

OAKLAND COUNTY CLIMATE VULNERABILITY ASSESSMENT PRIMER



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Acknowledgements & Contacts.

A step-by-step guide to help municipalities understand climate hazards and prepare for further assessment and adaptation.

- *Identifying and prioritizing climate-related risks*
- *Defining the climate vulnerability assessment process*
- *Supporting data-driven and evidence-based decision-making*
- *Centering equity and enhancing community engagement in the planning process*

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How to Use This Primer.

This primer is designed to help local municipalities understand how climate change will impact their community. After following this primer, users should understand future climate projections, vulnerability, and the need for proactive adaptation to climate hazards. Users do not need prior experience in climate planning.

The primer offers a step-by-step framework for understanding the three main components of climate vulnerability: exposure, sensitivity, and adaptive capacity. Users will explore each of these components in their local context. Where possible, data sets, online mapping resources, and relevant climate projections are provided.

To help users organize and present the results of their preliminary climate vulnerability assessment, a report template was created to accompany this primer. The template is a separate file, called “Preliminary Climate Vulnerability Assessment Template.” The template allows users to create a customized report while working through the primer. **Instructions in bold** indicate that there is a corresponding template section to input data.

Finally, the primer provides an overview and resources for pursuing the next steps of vulnerability assessment and adaptation action.

There is no one-size-fits-all formula for exploring climate vulnerability. This template provides guidance for the process, but your community provides the local expertise. Your main role will be synthesizing knowledge and experiences from multiple sources, understanding how they connect, and grounding your work in community knowledge and priorities.

This report can serve a diverse range of users, including municipal staff (city planners, sustainability coordinators, hazard mitigation planners, and public works professionals), elected officials, advisory boards, community-based organizations, and consultants supporting local climate adaptation efforts. The content is written to be both accessible to non-technical readers and adaptable across different planning contexts, regardless of users' technical expertise in climate science.

Before following individual steps within the primer, users should review the complete document to gain an understanding of the process and available tools. Users can reference specific sections as needed to support planning initiatives, grant applications, zoning revisions, or public engagement activities. This report is designed for reuse and customization, serving as a living resource for ongoing climate resilience efforts.

Introduction.

Climate change refers to long-term changes in the Earth's climate system, including shifts in average weather patterns and increased variability, occurring over decades or longer (IPCC, 2021; NASA, n.d.; UNFCCC, 1992). **Climate vulnerability** refers to the degree to which people, institutions, systems, or communities are adversely affected by climate hazards.

Communities across Michigan are already experiencing the impacts of a changing climate. Since 1951, average temperature in the Great Lakes region has warmed by approximately 2.9°F, with winter temperatures increasing fastest. Over the same period, annual precipitation rose by roughly 15%, and the volume of rain falling in the heaviest 1% of storms increased by 36% ([GLISA](#)). These shifts have led to more frequent and intense weather events, such as heavier storms, historic flooding, and heatwaves. These events create hazards for human health, community infrastructure, and the economy.

Between 2020 and 2025, Oakland County communities have experienced a range of climate-related impacts. A few examples are highlighted below:

- On August 24, 2023, heavy rainfall of 3-5 inches over a few hours caused widespread basement flooding and road closures across Metro Detroit, significantly impacting parts of Oakland County.
- The record-breaking global heat events of 2023, driven by El Niño and amplified by climate change, brought extreme temperatures to Michigan. There has been an increase in the frequency and severity of extreme heat events across Southeast Michigan.
- In June 2022, the Great Lakes Derecho, a long-lasting, fast-moving windstorm, swept through the Midwest and caused widespread power outages affecting more than 400,000 households. The storm hit during a heatwave, compounding the threat to public health and critical systems.

Events like this are becoming increasingly common and intense. Local governments have a responsibility to prepare for these evolving conditions. Assessing climate vulnerability empowers local municipalities to understand their specific risks, identify the populations and systems most vulnerable to them, and plan targeted adaptation strategies that are equitable and effective.

