Key Findings and Methodological Advancements from the Social, Policy and Governance Components of RACC & the Status of RACC's Role in the Adaptive Management of the Lake Champlain Basin

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Social, Policy and Governance Science Team Leader

RACC Research Retreat

February 6, 2016

RACC Research on Adaptation to Climate Change

VERMONT EPSCoR

NEWRnet Delaware • Rhode Island • Vermont North East Water Resources Network

SEGS Lab Social Ecological Gaming & Simulation

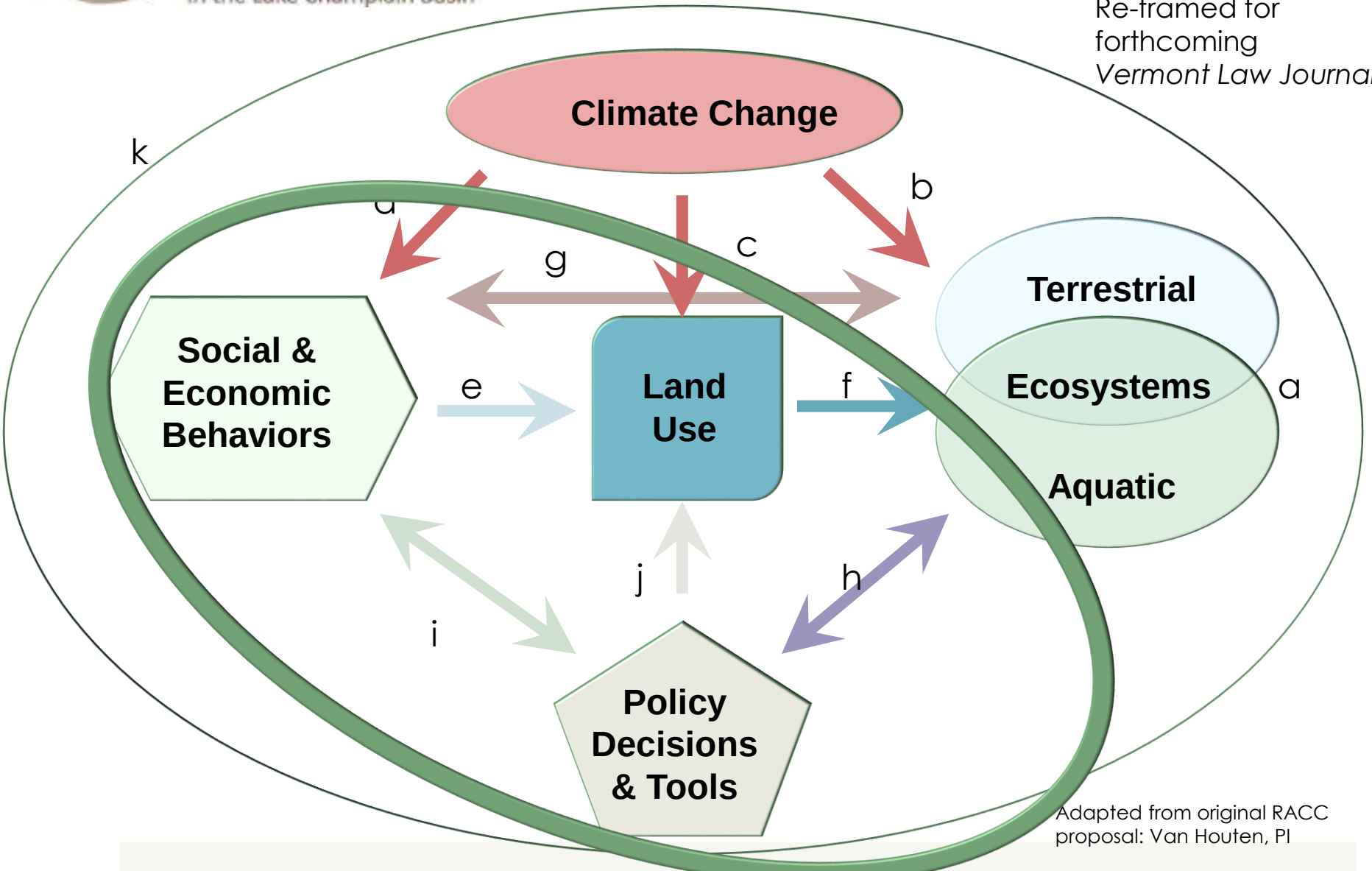
Social and Policy Science Core

- Sarah Coleman – Ph.D. Student (Plant and Soil Sciences)
- Yushiou Tsai – Postdoctoral Fellow, RACC
- Steven Scheinert – Postdoctoral Fellow, RACC
- Richard Kujawa, St. Michael's College (Environmental Policy and Studies)
- Clare Ginger, UVM (RSNR)
- Stephanie Hurley, UVM (Plant and Soil Sciences)
- Scott Merrill, UVM (Plant and Soil Sciences)
- Asim Zia, UVM (Community Development & Applied Economics)
- Chris Koliba, UVM (Community Development & Applied Economics)

RACC
Research on Adaptation to Climate Change in the Lake Champlain Basin

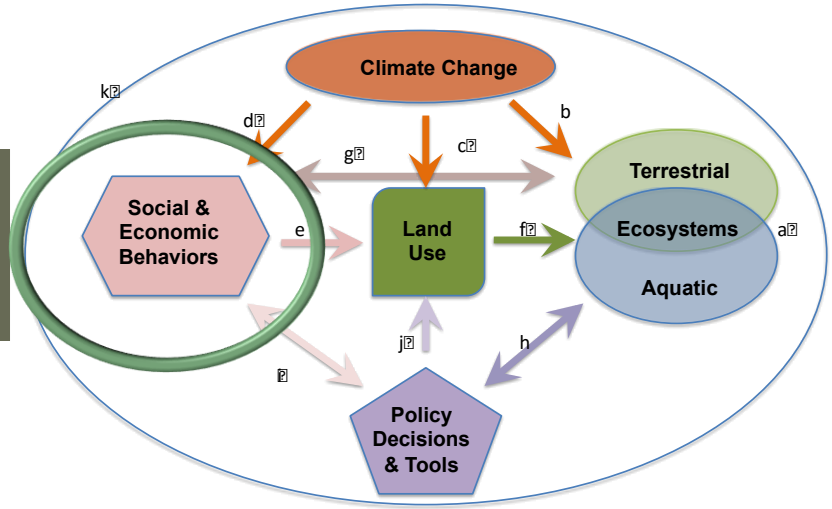
RACC Model: LCB as Complex Adaptive System

Re-framed for forthcoming *Vermont Law Journal*



Adapted from original RACC proposal: Van Houten, PI

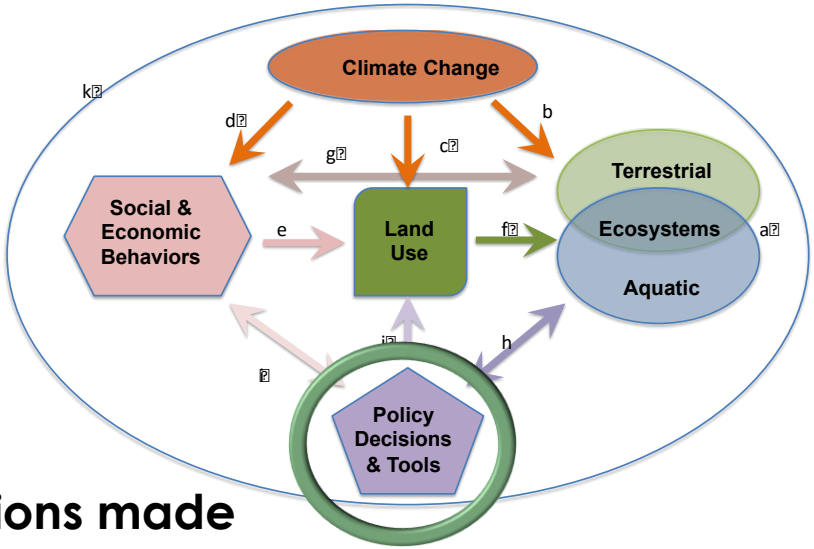
Social and Economic Behavior



- **How can social and economic behavior be modeled? (**Zia et al., in progress; Merrill et al., in progress; Miller et. al., under review; Zia et al., 2013)

METHODOLOGICAL ADVANCES: Triangulation of **agent based modeling (ABM)**, **experimentation games**, **focus group**, and **survey** techniques to deepen our understanding of human behavior.

