Diffusion and Transformation of Knowledge about Climate Change Through Social Networks in the Great Lakes Region

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Abstract

We will present three phases of analyses of social networks as they relate to the diffusion of knowledge and policy orientated behavior in the Great Lakes region.

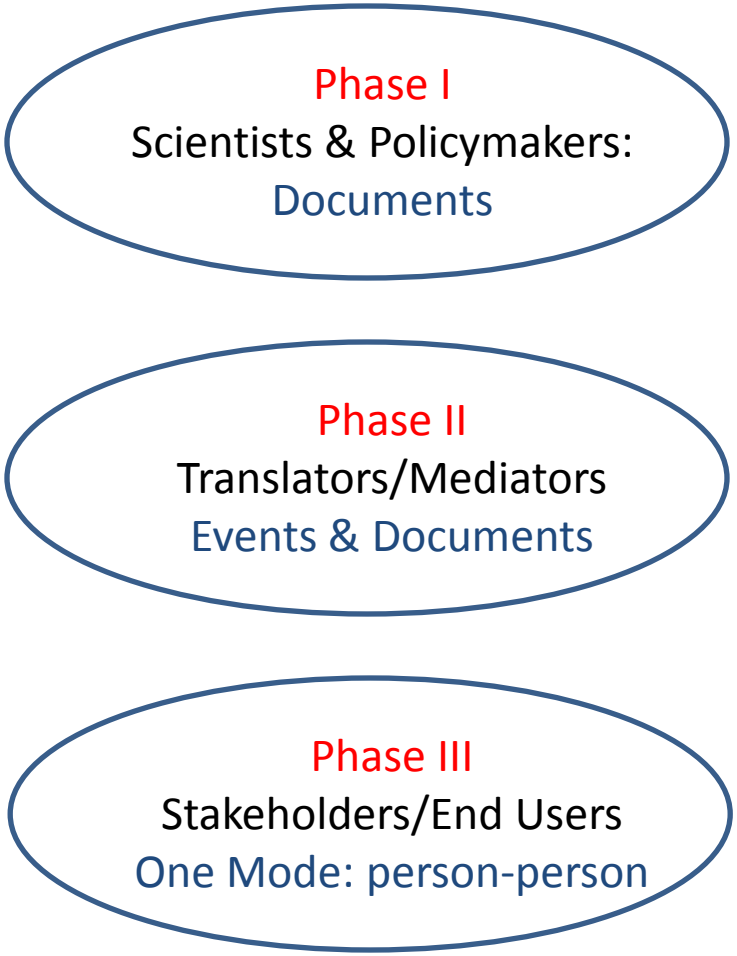
Phase I (data from 1997-2009): We identify a network based on who co-authored policy documents about climate change in the Great Lakes region, finding that those who bridged between clusters in the network were more likely to engage in policy oriented behaviors.

Phase II (data from 2009-2013): We define a network based on participation in events (e.g., conference calls, miniconferences) about climate change in the Great Lakes region. We find that location in the social space of this network is related to beliefs about the future of lake levels, but not freeze-thaw cycles, in the Great Lakes.

Phase III (data from 2013): We identify networks of close colleagues (from survey responses) among stakeholders and affiliates of the Alliance for the Great Lakes who focus on ravine management. We then interpret the diffusion of practices associated with ravine management relative to the close colleague network, finding that one of the actors in Phase II plays a key role in the diffusion of information about climate change among the stakeholders in Phase III.

Thus this set of analyses offers the potential to track the diffusion of knowledge about climate change beginning with interactions among regional scientists and policy-makers through intermediaries and then to stakeholders whose exposure to knowledge may change their day to day actions.

Levels of Analysis



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Phase I

Network Location and Policy-Oriented Behavior: An Analysis of Two-Mode Networks of Coauthored Documents Concerning Climate Change in the Great Lakes Region*,†

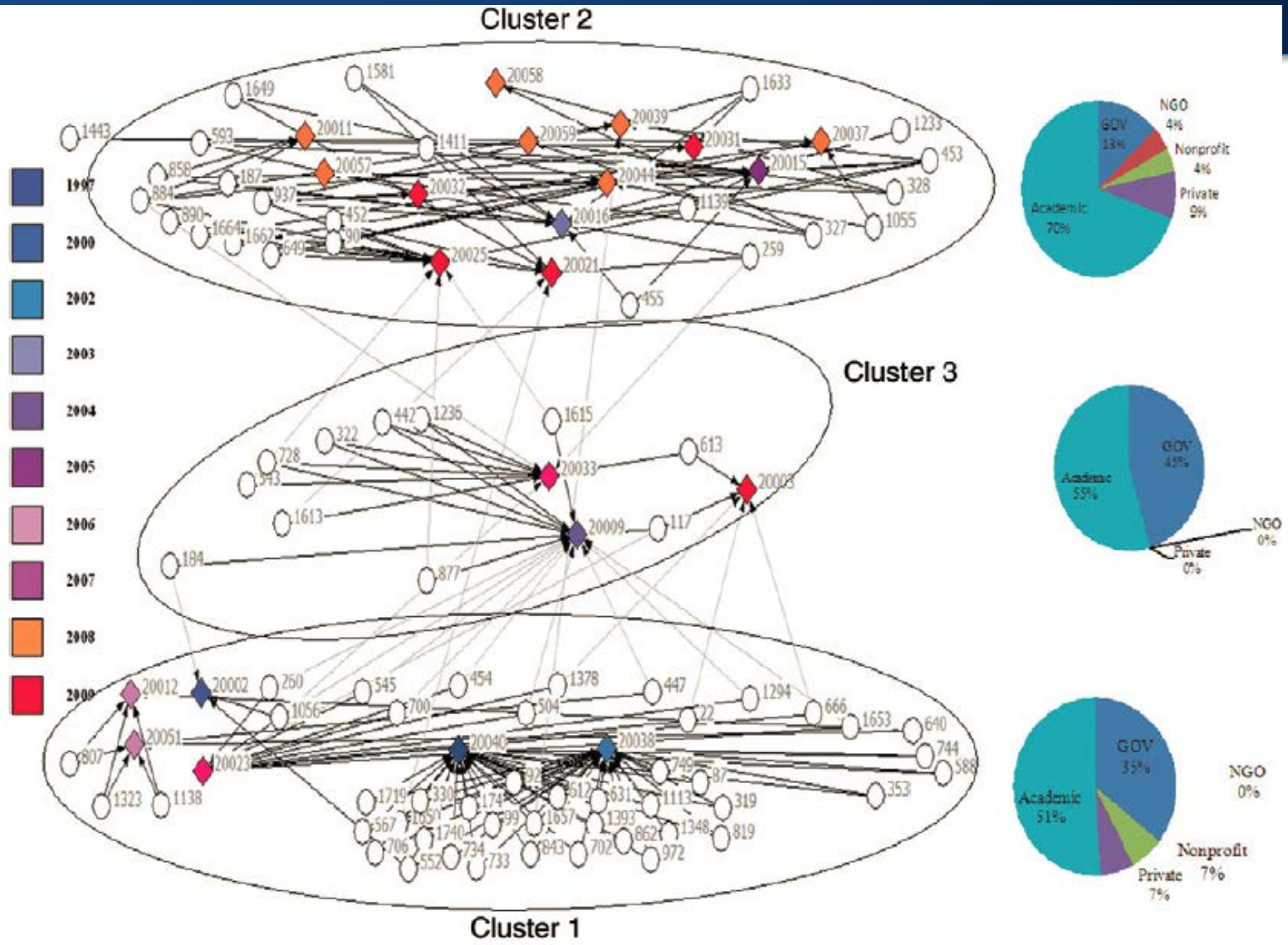
Ken Frank, I-Chien Chen, Youngmi Lee, Scott Kalafatis, Tingqiao Chen, Yun-Jia Lo, and Maria Carmen Lemos

This study explores how a scientist's location in science-based policy networks can affect her policy-oriented behaviors. In particular, we hypothesize that those scientists who fill structural holes in their networks will be more likely than others to engage in policy-oriented behaviors. The network data are defined by scientists' coauthorship on policy documents regarding climate change in the Great Lakes. We employ a two-mode network analysis to identify clusters of scientists who coauthored similar documents, and relative to those clusters, we identify those who fill structural holes by bridging between clusters. We find that those scientists who bridged between clusters were more likely to engage in policy-oriented behaviors of policy advocacy and advising than were others in the network. This is an example of a link between network location and policy-oriented behavior indicative of the broader phenomenon of how individuals exert agency, given structural constraints.