It is critical to note that climate change does not affect everyone equally. Communities that are historically underserved, environmentally burdened, or socially marginalized often face disproportionate impacts from climate hazards. For this reason, equity is a central consideration throughout this primer and is integrated into both the analysis and recommendations that follow.

Regional Climate Change.

The Great Lakes region is already experiencing noticeable impacts from climate change. According to [GLISA](#), the region has warmed by an average of 2.9°F since 1951, with warming occurring year-round but most pronounced in the winter months. Climate models project that by the end of the century, the region will see significantly more warming, between 6°F and 11°F. This warming leads to cascading effects across natural systems, human health, economic systems, and community infrastructure.

Changes in precipitation are also among the most critical shifts in the region. The Great Lakes states have seen a 14% increase in annual precipitation since the early 20th century, with more frequent and intense heavy rainfall events. This increase in precipitation contributes to stormwater system overload, surface flooding, and basement backups, especially in areas with aging infrastructure and high impervious surface coverage.

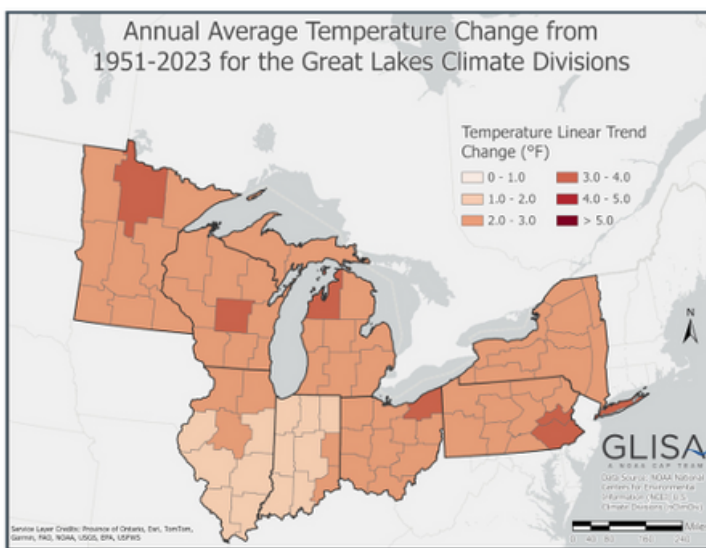


Figure 1. [GLISA Great Lakes Historic Temperature Changes](#)

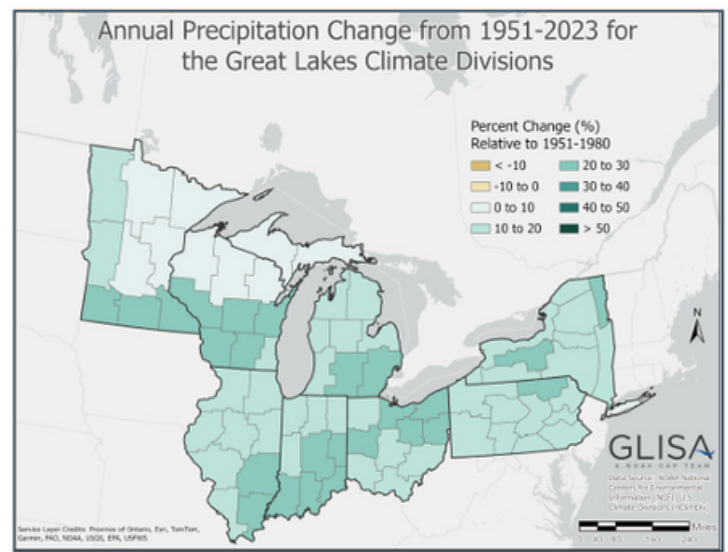


Figure 2. [GLISA Great Lakes Historic Precipitation Changes](#)

In addition to warmer and wetter conditions overall, the Great Lakes region is experiencing shifts in seasonal patterns, such as earlier snowmelt, shorter winters, and longer growing seasons. These changes disrupt ecosystems, create challenges for snow and ice management, and increase the potential for vector-borne diseases. These transitions may affect infrastructure maintenance, local recreation, and energy use patterns in municipalities where winters are historically cold and snowfall is a defining seasonal feature. Unpredictable weather also creates vulnerability for agricultural producers, through crop and income loss.

