Planning for Community Resilience in Michigan

A Comprehensive Handbook

April 2017

Acknowledgments

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The statements, findings, conclusions, and recommendations in this handbook are those of the authors and do not necessarily reflect the views of the Department of Environmental Quality and the National Oceanic and Atmospheric Administration.

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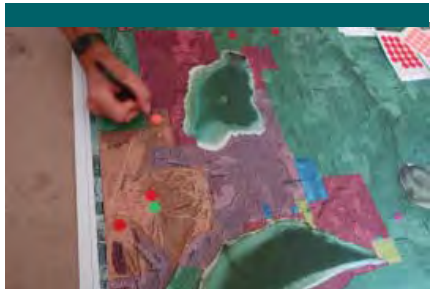

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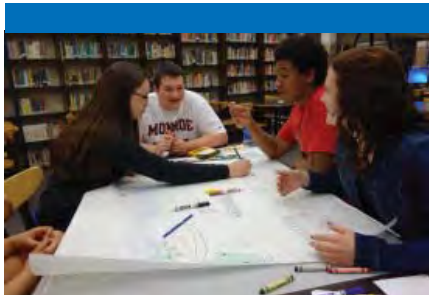

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Community Resilience is "the capacity of (communities) to function, so that the people living and working in (communities) – particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter."

The Rockefeller Foundation

Chapter {1}

Building Community Resilience in Michigan

As land-use planners and policy makers, we are committed to thinking long-term about changes and trends, and how they will impact our communities and natural resources. This chapter explains how to use this Handbook, gives a brief overview of climate trends in Michigan, and explains how the role of the planner fits within the resiliency framework.

Many of the 21st century urban and suburban issues faced by Michigan communities have a direct or indirect connection to global forces far beyond direct local control. Our food systems, critical infrastructure, natural resources, and social systems are intricately connected to and impacted by a wide range of global, regional and local forces, including climate change. How can local communities effectively respond and thrive?

Though complex, these interlinked systems and challenges also offer a unique opportunity for communities to take a truly comprehensive approach to community planning and resource management.

Defining Community Resilience

Resilience has become an umbrella term for the planning and design strategies needed to help communities meet the economic, social, environmental and climate challenges of the future. Community resilience is a measure of the sustained ability of a community to utilize available resources to respond to, withstand, and recover from adverse situations.

Communities interested in becoming more resilient assess their vulnerabilities and make action plans to reduce their sensitivities and exposures to hazards of all kinds. For example, local governments can improve building standards to reduce heating and cooling challenges posed by severe temperature swings (both cold and heat).

Improvements in social cohesion and civic engagement also improve community resilience, by increasing the capacity of volunteer organizations and providing more secure neighborhoods, among other things. Planning processes can help increase civic engagement

SIX AVENUES FOR INTEGRATING RESILIENCY INTO LOCAL POLICIES, PLANS, AND PROJECTS

	TOPIC	DOCUMENT TYPE
1	**TRADITIONAL PLANNING**	Master Plans Parks and Recreation Plans Neighborhood Plans Zoning Ordinances Downtown Development Plans
2	**MULTI-JURISDICTIONAL AND REGIONAL**	Natural Hazard Mitigation Plans Regional Management Plans Brownfield Redevelopment Strategies
3	**GENERAL MUNICIPAL RESPONSIBILITIES AND ADMINISTRATIVE REVIEW**	Stormwater Management Development and Redevelopment Proposals Capital Improvement Plans
4	**POLICY AND ADVOCACY**	Energy Planning and Policy Climate Actions Plans Aging in Place Affordable Housing Food Security
5	**TRANSPORTATION**	Corridor Plans Long-Range Transportation Plans Non-motorized Plans
6	**NATURAL RESOURCES**	Food Policy and Agricultural Preservation Watershed Management Plans Invasive Species Management Plans Forest Management Plans

by improving communications and cooperation between local officials, cultural organizations and service organizations, and by organizing broader community projects.

To improve economic resilience, communities can work to encourage and support local production of goods and supplies, increasing self-reliance and reducing the flow of funds out of the community. Programs to encourage local investing and entrepreneurship have been helpful in building both employment and production capacity. Local investments, consumption of locally produced products, and locally owned businesses all help to diversify the community's economy, giving it greater resilience.

Climate Adaptation and Mitigation

While both have an important role in land use planning policies, it is important to note the difference between climate adaptation and mitigation. According to the National Aeronautics and Space Administration (NASA), responding to climate change involves a two-pronged approach: reducing and stabilizing the levels of heat-trapping greenhouse gases in the atmosphere ("mitigation"); and adapting to the climate change already in the pipeline ("adaptation"). While local communities can achieve substantial local benefits through adaptation strategies, the reduction of greenhouse gas emissions also has a critical role, and its importance in local policy should not be understated. Many adaptation strategies also have mitigation benefits. For example, sourcing food locally is an adaptation strategy by reducing dependence on national and global markets that may be compromised by climate change. At the same time, greenhouse gas emissions are reduced by reducing vehicles miles traveled. Communities that consistently and systematically take advantage of these types of "win/win" situations will be best equipped to face any challenges that come.

INTENDED AUDIENCES

- Professional Planners
- Planning Commissioners
- Natural Resource Managers
- Elected Officials
- Public Works Directors
- Community Organizers
- Environmental and Policy Advocacy Organizations
- Public Health Officials
- Emergency Responders

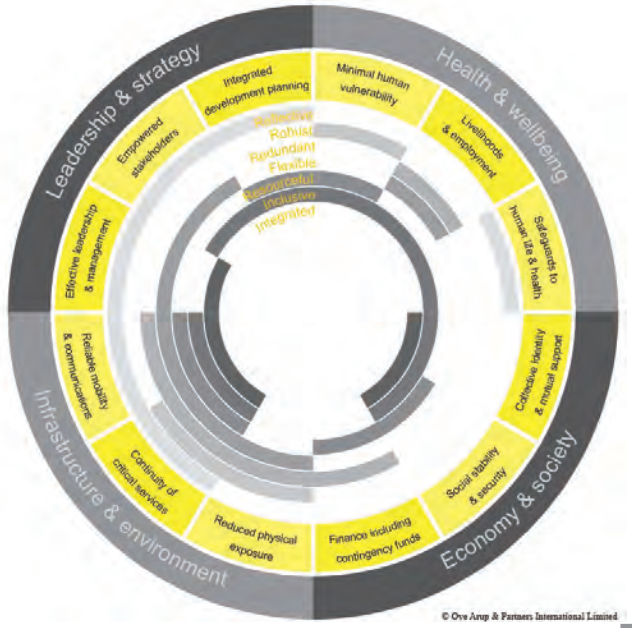
This Handbook explores a number of important resiliency topics, including Local Governance and Leadership, Gray and Green Infrastructure, Transportation, Local Food and Food Systems, Housing and Neighborhoods, Natural Resources, Public Health, Coastal Processes, and Energy.

