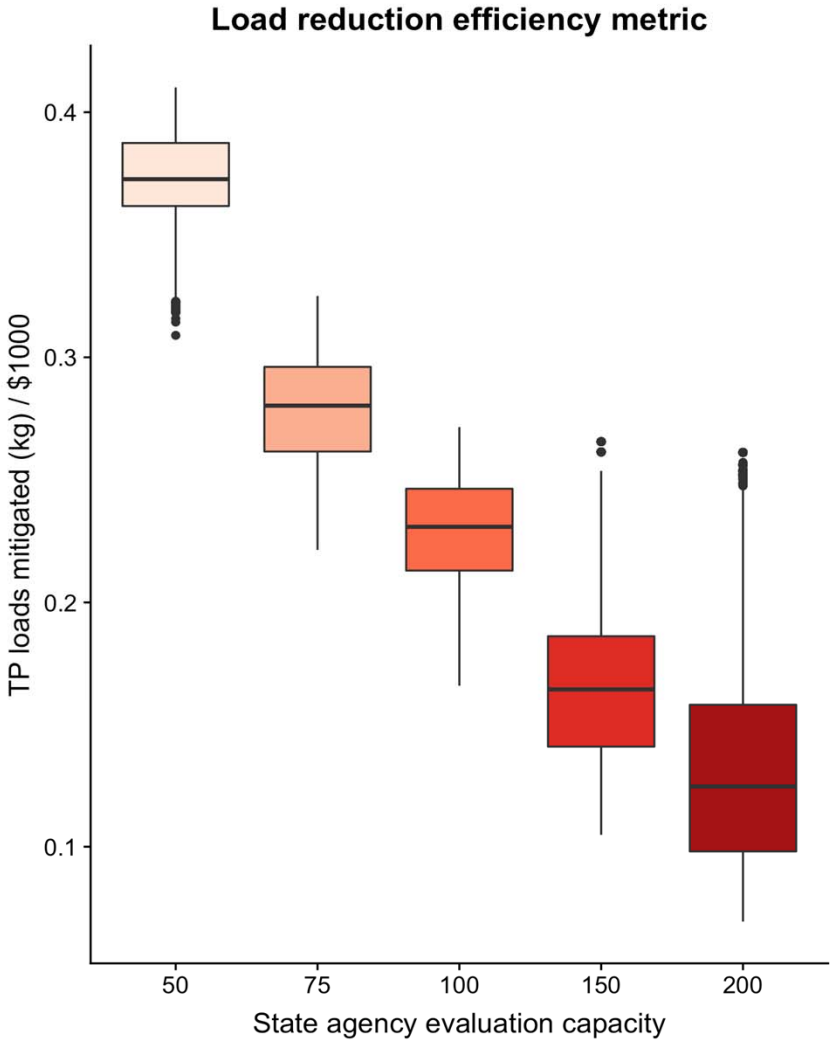
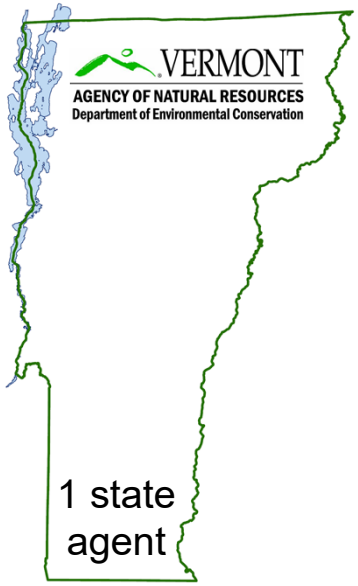
You motivate what you measure…