Much of Southeast Michigan will likely face more frequent and longer heat waves by mid-century. This trend increases the risk of heat-related illness, particularly for vulnerable populations such as older adults, residents with pre-existing health conditions, and those without access to air conditioning. Urbanized areas with fewer trees, extensive paved surfaces, and dense development experience even higher temperatures than the surrounding regions.

Why Assess Climate Hazards?

Assessing climate hazards allows communities to strategically and proactively adapt to the changing climate. This adaptation can protect community assets, public health, and economic vitality.

A **climate vulnerability assessment** evaluates a community, system, or resource's vulnerability to the impacts of climate change. It investigates expected changes in climate, and how the changes interact with local environments, infrastructure, and populations. This primer follows the Intergovernmental Panel on Climate Change Climate Vulnerability Assessment Framework, which defines vulnerability as a function of three interrelated components: exposure, sensitivity, and adaptive capacity.

- **Exposure** refers to the presence of people, assets, and ecosystems in places where they could be negatively affected by hazards. This includes the frequency and intensity of events such as extreme rainfall, heatwaves, or flooding. For example, Michigan is **exposed** to heat waves, but not tsunamis.
- **Sensitivity** refers to the degree to which a system or population is impacted when exposed to climate hazards. The extent of impact depends on factors such as the condition of infrastructure, population health, and access to resources. For example, outdoor workers, people over 65, or people with certain medical conditions are more **sensitive** to extreme heat than individuals who can stay inside, younger adults, or healthy individuals.
- **Adaptive capacity** is the ability of a community to prepare for, respond to, and recover from climate impacts. This includes access to resources, public services, governance, and community networks. For example, a community with public cooling centers can **adapt** better to extreme heat than a community without public cooling centers. Communities with strong social support systems, effective emergency response, and proactive planning are more likely to reduce their vulnerability through **adaptation**.

By analyzing these three components together, a climate vulnerability assessment enables local governments and stakeholders to identify who and what is most at risk, and to design targeted strategies that enhance resilience and equity. This approach ensures that future planning and investments are informed by both environmental data and community realities.

Example of Components to Consider in a Climate Vulnerability Assessment		
Exposure	Sensitivity	Adaptive Capacity
Drought	Pre-existing health conditions	Education, Skills, Language
Flood	Social Demographics	Social Networks
Heat	Proximity to Water Bodies	Public Participation
Windstorm	Energy Burden	Physical abilities
Snowstorm	Age & Condition of Infrastructure	Financial abilities

Table 1. Vulnerability Assessment Framework

Understanding Exposure.

Understanding which climate hazards may impact your community is the foundation of a climate vulnerability assessment. The U.S. Climate Resilience Toolkit hosts a [list of hazards](#), and additional hazards are listed in the included assessment template. Use the following resources to identify what hazards your community is exposed to:

1. *Historic hazards.* Use a search engine to look for news reports of climate-related hazards that have occurred in your municipality in the past 15–25 years. Consider events such as major storms, power outages, floods, heat waves, blizzards, poor air quality, etc. **List these events with a brief description in the “Climate Change Impacts” section of the assessment template.**
2. *Historic climate data.* Research how climate conditions have already changed in your community. You can use the [Climate Explorer tool](#) to see historic data and visualizations. You can also use the GLISA [Interactive Climatologies](#) site to locate the weather station closest to your community, which will have historic data. **Use one of these resources to research historic changes in climate conditions and record the data in the template.** For Oakland County users, data from the two closest weather station are already included in the template.
3. *Future hazard exposure.* Explore your community’s projected climate trends using a tool such as [Climate Explorer](#). Think about any new hazards that may occur due to the projected changes, or any existing hazards that may intensify. **Add these climate hazards to the “Climate Change Impacts” list.**