KEY WORDS: policy behavior, networks, scientists, climate change

Gary Robins
Mark Lubell
Chris Weible Eds

Clusters of Scientists ○ who Co-authored Documents ◆ about Climate Change in the Great Lakes Region 1997-2009



KliqueFinder

Document Sources

Technical Appendix: Documents by Cluster

- Cluster 1
  - –20040: Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change in the Great Lakes Region
  - –20002:Adapting to Climate Change and Variability in the Great Lakes-St. Lawrence Basin
  - • 20038:Preface to the Potential Impacts of Climate Change in the Great Lakes Region
  - •20023: From Impacts to Adaptation: Canada in a Changing Climate 2007
- Cluster 2
  - •20015:Confronting Climate Change in the Great Lakes Region: Impacts on Our Communities and Ecosystems
  - •20016:Confronting Climate Change in the Great Lakes Region
  - •20011: Climate Change in the Great Lakes Region: Starting a Public Discussion
  - •20021: Ecological Impacts of Climate Change
  - •20025: Global Climate Change Impacts in the US: A State of Knowledge Report from the U.S. Global Change Research Program
  - •20031: Informing Decisions in a Changing Climate: Panel on Strategies and Methods for Climate-Related Decision Support
  - •20032: Introduction: Assessing the effects of climate change on Chicago and the Great Lakes
  - •20037: Potential Impacts of Climate Change on U.S. Transportation
  - •20039: Chicago Climate Action Plan
  - •20044: Scientific Assessment of the Effects of Global Climate on the United States
  - •20059: Economic Impacts of Climate Change on Pennsylvania
- Cluster 3
  - •20009: Climate Change Impacts and Adaptation: A Canadian Perspective
  - •20003: Adapting to Climate Change in Ontario: Towards the Design and Implementation of a Strategy and Action Plan (Report of the Expert Panel on Climate Change Adaptation)
  - •20033: IPCC 4th Assessment Report, Working Group II Report "Impacts, Adaptation and Vulnerability" North America, Chapter 14 :

Interpretation

- 3 positions (or clusters)
- Statistically significant (rejecting null of no clustering)
- Each group a mixture of
  - academic and government
- Define bridging role relative to clusters
- Relate bridging role to outcomes
  - Policy advocacy and activism

Measures of Policy Oriented Behaviors Coded from Data on Web

- *Political Advocacy*: Extent to which an actor engages in activities with an intention to influence policy and behavior.
  - participation in meetings,
  - media campaigns regarding climate change issues,
  - participating in conferences and workshops that engage decision-makers,
  - participating in interviews, press conferences, writing articles or blogs to increase awareness of climate change and advocate climate change-related action.

- *Policy advising*: Attendance at policy-related or governmental meetings, in the role of directly informing policies or plans (e.g. contributing solutions, participating in policy design) with research about climate change and expert knowledge.

- *Scale for Both*: 0 to 4 (5 scales).
  - 0: no evidence that the actor was involved in policy advocacy activity
  - 1: the actor's reports or publications were aimed at being policy-relevant (i.e. expressed the intention or claim that the document could inform policy)
  - 2: actor's activities were related to policy advocacy, but it was not their primary activity
  - 3: policy advocacy was a primary activity.
  - 4: consistently involved in policy advocacy over time.

Bridgers more Engaged in Policy Advocacy and Advising

Those who bridge between clusters of actors were more involved in *policy advocacy* than others in the social system

Bridgers more likely to be engaged in political advocacy

- 2.15 for bridgers versus .7 for others (on our scale from 0 to 4). ($p \leq .0001$).

– Controlling for differences among groups and sector, the bridgers were more likely to be policy advocates

- estimated difference of 1.56, standard error of .34, $p \leq .0001$.

Those who bridge between clusters of actors were more involved in policy advising than others in the social system.

3.6 for bridger's versus 2.4 for others (scale of 0-4; $p \leq .002$).

– Controlling for differences among clusters and sector

- difference of 1.30 (standard error of 0.34, $p \leq 0.001$).

- Key: Using current sensitivity analyses, these inferences are moderately robust by social science standards
- Not that sensitive to tentatively placed actors

Robustness of Inference

- Large "impact of confound" required to invalidate inference
  - Omitted variable must be correlated at .54 with bridging role and with policy advocacy to invalidate the inference that the bridging role has an effect on policy advocacy
  - See spreadsheet for calculating indices [KonFound-it!©]
  - powerpoint with examples and calculations (includes reference to STATA, SAS and SPSS)
  - Details
- Stronger than inference regarding relationship between CO2 and temperature.
  - Although CO2 and temperature included lagged variables (key)
- Inference sustained (but not as strong) if bridging not defined by "From Impacts to Adaptation" (document 20023)
- Alternative:
  - Estimated effect of r=.44 is twice as large as threshold for statistical significance r=.22 (used as a threshold for causal inference)
  - →to invalidate the inference, 50% of the data would have to be replaced with counterfactual cases in which there was no effect of bridging on policy involvement (Frank et al, 2013)
- Qualitative

Qualitative: The Constraint for the Non-bridger

Actor 374 (Insular): Structural constraint makes it difficult to bridge

> In the last ten years or so it's become obvious that we need to engage more with other groups, especially scientists. Our organization especially was too insular ten years ago. The issue of climate change has been one of the drivers of realizing that and making an effort to change it.

Need for quantitative analysis: Actors don't really know effect of social structure on behavior:

"I can't really tell you what interactions have pushed future involvement and what haven't."

Limitations to Phase I

- Internal Validity:
  - Wish we had longitudinal data
    - Control for prior tendency for policy behavior
    - Difficult to measure – lag between participation and in documents
  - Subjective interpretation based on the network pictures
- External validity
  - Narrow range of documents
  - Focus on Great Lakes region
  - Apply to other scientific issues (health or education)
- Mechanism
  - Do not understand individual sensemaking
  - Need more about documents (see Scott Kalafatis‘ work)

- Diffusion to Stakeholders!!??

Phase II 2009-2016

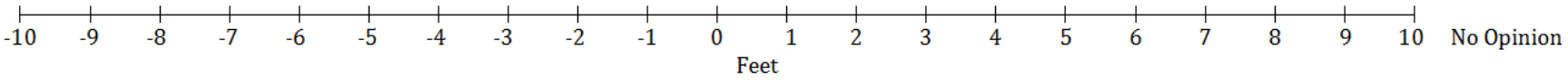
Knowledge Flows from Climate Scientists to Intermediaries

- Scientists, translators/mediators and practitioners in the Great Lakes
  - Extension agents, museum personnel, GLISA staff, etc
  - Roughly 120 respondents out of 180 non-retired population
- Events in which they participated from 2009-2013: Documents, miniconferences, conference calls .
  - Sponsors
    - **Collab:** Meeting of NOAA Great Lakes Climate Working Group with U.S .Geological Survey (USGS) and United States Environmental Protection Agency (EPA)
    - **NOAA:** National Oceanic and Atmospheric Administration
    - **Adpt:** Great Lakes Cities Climate Adaptation Integrated Assessment Meeting
    - **GLISA:** Great Lakes Integrated Sciences and Assessments Center Meeting **GLRICG:** Great Lakes Restoration Initiative Coordination Group
    - **MWCG**: Midwest Climate Group
    - **UMGLLC:** Upper Midwest and Great Lakes Landscape Conservation Cooperative Steering Committee
- Beliefs:
    - changes in lake levels (recent diffusion)
    - frequency and duration of freeze-thaw cycles (currently diffusing – baseline)

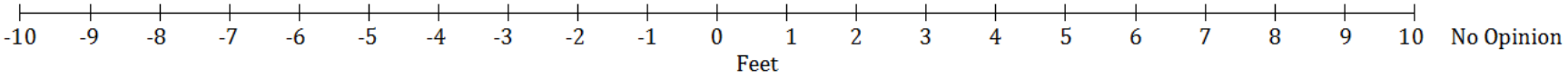
Measure of Lake Levels

1. How do you think lake levels will change in the Great Lakes compared to what they are right now? Please indicate your answers in feet on the lines below (WHOLE NUMBERS ONLY). This is not a test. Please answer to the best of your knowledge.

