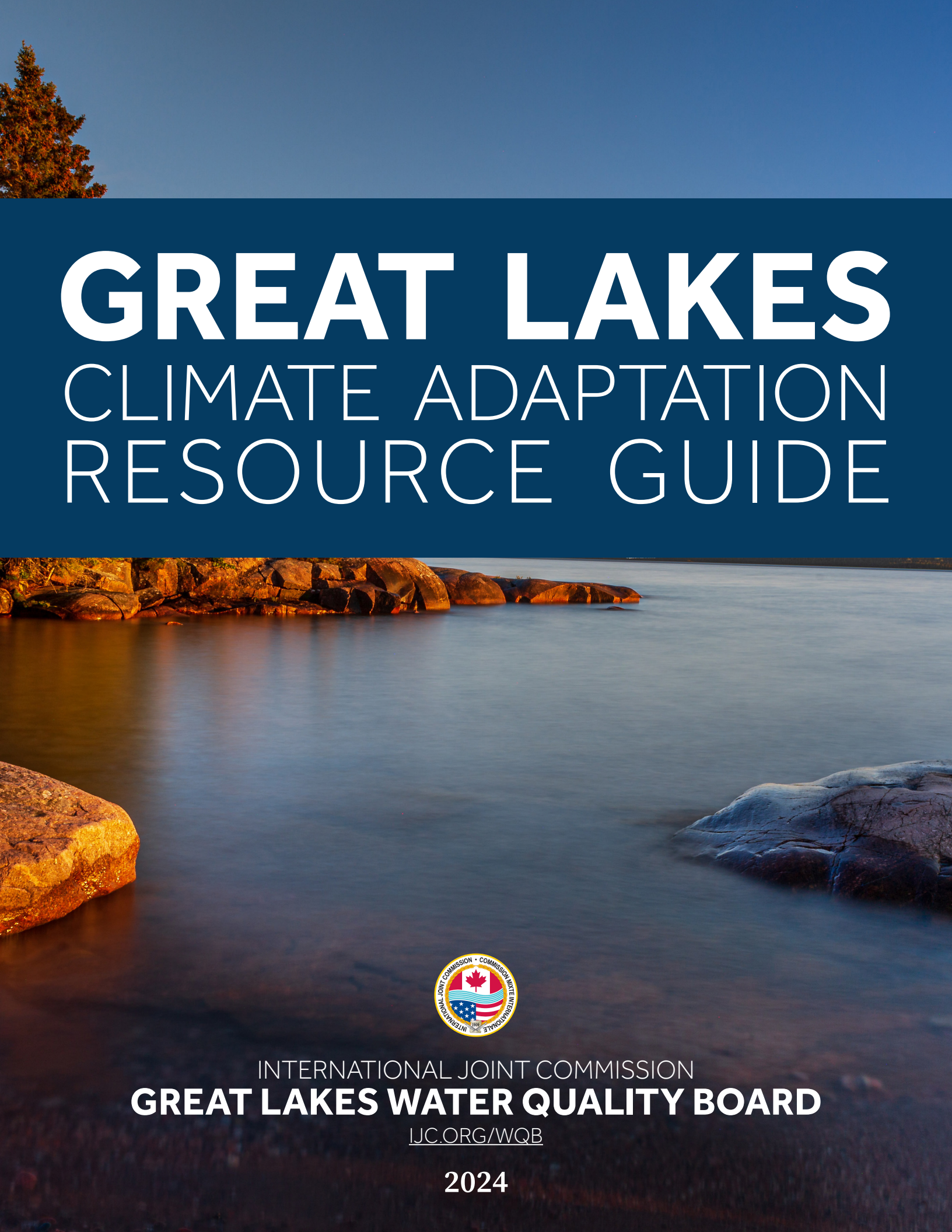

GREAT LAKES
CLIMATE ADAPTATION RESOURCE GUIDE

INTERNATIONAL JOINT COMMISSION
GREAT LAKES WATER QUALITY BOARD
IJC.ORG/WQB

2024

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GREAT LAKES CLIMATE ADAPTATION RESOURCE GUIDE

VOLUME I

GREAT LAKES
CLIMATE ADAPTATION AND RESILIENCE GUIDE

INTRODUCTION

The International Joint Commission (IJC) through its mission prevents and resolves disputes over boundary waters between Canada and the United States. The IJC recognizes that solutions to transboundary watershed problems often emerge from local communities. IJC's International Watersheds Initiative (IWI) uses an ecosystem approach to resolving transboundary water issues grounded on the belief that local communities, given appropriate assistance, are best placed to achieve solutions. The IJC is served in an advisory capacity by the Great Lakes Water Quality Board (WQB). The board recommends strategies to resolve and prevent management challenges facing the Great Lakes region. One of the board's recommendations, and in line with IJC's ongoing efforts to address climate change challenges impacting the Great Lakes, is the development of coordinated and binational climate adaptation strategies and tools. In addressing the larger climate change needs

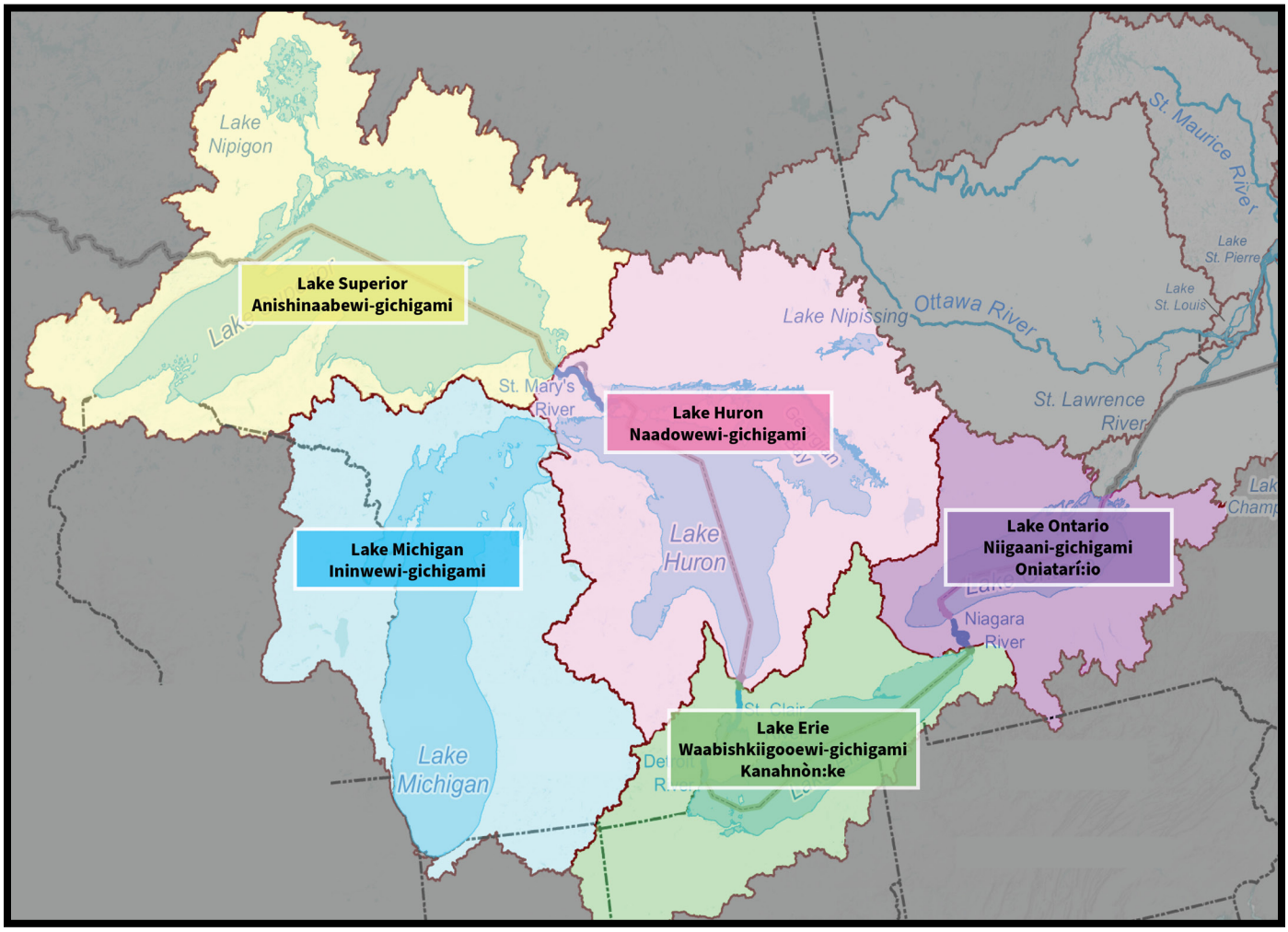


Figure 1. General overview map of the Great Lakes region showing basin drainage area. Credit: IJC. Explore the Royal Canadian Geographical Society and Swim Drink Fish Biinaagami online interactive map that identifies many other features such as political jurisdictions, land cover, watersheds, lake bathymetry and more, at: biinaagami.org/map.

of the region, the board recognized that communities of small (generally fewer than 5,000 to 10,000 in population) to medium size (generally more than 10,000 to fewer than 500,000 population) are particularly challenged in terms of the capacity and funding needed to adequately assess and address potential climate change effects. To that end, the board developed this resource guide with the help of a contracted team from Potomac-Hudson Engineering, Inc. (PHE), Michael Baker International, Inc., and LimnoTech.

This resource guide was developed to provide a simplified resilience framework (Volume I) and an organized listing (Volume II) of available planning tools, strategies, educational and outreach materials, and training resources. The guide is designed to support the numerous small- and medium-sized Canadian and US local/regional government jurisdictions throughout the Great Lakes basin in their climate adaptation and resilience efforts related to water resources (quality, quantity, management, etc.). Figure 1 illustrates the Great Lakes basin.

Volume I: Climate Adaptation and Resilience Guide provides an overview of climate change resiliency and includes a framework for determining how communities could identify and focus efforts related to community climate adaptations. While the presented framework can be followed step-by-step, a rigid process is not the intent. The steps are designed to be flexible so that communities can choose what tools, resources, and information they need. Framework steps can be implemented either sequentially or concurrently but should build upon one another.

Volume II: Climate Adaptation and Resilience Resources is an organized list of tools, guidance, and other information, such as case studies, that are available to assist communities in planning for climate change resilience and adaptation. Volume II centers on helping communities understand the intended purposes of various tools and how they are to be used, what types of technical assistance might be available, and how similar communities have used the tools and funding sources in their adaptation projects and efforts.

CLIMATE CHANGE RESILIENCE IN THE GREAT LAKES

OVERVIEW

As the largest freshwater system on earth, the Great Lakes are vital to both the region and the world. The board's 2024 Great Lakes Regional Poll found that people living within the Great Lakes basin were concerned about how climate change will impact water quality (83%), water quantity (77%) and community well-being (81%). Furthermore, 90% think that climate change will increase pressure on the Great Lakes (IJC Great Lakes Water Quality Board 2024 Great Lakes Regional Poll). These results align with a regional shift in focus toward climate resilience, the ability to adapt to environmental stressors, recover quickly from extreme events, and minimize future risk.

There are many considerations for planning climate adaptation and resilience actions at the local level. There are many resources (such as those identified in Volume II) and a common goal for increased resilience basinwide. It is important, moving forward, that community climate action and adaptation plans within the Great Lakes basin align with the larger regional and national planning efforts. This resource guide highlights aspects of climate adaptation and resilience actions that focus on the nexus of climate and water topics.

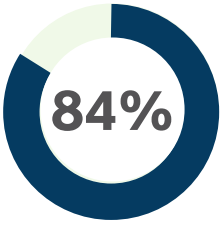
THE GREAT LAKES

$6T

The Great Lakes region generates a combined Gross Domestic Product (GDP) of US$6 trillion, or CDN $7.6 trillion.

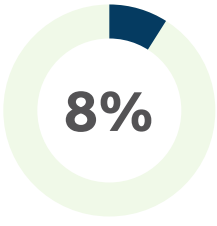
Source: Council of the Great Lakes Region, "The Great Lakes Economy"

FUN FACTS	
Total Shoreline Length	11,000 miles
Combined Surface Area	94,000 square miles
Gallons of Fresh Water	6 quadrillion gallons
Plants and Animals	Over 3,500 species
Fish	Over 170 species

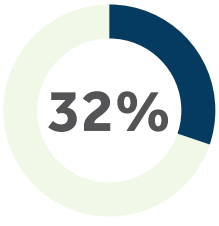


Percent of North America's fresh surface water comes from the Great Lakes

Percent of the world's fresh surface water comes from the Great Lakes



Percent of the US population live in the Great Lakes basin



Percent of Canadian population live in the Great Lakes basin

Sources: US Environmental Protection Agency, "Great Lakes Facts and Figures"; Michigan Sea Grant, "Great Lakes fast facts"

Climate-Driven Changes to the Watershed

- Increased annual average air temperatures
- Increased precipitation
- Higher surface water temperatures
- Reduced snow and ice cover
- More frequent extreme weather events
- Increased erosion rates
- Increased nuisance sedimentation
- Fluctuating lake water levels

Source: US Climate Resilience Toolkit

Ecosystem Impacts of Climate Change

- Greater occurrence of harmful algae blooms
- Declining numbers of and changes to ranges of wildlife and fish species
- Shifts in water availability
- Increases in invasive species
- Increased energy demand
- Reduced availability of water for hydropower energy production and cooling needs

Source: US Climate Resilience Toolkit

REGIONAL PRIORITIES

Regional and national plans identify several common climate-related priorities, including:

- Disaster relief
- Nature and biodiversity
- Health and well-being
- Economy and workers
- Infrastructure
- Nature-based solutions (NBS)

These common priorities impact our communities in many ways. Here are a few notable examples.

With increases in both the frequency and intensity of large storms and flooding, as well as droughts, **disaster relief** is becoming an ever-increasing concern. Increasing climate resilience will help reduce some of the pressure on disaster relief funds.

Many shifts to **natural systems and biodiversity** can be linked to climate change. Recent remapping of the plant hardiness zones in the United States reveals that more temperate plant species are able to survive in more northern regions. Traditional southern animal species, such as the brown recluse spider, are also becoming more abundant in northern regions. Some have also attributed shifts in game fisheries to climate change. For example, small-mouth bass are beginning to outcompete and, in some cases, offset walleye populations in some historic walleye lakes.

Climate-induced changes to our natural systems can also have impacts on **health and well-being**. Harmful algal blooms (HABs) are often exacerbated by more spring rainfall and warmer summer water temperatures. In 2014, HAB toxins in Lake Erie forced the City of Toledo to restrict drinking water use leaving 400,000 area residents without potable water for two days. In smaller lakes, HABs can lead to beach closures and contact restrictions for humans and dogs.

Much of the regional **economy and workforce** is directly or indirectly linked to the Great Lakes. Every state and province in the Great Lakes basin depends on shipping through the Great Lakes. Increased rates of storm-induced erosion within our rivers leads to increased rates of sediment deposition within our harbors. In turn, this sedimentation can reduce ship and recreational boat navigation and increase the frequency of expensive dredging activities.

Existing **infrastructure** has been designed using historical climate data and is under significant threat from changes in climate patterns. For example, record-high water levels, wind-induced seiches (a temporary disturbance or oscillation in lake waters), and meteotsunamis (wind-induced tsunamis) have damaged docks, homes, and shorelines around the Great Lakes.

Nature-based solutions (NBS) are a design philosophy that blends grey (concrete, stone, and steel) and green infrastructure. NBS often creates a semi-flexible edge to our infrastructure systems that can adapt to changes in climate and, ideally, self-heal after damaging events. NBS

designs often require more space, longer establishment periods, and different operation and management strategies than traditional grey infrastructure designs. However, the resilient benefits of NBS can outweigh the challenges.

These and other climate-induced effects occur throughout the Great Lakes region daily. A changing climate requires a new way to look at community planning and asset management. The resilience framework provided in Volume II is one way to better incorporate climate adaptations into community plans and asset/infrastructure management initiatives. The resulting resilience and adaptation plans should attempt to address the following larger national efforts.

NATIONAL ADAPTATION PHILOSOPHIES

There are myriad Indigenous Peoples who, since time immemorial, steward of the waters, lands, and living beings belonging to the Great Lakes ecosystem. The diverse and unique place-based knowledge and observations of Canadian First Nations, Métis, and US Tribes spans millennia. **Prioritizing Indigenous Knowledge** can yield climate adaptation strategies that work with our natural systems instead of trying to control or replace them.

Canada's Climate Resilience Vision

"All of us living in Canada, our communities, and the natural environment are resilient in the face of a changing climate. Our collective adaptation actions enhance our well-being and safety, promote justice, equity, and reconciliation with Indigenous Peoples, and secure a thriving natural environment and economy for future generations" (Government of Canada, "Canada's National Adaptation Strategy").

Canada's National Adaptation Strategy Guiding Principles *(paraphrased)*

- Respect jurisdictions and Indigenous rights.
- Advance equity and justice.
- Take proactive, risk-based measures.
- Maximize benefits and avoid maladaptation.

Canada's National Adaptation Strategy aims to "create a more climate-resilient society. By taking action to adapt to the changing climate" (Government of Canada, "Canada's National Adaptation Strategy"). The strategy presents a "shared path to a more climate-resilient Canada." Canada's vision and guiding principles are shown in the inset at right. Canada's strategy concludes with an Adaptation Action Plan that emphasizes valuing and prioritizing Indigenous Knowledge Systems, use of nature-based solutions, ensuring that infrastructure guidance, codes and standards include climate change risks and adaptation strategies, promoting education and shared understanding of climate change issues, ensuring access to tools and resources, and emphasizing the importance of monitoring and evaluations of effectiveness.

The United States defines ***adaptation*** as "The process of adjusting to an actual or expected environmental change and its effects in a way that seeks to moderate harm or exploit beneficial opportunities" and ***resilience*** as "The ability to prepare for threats and hazards, adapt to changing conditions, and withstand and recover rapidly from adverse conditions and disruptions" (US Global Change Research Program "Fifth National Climate Assessment").

