Evaluation of GLISA's Small Grants Program

2011-2015

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GLISA

A NOAA RISA TEAM

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About GLISA

The impacts of climate change already are, and will continue to be, deep and widespread in the Great Lakes region. Rising temperatures, increasing precipitation, extreme events, and longer frost-free seasons are already affecting agriculture, infrastructure, natural resources, public health, and vulnerable populations in cities and Tribal communities. GLISA works at the boundary between climate science and decision-makers, striving to enhance Great Lakes communities' capacity to understand, plan for, and respond to climate impacts now and in the future.

Our team of social and physical scientists work together to:

- Develop usable climate information tailored to stakeholder needs;
- Develop, implement, and evaluate resources and tools to apply climate information to decision making;
- Facilitate collaborative activities, education, and training and support stakeholder networks; and,
- Investigate emerging climate issues and synthesize findings for practitioners.

We work in a diversity of sectors, but especially in agriculture, cities, and Tribal communities to co-develop information, resources, and activities. GLISA has sustained partnerships with scholars and practitioners across the region at other universities, federal agencies, state, local, and Tribal governments, NGOs, professional associations, and businesses. Working together enables us to leverage expertise and relationships, and we always welcome new partnerships and opportunities.

Acknowledgments: The following former GLISA graduate students contributed to data collection and early analysis. Katherine Browne, Yun Jia Lo, Ian Robinson

For more information, visit glisa.umich.edu.

Key Sectors Engaged

Agriculture	Coast	Defense	Economy	Infrastructure
Health	Hazards	Tribes	Urban	Water

Engagement-Driven Research

- Assessing Adaptive Capacity
- Extreme Precipitation Events
- Lake-Effect Precipitation
- Sustained Assessment of Lakes
- Climate Model Evaluation
- Boundary Chains
- Drivers of Co-production
- Framing Climate Projections
- Scenario Planning
- Testing Remote Engagement
- Scaling-Up & Sustaining Engagement

Organizations Engaged

Federal 15	Cities 27
Tribes 9	State 9
NOAA 24	Academic 25
Non-Profits 33	Private 12

Regional Support

156	94	10	4.8M
Total Entities Engaged	Total Boundary Organizations Engaged	Networks Supported	Additional Funds Leveraged

Recommended citation: Jorns, J., L. Maillard, V. Rachmaninoff, S. Sen, O. Watson and M. C. Lemos. (2021) "Evaluation of GLISA's Small Grants Program." Great Lakes Integrated Sciences and Assessments (GLISA).

Glossary

- **Adaptive Boundary Chain Model:** The ABCM (Figure 1) links several boundary organizations to co-produce usable climate information with practitioners (Lemos et al. 2014). The main goal of the ABCM is to decrease the often-high transaction costs associated with sustained practitioner engagement (time, logistics, financial/human resources, trust and legitimacy). For further background, see The building of a model: How the idea of boundary chains emerged section (Section II).

- **Boundary organization:** a group or organization that sits in the "boundary" between science producers and practitioners (Kirchhoff et al. 2013). In the ABCM, these organizations effectively serve as a bridge, translating science into usable knowledge through the co-production process.

- **Complementarity:** how closely related the work of a boundary organization is to the work of practitioners (e.g., both may work directly in the field of climate adaptation in one instance, while only one may work in the climate adaptation field in another instance). Complementarity also refers to skill sets: organizations with complementary skill sets may gravitate toward working with one another to leverage the other's skills.

- **Co-production:** the iterative process of knowledge creation through a two-way relationship in which both parties provide input. In the ABCM, boundary organizations and practitioners co-produce knowledge together.

- **Embeddedness:** the strength of the relationships between GLISA and boundary organizations and between boundary organizations and practitioners, as well as the proximity of the relationships during a project (e.g., GLISA only contributed funding, or was directly involved in personal interactions in the project). Embeddedness can also refer simply to the number of connections between organizations within a network, with a higher number of connections translating to higher embeddedness.

- **Great Lakes Integrated Sciences and Assessments (GLISA):** In the context of the small grants projects, GLISA primarily serves as the funder and the provider of project-specific climate information. In the ABCM, GLISA also serves as a boundary organization.

- **User:** groups and individuals, such as local governments, practitioners, farmers or natural resource managers, who use knowledge to prepare for or adapt to climate impact. In the context of the ABCM, practitioners co-produce this knowledge with boundary organizations.

- **Resources:** the resources available to boundary organizations and practitioners (social, financial, and political capital; personnel capacity; strength of motivation; fit of existing climate knowledge).

I. Overview

Co-Producing Climate Knowledge in the Great Lakes Region

Since 2011, the Great Lakes Integrated Sciences and Assessments (GLISA) has competitively awarded small grants to regional organizations (hereafter "boundary organizations") committed to increasing the use of climate information in support of decision-making to prepare for and adapt to climate change impact in the Great Lakes region. These organizations often stand at the boundary between the production of climate knowledge by GLISA's universities/partner scientific organizations and practitioners and communities making decisions about adapting to climate change impacts. In the Small Grants Program (hereafter "the Program"), each boundary organization receives one-year grants (US $25K or $50K) to address concerns related to climate adaptation and mitigation across a diversity of sectors, geographies, and impacts.

Within GLISA, the Program has two main goals. The first goal is to scale up GLISA's presence and impact in the Great Lakes region by partnering with other organizations to increase the breadth and depth of GLISA's co-production of climate information model. By collaborating with these organizations, GLISA can: 1) more efficiently reach a broader number of practitioners, communities, and organizations, and 2) manage several projects at the same time across different sectors and types of climate changes and impacts. These include increases in precipitation and temperature, lake level variations, extreme storms, flooding, extreme heat events, and shifting of species and crops. The second is to test an experimental sustained engagement model—the Adaptive Boundary Chain Model ("ABCM," Figure 1)—which links several boundary organizations to co-create usable climate information with practitioners (Lemos et al. 2014). At the heart of the ABCM is the idea that while the co-production of knowledge can yield more usable climate information, the costs of sustained interaction for organizations, producers, and users of knowledge who engage in co-production are high. These costs include carrying out research and knowledge customization, time commitment and logistics to interact, financial and human resources to sustain relationships, as well as the often intangible cost of building trust and legitimacy among scientific institutions, boundary organizations, communities, and individuals. To lower these costs, the ABCM links boundary organizations that perform different parts of the co-production process—including carrying out basic research, managing the interaction between scientists and users to increase knowledge usability, and applying and evaluating co-produced knowledge in different contexts—thereby bridging the gap between researchers and those that use scientific knowledge such as local governments, natural resource managers, farmers, businesses, and planners. In principle, the ABCM works because these boundary organizations complement each other by relying on their previously established relationships with researchers and practitioners to build or maintain critical trust and legitimacy before, during, and after the co-production process. In addition, they manage process tasks such as organizing and leading interactive meetings and workshops between researchers and users, and sustain their engagement through time. Hence, by linking with other organizations that already have the trust of potential users, GLISA avoids the costs of building such relationships from scratch. Potential users, in turn, have the opportunity to co-develop customized, relevant knowledge that can support their decision needs. From GLISA's perspective, by funding boundary organizations that have existing relationships with practitioners, the tasks of network building, building on stakeholders' capacity to adapt, and co-producing knowledge become easier as costs are shared throughout the chain.

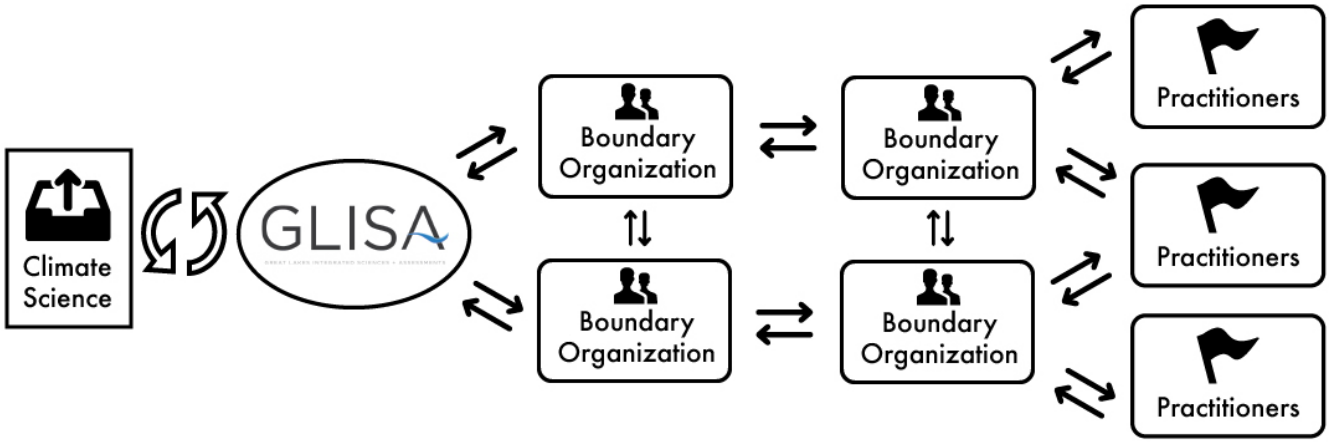
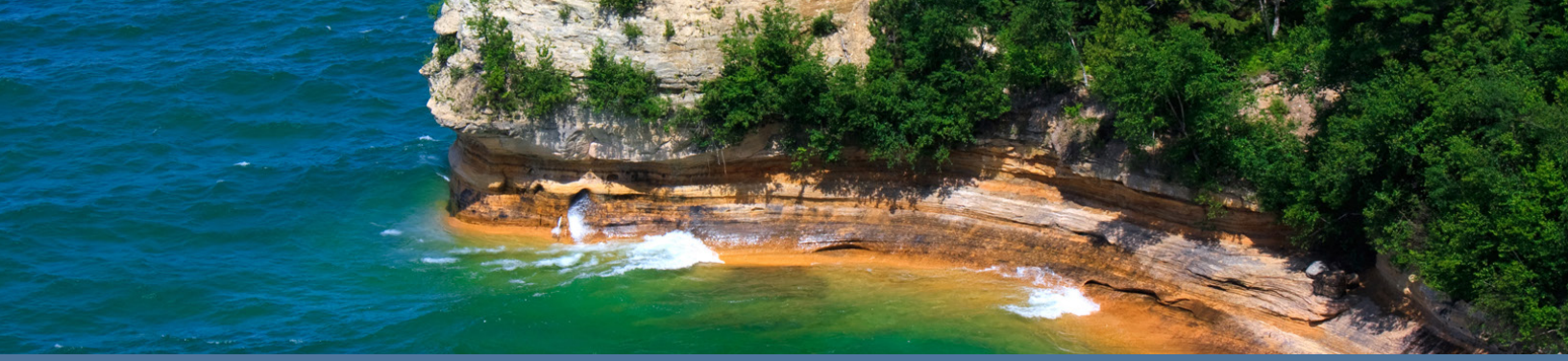


Figure 1. *The Adaptive Boundary Chain Model. GLISA produces climate science – as well as supplies funding – for boundary organizations (who in turn share knowledge with GLISA), with boundary organizations co-producing usable climate knowledge with users (practitioners).*

This report evaluates the first ten years of GLISA's ABCM model. To accomplish this goal, members of the GLISA team interviewed Principal Investigators (PIs) and other relevant organizational contacts for 16 small grants projects funded between 2011-2015 to explore what worked and what could be improved in future iterations of the Program. A second round of interviews were carried out in the summer of 2019 to understand longer-term impacts associated with the projects. These interviews focused on the characteristics, focus, and process of each project, especially the amount of hands-on assistance GLISA provided, the strength of already established relationships between boundary organizations and practitioners, the level of resources each organization had at its disposal, and the nature of their work and of the project outcomes. Ultimately, both sets of interviews aimed to understand the drivers of success in terms of dissemination of climate information, long-term impact, and the lessons that could inform the implementation of future small grant competitions. The next two sections focus, first, on how the ABCM emerged within GLISA, and second, on the social science literature supporting the conceptualization of the ABCM. Next, we describe the methods for the evaluation and analyze the data. The conclusion discusses lessons learned and how they may inform GLISA's next steps in improving and expanding the Small Grants Program and GLISA's impact in the Great Lakes region.