Policy Decision, Tools and Governance



- **How and where are major policy decisions made (governance)?** (Koliba et al, 2014; Scheinert et al., 2015; Zia et al., 2013; Scheinert et al., submitted; Koliba et al., 2016)

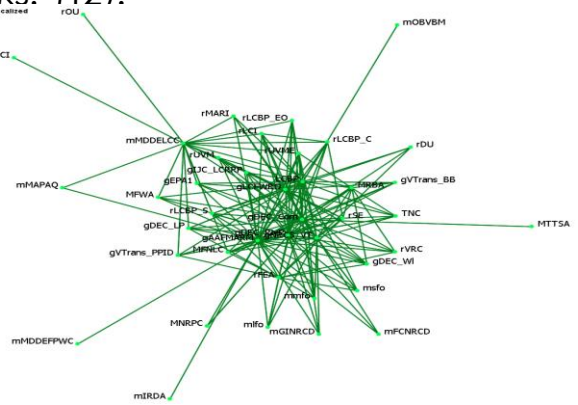
  METHODOLGOICAL ADVANCES: Network data being used to calibrate **Governance ABM**.

  Pioneered institutional network analysis techniques in the areas of **network boundary setting, task structure modeling, network growth and decay**, and **network authority structures**.

	TMDL	OFA
Node Count	48	75
Component Count	19	1
Isolate Count	16	0
Fragmentation	0.66	0.00
Degree Centralization	0.024	0.017
Betweenness Centralization	0.168	0.039
Eigenvector Centralization	1.356	1.068

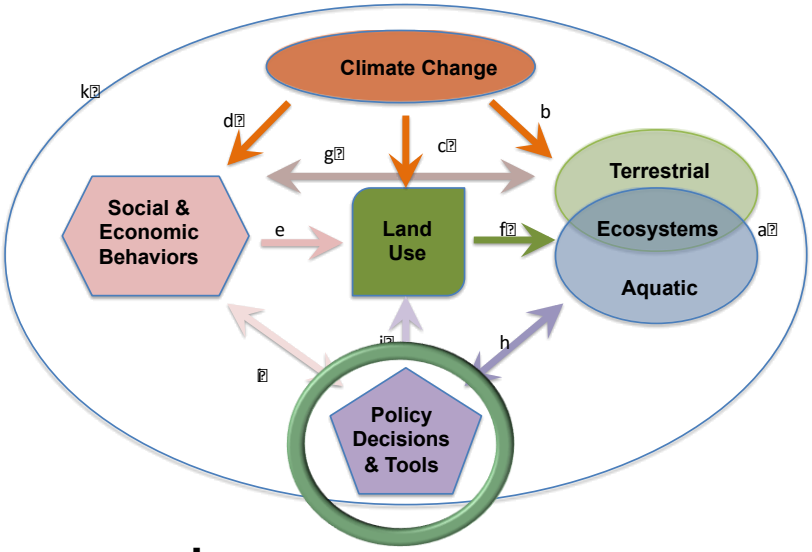
Advances in Institutional Network Analysis

Source: Koliba, C., Reynolds, A., Zia, A., and Scheinert, S. (accepted for publication). **Isomorphic Properties of Network Governance: Comparing Two Watershed Governance Initiatives in the Lake Champlain Basin Using Institutional Network Analysis.** *Complexity, Governance and Networks. 1(2).*



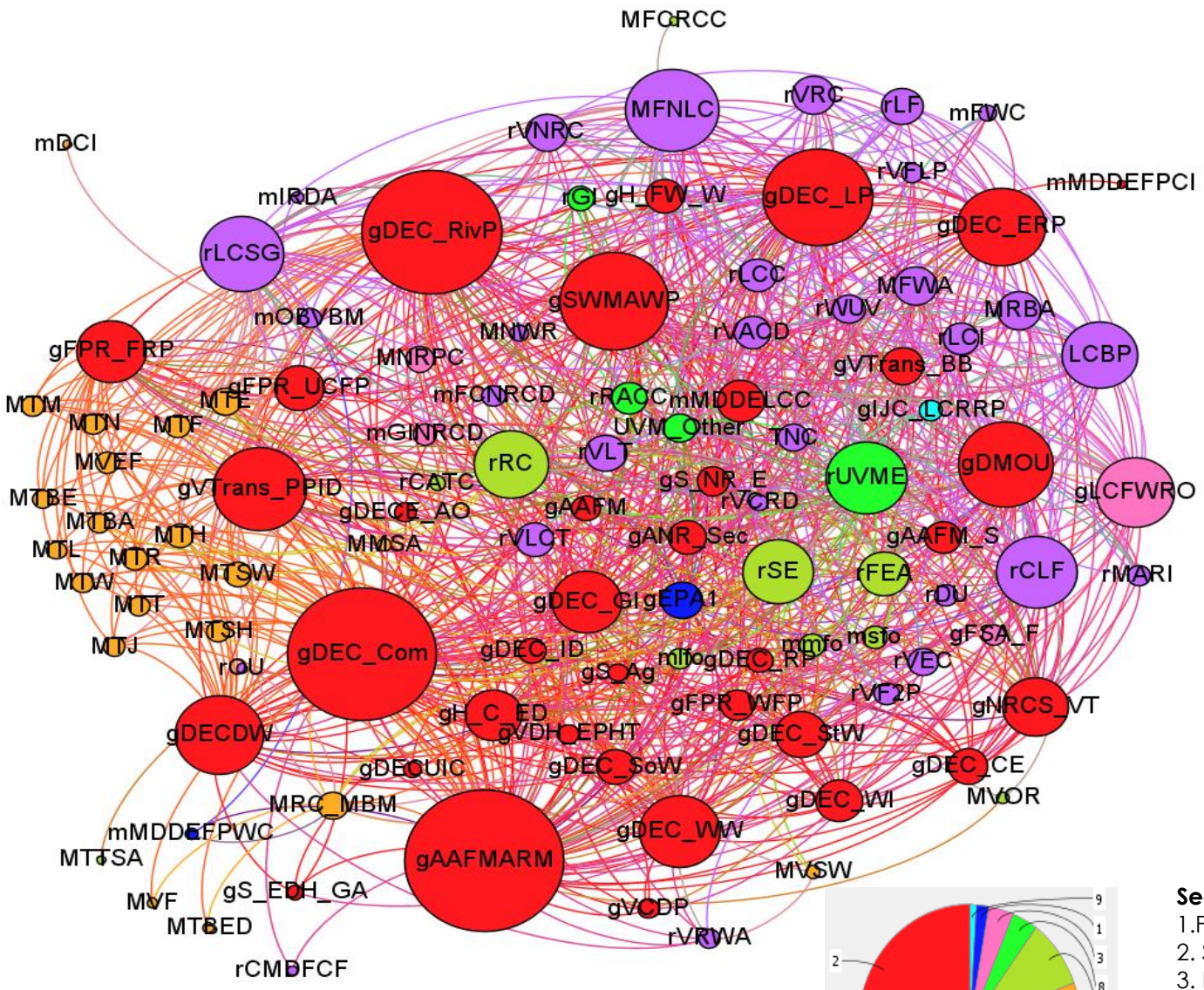
	Agriculture		Development		Forestry		Other		Full Plans	
	OFA	TMDL	OFA	TMDL	OFA	TMDL	OFA	TMDL	OFA	TMDL
	(n=80)	(n=93)	(n=48)	(n=129)	(n=2)	(n=20)	(n=63)	(n=43)	(n=193)	(n=285)
Economic Regulation	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
Env. Regulation†	32.5%	19.4%	20.8%	17.8%	0.0%	10.0%	9.5%	11.6%	21.8%	16.8%
Permits†	2.5%	2.2%	14.6%	7.8%	0.0%	5.0%	0.0%	2.3%	4.7%	4.9%
Public Information†‡	33.8%	46.2%	52.1%	45.7%	50.0%	50.0%	74.6%	53.5%	51.8%	47.4%
Contracts*†‡	1.3%	2.2%	4.2%	2.3%	50.0%	0.0%	3.2%	2.3%	3.1%	2.1%
Grants†	25.0%	16.1%	4.2%	10.1%	50.0%	15.0%	19.0%	11.6%	18.1%	12.6%
Loans and Guarantees	0.0%	1.1%	0.0%	3.9%	0.0%	5.0%	0.0%	0.0%	0.0%	2.5%
Tax Incentives	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	2.3%	0.0%	0.7%

Policy Decision, Tools and Governance

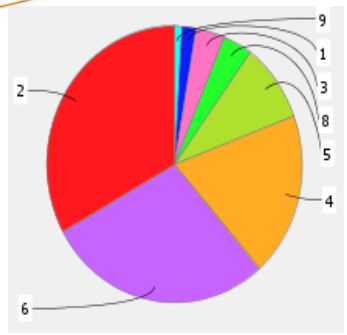


- **How and where are major policy decisions made (governance)?** (Koliba et al, 2014; Scheinert et al., 2015; Scheinert et al., submitted; Scheinert et al., in progress)

  KEY FINDINGS: Robust governance networks exist to support water quality management in the LCB. These networks are **dominated by state agencies**. Recent coordination between state agencies has resulted in new policy window for the region (see development of VT Clean Water Policy).