In the 2023 Fifth National Climate Assessment, the United States acknowledged that climate change impacts "are already far-reaching and worsening across every region of the United States" (US Global Change Research Program). Like the Canadian Adaptation Strategy, the US Assessment builds a case for proactive climate adaptation actions that will create a more resilient nation. The document includes key takeaways for several areas, including water, and also presents key messages for each of the US regions. In the Midwest (Great Lakes region), the Assessment recommends adaptation practices related to smart agriculture, green infrastructure, improved stormwater management, collaborative planning, and improved landscape and development planning (US Global Change Research Program).

CLIMATE CHANGE ADAPTATION STRATEGY FRAMEWORK

OVERVIEW

Resilience can be defined as the capacity to prepare for and adapt to environmental stressors and disturbances while recovering quickly and minimizing future risks. Resilience requires planning before and after environmental changes and impacts, combined with strategies for managing risks. A goal of any climate resilience strategy should be to strengthen the connection between planning and integrating adaptation measures that minimize the need for making major changes to protect life and property over time.

Climate Change Adaptation is "planning for and acting on the anticipated impacts of climate change." "Taking ambitious and collective action" to find "new ways of making decisions, building communities and businesses, and protecting each other and the places we value in anticipation of climate change" (Government of Canada, "Canada's National Adaptation Strategy").

Climate change resilience planning is further complicated by the regional reach of storms and extreme weather conditions. Environmental stressors and disasters reach across municipalities, states, provinces, and national borders. They require a consolidated and cooperative approach that pulls resources from many sources, which can make resilience and adaptation planning difficult for small- to medium-sized municipalities and communities. These smaller geographies do not often have the resources to commit unilaterally to large regional planning efforts. Even where there are watershed-based agencies to support collaboration, they are often difficult to finance without provincial/state and federal government support.

The small- to medium-sized communities of the Great Lakes region can follow a simplified resilience framework that is more efficiently implemented in the absence of substantial technical input and data sets.

Resilience planning is, at its core, a straightforward process and good decisions can be made in the face of uncertainty (e.g., using local planning tools). Finally, a roadblock on the way to climate resilience and adaptation is often the political will to enact the changes necessary. The following steps lay out a simplified process for resilience planning and include information on how to educate all stakeholders, including political leaders, on why resilience and adaptation planning is necessary and what each stakeholder stands to gain from a more climate-resilient and sustainable Great Lakes region.

As noted, this guide is focused on water. Water is the defining and uniting feature of the Great Lakes region. The guide's focus on water helps to simplify the complexities of climate change in the Great Lakes region by narrowing decision-making through a water lens.

The following discussion was informed by the US Climate Resilience Toolkit, which contains information on assessing resilience and planning adaptation strategies, including templates and worksheets. Canada's Climate Risk Institute Adaptation Resource Pathway provides a similar framework of steps and adaptation tools that can supplement this guidance.

Figure 2 on the following page is a simplified resilience framework that illustrates different phases and the overlapping nature of this work, as discussed in the following sections.

1. INITIATE & ENGAGE (EDUCATE)

The first step of resilience planning involves engaging with a wide variety of interested and/or affected parties and rightsholders to identify the most pressing climate-related water resource issues and needs. Climate change has a wide scope and range of potential impacts to/from water flowing into and within the lakes. Attempting to develop strategies to cover every possible scenario, impact potential, and adaptation need is impractical. Focusing municipal and community efforts is key.

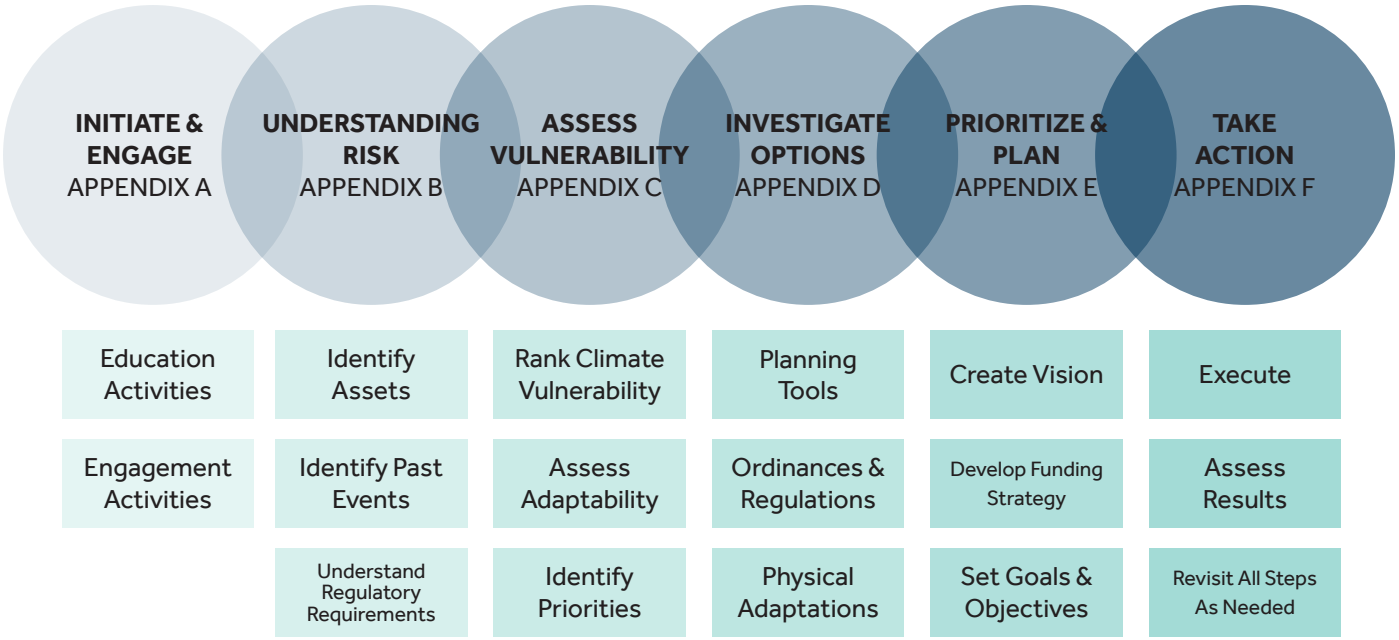


Figure 2. Simplified Resilience Framework

The purpose of engaging and educating is to tap into local knowledge and experiences related to water resources and impacts to help focus the planning efforts from the start. The list of needs could be extensive. It is up to each municipality or group of municipalities to think carefully about where the most benefit is likely to be gained now.

Appendix A provides resources to help you identify the interested parties in your community. Interested and/or affected parties include impacted communities, residents, public sector agencies, watershed management organizations, landowners, local businesses, elected officials, special interest groups, and the public. At this stage, it is often better to focus on developing a group of representatives and experts with the knowledge required to identify appropriate issues and concerns.

Community Champions

- Help maintain forward momentum.
- Use their networks to gather knowledge and share results.
- Provide input on who should be involved.
- Share information with community members and groups.

Avoid Common Pitfalls

Whether or not someone agrees on the reasons and causes behind climate change, the fact is that **weather patterns are changing**. Many areas are getting warmer, precipitation patterns are changing, **more intense storms** are becoming common, and **water pollution** and other concerns are becoming more prevalent (**invasive species, harmful algae blooms**, etc.).

Whether these changes are natural occurrences or induced by human activity, communities **still need to prepare and plan for the changes**.

It is also vital to identify and honor the relevant rights and responsibilities of your region's First Nations, Métis or Tribal governments. Coordinate early and often to include and respect their sovereignty, and ensure Indigenous communities themselves define their required and desired role in your planning efforts. Building trust, earning respect, and extending reciprocity to the First Nations, Métis and/or Tribes of your community and region are critical prerequisites for conducting planning efforts to serve all people.

A vital step in resilience planning is educating all interested parties on the impacts of climate change and establishing a shared vision so that a proactive

and sustainable plan can be developed. The previous infographics and **Appendix A** provide a few educational resources that may be useful for engagement. Volume II also contains links to a variety of educational resources and case studies.

2. UNDERSTAND RISKS

Understanding your community's climate-related risks requires identification of those assets that are important to your community. The goal here is to list any community asset or service that is directly or indirectly affected by water-related hazards. Brainstorming with community leaders and members is a cost-efficient and effective way to complete this step.

For some community assets, there may be questions related to ownership or jurisdiction. In these cases, the best course of action for privately owned assets could be an educational campaign designed to help private property owners understand the value of implementing their own adaptation practices and strategies. For assets in municipal or agency control, a wide variety of adaptation strategies may be available, and the next step would then be consideration of past events and possible future weather-related events that might affect the asset. You can brainstorm or apply lessons learned from other communities facing similar issues that took specific actions or projects to address climate-related water risks or impacts. This analysis should also include some consideration of what could happen to the asset if the event did occur.

Appendix B provides additional tools and guidance on identifying assets and hazards. Volume II contains links to a variety of resources and case studies related to identifying assets and understanding risks.

3. ASSESS VULNERABILITY

Assessing vulnerability will allow you to identify which assets are the most vulnerable. There are detailed, sophisticated methods for vulnerability analysis that would likely require assistance from climate change practitioners. See the US Climate Resilience Toolkit and Canadian Adaptation Resource Pathway for more information on quantitative analysis methodologies.

For most communities as a good first step, assessing vulnerability can be a qualitative and subjective analysis based on local knowledge and understanding of the assets and hazards. A determination can then be made for high-risk assets and situations whether quantitative analyses are necessary. An important piece of vulnerability assessments is to consider the adaptive capacity of your assets. Adaptive capacity includes both how easily the asset could rebound or recover from a hazard event and how easy it would be to implement adaptation strategies that would improve recoverability.

Appendix C provides additional tools and guidance on assessing vulnerability. Volume II contains links to a variety of resources and case studies related to assessing the vulnerability of assets.

4. INVESTIGATE OPTIONS

Investigating options is when you start to consider possible solutions for your highest risks. You can use brainstorming and review of how other communities have dealt with similar issues to identify specific actions or projects that could be implemented to address climate-related water needs.

Consider past water-related events that resulted in damage and what actions may have reduced or avoided impacts, including planning-level actions that may have prevented buildings or other infrastructure from locating within hazard-prone areas. Use this information to identify actions and adaptation measures that might prevent future problems and damage. Keep a wide focus here and look at everything from planning actions, to education, and adaptations that require design and construction efforts.

Appendix D provides additional tools and guidance on investigating adaptation options. Volume II contains links to a variety of resources and case studies.

5. PRIORITIZE AND PLAN

The next step is to develop a prioritized strategy to decide what to tackle first, to identify what types or amounts of funding might be needed, and to help incorporate ideas into plans, ordinances/by-laws, and the decision-making process. This step will also plan for the design of any identified built projects or actions. The implementation strategy should identify the responsible party, planning costs, required approvals for implementation, design, and construction, and potential funding sources. Ideally, prioritize strategies, such as built projects, master plans, ordinances, bylaw updates, regional planning efforts and

more. Such prioritization, in turn, allows for the greatest needs to be met first.

Developing a rudimentary idea of the cost-benefit of any adaptation strategies could be helpful at this point. Once you have solutions prioritized, develop a timeline for how long it will take to implement each solution.

Appendix E and Volume II provide additional resources and links to tools and case studies.

Funding

Much of the funding for municipal or community implemented adaptation strategies will come from either municipal sources or from state, provincial, and/or federal funding. Attempting to obtain funding can be a highly competitive and time-consuming process. Many smaller communities do not have the time or in-house expertise to develop a high-scoring application. In addition, small communities do not often compete well against larger municipalities, as the latter are often proposing much bigger projects with greater reaches and benefits to a larger population. Collaborating with other neighboring municipalities, community or watershed organizations when submitting grant applications is one way to elevate the attractiveness of a project. Most grant programs value collaborations and combining forces result in larger, more wide-reaching projects that compete better.

Finding free or low-cost technical assistance in preparing grant applications can be difficult. Part of the solution is relying on interested and/or affected parties and reaching out to often overlooked areas of assistance. Broadening the outreach can bring a wealth of experiences and expertise. Most people are also more than willing to help and have a chance to demonstrate their knowledge. **Appendix E** provides some additional guidance on how and where to find help.

6. TAKE ACTION

Adaptation strategies that are solely changes in existing municipal ordinances/bylaws, requirements, or permitting may take little effort or funding to implement. Other more costly adaptation strategies will likely require consideration of how to fund the necessary steps (planning, design, regulatory approvals, construction, and maintenance). Partnerships with community organizations, businesses, and even other communities can be formed to pursue broader adaptation strategies. Such partnerships can help with grant applications as collaborative efforts typically rate better in scoring. Volume II provides a number of case studies that present information on how several communities and organizations formed partnerships and collaborations related to resilience and climate adaptation. Volume II also provides information on and links to organizations that may be able to provide technical assistance to support communities in their adaptation efforts.

An important part of taking action is tracking and monitoring implementation of any adaptation solutions. Tracking completed efforts and the results is important especially in keeping stakeholders updated and engaged in what is an iterative process. Monitoring how the adaptation strategies perform during weather events is vital. Appropriate monitoring, which can be as simple as visual assessment of how well any improvements held up, helps you know whether the implemented strategies are sufficient and are going to perform as planned.

Monitoring of performance will allow you to make adjustments and changes as needed. It will also inform your planning process as you iterate through the different parts of the resilience framework over time. Reviewing the list of identified assets, risks, vulnerabilities, and possible adaptation strategies periodically, at least once a year, will allow for identification of assets or risks that may have been overlooked on the first iteration. Integrating what you have learned from previous adaptation strategy implementation and monitoring will allow for better identification of future improvements. **Appendix F** provides additional tools and guidance.

VOLUME II

GREAT LAKES CLIMATE ADAPTATION AND RESILIENCE RESOURCES

CLIMATE ADAPTATION AND RESILIENCE RESOURCES

This resource guide includes many of the tools, case studies, and other resources available for communities that are developing adaptation strategies and plans. The tools have been organized according to the Resilience Framework stages (steps) reviewed in Volume I.

The tools or resources are sorted under the Resilience Framework stages by the type of tool (resource legend). Each tool or resource is also color coded (see below) to indicate the source of the tool by (in alphabetical order): Canada (CA), Canadian Indigenous (First Nations, Métis), US Indigenous (Tribes), and United States (US). The source of the tool is used for categorization rather than geographic extent because tools developed by one geographic unit could still be useful to another geography or region. There was no intent in this guide to specify whether a tool or resource would be useful or applicable to any specific communities or municipalities.

Each tool is then labeled with a variety of information including applicable geography (some tools are only applicable to Canada, some only to the US), type of tool (bulleted list of categories in inset), and other information that will assist municipalities and communities with selecting resources that are appropriate to their effort.

RESOURCE LEGEND

TYPE OF TOOL


Data tool


Tool Helpers (guides, training)


Case Studies


Decision-maker Support Tools


Economic Tools


Funding (including grant writing)


Technical Support

GEOGRAPHY (COLOR CODE)

United States (US)

US Indigenous

Canada (CA)

CA Indigenous

Any Geography

CLIMATE CHANGE & RESILIENCE RESOURCES

1. INITIATE AND ENGAGE

2. UNDERSTAND RISK

3. ASSESS VULNERABILITY

4. INVESTIGATE OPTIONS

CLIMATE CHANGE & RESILIENCE RESOURCES *(CONT.)*

4. INVESTIGATE OPTIONS *(CONT.)*

5. PRIORITIZE AND PLAN

6. TAKE ACTION

1. INITIATE AND ENGAGE

1.1 GLISA GREAT LAKES FACT SHEET

GLISA (Great Lakes Integrated Sciences and Assessments) has developed extensive information on climate change effects in the Great Lakes region. Their two-page fact sheet provides a thorough overview of the climate changes affecting the Great Lakes region.

STRATEGY:	Education
TYPE OF TOOL:	Tool Helper (Fact Sheet)
HAZARD(S) ADDRESSED:	Algal Blooms; Droughts; Erosion; Extreme Weather; Flooding; Frost; Lake Level Fluctuation; Rainfall; Snow, Ice Cover & Lake Temperature; Temperature; Water Availability
GEOGRAPHIC SCALE:	Regional
COST TO USE:	Free
MORE INFORMATION:	GLISA (originally the Great Lakes Integrated Sciences and Assessments) is one of 12 Climate Adaptation Partnerships (CAP, formerly known as the Regional Integrated Sciences and Assessments or RISA) supported by the National Oceanic and Atmospheric Administration (NOAA).
LINK	glisa.umich.edu/wp-content/uploads/2021/04/GLISA-2-Pager.pdf

1.2 LAKE HURON ENVIRONMENTAL TEACHERS' WORKSHOP

This 2010 workshop can be used as a guidance for educating Great Lakes communities about climate change and impacts.

STRATEGY:	Evaluation & Feedback
TYPE OF TOOL:	Tool Helper (Workshop)
GEOGRAPHIC SCALE:	Canada: Lake Huron
IMPACTED SECTOR:	Agriculture; Biodiversity; Local Climate Change
COST TO USE:	Free
LINK:	lakehuroncommunityaction.ca/wp-content/uploads/2016/03/LH-Teacher-Workshop-Final-Report-and-Work-Plan.pdf

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

1.3 CLEVELAND METROPARKS—CLEVELAND HARBOR EASTERN EMBAYMENT RESILIENCE STUDY (CHEERS)

Cleveland Metroparks needed to consider how to engage surrounding neighborhoods and residents in restoring Lake Erie's eastern shorefront. They worked closely with community-based organizations and stakeholders to conduct virtual and in-person outreach activities and develop multilingual engagement materials for all ages.