II. The Building of a Model

How the Idea of Boundary Chains Emerged

When GLISA was created in 2010, its biggest challenge was to rapidly understand whether and how practitioners in different sectors were addressing the need to mitigate and adapt to climate change and the role GLISA could play in further supporting them. Because GLISA's established geographic reach included eight U.S. states and the Canadian Province of Ontario, the initial team needed to design an approach that allowed GLISA to reach its large region and the numerous sectors likely to experience climate impacts. From the beginning, it was clear that the idea of carrying out a broad needs assessment across the entire region was not feasible, so rather than limiting GLISA to a few sectors and geographies, the team designed an innovative two-pronged strategy to engage stakeholders.

First, GLISA carried out extensive secondary research of reports and documents produced by stakeholders in the region describing their climate knowledge needs. This initiative, in collaboration with two other RISAs (the Western Water Assessment (WWA) and the Carolinas Integrated Sciences and Assessments (CISA)), yielded important information about sectors and communities that were mobilized to respond to climate change impacts in the Great Lakes region (see Dilling et al. 2015).

Second, within GLISA, the team brainstormed different opportunities to leverage resources that were mobilized in the region in order to extend the organization's reach. One idea was to identify climate change research projects (e.g., scientific assessments) that were in process and fund stakeholder interaction in these projects to increase the usability of the knowledge produced (see description of First Generation Grants, below). While this was a promising idea, it did not yield the expected outcomes, especially because many of the projects funded had little experience working with stakeholders or did not produce knowledge that fit stakeholders' needs. However, among those projects funded, there was an outlier (led by the Huron River Watershed Council) whose main goal was to create a network of users rather than to create knowledge. The outcomes of this project were much more positive in terms of usable knowledge than the others and the project taught GLISA valuable lessons (for a detailed description, see Briley et al. 2015). By focusing on stakeholders rather than knowledge, the project pushed GLISA to think "outside the box" and focus on the boundary between knowledge production and use as a valuable asset for co-production. GLISA realized that complementarity with other existing regional organizations could be an important dimension in meeting GLISA's goal in the Great Lakes region to act as a boundary between The University of Michigan (UM) and Michigan State University (MSU) climate scientists and users. GLISA then sought to work with other boundary organizations who were close or willing to organize stakeholders to co-produce actionable knowledge. The team hypothesized that GLISA could increase its reach by partnering with other organizations that had existing relationships with stakeholders, thereby decreasing the costs of organizing and building trust and legitimacy. Because GLISA did not know who these boundary organizations were and could not fund all of them, the team designed a funding competition to select the most promising projects that fit GLISA's co-production goals.

GLISA also saw the model as an opportunity to adaptively change by designing each subsequent competition with lessons from prior competition outcomes (for details, see Lemos et al. 2014). To date, GLISA has funded three rounds of small grants projects. While the projects are funded separately, beginning in the second round of funding, GLISA made a concerted effort to build and sustain a network of funded partners by requiring that project leads met regularly over teleconference (the GLISA network calls), talked about their projects with each other,

and presented their goals and results during GLISA's advisory board meetings. The following section describes each generation of the Small Grants Program competition.

- **First Generation:** The first two years of the competition (2011, 2012) funded 11 boundary organizations. In this first iteration of the competition, GLISA sought to build its network of boundary organizations in the region by broadly soliciting projects to "support scientific assessments (...) with the goal of identifying and understanding the potential impacts, responses, vulnerabilities, opportunities, and barriers to adaptation to climate variability and change…" The call for proposals required boundary organizations to engage decision-makers during the project, but it did not advise how those interactions should occur. The call also did not specify or constrain the kind of climate information GLISA or the level of capacity GLISA could provide. Most grantees were university researchers who committed to add a stakeholder component to their ongoing conventional research projects.

- **Second Generation:** The next three years of the competition (2013, 2014, 2015) funded 12 boundary organizations (one organization was funded for two projects). This generation focused the competition on engagement and problem-solving rather than ongoing research projects. GLISA narrowed the call for proposals accordingly to "fund organizations to engage networks of stakeholders in science-grounded processes to identify, assess, and/or resolve climate-related problems or management issues." Notably, the 2014 competition funded both new partnerships (Emerging Action awards) and previously funded grantees (Sustained Assessment awards). The call also detailed the types of climate information and general project support GLISA could provide. While a few grantees were academic institutions, such as in the First Generation, several were non-profit organizations.

- **Third Generation:** The most recent competition funded 10 boundary organizations for 11 projects in 2019 (one organization was funded for two projects) to "sustain and strengthen GLISA's network of boundary organizations, foster close interaction between and among GLISA knowledge brokers and grantees, learn what GLISA products are ready to scale-up in the region and beyond, and to increase our impact in the Great Lakes." In this competition GLISA offered three specific service categories for applicants to choose from. Each category was based on an existing type of service that GLISA knew had been previously successful, and each service included sub-categories paired with examples of tangible results from prior projects. This was intended to scale-up GLISA's impact in the region by applying already developed frameworks to other sectors and geographies as well as to streamline GLISA's participation in each project by clearly defining what information and support GLISA can (and cannot) provide. Grantees include academic institutions, non-profit organizations, and state agencies in the U.S. and Canada. These projects are not included in this evaluation as the projects are still ongoing (see Conclusions for how GLISA adapted the Program for the Third Generation based on evaluation findings).

Project List

A total of 16 projects were included in the 2011-2015 evaluation of the Program. This total does not include the small grants projects awarded in 2019. For more information on any of the projects below, please click on the project title to be taken to that project's page on GLISA's website.

First Generation:

- Decision Support and Great Lakes Lake Whitefish in a Changing Climate (2011); *Grantee: Abigail Lynch, Michigan State University*
- Great Lakes Evaporation: Implications for Water Levels (2011); *Grantee: John Lenters, LimnoTech*
- Mid-Michigan Heat Model (2011); *Grantee: Laura Schmitt Olabisi, Michigan State University*
- Winter Adaptation Measures for the Chicago Climate Action Plan (2011); *Grantee: Martin Jaffe, Illinois-Indiana Sea Grant College Program*
- Assessing Climate Risks for the Michigan Tart Cherry Industry (2012); *Grantee: Dr. Nikki Rothwell, Northwest Michigan Horticulture Research Station*
- Huron River Watershed Council: Creating Climate Resilient Communities (2012-2013); *Grantee: Rebecca Esselman, The Huron River Watershed Council (HRWC)*

Second Generation:

- Climate-Informed Ravine Management (2013); *Grantee: Angela Larsen, Alliance for the Great Lakes*
- Helping Marina and Harbor Operators Respond to Climate Change (2013); *Grantee: Jim Diana, Michigan Sea Grant*
- Making it Personal: Diversity and Deliberation in Climate Adaptation Planning (2013); *Grantee: Roopali Phadke, Macalester College*
- Toward Extreme Weather and Climate Resilience in the Region of Peel (2013); *Grantee: Chandra Sharma, Toronto and Region Conservation Authority (TRCA)*
- Tribal Climate Change Adaptation Planning (2013); *Grantee: Dean Fellman, Center for First Americans Forestlands*
- Twin Cities Transportation Study: Adapting to Climate Change and Variability (2013); *Grantee: Claire Layman, Michigan State University Extension*
- Assessing and Mitigating Municipal Climate Risks and Vulnerabilities in York Region, Ontario (2014); *Grantee: Stewart Dutfield, Ontario Climate Consortium*
- Implementing Forest and Water Climate Adaptation Solutions to Build the Resilience of Two Northwoods Communities (2014); *Grantee: Deb Kleinman, Model Forest Policy Program*
- Ready & Resilient: Climate Preparedness in Saint Paul, Minnesota (2014); *Grantee: Roopali Phadke, Macalester College*
- The Climate-Ready Infrastructure and Strategic Sites Protocol (CRISSP) (2014); *Grantee: David Ullrich, Great Lakes and St. Lawrence Cities Initiative*

III. Co-Producing Knowledge in Boundary Chains and Evaluating Outcomes

The cost of co-production. Engagement with practitioners and stakeholders is a well-established tenet of the RISA network research and practice. The rationale is that knowledge that is co-produced with potential users is more likely to be usable in support of climate adaptation decision-making (Lemos and Morehouse 2005, Meadow et al. 2015, Simpson et al. 2016, Riley 2021). When properly executed, co-production can result in the two-way transfer of knowledge between parties – informing researchers and users of climate science about the needs, usability, and practicality of specific information (Howarth et al. 2017).

While the evidence that co-producing climate knowledge increases use is compelling (Arnott et al. 2020), the costs associated with co-production suggest the need to better evaluate these costs against potential outcomes (Lemos et al. 2018). As mentioned above, these costs include not only funding the human and logistical resources required to sustain the high level of interaction involved in co-production, but also the longer-term investment in building trust and legitimacy between researchers and users of knowledge (Lemos et al. 2014). Additionally, new research has identified other potential pitfalls, such as overreliance on the same group of stakeholders to engage that lead to 'stakeholder fatigue' (Newton and Elliott 2016) and the growing pressure on the academic community to engage when researchers may lack inclination, training, and institutional incentive to do so (Lemos et al. 2018). Finally, recent research has highlighted how social and power imbalance between participants in co-production may exacerbate issues of inequity, justice, and legitimacy in co-production (Turnhout et al. 2020, Vincent et al. 2020).

Emerging research on how to mitigate the costs of co-production points to different strategies, including reliance on boundary organizations and boundary spanning (Reed and Abernethy 2018, Goodrich et al. 2020), concerted attention towards issues of legitimacy, trust, equity, and inclusion in collaborative research (Djenontin and Meadow 2018, Cvitanovic et al. 2015), and use of technology to decrease logistical costs, especially time and money required to sustain engagement (Lemos et al. 2019).

The role of boundary organizations. Boundary organizations sit between knowledge producers and users with the goals of enabling co-production and bridging and brokering scientific knowledge towards action (Kirchhoff et al. 2013, Reed and Abernethy 2018). They facilitate collaboration between scientists and stakeholders (Bednarek et al. 2015), broaden the field of actors who can participate in knowledge co-production, and blend top-down solutions and information with local credibility and knowledge (Fudge and Hiruy 2019). They can also potentially promote the inclusion of different kinds of knowledge, such as traditional ecological knowledge and lay knowledge, into decision-making and help navigate and mediate unequal and uneven power dynamics between different actors (Gray 2016).