CASE STUDY

Establishing a Framework for Building Community Resilience

There are likely as many definitions of resilience as there are communities. While each community is unique, it can be helpful to employ a framework to better understand what resilience is, how it can be measured, and how a community can go about increasing its resilience.

The Rockefeller Foundation has been pioneering work on climate resilience in communities across the world for over a decade. Developed with the support of the Rockefeller Foundation, the *City Resilience Index* is one such framework for articulating community resilience. Visit www.rockefeller-foundation.org/report/city-resilience-index/ to learn more.



High school members of a Student Advisory Committee in Grand Haven identify assets and vulnerabilities in their community as a part of a resiliency planning process.

How to Use This Handbook

This Handbook is intended to be used as a reference tool by a diverse array of land-use policy and planning practitioners. Resiliency encompasses a wide variety of topics and sectors, so to truly benefit local communities, principles of resilience can be practiced at all levels of government and throughout the greater community.

We hope the case studies and best management practices will prove useful to elected officials and other public servants looking to identify resiliency policies and programs that make sense for their community. Planning commissioners can use the site plan review reference guide and recommendations for guiding a public planning process. We hope the overview of data and tools for conducting vulnerability assessments will also be useful to professional planners.

Coastal Dynamics

Because of the unique challenges that coastal communities face, many of the adaptation strategies highlighted in this Handbook are of communities located along one of the Great Lakes. However, many of the challenges that coastal communities face are not unique, and many of the case studies on coastal communities are transferable to other communities in Michigan.

Key Resiliency Topics

Throughout this Handbook, we will explore data, policies and plans that support key topics relating to resiliency. The nine key topics we will explore are as follows:

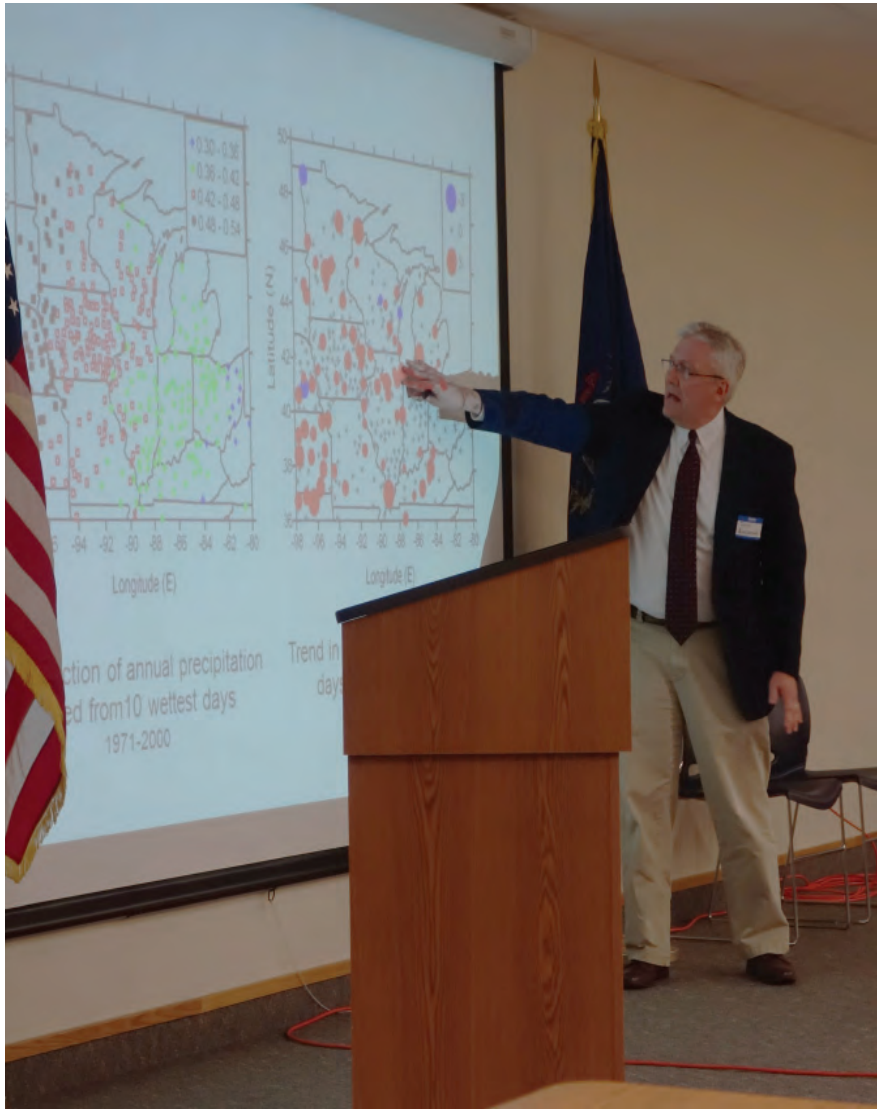
- *Local Governance and Leadership*
- *Gray and Green Infrastructure*
- *Transportation*
- *Local Food and Food Systems*

- *Housing and Neighborhoods*
- *Natural Resources*
- *Public Health*
- *Coastal Processes*
- *Energy*

An effective resilience planning process engages these diverse sectors and their stakeholders in a meaningful way, and presents implementable strategies for integrating resilience into plans, policies and initiatives.

State and Local Experts

Data and information sharing is paramount to any collaborative resilience planning effort undertaken by a community. Because of the interdisciplinary nature of topics that touch upon climate adaptation, each community will require different data and expertise to inform its planning process. We have collected a variety of case studies and examples from a wide variety of community types in the Great Lakes region. While by no means exhaustive, we've also compiled a list of experts working on resiliency planning and climate adaptation at the state and local level in Michigan (see the Appendix). These people, places and organizations are great places to start when gathering background information and identifying speakers to inform the community-education portion of your public engagement process.