In 5 years (in 2019):

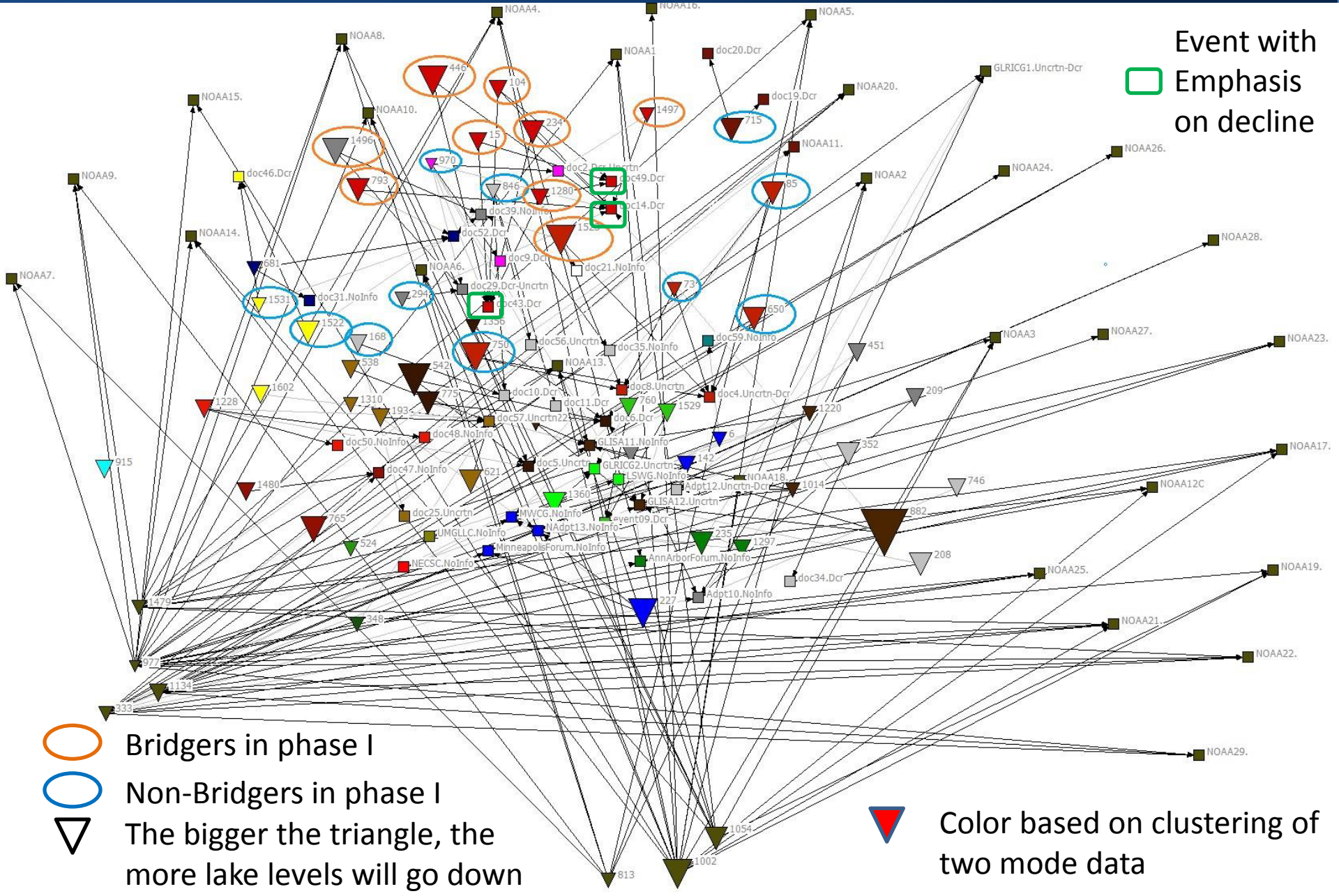


In 20 years (in 2033):



Not intended to be a test – there is legitimate variation

Network of Intermediaries and Events with Perceptions of Changes in Lake Levels



Event 43: Decrease Predicted, Uncertainty not Emphasized

From Impacts to Adaptation: Canada in a Changing Climate 2007

(1) Page 9

TABLE SR-2: Some observed impacts of changing climate on physical and biological systems in Canada.

River and lake levels – changes in water levels and timing of peak flow events	• decline in summer and fall runoff in Prairies, leading to lower lake and river levels at those times • trend towards earlier spring runoff	2, 5, 6, 7, 8 and 9

Although most scenarios of future climate project increases in regional precipitation (Figure 12), the increase in evaporation caused by higher temperatures is expected to lead to an overall

The projections of water level changes described above

Huron are presented in Figure 15. In the majority of experiments, lake levels are projected to decrease (Mortsch et al., 2000, 2006; Cohen and Miller, 2001; Lofgren et al., 2002; Kling et al., 2003).

variability observed during the last 50 years. Under scenarios of lower temperature increases and wetter conditions, increases of 0.02 m annually and 0.07 m in the winter are projected for Lake Ontario. Reductions are projected to be most pronounced in the lakes Michigan-Huron basin, at 0.73 to 1.18 m by the 2050s (Mortsch et al., 2006). It is also expected that low levels will occur more frequently, especially in Lake Erie, and that seasonal variation will increase (Mortsch et al., 2000; Lofgren et al., 2002; Croley, 2003). The impacts of lower water levels will be most pronounced in parts of the system that are already shallow, specifically western Lake Erie, Lake St. Clair, and the St. Clair and Detroit rivers (de Loë and Kreutzwiser, 2000).

Lake Superior and St. Lawrence River orders of approval, administered by the International Joint Commission. The study further noted that the control structures on the St. Mary's and St. Lawrence rivers may require significant modification to accommodate water level changes, and that the increased dredging required to maintain navigation routes under low water conditions would involve excavation and subsequent management of contaminated materials. Finally, the study concluded that the existing Lake Superior and Lake Ontario water level regulation plans are inadequate to deal with future low water levels, as maintaining minimum outflows would draw down the level of the lakes by several metres.

Uncertainty not Emphasized in Original Documents

1.

Mortsch, L., Hengeveld, H., Lister, M., Lofgren, B., Quinn, F.H., Slivitzky, M. and Wenger, L. (2000): Climate change impacts on the hydrology of the Great Lakes St. Lawrence system; Canadian Water Resources Journal, v. 25, no. 2, p. 153–179.

1) lake level decrease

transpiration. Increases in the evaporation:precipitation ratio will likely occur. Unless the rise in temperature and increase in evapotranspiration are accompanied by substantial increases in precipitation or significant decreases in plant stomatal resistance from higher concentrations of atmospheric CO_2, declines of lake levels, streamflows, wetland levels, soil moisture, and groundwater levels are likely (Schindler, 1997; Marsh and Lesack, 1997; Croley, 1990; Hartmann, 1990; Poiani *et al.*, 1996; Sanderson and Smith, 1993).

2) lake level decrease

The transient scenarios from the CCCma's CGCM1 suggest a drier, warmer climate due to the 'enhanced greenhouse effect'. Lake levels decline 0.2–0.7 m by 2030 and 0.3–1 m by 2050 (see Table 9). Except for Lake Ontario, the changes are greater than natural variability (Quinn and Lofgren, 2000). Mean annual runoff and outflow also decrease. Higher air temperatures increase evapotranspiration and lake surface evaporation.

Uncertainty in Original Document

J. Great Lakes Res. 28(4):537–554
Internat. Assoc. Great Lakes Res., 2002

Evaluation of Potential Impacts on Great Lakes Water Resources Based on Climate Scenarios of Two GCMs

Brent M. Lofgren[1,*], Frank H. Quinn[1], Anne H. Clites[2], Raymond A. Assel[1], Anthony J. Eberhardt[2], and Carol L. Luukkonen[3]