Figure 3. Climate Hazard Example - Flooding



Figure 4. Climate Hazard Example - Drought



Figure 5. Climate Hazard Example - Wind Storm



Figure 6. Climate Hazard Example - Snow Storm

Understanding Sensitivity.

Next, you will explore how sensitive your community is to the identified hazards. You will identify sensitive populations, neighborhoods, assets, and systems. Systems include food systems, transportation systems, energy and water systems, and others.

It is valuable to choose a few priority populations or systems to focus on. If possible, meet with community members, planners, public works, and infrastructure engineers to identify priorities. Lived experiences and community priorities are integral to this process. **List priority systems in the “Sensitivity to Climate Hazards” section of the template.**

This section offers resources to identify sensitive populations, systems, assets, or neighborhoods and, if needed, prepare data for stakeholder meetings. Research factors contributing to sensitivity, such as:

1 BUILT ENVIRONMENT & INFRASTRUCTURE

- Stormwater infrastructure age and capacity (sewer maps, maintenance records)
- Road networks and major transit corridors
- Location of critical facilities (hospitals, fire stations, shelters)
- Housing stock age, type (single-family, multi-unit), and condition
- Land use and zoning maps
- Impervious surface area
- Tree canopy coverage
- Urban heat island data

Online resources to find this data include:

[SEMCOG Flood Risk Tool](#) & [Green Dashboard](#) | [Headwater Economics](#)
[Neighborhoods at Risk](#) | [Tree Equity](#)

2 DEMOGRAPHIC & PUBLIC HEALTH DATA

- Population density
- Age-based vulnerability (% under 5, % over 65)
- Households below the poverty line
- Renters vs. homeowners
- People of color (% non-white population)
- Linguistic isolation (limited English)
- Disability status
- Uninsured population
- Health indicators (asthma, heart disease, low birth weight)
- Proximity to pollution sources

Online resources to find this data include:

[US Census Bureau](#) | [MiEJ Screen](#)
[SEMCOG Community Explorer](#) &
[Demographic Emphasis Areas](#)

Not all listed factors are relevant to every community, and the listed factors are not exhaustive. Some information may require local studies, surveys, or community engagement. You may need to request data from regional partners or utilities. However, many data can be found online at the sources above or in Appendix B. The next section highlights online mapping tools to deepen sensitivity research.

Record relevant data and any stakeholder input in the template. Whenever possible, group data based on geographic sections. This will allow you to prioritize adaptation resources where most needed.