A Quick Primer on Climate Trends

As stated by the Intergovernmental Panel on Climate Change (IPCC), significant changes in the Earth's climate have been observed. Climate and atmospheric scientists agree that the Earth's climate is warming and that the cause of this phenomenon is human-induced greenhouse gas (GHG) emissions. Global average temperatures have certainly increased, and each of the past three decades have progressively been the warmest on record. These temperature increases correspond with measurable increases in the concentration of greenhouse gases in the atmosphere.

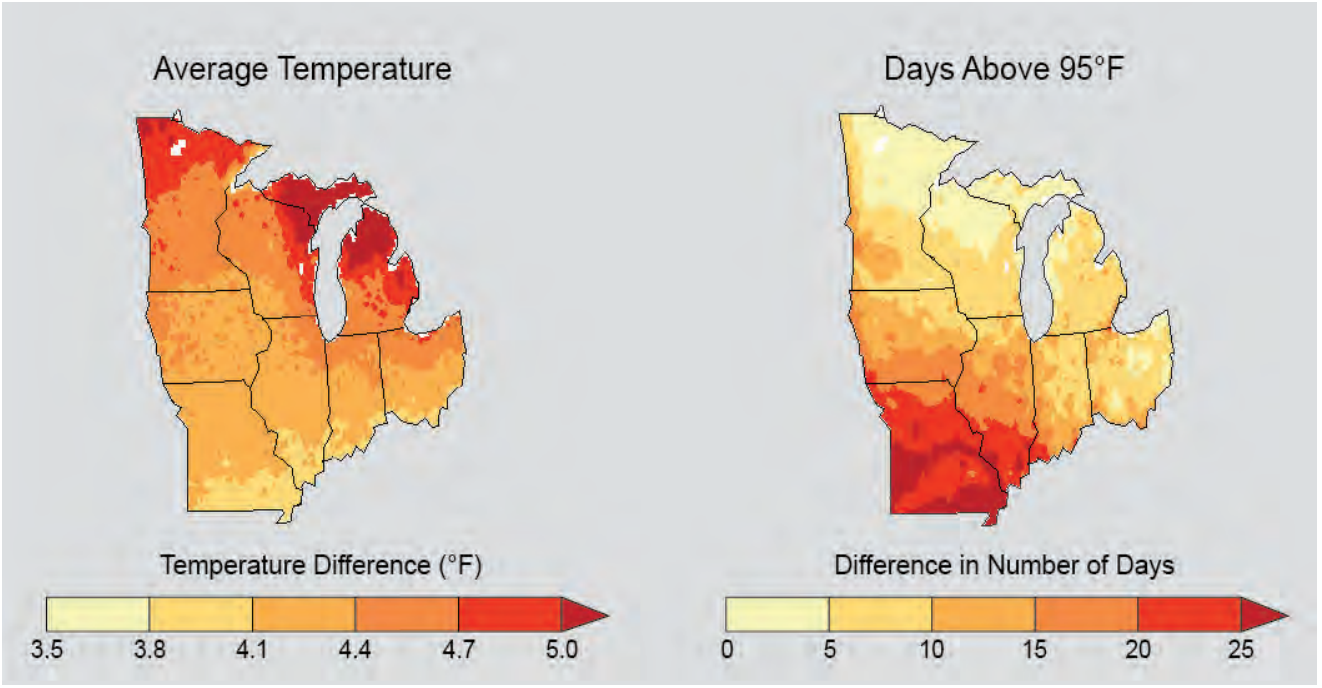
The impacts of climate change on agriculture, infrastructure and human health can be felt across Michigan and the Great Lakes region. The Great Lakes Integrated Sciences and Assessments Program (GLISA) is a partnership between the University of Michigan and Michigan State University, housed in the Graham Sustainability Institutes's Climate Center at the University of Michigan. As one of 10 regional centers funded by the National Oceanic and Atmospheric Administration (NOAA), GLISA builds

EFFECTS ON THE WATER CYCLE

"Rising temperatures will accelerate the global water cycle. This means more droughts, more storms, and more floods."

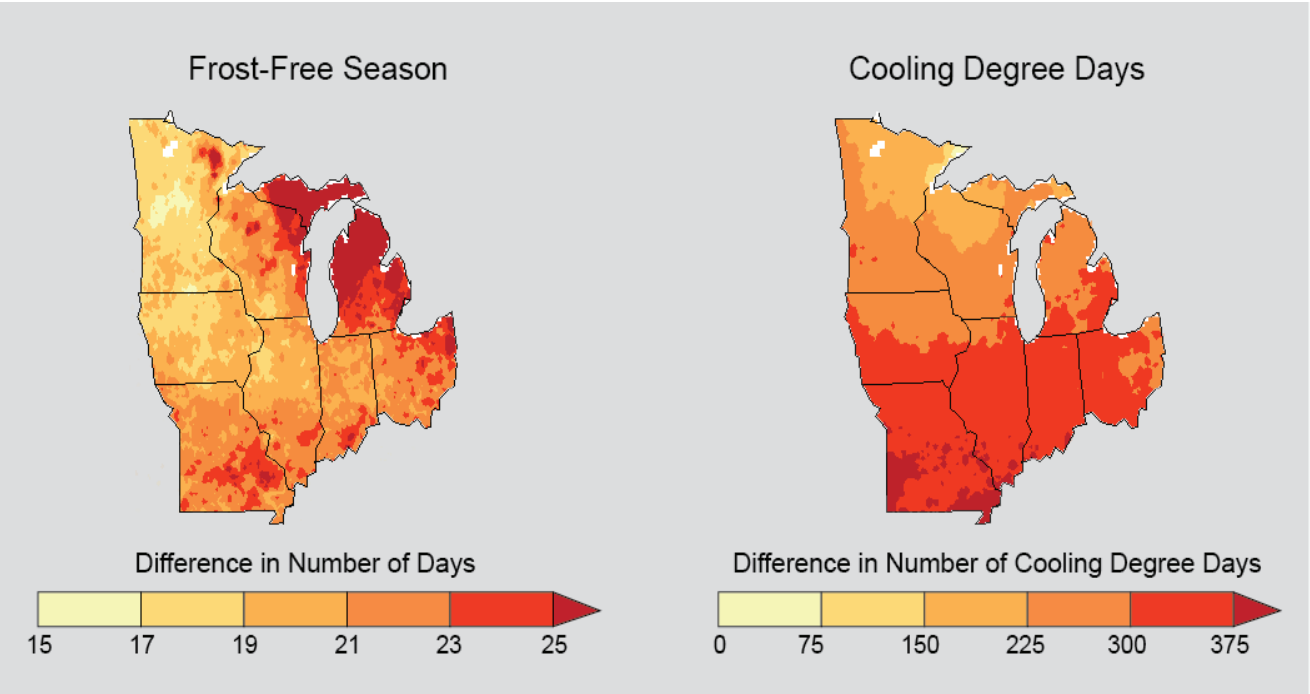
Stephen Wittman
University of Wisconsin
Climate Change in the Great Lakes Summary Report

