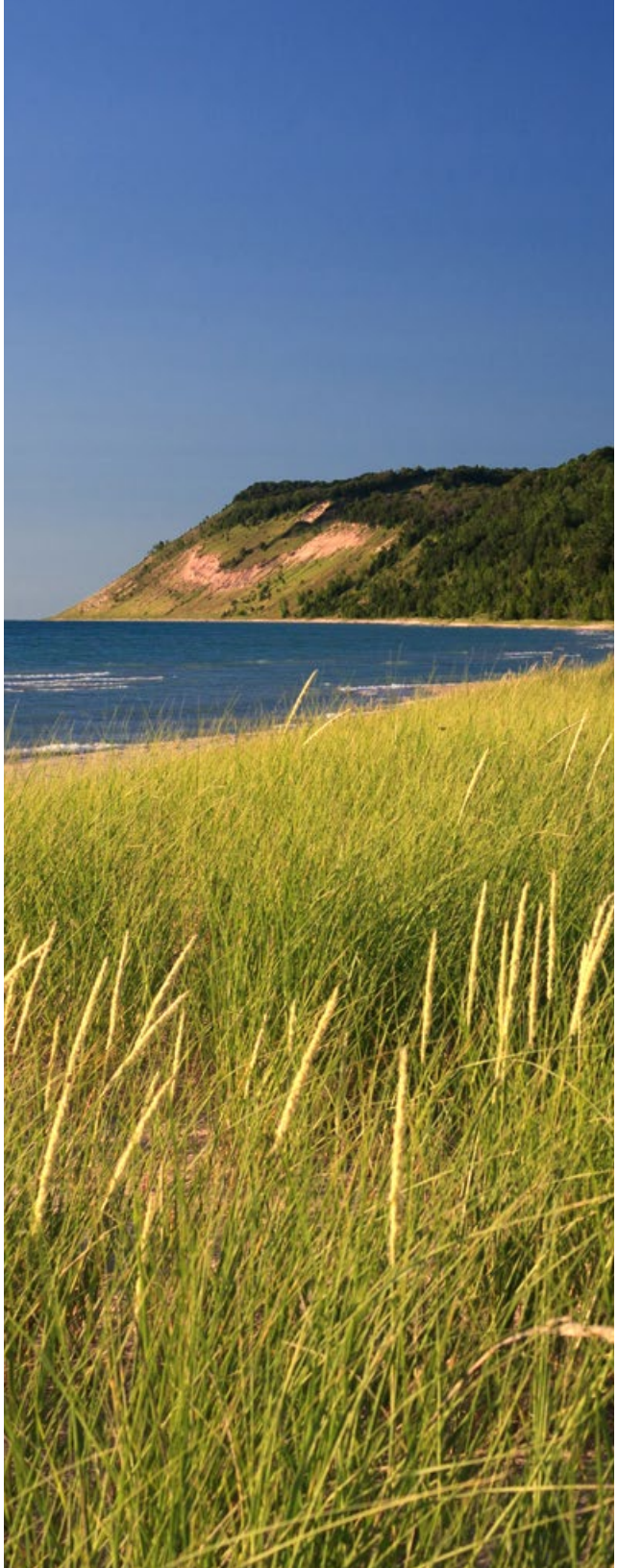
GLISA Phase II Final Report

2015-2022

GLISA



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SYMBOL LEGEND

	Impacts
	Outreach
	Web Resources & Tools
	Publications
	Research Findings

The work described in this report was supported by NOAA award number NA15OAR4310148 to the University of Michigan to support the Great Lakes Integrated Sciences and Assessments (GLISA). In some cases these funds were leveraged to win additional, external awards or to secure cost share or in-kind funding. Those instances are marked throughout the report with the source of the external funds under the header 'Leveraged Funds.'

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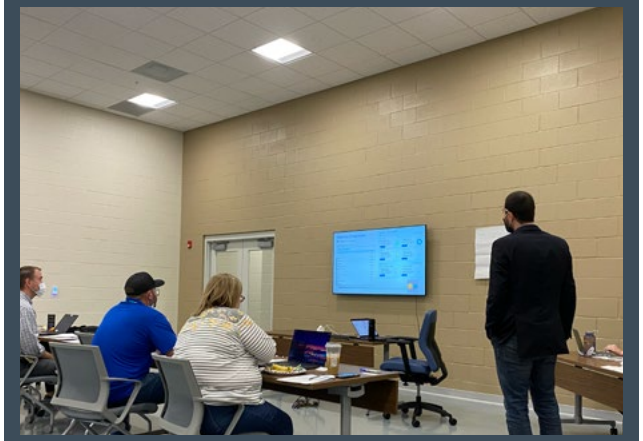
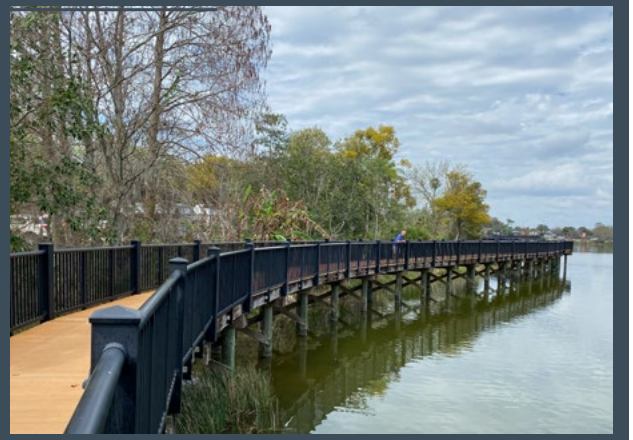
Photo credits William (B.J.) Baule and Dan Brown unless otherwise noted.

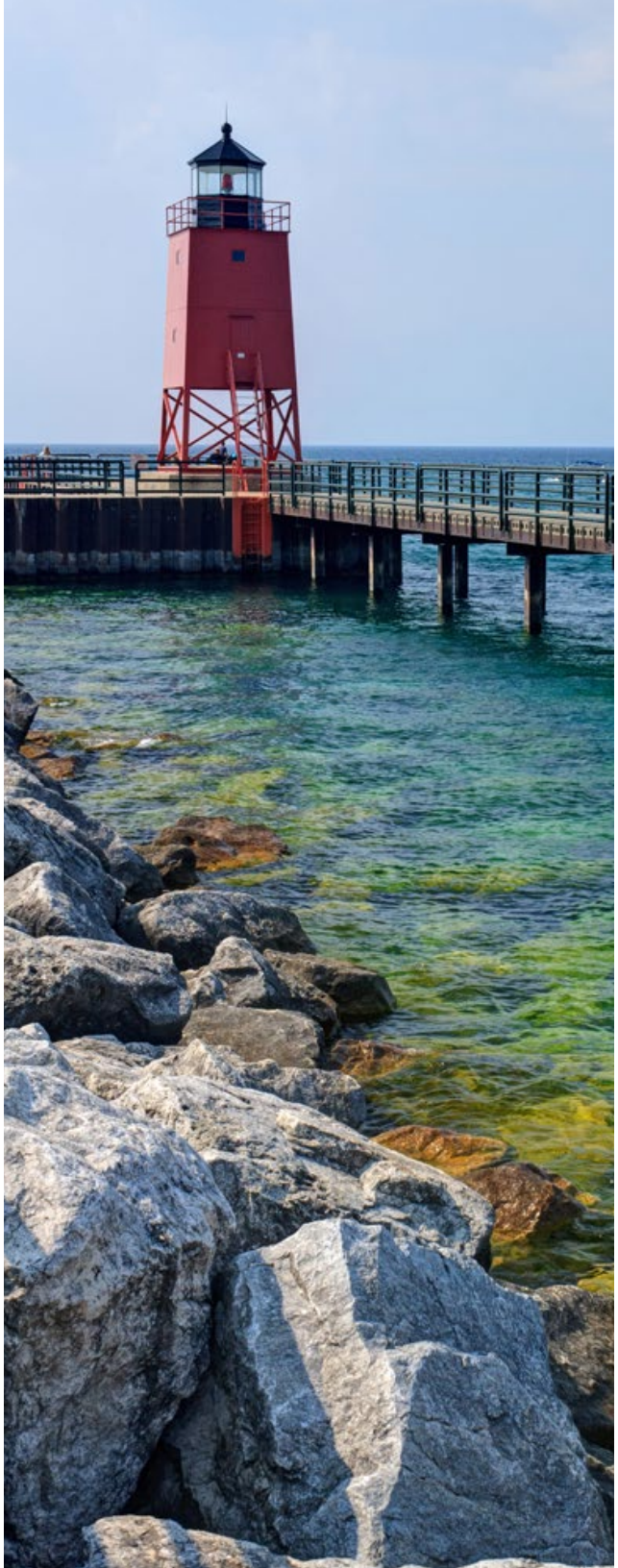
ACRONYMS

ASAP	American Society of Adaptation Professionals
CMIP	Coupled Model Intercomparison Project
ECCC	Environment and Climate Change Canada
GCM	Global climate model
GL	Great Lakes
GLERL	Great Lakes Environmental Research Laboratory
GLISA	Great Lakes Integrated Sciences and Assessments
GLOS	Great Lakes Observing System
GLWQA	Great Lakes Water Quality Agreement
HighResMIP	High Resolution Model Intercomparison Project
HRWC	Huron River Watershed Council
ITCM	Inter-Tribal Council of Michigan
MRCC	Midwest Regional Climate Center
MSU	Michigan State University
NA-CORDEX	North American Coordinated Regional Climate Downscaling Experiment
NCA4	Fourth National Climate Assessment
NOAA	U.S. National Oceanic and Atmospheric Administration
NPS	U.S. National Park Service
RCM	Regional climate model
SARP	Sectoral Applications Research Program (NOAA)
SGP	GLISA Small Grant Program
TRCA	Toronto and Region Conservation Authority
UM SEAS	University of Michigan School for Environment and Sustainability
USDA	U.S. Department of Agriculture
USDN	Urban Sustainability Directors Network
UW-RegCM4	University of Wisconsin Regional Climate Model Version 4
VA	Vulnerability Assessment





Top & Middle: City of Cedar Key (top) and Casselbury (middle) (FL) staff participate in a FloodWise Communities stormwater vulnerability assessment workshop.
Bottom: City of Casselbury (FL) stormwater infrastructure
Credits: Natalie Herbert



GLISA TEAM

GLISA is housed jointly at the University of Michigan (UM) and Michigan State University (MSU), in the School for Environment and Sustainability (SEAS) and at the Center for Global Change and Earth Observations, respectively. Its team includes an interdisciplinary group of Principal Investigators (PIs), staff and researchers, and students.

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GLISA TEAM

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Top: May 2020 Zoom team photo
Bottom: Team photo at the 2018 Great Lakes Adaptation Forum
Credit: Jenna Jorns

Climate Adaptation Partnerships
Formerly RISA

GLISA is one of 12 Climate Adaptation Partnerships (CAP, formerly known as RISA) supported by the National Oceanic and Atmospheric Administration (NOAA) Climate Program Office that focus on advancing equitable adaptation through sustained regional research and community engagement. In 2022, Congress directed NOAA to change the name of the Regional Integrated Sciences and Assessments (RISA) program to "Climate Adaptation Partnerships (CAP)." This new name is fitting for the program as it exists today.

"Climate" acknowledges the program's focus on long-term change and variability.

"Adaptation" encompasses approaches to reduce negative impacts of climate change and maximize emerging opportunities.

"Partnerships" refers to the web of collaborative relationships between researchers and community decision makers within the regions. It also refers to the larger connections among regional teams that support the peer-to-peer learning that builds local capacity and expertise for national impact.

ABOUT GLISA

GREAT LAKES REGION

The Great Lakes (GL) region represents a unique socio-ecological system shaped by abundant water resources and diverse ecosystems across eight US states and two Canadian provinces. The impacts of climate change already are, and will continue to be, deep and widespread in the 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 is the NOAA CAP/RISA team for the GL region (see left). Although GLISA formally serves the GL basin (see map, pg. 6), including parts of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin, and Ontario, in practice its engagement has gone beyond the watershed to serve communities, organizations, and governments in these states and provinces located outside of the basin.

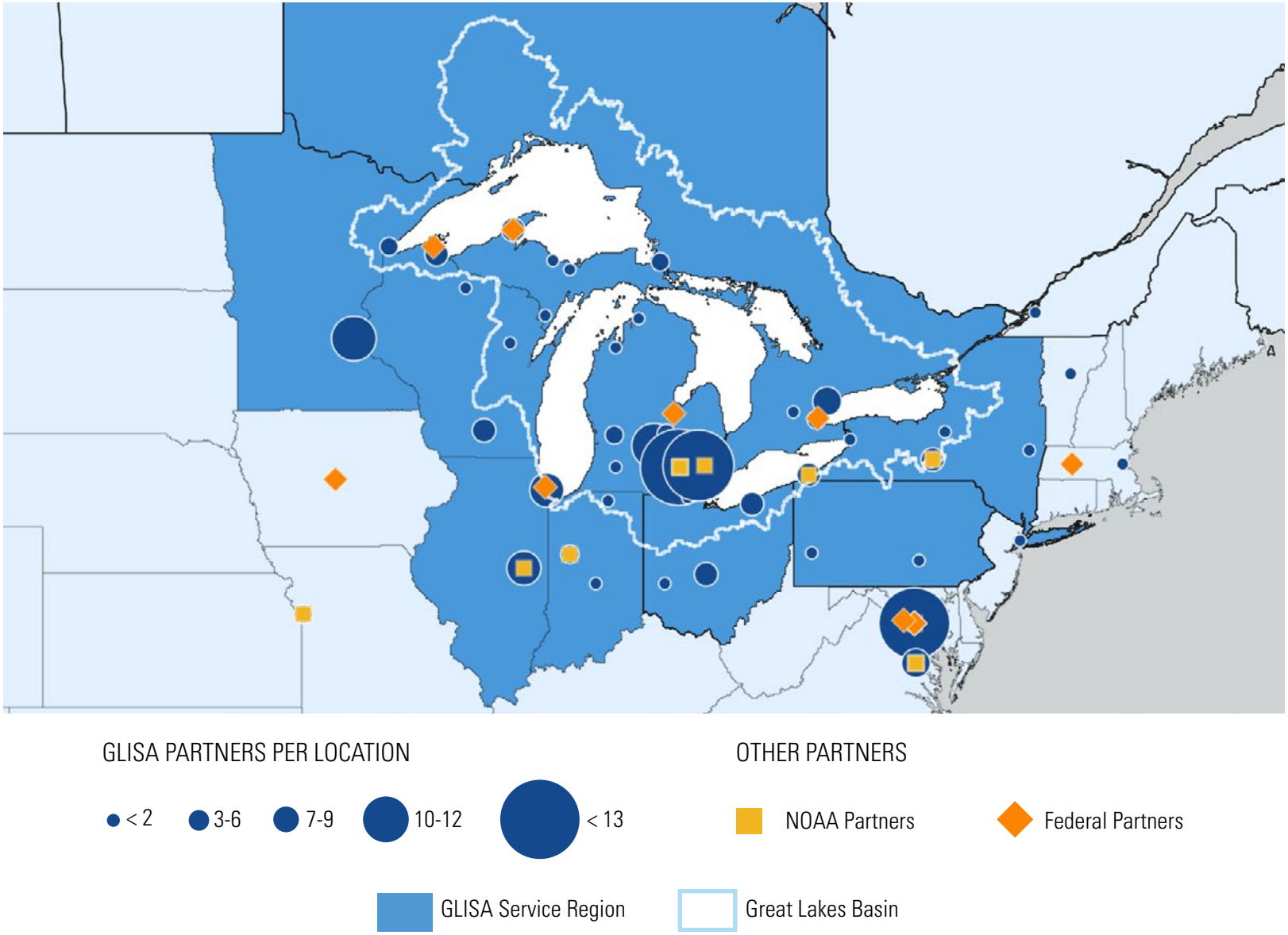
HISTORY

GLISA was established in 2010 as a collaboration between the University of Michigan (UM) and Michigan State University (MSU). During this time, GLISA has played an important role in the region by co-producing usable climate information with a diverse array of partners while also advancing fundamental physical and social science in support of climate adaptation action. In Phase I (2010-2016), GLISA used an adaptive approach to achieve its goals through a Small Grants Program and by customizing climate observations and projections in response to user needs. This model extended the breadth and depth of GLISA's work while building a reputation in the region of responsiveness and trust. In Phase II (2016-2022), GLISA continued this approach by investing its core funding in engagement and co-production of usable information in three focus areas - cities, Tribes, and agriculture.