Scheinert et al., 2014



2014 Water Quality Technical Assistance Network for Missisiquoi Watershed

Sector Label Key:

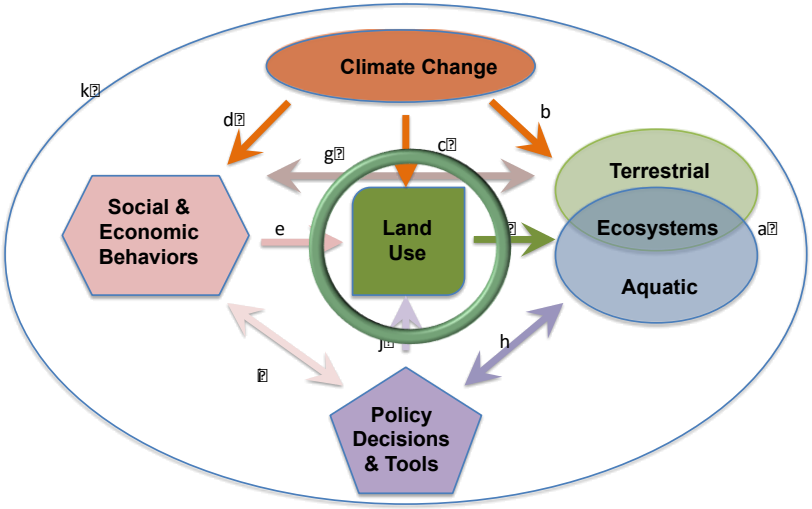
1.Federal Governing Actors
2. State/Provincial Governing Actors
3. Regional/Geo-governing Actors
4. Local/Municipal Governing Actors
5. Private (For-Profit) Enterprise
6. Non-Governmental and Non-Profit Org.
7. Citizen Actors
8. Research Actors
9. International Governing Actors

Subnetwork structures differentiated by:

- **Policy Domain**
  - -Storm water -Wastewater -Agriculture
  - -Development -River corridor -Forestry
- **Policy Tool**
  - -Grants -Contracts -Cost share
  - -Permits -Easements -Technical assistance
- **Action Arena**
  - -Tactical Basin Planning -Regional Planning -TMDL
  - -Agriculture technical assistance

(Scheinert et al., in progress; Koliba et al., in progress)

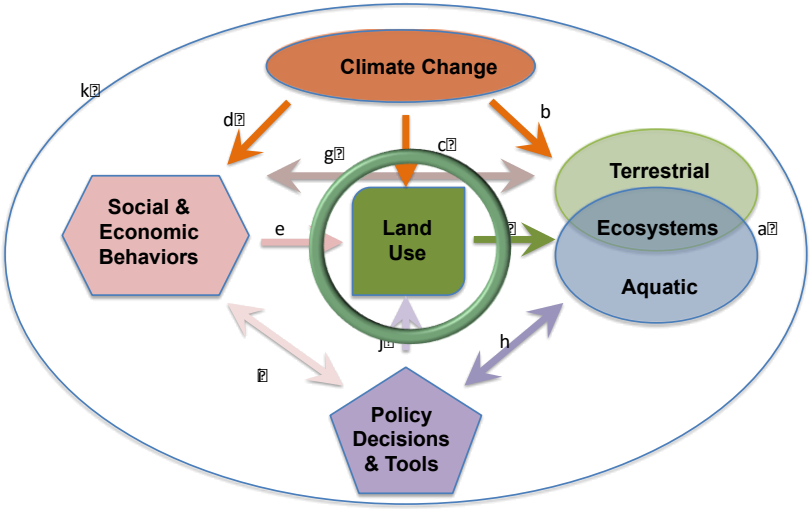
Land Use



- **What has been the historical land use pattern for specific watersheds in the LCB?** (Tsai et al., 2015)

METHODOLGICAL ADVANCE: **Agent-based modeling** of land use and land transitions constructed and calibrated to 1990 land use patterns by classifying **both land users and land parcels as agents.**

Land Use

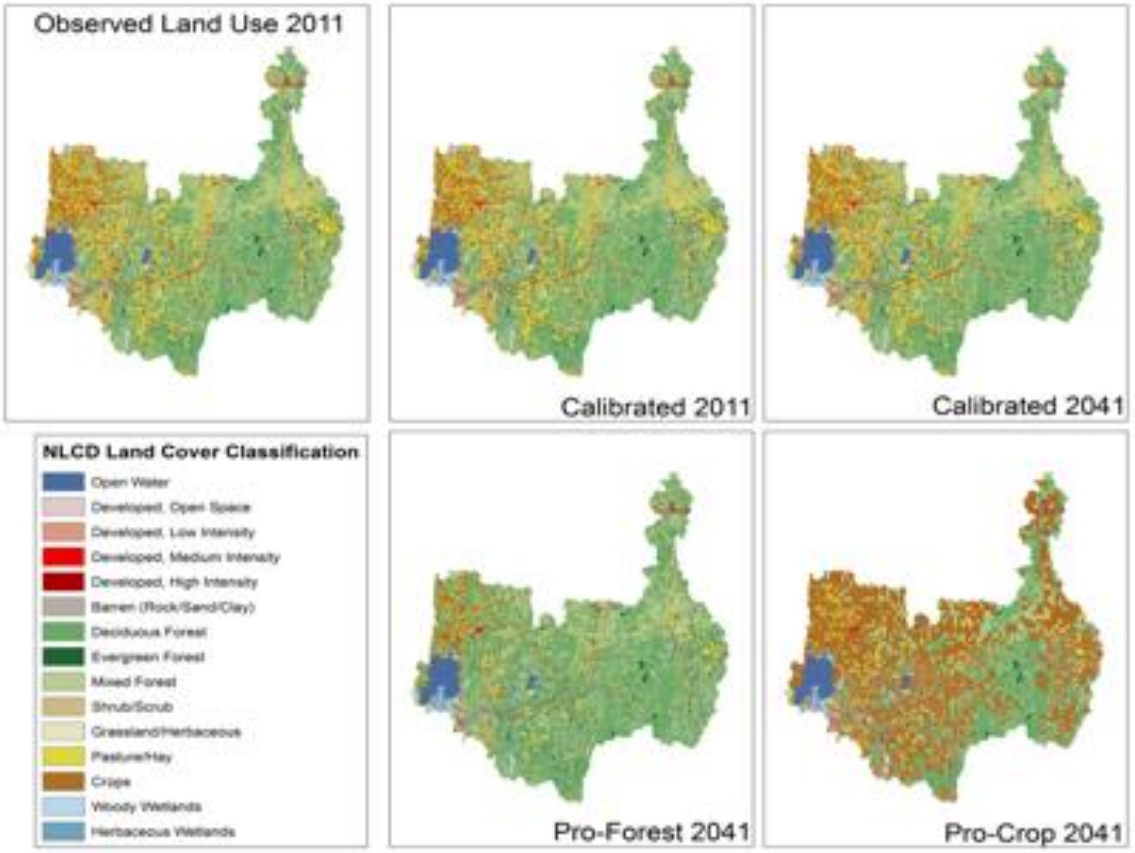


- **How can land use scenarios and possible interventions shape land use patterns?** (Tsai et al., in progress; Coleman, close to sub.)

KEY FINDING: Pro-agricultural, pro-forestry and pro-development land use **scenarios extending to 2040** have been devised.

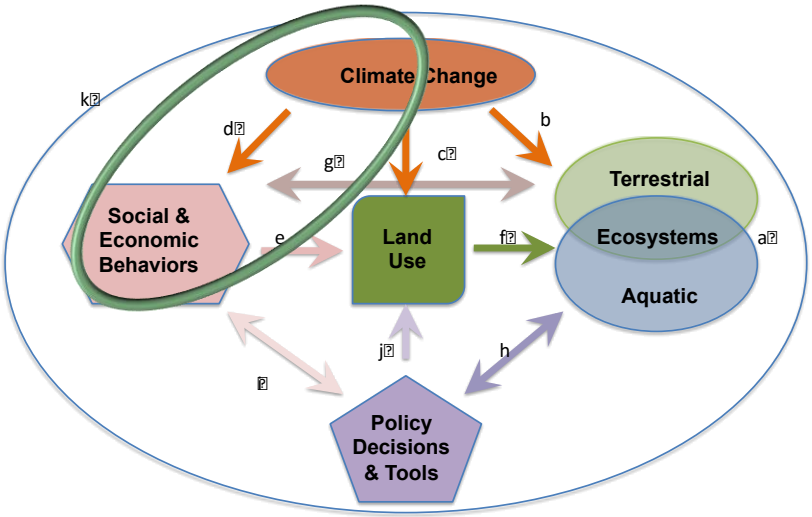
METHODOLOGICAL ADVANCE: Novel uses of **crowdsourcing** to garner stakeholder input on innovative policy interventions.