As mentioned before, GLISA's role as a boundary organization is grounded in an experimental model whose main goal was to design an adaptive engagement model that allowed for fast and broad interaction with stakeholders seeking to increase the use of climate information in the Great Lakes region (Lemos et al. 2014, also see Section II). By relying on Great Lakes organizations that had existing relationships with stakeholders, GLISA experimented with the concept of boundary chains, in which several organizations iterate with each other to create, broker, and sustain co-

production. Conceptually this model advanced three main types of chains: key-chains, linked chains, and sustained chains. Figures 2, 3, and 4 below depict the different chain models. In practice, the three models represent different types of relationships funded by GLISA that vary in terms of the number of organizations involved, the depth of their connection with GLISA and with each other, and their ability to sustain these relationships through time (Lemos et al. 2014).

Figure 2. *The Linked Chain. A series of boundary chains are connected to intermediate knowledge between producers and users. Knowledge intermediation is continuous.*

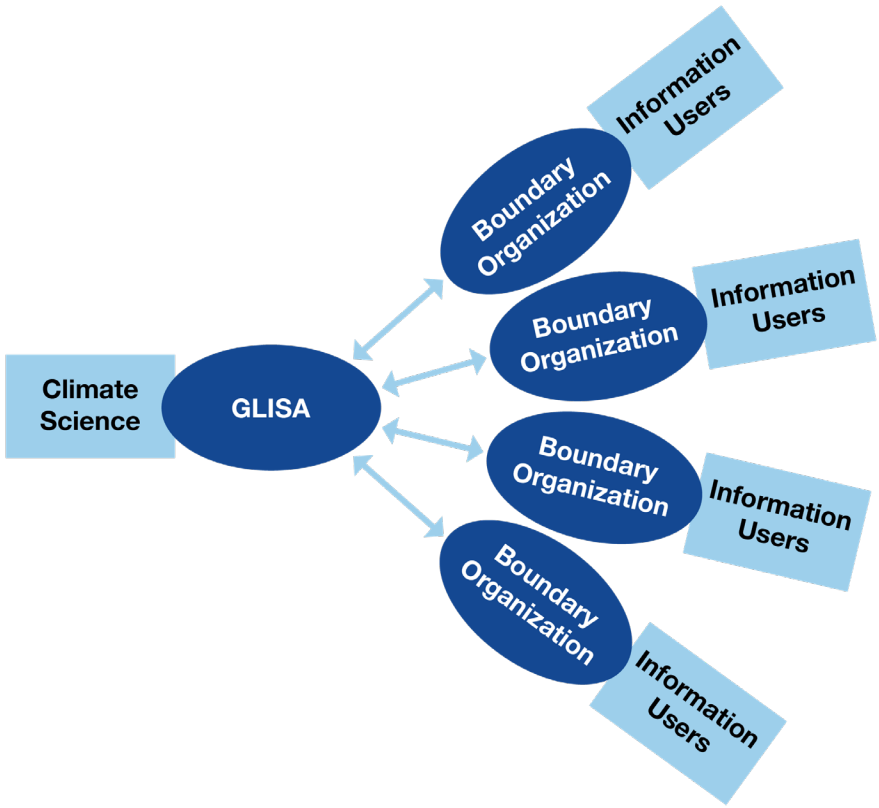


Figure 3. *The Key Chain. Multiple boundary organizations connect with one boundary organization, in this case GLISA, that works on co-producing knowledge.*

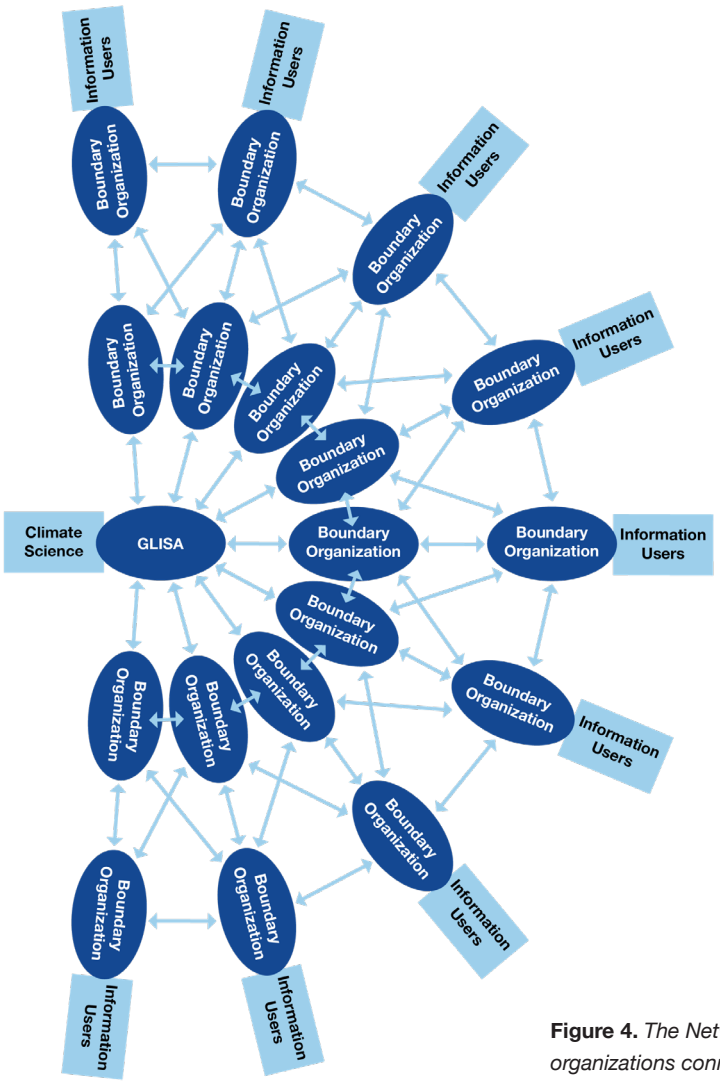


Figure 4. *The Networked Chain. Multiple boundary organizations connect with other boundary organizations to intermediate and co-produce knowledge.*

Evaluating co-production and boundary chains. Research on evaluating co-production, its impact, and potential pitfalls has increasingly highlighted the need to develop metrics that not only account for process (e.g., intensity of interaction, participatory approaches, equity, and power), but also for outcomes (e.g., types and extent of use, long-term impact) (Meadow et al. 2015, Wall et al. 2017, Mach et al. 2020). For example, Wall et al. (2017) developed a suite of indicators on how best to evaluate co-production, with indicators falling into six broad categories: inputs, process, outputs, outcomes, impacts, and external factors. Meadow et al. (2015) also describes different approaches to evaluate co-production, including using a set of metrics created by the National Research Council (NRC) that focus on assessing the strengths and nuances of the relationships between scientists and practitioners (see also Klenk et al. 2015).

Yet, there has been considerably less focus in the literature regarding how to evaluate boundary organizations. To discuss how to evaluate the Program, in 2014 GLISA sponsored a workshop with grantees and other scholars in the field to discuss the role of boundary chains both theoretically and practically. The workshop proposed a theoretical framework (Kirchhoff et al. 2015b) focusing on three main variables — complementarity, embeddedness, and resources (e.g., financial, human, logistics, time) — that shape boundary chains' success and create synergies between producers and users of knowledge. The framework was then used to evaluate a number of

the small grants projects as well as a few other cases in the U.S. where boundary organizations acted as an intermediary between producers and users of climate knowledge. The results of the workshop were published in a special issue of the journal Climate Risk Management in 2015. Figure 5 (Kirchhoff et al. 2015b) depicts the conceptual model supporting the evaluation of boundary chains.

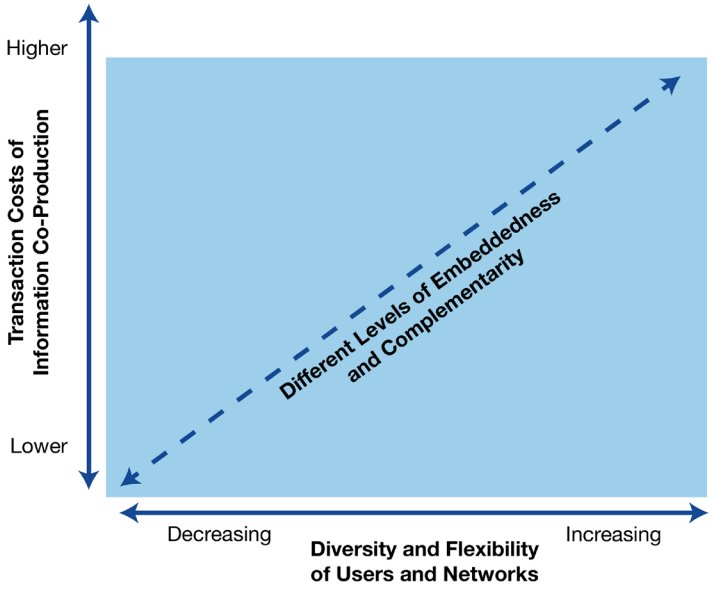


Figure 5. *The relationship between different levels of embeddedness and complementarity in boundary chains and the transaction costs of information co-production and the diversity and flexibility of users and networks. (Kirchhoff et al. 2015b).*

In the model, *complementarity* refers to the way in which the different skill sets and resources that each organization brings to the chain complement each other, which in turn adds value and efficiency to each step of the co-production process. For example, a small grant project led by the Huron River Watershed Council (HRWC) organized a network of stakeholders (the Climate Resilient Communities Project) in the water sector and facilitated monthly meetings to discuss the potential impact of climate change on the resilience of different local water systems, while GLISA provided the climate expertise. A longitudinal study of the project showed that the complementarity between GLISA and HRWC and the embeddedness between HRWC and the Climate Resilient Communities Project stakeholders were critical for project success. GLISA and HRWC benefited from each other's skills and resources: the HRWC grew more fluent in climate brokering, and GLISA used the HRWC's connections to establish new partnerships (Briley et al. 2015). Similarly, a case study focusing an environmental non-profit organization in California, the West Coast Ocean Acidification and Hypoxia Science Panel, showed that boundary chains provide a form of social complementarity, whereby members of the boundary chain benefit from relationships established by others within the chain to make new connections (Meyer et al. 2015).

Embeddedness, or the ties that bind boundary organizations to each other, is also vital to boundary chain success. Embeddedness focuses on: a) the mutual dependency between boundary organizations where the actions undertaken by one will at least partially influence the decision-making of another, b) the role each participant fills in the chain, and c) how participants have confidence in the ability of other participants to fill their respective roles (Kirchhoff et al. 2015b). A major component of embeddedness is an iterative relationship-building approach that improves knowledge usability by encouraging each organization to become familiar with and respect each other's perspective and approach. For example, in the study of GLISA and HRWC, the established relationship and open dialogue between both boundary organizations and the stakeholders of the Climate Resilient Communities Project allowed for a better understanding of what sort of climate information project participants needed and wanted, the limitations of the current state of climate science that may preclude meeting these needs and wants (i.e., in terms of scale and skill), and the discovery of other possible pragmatic solutions that can meet users' needs (Kirchhoff et. al 2015b).

Resources are the tangible and intangible assets and skills available to boundary organizations and practitioners. Examples include social, financial, and political capital, personnel capacity, strength of motivation, and fit of existing climate knowledge.