STRATEGY:	Education & Partnership
TYPE OF TOOL:	Case Study
GEOGRAPHIC SCALE:	Regional
IMPACTED SECTOR:	Cultural & Natural Resources; Infrastructure
COST TO USE:	Free
LINK:	toolkit.climate.gov/case-studies/cleveland-metroparks-%E2%80%94-cleveland-harbor-eastern-embayment-resilience-study-cheers (Source: US Climate Resilience Toolkit)

1.4 ALL HANDS ON DECK: CREATING GREEN INFRASTRUCTURE TO COMBAT FLOODING IN TOLEDO

Staff at the City of Toledo partnered with government agencies, local businesses, and non-profit organizations to consider and begin implementing green infrastructure projects to deal with flooding. Their work also inspired a guide advising other communities how they could do the same.

STRATEGY:	Education & Partnership
TYPE OF TOOL:	Case Study
GEOGRAPHIC SCALE:	City; Community; Municipality
IMPACTED SECTOR:	Ecosystems; Human Health; Property & Infrastructure; Social Vulnerability
COST TO USE:	Free
LINK:	toolkit.climate.gov/case-studies/all-hands-deck-creating-green-infrastructure-combat-flooding-toledo (Source: US Climate Resilience Toolkit)

1. INITIATE AND ENGAGE (CONTINUED)

1.5 VISUALIZING FLOODING IN GREEN BAY

Coastal managers can use tools develops by NOAA and the US Federal Emergency Management Agency (FEMA), as well as the Lake Level Viewer and CanVis help stakeholders envision potential natural and human-caused changes. This is a case study that demonstrates how these resources were used to understand flooding risk in Wisconsin.

STRATEGY:	Education
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Extreme Waves; Flooding; Level Fluctuation; Storm Surge
GEOGRAPHIC SCALE:	Regional; Wisconsin
MORE INFORMATION:	Digital tools give users a way to visualize lakes at various water levels. When property owners see the potential for flooding and other coastal hazards, they can be inspired to plan ahead for resilience.
LINK:	toolkit.climate.gov/case-studies/visualizing-flooding-green-bay (Source: US Climate Resilience Toolkit)

1.6 INTEGRATING EDUCATION AND STORMWATER MANAGEMENT FOR HEALTHY RIVERS AND RESIDENTS

The City of Ann Arbor recognized stormwater runoff as a growing threat to the quality of their water supply. They're addressing the issue with two complementary strategies.

STRATEGY:	Education
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Extreme Weather; Precipitation; Stormwater Runoff
GEOGRAPHIC SCALE:	Municipal
IMPACTED SECTOR:	Ecosystems; Infrastructure; Human Health
COST TO USE:	Free
LINK:	toolkit.climate.gov/case-studies/integrating-education-and-stormwater-management-healthy-rivers-and-residents (Source: US Climate Resilience Toolkit)

Tool Type:


Data Tool


Tool Helpers


Case Studies


Decision Support


Economic Tools


Funding


Technical Support

Geography:

United States (US)

US Indigenous

Canada (CA)

CA Indigenous

Any Geography

1.7 USE OF GAMES AS EDUCATIONAL RESOURCES: THE WATERSHED GAME

The Watershed Game is designed as an educational tool for individuals to understand the connection between land use and water quality. There are two versions geared towards different audiences. The Local Leader version is available for four watershed models: streams, rivers, lakes and coasts. Participants learn how a variety of land uses impact water and natural resources, increase their knowledge of best management practices, and learn how their choices can prevent adverse impacts. The classroom version is available for streams and coasts and emphasizes collaboration and cooperative decision-making.

STRATEGY:	Education; Local Planning, Regulations & Policy
TYPE OF TOOL:	Tool Helper
HAZARD(S) ADDRESSED:	Stormwater Management; Water Pollution
GEOGRAPHIC SCALE:	Regional; Municipal (Scalable)
COST TO USE:	$125-195 USD depending on version.
LINK:	seagrant.umn.edu/programs/community-resilience-program/watershed-game

1.8 TWIN PORTS CLIMATE CONVERSATIONS

Minnesota Sea Grant co-facilitated and produced 10 Twin Ports Climate Conversations webinars reaching 490 community professionals and members of the public with information about community climate-change predictions, regionally relevant adaptation and mitigation strategies, and provided a platform for the local community to collectively engage on climate issues.

STRATEGY:	Education & Outreach
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Customizable
GEOGRAPHIC SCALE:	Regional
COST TO USE:	Free
LINK:	seagrant.umn.edu/programs/community-resilience-program/tpcc

1. *INITIATE AND ENGAGE (CONTINUED)*

1.9 WHEN CLIMATE CHANGE HITS HOME

Goshen, Indiana utilized the Linked Boundary Chain Model to connect with partner organizations and collaborate on accessing and understanding climate and socioeconomic data. One useful method was handing out templates at local workshops to fill out available climate and socioeconomic data, and historical expertise. The assessment can be turned into a report and distributed.

STRATEGY:	Local Planning, Regulations & Policy; Programmatic
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Flooding
GEOGRAPHIC SCALE:	US: City/Community
IMPACTED SECTOR:	Property & Infrastructure; Social Vulnerability
COST TO USE:	Free
LINK:	news.engin.umich.edu/2022/09/when-climate-change-hits-home/

1.10 CENTERING RACIAL JUSTICE IN URBAN FLOOD ADAPTATION

This report can be used to center racial justice in urban adaptation and use tools identified to develop diverse strategies for flood mitigation.

STRATEGY:	Advancing Health, Equity & Social Resilience
TYPE OF TOOL:	Decision-maker Support Tool
HAZARD(S) ADDRESSED:	Environmental Racism; Flooding
GEOGRAPHIC SCALE:	Regional
IMPACTED SECTOR:	Infrastructure; Public Health
COST TO USE:	Free
MORE INFORMATION:	This resource provides a 2-pager with an executive summary of the resource's content: graham.umich.edu/media/pubs/Catalyst-Report-Centering-Racial-Justice-in-Urban-Flood-Adaptation-48508.pdf
LINK:	graham.umich.edu/media/pubs/Catalyst-Report-Centering-Racial-Justice-in-Urban-Flood-Adaptation-48491.pdf

Tool Type:


Data Tool


Tool Helpers


Case Studies


Decision Support


Economic Tools


Funding


Technical Support

Geography:

United States (US)

US Indigenous


Canada (CA)


CA Indigenous


Any Geography

1.11 NAVIGATING GREEN INFRASTRUCTURE MAINTENANCE WITH CAPITALIZED ESTABLISHMENT COSTS

This report by the Environmental Policy Innovation Center and the WaterNow Alliance asserts that by appropriately treating establishment period costs as capital costs, water managers can leverage the US Clean Water State Revolving Fund (CWSRF) to invest in Green Infrastructure (GI) while reducing the impact of those investments on annual operating and management budgets and giving more time for training project owners about long-term maintenance.

STRATEGY:	Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Decision-maker Support Tool
HAZARD(S) ADDRESSED:	Stormwater
GEOGRAPHIC SCALE:	Great Lakes basin
IMPACTED SECTOR:	Economy; Water Management
COST TO USE:	Free
LINK:	static1.squarespace.com/static/611cc20b78b5f677dad664ab/t/64835bffd316c93e2677b796/1686330372197/EPIC_WaterNow_2023_GI_Maintenance_FINAL2.pdf

1. INITIATE AND ENGAGE (CONTINUED)

1.12 INTEGRATING EQUITY INTO FLOOD RESILIENCE INVESTMENTS

As governments in northeastern Illinois invest in flood resilience, prioritizing communities that face disproportionate flood impacts will be crucial to ensure that all residents have access to the resources they need to thrive. Drafted by the Chicago Metropolitan Agency for Planning (CMAP) in collaboration with community-based organizations, Integrating Equity into Flood Resilience Investments shows engineers, planners, and decision makers why investments must be made equitably, outlines key considerations for integrating equity (from planning and design to maintenance and funding), and highlights successful examples.

STRATEGY:	Education
TYPE OF TOOL:	Tool Helper (Education)
HAZARD(S) ADDRESSED:	Equity, Flooding, Key Considerations
GEOGRAPHIC SCALE:	Any
IMPACTED SECTOR:	Community
COST TO USE:	Free
MORE INFORMATION	This resource was developed in the northeastern Illinois area; however, it provides useful information that applies across any community.
LINK:	cmap.illinois.gov/wp-content/uploads/FloodResilienceGuide_CMAP_Web.pdf

1.13 BUILDING COASTAL RESILIENCE

Six-part video series to learn how your coastal community can build resilience.

STRATEGY:	Education
TYPE OF TOOL:	Tool Helper (Education)
HAZARD(S) ADDRESSED:	Coastal Storms; Erosion; Flooding; Water Levels
GEOGRAPHIC SCALE:	US; Michigan
IMPACTED SECTOR:	Coastal areas
COST TO USE:	Free
MORE INFORMATION	While developed for the state of Michigan, the information in these videos could serve as a useful educational resource for any community.
LINK:	michigan.gov/egle/about/organization/water-resources/coastal-management/michigans-resilient-coast

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

1.14 MINNESOTA CLIMATE CHANGE FACT SHEET

A fact sheet of climate change statistics and data in the state of Minnesota.

STRATEGY:	Education
TYPE OF TOOL:	Tool Helper (Fact Sheet)
HAZARD(S) ADDRESSED:	Climate Change
GEOGRAPHIC SCALE:	Minnesota, US
IMPACTED SECTOR:	Climate Change
COST TO USE:	Free
LINK:	files.dnr.state.mn.us/natural_resources/climate/change/climatechange-factsheet.pdf

2. UNDERSTAND RISK

2.1 CLIMATE DATA FOR A RESILIENT CANADA

Environment and Climate Change Canada has put together a database of easily accessible climate data and projections. Explore, analyze, and download high-resolution climate data by location, variable, and sector. Each figure includes an explanation of how to read it. The website also has resources for understanding and implementing the data to decision-making. This resource provides a detailed look into climate predictions while explaining what the user is seeing.

STRATEGY:	Education; Green Infrastructure & Nature Based Solutions
TYPE OF TOOL:	Data Tool
HAZARD(S) ADDRESSED:	Customizable
GEOGRAPHIC SCALE:	City; Community; Canada
COST TO USE:	Free
MORE INFORMATION:	This resource can also be used to Investigate Options.
LINK:	climatedata.ca

2.2 US NATIONAL CLIMATE ASSESSMENT

The US Global Change Research Program releases an assessment approximately every four years about the impacts of climate change and projects major trends for the subsequent 25 to 100 years. The assessment is broken down into region, with the Midwest Region being most relevant for Great Lakes states. The Northeast section may also be relevant for stakeholders in Pennsylvania and New York.

STRATEGY:	Education & Outreach
TYPE OF TOOL:	Data Tool
HAZARD(S) ADDRESSED:	Temperature, Precipitation, Drought, Agricultural Impacts, Ecosystem Disruptions, Human Health Risks, Infrastructure Vulnerabilities, Water Quality and Quantity Issues
GEOGRAPHIC SCALE:	Census Tract; County; US
COST TO USE:	Free
MORE INFORMATION:	This resource can also be used to Assess Vulnerability.
LINK:	Archived at: repository.library.noaa.gov/view/noaa/61592

Tool Type:


Data Tool


Tool Helpers


Case Studies


Decision Support


Economic Tools


Funding


Technical Support

Geography:

United States (US)

US Indigenous


Canada (CA)


CA Indigenous


Any Geography

2.3 MINNESOTA CLiMAT (CLIMATE MAPPING AND ANALYSIS TOOL)

The University of Minnesota Climate Adaptation Partnership created this interactive online tool that provides highly localized climate projections for Minnesota.

STRATEGY:	Local Planning, Regulations & Policy
TYPE OF TOOL:	Data Tool
HAZARD(S) ADDRESSED:	Temperature; Precipitation; Snow Cover; Relative Humidity; Soil Moisture; Soil Temperature; Lake Ice; Lake Temperature
GEOGRAPHIC SCALE:	City; Community; Minnesota (Scalable)
COST TO USE:	Free
MORE INFORMATION:	Climate projections are scalable down to the 2.5 mi (4 km) scale.
LINK:	climate.umn.edu/MN-CliMAT

2.4 US GREAT LAKES COASTAL RESILIENCE ASSESSMENT

This report details areas throughout the Great Lakes regions where communities and their assets are exposed to a range of coastal and inland flood-related threats. Policymakers can use said outputs to make informed decisions about conservation and resilience projects. Authored by UNC Asheville National Environmental Modeling and Analysis Center, prepared for the US National Fish and Wildlife Foundation.

STRATEGY:	Green Infrastructure & Nature Based Solutions
TYPE OF TOOL:	Decision-maker Support Tool
HAZARD(S) ADDRESSED:	Coastal and Inland Flooding; Flood-related Threats
GEOGRAPHIC SCALE:	Great Lakes region
IMPACTED SECTOR:	Coastal areas
COST TO USE:	Free
LINK:	nfwf.org/sites/default/files/2023-06/us-great-lakes-coastal-resilience-assessment-2023.pdf

2. UNDERSTAND RISK (CONTINUED)

2.5 ONTARIO PROVINCIAL CLIMATE CHANGE IMPACT ASSESSMENT

Use this assessment to get a baseline understanding of how Ontario is affected and will be affected in the future by climate change. The assessment evaluates impacts across the province on a regional scale. It considers the unique geographies, economies, municipalities, and communities of each region, focusing on key themes.

STRATEGY:	Education
TYPE OF TOOL:	Case Study; Technical Support
GEOGRAPHIC SCALE:	City; Community; Ontario, Canada
IMPACTED SECTOR:	Business & Economy; Ecosystems & Environment; Food and Agriculture; Infrastructure; Public Health
COST TO USE:	Free
MORE INFORMATION:	This resource can also be used to Investigate Options.
LINK:	ontario.ca/page/ontario-provincial-climate-change-impact-assessment

2.6 REGIONAL CLIMATE CHANGE MAPS

Use these maps of projected climate changes in the region to explain mid-century temperature and precipitation projections for 2040-2059. Created by GLISA.

STRATEGY:	Advancing Health, Equity & Social Resilience
TYPE OF TOOL:	Data Tool (Maps)
HAZARD(S) ADDRESSED:	Average Temperature; Cooling Degree Days; Growing Season; Over 1" Precipitation; Temperature over 90F; Temperature over 100F; Temperature below 20F; Total Precipitation (by Season)
GEOGRAPHIC SCALE:	Great Lakes region
COST TO USE:	Free
LINK:	glisa.umich.edu/great-lakes-regional-climate-change-maps/

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

2.7 CLIMATE CHANGE SCENARIOS FOR CITIES

GLISA partnered with local Great Lakes adaptation planners to provide a set of easily customizable climate scenarios and a scenario planning workbook to aid in city and local planning. Scenarios are broken up by season and by weather event for convenience and are customizable depending on unique geographic characteristics. These scenarios can also be used at larger spatial scales (e.g., county) and are intended to be transferable across cities or communities. Accompanying the scenarios is a workbook designed to break down the process of planning through a workshop. This resource provides an easily understood of representation of climatic event effects on infrastructure as well as a step-by-step process for planning.

STRATEGY:	Advancing Health, Equity, & Social Resilience; Education
TYPE OF TOOL:	Decision-maker Support Tool
HAZARD(S) ADDRESSED:	Changing seasonal hydrologic cycle; Erosion; Extreme Heat; Extreme Cold; Floods; Freeze/Thaw; Heavy Snowstorms; Ice Storms and Freezing Rain; Intense Storms and Storm Surge; Lake Level Fluctuation; Massive Sudden Snowmelt; Prolonged drought
GEOGRAPHIC SCALE:	City; Community; County
IMPACTED SECTOR:	Energy; Emergency Response; Infrastructure; Public Health; Residential; Transportation; etc.
COST TO USE:	Free
MORE INFORMATION:	This resource could reasonably be used as an education tool for the general public. This resource can also be used to Assess Vulnerability.
LINK:	glisa.umich.edu/future-climate-scenarios-for-great-lakes-cities/

2. UNDERSTAND RISK (CONTINUED)

2.8 FEMA NATIONAL RISK INDEX

Use FEMA's interactive online mapping application to compare Expected Annual Loss, Social Vulnerability, and Community Resilience for 18 natural hazards. Data is able be viewed either by county or census tracts.

STRATEGY:	Advancing Health, Equity & Social Resilience; Education & Outreach
TYPE OF TOOL:	Decision-maker Support Tool; Data Tool
HAZARD(S) ADDRESSED:	Coastal Flooding; Cold Wave; Drought; Hail; Heat Wave; Hurricane; Ice Storm; Landslide; Lightning; Riverine Flooding; Strong Wind; Tornado; Wildfire; Winter Weather
GEOGRAPHIC SCALE:	Census Tract; County; US
IMPACTED SECTOR:	Community Resilience; Social Vulnerability; etc.
COST TO USE:	Free
MORE INFORMATION:	This resource can also be used to Assess Vulnerability.
LINK:	hazards.fema.gov/nri/

2.9 COASTAL RESILIENCE PROJECT WORKSHEET

The Great Lakes and St. Lawrence Cities Initiative created this worksheet to gather information on local coastal resilience projects in preparation for discussions during workshops. It can be used either in the intended way or it can be used as a planning exercise where a resilience project is planned by filling it out.

STRATEGY:	Education & Outreach
TYPE OF TOOL:	Decision-maker Support Tool
HAZARD(S) ADDRESSED:	Customizable; Flooding; Increased Precipitation
GEOGRAPHIC SCALE:	City; Community; Coastal; Lake Scale
IMPACTED SECTOR:	Customizable (NOTE: the worksheet was developed for the Lake Michigan Coastal Resilience Initiative project, but as noted above the resource is applicable to anywhere in the Great Lakes region)
COST TO USE:	Free
LINK:	glslcities.org/wp-content/uploads/2021/11/LAKEMI1.pdf

Tool Type:


Data Tool


Tool Helpers


Case Studies


Decision Support


Economic Tools


Funding


Technical Support

Geography:

United States (US)

US Indigenous

Canada (CA)

CA Indigenous

Any Geography

2.10 TRIBAL CAPACITY BUILDING AND ADAPTATION PLANNING: THE UNITED STATES

This resource provides a summary of climate change from a tribal perspective, with an emphasis on how colonial trauma exacerbates its impact and the complexity of climate governance. It also details the work of Northern Arizona University in addressing climate related issues.