Land Use Scenarios Projected to 2040



(Tsai et al., in progress)

Social and Economic Behavior and Climate Change



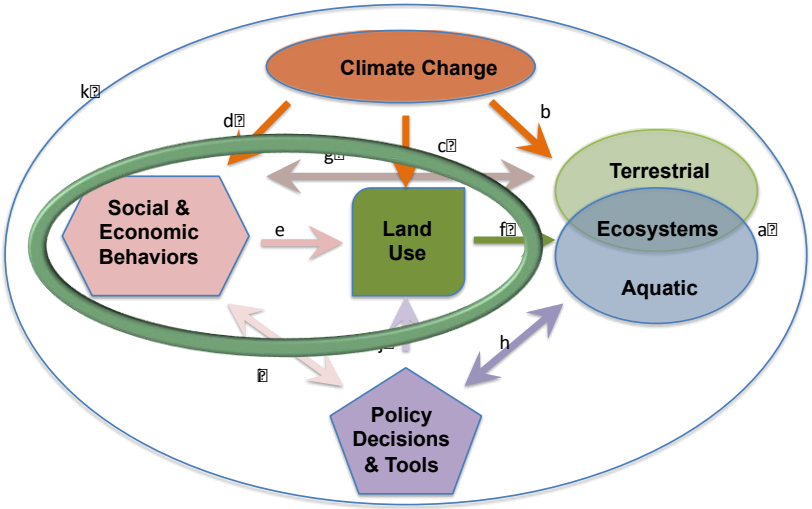
- **What are the public's perceptions of climate change and how do their ideological orientations and exposure to disastrous impacts of extreme events influence these perceptions?** (Zia at el., 2014.; Koliba et al., 2014)

KEY FINDING: Exposure to **extreme events** may not alter perceptions of Climate Change.

Ideological orientation of respondant most often drives perception of climate change.

Overall, Vermonters are concerned about climate change.

Social and economic behavior and Land use



- **How do land management customs, knowledge, preferences shape landscape and land management practices?** (Tsai et al., 2015; Zia et al., 2014; Merrill et al., in progress; Miller et al., under review; Coleman, close to sub.; Hurley et al., in progress)

KEY FINDINGS: **Economic conditions** of farming enterprise drive land use transition (Tsai et al., 2015)

Economic health of farms drives land use

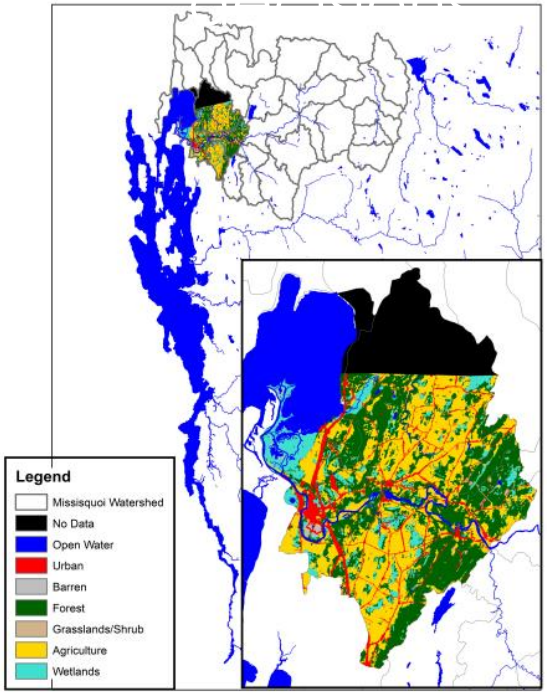


Fig. 2. The western Missisquoi Watershed (colored area) versus the entire Missisquoi Watershed. The colored area displays the observed land-use pattern of the NLCD 1992 eight-class classification system.

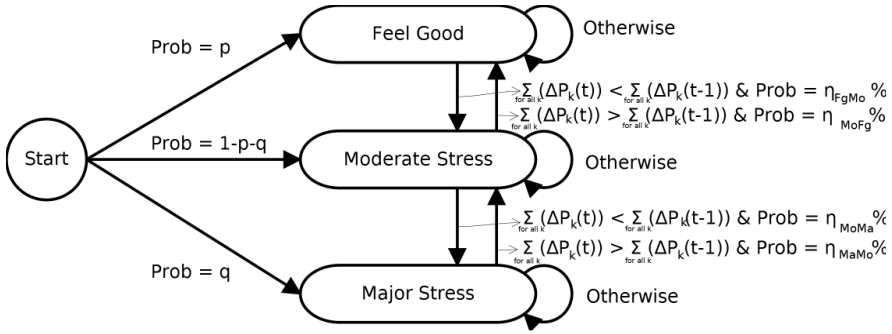
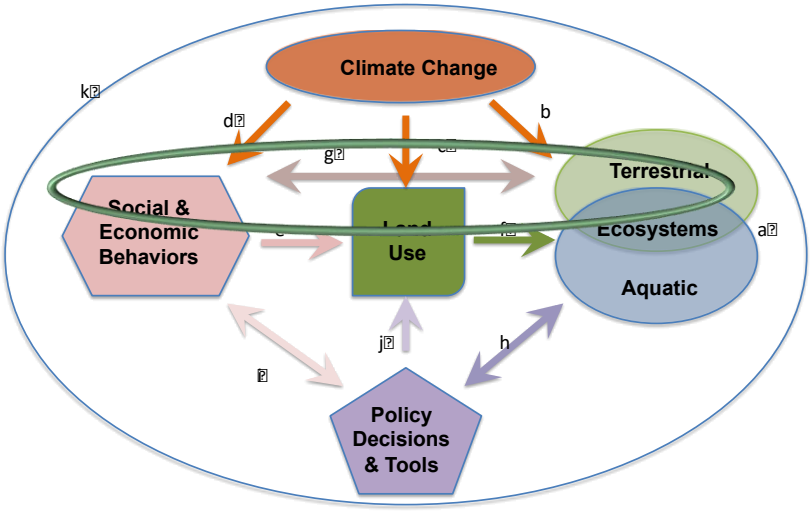


Fig. 4. The dynamics of the farmers' financial conditions over time. η_{FgMo}%, η_{MoFg}%, η_{MoMa}% and η_{MaMo}% are probabilities that a farmer's financial conditions change from one state to another in year t. (change Produtivity(t) to sum(P_i(t))

Tsai et al., 2015

Terrestrial and aquatic systems and Social and economic behavior



- **How and to what extent does the public value water quality? What factors influence pro-environmental preferences?** (Koliba et al., 2014)

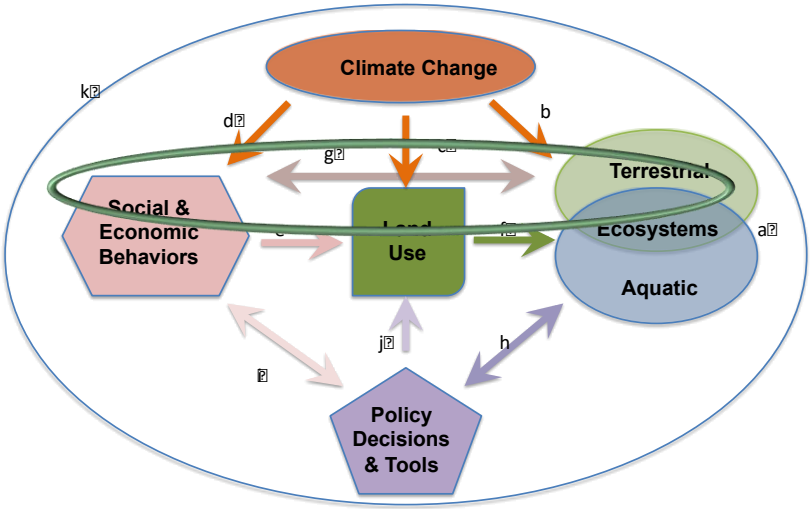
  KEY FINDINGS: A Vermonter's level of use of natural resources for **recreational activities** is positively correlated to the support for **water quality.**

  Blue green algae blooms shaped by the **social and economic** behaviors of land users (Zia et al., IAM)

- **How does declining water quality impact economic behavior?** (Zia and Low, 2013)

  KEY FINDING: **Housing prices** close to polluted parts of Lake Champlain have dropped, in part due to **poor water quality**.

Terrestrial and aquatic systems and Social and economic behavior



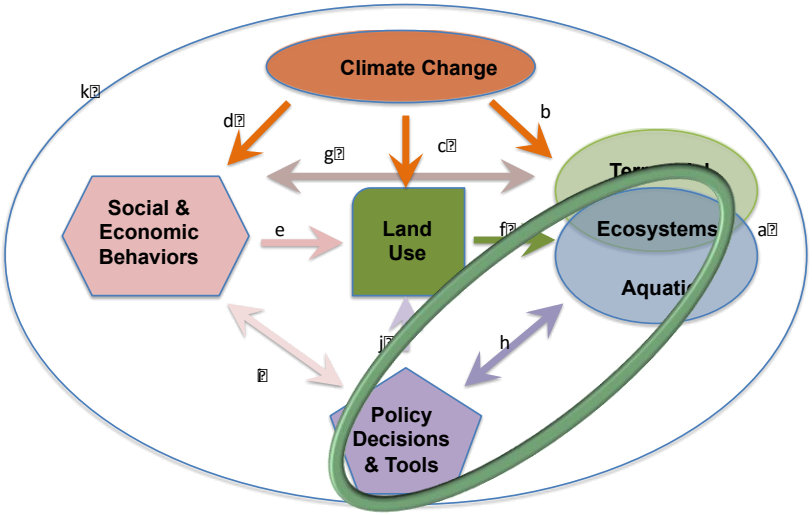
- **How do social and ecological behaviors shape hydrological dynamics (stream flow and lake)?** (Tsai, et al., work in progress; Zia et al., IAM)

  METHDOLOGICAL ADVANCE: A critical component of the RACC IAM.