FOCUS AREAS

GLISA ENGAGEMENT

GLISA's Phase II engagement map shows the geographical coverage and distribution of its partners in the region. The relative size of the circle indicates the number of partners in a location, from 1 to 15. Some partners located outside the GL are not shown in the map, but are listed in 'Partnerships' (pgs. 39-40).



Dewulf, et al. 2020: Usable Environmental Knowledge from the Perspective of Decision-Making: The Logics of Consequentiality, Appropriateness, and Meaningfulness

Frank et al. 2022: A Network Intervention for Natural Resource Management in Context of Climate Change

Goodrich et al. 2020: Who Are Boundary Spanners and How Can We Support Them in Making Knowledge More Actionable in Sustainability Fields?

Kalafatis and Lemos 2017: The Emergence of Climate Change Policy Entrepreneurs in Urban Regions

Kalafatis 2017a: When Do Climate Change, Sustainability, and Economic Development Considerations Overlap in Cities?

Kalafatis 2017b: Comparing Climate Change Policy Adoption and Its Extension across Areas of City Policymaking

Lemos et al. 2018: To Co-Produce or Not to Co-Produce

Lemos et al. 2019: The Closer, the Better? Untangling Scientist–Practitioner Engagement, Interaction, and Knowledge Use

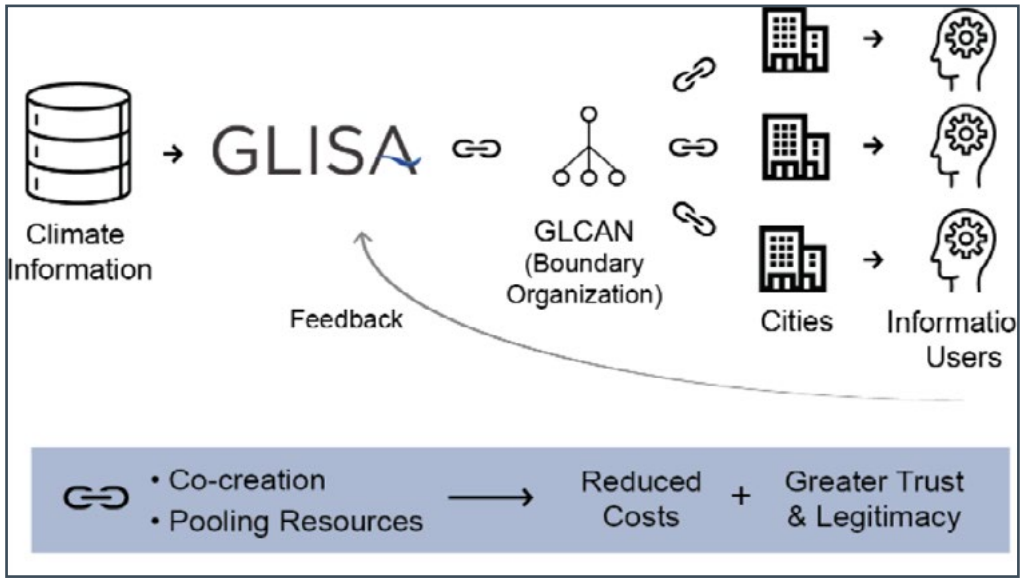
Mach et al. 2020: Actionable Knowledge and the Art of Engagement

ROLE IN THE REGION

BOUNDARY CHAIN MODEL OF STAKEHOLDER ENGAGEMENT

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.

Through its boundary chain model of stakeholder engagement, GLISA partners with other institutions that also act as boundary organizations. By working with them and their existing stakeholder networks, it pools resources and builds trust & legitimacy faster - thereby bridging the gap between researchers and those that use scientific knowledge such as local governments, natural resource managers, farmers, businesses, and planners. In the following example, GLISA administers and partners with the Great Lakes Climate Adaptation Network (GLCAN, pg. 13) and its member cities to customize climate data and information for individual community planning needs. The climate information is tailored and moves through different boundary organizations (links in the chain) to connect science to users. By co-creating information and pooling resources throughout the chain, trust and legitimacy are built and cost is decreased.



Credit: Adapted from Lemos et al. 2014, American Meteorological Society.

In Phase II, GLISA deepened its research focus on drivers and outcomes of co-production and use of scientific information in decision-making, boundary work, and social network analysis. It also pioneered an assessment of adaptive capacity and drivers of climate adaptation in GL cities.

ROLE IN THE REGION

SMALL GRANTS PROGRAM

One way GLISA implements the boundary chain model is through it's Small Grants Program (SGP). By funding boundary organizations that have existing relationships with practitioners, the tasks of network building on stakeholders' capacity to adapt, and co-producing knowledge become easier as costs are shared throughout the chain.

The goals of GLISA's Phase II competition were 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 and services were ready to scale-up in the region and beyond, and to increase its impact in the Great Lakes.

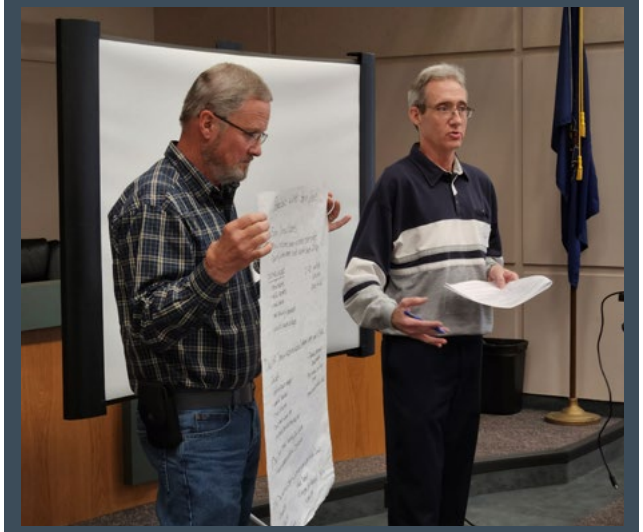
In Phase II, GLISA funded 10 projects to state agencies, Sea Grant programs, non-profits, and universities spanning topics such as public health, stormwater management, in-migration, agriculture, and law. The projects are highlighted throughout this report.

INTERNAL EVALUATION

To improve and adapt the SGP, GLISA conducted an internal evaluation by carrying out interviews and a network analysis of the Phase I grant projects. The evaluation showed the SGP has been successful in expanding GLISA's engagement coverage and allowing GLISA to work with a diversity of sectors cost-effectively, but identified a number of areas for improvement for stakeholder engagement, efficient use of resources, and application of climate information.

In response to this evaluation and in an effort to streamline its contribution to support more projects simultaneously, GLISA offered a menu of "GLISA climate service categories' for applicants to choose from and required both existing relationships with intended stakeholders and a specific, identified use of climate information (e.g., management decision, plan) to be identified in the Phase II applications. GLISA also facilitated quarterly grantee network meetings.

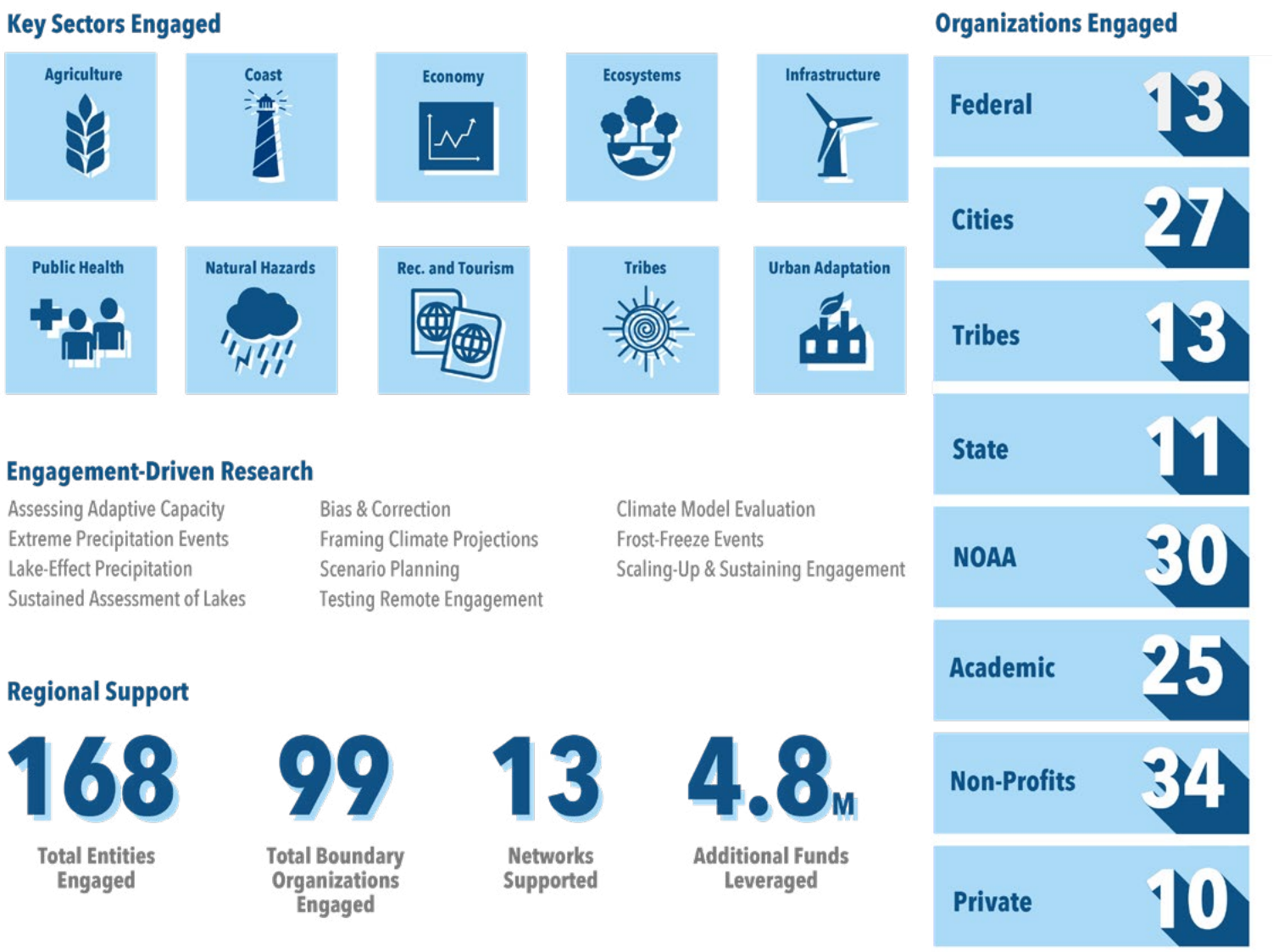
Jorns et al. 2021: Evaluation of GLISA's Small Grant Program



October 2022 scenario planning workshop in Erie, PA; culmination of 2019 GLISA small grant to Pennsylvania Sea Grant for project, 'Preparing Erie, Pennsylvania for Extreme Weather - What to do and Where to Start
Credit: Kim Channell

DASHBOARD

GLISA's Phase II dashboard highlights its engagement metrics, key sectors, and research areas. By continuously applying to outside grants to expand its research and impact, GLISA yielded an additional $4.8M in funding through external awards and university cost share. Details about these partnerships, networks, and projects are described throughout this report.



REGIONAL EXPERTISE

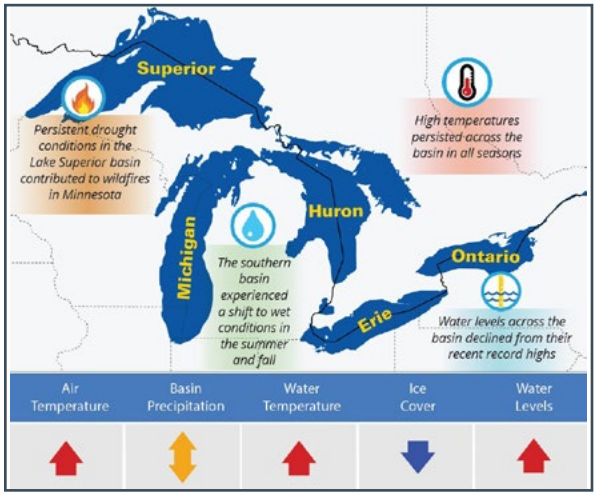
SUSTAINED ASSESSMENT

GLISA maintained a suite of resources developed in Phase I, proven to be valuable to stakeholders, including regional maps, station and division climatologies, and a Climate Change in the GL two-pager. New resources developed in Phase II include climatologies for freezing rain, arctic amplification and oscillation and freeze-thaw cycles, and a 'Sustained Assessment of the Lakes' (pgs. 19-21).

The new 'Annual Climate Trends and Impacts Summary' provides a timely and succinct summary of the past year's climate trends, notable climate-related events, and relevant new research, assessments, and activities in the context of the GL.

The summary is used by the GLWQA Executive Committee and its 10 Annexes to inform research priorities and meet reporting requirements in the U.S. and Canada.

From 2017 to 2022, GLISA led the development of a new annual climate summary to fill the gap for basin-wide climate information between the existing quarterly climate summaries and the national climate assessments. GLISA coordinated a working group of partners from Environment and Climate Change Canada (ECCC), NOAA Great Lakes Environmental Research Laboratory (GLERL), NOAA National Centers for Environmental Information, NOAA Climate Program Office, Northeast Regional Climate Center, University of Illinois, and the Midwest Regional Climate Center (MRCC) and solicited feedback from an array of regional networks. This contributes to NOAA's commitment to the Great Lakes Water Quality Agreement (GLWQA) Annex 9 on Climate Change Impacts.