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Ann Arbor, Michigan 48105

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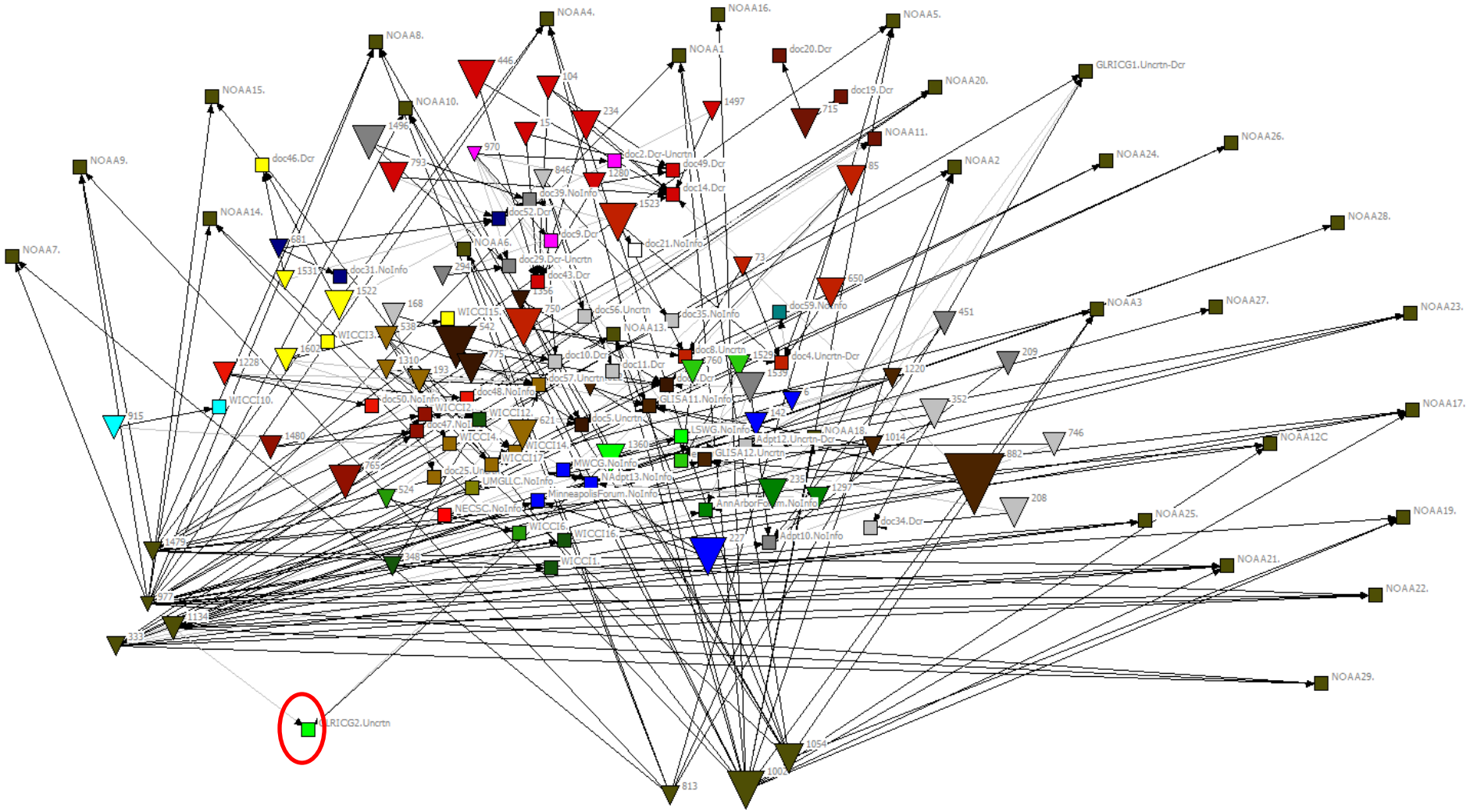
15 Rolling Hills Dr.
Orchard Park, New York 14127

pers, recreational boaters, and natural ecosystems. On one hand, a hydrological modeling suite using input data from the CGCM1 predicts large drops in lake levels, up to a maximum of 1.38 m on Lakes Michigan and Huron by 2090. This is due to a combination of a decrease in precipitation and an increase in air temperature that leads to an increase in evaporation. On the other hand, using input from HadCM2, rises in lake levels are predicted, up to a maximum of 0.35 m on Lakes Michigan and Huron by 2090, due to increased precipitation and a reduced increase in air temperature. An interest satisfaction

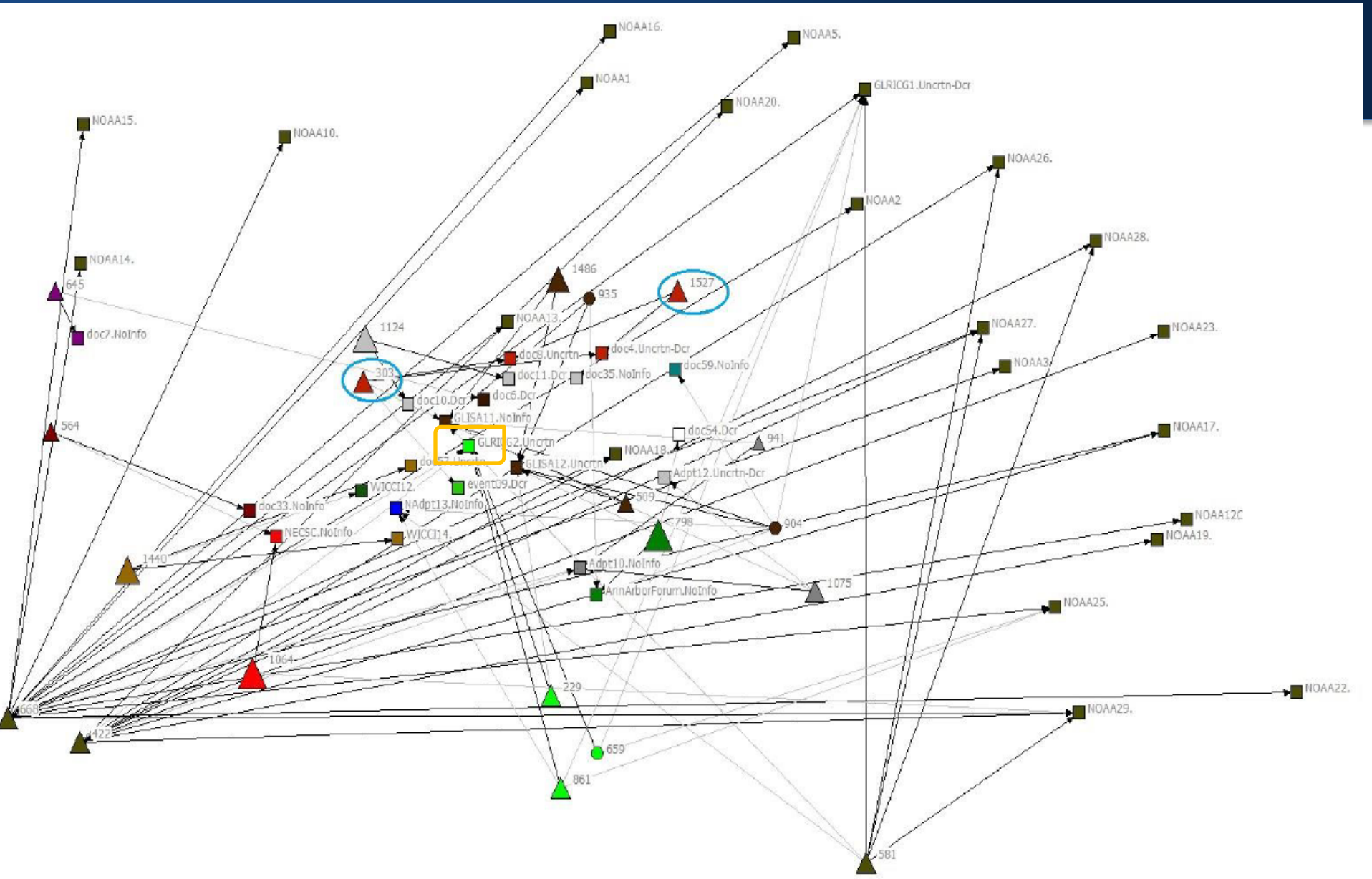
pers, recreational boaters, and natural ecosystems. On one hand, a hydrological modeling suite using input data from the CGCM1 predicts large drops in lake levels, up to a maximum of 1.38 m on Lakes Michigan and Huron by 2090. This is due to a combination of a decrease in precipitation and an increase in air temperature that leads to an increase in evaporation. On the other hand, using input from HadCM2, rises in lake levels are predicted, up to a maximum of 0.35 m on Lakes Michigan and Huron by 2090, due to increased precipitation and a reduced increase in air temperature. An interest satisfaction model shows sharp decreases in the satisfaction of the interests of commercial navigation, recreational boating, riparians, and hydropower due to lake level decreases. Most interest satisfaction scores are also reduced by lake level increases. Drastic reductions in ice cover also result from the temperature increases such that under the CGCM1 predictions, most of Lake Erie has 96% of its winters ice-free by 2090. Assessment is also made of impacts on the groundwater-dependent region of Lansing, Michigan.

Event 1781: Uncertainty Emphasized, but People who Believe Lake Levels will go Down Did Not Attend:

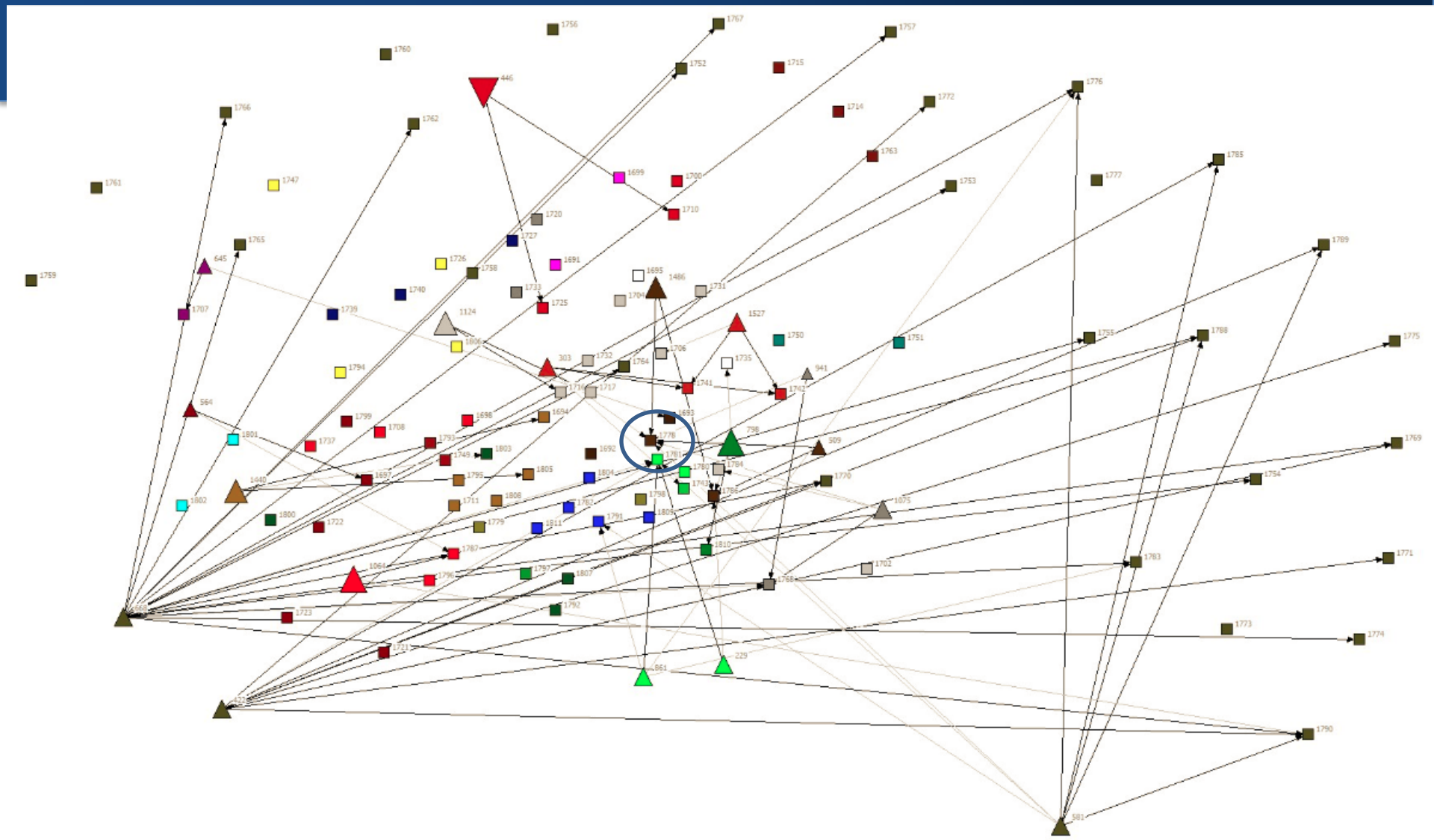
Comment: Still thinking that the message to the public is that the projected drops in lake levels are exaggerated, so whether it is going to go up or down is a stronger question than it was perceived to be a couple months ago.



Event 1781 also Attended by Many People who Think Lake Levels Will Go Up ▲. Why Didn't it Influence Them? Competing Messages?



Event 1778: GLISA event

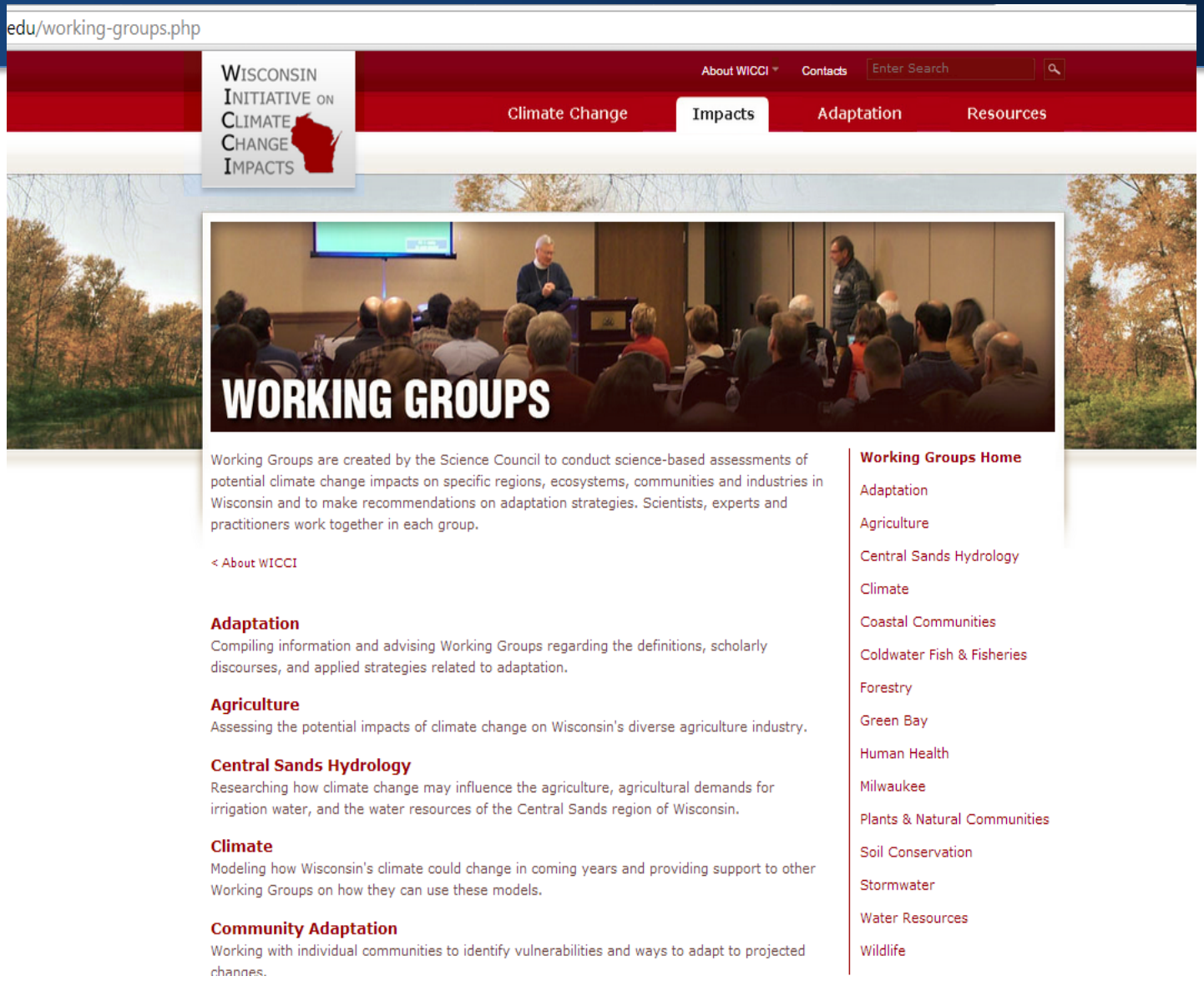


Event 1778: GLISA event

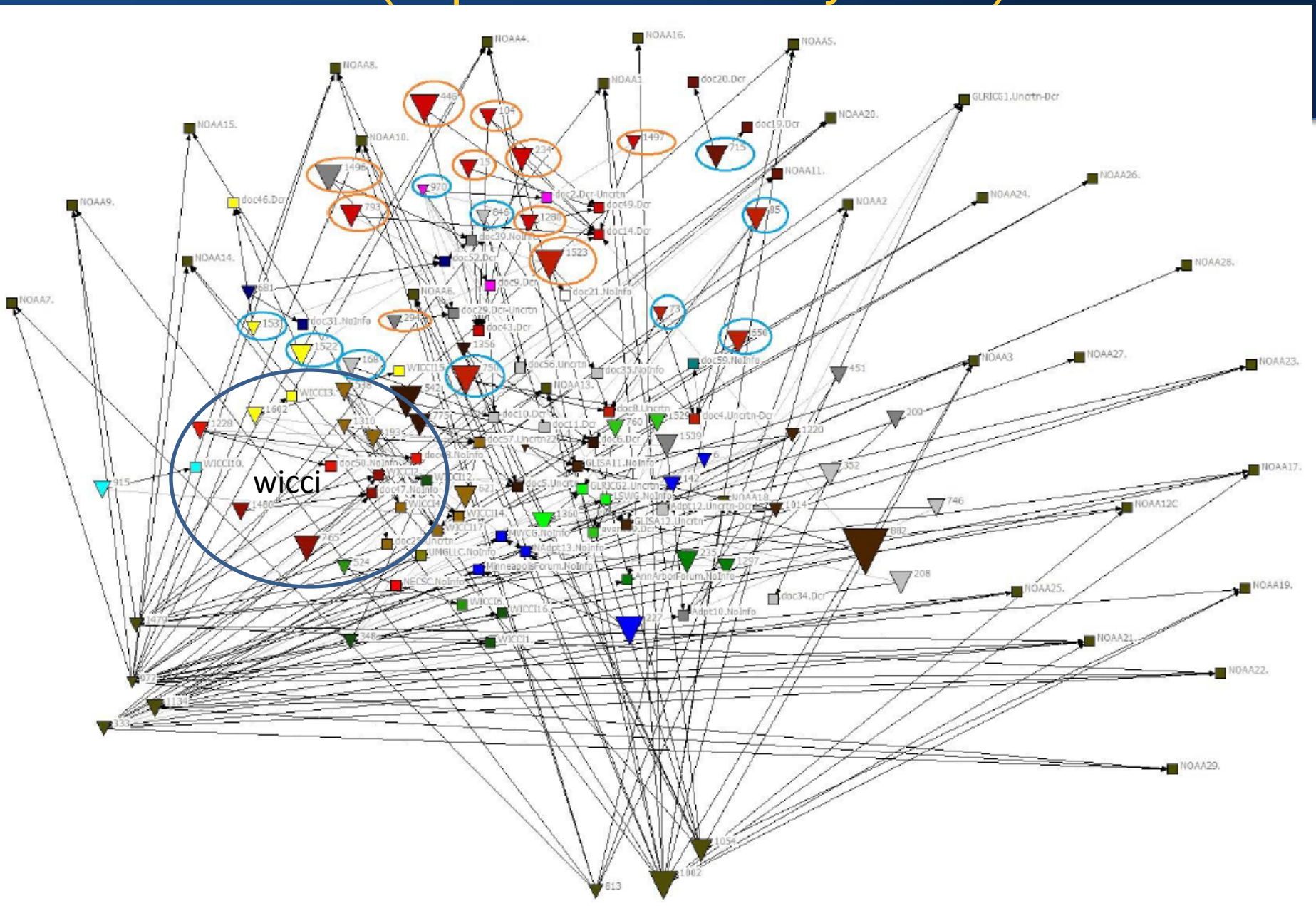
- Some familiar faces, but lake levels not discussed as far as we can tell
- http://glisa.umich.edu/events/glisa-symposium-2011
- Hmmmmm.
-