- **How is the social and economic behavior shaped by lake water quality?** (Koliba et al., 2014; Scheinert et al., 2014)

  KEY FINDING: The public's support of **water quality** is **not spatially constrained** by proximity to LC,

Policy decisions, tools and governance and Terrestrial and aquatic systems



- **What has been the policy response to decreasing water quality in Lake Champlain?** (Koliba et al., 2013; Scheinert et al., 2014; Scheinert et al., 2015; Koliba et al., 2014; Coleman, in progress).

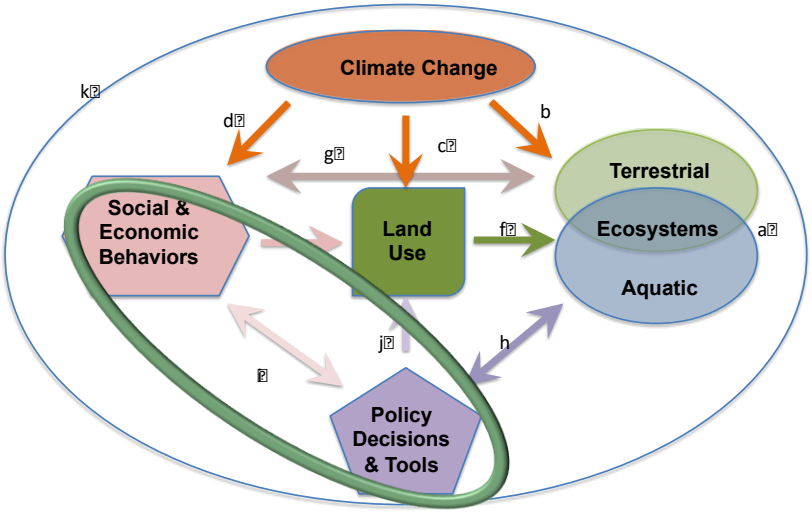
KEY FINDINGS: After study of the 2011 Opportunities for Action and the then draft TMDL plan, we conclude that both plans recommend a similar **balance of regulatory and incentives-based policy tools** to advance water quality goals, suggesting a consensus forming around policy options.

Vermonters see it as the role of **state government**, then **individuals**, to insure water quality.

Vermonter's see **water quality as a statewide concern**. They are **willing to pay for water quality** to certain levels and through certain policy tools.*

* Used to inform some aspects of Act 64

Policy decisions and tools
Social and economic behavior

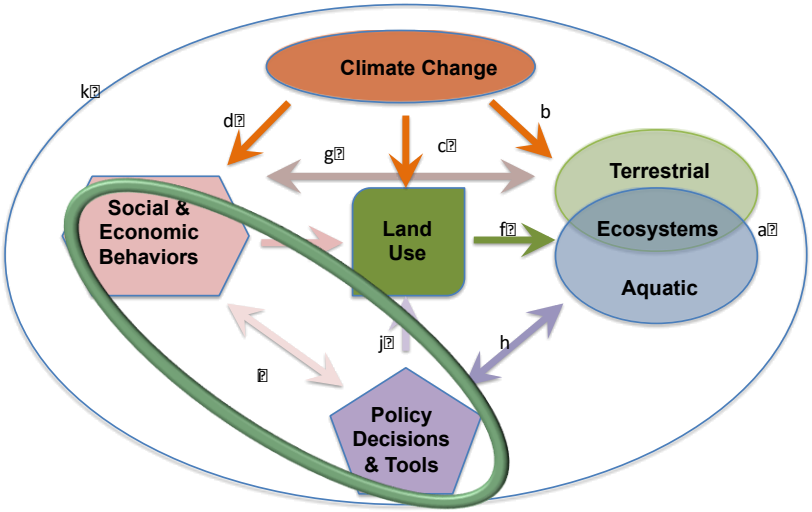


- **How do public policies shape human behavior?** (Zia et al., 2014; Merrill et al., 2015; Miller et al., under review; Tsai et al., 2015; Scheinert et al., 2016)

METHODOLIGICAL ADVANCES: **Policies can be used to sanction or reward** certain behaviors and these policy mixes can be simulated.

The flow of **financial resources** to incentivize behaviors can be simulated.

Policy decisions and tools
Social and economic behavior



- **How do public policies shape hum**
  (Zia et al., in progress; Zia et al., 2014; Merrill et al., 2015; Miller et al., under review; Tsai et al., 2015; Scheinert et al., 2016; Hurley et al., in progress)

KEY FINDINGS: **Familiarity with and/or capacity to implement** specific best management practices (such as riparian buffers, cover cropping, and conservation tillage) influences an actor's willingness to adopt certain practices.

Households willing to pay to install **green infrastructure** at specific levels.

BMP adopters may be groups as utility maximizers, altruists and learners.

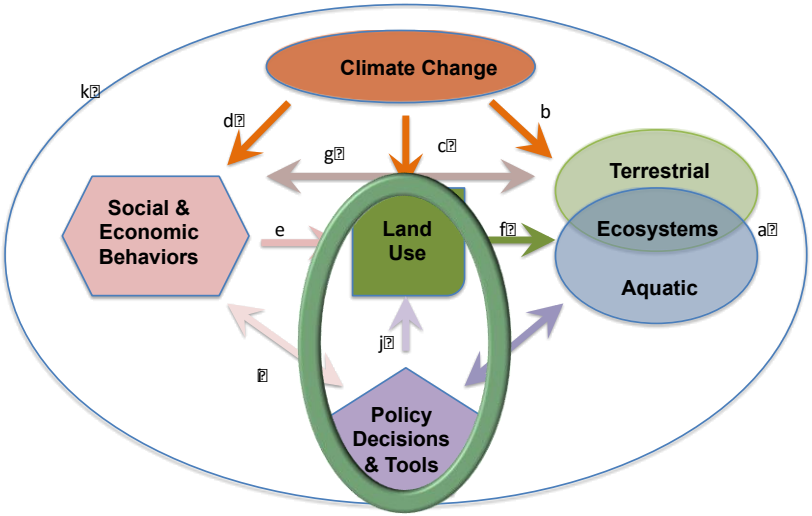
"Locus of Control" very important for the adoption of farming best management practices (BMPs)

Table 2: Weighted OLS Regression Models Predicting Farmer Intention to Adopt Nutrient Management Practices in Missisquoi and Lamoille Watersheds (N=80)

	Planned Crop Rotations	Soil Test at least every three years	Strip Cropping	N, P & K Applications at rates recommended by soil tests	Buffers at field edges
Past Practice	0.6889** (0.2182)	0.1248 (0.2407)	0.9137** (0.4307)	-0.0274 (0.2103)	0.7296** (0.3449)
Attitude	-0.2184 (0.1663)	0.1425 (0.1330)	-0.2848 (0.2388)	0.1429 (0.1389)	-0.3071* (0.1797)
Perceived Social Norm	Omitted due to MC	Omitted due to MC	Omitted due to MC	0.1556* (0.0890)	0.1854 (0.1259)
Perceived Behavioral Control	0.9077*** (0.1378)	0.7750*** (0.0924)	0.8056*** (0.2437)	0.8672*** (0.0936)	0.7883*** (0.1034)
Constant	-0.7445** (0.2467)	1.0419** (0.4376)	0.3423** (0.0932)	-0.7398** (0.2663)	-0.7516 (0.3064)
R^2 and (BIC)	0.7354 (343.70)	0.6984 (338.98)	0.8163 (264.53)	0.7909 (321.23)	0.6522 (372.31)

Source: Zia at al, 2013 Farmer BMP Survey, University of Vermont

Policy decisions, tools and governance and Land use

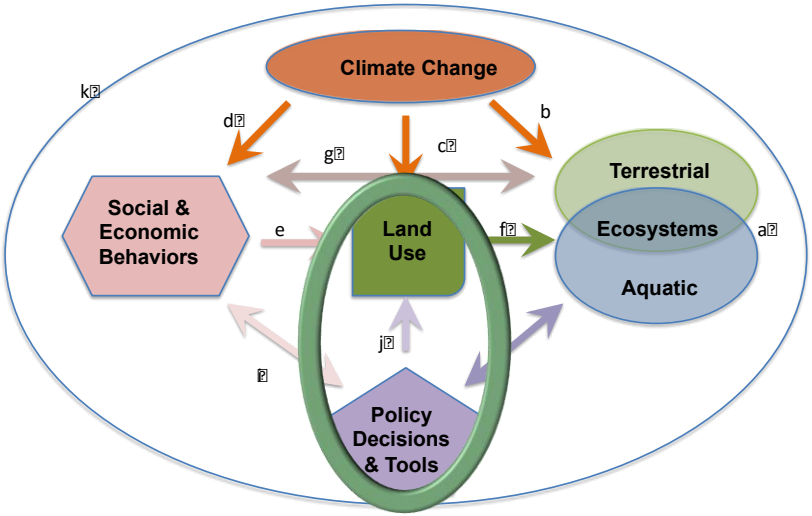


- **How do resources allocated through governance networks impact land use, land use transitions and land management practices?** (Koliba et al., 2013; Zia et al., 2013; Koliba et al., 2014; Scheinert et al., 2014; Scheinert et al., 2015; Zia et al., in progress)

METHODOLOGICAL ADVANCES: Have linked **experimental game results with land use ABM**s.