Projected Mid-Century Temperature Changes in the Midwest



capacity to manage risks from climate change and variability in the Great Lakes region. According to GLISA, temperatures across the State of Michigan are expected to increase, both in terms of averages and extremes. Assuming current greenhouse gas emission rates continue to rise, Michigan is expected to see up to a 5˚F increase in average air temperature between 2041 and 2070, while portions of the Upper Peninsula may witness an even greater rise. An additional 30 to 70 days per year, depending on the region, are expected to exceed 90˚F. The growing season (frost-free season) will likely extend to include an additional 40 to 50 days each year by 2100.

Precipitation is projected to increase on average but concentrate in more intense precipitation events, likely resulting in greater periods of both extreme flooding and extreme drought. An additional 2 to 3 inches of annual precipitation is expected for Michigan, and the number of days each year experiencing heavy rain falls is expected to increase by at least 1 day per year.



This graphic summarizes the projected changes to average temperature, days above 95 degrees, the frost-free season, and the number of cooling-degree days by the middle of the 21st century. Source: National Climate Assessment. From GLISA via the National Climate Assessment.

WHAT ARE COOLING DEGREE DAYS?

Rather than a reference to calendar days, "degree days" are measures used to calculate the effect of outside air temperature on building energy consumption. "Cooling degree days" (CDD) relate to the energy consumption required to cool buildings.

Impacts to the Great Lakes

Great Lakes water levels have oscillated by as much as six feet over the last 100 years. Climate models predict that these oscillations will continue in the future, and may even increase in intensity. Two natural variables control Great Lakes water levels: precipitation, and the rate of evaporation. Warmer average temperatures are causing less ice cover to form on the Great Lakes in the winter, which greatly increases evaporation. Less ice cover also causes a net increase in water temperatures. Researchers have also found that Great Lakes shorelines may be subject to more erosion and flooding risk as a result of climate variability.

"After 15 years of very low Great Lakes water levels, now is a critical time for coastal communities to be planning for resilience. The rapidly rising water levels we have recently witnessed have vividly demonstrated the increased vulnerability of Great Lakes coastlines."

Guy Meadows, Director
Great Lakes Research Center
Michigan Technological University

Cold-water fish species such as the walleye, northern pike, and yellow perch are most susceptible to warming water conditions. Projected increases in temperatures accompanying the expected increases in carbon dioxide levels during this century will move the habitat boundaries for fish. Because they are more vulnerable to warming, streams and shallow ponds will experience greater changes and losses in fish populations than deep lakes.

CASE STUDY

Using Climate Data to Manage Ecosystems in the Huron River

Rising air temperatures, coupled with increased frequency and intensity of storms, threatens the habitat for organisms that depend upon rivers. As a result of climate change, river water temperatures may also rise and be increasingly vulnerable to non-point source pollution. The Huron River Watershed Council (HRWC) has been protecting the Huron River for over 50 years, but with the threat of climate change comes new challenges, and new strategies must be implemented to address them.

HRWC uses climate data to inform local policy through its *Climate-Resilient Communities* program. HRWC has partnered with GLISA to equip county officials, public works directors, municipal planners, and natural area managers in the watershed with the information they need to make good decisions about adapting to climate change impacts. The groups review various climate scenarios, discuss best practices and case studies on adaptation strategies, and gain commitments for action. The following is one example of a policy that responds to climate change.

To keep the river temperature cool, the HRWC prioritizes keeping the watershed landscape natural. Forty-four percent of the watershed is covered by forests, wetlands, and fields. One strategy is to maintain tree coverage along the river, as this provides shade to cool the river water and restores habitat for the surrounding ecosystem.

Zoning ordinances can play an especially big role in protecting the river against warming water temperatures. With the acknowledgment that a river is only as healthy as its tributaries, some of the communities along the Huron River have expanded their floodplain overlay zones with tributary overlay zones to protect the river from contaminated tributary inflow. Some have applied *Natural River District* regulations to tributaries, such as protection of native vegetation, prohibition of building within a floodplain, and minimum frontage requirements, among others. In the Natural Rivers District of the Huron River, no new commercial, industrial or extractive development is allowed within 300 feet of the river or its tributaries. Natural River Zoning is administrated by the Michigan Department of Natural Resources (MDNR) through the Natural Rivers Program to preserve, protect and enhance designated river systems through setbacks and other natural features protections. The result of these regulations is less erosion and cooler water temperatures. Through HRWC's Water Quality Monitoring Program, volunteers test water quality twice per month between April and September to evaluate progress and any new threats to the river.

Volunteers assisting with river restoration on the Huron River. Photo courtesy of Huron River Watershed Council.

Weather Events Timeline in Michigan

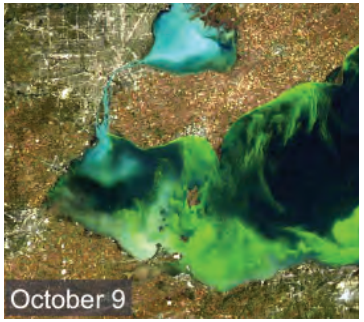
Extreme weather events are on the rise globally, nationally, and in Michigan. This timeline highlights major climate events that have occurred in Michigan in the last decade. While definitions vary slightly, a heat wave is usually three or more consecutive days with temperatures above 90 degrees Fahrenheit. A storm is considered extreme when more than two inches of rain fall within 24 hours.

ALGAE BLOOMS

STORMS AND FLOODING

TEMPERATURE CHANGE

JULY 17, 2006
A combination of severe winds and thunderstorms originating in the Upper Peninsula spread across the northern part of the Lower Peninsula, leaving over 270,000 residents without power. Wind gusts reached 111 mph, uprooting trees, damaging homes, and ruining the grape and cherry crops.



2011
Toxic algae, more correctly known as cyanobacteria, in Lake Erie's Western Basin made water unsafe to drink and unsafe for body contact. According to the World Health Organization, toxic levels were 1,200 times higher than the limit for safe drinking water. Toxic algae can cause rashes, vomiting, numbness and restricted breathing.