Events can Include WICCI (Virtual)

[WICCI]



Emergent Structure Including WICCI Chat Rooms (separated social systems)



Interpretation

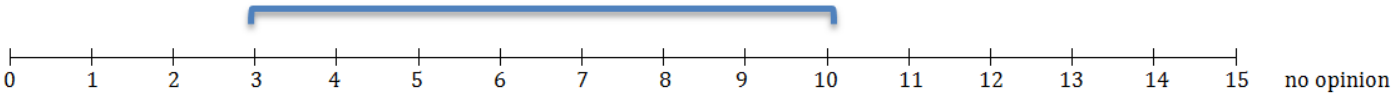
- Alignment of 20-year lake levels with social structure
  - People with similar beliefs are attracted to similar events?
  - Events shaped people
    - Those who coauthored 4th IPCC predict lower lake levels
  - People influenced one another at shared events
  - Canadian group believes lake levels will drop more.
  - Not a lot of exposure of US to Canadians
- (not shown) Lack of alignment between 20-year freeze-thaw cycles and social structure
  - Social dynamics have not been initiated

Measure of Freeze-Thaw Cycles

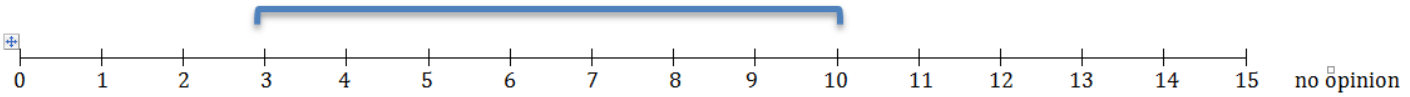
6. Think about the freeze thaw cycles within a season (e.g. snow storm followed by complete melt of snow cover). How many land freeze thaw cycles do you expect to occur on average statewide in Michigan in January of 2018 (in 5 years) and January of 2033 (in 20 years)? Please indicate your answers on the lines below (WHOLE NUMBERS ONLY). This is not a test. Please answer to the best of your knowledge.

The bars below indicate the current range of 3 to 10 cycles in January on average statewide in Michigan. *

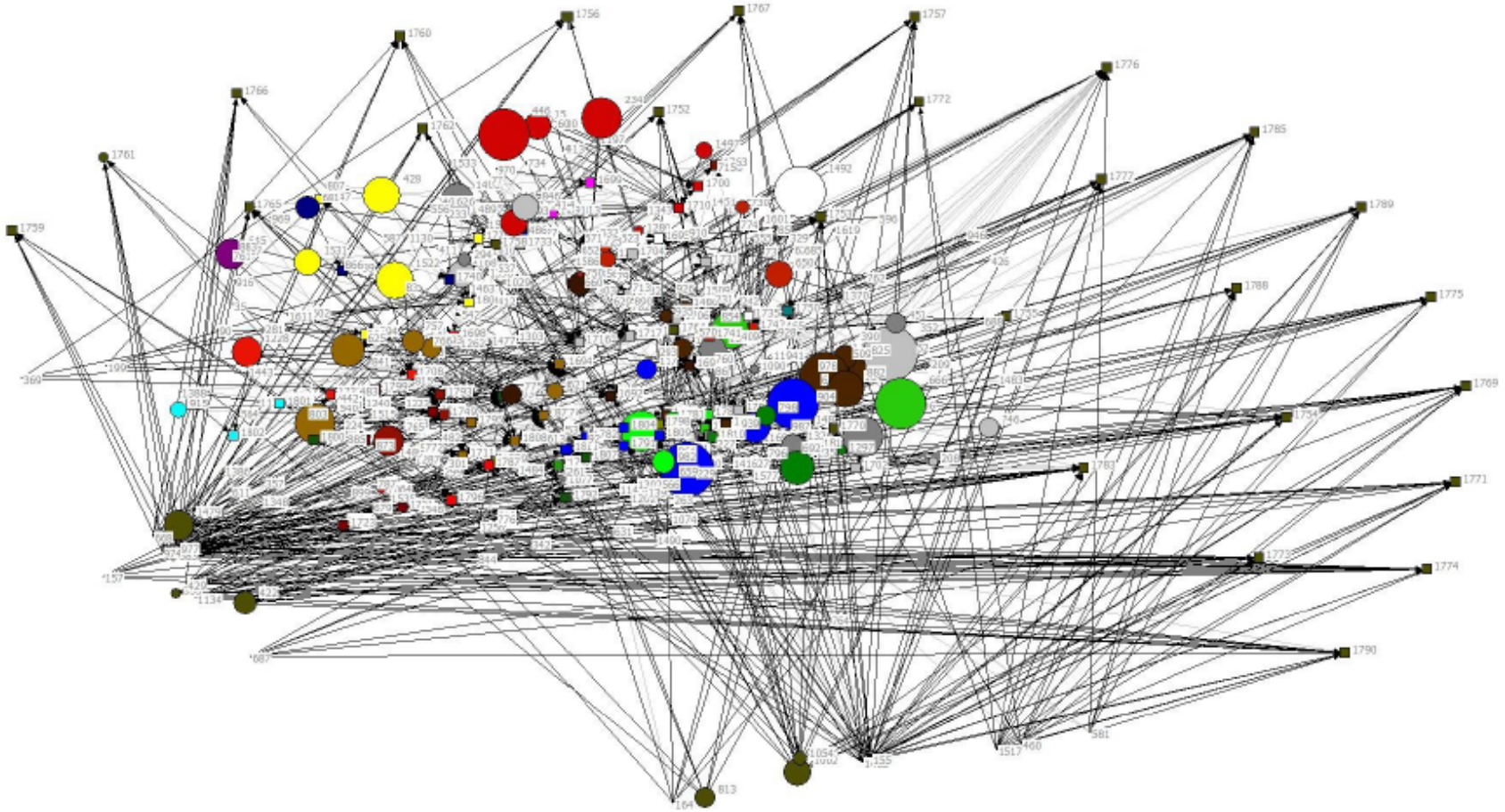
Number of land freeze-thaw cycles in Michigan in January of 2018 (in 5 years):



Number of land freeze-thaw cycles in Michigan in January of 2033 (in 20 years):



Freeze-thaw cycles and Social Structure: Not much Alignment



Limitations of Phase II

Did we get the right events?

Did we get the right people?

Were people with similar beliefs attracted to similar events, or did events influence them?