STRATEGY:	Advancing Health, Equity, & Social Resilience; Education & Outreach
TYPE OF TOOL:	Decision-maker Support Tool (Report)
HAZARD(S) ADDRESSED:	Biodiversity Loss; Flooding; Water Availability; Water Quality
GEOGRAPHIC SCALE:	Tribal Nation(s)
COST TO USE:	Free
LINK:	link.springer.com/chapter/10.1007/978-3-030-97826-6_4

2.11 STATE CLIMATE SUMMARIES

State Climate Summaries provide summaries consist of observed and projected climate change information and focus on aspects that are part of NOAA's mission. The summaries cover assessment topics like historical climate variations and trends, future climate model projections of climate conditions during the 21st century, and past and future conditions of sea level and coastal flooding.

STRATEGY:	Advancing Health, Equity, & Social Resilience; Education
TYPE OF TOOL:	Decision-maker Support Tool
GEOGRAPHIC SCALE:	State; US
IMPACTED SECTOR:	Emergency Response; Energy; Infrastructure; Public Health; Residential; Transportation; etc.
COST TO USE:	Free
LINK:	statesummaries.ncics.org/

2. UNDERSTAND RISK (CONTINUED)

2.12 CHEQUAMEGON BAY AREA ADAPTATION PLANNING GUIDE

This guide, developed by the Northland College Center for Rural Communities, brings together findings from global climate change assessments, national human health reports, regional–and state–level climate change impacts, and primary social science data collected across Chequamegon Bay communities to share information and make recommendations that are as specific and tailored to the Chequamegon Bay Area as currently possible.

STRATEGY:	Advancing Health, Equity & Social Resilience; Cultural & Natural Resources
TYPE OF TOOL:	Decision-Maker Support Tool
HAZARD(S) ADDRESSED:	Crop Stress; Droughts; Elevated CO2; Erosion; Flooding; Habitat; Invasives & Diseases; Precipitation; Lake Chemistry; Lake Ice Cover; Temperature
GEOGRAPHIC SCALE:	US; Wisconsin
IMPACTED SECTOR:	Agriculture & Food; Cultural & Natural Resources; Economy; Infrastructure & Housing; Land Use; Transportation; Waterfront & Coastal Resources
COST TO USE:	Free
LINK:	northland.edu/wp-content/uploads/2019/05/CRC-ClimateChangeAdaptationGuide.pdf

2.13 GUIDE TO CONDUCTING A CLIMATE CHANGE ANALYSIS AT THE LOCAL SCALE: LESSONS LEARNED FROM THE DURHAM REGION

Use this guidance document from the Ontario Climate Consortium to develop climate modeling studies in a way that is understandable and replicable, while supporting consistency in the climate modeling approaches used across Ontario municipalities.

STRATEGY:	Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Technical Support
HAZARD(S) ADDRESSED:	Accumulated Storm Surface Runoff; Days with Lightning; Extreme Humidex; Freezing Rain and High Winds; Freezing Rain More Than 3 Hours (and 1 Hour); Heat Wave Temperature; Heavy Rain; High Intensity Short Duration Rainfall; Ice Storms; Tornado Precursors
GEOGRAPHIC SCALE:	City; Community; Canada
COST TO USE:	Free
MORE INFORMATION:	This resource can also be used to Investigate Options.
LINK:	climateconnections.ca/app/uploads/2021/03/Final-Guide-to-Conducting-a-Climate-Change-Analysis-OCC_Nov.pdf

Tool Type:


Data Tool


Tool Helpers


Case Studies


Decision Support


Economic Tools


Funding


Technical Support

Geography:

United States (US)

US Indigenous

Canada (CA)

CA Indigenous

Any Geography

2.14 PENNSYLVANIA CLIMATE IMPACTS ASSESSMENT 2021

Pennsylvania's 2021 Climate Impacts Assessment presents updated climate projections based on the latest available downscaled climate model data.

STRATEGY:	Education; Risk Assessment
TYPE OF TOOL:	Data Tool
HAZARD(S) ADDRESSED:	Increasing Average Temperatures, Heavy Precipitation and Inland Flooding, Extreme Heat Events, Landslides, Sea Level Rise, Severe Tropical Storms
GEOGRAPHIC SCALE:	Pennsylvania; US
COST TO USE:	Free
MORE INFORMATION	This resource can also be used to Assess Vulnerability.
LINK:	greenport.pa.gov/elibrary//GetDocument?docId=3667348&DocName=PENNSYLVANIA%20CLIMATE%20IMPACTS%20ASSESSMENT%202021.PDF

2.15 CLIMATE RESILIENCE IN OHIO

This white paper presents an overview of the impacts that Ohio's communities are likely to experience from the effects of climate change. After this overview, the paper discusses climate change adaptation and mitigation in the context of public health accreditation by the Public Health Accreditation Board (PHAB).

STRATEGY:	Education
TYPE OF TOOL:	Data Tool
HAZARD(S) ADDRESSED:	Extreme Heat, Severe Storms and Flooding, Air Quality Degradation, Vector-Borne Diseases, Water Quality Issues
GEOGRAPHIC SCALE:	Ohio; US
COST TO USE:	Free
MORE INFORMATION	This resource can also be used to Assess Vulnerability.
LINK:	ohiopha.org/wp-content/uploads/2022/02/ClimateResilienceInOhio.pdf

2. *UNDERSTAND RISK (CONTINUED)*

2.16 ASSET MANAGEMENT ONTARIO CASE STUDIES

A number of case studies about asset risk assessment, management strategies, and decision making.

STRATEGY:	Case Studies
TYPE OF TOOL:	Tool Helper (Case Studies)
HAZARD(S) ADDRESSED:	Asset Risk assessment
GEOGRAPHIC SCALE:	Ontario; Canada
COST TO USE:	Free
MORE INFORMATION:	This resource may also apply across any region or community.
LINK:	amontario.ca/case-studies/

3. ASSESS VULNERABILITY

3.1 FREDERICKTOWN, MO PREPARES FOR DROUGHT RISK WITH CLIMATE RESILIENCE EVALUATION AND AWARENESS TOOL (CREAT)

See how a water utility in Fredericktown, Missouri used a US Environmental Protection Agency tool to assess climate vulnerability for their source water from drought, erosion, and sedimentation.

STRATEGY:	Economic Tools
TYPE OF TOOL:	Data Tool; Case Study
HAZARD(S) ADDRESSED:	Drought; Erosion; Sedimentation; Water Availability
GEOGRAPHIC SCALE:	Municipal
COST TO USE:	Free
LINK:	epa.gov/arc-x/fredericktown-missouri-prepares-climate-change-drought-risk

3.2 GREAT LAKES CLIMATOLOGIES

Learn how climate (temperature and precipitation) has already changed in your area through these historical local climate data summaries. It is separated by region and included counties are listed in each region. It also includes metrics like temperature and precipitation in easily understood tables and graphs. Use this resource if you are looking for more tailored climate summaries. Produced by GLISA.

STRATEGY:	Infrastructure & Capital Improvement; Cultural and Natural Resources
TYPE OF TOOL:	Data Tools (Interactive Map)
HAZARD(S) ADDRESSED:	Growing Season; Precipitation; Temperature
GEOGRAPHIC SCALE:	US; Great Lakes region
COST TO USE:	Free
MORE INFORMATION:	Includes limited climate data for some Canadian communities
LINK:	glisa.umich.edu/climate-data/great-lakes-climatologies/

3. ASSESS VULNERABILITY (CONTINUED)

3.3 NOAA QUANTITATIVE PRECIPITATION FORECASTS

View or download quantitative precipitation forecasts as a multi-chart series, KML, or shapefiles to visualize 6-hourly and 24-hourly contours. Produced by the US NOAA National Weather Service.

STRATEGY:	Cultural & Natural Resources
TYPE OF TOOL:	Data Tool (Forecasts)
HAZARD(S) ADDRESSED:	Precipitation Totals
GEOGRAPHIC SCALE:	City; US
COST TO USE:	Free
LINK:	wpc.ncep.noaa.gov/qpf/qpf2.shtml

3.4 CLIMATE CHANGE HAZARDS INFORMATION PORTAL (CCHIP)

Access a wide variety of climate data, while being able to receive context as well as future projections. This resource is focused on impacts of climate change on physical infrastructure but can be used for wider purposes.

STRATEGY:	Infrastructure & Capital Improvement
TYPE OF TOOL:	Data Tool
HAZARD(S) ADDRESSED:	Rainfall; Temperature
GEOGRAPHIC SCALE:	City; Canada
IMPACTED SECTOR:	Health & Safety; Infrastructure
COST TO USE:	Free
LINK:	climateriskinstitute.ca/cchip/

Tool Type:


Data Tool


Tool Helpers


Case Studies


Decision Support


Economic Tools


Funding


Technical Support

Geography:

United States (US)

US Indigenous

Canada (CA)

CA Indigenous

Any Geography

3.5 NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES

Enter a location or use the map to see tabular and graphical data for local precipitation depth and intensity frequency estimates. Use this resource if you are looking for detailed precipitation data for a localized area. Provided by the US NOAA National Weather Service

STRATEGY:	Infrastructure & Capital Improvement
TYPE OF TOOL:	Data Tool (Map-Based Data Interface)
HAZARD(S) ADDRESSED:	Precipitation Depth; Precipitation Intensity
GEOGRAPHIC SCALE:	US; City
COST TO USE:	Free
LINK:	hdsc.nws.noaa.gov/pfds/

3.6 NOAA CLIMATE EXPLORER

Use this resource to explore how climate is projected to change in any county in the United States.

STRATEGY:	Cultural & Natural Resources
TYPE OF TOOL:	Data Tool (Interactive Map; Graphs)
HAZARD(S) ADDRESSED:	Average Temperature; Cooling Degree Days; Growing Season; Over 1" Precipitation; Temperature below 20F; Temperature over 100F; Temperature over 90F; Total Precipitation (by Season)
GEOGRAPHIC SCALE:	City; US
COST TO USE:	Free
MORE INFORMATION:	Note that the flooding tab does not include the Great Lakes as Coastline.
LINK:	crt-climate-explorer.nemac.org/

3. ASSESS VULNERABILITY (CONTINUED)

3.7 ANNUAL CLIMATE TRENDS AND IMPACTS SUMMARY FOR THE GREAT LAKES BASIN

Explore this synthesis report summarizing the previous years' climate trends, events, new research, assessments, and related activities in the Great Lakes region.

STRATEGY:	Cultural & Natural Resources
TYPE OF TOOL:	Data Tool (Report)
HAZARD(S) ADDRESSED:	Air Temperature; Basin Precipitation; Drought; Harmful Algal Blooms; Ice Cover; Water Levels; Water Temperature; Wildfires
GEOGRAPHIC SCALE:	US; Great Lakes region
IMPACTED SECTOR:	Agriculture; Ecosystems; Public Health
COST TO USE:	Free
LINK:	glisa.umich.edu/summary-climate-information/annual-climate-trends/

3.8 CLIMATE AND HAZARD MITIGATION PLANNING (CHAMP) TOOL

Use this tool to explore climate data and hazard information through interactive visuals and explanatory text. CHAMP provides users with a single point of access to county- and region-specific historical climate and hazard data and future projected climate information. The tool displays these climate metrics, hazard data, and hazard impacts in a visual format with downloadable data visualizations and tables that are accompanied by explanatory text.

STRATEGY:	Education & Outreach; Economic Tools
TYPE OF TOOL:	Data Tool (Interactive Map)
HAZARD(S) ADDRESSED:	Coastal Hazards; Extreme Heat; Extreme Rainfall/Flooding; Fog; Great Lakes Hazards; Severe Weather; Tropical Storms/Hazards; Wildfire; Winter Weather
GEOGRAPHIC SCALE:	City; US
COST TO USE:	Free
LINK:	champ.rcc-acis.org/

Tool Type:


Data Tool


Tool Helpers


Case Studies


Decision Support


Economic Tools


Funding


Technical Support

Geography:

United States (US)

US Indigenous

Canada (CA)

CA Indigenous

Any Geography

3.9 LAKE LEVEL VIEWER

Explore an interactive map for each Great Lake to see lake level change and coastal society and business vulnerability.

STRATEGY:	Education & Outreach
TYPE OF TOOL:	Data Tool (Interactive Map)
HAZARD(S) ADDRESSED:	Lake level fluctuations
GEOGRAPHIC SCALE:	Great Lakes basin
IMPACTED SECTOR:	Social Vulnerability
COST TO USE:	Free
LINK:	coast.noaa.gov/digitalcoast/tools/llv.html

3.10 TORONTO ISLANDS FLOOD CHARACTERIZATION AND RISK ASSESSMENT PROJECT

Use this report as an example risk assessment. This report characterizes floods in the Toronto Islands and presents the conceptual designs, estimated quantities, and budgetary cost estimates for the flood mitigation alternatives.

STRATEGY:	Evaluation & Feedback
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Air Temperature; Drought; Flood; Flooding; Ice; Precipitation; Water Levels; Water Temperature; Wave Conditions; Wind
GEOGRAPHIC SCALE:	Toronto, Ontario; Canada
COST TO USE:	Free
LINK:	trca.ca/toronto-islands-flood-characterization-risk-assessment/

3. ASSESS VULNERABILITY (CONTINUED)

3.11 GRAND COUNCIL TREATY #3 FLOOD VULNERABILITY STUDY

Ongoing Flood Vulnerability Study that will determine the impacts of future flooding within Niisaachewan Anishinaabe Nation and the Treaty #3 territory, map out potentially vulnerable areas, and build capacity in our community.

STRATEGY:	Cultural & Natural Resources
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Loss of cultural sites; Natural environmental impacts; Water level rise
GEOGRAPHIC SCALE:	First Nations; Métis
IMPACTED SECTOR:	Culture; Economy; Ecosystems; Infrastructure
COST TO USE:	Free
LINK:	niisaachewan.ca/news/flood-vulnerability-study/

3.12 CHATHAM-KENT LAKE ERIE SHORELINE STUDY

Use this case study to see how the Municipality of Chatham-Kent used shoreline study results, assessed costs, and implemented new shoreline policies and adaptation strategies to address respective challenges of 4 different regions.

STRATEGY:	Evaluation & Feedback
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Accretion; Erosion; Flooding; Slope Stability; Wetlands Loss
GEOGRAPHIC SCALE:	Lake Erie; Chatham-Kent, Ontario; Canada
IMPACTED SECTOR:	Agriculture; Connectivity; Natural Environment; Property; Social Environment; Transportation
COST TO USE:	Free
LINK:	lowerthames-conservation.on.ca/wp-content/uploads/2021/09/Chatham-Kent-Lake-Erie-Shoreline-Study-2020.05.25.-reduced-size.pdf

Tool Type:


Data Tool


Tool Helpers


Case Studies


Decision Support


Economic Tools


Funding


Technical Support

Geography:

United States (US)

US Indigenous

Canada (CA)

CA Indigenous

Any Geography

3.13 USING DEMONSTRATION STORMS TO PREPARE FOR EXTREME RAINFALL

Communities can use a storm transposition simulation and the NOAA NEXRAD rainfall data from any recent rainfall event to understand how a similar event could impact their community.

STRATEGY:	Infrastructure & Capital Improvement
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Extreme Rainfall; Flooding
GEOGRAPHIC SCALE:	City; Community; US
IMPACTED SECTOR:	Health & Safety; Infrastructure
COST TO USE:	Free
LINK:	toolkit.climate.gov/case-studies/using-demonstration-storms-prepare-extreme-rainfall (Source: US Climate Resilience Toolkit)

3.14 MANAGING NATURAL ASSETS TO INCREASE COASTAL RESILIENCE: GUIDANCE DOCUMENT FOR MUNICIPALITIES

From the Municipal Natural Asset Initiative, the Managing Natural Assets to Increase Coastal Resilience Incorporates the Natural Asset Management Methodology that has been adopted in Canada to support communities seeking to identify, understand, measure and manage natural assets. This guide was specifically developed to teach the suite of tools of associated with the methodology, develop asset management options and evaluate options. It is best suited to a municipality/community with GIS capabilities.

STRATEGY:	Education; Infrastructure & Capital Improvement
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Accretion; Flooding; Storm Surge; Wave Attenuation
GEOGRAPHIC SCALE:	City; Community; Canada
IMPACTED SECTOR:	Coastlines; Infrastructure
COST TO USE:	Free
LINK:	naturalassetsinitiative.ca/wp-content/uploads/2024/07/NAI-Coastal-Asset-Guidance-doc_en.pdf

3. ASSESS VULNERABILITY (CONTINUED)

3.15 US CLIMATE RESILIENCE TOOLKIT PRACTITIONER GUIDE RESOURCES

A compendium of worksheets, templates, guidance, data tools, training, case studies and other resources, organized by the six

STRATEGY:	Local Planning, Regulations, & Policy
TYPE OF TOOL:	Decision-Maker Support Tools (Multiple)
GEOGRAPHIC SCALE:	US; Community; City
COST TO USE:	Free
MORE INFORMATION:	This resource functions across multiple stages of resilience planning.
LINK:	toolkit.climate.gov/practitioner-guide-resources (Source: US Climate Resilience Toolkit)

3.16 RISK AND RETURN ON INVESTMENT TOOL

This tool is a desktop software that calculates potential financial losses associated with flood and erosions related impacts and identifies cost optimized strategies for community resilience. The Canadian Climate Risk Institute's Risk and Return on Investment Tool (RRROIT) uses data many communities already have at their disposal to identify flood and erosion risks under current and future climate change scenarios. RROIT calculates the potential financial losses associated with flood- and erosion-related impacts and produces maps and supporting information to prioritize areas for attention.