IV. Methods

This evaluation relied on surveys, key informant interviews, and network mapping data to analyze three dimensions of co-production between organizations (Ostrom 1996, Kirchhoff et al. 2015a): embeddedness, complementarity, and resources. GLISA examined the role of these three dimensions in each funded boundary chain in the sample, especially in terms of how they impacted project outcomes. The main goal of the evaluation is to examine what worked in terms of meeting GLISA's boundary chain goals to inform the design and implementation of future small grants competitions and GLISA's engagement strategies. It should be noted that this evaluation was conducted internally by GLISA as part of a graduate student practicum at the University of Michigan School for Environment and Sustainability. Several graduate students worked with GLISA staff and faculty to design and conduct the evaluation and complete this report.

As mentioned above, GLISA conducted two sets of surveys and interviews in 2016 and 2019. This report analyzes and summarizes data collected from both sets of interviews for the 16 small grants funded between 2011-2015. We sought to answer the following questions:

- How effective is the ABCM?
- How effective were the funded boundary chains in terms of brokering and bridging usable knowledge? To what extent did the boundary chains foster and deepen climate information use by decision-makers?
- Are more embedded chains more likely to share, bridge, and broker information?
- Were chains with greater resources (i.e., human, financial, social capital) more successful?
- Did boundary organizations that had previously worked with climate science and information and climate-related decisions (i.e., were more complementary to GLISA) have greater positive outcomes than organizations that were less complementary?

Surveys and interviews. Online surveys were administered to all funded boundary organizations using Qualtrics software. The first round of surveys were administered immediately after each project was completed and the second round was administered in 2016 to focus on project outcomes in subsequent years. The surveys asked boundary organizations about their characteristics (how much of the organization's time is dedicated to working on issues related to climate change), their relationship with GLISA (how often they mentioned GLISA in climate presentations, as well as their ongoing interactions with GLISA), the information they received from GLISA (the type of information, as well as how useful it was), and how each organization's network changed due to the Program funding. For a full list of questions asked to boundary organizations, please see Appendix A.

Of the 16 projects included in this evaluation, six are from the First Generation and 10 are from the Second Generation. For each project, GLISA conducted two rounds of key informant interviews. The first round was carried out shortly after project completion (2014-17), and the second round was in the summer of 2019. Key informants include project PIs and at times other participants. For the second round of interviews, GLISA attempted to interview the same contact(s) as in round one; however, due to time elapsed between interviews and internal boundary organization restructuring, round one contacts were not always available. In those cases, a contact involved with the project that remained at the organization was interviewed. One project was unresponsive for the round two interview and no organizational contact could be reached; that project is included in round one data analysis but not round two. Following the second round interviews, both sets of interviews were qualitatively coded to identify main project themes and outcomes; those results are presented below in project findings. GLISA also carried out key informant interviews with the four GLISA climatologists

(i.e., the GLISA staff person who primarily interacted and collaborated with each small grant organization) in 2020 to understand their perspectives and experiences with the projects for which they provided climate information and mentoring. Specifically, the interviews focused on the factors the climatologists believed were the most critical to project outcomes. All interviews were transcribed and coded and all the data was organized using the qualitative data software NVivo for analysis. To protect the identity of the interviewee, all quotes included in the report have been removed of identifying project information.

Finally, network mapping data was collected using the network data software UCINET both in 2014 and 2016. The goal of the data was to understand the level of connections and interactions between all projects during their award period and after the funding ended.

Coding. A specific set of initial codes was developed and used in all round one interviews with inductive coding techniques to reach a more granular understanding of specific relevant variables, depending on the content of individual interviews. Broad themes included the three main dimensions of the ABCM *(complementarity, embeddedness, and resources),* and three main desirable outcomes *(continued collaboration, positive results relative to goals, and indicators of success).* Coding for round two interviews built on the foundation of round one, streamlining and expanding the codes for both drivers and outcomes to reflect the new rounds of interviews. For more information on the coding process, see Appendix B.

V. Project Findings

V.I. Projects' Characteristics and Their Relationship with GLISA

The data from the surveys applied immediately after project completion and in 2016 focused on the boundary organizations funded by the Program, including their characteristics, information use, and the character of their relationship with GLISA. The findings are described below.

Characteristics of the boundary organizations funded by the Program. Overall, climate change and the GLISA project represented a small part of the funded boundary organizations' work streams. Most organizations in GLISA's small grants program have existed for longer than thirty years (Q1a) but have been involved in climate issues for fewer than ten (Q1b). While many organizations dedicate less than 40% of their work to climate change issues (Q2a), GLISA's main points of contact within the organizations (the survey respondents themselves) tend to dedicate more of their time to climate work (Q2b) compared to colleagues at their organizations. Organizations also varied substantially in the amount of time they dedicated to the small grant project (Q3a).

Funded boundary organizations support a collaborative and open environment of information-seeking and sharing. A large majority of respondents stated that their respective organizations promote information seeking: 96% of participants felt that their organization supported individual efforts to seek new information (Q3c), 82% felt that they had discretion to seek new information (Q3f), 82% felt that their organization provided financial support to facilitate access to new information (Q3d), and 87% felt that it was easy for them to provide or adopt new information (Q3g). Respondents indicated a highly collaborative environment, with 78% strongly agreeing that they collaborate with others when they seek new information (Q3e).

Relationship with GLISA. Organizations vary widely in how frequently they deliver climate presentations and how regularly they mention GLISA in these presentations. More than three quarters of the surveyed organizations regularly deliver presentations related to climate change (Q4), but there is a significant range in the number of presentations delivered (between 1 and 30 in a year) (Q5). Organizations varied widely in how frequently they mentioned GLISA in these presentations: 28% "always" mentioned GLISA and 67% mentioned GLISA "most of the time" or "sometimes." No organization responded that they "never" mentioned GLISA (Q6).

Organizations report a sustained relationship with GLISA. Both during and after the GLISA-funded project, small grants organizations reported referring GLISA to other organizations at high rates (78% and 82%, respectively) (Q7a-b). Organizations also reported high rates of sustained engagement, with 70% of respondents continuing work with GLISA following the completion of the funded project (Q8). Most organizations (65%) felt that they provided input into GLISA's overall work (Q3b).

Information and Guidance. Organizations were highly satisfied with GLISA information and guidance, and they applied this information to GLISA and non-GLISA work at high rates. Organizations reported receiving a diversity of information and guidance from GLISA, including localized climate information (64%), references to other organizations (59%), climate information for scenario planning (55%), education (36%), and training (14%) (see Figure 6). They indicated high levels of satisfaction with all the information and guidance they were provided (see Figure 7). Localized climate information and references had the highest rates of satisfaction, whereas training and education had the lowest rates of satisfaction compared to other types of information and guidance. Organizations reported applying GLISA information to GLISA-funded

projects at high rates (almost 80% across information types) and to non-GLISA work at slightly lower rates (70% across all types). For GLISA-funded projects, localized climate information and references were the most applied, while education and training were the least applied (Q10-27).

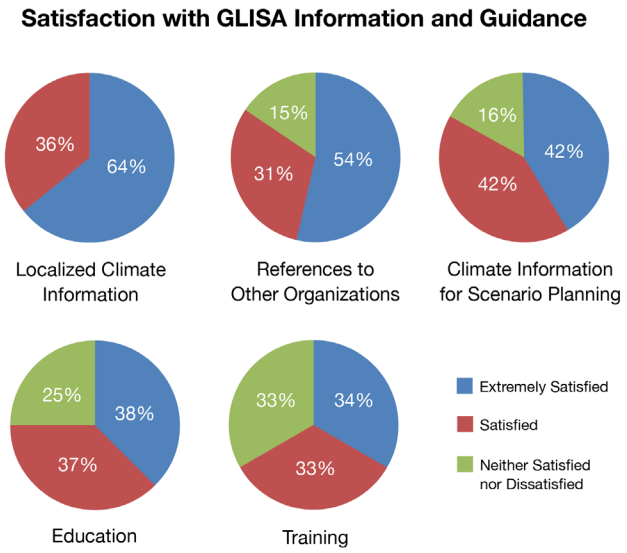


Figure 6.

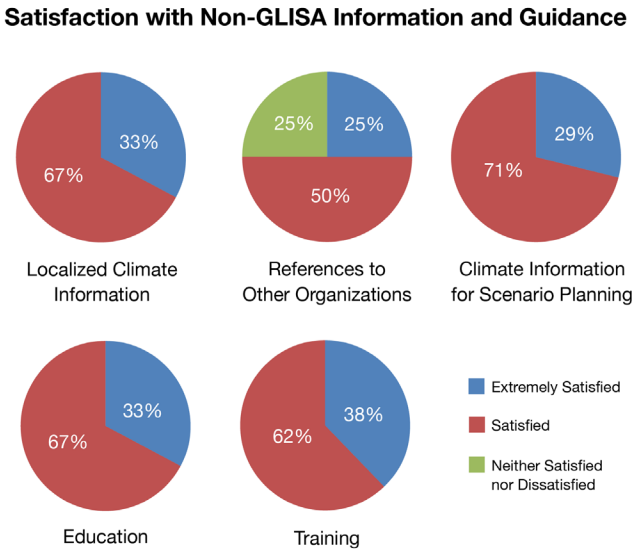


Figure 7.

V.2. Understanding Drivers of Success

The strength of relationships and processes of relationship-building (embeddedness) were the most common themes from interviews with project PIs following the initial completion of each project. Cited most often out of any factor, embeddedness played an integral role in the practical functioning of the ABCM: all projects (16 out of 16) mentioned some element of embeddedness as important, with interviewees at boundary organizations often mentioning their close relationship with GLISA as an important factor in executing the project (11 out of 16). Previously established relationships and/or close working relationships between boundary organizations and practitioners (eight out of 16 for both) were also mentioned as an important consideration in executing the projects.

In interviews, many boundary organizations described how the grants facilitated relationship-building beyond that of a usual donor-grantee connection:

"We turned to GLISA because of the funding at first, and it was a surprise how much they approached working with grantees as partners. At first, it was about funding. I wasn't aware ahead of time about how much richer the partnership would be than with our typical funder."

The levels of "thickness" or intensity of relationships was a common theme described throughout the interviews. Boundary organizations referred to their partnership with GLISA as "unique," "critical," and "instrumental." GLISA provided not only funding, but also coaching, training, and in-person support to boundary organizations and the practitioners. The data from the round one interviews indicates that projects that often mentioned close working relationships between GLISA and boundary organizations as well as boundary organizations and practitioners showed a higher number and strength of positive project outcome indicators than projects with fewer mentions.

Interviewees also cited the complementarity between GLISA and their organization as a pivotal factor for the success of their project. Although interviewees reported that embeddedness was more important than complementarity for accomplishing their goals, all but one project mentioned complementarity during first round interviews as a factor for success (15 out of 16). Complementary work in climate adaptation by boundary organizations was cited in a majority of cases (nine out of 16 projects), while work in a field other than climate

adaptation (six out of 16) and an interdisciplinary approach to co-production (two out of 16) were mentioned less often.

One organization described how closely connected the regional climate adaptation community is and how this connection fostered working relationships inside and outside of the Program:

"We're all involved in the climate adaptation community. I see [GLISA] at the adaptation forum in St. Louis. There have been communications on and off because of our overlapping interest and work in climate adaptation."

Out of the three main dimensions driving boundary chain success, resources was the least mentioned in the first round of interviews (10 out of 16). Interviewees mentioned some sort of previous knowledge aiding them in the project as the strongest factor among overall resources shaping success (four out of 16). Users' lack of resources and motivation, lack of personnel, political capital, and previous relationships were also mentioned as challenges (two out of 16).