Example of summary infographic used on the first page of the summary

CONTRIBUTION TO FOURTH NATIONAL CLIMATE ASSESSMENT (NCA4)

As a regional climate expert and trusted boundary organization, GLISA was asked to serve as a co-author on the Midwest chapter of NCA4. Co-Director Dr. Maria Carmen Lemos and Program Manager Dr. Jenna Jorns were co-authors and PhD student Katherine Browne was a Technical Contributor. The GLISA team advocated for a new section in the Midwest chapter on Community Vulnerability and Adaptation, featuring a case study on the GL Climate Adaptation Network and GLISA's role in its formation and work (pg. 13). GLISA also co-hosted the Ann Arbor (MI) satellite location of the Midwest Regional Engagement workshop with GLERL on March 1, 2017. One outcome of stakeholder feedback was the creation of a special GL case study for NCA4, which GLISA and GLERL co-led.

GLISA impact story

REGIONAL EXPERTISE

GREAT LAKES ENSEMBLE

GLISA's flagship physical sciences project in Phase II was its Great Lakes Ensemble effort to inventory and evaluate future climate simulations to determine which models offer the highest quality information for the GL region.

Many climate models do not provide credible information for the GL region, because they poorly represent the lakes themselves and lake-land-atmosphere dynamics. This evolved into a community of experts and practitioners (pgs. 39-40), with whom GLISA co-developed and published a climate model evaluation and consumer-reports framework.

EVALUATION FRAMEWORK

GLISA evaluated >70 models from CMIP5 (40), NA-CORDEX (19), UW-RegCM4 (6), CMIP6 HighResMIP (12) to establish a set (ensemble) that best represents important components of the GL climate. Data processing methods (i.e., downscaling and bias correction) were also assessed for their impact on the data quality. GLISA looked for climate models that include 1D or 3D lake simulations that aim to better represent the influence of the lakes.

GLISA worked with a binational Science Advisory Committee (SAC) and Practitioner Working Group (PWG), composed of a diverse group of scientists and practitioners, to make scientific decisions and co-develop resources and publications (pg. 40 for membership).

The SAC helped GLISA:

1. Better understand the interactions between the lakes and regional climate;
2. Develop a set of model evaluation standards specific to the GL; and,
3. Reach out to end users to help inform products of the ensemble.

The PWG:

1. Provided feedback on existing GLISA products used by stakeholders (e.g., city climatologies);
2. Co-developed new products (i.e., scenarios, consumer-style data guides); and,
3. Investigated how to scale products to larger audiences and increase usability.

> "I'm writing to offer my congratulations on developing and producing GLISA's 'A Practitioner's Guide to Climate Model Scenarios.' That overview is easily the best I've seen in laying out the model basics and process questions that users need to consider as they work to incorporate model projections into impacts and decision processes." - Deputy Director, Southeast Climate Adaptation Science Center

In collaboration with the SAC and PWG, GLISA:

- Applied the evaluation framework to evaluate the presence of the lakes in CMIP5 simulations (Briley et al. 2021). GLISA anticipated regional climate models (RCMs) would provide a better physical representation for the region (e.g., better simulation of lake-atmosphere interactions), but in many cases RCMs had stronger biases than coarser global climate models (GCMs). This finding suggests that the GCMs, due to their lack of or poor lake representations, and the studied RCMs, which do not adequately capture important lake dynamics, have high uncertainty in their future projections.

Model checklist defining the criteria that models should meet to provide the highest-quality information for regional planning. Adapted from Briley et al. 2020.

- Assessed model biases of temperature and precipitation for two CMIP5 ensembles (NA-CORDEX, UW-RegCM4). GLISA developed guidance on bias correction to aid users in accurately interpreting the data (Gates and Rood, 2021).
- Investigated the representation of lake-effect precipitation using a clustering technique (manuscripts in preparation);
- Developed a suite of 'climate model consumer reports' (Briley et al. 2020), a novel approach to communicate this information to practitioners, which includes a buyer's guide and climate model report cards for each evaluated ensemble. This information can guide users towards models that best simulate the physical processes that matter most to their application (e.g., lake-effects, land processes).
- Developed several guidance resources to address users' needs in the region, including a practitioner guide for those using or wanting to use future climate information in their work. The guide introduces the climate model scenarios that are used to drive climate models forward in time and summarizes differences between these scenarios for the GL region to show how choice of model scenario affects future projections (see testimonial on previous page).

A Practitioner's Guide to Climate Model Scenarios

Briley et al. 2021: Large lakes in climate models: A Great Lakes case study on the usability of CMIP5

Briley et al. 2020: Increasing the Usability of Climate Models through the Use of Consumer-Reports-Style Resources for Decision-Making

Briley et al. 2015: The role of meteorological processes in the description of uncertainty for climate change decision making

Gates and Rood 2021: Overview and Guidance on Bias Correction

Notaro et al. 2022: Representation of Lake-Atmosphere Interactions and Lake-Effect Snowfall in the Laurentian Great Lakes Basin among HighResMIP Global Climate Models

Sustained Assessment of Climate Models

Climate Model Buyer's Guide

Climate Model Report Cards

Cross Model Comparison Charts

Climate Model Bias Webpage

COLLABORATION & TRAINING

GLCAN

The Great Lakes Climate Adaptation Network (GLCAN) is a network of local government staff that work together to identify and act on climate adaptation challenges. The network provides the opportunity for peer learning that fosters cross-regional connections and allows members to share best practices, overcome challenges, and collaborate on shared goals. GLISA and its Practitioner in Residence has convened and provided administrative support for GLCAN since 2015, as a regional network of the Urban Sustainability Directors Network (USDN).

Network fact sheet

Leading by Example: Tools and Resources for City Adaptation

NETWORK SUPPORT

GLISA relied on GLCAN to recruit communities to participate in its vulnerability assessment (VA) projects (pgs. 37-38). 13 of the 15 participating cities were GLCAN members at the time of recruitment, and all now actively participate in the network.

Based on member interest, a sustainable purchasing cohort was formed. As a result, several members applied for the Bright Cities program through the Healthy Babies Bright Futures organization, which provides small grants and technical assistance to local governments that want to reduce exposure to neurotoxic chemicals and pollutants.

GLISA's partnership with GLCAN was featured in the NCA4 Midwest chapter, in a case study on how the network illustrates the boundary chain model of stakeholder engagement to support municipal VAs and adaptation planning. It was also featured in a Michigan Sustainability Case, a teaching module for co-development of climate knowledge that's been used in at least two courses and accessed by 31 users outside UM.

Map of active GLCAN member governments in the U.S. and Canada

GLISA team members served on a number of committees, networks, and advisory groups to share its expertise, build regional capacity, and develop relationships:

- American Meteorological Society Working Group on Climate Change and Socioeconomic Inequality in the Great Lakes Region
- Climate Prediction Applications Science Workshop Planning Committee (CPASW)
- CMIP6 Task Force
- GLOS Smart Great Lakes Initiative Data and Information Team
- GLWQA Annex 9 Extended Subcommittee
- Land of Lincoln Scenario Planning Advisory Group
- Michigan Climate Coalition
- Midwest Global Learning and Observations to Benefit the Environment (GLOBE)/Earth System Science (ESS) Collaborative
- Midwest Climate Partners Group
- NOAA Model Diagnostics Task Force
- NOAA GL Regional Collaboration Team
- Regional Adaptation Forum Group
- Wisconsin Initiative on Climate Change Impacts Climate Working Group

COLLABORATION & TRAINING

SCENARIO PLANNING

Scenario Planning: First adapted and implemented with the National Park Service in Phase I, GLISA's scenario planning approach describes plausible future events and has stakeholders respond to them. The goal is to account for uncertainty using a framework to plan for potentially disastrous disruptions, rather than focusing on likely outcomes.

Planning for multiple plausible futures, including extremes, can increase the robustness of management practices and preparedness for climate change impacts.

Before a workshop co-facilitated by GLISA and a lead practitioner, GLISA meets with stakeholders to identify key management concerns or vulnerabilities to develop climate impact scenarios - the foundation for a series of exercises during the workshop. In Phase II, GLISA co-developed, implemented, and refined its approach with the Michigan National Guard (pg. 28), coastal beach managers in Illinois (pg. 28), tribes in Michigan (pg. 32), community planners and emergency managers in Pennsylvania (pg. 36), and decision-makers in the Lake Ontario basin (pg. 25).

VULNERABILITY ASSESSMENTS

Cities require VAs for virtually every planning process (e.g., natural hazards, infrastructure), but they are rarely coordinated across planning domains. To save municipal staff time and resources, GLISA, in collaboration with GLCAN, Headwaters Economics, The Huron River Watershed Council, and USDN, co-developed a municipal VA process with five GL cities in 2017 to mainstream adaptation planning by integrating climate-smart and equity-focused information into city planning.

The pilot vulnerability assessment process has been adapted to stormwater management and implemented with over 70 communities in the Great Lakes and Gulf regions, serving as a model for how to customize and scale a co-developed methodology from one sector and region to another (pgs. 37-38).

COMMUNICATIONS

GLISA launched a new website in February 2021 to respond to user feedback to make its work and resources more easily accessible. With the launch, GLISA published several new web-based resource pages including: Climate Model Biases, Freezing Rain, Arctic Oscillation and Amplification, Freeze-Thaw Cycles, and a Sustained Assessment of the GL (pgs. 19-21). GLISA also launched a library of 16 impact stories highlighting successful projects from GLISA's first 10 years. This library will be expanded over time to add more stories.


GLISA

Predicting Lake Ice with the Apostle Islands National Lakeshore

Overview

- Purpose: To forecast the onset of seasonal ice coverage in Lake Superior to inform Apostle Islands National Lakeshore management and planning.
- Partner: National Park Service (NPS), NOAA Great Lakes Environmental Research Laboratory (GLERL), University of Miami
- People: Apostle Islands National Lakeshore staff
- Impact: Created a new model that can successfully forecast the likelihood that Lake Superior freezes firmly enough to provide safe access to the caves, as well as the date of ice formation.

On Apostle Islands National Lakeshore, along the coast of Lake Superior near the border of Wisconsin and Michigan's Upper Peninsula, ice caves used to be a regular occurrence. Consistently cold weather would allow the caves to form, and visitors could walk on frozen Lake Superior to witness a winter spectacle. A 2018 report by the National Park Service estimates over 250,000 visitors to the park that year, generating $40 million in visitor spending and 576 jobs. The total economic output for that year was calculated to be $48 million, with 98.5% of spending coming from non-local visitors. Ice cover at Apostle Islands used to be certain, but starting in the 1990s a period of variability began with several years of no safe ice cover due to climate change that continues today.

The extreme variability in temperature and ice cover has made planning very difficult for the National Park Service (NPS), which manages Apostle Islands. To open the caves, the park needs to ensure that the lake ice is thick enough to support thousands of visitors. Sending out staff to assess the status of the ice and caves can also be risky. Then there's the question of budgeting—how do you manage the park's financials without knowing whether it will receive revenue from 250,000 visitors, or no visitors at all? In a 2015 scenario planning process to help the NPS envision and prepare for possible future climate conditions, a park official wondered aloud about whether it would be possible to predict ice formation in time for the park to make planning decisions. The question sparked a partnership between Apostle Islands and Great Lakes Integrated Sciences and Assessments (GLISA).

Generally, ice forms through interactions between water levels, temperature, and atmospheric events. To model these dynamics, GLISA staff and partners at the NOAA Great Lakes Environmental Research Laboratory (GLERL) and the University of Miami looked to phenomena such as El Niño and the Arctic

Icicles in Apostle Island Sea Cave. Source: Flickr, Billboard Art Project

An Example Impact Story: Predicting Lake Ice with the Apostle Islands National Lakeshore

COLLABORATION & TRAINING

MENTORSHIP

GLISA is dedicated to training and mentoring students to provide real-world experience applying climate information to decision-making in the GL region. GLISA continued its partnership with the UM Applied Climate masters program in the College of Engineering, providing opportunities for students' practicums. GLISA also hired and mentored several research assistants at the UM School for Environment and Sustainability.

GLISA mentored and trained more than 30 students and for the first time, worked with undergraduates as part of the Doris Duke Conservation Scholars program for underrepresented identities.

GLISA staff and graduate students celebrating a successful 2018 GL Adaptation Forum

STUDENT TESTIMONIALS

"My experience with GLISA has absolutely prepared me for the next stage of my career. I hope to work in local government – specifically in a sustainability or resilience planning role – and all of my GLISA projects were relevant to this work in some way. Working on the Gulf Research Program project in particular has strengthened my stakeholder engagement skills, particularly with workshop facilitation. I feel much more equipped to talk about the basics of climate science and climate impacts with stakeholders. Through the SARP and Gulf projects, I became familiar with best practices in climate and social vulnerability assessments, and learned a lot about stormwater management and adaptation in different regional contexts. Supporting the GL Climate Adaptation Network through both compilation of helpful resources and meeting support has allowed me to expand my network and make connections with practitioners across the region in my career field of choice." - Recent graduate, who worked on the Gulf, SARP, and GLCAN projects (pgs. 37-38)

"The best part of working with GLISA was developing working and learning relationships with a community of colleagues, experts, and stakeholders around the GL. The dynamic position of GLISA as a boundary organization allows for many lines of interdisciplinary work that is motivated by science and people. I'm very grateful for the continuous drive to support each other within the GLISA office that fosters active communication and learning on the job. Within this environment I was able to learn from mistakes as well as successes toward becoming a more capable scientist and climate communicator."- Former GLISA student, now with the U.S. Global Change Research Program

"Considering my next job is in the federal government, working with GLISA has exposed me to some of the intricacies of working within such a field (i.e., funding, word choice/intent, etc.) and as such has given me a competitive advantage to my peers. One of the best parts of working with GLISA was getting to experience the real-time collaboration on projects, and seeing the results of my work come to fruition and be posted/distributed on the website. It's a great feeling knowing that I contributed directly to clear, succinct, and usable knowledge distribution on such a large scale platform."- Recent graduate, now with the State of Michigan Environment, Great Lakes, and Energy (EGLE)

PROJECT LIST BY THEME

AGRICULTURE 5	CLIMATE DATA FOR ADAPTATION 7
CONVENING 3	ECONOMY 5
NATURAL RESOURCES 5	TRAINING & EDUCATION 6
TRIBES 4	URBAN ADAPTATION 10

1. Economics of Wind Machine-Based Frost Control for Tree Fruit Production
2. Great Lakes State Climate Change Summaries for Agriculture
3. Heavy Precipitation and Nitrogen Management
4. Projected Changes in Frequency of Major Tree Fruit Diseases in the Central Great Lakes Region
5. Moving Michigan farms towards climate and weather resiliency: the creation of a ''weather and climate ready'' assessment tool

AGRICULTURE

GLISA's agricultural work focused on weather- and climate-dependent factors affecting agriculture, sustainable agricultural practices, and creating more resilient farming operations.

ECONOMICS OF WIND MACHINE-BASED FROST CONTROL FOR TREE FRUIT PRODUCTION

Partner: MSU Extension

This project evaluated the economics of wind machine-based technology for mitigating the impact of frost on apple and cherry production in Michigan to help growers better quantify their current weather and climate-related production risks and inform decisions regarding capital investment. Using a capital partial budgeting model, frost events were simulated on a daily basis with a temperature-based model to estimate the frequency and severity of cold damage for a given location. The team then developed a series of simulated years with estimated crop yields to compare the difference in net revenues between management approaches including none, wind machine frost protection, crop yield insurance, and the combination of wind machine frost protection and crop insurance.