DECEMBER 2013
An ice storm caused a blackout for hundreds of thousands of homes for nearly two weeks. The violent storm knocked over trees and power lines across Michigan and the Northeast.

JUNE 2008
In the wettest June to date, with up to 10 inches of rainfall in less than 24 hours in some areas, a record-breaking storm turned 11 counties into federal disaster areas. The storm killed at least eight people and over 730,000 homes experienced a blackout. In 2013 dollars, this storm caused $16.2 billion in damage, and other states in the region suffered even worse impacts.

JANUARY-AUGUST 2012
Surpassing the mark set in 1998, 2012 becomes the hottest year on record. March 2012 stands out, as 23 different temperature records are broken in that month alone.

MARCH-MAY 2012
Following an unusually warm spring, a cold snap of freezing weather destroyed 90% of the tart cherry crop, the worst year ever recorded in Michigan, with an estimated $210 million in damages across the state.

APRIL 2013
Three dates within the month of April exceeded two inches of rainfall in a day. In Grand Rapids, the Grand River rose nearly two feet above its previous record level in 1985. The river did not breach the flood wall, but 435 million gallons of partially-treated sewage entered the river. Some 700 people were evacuated, and the mayor declared a state of emergency.

SUMMER 2014
Considered one of the most serious public health disasters of 2014 in the Midwest, an algae bloom in Lake Erie left 400,000 people across Michigan and Ohio without drinkable water. Algae blooms are partially caused by warmer waters.

NOVEMBER 2015
The largest algae bloom yet in Lake Erie; it was the size of New York City.

AUGUST 2014
A storm swamped Detroit with 6 inches of rainfall in just 8 hours, causing $1.8 billion in damages, flooding the metro region and resulting in a federal disaster declaration.

DECEMBER 2015
A tornado touched down in Canton, the first tornado in Michigan history to strike in December and only the third ever recorded in the winter months. Unseasonably warm air combined with strong winds enabled the tornado to develop very quickly, with little time to issue a warning.

AUGUST 2016
Six tornadoes hit western Michigan, five of which from one storm. Two of the tornadoes were rated EF-1, with the maximum wind speeds ranging between 90-100 mph. At 50-100 yards wide, these tornadoes were larger than usual and caused considerable damage.

WINTER 2013-2014
In the winter of the "polar vortex," temperatures dipped considerably below average. The Mayor of Lansing issued a snow emergency that prohibited non-essential travel. In February, daily record lows were set in Gaylord (-29°F), Flint (-16°F), Grand Rapids (-12°F), and Newberry (-41°F).

AUGUST 2015
Severe storms hit northern Michigan with hail the size of a softball, the largest hail ever documented in the state. With winds up to 80 mph, thousands of trees were uprooted and power lines were downed.

SUMMER 2016
The hottest summer on record in Metro Detroit. Although it didn't set the record for the number of 90-degree days, it was consistently hot throughout the summer, with 12 days of 90+ degree weather.

Photo sources (from left to right):

1. http://www.huffingtonpost.com/2014/08/04/lake-erie-algae-bloom-2014-_n_5647824.html 2. http://www.disclose.tv/action/viewvideo/228621/northern_hemisphere_crop_losses_spring_2016_cherry_80_apricot_60_wheat_6_and_more/ 3. http://interactives.woodtv.com/photomojo/gallery/6944/136725/mid-april-storms-cause-flooding/division-avenue/ 4. https://consumersenergyinyourcommunity.wordpress.com/2013/12/22/ice-storm-results-in-thousands-of-power-outages-across-michigan/ 5. http://www.weather.gov/apx/2015Aug2recap 6. http://www.freep.com/story/news/local/michigan/2016/08/20/tornado-strikes-grand-rapids-extensive-damage-reported/89051482/

A Planner's Responsibility to the Principles of Resiliency

In 2008, the American Planning Association (APA) adopted a policy guide on climate change, which has since been amended based on emerging science, local tools, and new policy responses. The policy guide notes that planners are in a unique position to address climate change issues because "the problem itself presents the full spectrum of the classical planning dilemma — it is long-range in nature, comprehensive in scope, and significant in impact." Changes to our climate will require proactive responses across all planning sectors, including land use, transportation, natural resource management, public health and safety, and economic development.

Many of the tools planners have been using for years are appropriate strategies for responding to climate change. For example, the principles of Smart Growth that concentrate growth in compact, walkable urban centers reduce our dependency on fossil fuels and promote sustainable transportation and housing options. A community with a walkable urban core is also well-situated to foster meaningful social relationships and provide adequate access to food, water, and other social services in the event of a weather-related emergency. Another example is Low Impact Development (LID), a practice that planners and engineers have used for years to manage stormwater runoff. By designing small-scale stormwater control systems to replicate ecosystem services provided by the watershed, communities can reduce negative impacts to water quality and infrastructure from extreme precipitation events. These ideas and policies are considered "actions of no regret," because they often move a community toward climate adaptation or greenhouse gas mitigation while also accomplishing other large community goals.

The American Planning Code of Ethics states that planners "shall seek social justice by working to expand choice and opportunity for all persons, recognizing a special responsibility to plan for the needs of the disadvantaged and to promote racial and economic integration. We shall urge the alteration of policies, institutions, and decisions that oppose such needs."

Vulnerable Populations

From a social equity standpoint, planners have a special responsibility to plan for populations that will be most negatively impacted by climate change. Research and data suggests that lower-income communities will bear a disproportionate burden from climate change impacts. For example, these populations are often housed disproportionately in floodplains, have less access to parks and greenspace (amplifying the urban heat island effect), and live in older homes that are more likely to flood. According to the U.S. Environmental Protection Agency (EPA), the annual mean air temperature of a city can be 2° to 5°F warmer than its more rural surroundings. In the evening, the difference can be as high as 22°F.

Michigan Association of Planning

From a statewide planning perspective, the Michigan Association of Planning (MAP) has made community resilience a high priority. MAP developed a statewide training module for local officials on community resilience, and provided funding and technical assistance to local communities in Michigan to prepare plans and zoning ordinances that integrate best practices and policies for improving community resiliency. A summary of local best management practices can be found on the MAP website at www.planningmi.org.

"Resilience planning has become foundational to the work of the Michigan Association of Planning. As a professional organization for community planners and elected and appointed officials, it is our responsibility to provide best practices to local leaders, who in turn implement regulatory and programmatic solutions that mitigate the harmful and expensive impacts of weather-related events."