KEY FINDING: Robust governance network exists and are dominated by state level actors and constrained by **federal level program rule structures**.

Policy decisions, tools and governance and Land use



- **Does the existing network structure provide sufficient capacity to support the implementation of Act 64 and a range of (other) innovative policy scenarios?** (Coleman, close to submission; Scheinert et al., in progress)

KEY FINDINGS: Over **55 policy interventions** were developed through the use of innovative Delphi techniques.

The **network capacity** of dozen key interventions is being studied.


RACC
Research on Adaptation to Climate Change
Crowdsourcing Solutions to Climate Change for the Lake Champlain Basin
Logout
Introduction & Directions
Personal Information
Background Materials
My Interventions
All Interventions
General Discussions
My Interventions: Envisioning climate change adaptation interventions
Save
Considering the problems of climate change and water quality, please suggest one or more adaptive interventions to address these issues using the form below. Material is available under tabs "BACKGROUND MATERIALS" to provide context and inspiration. Please click on the help icons for instructions on completing each field, or refer to the introduction for more information.
Chris Koliba's Interventions
Primary Domain
Scope
Title
Rationale
Comments

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RACC
Research on Adaptation to Climate Change

Q3: Social and Policy Science Team Main Question:

In the face of uncertainties about climate change, land use and lake response scenarios, how can <u>adaptive management</u> interventions (e.g. regulation, incentives, treaties) be *designed*, valued and implemented in the multi-jurisdictional Lake Champlain Basin?

Adaptive management is a systematic process for improving management policies and practices by **<u>learning from the outcomes of management strategies</u>** that have already been implemented. Adaptive water management aims to increase the adaptive capacity of the water system by putting in place both learning processes and the conditions needed for learning processes to take place.

(Geldof 1995, Pahl-Wostl 2004, 2007)

EPS 1101317

RACC Role in Adaptive Management*

"Providing basic research and action science that leads to optimal scenarios: Influencing the public and policy makers: Resolving complex, multi-stakeholder issues"

- Quality of scientific awareness and understanding of **social dimensions of change**
- Quality of scientific awareness and understanding of the **ecological components of change**
- Ability to understand **social-ecological dynamics of change**
- Ability to **frame and message** the socio-ecological dynamics of change
- Ability **to influence socio-ecological adaptation** at scale

*Culled from "Building a Culture of Water Quality" Process – Echo Center

Some Key Partners:

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

Stakeholder scenario generation

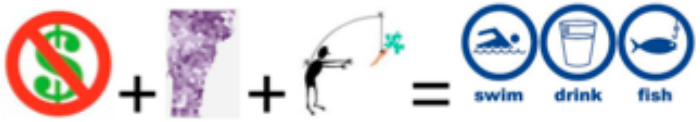
"Mediated Modeling" Workshops :

CLIMATE CHANGE IMPACTS:
November 2012

WATER QUALITY INTERVENTION DEVELOPMENT:
March -May 2014

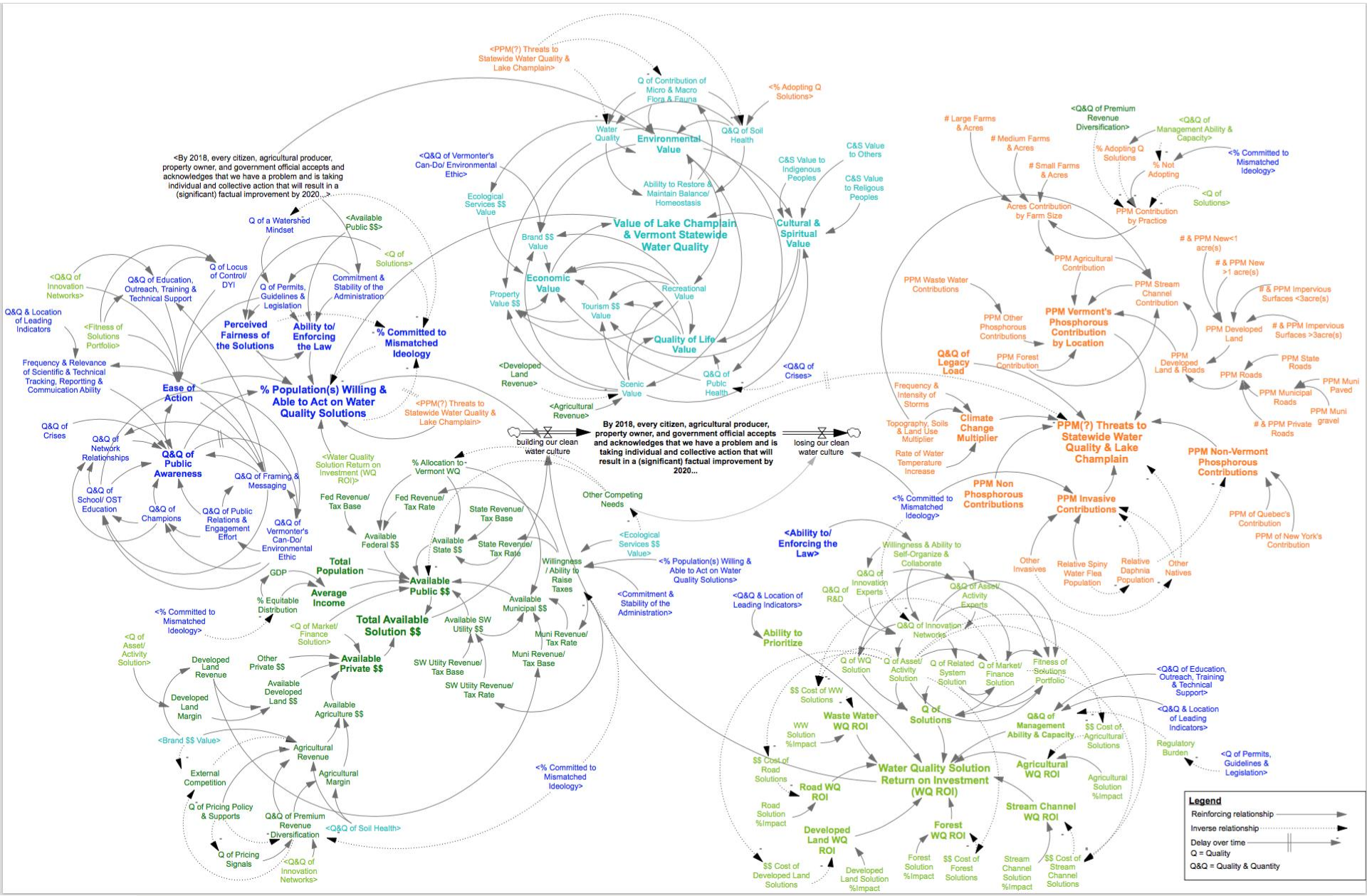
WATER QUALITY SCENARIO DEVELOPMENT:
October 2015