STRATEGY:	Infrastructure & Capital Improvement
TYPE OF TOOL:	Economic Tool
HAZARD(S) ADDRESSED:	Erosion; Flooding
GEOGRAPHIC SCALE:	Canada
IMPACTED SECTOR:	Health & Safety; Public Health
COST TO USE:	Free
LINK:	climateriskinstitute.ca/rroit/

Tool Type:


Data Tool


Tool Helpers


Case Studies


Decision Support


Economic Tools


Funding


Technical Support

Geography:

United States (US)

US Indigenous

Canada (CA)

CA Indigenous

Any Geography

3.17 GUIDE TO FLOOD SUSCEPTIBILITY AND STORMWATER PLANNING

Urban flooding is a common concern among the Greater Chicago, Illinois region's municipalities, but many lack the resources to identify ways to address flooding issues. For example, a village may know that an area floods regularly, but they may not why or how to fix it. The Guide to Flood Susceptibility and Stormwater Planning details how communities can identify problem areas and causes and identify opportunities for improvements that can reduce flooding. Produced by the Chicago Metropolitan Agency for Planning (CMAP).

STRATEGY:	Stormwater problem areas identification
TYPE OF TOOL:	Tool Helper (training)
HAZARD(S) ADDRESSED:	Urban flooding and stormwater
GEOGRAPHIC SCALE:	Chicago Region; US
IMPACTED SECTOR	Stormwater
COST TO USE:	Free
LINK:	cmap.illinois.gov/wp-content/uploads/FSSP_072318.pdf

3.18 PLANNING FOR COMMUNITY RESILIENCE IN MICHIGAN

This handbook is intended to be used as a reference tool by a diverse array of land-use policy and planning practitioners.

STRATEGY:	Land Use Policy & Planning
TYPE OF TOOL:	Tool Helper
HAZARD(S) ADDRESSED:	Land Use Policy and Planning for Vulnerability
GEOGRAPHIC SCALE:	City; US
IMPACTED SECTOR	Land Use
COST TO USE:	Free
LINK:	resilientmichigan.org/downloads/michigan_resiliency_handbook_web.pdf

3. ASSESS VULNERABILITY (CONTINUED)

3.19 LAKE SUPERIOR CLIMATE CHANGE IMPACTS AND ADAPTATION

This is a recent and comprehensive report that summarizes expected and cross-cutting impacts of climate change on all biophysical aspects of Lake Superior (fisheries, bird migration, pollutants, flooding, etc.). It is based on a review of other studies, and proposes a framework for monitoring changes in the Lake Superior basin.

STRATEGY:	Monitoring
TYPE OF TOOL:	Data Tool
HAZARD(S) ADDRESSED:	Fisheries; Flooding; Pollution
GEOGRAPHIC SCALE:	Lake Superior; US
IMPACTED SECTOR	Lakes and Water
COST TO USE:	Free
LINK:	conservancy.umn.edu/items/f51516f3-c0de-47c7-a92f-20de8d219c9e

3.20 CLIMATE CHANGE VULNERABILITY ASSESSMENT TOOL FOR DRINKING WATER SOURCE QUALITY

Downloadable tool to help assess drinking water source quality vulnerability.

STRATEGY:	Vulnerability Assessment
TYPE OF TOOL:	Data Tool
HAZARD(S) ADDRESSED:	Threats to Water Quality
GEOGRAPHIC SCALE:	Ontario, Canada
IMPACTED SECTOR	Drinking Water
COST TO USE:	Free
LINK:	conservationontario.ca/resources?tx_fefiles_files%5Baction%5D=download&tx_fefiles_files%5Bcontroller%5D=File&tx_fefiles_files%5Bfile%5D=585&cHash=495c3cc4490f780e3cc9898864fed652 (NOTE: the PDF of this report will automatically download when you open this hyperlink).

4. INVESTIGATE OPTIONS

4.1 US EPA NATIONAL STORMWATER CALCULATOR

Use this software app to estimate the annual amount of rainwater and frequency of runoff from a specific site using green infrastructure as low impact development controls.

STRATEGY:	Cultural & Natural Resources
TYPE OF TOOL:	Data Tool
HAZARD(S) ADDRESSED:	Rainwater Totals; Runoff Frequency
GEOGRAPHIC SCALE:	US
IMPACTED SECTOR:	Infrastructure
COST TO USE:	Free
MORE INFORMATION:	It can also be used to Prioritize & Plan.
LINK:	epa.gov/water-research/national-stormwater-calculator

4.2 MNSG CODE AUDITS

Minnesota Sea Grant (MNSG) is working to build the capacity of the Duluth Urban Area to adopt and install green infrastructure to address water-quality impairments and coastal flooding impacts. They do this through a code audit for both the City of Duluth and Midway Township, Minnesota, to identify barriers to green infrastructure (GI), provide alternative language that will remove these barriers and promote the use of GI within these communities, and develop outreach on how ordinance language impacts on-the-ground practices.

STRATEGY:	Local Planning, Regulations & Policy; Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Case Study; Tool Helper (Guide)
HAZARD(S) ADDRESSED:	Extreme Weather; Flooding; Water Quality
GEOGRAPHIC SCALE:	Municipality; Minnesota; US
IMPACTED SECTOR:	Infrastructure; Local Policy
LINK:	seagrant.umn.edu/programs/community-resilience-program/code-audits-community-government-partnerships

4. INVESTIGATE OPTIONS (CONTINUED)

4.3 GLCAN THROUGH PARTICIPANTS' EYES

Watch this video to hear from city sustainability staff from Evanston and Indianapolis about their experience working with GLISA and developing a Vulnerability Assessment through the Great Lakes Climate Adaptation Network (GLCAN).

STRATEGY:	Evaluation & Feedback
TYPE OF TOOL:	Tool Helper (Video)
HAZARD(S) ADDRESSED:	Annual Rainfall; Extreme Cold; Extreme Heat; Hail; Lightning; Severe Winter Weather; Tornadoes; Winds
GEOGRAPHIC SCALE:	US
IMPACTED SECTOR:	Infrastructure; Social Vulnerability; Transportation
COST TO USE:	Free
LINK:	youtube.com/watch?v=vgcUPWqEtNo

4.4 GREAT LAKES COASTAL RESILIENCE PLANNING GUIDE

Case studies to explore how local planners and practitioners are using data, tools, methods, and policies to make communities resilient. This resource breaks down into impacted sectors so policymakers can easily prioritize. Produced by the Association of State Floodplain Managers and NOAA Office for Coastal Management.

STRATEGY:	Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Case Study; Tool Helper (Guidelines)
HAZARD(S) ADDRESSED:	Erosion; Flooding; Invasive Species; Lake Level Fluctuations
GEOGRAPHIC SCALE:	US
IMPACTED SECTOR:	Habitat & Environment; Health & Safety; Infrastructure; Land Use & Zoning
COST TO USE:	Free
LINK:	greatlakesresilience-floodscience.hub.arcgis.com/

Tool Type:


Data Tool


Tool Helpers


Case Studies


Decision Support


Economic Tools


Funding


Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

4.5 ADAPTING TO A CHANGING COAST FOR LOCAL OFFICIALS

Use this resource to consider options local officials could consider to address changing coastal bluffs and beaches.

STRATEGY:	Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Tool Helper (Guide)
GEOGRAPHIC SCALE:	US; Regional (Southeastern WI)
IMPACTED SECTOR:	Coastlines
COST TO USE:	Free
LINK:	publications.aqua.wisc.edu/product/adapting-to-changing-coast-for-local-officials/

4.6 AN ASSESSMENT OF COASTAL RESILIENCE IN GREAT LAKES COMMUNITIES

University of Michigan students conducted a series of 56 interviews and focus groups with municipalities and resource providers across the basins. Their efforts resulted in a library comprising 1,000+ coastal resources with a separate library consisting of 100+ relevant funding opportunities.

STRATEGY:	Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Tool Helper (Report)
GEOGRAPHIC SCALE:	US
IMPACTED SECTOR:	Coastlines
COST TO USE:	Free
LINK:	glslcities.org/initiatives/university-of-michigan-coastal-resilience-research-project/

4. INVESTIGATE OPTIONS (CONTINUED)

4.7 STAYING EVEN WITH MOTHER NATURE

On the southeastern shore of Lake Michigan, the city of St. Joseph is vulnerable to flooding from storm surges. Residents and city officials recognized the need to build resilience and worked together to enact a "no-build" ordinance to help minimize coastal erosion and retain beach access.

STRATEGY:	Green Infrastructure & Nature-Based Solutions; Local Planning, Regulations & Policy
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Erosion; Lake Level Fluctuation; Storm Surge
GEOGRAPHIC SCALE:	City; US
IMPACTED SECTOR:	Infrastructure; Shorelines
COST TO USE:	Free
LINK:	toolkit.climate.gov/case-studies/staying-even-mother-nature (Source: US Climate Resilience Toolkit)

4.8 DEVELOPING THE KEWEENAW BAY INDIAN COMMUNITY HAZARD MITIGATION PLAN

The Keweenaw Bay Community developed their hazard mitigation plan for current and future changes from climate change. Dione Price and Rachael Pressley's combined knowledge and experience helped guide their approach to facilitating an inclusive hazard mitigation planning process that ensured Indigenous culture, knowledge, science, kinship, and perspectives were incorporated into the plan. The Keweenaw Bay Indian Community is concerned with how the impacts from climate change and coastal hazards may disrupt Anishinaabe culture.

STRATEGY:	Cultural & Natural Resources
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Biodiversity; Declining Ice Cover; Extreme Weather; Temperature
GEOGRAPHIC SCALE:	Tribal Nation
COST TO USE:	Free
MORE INFORMATION:	This plan incorporates Population and Demographics factors.
LINK:	toolkit.climate.gov/case-studies/developing-keweenaw-bay-indian-community-hazard-mitigation-plan (Source: US Climate Resilience Toolkit)

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

4.9 GREEN INFRASTRUCTURE INVESTMENTS IN TWO HARBORS, MN

To control the pollution level and turbidity of water entering Lake Superior, and to better prepare the town to withstand damage from future flood events, Two Harbors implemented a combination of retrofitting, Low Impact Development, and flood control structures.

STRATEGY:	Local Planning, Regulations, & Policy
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Flooding
GEOGRAPHIC SCALE:	US; City
IMPACTED SECTOR:	Infrastructure; Transportation
COST TO USE:	Free
LINK:	toolkit.climate.gov/case-studies/two-harbors-investments-green-infrastructure-pay (Source: US Climate Resilience Toolkit)

4.10 NO NET LOSS OF WETLANDS

See how Lake County, Illinois implemented a no-net-loss wetland acreage policy with a net gain in wetland function goal to improve their water quality and flood storage capacity.

STRATEGY:	Cultural & Natural Resources; Local Planning, Regulations & Policy
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Drought; Sea Level Rise; Wildfires
GEOGRAPHIC SCALE:	Regional; US
IMPACTED SECTOR:	Wetlands
COST TO USE:	Free
LINK:	epa.gov/arc-x/lake-county-illinois-stormwater-commission-develops-tool-support-wetland-restoration-planning (Source: US EPA Arc-X)

4. INVESTIGATE OPTIONS (CONTINUED)

4.11 STORMWATER MANAGEMENT CAPABILITIES

See how the Minnehaha Creek Watershed District in Minnesota considered climate projections to better understand climate threats and vulnerability to stormwater management capabilities.

STRATEGY:	Education
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Flooding; Precipitation
GEOGRAPHIC SCALE:	City; US
IMPACTED SECTOR:	Infrastructure & Property
COST TO USE:	Free
LINK:	epa.gov/arc-x/minnehaha-mn-creek-watershed-district-assesses-stormwater-management-climate-vulnerability (Source: US EPA Arc-X)

4.12 QUINAULT INDIAN NATION VILLAGE RELOCATION PLAN

See how the Quinault Indian Nation is considering climate (sea level rise, storm surge, and river flooding) and non-climate (tsunami) risks together to form a village relocation plan.

STRATEGY:	Local Planning, Regulations & Policy
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Flooding; Sea Level Rise; Storm Surge
GEOGRAPHIC SCALE:	Tribal Nation(s)
IMPACTED SECTOR:	Infrastructure
COST TO USE:	Free
LINK:	epa.gov/arc-x/quinault-indian-nation-plans-relocation (Source: US EPA Arc-X)

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

4.13 ONE BLOCK AT A TIME

The goal of the Minnesota Sea Grant project One Block at a Time is to increase community resilience to climate hazards, particularly the impacts of flooding, in vulnerable frontline communities across the Great Lakes region. By installing rain barrels, one block at a time, residents can reduce the amount of water that flows from their property while conserving water that's free water for use in their gardens and yards.

STRATEGY:	Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Extreme Weather; Flooding; Stormwater Runoff
GEOGRAPHIC SCALE:	Regional
IMPACTED SECTOR:	Infrastructure
COST TO USE:	Free
LINK:	seagrant.umn.edu/programs/community-resilience-program/one-block-time

4.14 NOAA COASTAL RESILIENCE PROJECTS LEVERAGING THE GREAT LAKES RESTORATION INITIATIVE

This US NOAA Office for Coastal Management web page provides project snapshots and examples, additional resources, tools and regional data sets, highlighting coastal resilience projects leveraging Great Lakes Restoration Initiative (GLRI) funding. For all GLRI projects, visit glri.us.

STRATEGY:	Education & Outreach
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Dune Deterioration; Erosion; Flooding
GEOGRAPHIC SCALE:	US
IMPACTED SECTOR:	Ecosystems and Biodiversity; Subsistence
COST TO USE:	Free
LINK:	coast.noaa.gov/regions/greatlakes/glri/

4. INVESTIGATE OPTIONS (CONTINUED)

4.15 BUILDING COMMUNITY RESILIENCE WITH NATURE- BASED SOLUTIONS: A GUIDE FOR LOCAL COMMUNITIES

The primary goal of this guide is to help communities identify and engage the staff and resources that can be used to implement nature-based solutions to build resilience to natural hazards, which may be exacerbated by climate change. The focus of this guide is local communities, but many of the ideas and advice may also apply to state, territorial, and tribal governments.

STRATEGY:	Economic Tools and Incentives; Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Decision-maker Support Tool
HAZARD(S) ADDRESSED:	Customizable
GEOGRAPHIC SCALE:	US; City/Community
COST TO USE:	Free
LINK:	fema.gov/sites/default/files/2020-07/fema_bric_nature-based-solutions-guide_2020.pdf

4.16 TRIBAL CLIMATE ADAPTATION GUIDEBOOK

Tribes across North America are leading the way on climate change adaptation. The Tribal Climate Adaptation Guidebook highlights exemplary Tribal efforts in a comprehensive climate adaptation framework that recognizes the distinct circumstances of Tribal governments, cultures, and knowledge systems. This tool provides a step-by-step guide to adaptation planning with Tribal-specific examples.

STRATEGY:	Economic Tools and Incentives; Local Planning, Regulations & Policy
TYPE OF TOOL:	Decision-maker Support Tool
HAZARD(S) ADDRESSED:	Customizable
GEOGRAPHIC SCALE:	Tribal Nation
COST TO USE:	Free
LINK:	tribalclimateadaptationguidebook.org/

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

4.17 AMENDING LAND USE CODES FOR NATURAL INFRASTRUCTURE PLANNING

Learn how a Sea Grant agent is working with one community to audit and amend its existing land use codes and ordinances to be more inclusive of green infrastructure projects.

STRATEGY:	Green Infrastructure & Nature Based Solutions; Local Planning, Regulations & Policy
TYPE OF TOOL:	Case Study; Decision-maker Support Tool
HAZARD(S) ADDRESSED:	Extreme Weather; Flooding; Water Quality
GEOGRAPHIC SCALE:	City; US
IMPACTED SECTOR:	Infrastructure; Local Policy
COST TO USE:	Free
LINK:	toolkit.climate.gov/case-studies/amending-land-use-codes-natural-infrastructure-planning (Source: US Climate Resilience Toolkit)

4.18 CHICAGO CLIMATE ADAPTATION GUIDEBOOK

This guidebook surveys climate change impacts in the Chicago area and suggests potential adaptation measures for municipalities to address them. Yet communities will still need to establish a process to study their particular vulnerabilities and to implement adaptation measures that work for their individual circumstances.

STRATEGY:	Climate Change Impacts and Suggested Adaptations
TYPE OF TOOL:	Decision-maker Support Tool
HAZARD(S) ADDRESSED:	Varies
GEOGRAPHIC SCALE:	US; Chicago area
IMPACTED SECTOR:	Any
COST TO USE:	Free
MORE INFORMATION:	It can also be used to Prioritize & Plan and Take Action.
LINK:	cmap.illinois.gov/wp-content/uploads/FY13-0119-Climate-Adaptation-toolkit-lowres.pdf

4. INVESTIGATE OPTIONS (CONTINUED)

4.19 USING NATURAL MEASURES TO REDUCE THE RISK OF FLOODING AND EROSION

This document does the following: Describes natural resilience measures and how they can be used to mitigate the risks of flooding and erosion; Provides definitions for different types of natural resilience measures and distinguishes among conserved, restored, nature-based and hard structural approaches; Provides information on the value and benefits of using natural resilience measures, along with information on the co-benefits they provide; Lists key factors to consider in the restoration, design and construction of natural resilience measures.

STRATEGY:	Natural Solutions
TYPE OF TOOL:	Tool Helper (Guide)
HAZARD(S) ADDRESSED:	Erosion; Flooding; Water Quality
GEOGRAPHIC SCALE:	Municipality
IMPACTED SECTOR:	Infrastructure; Local Policy
COST TO USE:	Free
LINK:	extapps.dec.ny.gov/docs/administration_pdf/crranaturalmeasuresgndc.pdf

4.20 QUINTE CONSERVATION ONTARIO RESPONSE TO DROUGHT MANAGEMENT

A case study describing strategies used by Quinte Conservation Ontario to respond to drought threats.