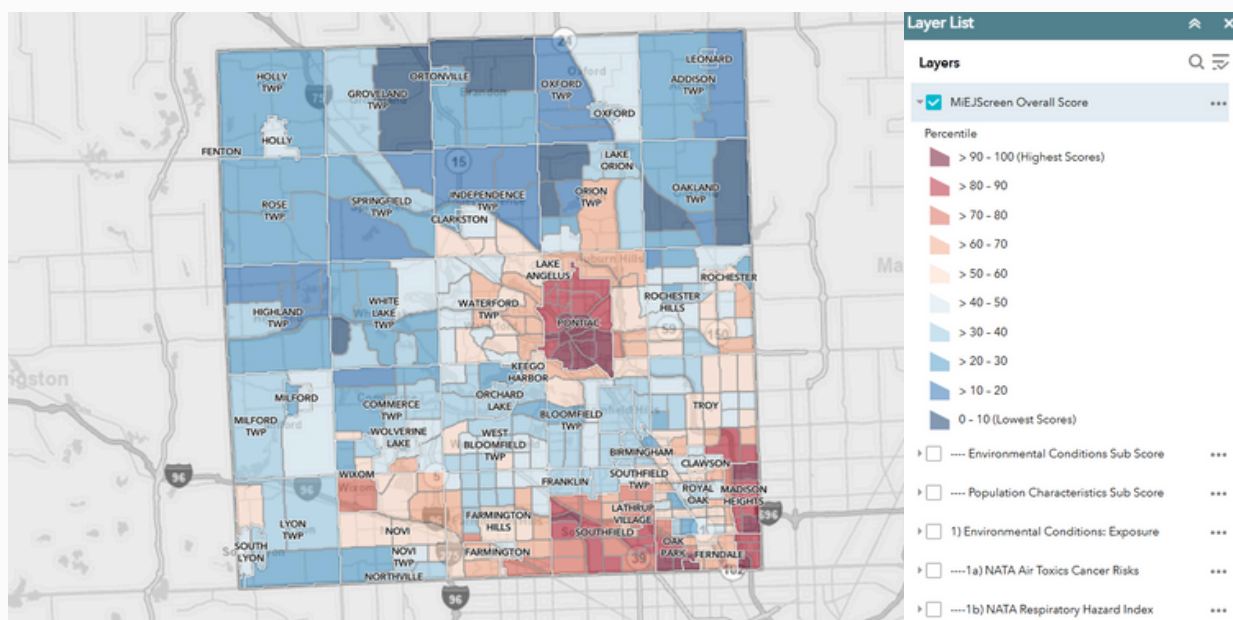
Mapping Tools.

There are multiple free online mapping tools that can help you analyze the exposure and sensitivity of distinct geographic areas. This section explores how to use two of these mapping tools. Additional tools and full website URLs are listed in Appendix C.

The [Michigan Environmental Justice Screening Tool \(MiEJScreen\)](#) provides a user-friendly and publicly accessible platform for evaluating local characteristics contributing to social and physical sensitivity. Developed by the Michigan Department of Environment, Great Lakes, and Energy (EGLE), this tool offers census tract-level data on environmental exposures, demographic characteristics, and health-related burdens.

Using MiEJScreen’s interface, users can:

1. Search for “[Municipality], MI” and view boundaries and tracts of interest
2. Activate relevant data layers via the Layer List. Turn on legend if needed.
3. Click on individual census tracts to view percentile rankings for key indicators
4. Export maps using the Print function for inclusion in reports and presentations



The [Neighborhoods at Risk](#) tool provides an interactive platform for exploring neighborhood characteristics and national climate projections. Developed by Headwater Economics, data is also shown at the census tract level, and the tool offers auto-generated reports of the data. A video on how to use the tool is featured on the website’s home page.

These low-barrier spatial analysis methods enable municipalities to create clear, data-driven maps of vulnerability without advanced GIS software or technical staff. The results help prioritize investments in neighborhoods facing the greatest environmental and social risks.

For communities within the Southeast Michigan Council of Government’s jurisdiction, SEMCOG has many additional mapping datasets, including the [Flood Risk Mapping](#) tool which shows major roadways at risk of flooding, the [GREEN dashboard](#), for green infrastructure and more. (Appendix B)

Understanding Adaptive Capacity.

To understand adaptive capacity, you will investigate who has access to and control over natural, social, physical, and financial resources. These resources allow people and systems to adapt to climate hazards. Local governments must consider how to increase access to resources, and how best to use government resources to equitably improve adaptive capacity.