Yet, when prompted, there are many interesting and illuminating descriptions of how organizations leverage their resources for projects, as well as how existing resources affect project outcomes. For instance, one project mentioned having facilitation expertise on their project staff as a factor in accomplishing their goals:

"One of my colleagues who is experienced in facilitating, planning meetings, brainstorming meetings worked with [the university] and attended and assisted with the community climate adaptation conversations."

Another project mentioned the motivation of practitioners to engage as perhaps the most important component of their project's successful outcome:

"We could have had all of the localized information that we wanted [from GLISA] but it wouldn't have worked if the [communities] didn't bring themselves together. That's probably the most critical piece – that the [community] wanted to work on the project."

Finally, some projects mentioned the challenges associated with creating lasting change in the process of co-production without providing funding past project completion. For many of these projects, project funding allowed for a critical step in adaptation planning or action to be completed and for different types of capacity to be built, though continued project-specific action stopped once funding was completed. One project in particular highlights these challenges:

"Each of the communities is resource constrained. We had applied for continuing funding so they could pay for staff to continue working on things. We didn't get it. I know there are great applications but I know that for [the practitioners], because they didn't get funding from this stream and other streams, they're back to doing their core work and integrating climate into it, but they're not pushing on some of the things that we were supporting last year."

Trust, a core concept of the boundary chain model, was also mentioned as critical in the co-production process in two projects in round two interviews. One project particularly highlighted the importance of trust-building and long-standing community relationships, especially when working with communities that have experienced exploitative relationships with outside organizations:

"So the challenges are different with each of those communities because they have a different relationship to academia and to government. So it takes a lot of nuance. The neighborhood that is the historically black neighborhood... the challenge is that they've been approached by many different academic outfits and grants, and such things, and have had really extractive relationships and there's just not a lot of trust. So the trust-building work is very different there then when we were working, for example, in this [neighborhood] where it's a lot more new immigrants, and the challenges are not about distrust, but about access – because of language barriers."

Beyond embeddedness, complementarity, and resources, the interviews also yielded other interesting data that supports the evaluation of the Program's performance. For example, although not specifically addressed in the first round of interviews, expected long-term impact was mentioned in a majority of cases (10 out of 16). Respondents voluntarily mentioned (eight out of 16) some form of continued collaboration following the project, whether it was between GLISA, the boundary organizations, practitioners, newly formed networks, or a combination of the four as long-term markers of success (see Figure 8 for an example of the networked boundary chain in practice and Appendix C for a larger network analysis of projects).

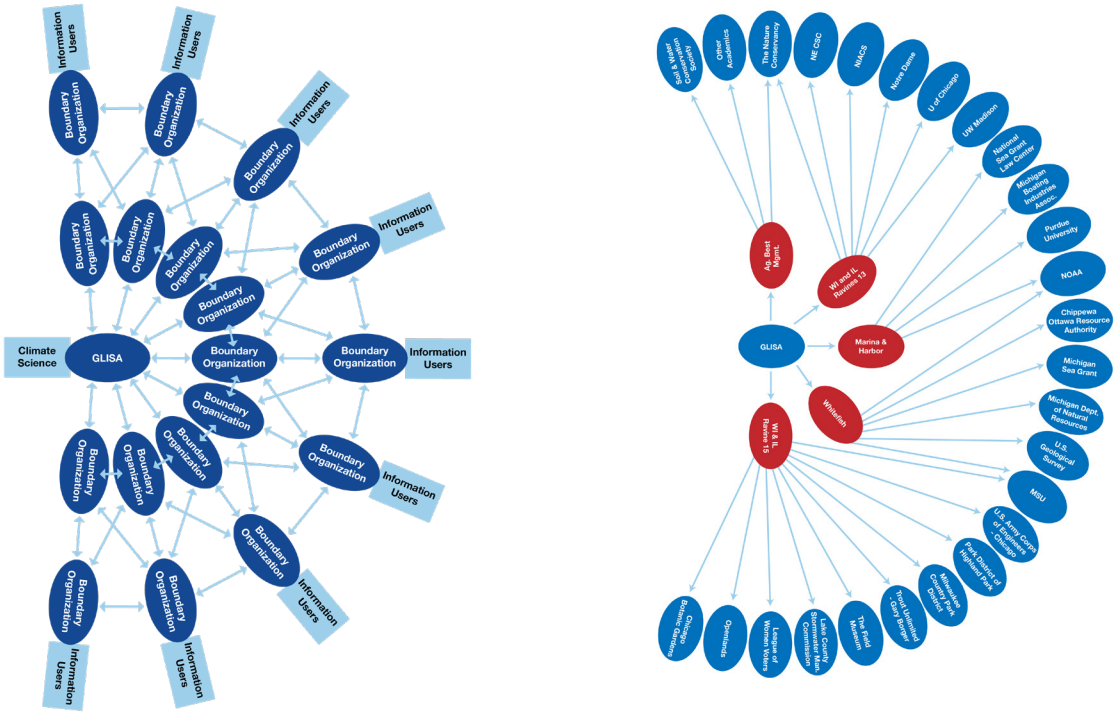


Figure 8. *Networked chain model compared to applied networked chain developed during the completion of the small grant projects. Projects are shown in red while other boundary organizations connected to the projects are shown in blue. Full project titles are: How Sensitive are Agricultural Best Management Practices and Models to Climate Change? Framing Key Issues and Uncertainties with Expert Opinion (Ag. Best Mgmt.), Implementation of a Coastal Vulnerability Assessment, Adaptation Strategies, and Adaptive Risk Management Metrics by Wisconsin and Illinois Land Managers into Ravine Restoration Practices and/or Land Use Decisions (WI and IL Ravines 13), Helping Marina and Harbor Operators Respond to Climate Change (Marina & Harbor), Designing a Decision Support System for Harvest Management of Great Lakes Lake Whitefish in a Changing Climate (Whitefish), Resilient Coastal Communities: Growing the Network and Building the Capacity of Local Leaders (WI & IL Ravine 15).*

This suggests that GLISA's attempts to create and support networks were at least partly successful, although the formal network analysis of contact between the projects once funding lapsed showed a significant decrease (see Section V.2), suggesting less success in sustaining the network of grantees themselves. Given the diversity of grantees and constant need to search for funding, this result is not surprising. Yet, particularly when discussing their own project continuation, informants mentioned how they continue to leverage the network they built during the project and how their current work is sometimes indistinguishable from the original project:

"Through the years, the lines blur as to what is our project and what is ongoing collaboration."

Similarly, outcomes such as a new project or network were also mentioned in 10 out of 16 projects. New knowledge networks (eight projects), increased credibility (eight), and increased capacity (seven) were also mentioned often, whereas reorientation of future organization project plans (four) and reduced costs (two) were mentioned less often. A more robust account of the long-term status of the projects was explored in the second round interviews (see Section V.3.).

An interesting theme in interviews was the importance of the in-person interactions with the GLISA climatologists at workshops. Five out of 16 projects mentioned that having a GLISA climatologist physically present at their meetings aided in their project by providing credibility for the climate information or giving attendees an opportunity to ask questions to understand the climate information:

"GLISA was in the room with these teams for most of the meetings over the course of three years. In-person staff time was critical. They also could bring their knowledge of the science to the group and help the group get that basic climate literacy that allowed them to think about how that would change practices or influence the way they do things."

Some of the interviewees (six out of 16) also alluded to the added value of having the climatologist work collaboratively with local communities:

"GLISA's information hooked us up with one or two climate people who can make maps and projections and look at historical data. They created tailored reports for each of the [communities] we worked with and [they] defined the boundaries of what they wanted."

Increased communication and engagement was also cited often as an outcome (13 out of 16), especially the boundary organization's role as a translator of climate science into usable information —a critical goal in the ABCM:

"We were able to take climate information [from GLISA], which is pure science, and translate that for our municipal partners into more robust risk assessment instruments and tools… The money we got from GLISA actually helped us kickstart the implementation of [an] adaptation strategy."

Some projects (four out of 16) discussed the importance of the grant in facilitating collaboration—whether that was between different organizations, researchers, or even in city government departments that were previously quite siloed:

"It was really about not so much funding to allow us to take measurements. It was more grease and glow to bring people together and share ideas with the others that we could apply to the situation in the sense that it put us all in the same room together more often and we are able to coalesce and come up with some broader conclusions than we could have on our own. This blossomed and grew subsequent activities from it. More in the style of cooperation as opposed to competition."

"At first, it was a little bit of a territorial thing because we were already there working on climate change… And then it became that this can all be mutually beneficial and it worked out fine… This ice-breaking. We got past that and realized there was plenty of work to be done by everybody but there was an initial awkwardness."

"This protocol has forced more city departments to collaborate more with each other and exchange more data and three or four of our cities, we have never had a reason to talk to these people. We are surprised but this took them out of their silo in their day to day business which is a very positive unexpected effect."

Finally, negative project outcomes were mentioned infrequently, with challenges moving forward (five out of 16) and project failure (three out of 16) being the most cited. Challenges included difficulties raising additional money for organizational needs, lack of organizational capacity to follow up on projects, and trouble creating momentum to keep projects moving forward. Failures included two separate mentions of boundary organizations receiving climate data from GLISA that were not specific enough and an organization sending their final product to a large city that did not utilize it due to the city bureaucracy.

V.3. Understanding Longer-Term Impact

Interviewees from each project were reinterviewed during June–August 2019 to update project status and explore what has happened since the funding and the GLISA-led network calls ended. These interviews focused on examining where each project stood after completion, if there was a lasting and/or ongoing long-term impact associated with the project, and what circumstances might have influenced that long-term impact.

First, interviewees were asked about the current state of the project and whether there was a long-term impact and/or the project impact still existed. A majority of interviewees stated that an impact of the project still existed (10 out of 15), with a third stating a tenuous or uncertain long-term impact (five out of 15). Only one project stated definitively that the project had no lasting impact. For projects that mentioned a long-term impact, a general theme was that the initial project created a foundation for work that came afterward—whether it was forming networks that organizations continue to rely on or creating a spark for future ideas. One organization spoke of the inherent difficulty in evaluation work while describing the long-term relationship-building aspect of the project:

"We have relationships with those organizations and those individuals that we worked with, and we continue to have those relationships, so in some ways what has continued on is our general collaboration and work together. I'd say that is the impact—it's hard to know if, you know, we worked with hundreds of individuals, if their climate literacy has improved, but I think the bigger impact is that we've created these relationships, and we continue to work together on climate and environmental projects."

Many projects mentioned that the small grants projects represented the first foray into climate adaptation work that communities or organizations continue to pursue, and therefore represented an important trigger to build upon:

"Where the [project] was kind of pilot tested, it has been the starting point for a whole lot of work on climate adaptation."

"[The project] has been used as a foundational document for about five or six vulnerability assessments that have been completed… So it was kind of step one of a much larger process in the region, but I think it was a very powerful base that they could start from in a good way."

"I think you could say that your grant was sort of the inception of some of those [climate adaptation] ideas."

For some projects, the grants served as the catalyst for hiring or trying to hire new staff to focus on climate work (three out of 16 projects discussed this in first round interviews). One project was unsuccessful in raising the funds to do so. However, in two of the projects, the organization successfully added a permanent climate position:

"With some significant funds raised, the organization decided to hire for my position to build some permanent climate capacity into our shop. GLISA project funds and staff helped us build that capacity."