Wanyama et al 2020: Modeling land suitability for Vitis vinifera in Michigan using advanced geospatial data and methods

Kiefer et al. 2021: Extreme minimum temperatures in the GL region of the United States: A climatology with implications for insect mortality

GLISA SMALL GRANT: GREAT LAKES STATE CLIMATE CHANGE SUMMARIES FOR AGRICULTURE

Partners: Michigan Technological University (grantee), USDA Midwest Climate Hub, USDA Northern Forest Climate Hub, NOAA Central Region Climate Service, Ohio State University

Agricultural producers recognize and are concerned with the increased frequency of climate extremes, such as flooding, droughts, and late freezes, and timely communication of state-specific information that focuses on relevant agricultural commodities (crops, livestock, forestry) is critical for both increasing understanding of these changes as well as reducing the risks to producers. This project created state-level agriculture-climate summaries for the eight states in the GLISA and USDA Midwest Climate Hub regions (MN, WI, IA, MO, IL, IN, MI, OH) with input from stakeholders to ensure the information is relevant to important crops/livestock in each state.

Five stakeholders were engaged in June and July 2020 in a series of virtual planning meetings to discuss key agro-climatic variables to calculate for the climate summaries.

Climate Change Impacts on Illinois Agriculture (2022)

HEAVY PRECIPITATION AND NITROGEN MANAGEMENT

Partners: National Snow and Ice Data Center, Alaska Ocean Observing System

Increasing intensity and frequency of heavy precipitation events are damaging to crops and often result in large financial losses and other damages from the resulting flooding, but establishing a quantitative relationship over time between heavy precipitation and crop losses has proven difficult due to heterogeneities in practices over several decades. GLISA collaborated with water managers to better understand the role of increasing precipitation and heavy precipitation events on nitrogen fertilizer management and how irrigation strategies will need to evolve under climate change using a combination of field data and crop models.

Two producers participated in the field portion of the project that allowed GLISA to take soil and plant samples to calibrate crop models. In return they received tailored fertilizer prescriptions for their fields.

Increases in annual total precipitation, heavy precipitation events, and annual number of wet days were found from the mid 20th century through early 21st century across the Midwest, with the increase generally being greater and more spatially consistent in the eastern portions of the region. Crop modeling results indicated that lower yielding areas of agricultural fields were responsible for the majority of nitrogen loss with the largest loss events occurring in years following droughts.

Several local producers are using the modeling framework that was developed to tailor fertilizer applications to their fields to improve the usage of nitrogen fertilizers.

Baule et al. 2022: Trends in quality controlled precipitation indicators in the United States Midwest and Great Lakes Region

Baule et al. 2017: Northwest Ohio crop yield benefits of water capture and subirrigation based on future climate change projections

Gunn et al. 2019: Investigating maize subirrigation strategies for three northwest Ohio soils

Gunn et al. 2018: Modeled climate change impacts of subirrigated maize relative yield in northwest Ohio

Hunt et al. 2020: A perspective on changes across the U.S. Corn Belt

PROJECTED CHANGES IN FREQUENCY OF MAJOR TREE FRUIT DISEASES IN THE CENTRAL GL REGION

Tree fruit production in the GL region is a significant factor in the region's agricultural economy and the moderation of regional climate, particularly in the areas leeward of the lakes, allows for the commercial production of specialty crops not common in other areas of similar latitude. GLISA investigated the historical frequency and severity of radiation freeze events, applications for frost prevention systems in tree fruit orchards, and the projected changes in the frequency of tree fruit diseases under a changing climate.

The frequency and severity of these diseases are heavily dependent on diurnal variations and combinations of air temperature, humidity, and precipitation.

Andresen and Baule 2020: Perennial systems (temperate fruit trees and grapes)

MOVING MICHIGAN FARMS TOWARDS CLIMATE AND WEATHER RESILIENCY: THE CREATION OF A "WEATHER AND CLIMATE READY" ASSESSMENT TOOL

Partners: MSU Extension, MSU W.K. Kellogg Biological Station

Other than conventional crop insurance, there is little support for farmers to help manage weather and climate related risks. The team developed a prototype assessment tool for Michigan annual field crops and perennial tree fruit crops on weather-related vulnerability and sustainability based on an existing framework created by the University of Nebraska-Lincoln. The assessment asks about farm management and operational conditions and produces a vulnerability map for each farm.

The assessment was reviewed by a group of agriculture professionals within government, private and public sectors, as well as 10 farmers based in Michigan and modified based on the review prior to its release.

Climate Ready Farm Assessments

1. Development of Ontario Climate Divisions
2. Freeze/Thaw cycle analysis for the Great Lakes region
3. Expanding the Great Lakes Adaptation Date Suite (GLADS) for Comprehensive Climate Adaptation
4. Sustained Assessment of the Great Lakes
5. Trends in Freezing Rain in the Great Lakes Region
6. Investigation of the Arctic Amplification and Oscillation and their Effects on the Great Lakes Region
7. Predicting the Onset of Seasonal Ice Cover for Apostle Islands National Lakeshore

CLIMATE DATA FOR ADAPTATION

GLISA continued to curate and translate high quality climate observations and projections for use in decision-making in the GL by developing innovative new frameworks and models, and updating existing resources.

DEVELOPMENT OF ONTARIO CLIMATE DIVISIONS

Partners: Working group (see below)
Leveraged Funding: GLOS (part of GLADS, pg. 20)

GLISA's GL climatologies include climate division (multi-county, defined by NOAA for the U.S.) summaries at an intermediate spatial scale that has proven valuable to many of GLISA's partners and serve as a good starting point for describing sub-regional climate changes. With the guidance of partners from Canada and the U.S., GLISA developed spatial boundaries for 23 Ontario Climate Divisions based on the boundaries of the Conservation Authorities in Ontario and calculated the future temperature and precipitation trends for the new divisions based on the spatially-averaged projections of the UW-RegCM4

Working group (26 members) from: ECCC, Natural Resource Canada, Ministry of the Environment, NOAA National Centers for Environmental Information, Aquanty, the Climate Risk Institute, the City of St. John's, the Ontario Climate Consortium, Ouranos, 10 Conservation Authorities

The Maitland Valley Conservation Authority (MVCA) requested the projection data for the division containing MVCA (i.e, Ontario Climate Division 4) to use for their work.

Shapefile download of boundaries; future projections for temperature and precipitation change for divisions available in GLADS (pg. 20) and in GLISA's online division climatologies (expected 2023)

FREEZE/THAW CYCLE ANALYSIS FOR THE GL REGION

Practitioners expressed a need for updated information on how freeze-thaw cycles (FTCs) are changing in the GL to aid in planning across several industries including tourism, transportation, and agriculture. Current trends were available only through 2010, so GLISA expanded its existing analysis to include data through 2021.

FTCs are decreasing over time, and have seen the biggest decreases region-wide in the past 20 years. FTCs are likely to continue decreasing in the future, though the amount varies by location. Individual locations are more prone to fluctuations than others on an annual basis.

Freeze-thaw cycle climate impact webpage

EXPANDING THE GL ADAPTATION DATE SUITE (GLADS) FOR COMPREHENSIVE CLIMATE ADAPTATION PLANNING

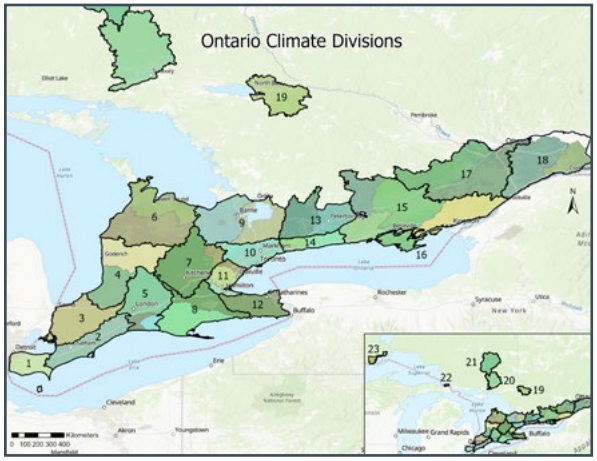
Leveraged Funding: GLOS

GLISA developed and continues to curate the GL Adaptation Data Suite (GLADS) — a first-ever clearinghouse of standardized historical observations and future projection data for the GL region — and launched an online user interface for users to query and download GLADS data.

Prototype interface demonstration at 2022 National Adaptation Forum

GLADS data has been available by request since 2017 and GLISA regularly receives several requests per year from regional researchers, practitioners, and students.

GLADS user interface (prototype as of December 2022)

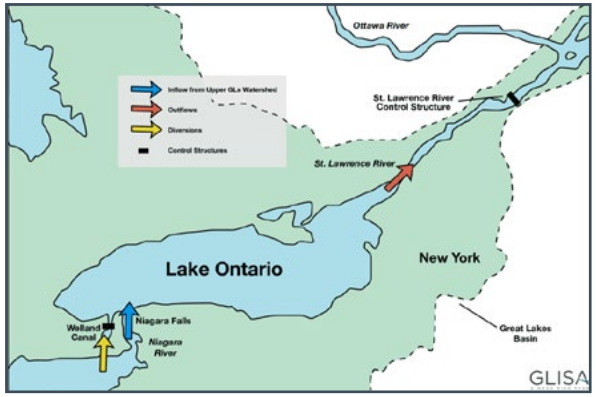


Map of Ontario climate divisions

SUSTAINED ASSESSMENT OF THE GL

Lake levels and ice cover are basic, integrated measures important to lake and coastal ecosystems, coastal communities, and regional climate. They are influenced by accumulated heat and precipitation, cloudiness, wind, stream flow and lake circulation, and by human decisions on water and ice management. Existing research and information on these topics was generated in an uncoordinated way and not available in a single location. GLISA developed this new resource to be a continuous, sustained process to assess knowledge of GL ice cover, lake levels, hydrology, and climate. This effort is meant to create the capability to more easily extract information for specific applications and support continuous evaluation of research priorities to address knowledge gaps.

Sustained Assessment of the GL webpage containing overviews of lake levels and lake ice, lake climatologies, state of the research, and data sources



Map of Lake Ontario basin annotated with major inflows and outflows from the Assessment's Lake Ontario Climatology

TRENDS IN FREEZING RAIN IN THE GL REGION

Ice storms have expensive and sometimes deadly effects on major population centers in the GL region. This project investigated changes in the spatial and temporal distribution of ice storms, including possible links to climate change, extending the most recent GL freezing rain climatology (1976-1990) through 2021.

A northward shift in freezing rain incidence is found across the GL on an annual basis, accompanied by a seasonal trend toward winter, with more frequent freezing rain occurrence in January and fewer incidences of freezing rain in the fall and spring months of November and March, respectively. This is consistent with warmer temperatures and northward-moving extratropical cyclone tracks. Observed trends have generally matched and outpaced model projections.

Freezing rain climate impact webpage

CLIMATE DATA FOR ADAPTATION

INVESTIGATION OF THE ARCTIC AMPLIFICATION AND OSCILLATION AND THEIR EFFECTS ON THE GL REGION

Arctic Amplification (AA) has become one of the clearest global signatures of climate change over the last few years. The Arctic Oscillation (AO) is a mode of variability that is focused over the mid to high latitudes, describing how surface air pressure patterns are arranged in relation to each other. The setup of these pressure patterns influences the jet stream, which, in turn, influences midlatitude weather and climate in the GL. Due to the impact that AA and/or the AO can have on weather in the region, GLISA evaluated and summarized the current state of the research for stakeholder use and investigated potential relationships between the wintertime cold pool size and GL ice coverage.

While the trend between AA and a more wavy jet stream, or a jet stream that flows with more of a north-south component than is typical, is consistent between studies, there is variability in conclusions related to extreme weather and the midlatitude circulation. Future projections suggest that AA will impact the midlatitude circulation in the future, but there is extensive uncertainty in these projections.

Arctic amplification and arctic oscillation climate impact webpage

PREDICTING THE ONSET OF SEASONAL ICE COVER FOR APOSTLE ISLANDS NATIONAL LAKESHORE

Partners: NOAA GLERL, NPS, Apostle Islands National Lakeshore (APIS), University of Miami

APIS in northern Wisconsin on Lake Superior is home to majestic and popular ice caves, but they are only open in winters when it's safe for visitors to walk across the ice of the frozen lake. Ice cover at APIS used to be a sure thing, but starting in the 1990s a period of variability began with several years with no safe ice cover due to climate change that continues today. This kind of uncertainty created problems for park managers and visitors. In response, GLISA and collaborators worked with the NPS to forecast the first date of solid ice in the park.

Iterative engagement with NPS to identify the geographic area of concern, define adequate ice cover, and understand the connection between the science and management questions

GLISA developed a new statistical model that simulates the onset of seasonal ice cover along the APIS shoreline. The new approach can reliably predict months in advance whether ice will form in a given winter, as well as the timing of the forecast. The team also developed a new model to forecast the likelihood that Lake Superior freezes firmly enough to provide safe access to the caves to inform seasonal management decisions for tourism.

The NPS uses the predictions to decide staffing needs for the upcoming season and what budget is needed to support this staff. The data then informs what level of preparedness this staff needs, depending on when the ice season is predicted to start. This work ensures the continued economic success of not only the Park itself, but also of the surrounding community that benefits from the visitors.

Ji et al. 2019: Modeling Seasonal Onset of Coastal Ice

GLISA impact story

Icicles in Apostle Island Sea Cave
Credit: Flickr, Billboard Art Project

"These models could be useful not only for supporting safe pedestrian traffic on ice in coastal areas of the GL, but for large and small-craft vessel navigation, fishing and hunting, and other human activities around the world." – Richard Rood, GLISA Co-PI

CONVENING

Planning and hosting in-person and remote workshops, webinars, and conferences positions GLISA to communicate climate data and information to its existing network, build new relationships for future collaboration, and learn what gaps remain.

1. 2021 Great Lakes Climate Modeling Workshop
2. Great Lakes Adaptation Forum (2016, 2018)
3. Filling the Gaps: Climate and Weather Information for Small- and Medium-size Water Utilities

2021 GL CLIMATE MODELING WORKSHOP

Partners: NOAA GL Regional Collaboration Team, ECCC, MRCC
Leveraged Funding: ECCC (via GLWQA Annex 9)

Under the auspices of the GLWQA Annex 9 on Climate Change Impacts, GLISA planned and facilitated the second GL Climate Modeling Workshop to sustain regional discussions around the topics of physical climate modeling, translating climate information, model bias and lake levels.

Four virtual sessions across four days in March 2021 (>60 attendees)

Workshop organizers distilled the presentations and discussions into a series of recommendations in the final workshop report (see below) for climate modelers, climate information users and translators, and funders.

Responses to a feedback survey indicated climate modelers found the workshop relevant for their work, in particular learning about recent research not yet published and examples of real-life applications of climate information for decision-making. Translators and practitioners enjoyed hearing from and interacting with the modelers directly to better understand current challenges and limitations, as well as new projects and tools. A common theme noted across participating modelers, translators, and practitioners was the benefit of an open exchange of dialogue and a request for more time for interactions and discussion in future workshops. Given the interest from workshop participants, Annex 9 is pursuing options to facilitate a more structured series of ongoing modeling conversations between workshops.