STRATEGY:	Drought Adaptation
TYPE OF TOOL:	Tool Helper (Case Study)
HAZARD(S) ADDRESSED:	Drought
GEOGRAPHIC SCALE:	Regional; Quinte, Ontario; Canada
IMPACTED SECTOR:	Local Policy; Infrastructure
COST TO USE:	Free
LINK:	changingclimate.ca/site/assets/uploads/2021/11/Quinte-Conservation-ON-case-study-Oct-22-2021-EN.pdf

5. PRIORITIZE AND PLAN

5.1 A PRACTITIONER'S GUIDE TO CLIMATE CHANGE ADAPTATION IN ONTARIO'S ECOSYSTEMS

Guide introducing the concepts of climate change adaptation, vulnerability, and risk. It also describes vulnerability and risk assessment tools and techniques, and a framework that can be used to support adaptive management in a rapidly changing climate. Overall, it seeks to assist natural resource managers to identify ways that climate change vulnerabilities and risks can be integrated into decision-making processes that include adaptation action plans, strategies, and policies. Produced by the Ontario Centre for Climate Impacts and Adaptation Resources.

STRATEGY:	Education & Outreach
TYPE OF TOOL:	Tool Helper (Report)
HAZARD(S) ADDRESSED:	Biodiversity Loss; Deforestation; Invasive Species; Temperature; Water Resource Degradation; Wetland Degradation
GEOGRAPHIC SCALE:	Canada; City
IMPACTED SECTOR:	Ecosystems and Biodiversity; Social Vulnerability
COST TO USE:	Free
MORE INFORMATION:	This resource spans multiple stages but it is also useful for Assessing Vulnerability.
LINK:	cakex.org/documents/practitioner%E2%80%99s-guide-climate-change-adaptation-ontario%E2%80%99s-ecosystems

5.2 SUPPORTING TRIBAL CLIMATE CHANGE ADAPTATION PLANNING THROUGH COMMUNITY STRATEGIC FOREIGN SCENARIO DEVELOPMENT

GLISA worked with Sault Ste. Marie Tribe of Chippewa Indians, Red Lake Nation, and Oneida Tribe of Wisconsin to plan a full day workshop on climate adaptation planning.

STRATEGY:	Local Planning, Regulations, & Policy
TYPE OF TOOL:	Case Study
GEOGRAPHIC SCALE:	Tribal
IMPACTED SECTOR:	Biodiversity; Commercial; Forestry; Public Health
COST TO USE:	Free
LINK:	glisa.umich.edu/media/files/projectreports/GLISA_ProjRep_Strategic-Foresight.pdf

5. PRIORITIZE AND PLAN (CONTINUED)

5.3 CLIMATE ADAPTATION IN EVANSTON, ILLINOIS

Key takeaways and transferable knowledge include drawing on existing sustainability frameworks; considering climate change in day-to-day operations and existing plans; looking for common-sense actions with future benefits; and knowing your network.

STRATEGY:	Green Infrastructure & Nature Based Solutions; Evaluation & Feedback
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Extreme Cold; Extreme Heat
GEOGRAPHIC SCALE:	City; US
IMPACTED SECTOR:	Forestry; Public Health; Water Utilities
COST TO USE:	Free
LINK:	glslcities.org/wp-content/uploads/2015/11/Evanston_Case-Study_FINAL-DRAFT_062215.pdf

5.4 CLIMATE ADAPTATION IN MILWAUKEE, WISCONSIN

Key takeaways and transferable knowledge include turning crisis into a momentum for action; sharing resources to build consensus; and community and private-sector empowerment.

STRATEGY:	Housing & Buildings
TYPE OF TOOL:	Case Study
GEOGRAPHIC SCALE:	City; US
IMPACTED SECTOR:	Education; Health Services; Manufacturing; Trade; Transportation
COST TO USE:	Free
LINK:	glslcities.org/wp-content/uploads/2015/11/MilwaukeeCaseStudy_withFormat_Final.pdf

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

5.5 CLIMATE ADAPTATION IN NIAGARA REGION, ONTARIO

Key takeaways and transferable knowledge relate to leadership and dedication, collaboration, focus areas, and motivation.

STRATEGY:	Infrastructure & Capital Improvement
TYPE OF TOOL:	Case Study
GEOGRAPHIC SCALE:	Region; Canada
IMPACTED SECTOR:	Agriculture; Manufacturing; Tourism
COST TO USE:	Free
LINK:	glslcities.org/wp-content/uploads/2015/11/NiagaraRegionCaseStudy_withFormat_Final.pdf

5.6 CLIMATE ADAPTATION IN TRAVERSE CITY, MICHIGAN

Key takeaways and transferable knowledge relate to building collaborative partnerships; analyzing and assessing exposure and vulnerability; identifying core community values to bridge differences; innovating, taking risks, and trailblazing; being action oriented and responsive; and engaging the public.

STRATEGY:	Infrastructure & Capital Improvement
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Flooding; Precipitation; Temperature
GEOGRAPHIC SCALE:	City; US
IMPACTED SECTOR:	Agriculture; Tourism and Recreation
COST TO USE:	Free
LINK:	glslcities.org/wp-content/uploads/2015/11/Traverse-Case-Study_FINAL-copy-edited-template.pdf

5. PRIORITIZE AND PLAN (CONTINUED)

5.7 LAKE HURON SHORELINE MANAGEMENT PLAN

Ausable-Bayfield Conservation Authority updated its Shoreline Management Plan by building on previous technical studies, incorporating provincial policies, objectives, and Technical Guide. This plan addresses existing and future development along the shoreline.

STRATEGY:	Evaluation & Feedback
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Dynamic Beach; Erosion; Flooding; Sediment Accretion; Slope Instability; Wave Action; Wave Overtopping; Wave Uprush
GEOGRAPHIC SCALE:	Canada; Lake Huron
IMPACTED SECTOR:	Infrastructure
COST TO USE:	Free
MORE INFORMATION:	This resource may also be used for Outreach and Engagement
LINK:	abca.ca/planning/shorelinemanagement/

5.8 CITY OF ST. CATHARINES, ONTARIO CLIMATE ADAPTATION PLAN

One key initiative is the Natural Assets Study, which aims to identify and protect the city's natural assets such as wetlands and forests. St. Catharine's has also implemented a Green Infrastructure Plan to help manage stormwater runoff and reduce the risk of flooding.

STRATEGY:	Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Extreme Heat; Extreme Storms; Flooding; Lake Level Fluctuations
GEOGRAPHIC SCALE:	Canada; City
IMPACTED SECTOR:	Food & Agriculture; Forestry; Infrastructure; Water Management
COST TO USE:	Free
LINK:	stcatharines.ca/en/council-and-administration/resources/Climate-Adaption-Plan.pdf

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

5.9 HAMILTON, ONTARIO CLIMATE ACTION STRATEGY

One key initiative is the Hamilton Harbour Remedial Action Plan, which aims to improve water quality in Hamilton Harbour through a range of measures such as wetland restoration and the installation of stormwater management infrastructure. Hamilton has also developed a Heat Alert and Response System to help protect vulnerable populations during extreme heat events.

STRATEGY:	Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Case Study
GEOGRAPHIC SCALE:	Canada; City
COST TO USE:	Free
MORE INFORMATION:	This resource spans multiple stages but it is also useful for Assessing Vulnerability.
LINK:	hamilton.ca/home-neighbourhood/environmental-stewardship/environmental-plans-strategies/hamiltons-climate

5.10 THUNDER BAY, ONTARIO CLIMATE ADAPTATION PLAN

One key initiative is the Community Resilience and Emergency Preparedness Program, which aims to build community resilience through a range of measures such as emergency response planning and community education initiatives. Thunder Bay, Ontario has also implemented a Green Infrastructure Strategy to help manage stormwater runoff and reduce the risk of flooding.

STRATEGY:	Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Extreme Heat; Extreme Storms; Flooding; Lake Level Fluctuations
GEOGRAPHIC SCALE:	Canada; City
IMPACTED SECTOR:	Forestry; Infrastructure; Water Management
COST TO USE:	Free
LINK:	climatereadycity.com/wp-content/uploads/2015/12/Earthcare_Climate_Ready_City_Web1.pdf

5. PRIORITIZE AND PLAN (CONTINUED)

5.11 RED LAKE BAND OF LAKE SUPERIOR CHIPPEWA CLIMATE ADAPTATION PLAN

The Red Lake Band developed this plan to focus on their water and forest resources and includes a detailed characterization of water and forestry risks due to climate change. The Tribe also included a unique approach to goal setting as well as a SWOT analysis, which is typically used in business but worked well for their climate management initiative.

STRATEGY:	Green Infrastructure & Nature-Based Solutions
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Drought; Flooding; Forestry; HABs
GEOGRAPHIC SCALE:	Tribal Nation(s)
IMPACTED SECTOR:	Fishing; Forestry; Water Resources
COST TO USE:	Free
MORE INFORMATION:	This resource was released in 2014 and may be considered out of date.
LINK:	forestadaptation.org/sites/default/files/demonstration-files/Red-Lake-Forest-Water-Climate-Adaptation-Plan-Final-2014.pdf

5.12 AANJI-BIMAADIZIIMAGAK O'OW AKI

The Great Lakes Indian Fish and Wildlife Commission's (GLIFWC) first and second Vulnerability Assessment bring together Traditional and Scientific Ecological Knowledge to examine the climate change vulnerability of a set of beings in the upper Midwest Ceded Territories by the mid-21st century.

STRATEGY:	Cultural & Natural Resources
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Air Temperature; Fire; Growing Season; Ice Cover; Precipitation; Species Effected; Water Temperature
GEOGRAPHIC SCALE:	Tribal Nation(s)
IMPACTED SECTOR:	Biodiversity; Ecosystems; Human Health
COST TO USE:	Free
LINK:	glifwc.org/ClimateChange/VulnerabilityAssessment.html

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

5.13 1854 TREATY AUTHORITY CLIMATE CHANGE VULNERABILITY ASSESSMENT AND ADAPTATION PLAN

The 1854 Treaty Authority's Plan investigates changing climate conditions already and how they continue to affect the landscape and species within the 1854 Ceded Territory and the respective reservations. In addition to assessing changes, it also identifies climate-related vulnerabilities and identified actions that could be taken to create more climate resilient systems.

STRATEGY:	Advancing Health, Equity, & Social Resilience; Education & Outreach; Cultural and Natural Resources
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Air Quality; Ecosystems; Precipitation; Temperature Increase
GEOGRAPHIC SCALE:	Tribal Nation(s)
IMPACTED SECTOR:	Cultural Resources; Natural Resources; Public Health
COST TO USE:	Free
LINK:	tribalresilienceactions.org/plans/?_keyword=1854

5.14 COMMUNITY ENABLED LIFECYCLE ANALYSIS OF STORMWATER INFRASTRUCTURE COSTS (CLASIC)

Use the CLASIC screening tool that shows scenarios for different stormwater control measures to assess respective life-cycle costs, performance co-benefits. Users can evaluate regulatory compliance; runoff volume reduction; water quality; social and environmental benefits; and life-cycle costs. Produced by the Water Research Foundation.

STRATEGY:	Education & Outreach
TYPE OF TOOL:	Decision-Maker Support Tool; Economic Tool
HAZARD(S) ADDRESSED:	Flooding
GEOGRAPHIC SCALE:	US
IMPACTED SECTOR:	Infrastructure; Water Management
COST TO USE:	Free
LINK:	waterrf.org/CLASIC

5. PRIORITIZE AND PLAN (CONTINUED)

5.15 USING CLEAN WATER STATE REVOLVING FUNDS FOR GREENING AND CLIMATE RESILIENCE

For more than thirty years, the Clean Water State Revolving Fund has been a critical funding stream used by local governments and utilities for the cleanup of water quality in rivers across the United States. Following the 2022 infusion of federal infrastructure funding, this program (which is implemented a little bit differently in each state) now offers transformational opportunities to communities challenged by historic disinvestment, environmental degradation, and climate change. Produced by American Rivers.

STRATEGY:	Cultural & Natural Resources
TYPE OF TOOL:	Decision Maker Support Tools; Funding
HAZARD(S) ADDRESSED:	Water Quality
GEOGRAPHIC SCALE:	US
COST TO USE:	Free
LINK:	americanrivers.org/resource/using-clean-water-state-revolving-funds-for-greening-and-climate-resilience/

6. TAKE ACTION

6.1 MODEL LOCAL LAWS TO INCREASE RESILIENCE

New York's Community Risk and Resiliency Act (CRRA) required New York Department of State in cooperation with Department of Environmental Conservation to develop model local laws to increase community resilience.

STRATEGY:	Policy
TYPE OF TOOL:	Tool Helper (Guide)
HAZARD(S) ADDRESSED:	Various
GEOGRAPHIC SCALE:	Municipality; US
IMPACTED SECTOR:	Local Policy
COST TO USE:	Free
LINK:	dos.ny.gov/model-local-laws-increase-resilience

6.2 GREAT LAKES ONE WATER (GLOW) PROJECT

The Minnesota Sea Grant Great Lakes One Water (GLOW) project brings together a diverse community leadership team focused on equitable access to information and participation in planning and strategies.

STRATEGY:	Programmatic
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Extreme Weather
GEOGRAPHIC SCALE:	Regional
IMPACTED SECTOR:	Public Mental Health & Wellbeing
MORE INFORMATION:	Free
LINK:	seagrant.umn.edu/programs/community-resilience-program/great-lakes-one-water

6. TAKE ACTION (CONTINUED)

6.3 GREEN ROOF BYLAW

Initiative from Toronto's Climate Action Plan, which requires new buildings over a certain size to include green roofs or other forms of green infrastructure to help manage stormwater runoff.

STRATEGY:	Local Planning, Regulations, & Policy; Programmatic
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Greenhouse Gases; Heat; Runoff
GEOGRAPHIC SCALE:	Canada; City
IMPACTED SECTOR:	Biodiversity; Economy; Energy; Public Health
COST TO USE:	Free
LINK:	c40.org/case-studies/city-of-toronto-s-eco-roof-incentive-program-and-green-roof-bylaw/

6.4 INTEGRATING EDUCATION AND STORMWATER MANAGEMENT FOR HEALTHY RIVERS AND RESIDENTS

Ann Arbor reduced stormwater runoff by updating the rate structure for its stormwater utility with educating the public and building support.

STRATEGY:	Local Planning, Regulations, & Policy
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Extreme Weather Events; Precipitation
GEOGRAPHIC SCALE:	US; City
IMPACTED SECTOR:	Ecosystems; Human Health
COST TO USE:	Free
LINK:	toolkit.climate.gov/case-studies/integrating-education-and-stormwater-management-healthy-rivers-and-residents (Source: US Climate Resilience Toolkit)

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

6.5 UNDERWATER INNOVATION AT ILLINOIS BEACH TO MITIGATE COASTAL EROSION

US EPA Great Lakes Restoration Initiative installed submerged rubble ridges to lessen storm waves and protect the eroding beach and unique terrestrial ecosystem in the dunes while preserving views and enhancing fish habitat.

STRATEGY:	Programmatic
TYPE OF TOOL:	Case Study
HAZARD(S) ADDRESSED:	Ice; Lake Level Fluctuations; Shoreline Erosion; Wave Action
GEOGRAPHIC SCALE:	US; City
COST TO USE:	Free
LINK:	blog.istc.illinois.edu/2022/02/18/underwater-innovation-at-illinois-beach-state-park-to-help-mitigate-coastal-erosion/

6.6 MICHIGAN MONTHLY SERIES ON BIPARTISAN INFRASTRUCTURE LAW AND INFLATION REDUCTION ACT RESOURCES

Part of a series of messages from the Michigan Department of Environment, Great Lakes, and Energy (EGLE) to share updates on relevant Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA) information related to energy and sustainability. This series will occur monthly and provide a snippet of upcoming federal grants, trainings, and other resources.

STRATEGY:	Local Planning, Regulations, & Policy
TYPE OF TOOL:	Funding
HAZARD(S) ADDRESSED:	Climate Change; Energy Inefficiency
GEOGRAPHIC SCALE:	Great Lakes; US
IMPACTED SECTOR:	Economy; Infrastructure
LINK:	content.govdelivery.com/accounts/MIDEQ/bulletins/3626b5e (NOTE: link is one example of an update from June 2023; the page includes a "subscription" option to get the latest updates)

6. TAKE ACTION (CONTINUED)

6.7 BRANCH OF TRIBAL CLIMATE RESILIENCE

The Branch of Tribal Climate Resilience partners with Tribal Nations and US Bureau of Indian Affairs agencies to incorporate climate considerations into their programs and policies by providing funding, training, technical assistance and organizational support. Tribes can leverage programs to further support their existing operations, program planning, project design, as well as Indigenous and Traditional Knowledges into their management and protection of Trust resources and Tribal economies.

STRATEGY:	Advancing Health, Equity & Social Resilience; Local Planning, Regulations & Policy
TYPE OF TOOL:	Funding; Technical Support
HAZARD(S) ADDRESSED:	Customizable
GEOGRAPHIC SCALE:	Tribal Nation(s)
COST TO USE:	Free
LINK:	bia.gov/bia/ots/tcr

6.8 COASTAL HAZARDS OF SUPERIOR (CHAOS)

The Coastal Hazards of Superior (CHAOS) is a Community of Practice (CoP) focusing on the Minnesota and Wisconsin coasts of western Lake Superior. CHAOS is a platform for engaging local community leaders, managers, researchers, and communicators with a shared concern about coastal hazards and their impacts.

STRATEGY:	Education & Outreach; Local Planning, Policy & Regulation
TYPE OF TOOL:	Technical Support
GEOGRAPHIC SCALE:	US; Regional; Lake Superior
IMPACTED SECTOR:	Coastlines
LINK:	seagrant.umn.edu/programs/community-resilience-program/lake-superior-coastal-hazards

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

6.9 COLLEGE OF MENOMINEE NATION'S SUSTAINABLE DEVELOPMENT INSTITUTE BUILDS CAPACITY

College of Menominee Nation's Sustainable Development Institute Builds Capacity for Tribal Climate Change Adaptation.

STRATEGY:	Economic Tools & Incentives
TYPE OF TOOL:	Technical Support
HAZARD(S) ADDRESSED:	Customizable
GEOGRAPHIC SCALE:	Tribal Nation
IMPACTED SECTOR:	Economics; Institutions; Land and Sovereignty; Natural Environment; Technology
LINK:	toolkit.climate.gov/case-studies/college-menominee-nations-sustainable-development-institute-builds-capacity-tribal (Source: US Climate Resilience Toolkit)

6.10 LINKING THE BOUNDARY CHAIN

With a changing climate threatening assets in the Great Lakes, local experts formed a boundary organization to bridge the gap between scientists and decision makers. Information about the Great Lakes Climate Adaptation Network (GLCAN).