In both rounds of interviews, interviewees in six out of 16 projects cited their small grant as the catalyst for further funding or funding proposals. In some, the networks formed through the project facilitated funding from new partner groups, while in others, the grantees and partners leveraged the project itself to seek out funding. Of the six projects where funds have been leveraged, one mentioned being unsuccessful in funding requests, two were not explicit in whether these funding requests had been successful, and three explicitly stated that their GLISA project had helped secure future funding. Grants ranged in size; one project mentioned receiving a grant of over $800,000 while others were smaller, yet critical in allowing the work to continue:

"In terms of policy, I know that the [city] has an initiative to continue or follow through on this work to build neighborhood resilience. They got a small grant… That clearly came out of the work that GLISA funded and that we did together."

"We used that work [GLISA work] in multiple funding grants. It allowed us to be able to articulate what the needed next steps are. Like any good planning document could and should. We use those in funding requests to fundraise."

In contrast, many of the projects that did not mention an ongoing impact seem to have been mostly focused on research (First Generation) rather than on engagement and action. For example, an early project described the grant mostly as a complement to their field activities:

"...you [GLISA] provided the funding to keep those sites going for a couple more years. So the funding was to

provide the means to continue the field work to keep those measurements going…since the funding has ended, we don't have any more funding to go out there and do field work."

Similarly, projects that were uncertain about long-term impacts mostly cited lack of time or resources to follow up and evaluate outcomes.

"I think at one point I wanted to follow-up and just find out, like, 'hey, how's the city used this information at all?,' and I just can't remember if we ever heard back…I guess I wish that I knew if that information is being used."

"I would say that we have not specifically followed up with them and found out where they stand with their projects and how they're doing."

Interviewees were also asked about complementarity, specifically whether the networks that were formed during the small grants projects still exist, and/or whether the projects expanded/utilized previously existing networks. Almost half of interviewees stated that networks formed during the project still existed (seven out of 15). For example, an early grantee mentioned that:

"[The project] formed this external network. And I know that was one of the exclusive goals of these grants, and I think that worked really well. So the initial partnership(s)... those have all stayed very strong and expanded."

Many organizations and individuals were uncertain or tepid about the original network still existing (six out of 15), echoing some of the capacity issues in relation to evaluation that came up in the round two question about long-term impacts:

"I can't say whether or not they have been interacting around this topic or others, you know, since the end of the project because I don't really have the capacity to kind of go and monitor that."

Three out of 15 interviewees, all from the First Generation of research-driven projects, stated that project networks did not exist anymore.

Finally, regarding network evolution, six out of 15 interviewees cited network expansion, one cited no expansion, and four reported no network change. Interestingly, one organization spoke of how the project reoriented its network building toward climate-related groups:

"So we strengthened relationships [between] jurisdictions, between the different subgroups, and then in terms of expanding relationships, we really I think focused—and will continue to focus—on expanding relationships related to climate change expertise."

As shown above, one recurring theme in the round two interviews was that many of the early small grants projects, most of them during 2011 when the program first started, were research-based; these projects display most of the "negative" or neutral project outcomes related to relationships, long-term impact, and network-building. In response to the difficulty of the First Generation projects to generate either the level of climate information use or network building, GLISA adaptively changed the competition requirements for the Second Generation projects to encourage organizations that already had a relationship with stakeholders to apply to the program. "Negative" outcomes from the First Generation served as vital learning opportunities to frame future requests for proposals, steer funding decisions, and generally make the Program more effective in later generations.

Lastly, interviewees were asked about resources, with a wide range of answers that largely echoed the findings from the first round of interviews. The main resource-related factors mentioned were existing/ongoing lack of financial support impacting the project (five out of 15), lack of expertise and personnel to carry the project forward (three out of 15), and the fact that the project allowed work that might not have been done otherwise (three out of 15). However, the subject of resources also surfaced in interesting and different ways during round two interviews. One project mentioned that rather than being a constraint, lack of resources actually encouraged them to design their decision tool in a more accessible way for their users:

"Yeah, well that was the whole idea, basically to develop a project that could be deployed with very small resources... So the tool that we developed, the whole idea was to use it with small resources, or low resources, and as a matter of fact try to use that even as a strength, because then we can – by having something that is low tech or you know, that's easily accessible that is user friendly—well, then we could empower the civil workers from the city, and get them directly involved, instead of having something that is only accessible to engineers or scientists."

This particularly shows how co-production can evolve

into unique processes over many scales of interaction in the face of constraints: a lack of resources drove the project design, with the needs and unique circumstances of practitioners heavily informing how the boundary organization approached the development of their tools.

V.4. Understanding GLISA Climatologists' Role in the ABCM

Four GLISA climatologists were interviewed in May 2020 to gain their perspectives on the Program, as well as what they viewed as the critical characteristics that drove successful projects. GLISA climatologists worked with and within projects to curate, tailor, and broker climate information and services to boundary organizations and practitioners. Each climatologist was involved with multiple projects highlighted in this report, although one only worked on earlier projects (First Generation), one only on later projects (Second Generation), and two on both earlier and later projects. All had general thoughts on what went into "successful" projects, as well as insights on the specific characteristics that led to positive project outcomes.

All climatologists believed that motivation and enthusiasm to engage from boundary organizations and users was the most important factor in shaping success. This often took the form of one person, or "champion," who drove the project along (this was explicitly mentioned by three out of the four climatologists interviewed). When neither motivation nor a champion were available, the project had a greater likelihood of stalling, or simply not reaching its full potential. Also mentioned was the importance of making the climate information presented to boundary organizations accessible enough to pass down from employee to employee if one of these "champions" happened to leave an organization. One climatologist explained the critical role of the champion (which often was the PI on the project) in carrying the work forward after GLISA project funding was completed:

"...there always had to be a champion that we could trust to carry the information forward. And that champion could look very different, but it had to be somebody that was in the community or in that organization that really was prepared to become that de facto climate change person for the organization. The project goals could have been very different, but whatever those goals were, whatever the project was, if there wasn't somebody that was really embracing that role, saying 'okay, we're going to do climate adaptation and really take this on,' you know... The project might have been successful, but it probably wasn't going to carry on beyond our engagement."

There were mixed views on what factors really mattered for success. For instance, the climatologists believed that the resources an organization possessed were not an important driving factor in deciding project outcomes, pointing to well-resourced organizations delivering sub-optimal outcomes and under-resourced organizations excelling in the Program. One climatologist pointed to an overarching lack of government funding as the main impediment to achieving action on climate change. On the other hand, they discussed their positive experiences working in a state that had a far higher budget than many others in the Great Lakes region.

Previous experience working in climate change was also seen as a critical asset as the continuing evolution of the program made it easier for the climatologists to quickly and efficiently bring boundary organizations and stakeholders up to speed. However, the ability on the part of communities to know how to fit the supplied information into a specific need was important:

"Thinking about the different communities where it really worked, [it] wasn't necessarily knowledge of climate data. It was willingness to listen to the data and then how good they were at figuring out: where does this data apply to something that we already know, or that we know how to make work... so we were giving them translated science, and it was how well they could take that translated science into action at the community scale that we would not have been able to identify."

One climatologist noted that it was particularly effective when the supplied information described an issue that could be solved with an existing framework already known by the boundary organization or practitioners—for instance, an existing state policy or state funding structure.

The strength of relationships (embeddedness) as a factor in projects was portrayed contextually by the climatologists. One climatologist cited a project that had not identified practitioners before starting the grant, and the outcomes suffered as a result—necessitating a shift in project strategy. However, they also mentioned the critical nature of previous trust and relationships among certain groups of practitioners, notably agricultural and Tribal communities. Bringing together the many links in the boundary chain—GLISA, the boundary organization, and

practitioners—at face-to-face meetings was also cited as an important consideration.

All of the climatologists spoke at length of the successful evolution of the Program. Designed as an experiment on how to best increase the usability of climate science and foster relationships in the Great Lakes region, the program adaptively evolved between generations based on lessons learned between iterations. There was agreement that First Generation (2011-2012) projects did not help build the boundary chain model as effectively as Second Generation (2013-2015) projects despite some positive academic outputs. One climatologist also spoke of the way the relationship between GLISA and boundary organizations changed between generations, with a fairly traditional funder-grantee model early on, versus a deeper, hands-on two-way relationship in the Second Generation.

The climatologists agreed that GLISA's adaptive changes were instrumental in driving positive changes, with the Program's calls for proposals becoming more effectively targeted and the idea of the intent of the boundary chain model becoming clearer. This in turn gave GLISA a better idea of whom and what should be funded. All of the interviewees in some way mentioned the importance of learning from projects that did not go as well as planned, and how that critically contributed to improving the Program:

"So when you figure out these null results, those are actually informative, it helps move [the program]. So it wasn't, you know, when we tried something that didn't work how we thought, that necessarily wasn't a bad thing."

VI. Conclusions

Overall the data collected through the interviews and surveys show that the Program met its main two goals. First, it has allowed GLISA to engage with a broad number and diversity of stakeholders in different geographies and sectors in the Great Lakes region to increase awareness of climate information to inform adaptation, co-produce actionable knowledge, and build partnerships. Second, it allowed GLISA to act adaptively in growing and deepening the Program and its engagement with stakeholders from one competition to the next. However, learning what worked best and adapting the Program design to meet the goals meant a few costly mistakes in the First Generation of projects. Yet the evolution of the Program proved to be highly positive for GLISA and its grantees as the data shows, albeit with different levels of success, longevity, and impacts. Below we look at different aspects of the data that informed the evaluation.

Embeddedness, complementarity, and resources. Early on in the Program, GLISA sought to understand its drivers and constraints both from a practical and theoretical basis to explain success. Theoretically, the social science research team developed a conceptual model that hypothesized three different dimensions of the ABCM to drive success:

a. Embeddedness (the strength of the relationships between GLISA and boundary organizations and between boundary organizations and practitioners, as well as the proximity of the relationships during a project);

b. Complementarity (how closely related the work of a boundary organization is to the work of practitioners (e.g., both may work directly in the field of climate adaptation in one instance, while only one may work in the climate adaptation field in another instance, also referring to skill sets: organizations with complementary skill sets may gravitate toward working with one another to leverage the other's skills));

c. Resources (the resources available to boundary organizations and practitioners (social, financial, and political capital; personnel capacity; strength of motivation; fit of existing climate knowledge)).

Analysis of the data shows that from the three dimensions, embeddedness is, by far, the most important driver among those analyzed, with the intensity and amount of interaction between GLISA/boundary organizations and/or boundary organizations/practitioners strongly correlating to positive co-production outcomes, relationship-building, and long-term impacts. While complementarity and resources were less important in the eyes of the grantees when queried, different resources such as personnel (e.g., presence of 'champions,' the availability of facilitation, or lack of people) were often mentioned either as drivers or constraints to success and long-term impact. The same is true for funding and resources to sustain their projects and relationships with stakeholders after the GLISA grants ended. In this sense, resources and what they mean to different interviewees are perhaps the factors that need the most attention in future evaluations both in terms of their availability and in terms of how they affect each other (e.g., how funding affects human capital and how human capital affects capacity and long-term impact).

Beyond complementarity, embeddedness, and resources, interviews mentioned a number of other factors that they believe affected the outcomes of the grants, such as the importance of different kinds of human capital. Factors such as motivated stakeholders and grantees, the presence of champions that push the process along, and specific expertise such as good communication and facilitation were all mentioned as assets. Finally, the quality and customization of the climate information was also pointed out as a highlight in the ability of the grantees to meet their goals.