Consider the priority sensitive systems or populations that you identified in the previous section. **Start by identifying adaptation resources for each priority systems/populations, and list them in the template.**

Adaptation resources can include:

1 COMMUNITY RESOURCES

- Good health/physical ability
- Individual financial resources
- Broadband internet access
- Access to healthcare services
- Knowledge or access to knowledge
- Trust in institutions
- Presence of neighborhood organizations or mutual aid groups

2 GOVERNMENT RESOURCES

- Location of community centers and cooling centers
- Emergency shelter locations
- Public transit accessibility
- Redundant systems
- Adequate stormwater systems
- Funding to update systems before hazards and recover after hazards

Next answer the questions below for each chosen system/population, referencing the adaptation resources, local knowledge, and community input when possible:

- Does the system/population have what it will need to adapt to the impacts identified?
- Can the system/population accommodate projected climate impacts with minimum disruption or costs?
- If not, what does the system/population need to help it adapt to the identified impacts?
- Is the system/population already stressed in ways that will limit its ability to accommodate identified impacts?

For example, examining the ability of low-income seniors to adapt to extreme heat may yield the following answers: “20% of low-income seniors do not have A/C in their homes. Purchasing and running an A/C unit would be a significant cost burden. To help adapt, the community can create a rebate program to help low-income residents purchase a high-efficiency A/C.” This framework allows you to explore the degree of cost, effort, and coordination needed to adapt to specific hazards.

As with sensitivity, data alone can’t provide a full understanding of adaptive capacity. Understanding this component of vulnerability requires community input. However, elements like green stormwater infrastructure, community resilience hubs, strong emergency response plans, communication strategies, available funding, and urban tree canopy all contribute to adaptive capacity, and are within control of local governments to influence.

Synthesis.

This primer serves as a foundation for your community’s adaptation journey. Users should have an understanding of the basic climate vulnerability in their community. Exposure, sensitivity, and adaptive capacity have been defined and explored within the local context. Data sets, online resources, and mapping tools have been provided.

Include your responses to the questions below in the “Results” and “Next Steps” sections of the template. These questions can provide guidance as your community considers its next steps in preparing for climate change. The “Next Steps” section below provides resources for continued work.

Adaptation is a continuous process and future climate conditions are uncertain. By taking the time to assess and prepare, you can empower your community to thrive and adapt in the face of a changing climate.

OVERALL RISK SUMMARY

- What are the most pressing climate risks for the community?
- Are risks escalating over time?
- Which systems are most at risk?

Include your answers in the “Results” section of the template.

IDENTIFIED GAPS IN CAPACITY OR KNOWLEDGE

- What limitations or challenges became evident during the assessment?
- Examples: lack of localized data, limited technical staffing, or funding constraints.

Include your answers in the “Next Steps” section of the template.

COMMUNITY STRENGTHS AND OPPORTUNITIES

- What existing strengths (community engagement, green infrastructure, community centers) can support adaptation?

Include your answers in the “Next Steps” section of the template.

PLANNING IMPLICATIONS

- How can this assessment inform local policies, zoning, infrastructure planning, and emergency preparedness going forward?

Include your answers in the “Next Steps” section of the template.

Next Steps.

To build on this work, users can conduct deeper climate vulnerability assessments, share findings from this primer with the community or internal stakeholders, review community plans, and/or recommend adaptation projects.

Conducting a further climate vulnerability assessment:

You may hire a consultant to conduct a climate vulnerability assessment or conduct the assessment internally. If you plan to conduct an assessment internally, utilize the Steps to Resilience provided by the [US Climate Resilience Toolkit](#). The US Climate Resilience Toolkit walks users through each step, including guidance on how to create your internal climate assessment team. If you plan to assess a highly technical system, such as a stormwater system, consulting technical experts is critical to success.

Community engagement around climate vulnerability:

You may want to share the findings from this primer with your community or with internal stakeholders. Consider the neighborhoods or populations that you identified as vulnerable in this primer. Host community events in those neighborhoods, and consider the best outreach methods to reach those populations. Stakeholders don't need to be climate experts - ask them about their experience with flooding, extreme temperatures, power outages, and how they adapt to these struggles.