Briley and Jorns, 2021: 2021 Great Lakes Climate Modeling Workshop Report.

"It was interesting for me to learn about issues and shortcomings of models directly from modelers. Especially when for me they are somewhat of a black box. What I liked most about the workshop was getting a better understanding of models and hearing the repeated message that there needs to be clearer language contextualizing what models can and can't do." Workshop attendee, NOAA

"Thank you for the amazing workshop. These things are a ton of work and it was well-designed and executed and offered real value. It was a great way to get an overview of the state of the research, needs and opportunities for translation and use. I'm new to the region so the networking was also really valuable." Workshop attendee, University of Minnesota

GL ADAPTATION FORUM (2016, 2018)

Partners: ASAP
Leveraged Funding: Forum sponsorships from external organizations

GLISA planned and hosted the 2nd and 3rd GL Adaptation Forums (GLAF) in 2016 and 2018, respectively, in Ann Arbor (MI). Both forums brought together more than 150 practitioners, scholars and students from the U.S. and Canada to discuss the latest in adaptation funding, technology, equity, and leadership. Hosting provided the opportunity to showcase GLISA's role as a trusted convener in the region and to feature its latest work, maintain existing relationships, and meet new partners.

2016 and 2018 GLAFs (>150 attendees each)

Feedback from follow-up surveys indicated that the vast majority of attendees considered their experience at the Forum to be excellent, with respondents particularly valuing the strong representation of Tribal and Indigenous perspectives, city-scale adaptation strategies, and the interconnection of multi-scalar/ sector work on climate change.

'Reflections on the 2018 Regional Adaptation Fora' report (contributor)

GLISA impact story

> "The Forum was very well organized, interactive and ran smoothly each day. I liked the engagement from so many different organizations and institutions. I appreciated the involvement of students and researchers (as well as support given to Tribal community members who had to travel for the forum). I was very excited for GLAF 2018, and it exceeded my expectations. I took away a lot of new knowledge and connections." 2018 GLAF attendee and travel scholarship recipient

FILLING THE GAPS: CLIMATE AND WEATHER INFORMATION FOR SMALL- AND MEDIUM-SIZE WATER UTILITIES

Partners: The Water Research Foundation
Leveraged Funding: NOAA SARP

GLISA organized and hosted a webinar to raise awareness of NOAA's Water Resources Dashboard and other relevant climate and weather tools among small- to mid-sized GL water utilities and developed guidance for four tools (i.e., Atlas 14, Climate Explorer, U.S. Environmental Protection Agency (EPA) Stormwater Calculator Quantitative Precipitation Forecasts).

July 2020 webinar (>170 attendees)

A key barrier for using NOAA tools is the time it takes to learn how to use them and assess their credibility.

Webinar recording, guidance documents for each tool, and a workshop summary

Networking at the 2018 Great Lakes Adaptation Forum
Credits: Alex Basaraba

1. Climate Change Opportunities Phase I: Creating Two Methodologies for Anticipating Growth in the Great Lakes Region
2. How to Use Economics to Build Support for Climate Adaptation
3. Development of an Adaptation Toolkit for Resiliency Champions at Businesses and Institutions in the West Michigan Region Identifying Economic Impacts of Inundation On New York's Lake Ontario Water Resources through Research and Engagement
4. Knowledge Co-Production in Effective Communication of Great Lakes Ice Forecasts

ECONOMY

For the first time, GLISA explored the economic impacts of climate change in the GL, partnering with small businesses, coastal communities, and federal agencies to understand practitioner concerns and information needs and develop new methodologies to address them.

GLISA SMALL GRANT : CLIMATE CHANGE OPPORTUNITIES PHASE I: CREATING TWO METHODOLOGIES FOR ANTICIPATING GROWTH IN THE GL REGION

Partners: ASAP (grantee), Florida State University
Leveraged Funding: New York State Energy Research and Development Authority (NYSERDA)

Population growth or decline from climate-driven migration can have significant impacts on a region's or municipality's economic growth, businesses, and markets. The project team worked with demographers, climatologists, and applied social scientists to accelerate the development of methodologies to assess, predict, and prepare for climate migration through a Climate Migration Methodology Accelerator that focused on equitable growth.

December 2020 and 2021 Preparing Receiving Communities workshops

The team found a statistically significant, positive association between temperature differentials and the number of migrants moving into the GL region after controlling for population size and distance. For out-migration, it appears that most migrants leaving the GL are not heading to warmer climates but are heading to cooler climates, after controlling for distance and population size.

GLISA small grant funding was leveraged to secure additional funding from NYSERDA to support the Climate Migration Methodology Accelerator.

Jacobson et al. 2022a

Literature review, typology report, summary report, blog post

HOW TO USE ECONOMICS TO BUILD SUPPORT FOR CLIMATE ADAPTATION

Partners: Headwaters Economics, USDN

The project team co-produced a report aimed at helping municipalities understand how to best make the case for local climate action. Focusing on the effective use of economic data and clear methods of communication, the report addresses the many complex and competing priorities that cities face – offering innovative solutions that help prioritize climate action at the municipal level.

Interviews and surveys with city practitioners to inform report

Lawson 2019

GLISA SMALL GRANT- DEVELOPMENT OF AN ADAPTATION TOOLKIT FOR RESILIENCY CHAMPIONS AT BUSINESSES AND INSTITUTIONS IN THE WEST MICHIGAN REGION

Partner: West Michigan Sustainable Business Forum (WMSBF, grantee)

WMSBF and partners developed a toolkit to guide individual resiliency champions in leading their businesses through a vulnerability assessment informed by predicted industry impacts and historical climate data and projections.

Four representative organizations in the West Michigan area piloted the assessment in the public school, pharmaceutical, health care, and hospitality industries.

WMSBF adopted the boundary organization language to forward new conversations around equity and the relationship with sustainable business to its funders, used the climate information for an environmental justice report and a health and equity partner proposal, and formed a dedicated stakeholder group.

Schoonmaker et al. 2017

Grand Rapids climate summary, GLISA impact story

"Our organization had been working to educate our stakeholders on climate adaptation for a number of years before this project, and had struggled to find a resource that fit the needs of the businesses and institutions that we knew would be impacted. We were telling them that they should be concerned about their operations and buildings but weren't able to answer their questions about how they should respond. Having specific climate data to inform these discussions is helping the organizations we work with accurately assess how they are vulnerable to climate change."- Executive Director, WMSBF

IDENTIFYING ECONOMIC IMPACTS OF INUNDATION ON NEW YORK'S LAKE ONTARIO WATER RESOURCES THROUGH RESEARCH AND ENGAGEMENT

Partners: Syracuse University, Cornell University, New York Sea Grant
Leveraged Funding: NOAA's SARP and Coastal and Ocean Climate Applications (COCA) Programs

Recent Lake Ontario flooding has left coastal communities unprepared for the immediate impacts on businesses, homes, and infrastructure. The project team worked with coastal communities in the Lake Ontario watershed to understand their flood risk and identify the water resources in jeopardy. GLISA led the scenario planning component of the project. Workshops enabled stakeholders to create vulnerability matrices and propose flood resiliency actions.

July 2021 water level scenario planning workshop for Wayne County (NY) (33 attendees); November 2021 workshop on advancing community resilience in Wayne County (NY)

Workshop participant recommendations contributed to the scoping of the NY Coastal Resilience Network to ensure local capacity and technical needs are addressed and that regional practitioners are engaged to work more efficiently with communities. NY Sea Grant also created online resources to inform flood risk and adaptation for municipal staff and tailored local government training events to focus on climate threats, flood impacts, and resilience

Channell and Austerman 2021

GIS layers and mapped economic

Shoreline property impacts linked to flooding

Flooding from Lake Ontario
Credit: Coastal Flooding Survey Project, Cornell University and New York Sea Grant.

ECONOMY

KNOWLEDGE CO-PRODUCTION IN EFFECTIVE COMMUNICATION OF GL ICE FORECASTS

Partners: Cooperative Institute for GL Research (CIGLR), NOAA GLERL

NOAA's GL Operational Forecast System (GLOFS) new short-term ice forecast provides predictions of ice movement, concentration, and thickness, intending to keep vessels in operation for as long as possible to reduce financial losses due to navigation risks (i.e., entrapment in the ice, collision, hull damage). GLISA collaborated with CIGLR and GLERL over a 3-year period to improve the usability of the forecast by conducting nine interviews with key informants and hosting two workshops where users were guided through an evaluation of the forecast prototype and a scenario-based exercise to explore how the forecast might be used in a real-world navigation scenario.

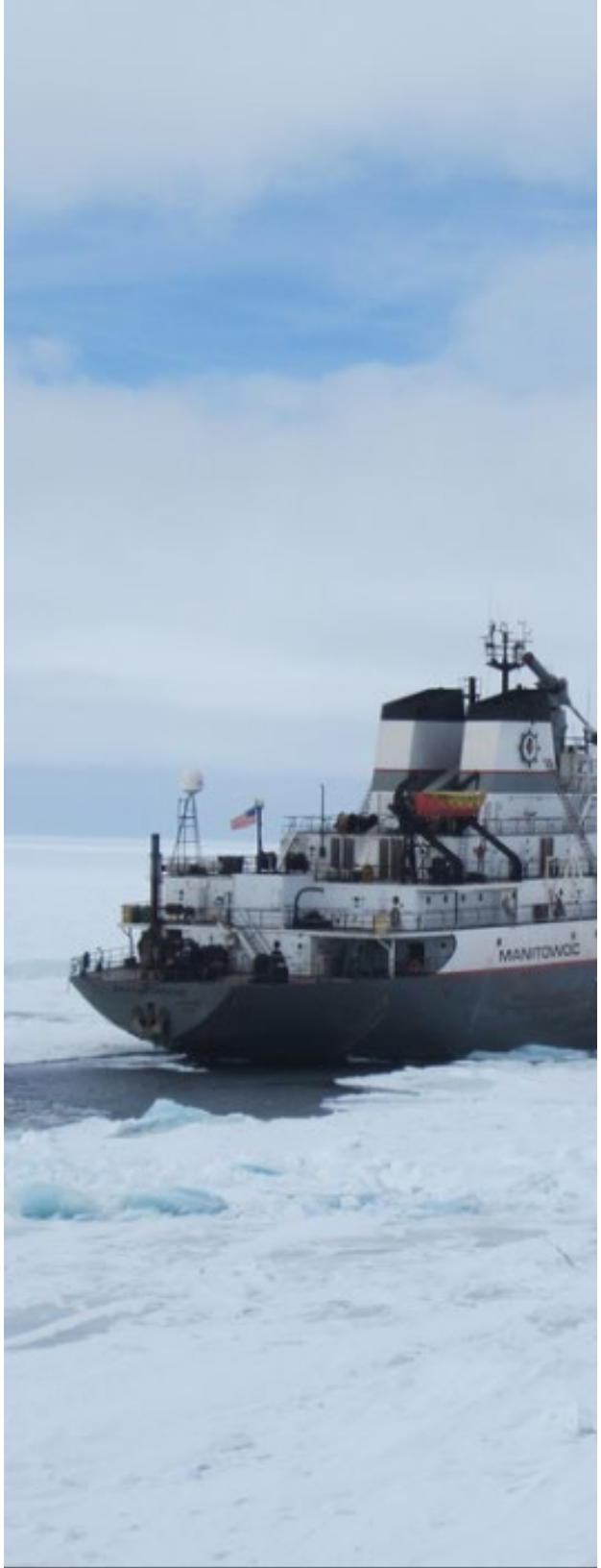
Two June 2021 workshops with the shipping industry, and U.S. and Canadian Coast Guards and U.S. Army Corps of Engineers

The team detailed the formation of a boundary chain model to co-produce a short-term GL ice forecast with agency, university, and industry partners, highlighting the different complementary and embedded roles and functions performed by the actors within the model and how these roles and functions promoted greater efficiency in knowledge co-production.

The NOAA National Ice Center is using the short-term ice forecast model and user requirements developed through this collaboration to inform the operationalized ice forecast for ship navigators to use for trip planning and real-time navigation decision-making.

Fujisaki-Manome et al. 2019, 2022

"Thank you for the work you are doing to improve the weather and ice forecasting on the GL. You are very organized, the meetings are engaging, and it is fun to be a participant. There are countless people within my organization that rely on ice information for safe voyage planning, to support critical business operations, and to ensure an uninterrupted flow of raw materials across the GL. The raw materials we move are integral to the North American supply chain and in many cases no other modes of transportation exist to move the materials GL ships move. I set-up an internal meeting with our operations team and our captains to share with them the exciting progress you've made. I hope you are able to continue your work for a long time and look forward to working together in the future. The ice forecasting tool is fantastic and it is exciting to be part of the work you are doing."- Workshop participant, a representative of a company in the U.S. shipping industry



Freighter Manitowoc in Whitefish Bay, Lake Superior, 3/22/13
Credit: NOAA, cited from the NOAA CoastWatch website

1. Apostle Islands National Lakeshore Climate Change Vulnerability Assessment
2. Development of Indicators for the Detroit River-Western Lake Erie Basin
3. Fort Custer Training Center Scenario (FCTC) Planning
4. Projected Impacts of climate change on coastal geologic evolution along the Illinois Coast
5. Resilient Coastal Communities: Growing the Network and Building the Capacity of Local Leaders

NATURAL RESOURCES

Analyzing existing data for custom applications with previous and new partners and applying that information using social science and scenario planning, GLISA applied its expertise in several projects focused on natural resources.

APOSTLE ISLANDS NATIONAL LAKESHORE CLIMATE CHANGE VA

Partners: Northern Institute of Applied Climate Science (NIACS), U.S. NPS

Building on the scenario planning workshop in 2015, GLISA partnered again with NPS and APIS to support their climate change vulnerability assessment for terrestrial ecosystems. The team updated and refined the original scenarios with downscaled climate data, end-of-century projections, and new information on several requested variables (i.e., lake ice, lake levels, arctic cold spells, wind speed, wave action, strong storms, snowfall, lake-effect show, lake currents) and co-authored a chapter on climate drivers for the assessment, including a discussion on climate models, uncertainty, and statistical versus dynamical downscaling.

Presentation to NPS partners at spring 2018 workshop

Handler et al. 2020

DEVELOPMENT OF INDICATORS FOR THE DETROIT RIVER-WESTERN LAKE ERIE BASIN

Partners: GL Institute for Environmental Research (University of Windsor), State of the Strait

The Detroit River-Western Lake Erie Basin Indicator Project, run by the US-Canada collaboration State of the Strait, is intended to compile and interpret long-term data bases for ecosystem indicators from the Detroit River-Western Lake Erie basin and translate the information into understandable terms for policymakers and managers at a biennial conference. GLISA contributed data analysis and custom narratives for several indicators to be presented at the 2019 meeting, including temperature, precipitation, ice cover, and lake levels.

The State of the Strait used indicator narratives written by GLISA to communicate trends to policy-makers and resource managers in order to identify data gaps and comprehensively assess the state of the ecosystem.