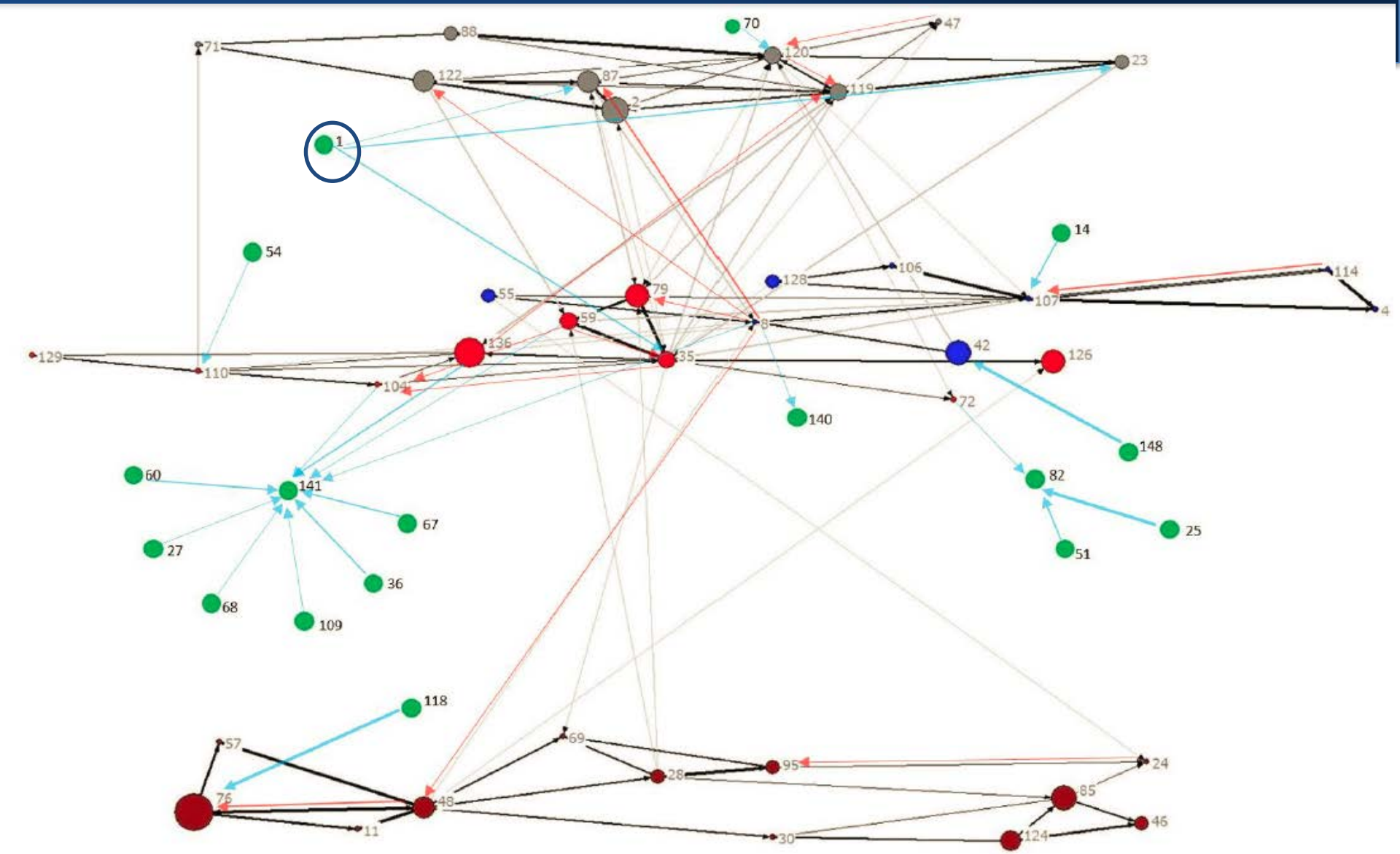
Need longitudinal data – that's the plan

How do ideas diffuse to the stakeholder!!??

Glimpse into Future Work in Phase III

- Study Stakeholder Networks
- Alliance for the Great Lakes (Angela Larsen, Olga Lyandres)
- Survey
  - core practices
    - Use of climate change knowledge in core practices
  - Networks:
    - Who are your closest colleagues?
    - From whom do you get information about climate change impacts?

Close Colleagues (Black Lines) and Knowledge Flow about Climate Change (Blue Lines, Green Nodes) within the Alliance for the Great Lakes
(size of node represents use of climate change in practice;
color of node represent subgroup membership based on close colleague data)
(data 2013)



Use of Climate Change Impacts to Manage Ravines

7. Please indicate the frequency with which you and/or your organization consider climate change impacts to ravines when engaged in each of the activities listed below:	Never	Yearly	Monthly	Weekly	Daily
a) Documenting the impact of stormwater run-off on my ravine(s) (e.g. erosion, changes in flow patterns, shifts in plant communities, etc.)					
b) Monitoring and documenting of invasive species populations					
c) Implementing controls for invasive species					
d) Implementing habitat restoration in the ravines					
e) Implementing guidelines for ravine buffers and slopes					
f) Monitoring to evaluate performance standards for buffers and slopes					
g) Analyzing monitoring data and re-evaluating management practices					
h) Assessing comprehensive risks to the ravines					
i) Evaluating how risks to ravines impact my organization's goals					
j) Managing finances for ravine management plan implementation					
k) Implementing educational and outreach programs for residents					

Blue α=.89

Red α=.88

Network Questions

For Questions 13-16, please see the attached collaborator list for reference.

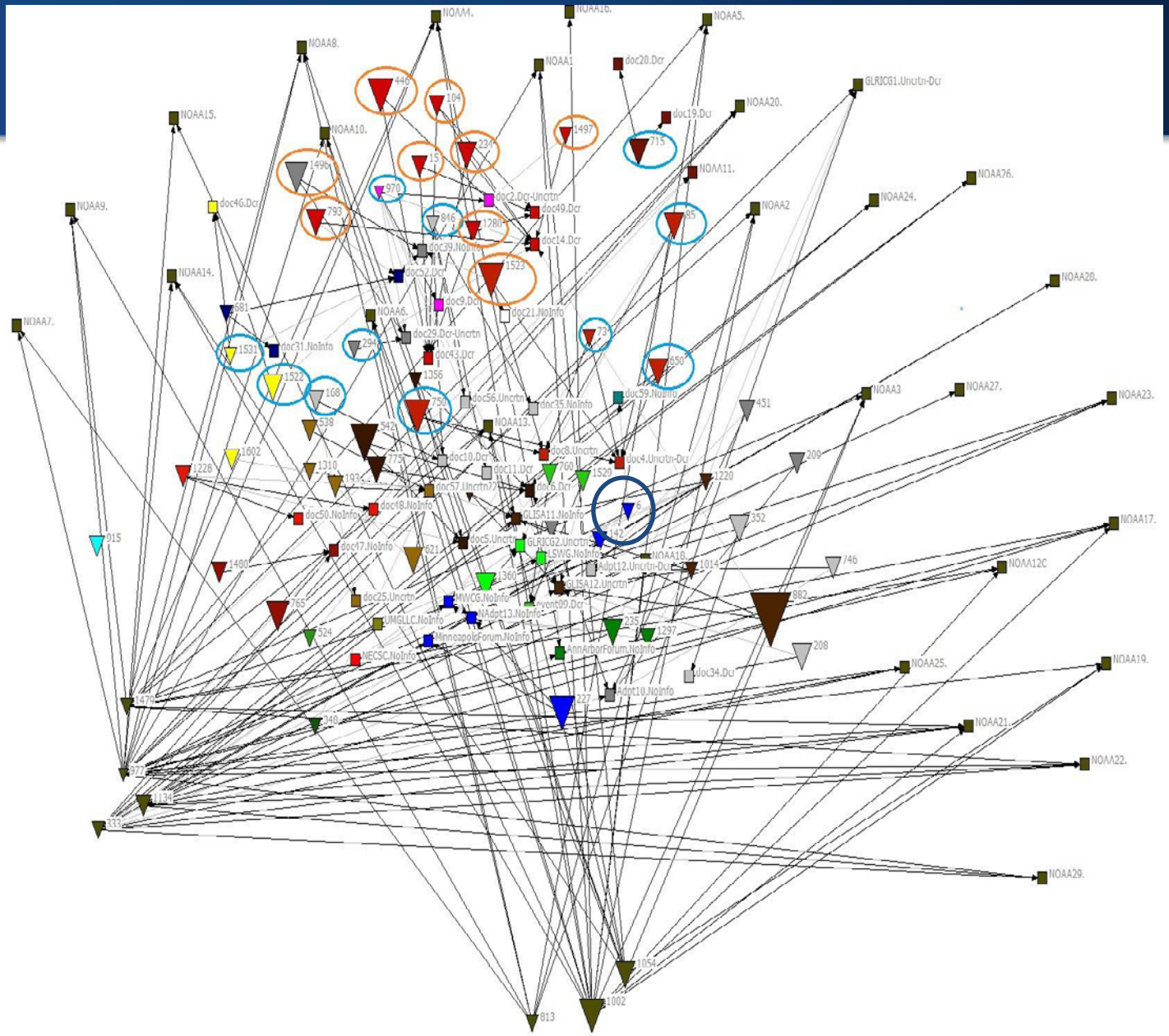
13. Please list the name of your closest colleagues *(within and outside your organization)* and the frequency with which you interact with each person. You don't need to fill in all blanks.	**Yearly**	**Monthly**	**Weekly**	**Daily**
a)				
b)				
c)				
d)				
e)				

Black lines in figure

15. In the past 3 years, who *(person)* gave you information about climate change impacts and how frequently? You don't need to fill in all blanks.	**Yearly**	**Monthly**	**Weekly**	**Daily**
a)				
b)				
c)				
d)				
e)				
f)				
g)				
h)				
i)				
j)				

Blue lines in figure

Actor 1 from Previous Slide was in the Intermediary Data (phase II), attended MWGC, Nadpt13,



Summary

- Phase I: social network of scientists and documents
  - Bridgers more policy active
- Phase II: social network of intermediaries and events
  - One group anticipates greater declines
    - Evidence in events and survey responses
    - Includes members of Phase I
- Phase III: social network of stakeholders
  - Knowledge flow about climate change and ravine management
  - Includes participant in Phase II

Please Fill out our Survey!