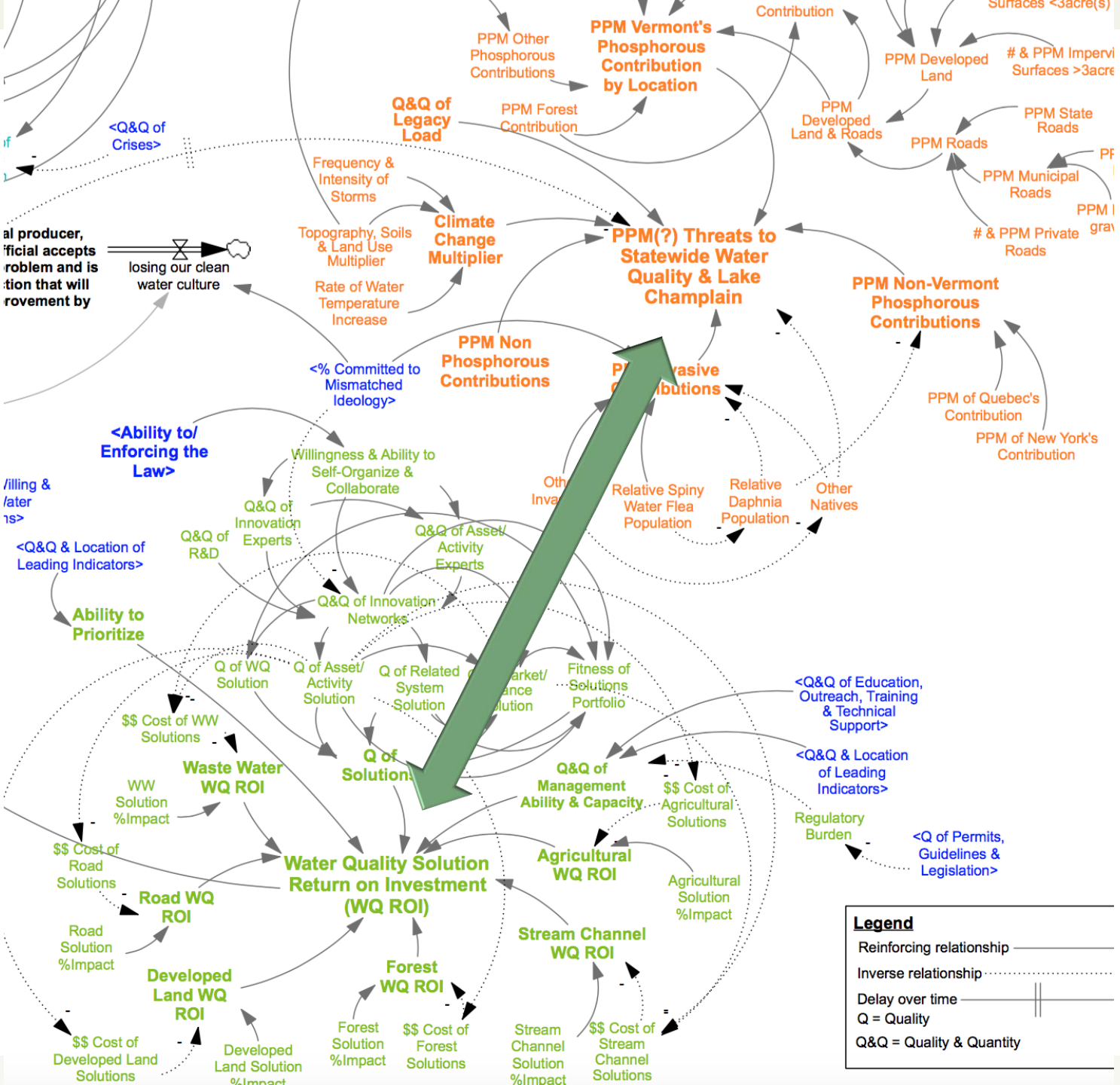
WATER QUALITY SCENARIO ASSESSMENT: late Spring 2016

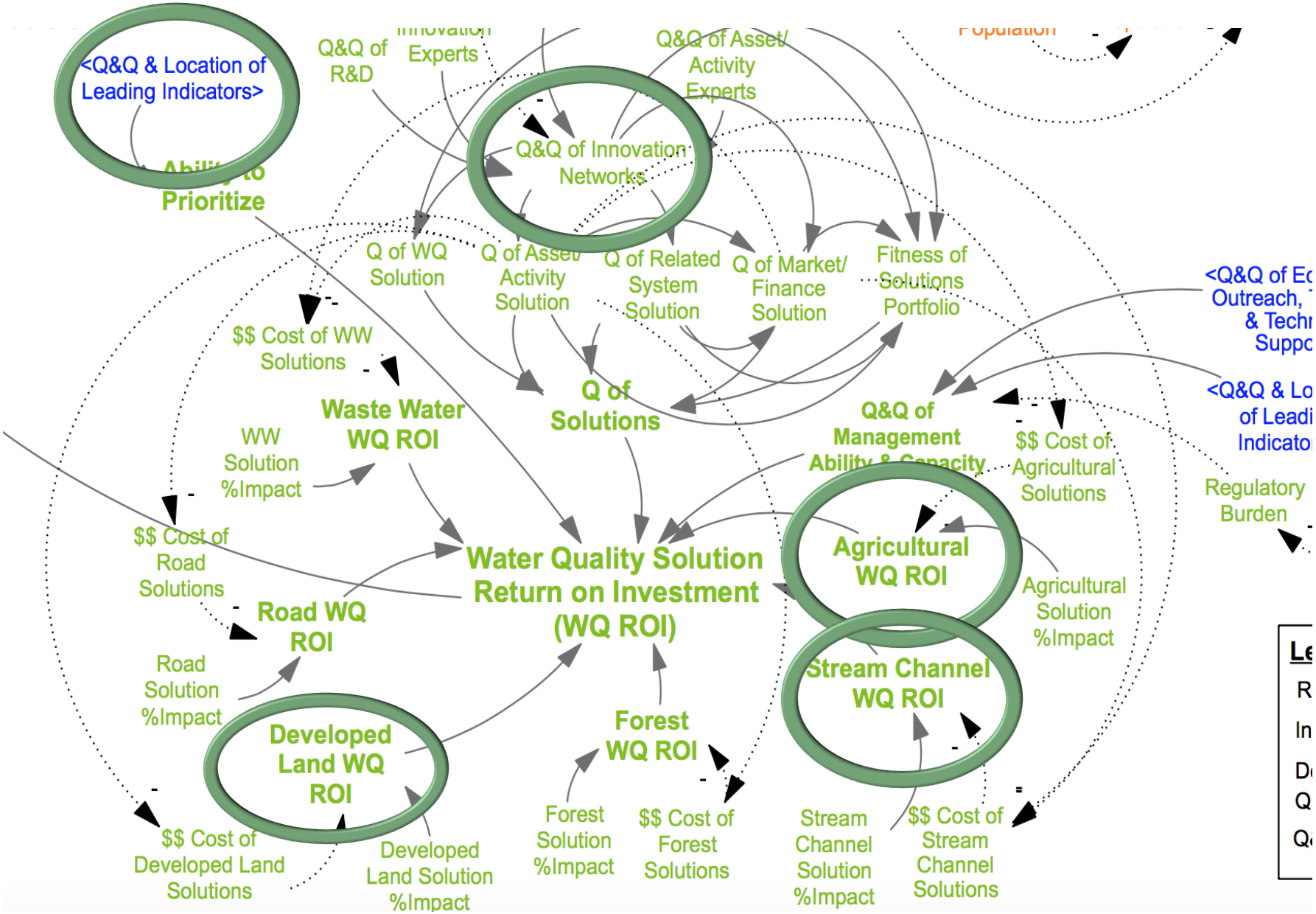


Scenario A:
In the midst of resource scarcity, with little political will or financial capacity to regulate for clean water protection, states and local governments operating in parallel rely heavily on market-based incentives and what federally-sourced incentives are available for clean water protection in the Lake Champlain Basin .

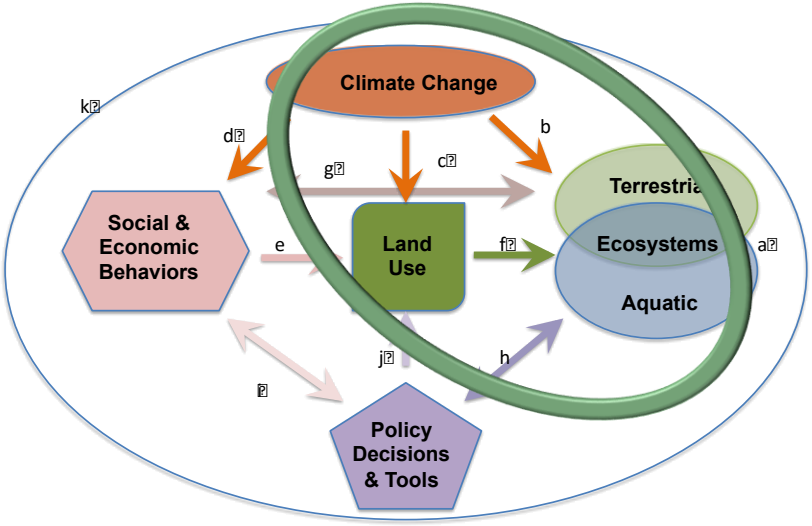
"CULTURE OF CLEAN WATER" SYSTEMS ANALYSIS