Andrea Brown, AICP,
Executive Director of the
Michigan Association of Planning

Legal and Policy Framework

Nationwide, agencies are taking proactive measures to mitigate climate change impacts through strategic initiatives, allocation of funding, and the development of policies at the local, state and national level. The following is a summary, although not exhaustive, of some of the federal and state agencies that are working on policies and programs to support local communities in their efforts to adapt to and mitigate the impacts of climate change.

Efforts at the Federal Level

While there is no uniform, overarching federal policy on addressing climate change, most sectors of government acknowledge the challenges and are proactively identifying solutions. In November 2013, former President Barack Obama established the "State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience," noting that climate change is already affecting communities in every region of the country as well as key sectors of the economy. In 2015, Obama announced the Clean Power Plan, limiting carbon dioxide emissions from power plants.

"Local, state and federal governments are increasingly stepping up to build resilient communities in the face of uncertain climate change impacts. Resilient communities are led by visionary leaders who understand the need for holistic and integrated policies that view our economy, our natural resources, our food system, our public health system, and our water and transportation infrastructures as one. The most successful communities will be the ones who put water at the center of their decision making processes. Why? Because if you make smart decisions about water, you necessarily will make smart decisions about energy, food, land use, transportation and everything else in your community. Water is life."

Liz Kirkwood, Executive Director, FLOW (For Love of Water)

The U.S. EPA collects data, conducts economy-wide cost-benefit analyses on proposed climate policies, and is setting a variety of regulatory and non-regulatory targets. The agency also provides technical assistance, analytical tools, and outreach support on climate change issues to state, local, and tribal governments.

The Center for Disease Control and Prevention (CDC) predicts climate change will have far-reaching implications on public health, and is working to address the health issues that may be associated with global climate change. The CDC's expertise and programs in environmental health, infectious disease, and other fields form the foundation of public health efforts in preparedness for climate change.

The Department of Defense (DoD) is preparing for the impacts of climate change by increasing resiliency on military installations. The DoD's 2014 Climate Change Adaptation Roadmap identified a number of high-level challenges anticipated for the military's domestic activities.

CASE STUDY

Preparing for the Public Health Impacts of Climate Change

Since 2010, the Michigan Department of Health and Human Services (MDHHS) has been working on building a climate-resilient public health system for Michigan at the state, local health department, and community levels. The Michigan Climate and Health Adaptation Program (MICHAP) is supported through funding from the Centers for Disease Control and Prevention. In 2016, MICHAP completed the Michigan Climate Health Profile, identifying five major health-related impacts to Michigan residents due to Climate Change:

- Respiratory Diseases
- Waterborne Diseases
- Vector-borne Diseases
- Carbon Monoxide (CO) Poisoning
- Heat-Related Illnesses

In 2016, MICHAP partnered with the nonprofit Land Information Access Association (LIAA) to develop and deliver a statewide training for planning professionals and policy makers on how local policy and land-use decisions can foster better health outcomes.

After completing a strategic plan for the State of Michigan based on results from the Health Profile and stakeholder input, MICHAP is beginning to work with communities to respond to health challenges. One example of a high-priority intervention MICHAP is focused on is reducing the impacts of extreme heat events. Over the next year, MICHAP will be working with residents in the City of Detroit and surrounding areas in Wayne, Oakland and Macomb counties to reduce the impact of extreme heat events on vulnerable populations.

The Michigan Climate Action Plan was a developed through a collaborative effort by a diverse array of state agencies, private companies, and non-profits.

Solar arrays, like this one in Monroe, are becoming increasingly more common as state and federal incentives and market forces make alternative energy more financially attractive.

The National Oceanic and Atmospheric Administration (NOAA) is working to help communities understand, plan for, and respond to climate variability and change through the development and delivery of climate information services, the implementation of a global observing system, and focused research and modeling to understand key climate processes.

The Federal Highway Administration (FHWA) states that extreme weather, sea-level change, and changes in environmental conditions threaten transportation infrastructure. The FHWA provides technical assistance to state, regional, and local transportation agencies to help enhance sustainability, improve resilience, and reduce energy use and emissions on the highway system.

The Department of Energy (DOE) has acknowledged the stress that global temperature rise, wildfires, drought and high electricity demand put on the nation's energy infrastructure, and supports research and innovation to invest in alternative energy sources and that makes fossil energy technologies cleaner and less harmful to the people and the environment.

"The single greatest threat to training for the MIARNG at Camp Grayling is wildfire."

Brigadier General Michael A. Stone

Efforts Underway in Michigan

In 2008, Governor Jennifer Granholm created the Michigan Climate Action Council to draft a blueprint for state climate change policies and actions, with the goal of reducing greenhouse gas

CASE STUDY

MIARNG Pilot Project Identifies Adaptation Strategies

As a part of a Department of Defense (DoD) pilot program, the Michigan Army National Guard (MIARNG) was selected to develop adaptation plans to respond to and help mitigate the adverse effects of climate change. The nonprofit Land Information Access Association (LIAA) led a series of multi-day charrettes with community members and military representatives at Camp Grayling Joint Maneuver Training Center, Fort Custer Training Center, and Selfridge Air National Guard Base. This innovative community-driven process was the first of its kind in Michigan and will serve as a model for installations across the country looking to integrate climate adaptation and resiliency planning into their daily operations.

Two main climate-related issues emerged as priorities for Camp Grayling in northern Michigan: increasing wildfire risk, and energy security. As drought becomes more frequent and more intense and forests are stressed by pests and other diseases, the installation and the greater Grayling community will likely experience a rise in wildfire occurrence. This has implications to both public safety and property. There are over 100 wildfires on average per year at Camp Grayling, resulting in disruptions to its training mission. The installation relies on the Michigan Department of Natural Resources (MDNR) for wildfire response and prevention. To reduce reliance on MDNR resources, Camp Grayling will need more seasonal staff and more full-time staff for wildfire protection to maintain fire breaks on an annual basis. Other key actions identified in the Camp Grayling planning process was the need for a comprehensive assessment or evaluation of the community's wildfire risk, and strategies for improved communication and collaboration between state agencies, local governments and the installation.

Residents of the greater community participate in a charrette to prioritize actions as part of a resiliency planning effort led by the Michigan Army National Guard.