State of the Strait Indicator Reports

NATURAL RESOURCES

FORT CUSTER TRAINING CENTER SCENARIO (FCTC) PLANNING

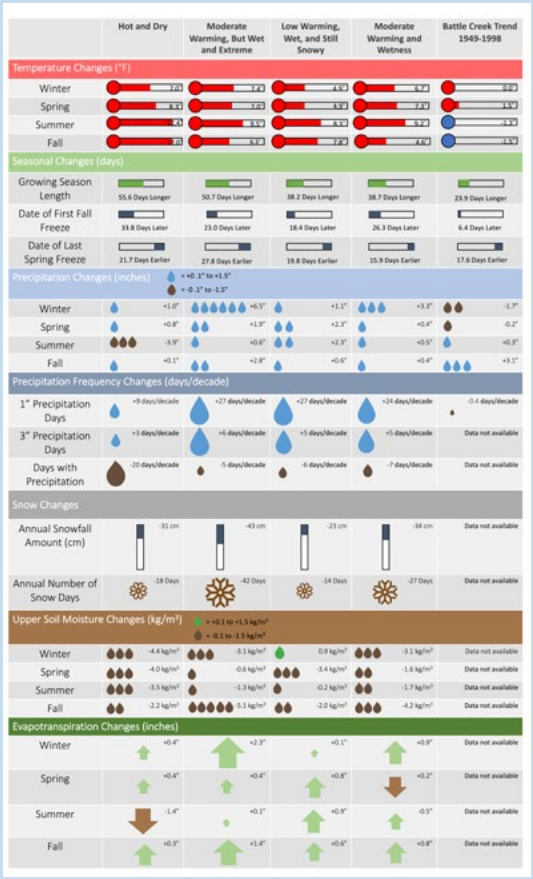
Partner: Michigan Army National Guard
Leveraged Funding: Amec/Wood PLC

For the first time in 2018, GLISA applied its scenario planning approach to a military installation with the Michigan Army National Guard in Battle Creek (MI) to support the Guard's goal of incorporating climate change into its mandated Integrated Natural Resource Management Plan (INRMP). GLISA led a scenario planning workshop and guided natural resource managers through learning about local climate trends and future projections to identify weather and/or climate events that challenge their management of specific natural resources (i.e., invasive species, high quality natural areas, etc.). The outcome was a set of four, specific climate scenarios focused on natural resource management areas that had already experienced stress due to climate variability, and managers wanted to be better prepared for these events in the future.

2018 scenario planning workshop at FCTC

FCTC won the 2020 Department of Defense Environmental Award for Natural Resource Conservation for their updated INRMP, partly for being the first installation to include climate information.

GLISA impact story



Climate scenario table depicting the four future scenario frameworks for Fort Custer and the local historical observed climate trends (last column) for comparison.

"It feels good to apply climate planning to a specific project. I'd like to do more!" - Workshop attendee

PROJECTED IMPACTS OF CLIMATE CHANGE ON COASTAL GEOLOGIC EVOLUTION ALONG THE ILLINOIS COAST

Partners: Illinois State Geological Survey (ISGS), University of Illinois at Urbana-Champaign, MRCC, Illinois State Water Survey
Leveraged Funding: IL-IN Sea Grant

GLISA partnered with ISGS and MRCC to help Illinois coastal communities develop proactive plans to better anticipate the future climate impacts to beach, bluff, and nearshore environments. GLISA developed qualitative projections for lake levels, lake ice, storms, and wind and three qualitative climate scenarios for southwestern Lake Michigan for Illinois Beach State Park and Waukegan Beach and co-facilitated a scenario planning workshop to incorporate the climate information into their erosion and stormwater planning.

August 2019 scenario planning workshop in Chicago with five practitioners from each park

At Illinois Beach State Park and Waukegan Beach, beach managers used climate information and skills gained from a scenario planning workshop GLISA co-facilitated with ISGS to better prepare for lake level variations.

GLISA SMALL GRANT : RESILIENT COASTAL COMMUNITIES: GROWING THE NETWORK AND BUILDING THE CAPACITY OF LOCAL LEADERS

Partner: Alliance for the GL (grantee)

The Alliance engaged with private residential landowners and local decision makers in ravines of concern in Illinois and Wisconsin to tackle ravine management by facilitating an extended network-building and adaptation planning process. GLISA helped the project leaders think about the social network dynamics underlying the flow of knowledge about climate change by conducting surveys before and after ravine restoration project events facilitated by the Alliance to modify the network over a two-year period. This was one of the first examples of the use of a description of network structure in terms of clusters that was then successfully used to target professional development.

2015 workshop and planning charlotte (>200 attendees)

Lake County Stormwater Management Commission launched a $252,000 multi-year Illinois Lake Michigan watershed management plan process. Illinois Coastal Management Program provided funding to the Lake County Forest Preserve District to update ravine data and assess fish habitats in ravine streams.

Frank et al. 2022: A Network Intervention for Natural Resource Management in the Context of Climate Change

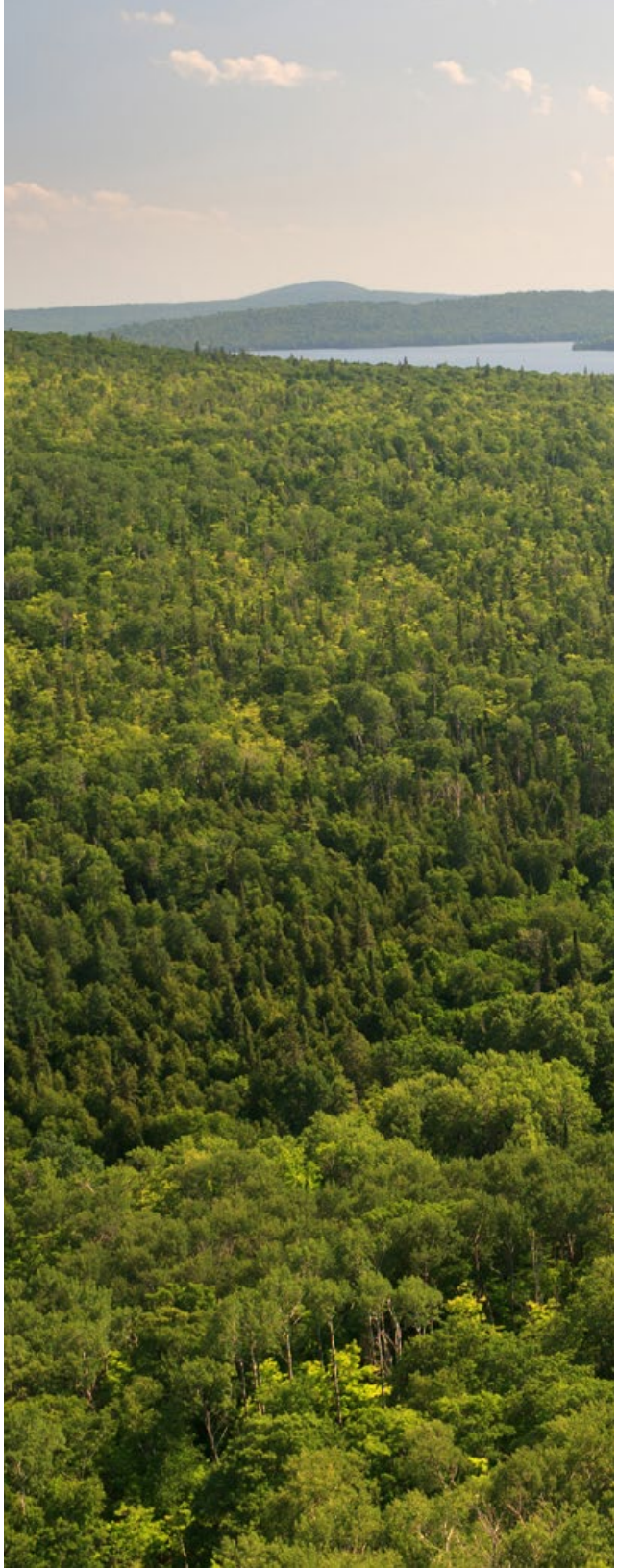
Larsen et al. 2017

GLISA impact story

Grand Rapid Highland Park's Rosewood Ravine
Credit: Lloyd Degrane.

"The Alliance coordinated the development of a nascent Ravine Alliance group in the Village of Glencoe, where residents on Ravine 2C are combining their efforts to understand and potentially manage their shared ravine together… In the workshop, ravine stakeholders and experts voted on the top priorities that the ravine region needed. All three are underway."- Senior Community Planning Manager, Alliance for the GL

June 2016 Planning Charrette
Credit: Kenneth Frank



1. Adaptation Evaluation Toolkit: A guide for local decision makers in the US
2. Applying Climate Information to Build Resilience: Translating Technical Results into Practical Tools for Community Decision Makers
3. Bringing For-Profit Companies into the Boundary Chain Model
4. Climate Resilience from the Youth Up
5. Responding to Climate Change in the Diverse Shiawassee River Watershed
6. Expanding Capacity to Utilize Public Health Law to Advance Climate Adaptation in the Great Lakes Region

TRAINING & EDUCATION

GLISA's work in training and education grew rapidly in Phase II, venturing into K-12 and higher education for the first time and training adaptation professionals, teachers, rural communities, and public health officials on GLISA's climate information and services.

ADAPTATION EVALUATION TOOLKIT: A GUIDE FOR LOCAL DECISION MAKERS IN THE US

Partners: ASAP, Meadow Evaluation

While adaptation professionals and other decision makers are actively implementing adaptation projects, few evaluate their projects' outcomes and impacts or obtain insights into how to improve. With input from an advisory group, GLISA launched an Adaptation Monitoring and Evaluation Toolkit to serve as a primer on monitoring and evaluation for adaptation professionals and equip them with resources for continued exploration of the topic.

Working session at 2018 GLAF

Adaptation Monitoring and Evaluation Toolkit webpage

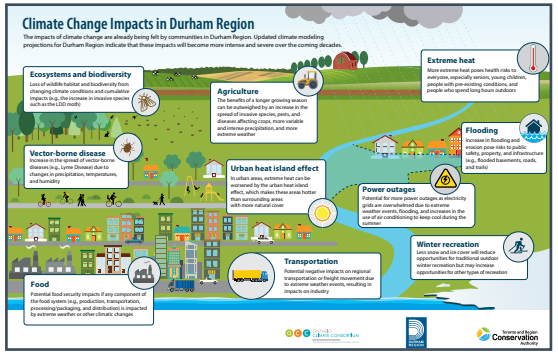
GLISA SMALL GRANT: APPLYING CLIMATE INFORMATION TO BUILD RESILIENCE: TRANSLATING TECHNICAL RESULTS INTO PRACTICAL TOOLS FOR COMMUNITY DECISION MAKERS

Partners: Toronto and Region Conservation Authority (TRCA, grantee), Durham Region, Ontario Climate Consortium

This project mobilized the use of regional climate projections that were previously developed in 2019 by undertaking four training sessions across the Region of Durham with stakeholders including municipal and conservation authority planners, engineers, GIS experts, and other technical staff. Training materials were produced for how the projections can be applied to research, planning, and decision-making related to natural environment projects. These were presented to regional practitioners in a series of training and scenario planning workshops throughout the course of the project.

Two training workshops in 2021 (>45 attendees each for public health and natural systems); scenario planning workshop in 2022 (>20 attendees)

Lam et al. 2022



Infographic developed by TRCA as part of their 2019 GLISA small grant project depicting local climate impacts.

GLISA SMALL GRANT: BRINGING FOR-PROFIT COMPANIES INTO THE BOUNDARY CHAIN MODEL

Partners: ASAP (grantee), Adaptation International

ASAP designed and tested a cutting-edge virtual workshop series to build private sector service provider knowledge and skills to meet the increase in their membership from the private sector. Through the workshop, parallel surveys, and interviews, the team identified the most important provider needs and barriers for using publicly available, vetted, region-specific climate data and information. Participants came away with a better understanding of GLISA products, climate data issues particular to the GL region, and how GLISA products and services could inform their work. ASAP then replicated and scaled this work with a second workshop for the GL, Carolinas, and Southwest regions in partnership with two other CAP/RISA teams.

September 2020 (>20 attendees) and October 2021 (>30 attendees) 4-part virtual workshops

At the University of Minnesota, researchers are adapting the methodology for assessing for-profit companies' climate data practices and needs to inform the development of better extension services.

Jacobson et al. 2022b

Practice and Needs Assessment report, Workshop report, Blog post

CLIMATE RESILIENCE FROM THE YOUTH UP

Partners: Michigan Sea Grant, Southeast Michigan Stewardship Coalition (SEMIS), EcoWorks Detroit, Detroit Public Schools, Ypsilanti Public Schools
Leveraged Funding: NOAA Office of Education

The project team conducted training and hands-on engagements with students and teachers as they incorporated climate change and adaptation into their curriculum. GLISA visited high school classrooms and engaged with students to discuss climate observations, impacts and resilience practices, and advised EcoWorks Detroit on tools in the U.S. Climate Resilience Toolkit to bring into the classroom.

11 classroom visits

Detroit and Ypsilanti public high school students at Martin Luther King, Ypsilanti, Communication and Media Arts, Renaissance, Cass Technical and Academy of the Americas High Schools are implementing community resilience projects focusing on climate change and adaptation based on GLISA data and guidance.

GLISA SMALL GRANT: RESPONDING TO CLIMATE CHANGE IN THE DIVERSE SHIAWASSEE RIVER WATERSHED

Partner: Friends of the Shiawassee River (grantee)

The project team conducted a community survey to assess stakeholders' perceptions and concerns related to the health of the Shiawassee watershed, and developed a five-part video series in response to improve awareness of climate change adaptation and mitigation for agriculture, recreation, and local governments in the area.

Community survey soliciting >400 responses via social media

New Climate Awareness webpage with online video series

GLISA SMALL GRANT : EXPANDING CAPACITY TO UTILIZE PUBLIC HEALTH LAW TO ADVANCE CLIMATE ADAPTATION IN THE GL REGION -

Partner: Network for Public Health Law and TSNE MissionWorks (grantee)

In collaboration with public health associations and departments in the GL region, the project team aimed to enhance practitioner capacity to utilize public health law to address climate change through a workshop at the 2022 Public Health Law, Climate Change, and Health Equity Summit and at subsequent virtual trainings. GLISA presented regional climate trends and trainers led the attendees through case studies and exercises to apply this data to potential adverse health impacts to examine state and local health departments' current legal authority to address the human health impacts of climate change. Network attorneys also offered limited legal technical assistance to public health leaders to further amplify their capacity to protect, promote, and improve health by enforcing and implementing current laws and working with partners to introduce innovative, evidence-based laws and policies.

October 2022 GL-focused workshop (>50 attendees); 1 virtual training in winter 2023

1. Bad River Band FEMA Pre-Hazard Mitigation Plan
2. Climate Adaptation Workshop and Extreme Precipitation Scenarios for Indigenous Tribes
3. Collaborative Assessment of Stormwater Runoff on Tribal Lands in Michigan
4. Lac du Flambeau Tribe Climate Change Resilience Plan

TRIBES

GLISA has sustained engagement with Tribes and Indigenous communities through informal and formal interactions with individual tribes and regional networks focused on hazard mitigation planning, extreme precipitation, vulnerability assessments, and stormwater runoff.