PPM Other Phosphorous Contributions
PPM Vermont's Phosphorous Contribution by Location
Contribution
PPM Developed Land
& PPM Impervi Surfaces >3acre
Surfaces <3acre(s)
Q&Q of Legacy Load
PPM Forest Contribution
PPM Developed Land & Roads
PPM State Roads
PPM Roads
PPM Municipal Roads
& PPM Private Roads
<Q&Q of Crises>
Frequency & Intensity of Storms
Topography, Soils & Land Use Multiplier
Climate Change Multiplier
Rate of Water Temperature Increase
PPM(?) Threats to Statewide Water Quality & Lake Champlain
losing our clean water culture
PPM Non-Vermont Phosphorous Contributions
PPM of Quebec's Contribution
PPM of New York's Contribution
<% Committed to Mismatched Ideology>
PPM Non Phosphorous Contributions
<Ability to/ Enforcing the Law>
Willingness & Ability to Self-Organize & Collaborate
Relative Spiny Water Flea Population
Relative Daphnia Population
Other Natives
Q&Q of Innovation Experts
Q&Q of R&D
Q&Q of Asset/ Activity Experts
<Q&Q & Location of Leading Indicators>
Q&Q of Innovation Networks
Ability to Prioritize
Q of WQ Solution
Q of Asset/ Activity Solution
Q of Related System Solution
Fitness of Solutions Portfolio
$$ Cost of WW Solutions
Waste Water WQ ROI
WW Solution %Impact
Q of Solutions
<Q&Q of Education, Outreach, Training & Technical Support>
<Q&Q & Location of Leading Indicators>
Q&Q of Management Ability & Capacity
$$ Cost of Agricultural Solutions
Regulatory Burden
<Q of Permits, Guidelines & Legislation>
$$ Cost of Road Solutions
Water Quality Solution Return on Investment (WQ ROI)
Agricultural WQ ROI
Agricultural Solution %Impact
Road WQ ROI
Road Solution %Impact
Stream Channel WQ ROI
Developed Land WQ ROI
Forest WQ ROI
$$ Cost of Developed Land Solutions
Developed Land Solution %Impact
Forest Solution %Impact
$$ Cost of Forest Solutions
Stream Channel Solution %Impact
$$ Cost of Stream Channel Solutions
Legend
Reinforcing relationship
Inverse relationship
Delay over time
Q = Quality
Q&Q = Quality & Quantity

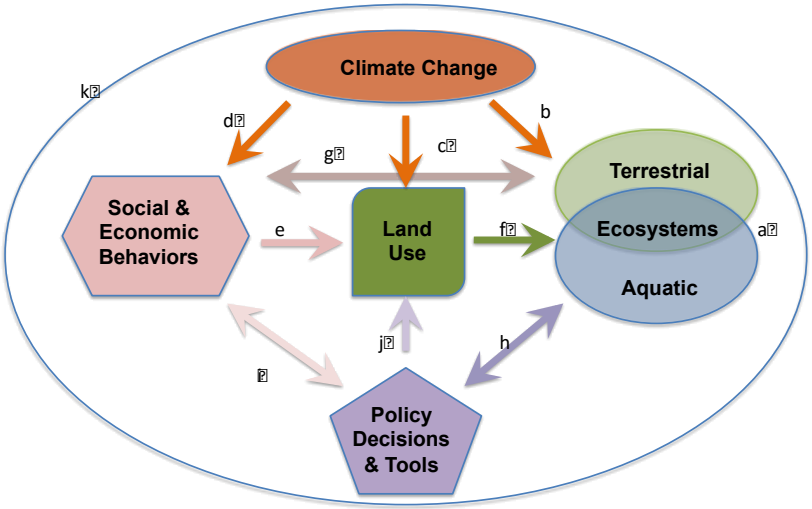

<Q&Q & Location of Leading Indicators>
Ability to Prioritize
Q&Q of R&D
Innovation Experts
Q&Q of Asset/ Activity Experts
Q&Q of Innovation Networks
Q of WQ Solution
Q of Asset/ Activity Solution
Q of Related System Solution
Q of Market/ Finance Solution
Fitness of Solutions Portfolio
$$ Cost of WW Solutions
Waste Water WQ ROI
WW Solution %Impact
Q of Solutions
Q&Q of Management Ability & Capacity
$$ Cost of Agricultural Solutions
Regulatory Burden
$$ Cost of Road Solutions
Water Quality Solution Return on Investment (WQ ROI)
Agricultural WQ ROI
Agricultural Solution %Impact
Road WQ ROI
Road Solution %Impact
Stream Channel WQ ROI
Developed Land WQ ROI
Forest WQ ROI
$$ Cost of Developed Land Solutions
Developed Land Solution %Impact
Forest Solution %Impact
$$ Cost of Forest Solutions
Stream Channel Solution %Impact
$$ Cost of Stream Channel Solutions

Some policy-relevant findings from Q1 and Q2 (?):



- Land use clearly impacts stream metabolism– e.g. we see clear signals between urban, agriculture and forested land covers and DO cycling
- Storm events impact TP and SRP levels
- Climate change is likely to exacerbate BGA blooms in both shallow and deep bays
- Water column stability impacts BGA blooms (effects of winds and storm mixing)
- Legacy phosphorus is a driver of shallow bay BGA blooms.
- Fish health is likely impacted by BGA blooms.
- Tracer signature and isotopic tracing could support more “precise” policy applications?
- Better understanding of streambank characteristics and sediment transport.

Adaptive Management: Critical questions



Several distinct, but inter-related factors are likely needing to be considered:

- The potential "cancelling out" effects of climate change upon the policy interventions directed at nutrient management? Can we answer: Will Increased temperatures and extreme weather events resulting from climate change crowd out and even overwhelm measures taken to reduce nutrient loading from land use practices?
- The behavioral limits of land users to fully enact best management practices through the use of incentives and voluntary compliance efforts need to be considered.
- Regulatory powers and enhanced efforts to stimulate innovation is needed.*

*Culture of Clean Water" Working Group

Current "Q3" Publications (spanning from in print to in progress)

COLEMAN, S., KOLIBA, C., ZIA, A., HURLEY, S. (TO BE SUBMITTED) **CROWDSOURCED DELPHIS: BROAD STAKEHOLDER PARTICIPATION AND FEEDBACK FOR ADAPTIVE MANAGEMENT OF COMPLEX ENVIRONMENTAL PROBLEMS.** *GLOBAL ENVIRONMENTAL CHANGE.*

Koliba, C., Reynolds, A., Zia, A., and Scheinert, S. (2015). **Isomorphic Properties of Network Governance: Comparing Two Watershed Governance Initiatives in the Lake Champlain Basin Using Institutional Network Analysis.** *Complexity, Governance & Networks. 1(2).* 99–118. DOI: 10.7564/14-CGN12

Koliba, C., Scheinert, S., Zia, A. (2016) **Toward a New Economics of Networks: Using Institutional Network Analysis to Study Principal-Agent and Co-Equal Ties .** *JPART.*

Koliba, C., Zia, A., Scheinert, S. and Logan, K. (2014). **Research on Adaptation to Climate Change: 2013 Water Quality Survey. VT EPSCoR. Burlington, VT.**

Koliba, C., Schroth, A., Bomblies, A., Van Houten, J., Zia, A., and Rizzo, D. (in progress). **The Lake Champlain Basin as a Complex Adaptive System: Insights from the Research on Adaptation to Climate Change (RACC) Project**. *Vermont Law Review*

Merrill, S., Zia, A., Koliba, C., and Hamed, A. (2016). **An examination of the effect of information: Awareness of buffer strip effects increases adoption rates."**

Miller, J., Conner, D., Zia, A., Wang, Q. and Darby, H. (Under Review). **Conjoint Analysis of Farmers' Response to Conservation Incentives**. *Renewable Agriculture and Food Systems*

Scheinert, S., Zia, A., Koliba, C., and Kujawa, R. (2014). **Vermonters' Willingness to Pay for Water Quality. VT EPSCOR**. Burlington, VT

Scheinert, S., Koliba, C., Hurley, S., Coleman, S., and Zia, A., (2015). **The Shape of Watershed Governance: Locating the Boundaries of Multiplex Networks.** *Complexity, Governance & Networks*. 2(1): 65–82. DOI: 10.7564/15-CGN25.

Scheinert, S., Zia, A., Koliba, C. and Merrill, S. (Submitted) **Forecasting Tie Accretion and Decay in a Voluntary Network**. *PLOS.*

Scheinert et al., (2016). ***Bridging the Meso and Micro Level Scales of Social Complexity within a Socio-Ecological System: Modeling the Relationship between Governance Networks and Land Use Decisions in the Northeastern Segment of the Lake Champlain Basin***

Tsai, Y., Zia, A., Koliba, C., Bucini, G., Guilbert, J., and Beckage, (2015). **An Interactive Land Use Transition Agent-Based Model (ILUTABM): Endogenizing Human Environment Interactions at Watershed Scales**. *Land Use Polic*doi:10.1016/j.landusepol.2015.07.008

Zia, A., Messer, K., Ding, S., Miao, H., Suter, J., Fooks, J., Trandafir, S., Uchida, E., Tsai, Y., Tunrbull, S. and Koliba, C. (Almost ready to be submitted). **Inducing cooperative behaviors for managing non-point source pollution: Evidence from a decision game in an idealized watershed.** *Ecology & Society.*

Zia A. and Low. (in progress**) Hedonic Analysis of Housing Prices in Algae Bloom Effected Communities**.

Zia, A., Kauffman, S., Koliba, C., Beckage, B., Vattay, G., and Bomblies, A. 2013. **From the Habit of Control to Institutional Enablement: Re-envisioning Governance of Social Ecological Systems from the Perspective of Complexity Sciences**. *Complexity, Governance and Networks.* 1(1). DOI: 10.7564/14-CGN4