With more frequent bouts of extreme weather, more people using the facility, and less maintenance funding, Camp Grayling had to come up with ways to ensure that its infrastructure can withstand multiple stressors. Brownouts occur regularly, and with instances of extreme heat on the rise, brownout occurrences could increase without a change to the current system. To lighten the load of traditional power generation, Camp Grayling has made it a goal to not only conduct an energy efficiency assessment, but the installation is also committed to generating alternative energy. Camp Grayling is also evaluating the feasibility of installing a biomass energy plant to protect itself from power outages, and has considered working with a local logging company to use excess biomass as a fuel source for the plant. Camp Grayling has also set the goal of installing two new wind funnels. These efforts both lower their reliance on other power sources and make the facility more energy secure. The installation's goal is to be net zero for energy in 2017.

emissions through technology innovation and policies that provide economic and environmental benefits. The Michigan Department of Environmental Quality (MDEQ) was the lead state agency for this effort. Since then, a number of other state agencies have made notable progress toward implementing climate adaptation policies. Key agencies and organizations that participated in the Council and are leading subsequent efforts to address climate adaptation include:

- *Michigan Army National Guard*
- *Michigan Department of Environmental Quality*
- *Michigan Department of Health and Human Services*
- *Michigan Department of Natural Resources*
- *Michigan Department of Transportation*
- *Michigan State Police*
- *Michigan Economic Development Corporation*
- *Michigan Public Service Commission*

Local Efforts

There are numerous communities in Michigan that are working at the local level to address climate change and increase resiliency. Some communities have adopted resiliency plans, while others have adopted sustainability plans or climate action plans. Many of these plans have been formally adopted by the local elected body, while others primarily serve an advisory role. There are a number of communities that have collaborated with neighboring jurisdictions to draft and adopt these plans, and most have had a strong emphasis on community engagement.

A Holland resident provides input as a part of the Resilient Holland master planning effort.

Existing Plans

Communities with Climate Actions Plans, Resiliency Plans, and/or Sustainability Plans, either in process or adopted as of February 2017.

- *Alger County*
- *Baraga Township*
- *Bay City*
- *Beaver Island*
- *Benton Harbor*
- *Camp Grayling Joint Maneuver Training Center*
- *City of Ann Arbor*
- *City of Dearborn*
- *City of Detroit*
- *City of East Jordan*
- *City of Farmington Hills*
- *City of Grand Haven*
- *City of Grand Rapids*
- *City of Hancock*
- *City of Hazel Park*
- *City of Holland*
- *City of Kalamazoo*
- *City of Ludington*
- *City of Marquette*
- *City of Monroe*
- *City of Muskegon*
- *City of Southgate*
- *City of St. Joseph*
- *City of Traverse City*
- *City of Trenton*
- *City of Ypsilanti*
- *Coastal Macomb County*
- *Fort Custer Training Center*
- *Frenchtown Charter Township*
- *Grand Haven Charter Township*
- *Hamlin Township*
- *Meridian Township*
- *Monroe Charter Township*
- *Muskegon County*
- *Pere Marquette Charter Township*
- *Selfridge Air National Guard Base*
- *Village of Northport*
- *Village of Sebewaing*

"Shifts in climate, economics, and technology are rapidly occurring, and a local government that does nothing or tries to apply old answers to the challenges ahead will not do well. To be successful, a community must be resilient. That is, local governments need to be proactive in understanding and meeting the anticipated challenges that the shifts in climate, economics, and technology are bringing."

Heather Seyfarth, Senior Planner at OHM Advisors

Chapter {2}

Climate Impacts on Michigan Communities

This chapter summarizes the impacts of long-term climate trends on people, the natural and built environment, and the economy. The impacts of climate change will differ somewhat depending on your region of the state, urban versus rural settings, and coastal versus inland communities. Climate change can be felt in single events and in long-term trends.

Observed changes and projected trends due to climate change will have big impacts for Michigan communities, and any effort to build community resilience must take these impacts into account. Michigan communities have already been exposed to changing and intensifying weather patterns (see timeline in Chapter 1). While most of the impacts of climate will be negative, there may be some positive impacts on communities, at least in the short term. Below is a list of predicted changes in Michigan. All of these changes will have a direct or indirect impact on people, the built environment, and the economy.

- *More frequent and severe storms*
- *Increases in winter and spring precipitation*
- *Less precipitation as snow and more as rain*
- *Reduced ice cover on the Great Lakes*
- *Extended growing season (earlier spring/later fall)*
- *Greater frequency and intensity of storms*
- *More flooding events with risks of erosion*
- *Increases in frequency and length of severe heat events*
- *Increased risk of drought and wildfire, particularly in summer*

SIX CLIMATE-CHANGE CONCERNS FOR MICHIGAN

1
EXTREME HEAT

2
HEAVY RAIN AND FLOODING

3
SEVERE WINTER STORMS

4
COASTAL DYNAMICS

5
NATURAL ECOSYSTEMS

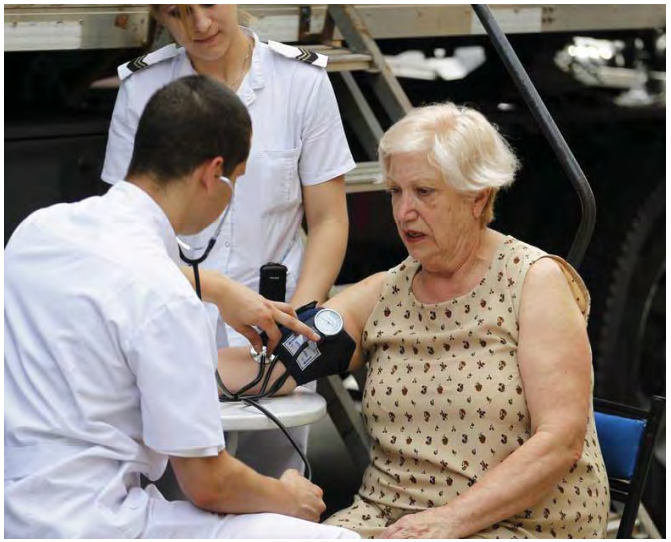
6
AGRICULTURE AND FOOD SYSTEMS

Extreme Heat

Summers are expected to become hotter and drier. Temperatures in Michigan have already risen by almost 2°F since the 1980s and are expected to increase between 2-7°F by the end of the 21st century.