Overall, this evaluation provides evidence that the ABCM and the Program adaptively shifting their approach drew more robust outcomes out of the co-production process. Just as critical, however, is the role that it can play in providing key information for the further growth and adaptability of the Program to help meet the evolving knowledge requirements of practitioners dealing with the impacts of climate change in their communities.

Informing the Program's Third Generation. This evaluation was underway during the development of the Program's Third Generation competition in 2019, allowing GLISA to adapt its competition design and structure based on project results and preliminary evaluation findings. With almost 10 years having passed since the Program's First Generation of projects in 2011, the landscape of climate adaptation work and co-production of climate knowledge in the Great Lakes region has grown and progressed substantially. No longer focused primarily on awareness, needs assessments, and network building, practitioner needs have evolved to focus more on implementation, innovation, and scaling-up successful frameworks. As a result, GLISA reframed the Program's 2019 competition approach to reflect the evolving needs of Great Lakes practitioners and approaches demonstrated as more and less successful, as well as early evaluation findings. Notably, the 2019 competition featured three 'GLISA service categories' for applicants to choose from, with sub-categories and specific examples for each. These categories not only allowed GLISA to increase its impact and scale-up existing, successful frameworks, but also allowed GLISA to support more projects at the same time by streamlining its role to be more efficient (11 projects instead of five per competition year)—offering specific service options and explaining explicitly in the call for proposals what GLISA can and cannot do. To reflect the findings on embeddedness and the importance of close, existing relationships between boundary organizations and stakeholders (see Section V.2), the call for proposals required applicants to, "Explain in detail the targeted stakeholders and how they will be resourced and engaged… Describe the nature of existing relationships and justify why any new relationships would be successful." This addressed the challenge identified in the more research-oriented First Generation projects, where engagement was either added onto ongoing work or new relationships were required in a short timeframe and as a result for both, not executed successfully (see Section V.3). For complementarity, GLISA maintains the regular network calls for grantees so that boundary organizations with similar missions and/or skills can build relationships, since some past grantees pursued future work together (see Section V.3). For resources, the project structure changed from a larger grant (US $50K) for one year to smaller grants for two years (US $20K year one, $10K year two) to address the challenge of short funding cycles for organizations with fewer resources and to fund more projects overall. Finally, GLISA required applicants to "describe the specific problem, decision, policy, and/or management issue" and how the project would address it with a list of outputs to avoid the climate information and project results not being specific enough for action (see Section V.2). GLISA will continue to evaluate the Program and adapt its approach for future small grant competitions.

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Appendix A
Survey Questions

Organization and Respondent Characteristics

Q1a. How long has your organization existed?
- 0-5 yrs
- 6-10 yrs
- 11-20 yrs
- 21-30 yrs
- 31+ yrs

Q1b. How long have you been involved in climate issues?
- 0-5 yrs
- 6-10 yrs
- 11-20 yrs
- 21-30 yrs
- 31+ yrs

Q2a. What percentage of your organization's work is related to climate change?
- 0-20%
- 21-40%
- 41-60%
- 61-80%
- 81-100%

Q2b What percentage of your work is related to climate change?
- 0-20%
- 21-40%
- 41-60%
- 61-80%
- 81-100%

Q3a. My organization/group spends a significant amount of time on activities related to the work funded by GLISA.
- Strongly Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Strongly Agree

Q3b. Overall, my organization provides input into the work of GLISA.
- Strongly Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Strongly Agree

Q3c. My organization supports my effort to seek new information.
- Strongly Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Strongly Agree

Q3d. My organization provides financial support to facilitate access to new information.
- Strongly Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Strongly Agree

Q3e. I collaborate with others when I seek new information.
- Strongly Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Strongly Agree

Q3f. I have discretion to seek new information.
- Strongly Disagree

Somewhat Disagree
Neither Agree nor Disagree
Somewhat Agree
Strongly Agree

Q3g. It is easy for me to provide or adopt new information.
Strongly Disagree
Somewhat Disagree
Neither Agree nor Disagree
Somewhat Agree
Strongly Agree

Small Grants Organizations- GLISA Relationship

Q4. Do you regularly give presentations related to climate change?
Yes
No

Q5. How many times have you given those presentations since the GLISA funded project?
(Qualitative)
Range: 1-30

Q6. How often have you mentioned GLISA in those presentations?
Always
Most of the time
About half the time
Sometimes
Never

Q7a. Have you or your organization ever referred GLISA to another organization, during the GLISA-funded project?
Yes
No

Q7b. Have you or your organization ever referred GLISA to another organization, after the GLISA-funded project?
Yes
No

Q8. Did your organization continue to participate in/work with GLISA after the project ended?
Yes
No

GLISA Information and Guidance

Q9. What type of information or guidance have you or your organization received from GLISA?
Localized climate information
Climate information for scenario-planning
Education Activities
Training
Referring other organizations
Other

Q10. How satisfied were you with the localized climate information you received from GLISA?
Extremely Satisfied
Somewhat Satisfied
Neither Satisfied nor Dissatisfied
Somewhat Dissatisfied
Extremely Dissatisfied

Q11. Did you apply the localized climate information you received from GLISA to your GLISA project?
Extremely Satisfied
Somewhat Satisfied
Neither Satisfied nor Dissatisfied
Somewhat Dissatisfied
Extremely Dissatisfied

Q12. Did you apply the localized climate information you received from GLISA to other work?
Yes
No

Q13. How satisfied were you with the climate information for scenario planning you received from GLISA?
Extremely Satisfied
Somewhat Satisfied
Neither Satisfied nor Dissatisfied
Somewhat Dissatisfied
Extremely Dissatisfied

Q14. Did you apply the climate information for scenario planning you received from GLISA to your GLISA project?
Yes
No

Q15. Did you apply the climate information for scenario planning you received from GLISA to other work?
Yes
No

Q16. How satisfied were you with the education activities

you received from GLISA?

- Extremely Satisfied
- Somewhat Satisfied
- Neither Satisfied nor Dissatisfied
- Somewhat Dissatisfied
- Extremely Dissatisfied

Q17. Did you apply the knowledge gained from the education activities you received from GLISA to your GLISA project?

- Yes
- No

Q18. Did you apply the knowledge gained from the education activities you received from GLISA to other work?

- Yes
- No

Q19. How satisfied were you with the training you received from GLISA?

- Extremely Satisfied
- Somewhat Satisfied
- Neither Satisfied nor Dissatisfied
- Somewhat Dissatisfied
- Extremely Dissatisfied

Q20. Did you apply the knowledge gained from the training you received from GLISA to your GLISA project?

- Yes
- No

Q21. Did you apply the knowledge gained from the training you received from GLISA to other work?

- Yes
- No

Q22. How satisfied were you with GLISA's reference(s) to other organization(s)/people for support?

- Extremely Satisfied
- Somewhat Satisfied
- Neither Satisfied nor Dissatisfied
- Somewhat Dissatisfied
- Extremely Dissatisfied

Q23. Did you contact the organization(s)/people GLISA referred you to for your GLISA project?

- Yes
- No

Q24. Did you contact the organization/people GLISA referred you to for other work?

- Yes
- No

Q25. How satisfied were you with the other information you received from GLISA?

- Extremely Satisfied
- Somewhat Satisfied
- Neither Satisfied nor Dissatisfied
- Somewhat Dissatisfied
- Extremely Dissatisfied

Q26. Did you apply the other information you received from GLISA to your GLISA project?

- Yes
- No

Q27. Did you apply the other information you received from GLISA to other work?

- Yes
- No

Non-GLISA Information and Guidance

Q28. What types of information or guidance related to climate have you or your organization received from organizations other than GLISA?

- Localized climate information
- Climate information for scenario-planning
- Education Activities
- Training
- Referring other organizations
- Other

Q29. How satisfied were you with the localized climate information you received from organizations other than GLISA?

- Extremely Satisfied
- Somewhat Satisfied
- Neither Satisfied nor Dissatisfied
- Somewhat Dissatisfied
- Extremely Dissatisfied

Q30. Did you apply the localized climate information you received from organizations other than GLISA to your GLISA project?

- Yes
- No

Q31. Did you apply the localized climate information you received from organizations other than GLISA to other work?

Yes
No

Q32. How satisfied were you with the climate information for scenario planning you received from organizations other than GLISA?

Extremely Satisfied
Somewhat Satisfied
Neither Satisfied nor Dissatisfied
Somewhat Dissatisfied
Extremely Dissatisfied

Q33. Did you apply the climate information for scenario planning you received from organizations other than GLISA to your GLISA project?

Yes
No

Q34. Did you apply the climate information for scenario planning you received from organizations other than GLISA to other work?

Yes
No

Q35. How satisfied were you with the education activities you received from organizations other than GLISA?

Extremely Satisfied
Somewhat Satisfied
Neither Satisfied nor Dissatisfied
Somewhat Dissatisfied
Extremely Dissatisfied

Q36. Did you apply the knowledge gained from the education activities you received from organizations other than GLISA to your GLISA project?

Yes
No

Q37. Did you apply the knowledge gained from the education activities you received from organizations other than GLISA to other work?

Yes
No

Q38. How satisfied were you with the training you received from organizations other than GLISA?

Extremely Satisfied
Somewhat Satisfied
Neither Satisfied nor Dissatisfied
Somewhat Dissatisfied
Extremely Dissatisfied

Q39. Did you apply the knowledge gained from the training you received from organizations other than GLISA to your GLISA project?

Yes
No

Q40. Did you apply the knowledge gained from the training you received from organizations other than GLISA to other work?

Yes
No

Q41. How satisfied were you with the reference(s) to other organization(s)/people for support that you received from organizations other than GLISA?

Extremely Satisfied
Somewhat Satisfied
Neither Satisfied nor Dissatisfied
Somewhat Dissatisfied
Extremely Dissatisfied

Q42. Did you contact the organization(s)/people that were referred by organizations other than GLISA for your GLISA project?

Yes
No

Q43. Did you contact the referring organization(s)/people that were referred by organizations other than GLISA for other work?

Yes
No

Q44. How satisfied were you with the other information you received from organizations other than GLISA?

Extremely Satisfied
Somewhat Satisfied
Neither Satisfied nor Dissatisfied
Somewhat Dissatisfied
Extremely Dissatisfied

Q45. Did you apply the other information you received from organizations other than GLISA to your GLISA project?

Yes
No

Q46. Did you apply the other information you received from organizations other than GLISA to other work?

Yes
No

Small Grants Organizations' Network

Q47. Please list the organizations, agencies, coalitions, or groups that your organization worked with most frequently during the GLISA funded year(s).

Q47a. Is this organization associated with your GLISA proposal?

Yes
No

Q47b. Was this organization referred by GLISA (e.g. through GLISA meetings or through GLISA faculty or staff?)

Yes
No

Q47c. Did your organization have this relationship prior to your involvement with GLISA?

Yes
No

Q47d. Did your organization do the following with this organization?

Exchange Information
Exchange Services
Refer other organizations/agencies/people
Share legal/official contract/funding

Q48. Please list the organizations, agencies, coalitions, or groups that your organization worked with most frequently within the last year

Q48a. Is this organization associated with your GLISA proposal?

Yes
No

Q48b. Was this organization referred by GLISA (e.g. through GLISA meetings or through GLISA faculty or staff?)