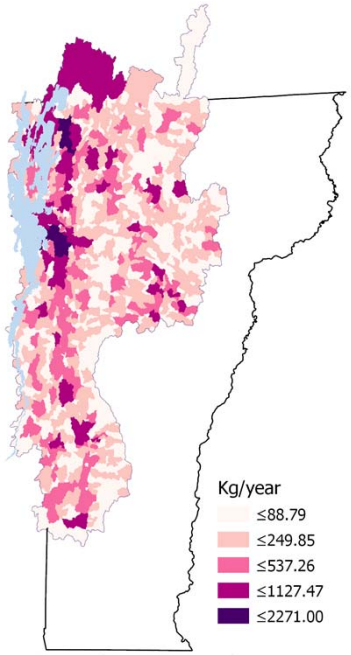


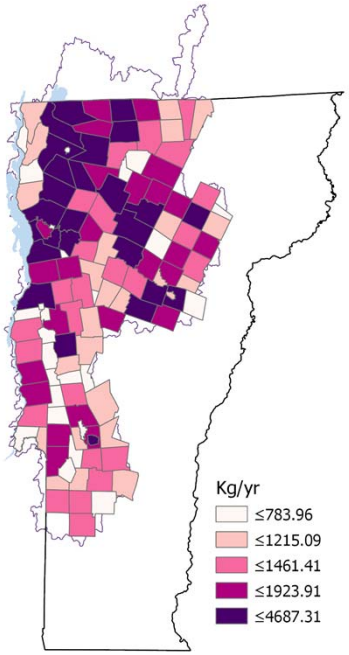
Governance ABM



1 state agent

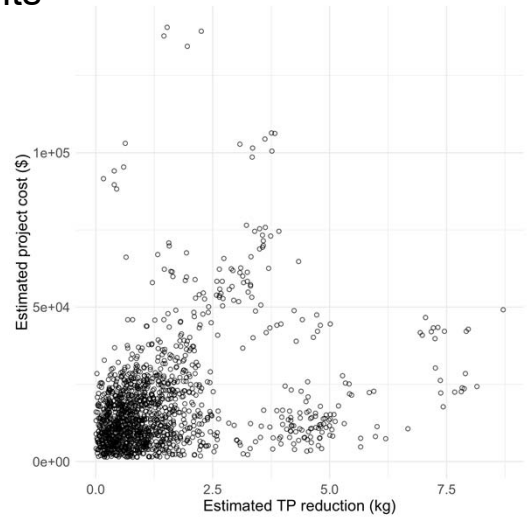
126 municipal agents

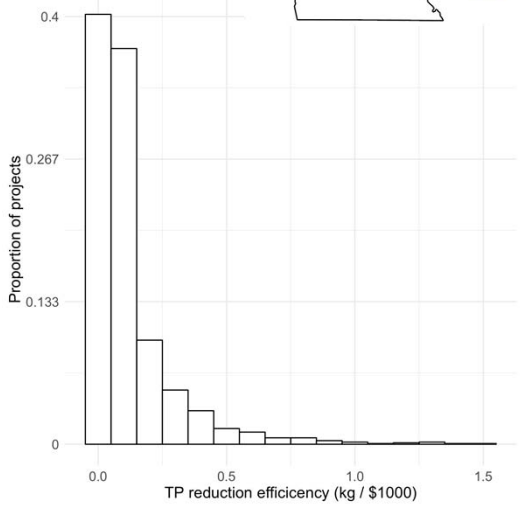