BAD RIVER BAND FEMA PRE-HAZARD MITIGATION PLAN

Partner: Bad River Band of Lake Superior Chippewa Tribe

The Tribe suffered $25 million in damages to roads and public infrastructure after a historic 2016 flood from a heavy precipitation event. After attending the Tribal Climate Workshop in 2017 (below), the Band reached out to GLISA for support developing their Pre-Hazard Mitigation Plan for FEMA. GLISA defined a suite of custom variables and thresholds of interest (i.e., temperature, precipitation, snow, extreme precipitation, and frost-free season) and shared them in the form of figures, a written summary, and a powerpoint presentation.

The Bad River Band of Lake Superior Chippewa Indians used customized future climate projections in their FEMA Pre-Hazard Mitigation Plan.

CLIMATE ADAPTATION WORKSHOP AND EXTREME PRECIPITATION SCENARIOS FOR INDIGENOUS TRIBES

Workshop attendees playing 'Game of Floods'
Credit: Jenna Jorns

Partners: Inter-Tribal Council of Michigan (ITCM)
Leveraged Funding: UM Graham Sustainability Institute

GLISA and ITCM co-produced four ecoregion localization climate summaries and four extreme precipitation scenarios in response to the Tribes' interest in scenario planning for future heavy precipitation events. The scenarios were then shared as part of a three-day climate workshop for use by environmental managers and other representatives in their climate adaptation planning. GLISA also facilitated the USDN 'Game of Floods' activity at the workshop and presented existing tools relevant to precipitation and stormwater.

October 2017 Tribal Climate Workshop (>30 attendees) at Bay Mills Indian Community College

The presentation on EPA's National Stormwater Calculator led to a follow-up project (next).

Ecoregion localization summaries, Michigan Extreme Precipitation, Scenario Guide, GLISA impact story

COLLABORATIVE ASSESSMENT OF STORMWATER RUNOFF ON TRIBAL LANDS IN MICHIGAN

Partners: Keweenaw Bay Indian Community, Grand Traverse Band of Ottawa and Chippewa Indians, Little Traverse Bay Bands of Odawa Indians, Saginaw Chippewa Indian Tribe of Michigan
Leveraged Funding: UM Graham Sustainability Institute

GLISA provided training on the U.S. EPA's National Stormwater Calculator (SWC) which provides a quantitative assessment of stormwater runoff in a community as well as the potential effectiveness and cost of low-impact development options to reduce runoff. Using the SWC is time- and cost-prohibitive for many Tribes, so GLISA collaborated with four ITCM member-tribes to assess their community's land use and potential vulnerability to heavy rainfall events using the tool.

2019-2021 virtual engagements for four Tribes

Four ITCM member-Tribes are using a stormwater assessment report to guide decision-making on vulnerability of key assets to extreme precipitation events.

LAC DU FLAMBEAU TRIBE CLIMATE CHANGE RESILIENCE PLAN

Partners: Adaptation International, Lac du Flambeau Tribe of Lake Superior Chippewa Indians, ICLEI Local Governments for Sustainability, Bullow & Haddow LLC
Leveraged Funding: U.S. Department of Energy

GLISA conducted a custom climate analysis for the geographic area of interest defined by the Tribe in northern Wisconsin, as part of a larger project to develop the Lac Du Flambeau Climate Change Resilience Plan. The plan ultimately informed the Tribe's Integrated Resources Management, Emergency Management, and Strategic Energy plans. GLISA also calculated climate thresholds for the Climate Change Vulnerability Index (CCVI) for culturally-significant species, and provided relevant literature on groundwater, ice cover and pollen.

May and November 2018 site visits; two virtual presentations

The Lac du Flambeau Tribe of Lake Superior Chippewa Indians used customized historical observations and future projections in their Climate-Smart Hazard Mitigation Plan, adopted by their Tribal Council and approved by FEMA in September 2019.

GLISA impact story

"GLISA was an indispensable part of the core project team for a recent project with the Lac du Flambeau Tribe in Wisconsin. The program is committed to the co-development of products that are both useful and usable by the project partners and that commitment came through clearly in this project. GLISA worked closely with the core team for the project to define a custom project boundary, complete detailed analysis of downscaled climate projections for that region, develop information graphics to share that information, and support the development of a science based climate change vulnerability assessment and updated hazard mitigation plan for the Tribe. Tribal staff members are using this information to help develop their annual budgets and guide investment in climate preparedness. At Adaptation International, we work as a boundary organization connecting communities to the best available science and would absolutely partner with GLISA again in support of our work in the region." Founder & Director, Adaptation International

1. Modernizing the Calumet River Industrial Corridor
2. Detroit Climate Action Strategy
3. Detroit Vulnerability Assessment and Sustainability Action Agenda
4. Development of Climate Impact Scenarios for GL Cities
5. Expanding Green Infrastructure as a Response to Environmental Injustice and Climate Change
6. Preparing Duluth Community Sectors for the Changing Climate
7. Preparing Erie, Pennsylvania for Extreme Weather-What to do and Where to Start
8. Comprehensive Vulnerability Assessment Template and Scenario Development for Great Lakes Cities
9. Co-producing Climate Knowledge and Sustained Engagement in the Great Lakes in Support of Stormwater Management Adaptation
10. Making Gulf Communities More Resilient: Scaling-up Customized Vulnerability Assessment for Extreme Events in Gulf Cities

URBAN ADAPTATION

GLISA's partnerships with cities have blossomed into a sustained network, scaling-up successful co-developed methodologies with existing partners to new communities and supporting urban planning processes across the region with GLISA's data and information.

GLISA SMALL GRANT: MODERNIZING THE CALUMET RIVER INDUSTRIAL CORRIDOR

Partners: Alliance for the GL (grantee), Calumet Industrial Corridor Working Group

Chicago's Southeast Side faces some of the City's worst economic and health conditions, which are compounded by extreme flooding and combined sewer overflows in the nearby Calumet River, exposing residents to contaminated water-based illnesses, toxic chemicals from nearby industries, and poor quality air. This project supported the Calumet Connect partners, the Chicago Department of Planning and Development, and the Chicago Public Health Department on a multi-year strategy to ensure equitable implementation of policies that integrate equity, health, and climate with a portfolio of funding and financing. The Calumet Connect partners have also incorporated the current issues of the COVID-19 pandemic, economic threats, and racial injustice, recognizing that immediate challenges reinforce previous social inequalities around water and air quality. GLISA surveyed members regarding their level of political advocacy and their social networks to support a network intervention to better facilitate knowledge flows about political advocacy and environmental health risks.

December (2019), January, February, March, July, August (2020) Calumet Industrial Corridor Working Group meetings

The Calumet Industrial Corridor Working Group is using GLISA's climate information for the Calumet River Industrial Corridor Modernization Plan and its Equitable Stormwater Management Strategy.

Climate and Health fact sheet

DETROIT CLIMATE ACTION STRATEGY

Partners: Detroiters Working for Environmental Justice (DWEJ), Detroit Climate Action Collaborative (DCAC)

DWEJ convened the DCAC to develop a community-driven climate action plan for the city. GLISA provided updated, localized climate information to inform the plan in 2017, including custom thresholds defined by stakeholders (e.g., days over 95°F).

GLISA participated in a press conference celebrating the launch of the plan.

DWEJ used customized climate data in the City's first-ever Climate Action Plan in 2017.

Detroit city climatology, GLISA impact story

DETROIT VULNERABILITY ASSESSMENT & SUSTAINABILITY ACTION AGENDA

Partner: City of Detroit

In 2019, GLISA provided custom climate analysis and served on a working group as part of the City of Detroit's climate adaptation strategy. This involved working with the Green Task Force team and Climate Equity Advisory Council, a group of residents representing different area codes of the city including representatives from environmental justice, homeless, refugee, and immigrant communities.

The team engaged with community members virtually and through a survey to understand areas of interest and center the strategy on equitable adaptation practices in areas with low-income families and vulnerable populations.

The City of Detroit used climate indicators on days over 90 and 100 degrees in their Sustainability Action Agenda in 2019.

DEVELOPMENT OF CLIMATE IMPACT SCENARIOS FOR GL CITIES

Leveraged Funding: GLOS

GLISA completed a suite of future climate scenarios tailored for GL cities to address common concerns, building on GLISA's scenario planning approach and partnerships with city practitioners. GLISA also produced an accompanying planning workbook to help guide cities through the scenario planning process.

Iterative feedback with GLISA's Practitioner Working Group (pg. 40)

TRCA utilized the scenarios for two workshops focused on the health impacts due to climate change in the region, customizing them to include long-term climate patterns and short-term weather events.

Climate Scenarios for GL Cities with accompanying workbook

EXPANDING GREEN INFRASTRUCTURE AS A RESPONSE TO ENVIRONMENTAL INJUSTICE AND CLIMATE CHANGE

Partners: Southeast Michigan Council of Governments (SEMCOG), Tetratech

Leveraged Funding: USDA McIntyre Stennis

This project responded to an urgent and timely opportunity to transform vacant, neglected, and underutilized land into a matrix of green infrastructure (GI) for the residents and ecology of the Detroit area by advancing the science necessary to make informed decisions about how to maintain the existing forestry as part of a broader GI strategy. GLISA contributed regional historical observations and model projections for southeast Michigan and presented the historical trends via webinar.

June 2020 webinar presentation to SEMCOG

GLISA SMALL GRANT: PREPARING DULUTH COMMUNITY SECTORS FOR THE CHANGING CLIMATE

Partner: MN Department of Natural Resources (grantee)

This project provided technical assistance and workshop support to aid Duluth's climate action planning and advance climate resilience for western Lake Superior region municipalities. It culminated in a Forum with presentations on regional climate, community case studies on climate mitigation and adaptation, tools to expedite climate action, and breakout sessions for participants to engage on climate action and adaptation. GLISA worked closely with the grantee to plan, facilitate, and administer the Forum.

February 2022 Western Lake Superior Climate Resilience Forum on with >100 stakeholders from local and tribal governments

The project team worked with the City of Duluth to develop a Duluth Climate Action Work Plan, utilizing information from the 2022 Forum and GLISA.

McDonnell et al. 2022

"The Climate Resilience Forum helped staff in the Lake Superior watershed share stories and common challenges for climate planning and action. With 115 other local government and regional planning staff registered, this was an important first conversation at a regional scale in our area. Duluth's Climate Action Work Plan was highlighted during a breakout session, sharing our tips and lessons learned. During the Climate Resilience Forum, basic climate summary information, the Headwaters Economics tool [Neighborhoods at Risk], and many other resources were highlighted. Many of these tools were not even on the radar screen of staff who attended the Forum. Conversation about continued networking and partnerships continue, even months after the Forum. Without funding to engage regional planning staff and bring in the expertise to run the workshop, we would never have been able to accomplish this on our own. The Forum helped to further develop relationships and connections with other local staff, in particular, County and City staff have done other joint presentations that included climate mitigation and adaptation as topics."- City of Duluth Sustainability Officer and Forum attendee

"The Climate Resilience Forum has expanded my network of colleagues, and this has been very valuable in moving forward climate-related work. Having few connections prior, being a part of the planning of the event helped me build meaningful relationships with professionals that will benefit future projects through technical assistance."- Senior Planner, Arrowhead Regional Development Commission

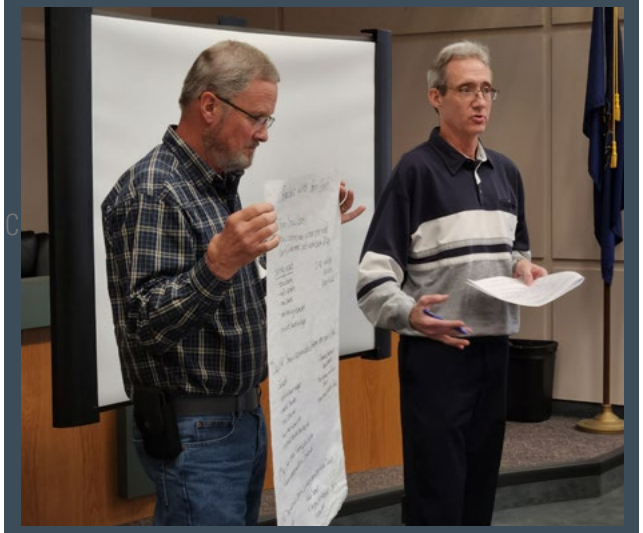
GLISA SMALL GRANT: PREPARING ERIE, PENNSYLVANIA FOR EXTREME WEATHER - WHAT TO DO AND WHERE TO START (SG)

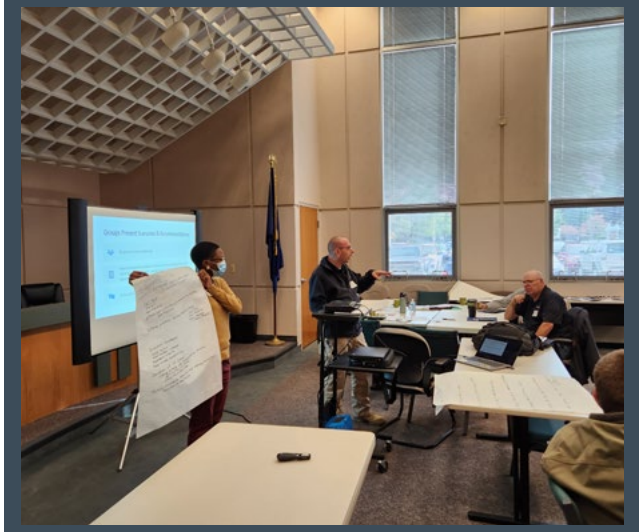
Partners: Pennsylvania Sea Grant (grantee), Community Resilience Action Network of Erie (CRANE)

To build resilience in Erie, PA Sea Grant worked with CRANE and GLISA to engage stakeholders within Erie County to identify and document local climate hazards and develop workable solutions. The team implemented a survey to identify county-wide perceptions, experiences, and concerns regarding extreme weather and developed a framing document, containing localized information on Erie's climate and a list of local assets potentially at risk to inform a VA for Erie County. The team hosted a scenario planning workshop that explored various extreme weather scenarios to inform county hazard mitigation planning efforts.

Survey with >80 responses; October 2022 workshop in Erie (>20 attendees)

Erie Community Vulnerability Assessment

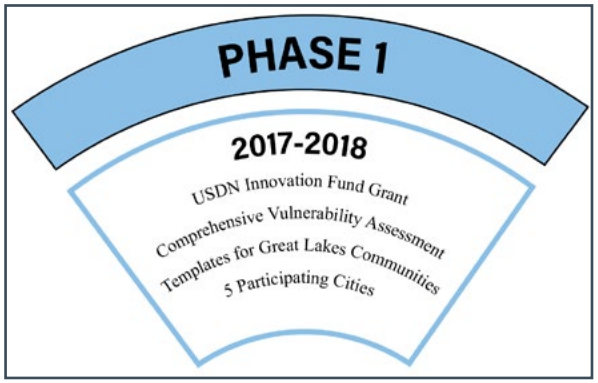




Caption: October 2022 workshop in Erie (PA)
Credit: Kim Channell

FEATURED PROJECT: SCALING-UP VULNERABILITY ASSESSMENTS & TESTING ENGAGEMENT METHODS

The next three projects are a phased series of efforts to scale-up a co-developed community vulnerability assessment (VA) template to new sectors and regions. Leveraging resources first from USDN and then NOAA, GLISA and partners sought to understand how to scale-up co-production of actionable knowledge using remote engagement. As a pilot, GLISA designed a qualitative experiment with 25 city practitioners in 12 GL cities using a previously co-produced VA tool. This, in turn, informed a successful proposal to the National Academy of Sciences for a quantitative experimental study with 250 practitioners in 54 cities in the U.S. Gulf region.