STRATEGY:	Education & Outreach; Advancing Health, Equity, & Social Resilience
TYPE OF TOOL:	Technical Support
GEOGRAPHIC SCALE:	Regional
LINK:	toolkit.climate.gov/case-studies/linking-boundary-chain (Source: US Climate Resilience Toolkit)

6. TAKE ACTION (CONTINUED)

6.11 COLLABORATIVE ACTION FOR LAKE MICHIGAN (CALM) COASTAL RESILIENCE

Building on the risk communication framework of the Southeastern Wisconsin Coastal Resilience Project, the Wisconsin Coastal Management Program, University of Wisconsin Sea Grant Institute, Wisconsin State Cartographer's Office, and the Wisconsin Department of Administration's State Geographic Information Officer partnered to develop the Collaborative Action for Lake Michigan (CALM) Coastal Resilience network funded by a NOAA Projects of Special Merit grant. CALM is a network for all of Wisconsin's Lake Michigan coastal communities working to continue building resilience to coastal hazards by expanding collaboration across the region, supporting development of local policies and plans, coordinating the regional prioritization of hazard needs, and sustaining and strengthening existing coastal resilience networks. CALM will focus on assisting communities in developing, revising, or adopting local ordinances and/or coastal hazard plans and policies through outreach, data development and management, and promoting products and tools.

STRATEGY:	Education & Outreach; Local Panning, Regulation & Policy
TYPE OF TOOL:	Technical Support
HAZARD(S) ADDRESSED:	Coastal Hazards
GEOGRAPHIC SCALE:	Regional; US; Lake Michigan
COST TO USE:	Free
LINK:	wicoastalresilience.org/

Tool Type:

Data Tool | Tool Helpers | Case Studies | Decision Support | Economic Tools | Funding | Technical Support

Geography:

United States (US) | US Indigenous | Canada (CA) | CA Indigenous | Any Geography

6.12 ONTARIO RESOURCE CENTRE FOR CLIMATE ADAPTATION (ORCCA)

The Ontario Resource Centre for Climate Adaptation (ORCCA) provides assistance to Great Lakes communities, including First Nation and Métis, and other Ontario users better understand, cope, manage, and adjust to changing climatic conditions. ORCCA provides programs such as direct technical support from ORCCA staff, supporting in implementing communication and outreach activities, and support to develop climate vulnerabilities and enhance resilience.

STRATEGY:	Local Planning, Regulations & Policy
TYPE OF TOOL:	Technical Support
HAZARD(S) ADDRESSED:	Customizable
GEOGRAPHIC SCALE:	Regional; Ontario, Canada
MORE INFORMATION:	Programs often operate on a yearly basis. ORCCA also operates a virtual support desk that provides direct technical support.
LINK:	orcca-craco.ca/

INDEX

ANY GEOGRAPHY

CANADA

TRIBAL AND FIRST NATIONS

TRIBAL AND FIRST NATIONS *(CONT.)*

UNITED STATES

UNITED STATES *(CONT.)*

APPENDICES

APPENDIX A – INITIATE AND ENGAGE

WHAT IS CLIMATE RESILIENCE?

The ability to bounce back and recover from a disaster event.

84%

of North America's fresh surface water comes from the Great Lakes

HOW CAN YOU HELP THE GREAT LAKES?

- Use less water.
- Keep it green (reduce pavement, concrete ditches, etc.)
- Reduce fertilizer use.
- Support legislative solutions.

ADAPTATION ACTIONS REDUCE IMPACTS & BUILD RESILIENCE

GREEN INFRASTRUCTURE

BETTER LAND USE PLANNING

WATER CONSERVATION

POLLUTANT CONTROLS

ADAPTATION BENEFITS

- INCREASED PROPERTY VALUES
- REDUCED PROPERTY DAMAGE
- LOWER INSURANCE PREMIUMS
- LESS LOSS OF LIFE
- LOWERED POLLUTION
- MORE GREEN SPACE

SOURCES

- epa.gov/greatlakes/great-lakes-facts-and-figures
- fool.com/money/research/how-will-climate-change-impact-homeowners-insurance-in-all-50-states/
- climatepolicyinitiative.org/wp-content/uploads/2021/10/Building-Climate-Resilience-in-Cities-Through-Insurance.pdf
- farmers.gov/sites/default/files/2022-09/farmersgov-fact-sheet-smart-nutr-mgnt-9-2022.pdf
- cnt.org/publications/green-stormwater-infrastructure-impact-on-property-values

Who to Involve and Engage Infographic

This infographic was created to help municipalities and communities determine who might be involved in the different parts of the Resilience Framework. This is not an all-inclusive list. The intent was to help municipalities to get started.

	General Public[1]	Municipal Organizations / Authorities[2]	State / Provincial Agencies[3]	Regional Organizations[4]	Federal Agencies[5]	Other[6]
Framework Step						
Initiate & Engage	X	X				X
Understand Risks		X	?	X	?	?
Assess Vulnerability		X	?	X	?	?
Investigate Options	X	X	?	X	?	?
Prioritize & Plan	X	X	?	X	?	?
Take Action	?	X	?	?	?	?

[1] Landowners (residential, commercial, industrial, developers, resident associations); tenants; farmers and agricultural organizations / groups; community and neighborhood organizations; business organizations

[2] Municipal staff, councils and committees; emergency management / services agencies, water / sanitary authorities, recreation authorities, drainage superintendents, source water protection authorities, Risk Management Officials/Officers for drinking water

[3] Departments of Transportation, Department of Health, Environmental Resource agencies; Ministries of Environment, Conservation, and Parks, Natural Resources and Forestry, Municipal Affairs and Housing, Agriculture Food and Rural Affairs, and Infrastructure

[4] Metropolitan planning organizations, conservation districts, conservation authorities, watershed groups, tourism agencies, non-governmental organizations and special interest groups (local naturalist clubs, rowing/canoeing clubs, watershed groups, Ontario Streams, Ontario Stone, Sand and Gravel Association, Ducks Unlimited, land trusts)

[5] U.S. Federal Emergency Management Agency, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration (US), Indigenous Nations, Environment and Climate Change Canada, Fisheries and Oceans Canada, Ministry of Energy and Natural Resources of Canada, Parks Canada, Infrastructure Canada, Port Authorities

[6] Healthcare, insurance companies, academia, marinas, professional associations

Apply the RAD Framework within the Adaptations Framework

The RAD (Resist-Accept-Direct) Framework, although not entirely new, underwent an adaptation in 2015 by the U.S. National Park Service and its partners. This modification aimed to enhance strategic thinking and facilitate clear communication regarding ecosystem transformation.

This simple and versatile decision-making tool can effectively support navigation and understanding of the Resilience Framework and Adaptations Implementation Process outlined in this guide. The Simplified Resilience Framework provided here can integrate RAD decision-making at crucial junctures where practitioners can:

- **Resist changes:** This involves identifying adaptation measures that counteract current changes to maintain the ecosystem's current state or slow down changes. Resisting change can make sense for high-risk assets where a loss of such asset would be detrimental to the community. Be aware that opting to "Resist" can result in complex and potentially costly adaptation measures, especially if an asset is highly vulnerable to climate impacts and a lot of investment would be required to stop or slow changes.
- **Accept changes:** This option involves allowing natural processes to proceed without intervention. While it involves minimal upfront costs, it may lead to higher costs in the future if assets suffer damage due to inaction. Accepting changes is often advisable for assets with low risks or minimal vulnerability to climate impacts.
- **Direct change:** Here, practitioners aim to guide the ecosystem or asset towards a desired future state through deliberate adaptation measures. This approach requires thorough planning during the Investigate Options stage to define clear goals and visions for the future state. Once the desired future state is established, appropriate adaptation measures can be explored to achieve this vision.

RAD Decision Points essentially occur at two locations within the Simplified Resilience Framework – at the “Understand Risk” stage and during “Assess Vulnerability.” As outlined in the above bullets, there is no one-stop-shop method for apply RAD; hard decisions must be made based on the input gathered from the Understand Risk and Assess Vulnerability steps. No two situations, communities or assets are the same; a decision for one may not make sense for a similar asset in another location. Remember that the Resilience Framework is iterative. During the Take Action step there is a need to monitor the results of actions and to reassess. Assets may, and will, need reconsidered. New RAD decisions, options, and plans will need investigated and implemented. The RAD approach is a simplified way to help organize decisions as you move through the process.

More information on RAD can be found here:

- U.S. National Park Service Report: irma.nps.gov/DataStore/DownloadFile/654543.
- RAD: A Paradigm, Shifting by John W Williams: academic.oup.com/bioscience/article/72/1/13/6429747.
- U.S. Geological Survey: academic.oup.com/bioscience/article/72/1/13/6429747.

APPENDIX B – UNDERSTANDING RISK

The table on the following page provides an example of types of assets (first column) that communities may consider in their resilience and adaptation planning. When brainstorming this list think about what is important to the community from a safety, cultural, connectivity, recreational, tax base, uniqueness, capital budget, maintenance or other perspective. Following the example table is a blank copy that can be pulled out of this document and used as a tool to help you document assets and risks as you work through steps 1 and 2 of the Resilience Framework.

For some community assets there maybe be questions related to ownership or jurisdiction (column 2 of the example table). For instance, a shoreline or stream riparian corridor may be within private property. In those instances, it is important to engage the property owner to understand their willingness to participate in a risk / vulnerability assessment and adaptation solutions planning process for that resource. The property owner also may need to be aware of the requirement for easements for maintenance or other purposes on the property after abatement measures are implemented. Working with a willing and engaged property owner(s) will be possible in some situations. In others, the property owner may refuse to engage in the process. In those instances, if failure of the asset is a detriment to the health and wellbeing of other community members or other assets, it may be necessary to use municipal authority to enact a solution. However, in most instances with an unwilling or uninterested property owner, it is probably best to revert to education and/or stewardship program funding as opposed to municipal jurisdiction or other regulatory requirements (e.g., provincial/federal).

The table also provides examples of types of hazards (columns 3 to 6) that may have been encountered historically and that could be experienced by the asset in the future (the graphic that follows this text provides additional examples of hazards and effects that could impact an asset). Stakeholder engagement can help identify what types of past water related events and hazards have occurred in your community. You can rely on stakeholder knowledge and research sources such as print and online newspaper archives and historic society records to identify potential hazards or where conservation authorities exist, contact them for current regulated areas and history of hazards in the area. Using this information then consider what might be likely over the next ten years (or other time frame of the community's choosing).

The final column provides a summary of what occurred as a result of past events and/or a qualitative analysis of the outcome of any future events.

Possible Hazards *(not all inclusive)*

- Floods
- Ice dams
- Harmful algal blooms (HAB)
- Heavy rainfalls
- Drought
- Erosion (waterways, shorelines)
- Fast snow melts
- Rising lake levels

Effects of Hazards

- Sewer system overflows
- Extreme runoff from fertilized (agricultural fields, maintained lawns, golf courses) or erodible lands
- Water borne pollution or sedimentation
- Industrial overflows
- Damage to roadways, bridges, and other infrastructure
- Storm system back-ups and overflows
- Increased sedimentation and debris laden runoff
- Shoreline damage and loss

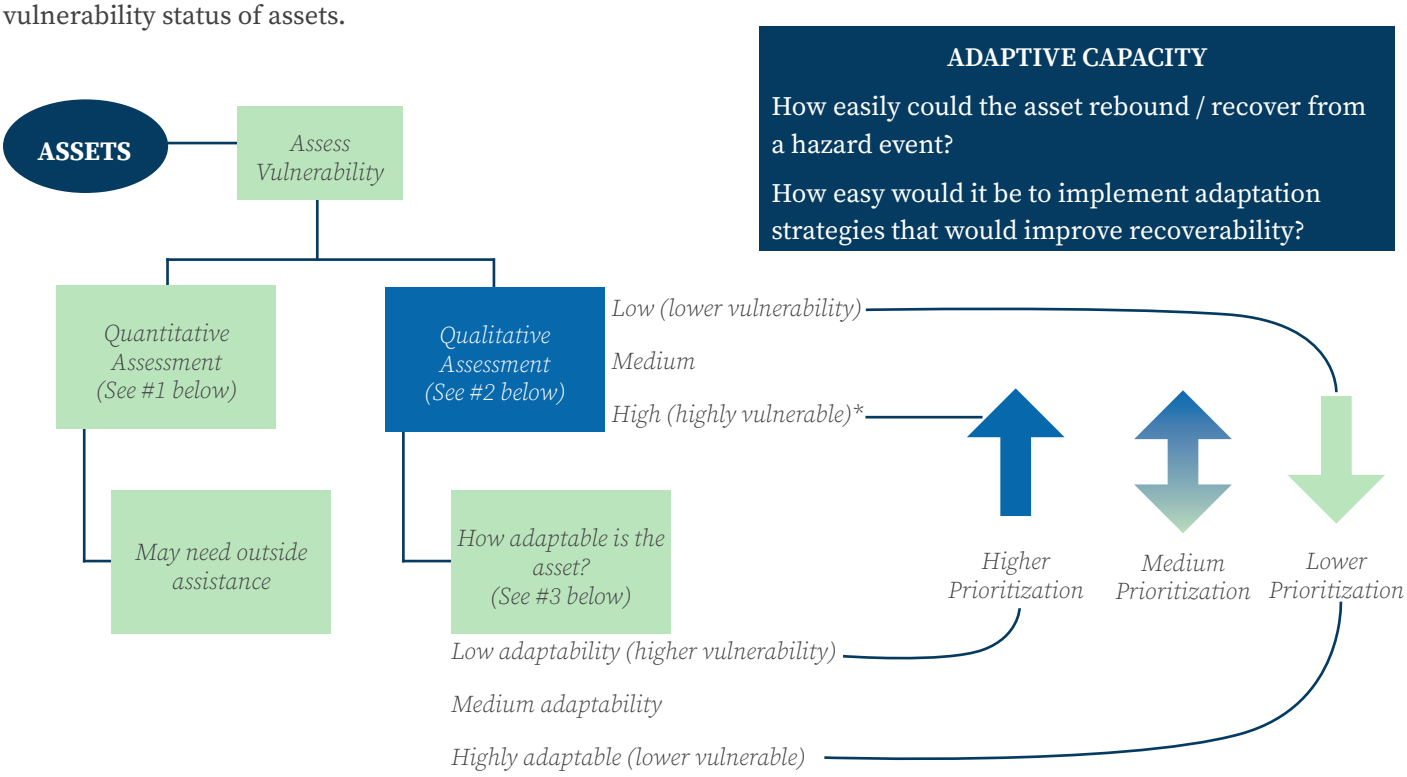
Understand Risks (EXAMPLE)						
Asset	Who Owns?	Hazard				Outcome of an Event *(EXAMPLES ONLY)*
		Flooding	**Heavy Rainfall**	**Drought**	**HAB**	
Water bodies (streams, rivers, lakes, ponds) – recreational use	Province or State	X	X	X	X	Damage to shorelines and nearby structures, unable to use for recreation.
Water bodies (see above) – potable water supply	Municipal	X	X	X	X	Pollutant load from a heavy rainfall runoff event has compromised the source; limiting water availability and increasing treatment costs.
Water bodies (see above) – irrigation	Private	X	X	X		Drought has reduced available water from normal sources and water now needs to be transported (trucked) from other locations.
Shorelines and riparian corridors	Private	X	X			Flooding & heavy rain has eroded the shoreline, increasing sediment load in the water and affecting recreational users (swim/boat) safety.
Treatment plants	Municipal	X	X	X		Overflow of sewage, lack of sufficient potable water for treatment.
Other community infrastructure (roads, bridges, buildings, dams)	Province or State / Municipal	X	X			Heavy rains have damaged a locally owned dam, causing a risk of failure. This required opening emergency spillways, reducing water availability for potable water.
Parks/green space	Municipal	X	X	X		Erosion, loss of park structures, unable to use
Land use planning tools*	Municipal	X	X	X	X	New development infrastructure failure, lawsuit due to insufficient consideration of resilient design standards
Farms	Private	X	X	X		Crop damage, fertilizer or livestock induced pollutant runoff into water bodies. Loss of farmland (and future productivity) due to erosion. Drought reduces crop production.
Industry / energy use (hydro plants, cooling towers, etc.)	Private / Corporate	X		X		Drought has reduced the availability of water and a local hydroelectric plant is now not able to operate at full capacity causing rolling brown outs and energy shortages.

** In Canada this could include, but may not be limited to, official plans, zoning by-laws, land use plans, subdivision plans, and land severances; in the U.S. this could include a wide variety of ordinances, including zoning ordinances and subdivision and land development ordinances (SALDOs); and in Indigenous Nations this could be a variety of tools including land use plans, conservation plans, and other tools, ordinances, or requirements.*

Understand Risks Worksheet						
Asset	Who Owns?	Hazard				Outcome of an Event
		_____	_____	_____	_____	

APPENDIX C – ASSESS VULNERABILITY

The following decision diagram is intended to help municipalities understand how to assess and evaluate the vulnerability status of assets.



**High risk / highly vulnerable assets may require a quantitative assessment. See #1 below.*

#1 - Quantitative Assessment (computer models & other data heavy assessment methods)

- Communities may choose to complete a more quantitative and detailed analysis using expert practitioners in the field of risk and vulnerability assessment.
- For high risk or highly vulnerable assets and situations, Quantitative Assessments may be necessary. When design of a solution is required (see Appendices D and E), quantitative data may be required.
- A quantitative assessment could include:
  - Analysis using tools, data, and computer-generated scenarios showing:
    - possible flood extent,
    - potential harmful algal bloom locations,
    - possible precipitation amounts, and
    - other data driven factors influencing vulnerability of assets.