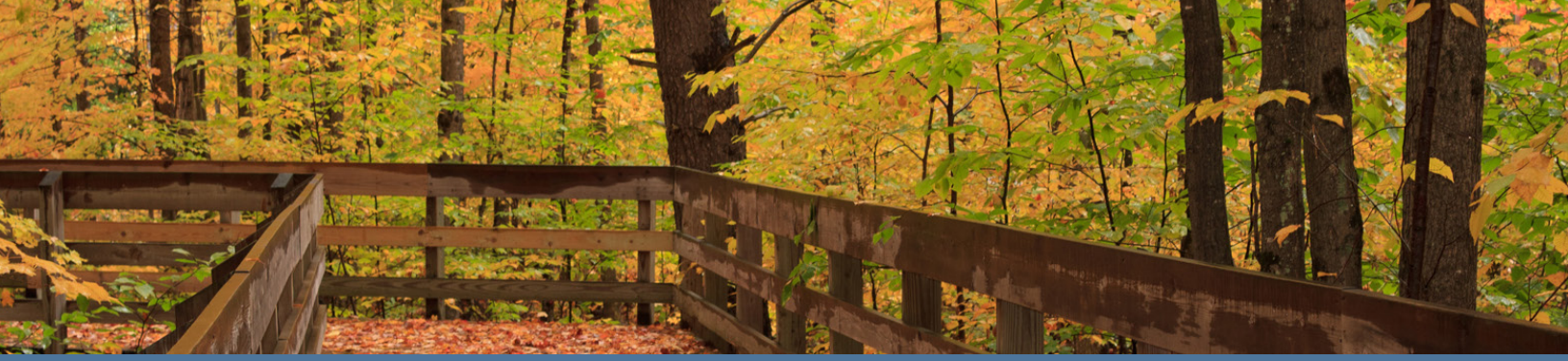
Yes
No

Q48c. Did your organization have this relationship prior to your involvement with GLISA?

Yes
No

Q48d. Did your organization do the following with this organization?

Exchange Information
Exchange Services
Refer other organizations/agencies/people
Share legal/official contract/funding



Appendix B
Coding

Round One Interview Factors and Outcomes

Factors	Sub-Factors
Embeddedness	B.O. & Prac. established relationship
	B.O. & Prac. work closely
	B.O. & Prac. new relationship
	GLISA & Prac. new relationship
	GLISA & B.O. established relationship
	GLISA & B.O. work closely
Complementarity	Do not work in climate adaptation
	Interdisciplinary
	Work in climate adaptation
Resources	B.O. lack of resources
	Practitioner lack of resources
	Motivation
	Personnel
	Political capital
	Previous knowledge
	Previous relationships
	Stakeholder climate knowledge

Outcomes	Sub-Outcomes
Results & Successes	Challenges moving forward
	Failures
	Increased capacity
	Increased communication & engagement
	Increased credibility
	Long-term impact
	New knowledge networks
	New project or working network formed
	Reduced costs
	Reorientation of organization
	Future implementation of boundary chain
Continued Collaboration	Continuing relationship
	No continuing relationship

Table 1. *First round interview coding factors, sub-factors, oucomes, and sub-outcomes.*

Round Two Interview Factors and Outcomes

Factors	Sub-Factors
Embeddedness	Continued Prac. & B.O. collaboration
	Project impact does not still exist
	Project impact existance is uncertain
	Project impact still exists
Complementarity	Little attempt at network building
	Network does not still exist
	Network existence is tenuous or uncertain
	Network expanded
	Network still exists
	No network expansion
	Project utilized already existing network
Resources	Clear end user communication of needs
	End user conservative political climate
	End user disorganization
	Existence of other grants during project
	Existing high financial resources
	Existing lack of financial support
	High end user org. turnover
	Lack of access in end user communities
	Lack of B.O.finances for follow up evaluation
	Lack of expertise to carry project forward
	Lack of trust in end user communities
	Previous B.O. climate knowledge
	Previous Prac. expertise
	Previous end user climate knowledge
	Project allowed work not otherwise possible
	Project valuable but expensive

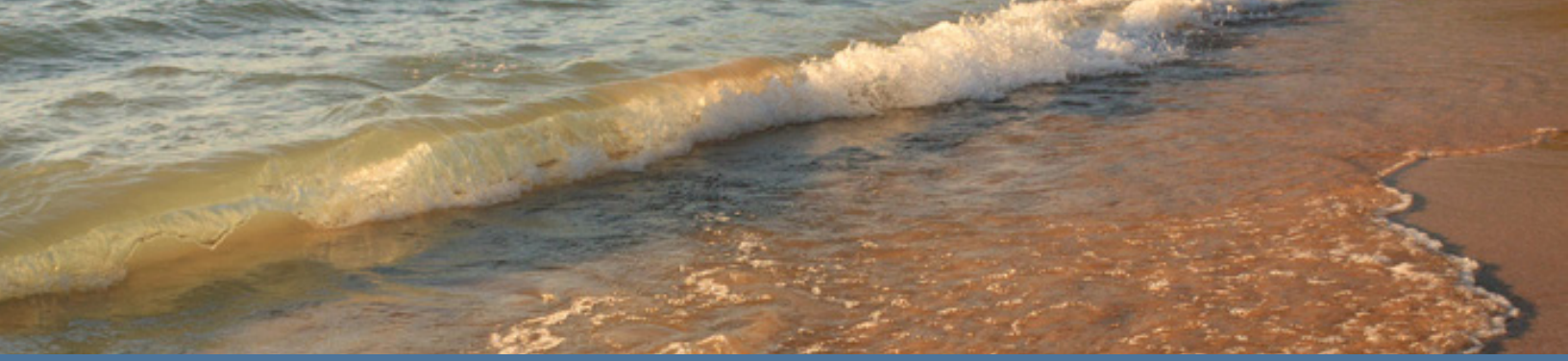
Outcomes	Sub-Outcomes
Results & Successes	Grant was impetus for future work
	Lessons learned
	Personal network expanded
	Potential integration into long-term plans
	Project brought disparate end users together
	Project built comfort to take on similar work
	Project built credibility & legitimacy
	Project empowered Prac. or shifted culture
	Project helped translate into understanding
	Project was end user goal specific
	Theoretical or methodological success
	Uncertain or unquantifiable impact

Table 2. *Second round interview coding factors, sub-factors, oucomes, and sub-outcomes.*

A specific set of initial codes were developed prior to the process of coding and were subsequently identified in all first round interviews (Table 1), with inductive coding techniques used to reach a more granular understanding of specific sub-factors depending on the content of individual interviews. These broad factors represented three main drivers and two outcomes: complementarity, embeddedness, and resources (drivers), and continued collaboration and results and successes (outcomes). The drivers were designed to build on existing work found in previous evaluation articles (Lemos et al. 2014, Kirchhoff et al. 2015b) and advance understanding of the critical factors that drive boundary chain outcomes.

For first round interviews, the continued collaboration and results and successes factors include project outcomes, with sub-factors concerning negative (i.e., failures or challenges moving forward) and positive (i.e., increased capacity, increased credibility, and reduced costs) outcomes. For simplicity of analysis, the main driving factors in the project – embeddedness, complementarity, and resources – were often compared against a grouping of seven positive outcomes to highlight patterns and trends within the data.

Coding for second round interviews (Table 2) built on the foundation of the first round, streamlining and expanding the codes for both drivers and outcomes to reflect the expanded interview questioning. Because second round interviews focused on the lasting effects of each project, the continued collaboration factor was examined in the main driving factors (embeddedness, complementarity, and resources) instead of as a standalone. The results and successes factor was expanded to include 12 sub-factors, as the round two interviews were lengthier and more outcome-oriented in nature.



Appendix C
Network Analysis

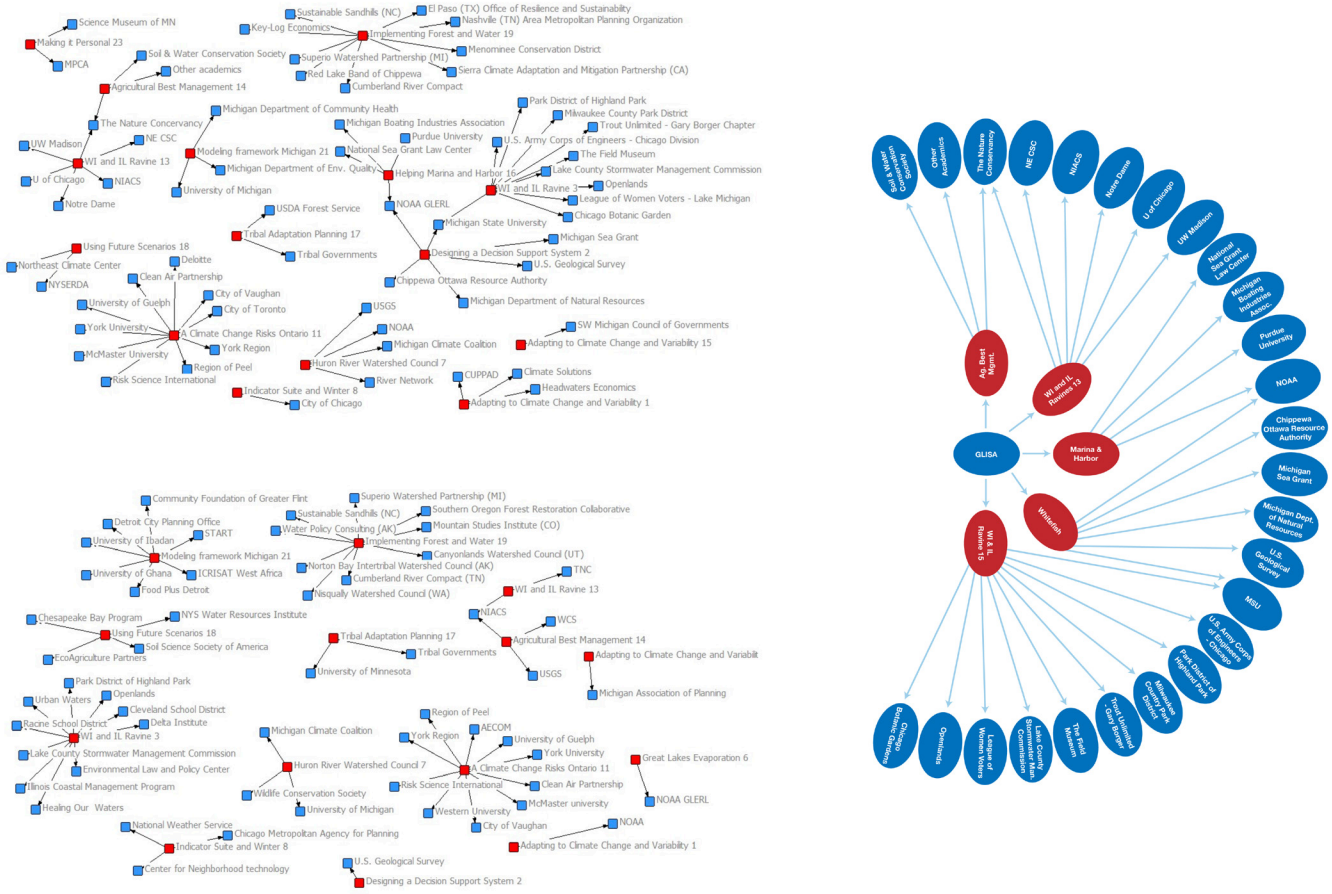


Figure 9. *Network maps of project relations based on survey responses.*