COMPREHENSIVE VA TEMPLATE AND SCENARIO DEVELOPMENT FOR GL CITIES

Partners: HRWC, Headwater Economics, GLCAN
Leveraged Funding: USDN

In the first phase, the team worked with five GL cities in 2017 to develop a comprehensive VA template to save municipal staff time and resources that are often dedicated to duplicative VAs and to streamline the incorporation of climate and socioeconomic information into those assessments. GLISA co-developed a localized climate summary with each community. Headwaters Economics developed Neighborhoods at Risk with socioeconomic and climate data. The resulting Microsoft Excel template and Word document could be applied to city-wide or project-specific assessments.

2017 co-production workshop in Ann Arbor (MI) (10 practitioners, 2 from each city)

Indianapolis (IN) created a Climate, Sustainability, and Resilience Plan using the tool, using climate and socioeconomic data as justification for prioritizing equity in resilience actions. Indianapolis also used the climate projections to provide a rationale for changing the size of the city's stormwater pipes and selecting which neighborhoods need cooling centers.

Neighborhoods at Risk tool (updated to national scale with more funding, pg. 38), GLISA impact story,

"Some of the primary benefits I've seen from it have been that it has essentially eliminated the conversations and the amount of time we had to spend on data source and data collection methodology. It provided the information in a way that a lot of people were able to digest it, which was really helpful."- Practitioner, City of Evanston

CO-PRODUCING CLIMATE KNOWLEDGE AND SUSTAINED ENGAGEMENT IN THE GL IN SUPPORT OF STORMWATER MANAGEMENT ADAPTATION

Partners: HRWC, City of Ann Arbor
Leveraged Funding: NOAA SARP

In the second phase, GLISA won more funding to adapt the VA template for stormwater management and implement it with 12 cities. At the same time, the team conducted a qualitative social experiment to assess whether the boundary chain model can reduce transaction costs for scaling-up sustained engagement by exploring three forms of engagement (in-person, webinar, self-guided).

Three in-person workshops and four webinar engagements in 2019; pre-recorded training videos

The team conducted 24 pre- and 19 post-interviews with individual practitioners to assess the effectiveness of each engagement type. Perceptions of credibility of the information and facilitators were similar across three modes of engagement. Practitioners reported that the in-person workshops were engaging and resulted in higher numbers of attendees while practitioners who participated in the self-guided mode appreciated its flexibility, but felt that they might have been able to encourage more participation from additional staff with a different format. Communities in the self-guided and live webinar treatments struggled with capacity in terms of staff time.

Key examples of impact and testimonials are shown here; see City Outcomes & Testimonials document for full list.

Toledo (OH) used the climate data to win an environmental justice grant.

The Ferndale (MI) City Council adopted the assessment in July 2020 and used it in their capital improvement planning process.

Goshen (IN) used the VA in the Flood Resilience Plan and Stormwater Master Plan to comply with new state mandates and applied for a grant to update a watershed management plan using the tool's socioeconomic data. This was featured in a UM Engineering news story.

Grand Rapids (MI) used data on observed and projected precipitation and temperature changes to formally declare climate change as a crisis through a City Commission resolution.

City vulnerability assessments and climate summaries

MAKING GULF COMMUNITIES MORE RESILIENT: SCALING-UP CUSTOMIZED VA FOR EXTREME EVENTS IN GULF CITIES

Partners: Adaptation International, Headwaters Economics, Stanford University, Southern Climate Impacts Planning Program (SCIPP)
Leveraged Funding: National Academy of Sciences Gulf Research Program

In the third phase GLISA scaled-up the VA tool to the U.S. Gulf region as part of a larger social experiment with more than 50 cities with another CAP/RISA team (SCIPP) to quantitatively assess cities' adaptive capacity and different forms of engagement (i.e., in-person, webinar-assisted, self-guided). 54 communities from Alabama, Florida, Louisiana, Mississippi, and Texas completed a stormwater VA in one of the three treatment methodologies with the project team. To aid in the assessments, each community received customized weather and climate and socioeconomic profiles and a regional climate summary. Especially exciting was the opportunity to enhance the existing VA tool by transforming what was an Excel workbook into a web-based application, FloodWise Communities, with a streamlined user interface.

32 community workshops (16 via webinar, 16 in-person) in 2021 and 2022 (>3 practitioners/community); recorded videos and tutorials for self-guided embedded in the web-based tool

Practitioners completed pre- and post-engagement surveys before and after conducting their assessments and had the option to participate in a post-interview. Data is still being collected as of December 2022.

Communities are using the VAs and customized data to apply for state and federal grants, prioritize stormwater projects, and communicate results to community partners.

Regional Climate Summary

PARTNERSHIPS

Significant Partnerships

Partner Name	Type	Description of Collaboration
Adaptation International	Private sector	Led Lac du Flambeau Tribe climate change resilience plan (pg. 33); partner on Gulf Research Program project to lead community recruitment and engagement (pg. 38); co-facilitator for Climate Service Providers Academy (pg. 31)
American Society of Adaptation Professionals (ASAP)	Non-profit/NGO	Co-host for 2018 GLAF (pg. 23); GLISA small grantee for two projects on climate migration (pg. 24) and the private sector (pg. 31)
Apostle Islands National Lakeshore	Federal agency	Stakeholder for ice forecasting project (pg. 21) and terrestrial ecosystems VA (pg. 27)
Bad River Band of Lake Superior Chippewa	Tribe	Stakeholder for customized data for FEMA Pre-Hazard Mitigation Plan (pg. 32)
Boxcar Studios	Private sector	Designed new GLISA website
Cooperative Institute for Great Lakes Research (CIGLR)	NOAA-funded entity	Partner on project to improve the usability of NOAA's new short-term ice forecast (pg. 26)
Detroiters Working for Environmental Justice	Non-profit/NGO	Used localized Detroit Climatology for City's Climate Action Plan (pg. 35)
EcoWorks Detroit	Non-profit/NGO	Created high school climate curriculum for Detroit climate literacy project (pg. 31)
Environment and Climate Change Canada	Federal agency	Canadian lead for GLWQA Annex 9 on Climate Change Impacts; sponsor of Annual Climate Trends and Impacts Summary for the GL Basin and 2021 Climate Modeling Workshop (pgs. 10, 22)
Great Lakes Climate Adaptation Network (GLCAN)	Network	Network supported by GLISA (pg. 13); partner in developing municipal VA template (pg. 37); mechanism for GLISA to recruit communities for projects
Great Lakes Observing System (GLOS)	NOAA-funded entity	Funder for Great Lakes Adaptation Data Suite (GLADS, pg. 20)
Headwaters Economics	Non-profit/NGO	Creator of Neighborhoods at Risk for municipal VA project series (pgs. 37-38); led report on different economic methods to motivate city adaptation (pg. 24)
Huron River Watershed Council (HRWC)	Non-profit/NGO	Led first phase of municipal VA project and supported second phase (pg. 37)
Illinois State Geological Survey	Academic	Led IL-IN Sea Grant project to help Illinois coastal communities develop plans to better anticipate the future
Inter-Tribal Council of Michigan (ITCM)	Tribal organization	Partner and host of 2017 Tribal Climate Workshop (pg. 32); partner for U.S. National EPA Stormwater Calculator training (pg. 33)
Lac du Flambeau Band of Lake Superior Chippewa Indians	Tribe	Stakeholder for custom climate analysis to inform Climate Change Resilience Plan (pg. 33)
Michigan Army National Guard	State	Stakeholder for scenario planning exercise to incorporate climate information in updated Integrated Natural Resource Management Plan (pg. 28)
Michigan Sea Grant	NOAA-funded entity	Led climate literacy project with Detroit and Ypsilanti (MI) high schools (pg. 31)
Michigan State University Extension	Academic	Led 'weather and climate ready" assessment tool for farmers (pg. 18); partner on nitrogen loss and heavy precipitation project (pg. 18)
New York Sea Grant	NOAA-funded entity	Co-led scenario planning for Lake Ontario coastal communities to evaluate economic impacts of flooding (pg. 25)
NOAA Great Lakes Environmental Research Laboratory (GLERL)	NOAA	Co-hosted Midwest Regional Engagement Workshop for NCA4 (pg.10); collaborator on ice forecasting work for Apostle Islands (pg. 21) and NOAA's GL Operational Forecast System (pg. 26)
NOAA Great Lakes Regional Collaboration Team	NOAA	U.S. lead for GLWQA Annex 9 on Climate Change Impacts; sponsor of Annual Climate Trends and Impacts Summary for the GL Basin and 2021 Climate Modeling Workshop (pgs. 10, 22)
Ontario Climate Consortium	Non-profit/NGO	Led 2019 GL Climate Modeling Workshop which GLISA supported (pg. 10); supported TRCA small grant project by translating climate projections (pg. 30)
Southeastern Michigan Stewardship Coalition (SEMIS)	Academic	Created a curriculum for high school teachers to empower students and teach residents about local climate impacts in for Detroit climate literacy project (pg. 31)
Southern Climate Impacts Planning Program (SCIPP)	NOAA-funded entity	Developed regional and city-specific climate summaries for Gulf Research Program project and supported adaptive capacity work (pg. 38)
Stanford University	Academic	Supported Gulf Research Program project by leading quantitative experimental analysis and pre- and post-surveys (pg. 38)
U.S. Global Change Research Program (USGCRP)	Federal agency	Coordinated Fourth National Climate Assessment, including the Midwest chapter and GLISA's two co-authors (pg. 10)
Urban Sustainability Directors Network (USDN)	Non-profit/NGO	Advised report on economic arguments for cities (pg. 24); supporting parent organization of GLCAN

Stakeholder Cohorts

Climate Modeling Workshop Planning Committee	NOAA GLERL, NOAA Great Lakes Regional Collaboration Team, ECCC, MRCC, Ouranos, UM SEAS
GLISA Small Grantees	Alliance for the Great Lakes, Friends of the Shiawassee River, Network for Public Health Law, Minnesota Dept. of Natural Resources, Michigan Technological University, Pennsylvania Sea Grant, Toronto and Region Conservation Authority, USDA Midwest Climate Hub, West Michigan Sustainable Business Forum
Practitioner Working Group (PWG)	ASAP, Huron River Watershed Council, Inter-Tribal Council of Michigan, Michigan Dept. of Natural Resources, Michigan Agriculture Advancement, Michigan Army National Guard, NOAA National Weather Service Detroit, University of Wisconsin Madison
Science Advisory Committee (SAC)	Aquanty, Climate Risk Institute, ECCC, NOAA Earth System Research Laboratory, Ontario Climate Consortium, Ouranos, University of Colorado Boulder, University of Minnesota, UM SEAS, University of Wisconsin Madison
Vulnerability Assessment Municipal Partners (pgs. 37-38)	Ann Arbor (MI), Buffalo (NY), Cleveland (OH), Columbus (OH), Dayton (OH), Dearborn (MI), Evanston (IL), Ferndale (MI), Goshen (IN), Grand Rapids (MI), Indianapolis (IN), Kalamazoo (IN), Madison (WI), Toledo (OH), Urbana (IL)

Additional Partners by Type

Academic: Cornell University, Florida State University, Great Lakes Institute for Environmental Research (University of Windsor), Macalester College, Michigan State University, Michigan State University AgBioResearch Upper Peninsula Research and Extension Center, Ohio State University, Purdue University, State Climate Office of Ohio, University of Illinois, Syracuse University, University of Miami, University of Michigan, University of Minnesota Duluth

Community group: Calumet Industrial Corridor Working Group

Federal (non-NOAA) partners: Center for Disease Control (CDC), International Joint Commission (IJC), National Aeronautics and Space Administration (NASA), Northern Institute of Applied Climate Science (NIACS), Shiawassee National Wildlife Refuge, U.S. Fish & Wildlife Service, US EPA, USDA Agricultural Research Service, USDA Northern Forest Climate Hub

Network: Great Lakes Indian Fish and Wildlife Commission, Michigan Climate Coalition, The Northern Michigan Environmental Health Directors

NOAA partners: Alaska Ocean Observing System, Illinois-Indiana Sea Grant, Lake Superior National Estuarine and Research Reserve, Minnesota Sea Grant, National Estuarine Research Reserve System Science (NERRS), National Snow and Ice Data Center, NOAA Central Region Headquarters, NOAA Earth System Research Laboratory (ESRL), NOAA Midwestern Regional Climate Center (MRCC), NOAA National Centers for Environmental Information, NOAA Office of Coastal Management, NOAA Office of Education, NOAA Regional Climate Service Director (RCSD), North Carolina Institute for Climate Studies, Northeast Regional Climate Center, Western Water Assessment (WWA), Wisconsin Sea Grant

Non-profit/NGO: EcoAdapt, Environment Erie, Great Lakes Saint Lawrence Cities Initiative, Green Building Alliance, ICLEI Local Governments for Sustainability, Michigan Association of Planning, National Geographic, National League of Cities, Ontario Centre for Climate Impacts and Adaptation Resources (now Climate Risk Institute), Saginaw Bay Watershed Initiative Network, Southeast Michigan Council of Governments (SEMCOG), State of the Strait, The Field Museum, The Great Lakes Public Health Coalition, The Nature Conservancy (TNC), The Water Research Foundation, The Wisconsin Association of Local Health Departments and Boards, TSNE MissionWorks, Wisconsin Public Health Association, Wisconsin Sea Grant

Local government: City of Bloomington (IN), City of Duluth (MN), City of Marquette (MI), City of St. John's (Newfoundland and Labrador), Cuyahoga County Planning Commission, Detroit Public Schools, Erie County - Department of Planning and Community Development, Metropolitan Water Reclamation District of Greater Chicago; Northeast Ohio Regional Sewer District, Ypsilanti Public Schools

Private sector: AECOM, Amec Foster Wheeler, Bullock & Haddow LLC, LimnoTech, John Wood Group PLC, Savanta (A GEI Company), Tetratech

State government: Durham Region, Illinois State Water Survey, Great Lakes Institute for Environmental Research - University of Windsor, Michigan Department of Health and Human Services, Michigan State Police - Emergency Management and Homeland Security Division, Minnesota Department of Health, Minnesota Department of Public Safety - Homeland Security and Emergency Management, Pennsylvania Department of Environmental Protection

Tribe or Tribal organization: 1854 Treaty Authority, College of Menominee National, Grand Traverse Band of Ottawa and Chippewa Indians, Keweenaw Bay Indian Community, Lac Vieux Desert Band of Lake Superior Chippewa Indians, Little Traverse Bay Bands of Odawa Indians, Menominee Conservation District, Nottawaseppi Huron Band of the Potawatomi, Red Lake Band of the Chippewa Indians, Saginaw Chippewa Indian Tribe, Sault Ste. Marie Tribe of Chippewa Indians

APPENDIX

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