#2 - Qualitative Assessment (brainstorming, surveys)

A Qualitative Assessment is much less data intensive and typically requires the knowledge of an asset's existing condition, of the area's history in terms of weather occurrences, and intrinsic understanding of the region. The 2-page worksheet on the following page can help with a Qualitative Assessment. The second part of the worksheet will help you identify the adaptive capacity of the asset (see inset). One worksheet should be completed for each asset being analyzed.

ASSET VULNERABILITY QUALITATIVE ASSESSMENT WORKSHEET

Name of the Asset:

Ask the following questions, depending on applicability to the asset being analyzed and circle the appropriate yes or no response.

Question	Vulnerability Assessment			
	Yes		No	
ASSET SPECIFIC QUESTIONS				
Is the asset located in an area that has historically experienced storm damage, flooding, etc.? (higher vulnerability)		1		0
Is the asset likely to be damaged by a climate induced hazard? (higher vulnerability)		1		0
Will loss of / damage to the asset greatly impact the community (higher vulnerability)? ("No" indicates more of an "inconvenience" than an impact to the community)		1		0
THE FOLLOWING QUESTIONS MAY APPLY DEPENDING ON THE ASSET BEING ANALYZED.				
Natural water body assets (streams, shorelines, lakes, etc.)				
Are the water bodies in your community surrounded by a robust and vegetated (not including agricultural fields) riparian corridor (generally 55 feet or more of width from the edge of the water) without the presence of development / buildings? (lower vulnerability)		0		1
Are the water bodies surrounded by development (hardscape, buildings and agricultural fields that abut or come within 55 feet of the water edge) that extend to the shorelines? (higher vulnerability)		1		0
Treatment plants, potable water supplies, and stormwater				
Are your treatment plants elevated above past and projected flood stages (lower vulnerability)? ("No" indicates that treatment plans are low in elevation making them susceptible to flood damage [higher vulnerability])		0		1
Is the existing potable water supply in a protected area that has little exposure to lawn / crop runoff, industrial outfalls, or erodible areas (lower vulnerability)?		0		1
Is the existing potable water supply in an area where industries, farms, golf courses, and other possible pollutant sources are adjacent to the water supply with little to no area for contaminate settling (higher vulnerability)?		1		0
Is the source of the potable water supply in an area protected by regulations or plans (Source Water Protection Plans, wellhead protection areas, intake protection areas)? (if yes, the resource could be considered more highly vulnerable).		1		0
Does your community have separate storm and sanitary sewers (lower vulnerability)? ("No" indicates that many combined sewer systems exist in the community)		0		1
TOTAL the points in the rows that are checked (both yes and no responses):				

Assets with a '0' score would be generally not vulnerable to climate induced effects. Any points here indicate an asset that has at least some vulnerability to climate impacts. The score does not give an idea of vulnerability extent only potential. The vulnerability points can help you prioritize between assets (assets with more points here should potentially be prioritized higher for adaptations than assets with lower points). The adaptability capacity analysis on page 2 of this worksheet will help you determine how easy it would be to adapt the asset to reduce its vulnerability. Combining the score on this page with the score on the following page can help you decide how highly to prioritize and asset (assets with a high vulnerability score on this page of the worksheet, combined with a high score in adaptability (page 2 of the worksheet) could prioritize higher as it would be anticipated that adaptations to those assets would be more valuable and may be completed more easily.

ASSET VULNERABILITY QUALITATIVE ASSESSMENT WORKSHEET (CONTINUED)

Question	Vulnerability Assessment			
	Yes		No	
ASSET SPECIFIC QUESTIONS				
Does the asset have flood barriers (if it is an asset where flooding is a risk)?		1		0
Is the asset in an area where there is available, municipal / community owned, space in which to make improvements? (assets that are constrained or that are in / adjacent to private properties may be less adaptable)		1		0
THE FOLLOWING QUESTIONS MAY APPLY DEPENDING ON THE ASSET BEING ANALYZED.				
Natural water body assets (streams, shorelines, lakes, etc.)				
Are there existing means to contain pollution?		1		0
Is the asset a large or fast-moving water body (able to recover more quickly from a pollution event than small, slow moving, or captive water body).		1		0
Is the area where the asset is located still relatively "green"? (Adaptation improvements to a greener shoreline would be less expensive and easier to implement than a shoreline that is confined by buildings, hard infrastructure, and utilities.)		1		0
Treatment plants, potable water supplies, and stormwater				
Does a potable water system have more than one source that are geographically separated? (A potable water treatment plant with multiple, geographically distant water supply sources would recover more quickly than a plant with a single supply source.)		1		0
TOTAL the points in the rows that are checked (both yes and no responses):				
As noted above the total score gives an idea of the ease of adapting an asset for climate change impacts. The higher the score, the more adaptable an asset may be. When combined with an idea the risks the asset faces (Appendix B), these points can help with prioritizing assets for adaptation measures. Prioritization is further discussed in Appendix E of the Adaptations Guide and Toolkit. The following inset box provides some additional prioritization considerations, which are also provided for ease of reference in Appendix E.				

Key Prioritization Considerations

- **Highly adaptable** assets would **prioritize lower** than assets that are low in adaptability, as the latter require more consideration to avoid future issues.
- **Quick to implement adaptation measures** are likely to cost less and should be considered as **higher prioritization**, unless the adaptation measure is proposed to an asset that is less critical.
  - Prioritizing expensive and timely adaptations to a potable water treatment plant might rank higher than adaptations to an undeveloped shoreline, even if the shoreline improvements are quick and less costly, due to the importance of the potable water source.
- Assets whose loss, even temporary, would cause **great hardship and/or loss of life** should **prioritize highly** in terms of adaptation consideration.

Much of the prioritization process revolves around the relative importance of the asset to the community, exposure to hazards, followed by how adaptable the asset already is, and the cost and time to implement any adaptations.

APPENDIX D – INVESTIGATE OPTIONS

The following table provides examples, again not all-inclusive (simply ideas to get a brainstorming or other engagement session started) of the types of adaptation options that may be available for a variety of assets. This is not an exhaustive list; the intent is to provide examples to help jump-start brainstorming and consideration of possible options.

Assess *Assets / Vulnerabilities*	***Implement Policies (audit / update / develop)***	***Implement Projects***
Flooding, erosion (coastal and inland)	Hazard Mitigation Plans, Zoning	Green infrastructure, nature-based solutions, retrofit and/or major maintenance of existing protection infrastructure, streambank restorations, wetland restoration
Approaching Buildout (little or no green space)	Zoning, land use and subdivision plans or ordinances, open space and greenway plans	Parks, greenways, natural area preservation
Nonpoint Source Pollution (agriculture, golf courses, etc.)	Permitting requirements that limit fertilizer and other chemical applications	Stewardship programs (e.g. Rural Water Quality program – Region of Waterloo)
Combined Sewer Overflows (CSOs)	CSO long term control plan	Construction of separate systems with a green infrastructure approach (grass swales, wetlands, etc.) used for stormwater
Municipal Separate Storm Sewer System (MS4/Stormwater Design Standards	Stormwater ordinances and/or program plans	Retrofitting of green infrastructure
Invasive Species	Land use/greenway/trail plans (require use of native species only and eradication of nonnative/ invasive species)	Eradication of an invasive and replanting with native species
Other (any and all possible water-related issues)	Local building and plumbing codes	No build areas, set-backs, strategic relocation plans

APPENDIX E – PRIORITIZE & PLAN

See Appendix C for more information on vulnerability and adaptability assessments. Prioritization could also consider a qualitative pro and con list for each adaptation strategy, along with a planning level cost estimate. An important concern to include is your **community's capacity to implement** identified solutions. This could be done with a simple ranking where a "1" indicates a solution the municipality could easily implement with current staff and a "2" would indicate a solution where the municipality would need to enlist the help of a design firm, construction firm or other organizations. Strategies with the most pros, least cons, lowest costs, and that are easily implementable ("1") would rank highest while other strategies would be subjectively ranked according to the same criteria. The key is to keep the ranking process simple, but to consider the value that is provided for the cost and the level of effort required to implement the solution.

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Much of the prioritization process revolves around the relative importance of the asset to the community, exposure to hazards, followed by how adaptable the asset already is, and the cost and time to implement any adaptations.

Planning Level Cost Estimates Tips

Cost estimates for a variety of adaptation strategies may be available in the various case studies included in this guide or via an internet search. Contact communities identified in the Volume II Case Studies that have completed similar projects and ask them for input on costs. There are many ways to estimate how much a project/strategy might cost to implement and the easiest and typically most useful way is to base your estimate on past similar projects.

Timeline for Development Tips

Once you have solutions prioritized, develop a simple timeline for how long it will take to implement each solution. Changes to ordinances might take a couple of months, while changes to an existing plan could take six months to a year. Adaptation strategies that require some level of design may take one to two years to implement. Funding is an important consideration. Needing to apply for grants and other sources of funding could add several months to a year or more to implementation timelines.

Grant Funding Competition and Application Assistance

Competition for grant funding can be very high and it can be difficult for smaller communities with smaller projects to compete well, especially for large state or federal grants. A few suggestions to help make projects more desirable to grant committees include:

- Collaborate with other municipalities to improve chances of funding
- Get community/watershed groups to help with applications and/or be a partner to the grant application
- Show how a variety of funding sources will be combined for the project
- In Canada, local Conservation Authorities (conservationontario.ca) will lead development of watershed/coastal funding proposals; some have staff assigned for that purpose. Check with your local conservation authority on programs and services already being offered or that could be offered in the future.

Grant applications can also be time consuming and very requirement specific. Many smaller communities do not have the expertise or staff to develop quality grant applications. The following tips can help with grant application development:

- Ask stakeholders if anyone has grant experience, or even just writing experience.
  - Grant requirements, while on the surface can seem intimidating, are usually not very difficult to understand.
  - Your local English teacher, librarian or business professional with a marketing or technical writing background may be willing to assist, for free, with writing the application.
  - A math teacher or local accountant may be willing to donate time to help with costing and benefits analyses.
- Reach out to local colleges to determine whether any Master's or PhD program students might need a project and could help.
- Local Cooperative Extension Offices may be able to provide assistance.
  - Cooperative Extension has been a service provided in both the U.S. and Canada, although the U.S. Offices may be more active (US: nifa.usda.gov/about-nifa/how-we-work/extension/cooperative-extension-system; Canada: uoguelph.ca/).

Grant Funding Sources (snapshot as of February 2024)

Numerous possible funding sources are available for climate adaptation in Canada. The following website is a useful place to start: canada.ca/en/environment-climate-change/services/climate-change/adapting/funding.html This link provides an overview of a number of funding sources available in Canada.

A wide variety of grants and funding programs are also available from the government of **Ontario, Canada** (ontario.ca/page/available-funding-opportunities-ontario-government). No open grant or funding programs were identified at the time of writing of this guide that would support climate adaptation projects. Several closed opportunities were noted that could, if they become available again, provide funding for climate adaptation projects and initiatives, including (see this link for information on the closed opportunities: ontario.ca/page/closed-funding-opportunities-ontario-government):

- Drinking Water Source Protection Program
- Great Lakes Local Action Fund
- Great Lakes Program
- Indigenous Communities Capital Grants Program
- Investing in Canada Infrastructure Program: Green Infrastructure Stream
- Ontario Community Environment Fund (ontario.ca/page/ontario-community-environment-fund)
- Species at Risk Stewardship Program
- Wetlands Conservation Partner Program

An additional Canadian funding source is the Federal of Canadian Municipalities, which supports local leadership in climate adaptation through the Green Municipal Fund. This fund provides 32 distinctive funding streams and opportunities: greenmunicipalfund.ca/funding.

A variety of federal and/or state funding sources are available to municipalities and Indigenous communities within the United States for actions related to water resources. There is no one site available in the United States describing each of these sources, therefore they are described briefly below:

National Oceanic and Atmospheric Administration (NOAA) – Community-Based Restoration Program (CBRP)

Funding for coastal and marine habitat restoration projects, such as hydrologic reconnection of wetlands, reef and bivalve shellfish habitat restoration. Feasibility studies, design, and implementation projects are eligible. Link: fisheries.noaa.gov/national/habitat-conservation/community-based-habitat-restoration

NOAA, National Fish & Wildlife Foundation, Shell and TransRE Public-Private Partnership (P3) National Coastal Resilience Fund (NCRF)

Funding (grants) for natural infrastructure to protect coastal communities from extreme storms and flooding while enhancing natural habitat. Capacity-building, planning, engineering, design and construction projects are eligible (living shoreline, floodplain/marsh/wetland restoration, and natural channel design). Link: nfwf.org/programs/national-coastal-resilience-fund

Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance (HMA)

Three funding programs for Hazard Mitigation Grants, Flood Mitigation Assistance, and Building Resilient Infrastructure and Communities (BRIC). Funds a broad range of hazards, including drought and flood risk reduction, aquifer storage/recovery, floodplain/stream restoration, and flood diversion/storage. BRIC prioritizes projects that mitigate risks to public infrastructure and lifelines, incorporate nature-based solutions, and support modern building codes. Link: fema.gov/grants/mitigation

FEMA Public Assistance (PA)

FEMA's largest grant program, which provides funds to assist communities responding to and recovering from declared disasters. This fund program is reactive and not proactive as this guidance intends. However, it is worth mentioning here, as communities with existing damage from past declared disasters could use this funding to further climate resiliency efforts. Link: fema.gov/assistance/public

Housing and Urban Development (HUD) Community Development Block Grant (CDBG) and CDBG-Disaster Recovery Program

Primarily provides funding for affordable housing in the most vulnerable communities, but the disaster recovery program can be used in ways similar to FEMA's PA grant program. CDBG funding may also be used as the non-Federal (local and/or state) match for other mitigation programs, such as HMA and PA mitigation. Link: hud.gov/program_offices/comm_planning/cdbg/ and hud.gov/program_offices/comm_planning/cdbg-dr

Section 319 Nonpoint Source Management Program (Section 319) [NPS Program]

Established under the US Clean Water Act, this program helps focus efforts to address nonpoint source (NPS) pollution caused by land runoff from rainfall and snowmelt. The funding can be used for technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and regulatory programs. Link: epa.gov/nps/319-grant-program-states-and-territories

While not a direct funding program, **FEMA's Community Rating System (CRS)** can lower flood insurance rates for communities that implement nature-based solutions and preservation actions related to funding. Communities can gain credits for eligible and appropriately implemented solutions that reduce FEMA flood insurance premiums. Link: fema.gov/floodplain-management/community-rating-system

The US Environmental Protection Agency (US EPA) Clean Water State Revolving Fund (CWSRF)

The state CWSRF programs provide low interest loans to eligible recipients for water infrastructure projects. Eligible projects include construction of publicly owned treatment works; nonpoint source pollution management program; measures to manage, reduce, treat, or recapture stormwater or subsurface drainage water; measures to reduce the demand for publicly owned treatment works capacity through water conservation, efficiency, or reuse; watershed pilot projects; water reuse; technical assistance to treatment plant operators; and other programs and projects. Link: epa.gov/cwsrf state by state contacts: epa.gov/cwsrf/state-cwsrf-program-contacts)

Many **US states** offer low interest loan programs for municipal projects, including (may not be an exhaustive list):

- Illinois – wastewater/stormwater and drinking water loans (epa.illinois.gov/topics/grants-loans/state-revolving-fund.html).
- Michigan – local government loan program (michigan.gov/treasury/finance/fin-prog/loan); Michigan Department of Environment, Great Lakes, and Energy (EGLE) Coastal Management Program 2025 Grant Funding Opportunity).
- Minnesota – Agriculture BMP loan program (mda.state.mn.us/business-dev-loans-grants/local-government-information-agbmp-loan-program).
- New York – see CWSRF above.
- Ohio – Ohio Water Development Authority offers a variety of loan programs (owda.org/program-guidelines).
- Pennsylvania – PennVest (pennvest.pa.gov/about-us/Pages/default.aspx).
- Wisconsin – Department of Natural Resources clean water and drinking water revolving loan fund (dnr.wisconsin.gov/aid/EIF.html).

APPENDIX F – TAKE ACTION

An important part of taking action is tracking and monitoring implementation of any adaptation solutions. Tracking completed efforts and the results is important especially in keeping stakeholders updated and engaged in what is an iterative process. Monitoring how the adaptation strategies perform during weather events is vital. Appropriate monitoring, which can be a simple as visual assessment of how well any improvements held up, helps you know whether the implemented strategies are sufficient and are going to perform as planned. Monitoring of performance will allow you to make adjustments and changes as needed. It will also inform your planning process as you iterate through the different parts of the resilience framework over time. **Reviewing the list of identified assets, risks, vulnerabilities, and possible adaptation strategies periodically, at least once a year**, will allow for identification of assets or risks that may have been overlooked on the first iteration. Integrating what you have learned from previous adaptation strategy implementation and monitoring will allow for better identification of future improvements. The following table is a sample tracking chart. Following the sample is a blank tracking spreadsheet the you can print and use for your own monitoring efforts.

Take Action: Sample Tracking Chart					
Adaptation Strategy	**Date of Event**	**Description of Event**	**Results / Observations**	**Date of Observation**	**Notes**
Grass lined swale replacing concrete pipe along Main Street	4/10/2030	Heavy rainfall	Water contained in swale; functioned well	4/15/2030	
	8/25/2030	Flooding	Water over-topped swale and eroded sides	8/25/2030	Consider depth of swale; consider type of vegetation
	8/25/2030	Flooding	Vegetation missing or dead	9/15/2030	May need more deep rooted vegetation than grass
Updated land use requirements, mandating that developers to use green / natural solutions unless they can prove such a solution would not work (enacted 5/15/2030)	N/A	General Observation	Most submitted plans use only green / natural designs and fit better with the ecosystem	10/20/2030	
	8/25/2030	Flooding	Extensive flooding throughout the region	8/26/2030 – 9/15/2030	Developments with green infrastructure and natural solutions seem to have less flood damage

Take Action: Tracking Chart Worksheet					
Adaptation Strategy	Date of Event	Description of Event	Results / Observations	Date of Observation	Notes

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