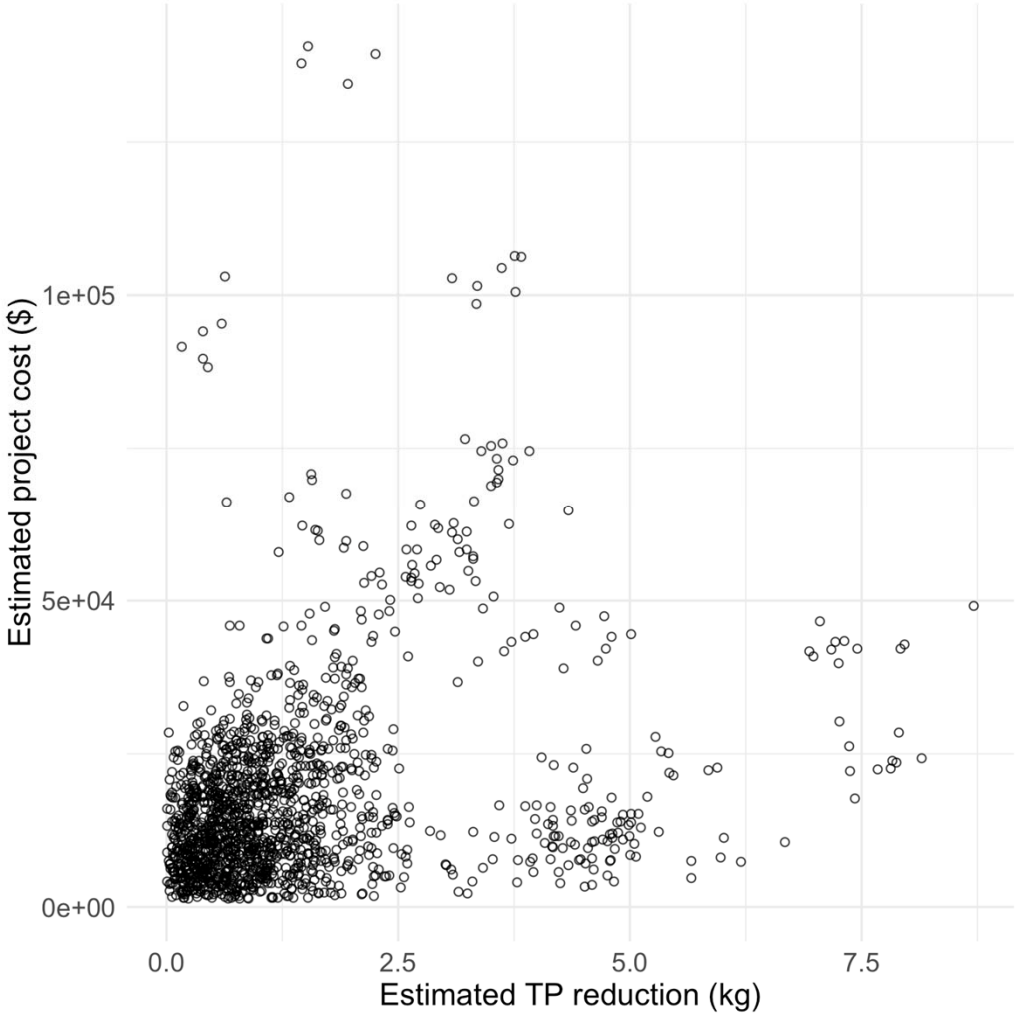
Spatially-explicit

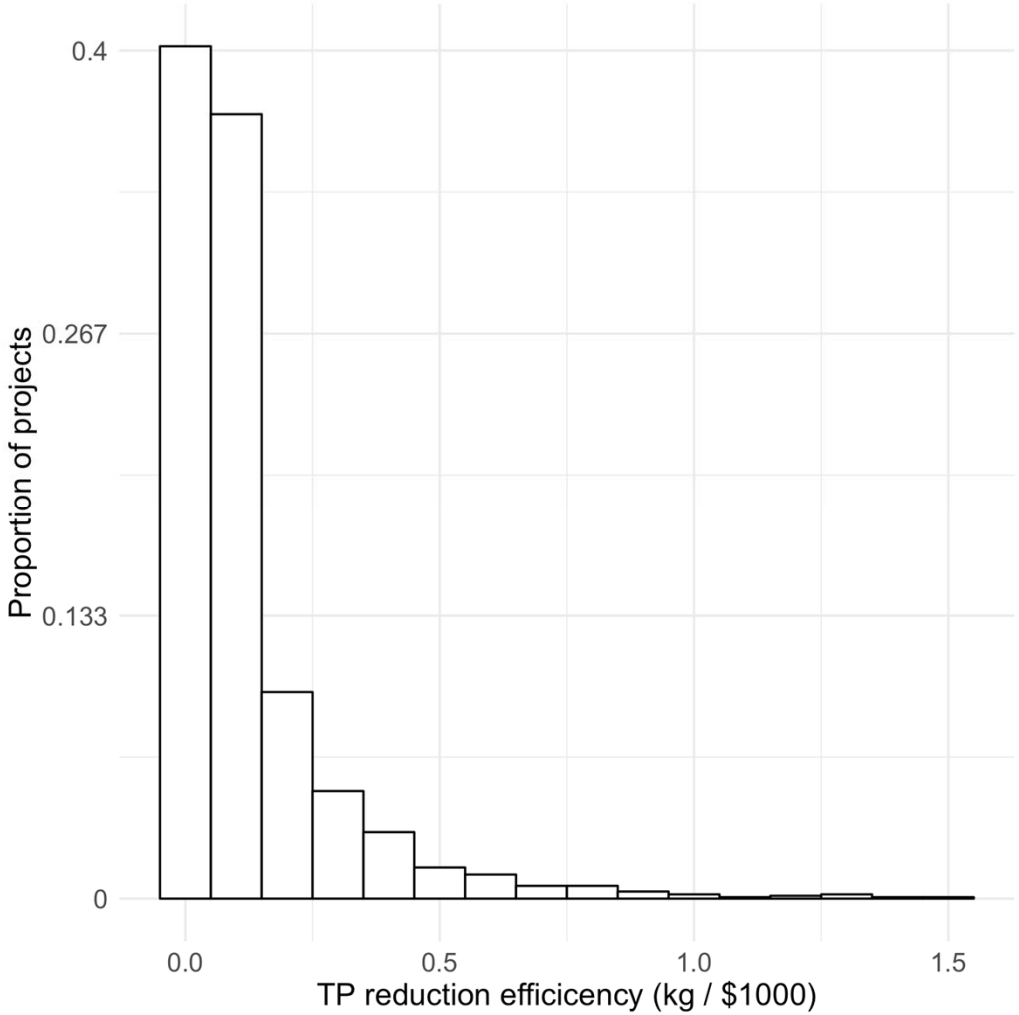
Empirically parameterized





Urban clean water projects empirical parameter distributions





Spatial mismatch between planning and implementation capacity