Reviewing community plans:

Your community likely has multiple planning documents that should include climate vulnerability. For example, your master land-use plan, comprehensive plan, green space plan, hazard mitigation plan, or downtown development plan. Present the findings of this primer to your planning team, and work together to identify ways to integrate climate vulnerability into planning. The [Michigan Association of Planners](#) has resources for professional planners.

Recommending adaptation projects:

You may have adaptation projects in mind after completing this primer. For example, if you identified a particularly flood-prone neighborhood, you may want to recommend green stormwater infrastructure investments. The climate hazard report can serve as a justification for proposing such projects. The US Climate Resilience Toolkits host a list of [potential adaptation strategies](#) that can be filtered by hazard.

Communities within Oakland County can reach out to Oakland County Office of Sustainability for technical assistance at sustainability@oakgov.com.

Appendix A.

Understanding Climate Science

- State of Michigan: Climate and Health Overview
<https://www.michigan.gov/mdhhs/safety-injury-prev/environmental-health/topics/climate/overview>
- NOAA's Climate 101: Science, Impacts, and Society
<https://coast.noaa.gov/digitalcoast/training/climate-101.html>
- Climate Central
<https://www.climatecentral.org/climate-local/41432>
- GLISA: Climate Trends in the Great Lake Region
<https://glisa.umich.edu/wp-content/uploads/2025/06/GLISA-Climate-Trends-2-Pager.pdf>
- GLISA: Summary Climate Information
<https://glisa.umich.edu/summary-climate-information/>
- Global Historical Climatology Network daily (GHCNd)
<https://www.ncei.noaa.gov/products/land-based-station/global-historical-climatology-network-daily>
- Dynamical Downscaling for the Midwest and Great Lakes Basin
<https://ccr.nelson.wisc.edu/visualization-and-tools/dynamical-downscaling-for-the-midwest-and-great-lakes-basin/>
- Interactive Climatology Map: ANN ARBOR, MI and FLINT, MI
<https://glisa.umich.edu/climate-data/great-lakes-climatologies/>
<https://glisa.umich.edu/station/ann-arbor-u-of-mich/>
<https://glisa.umich.edu/station/flint-bishop-intl-ap/>

Appendix B.

Assessing Climate Hazards, Sensitivity, and Vulnerability

- **Climate Vulnerability Assessment Framework**
<https://www.ipcc.ch/report/ar6/wg2/>
- **U.S. Climate Assessment Toolkit**
<https://toolkit.climate.gov/assess-vulnerability-and-risk>
- **Implementing the Steps to Resilience: Practitioner’s Guide**
https://drive.google.com/file/d/1HX2auZHpjeSPUWrKg4RdW50-xTTOC-_U/view
- **NOAA: Storm Events Database**
<https://www.ncdc.noaa.gov/stormevents/>
- **U.S. Census Bureau**
<https://www.census.gov/>
- **SEMCOG Data resources**
<https://maps.semco.org/CommunityExplorer/>
<https://maps.semco.org/DemographicEmphasisAreas>
<https://maps.semco.org/floodrisktool/>
<https://maps.semco.org/green/>
- **FEMA CDC Social Vulnerability Index**
<https://www.fema.gov/node/cdc-social-vulnerability-index>
- **NWS Heat Risk**
<https://www.wpc.ncep.noaa.gov/heatrisk/>
- **Tree Equity Dashboard**
<https://www.treeequityscore.org/map>

Appendix C.

Online Mapping Tools

- Michigan GIS Open Data
<https://gis-michigan.opendata.arcgis.com>
- Headwaters Economics
<https://headwaterseconomics.org/apps/neighborhoods-at-risk/>
- The Climate Explorer
<https://crt-climate-explorer.nemac.org/>
- MIEJScreen
<https://crt-climate-explorer.nemac.org/>

Next Steps and Adaptation Planning

- Michigan Association of Planners
<https://www.planningmi.org/aws/MAP/pt/sp/vulnerability-assessments>
- Climate Options Database
<https://toolkit.climate.gov/option>