The 2nd Survey about Future Lake Levels and Freeze Thaw Cycles

Consent Form:

Dear Stakeholder,

This survey concerns potential changes in lake levels and freeze thaw cycles in the Great Lakes region. It asks a variety of questions about you and your interactions with others. We will use this survey to relate participation in events and meetings with beliefs about lake levels and freeze thaw cycles. We are not evaluating the effectiveness of you or any program with which you are affiliated. We will use the results of the research to generally help people like you access and use knowledge about climate in Great Lakes region.

We plan to collect the following data as part of this research project:

1. Interviews of some stakeholders/mediators of knowledge
2. This 5-10 minute survey

Completing this survey indicates your consent as a participant in this study insofar as your responses will be analyzed. Participating in this study is voluntary, and we will keep all data collected confidential. Your privacy will be protected to the maximum extent allowable by law.

Will help us understand changes in beliefs

$10 incentive, $100 lottery

Return to Tingqiao or Yuqing at Booth in exhibits (Thursday evening or Friday morning)

Research Implications

- How to define and measure knowledge flows between open systems
  - Leverage events to define systems
  - Measure relevant beliefs
- Identify social structures
  - Link beliefs and actions to locations in social structures

Next Steps: Longitudinal

- Renewed Funding!
- Gathering current events and documents in which actors participate
- Resurvey in Fall 2015
- Model changes in beliefs as a function of network exposure

Policy implications: What can Change Agents such as GLISA do?

- Change agents
  - create venues which affect which social structures can emerge
  - Can influence participation/attendance venues
- Enhanced serendipity
  - Network structure always changing
  - Find gaps and help fill them
  - Encourage people to pursue own links
- Support Intermediaries connecting to stakeholders
  - Small grants
  - Organizational support
  - legitimacy

Please Fill out our Survey!

The 2nd Survey about Future Lake Levels and Freeze Thaw Cycles

Consent Form: https://msucoe.az1.qualtrics.com/SE/?SID=SV_6GxEzkNCcElNOnP

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Will help us understand changes in beliefs

$10 incentive, $100 lottery

Return to Tingqiao or Yuqing at Booth in exhibits (Thursday evening or Friday morning)

Thanks

- kenfrank@msu.edu

Event 49: Decrease Predicted, Uncertainty not Emphasized

Adapting to Climate Change in Ontario: Towards the Design and Implementation of a Strategy and Action Plan (Report of the Expert Panel on Climate Change Adaptation)

(1) P.46

Research in Lake Superior has shown that water temperatures may increase by as much as twice (4oC-8oC) the air temperature. Warmer water, combined with stronger winds and a longer ice-free period, is very likely to increase the volume of water evaporating from the surface of the lakes. Increased evaporation from the land surrounding the lakes, especially in summer, is likely to reduce the flow in rivers after the spring run-off. In the long-term, the most obvious combined result is likely to be a fall in the average lake levels of the four lower lakes currently projected to be between 15 and 115 cm over the next 40 years (Mortsch et al, 2006). These projected drops in lake levels are in addition to the historical fluctuations that have been documented over the past century, potentially exacerbating the impacts associated with lower lake levels, especially in connecting channels

Event 14: Decrease Predicted, Uncertainty not Emphasized

2. Doc 1710 (Published in 2004)

***Lake level will decrease.**

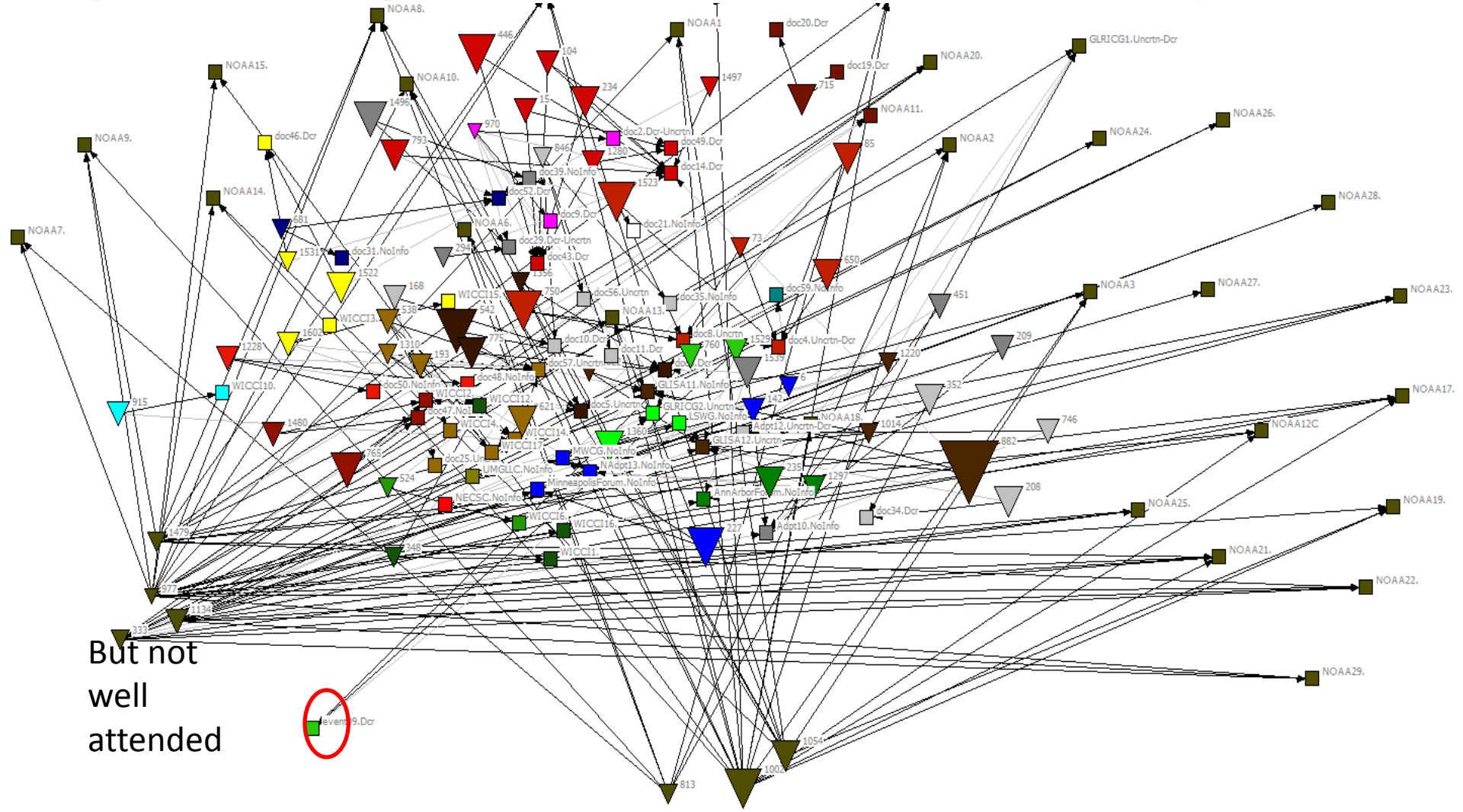
Climate Change Impacts and Adaptation: A Canadian Perspective

(1) table 2 page 36
Great Lakes basin
• Possible precipitation increases, coupled with increased evaporation leading to reduced runoff and declines in lake levels

Great Lakes basin	• Possible precipitation increases, coupled with increased evaporation leading to reduced runoff and declines in lake levels
	• Decreased lake-ice extent, including some years without ice cover

Event 09: Decrease in Lake Levels emphasized:
Key scientist emphasized that air …

and lake temperatures are increasing, winters are getting shorter, ice cover is decreasing, and precipitation patterns are moving toward more extreme events. Those trends are likely to continue, and most modeling efforts suggest lake levels will decline. These climate-driven changes are exacerbating most of the well-known stresses on Great Lakes ecosystems.



But not well attended