PEOPLE: Heat is the deadliest type of weather in the US. It has killed more people than hurricanes, tornadoes, floods, and lightening combined. According to the Michigan Department of Health and Human Services (MDHHS), heat exacerbates asthma symptoms and other pulmonary illnesses because it amplifies air pollutants and particulate matter. Heat also amplifies ground-level ozone levels, which are associated with higher hospitalization rates for asthma, more severe allergic reactions, and premature deaths for people with heart and lung disease. In 2014, asthma became one of the top 20 most common hospitalizations in the State of Michigan. People with pre-existing conditions, as well as the elderly, people who work outdoors, and low-income people, are the most vulnerable to extreme heat.

Climate change is also causing evening cooling to diminish. Warmer evenings give people less time to recuperate from peak heat and compel them to use air conditioning for more hours per day. People without access to parks and green spaces, air conditioning, or a vehicle will see greater impacts if they lack ways to find a relief from the heat.



"The biggest challenge we will be confronting is the uncertainty that surrounds changing weather patterns, especially heat waves and storms, coupled with uncertainty about how the lakes will respond in terms of standing water levels."

Richard Norton,
Professor,
University of Michigan

BUILT AND NATURAL ENVIRONMENT: Higher temperatures will also exacerbate what is known as the urban heat island (UHI) effect. As the name suggests, the urban heat island effect occurs in urban settings where there is asphalt and concrete that absorbs heat. As a result, cities and suburbs are typically hotter than rural areas.

As people rely more on air conditioning to stay cool, more pressure is put on the electrical grid during peak hours, particularly since heat hinders the efficiency of most of the electrical infrastructure in place. If the electricity infrastructure cannot accommodate increased demand and stress, there could be more frequent or prolonged power outages. For critical public services to continue during a power outage, cities must invest in backup generators, or take the opportunity to invest in alternative energy sources. Renewable energy that can be stored enables communities to recover quickly after losing power, or could circumvent the problem entirely.

Heat also contributes to the wear and tear on roads, and in some extreme cases, causes asphalt to buckle.

ECONOMY: Extreme heat takes a toll on human health. Higher temperatures exacerbate the symptoms of pulmonary and cardiac conditions. In addition to increased healthcare costs, prolonged periods of heat also translate to more money spent by households on air conditioning.

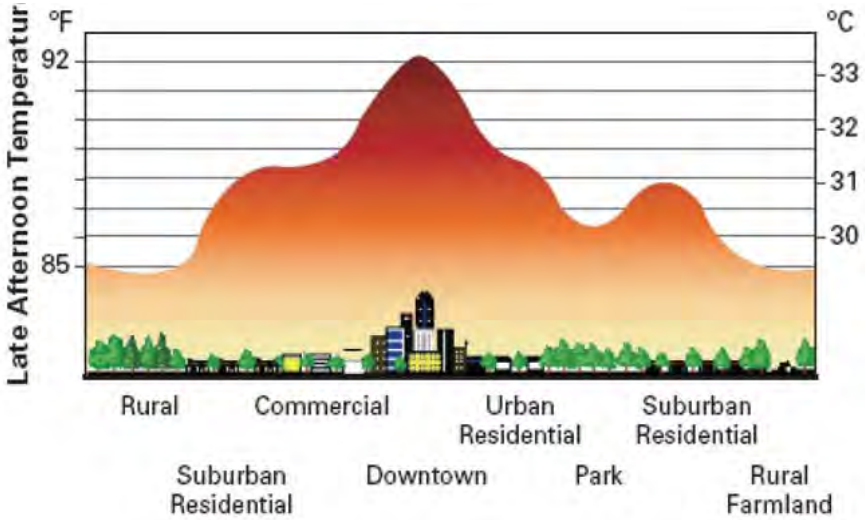
From a recreation and tourism standpoint, shorter winters mean ski resorts may be forced

"Michigan's geography and resources are globally unique and exhibit specific climate-related vulnerabilities. Climate change will amplify existing climate-related risks to human health, ecosystems, agriculture and the waters of the Great Lakes. Changing climate conditions will impact water quality, lake health and aquatic communities. Degradation of water and air quality represents an emerging threat to public health in Michigan from increased water- and vector-borne diseases and respiratory illness. Increased heavy precipitation events will further impact water quality and tax sewage treatment and stormwater infrastructure."

Stanley "Skip" Pruss, Principal and Co-Founder, 5 Lakes Energy LLC

to reduce their dates of operation. There may also be a reduction in the opportunity for activities like cross country skiing, ice fishing and snowmobiling. These types of snow-related activities are critical economic drivers for many communities in Michigan. Recreation providers may be forced to seek other types of revenue generators to compensate for less snowfall.

Some businesses are already responding. Emergency managers have reported a noticeable uptick in businesses, such as gas stations and restaurants, that advertise they have a backup power supply and can provide a climate-controlled environment. These business investments will likely increase over time.



An urban heat island is a metropolitan community with higher temperatures than nearby less developed or rural areas. As illustrated in this graphic, temperatures in the core of a city can be substantially greater than in surrounding areas. Source: Southwest Urban Hydrology.

CASE STUDY

Opening Cooling Centers in Grand Rapids

Cooling centers are climate-controlled places where people can go to escape the heat. Cooling centers are especially important for citizens who do not have access to air conditioning at work or at home. Michigan already has a tradition of using libraries and other public institutions as cooling centers. In the future, as this service becomes higher in demand, an emphasis must also be placed on spreading awareness and lowering barriers to reach a cooling center.

The City of Grand Rapids aims to have a heat wave safety checklist disseminated through appropriate channels such as the American Red Cross and the Public Health Services Emergency Response Team. Moreover, these channels can also provide residents with a list of cooling centers where they can find relief from the heat when needed.

Big urban areas like Grand Rapids — and even smaller downtowns such as Grand Haven (pictured) — are often significantly warmer than outlying rural areas.

Heavy Rain and Flooding

Heavy rains occur twice as frequently as they did one century ago, and rainfall has been projected to increase by another 20% by the end of the 21st century.

PEOPLE: Flooding puts residents and emergency response personnel in direct physical danger. The increased likelihood of flooding also means more runoff, which can pollute bodies of water and spread water-borne illnesses and infections. Water-borne diseases and poor quality drinking water are public health issues that can affect thousands of people at once. Flooded homes, if not properly and quickly addressed, become another large financial and health problem for property owners. Damp conditions spur the development of mold and reduce indoor air quality.

BUILT AND NATURAL ENVIRONMENT: During heavy precipitation events, communities are at increased risk of flooding and corresponding property and infrastructure damage. With increased precipitation, the 100-year floodplains expand, and more homes and infrastructure in the future will be prone to damage. The additional monetary costs of preparing for or repairing a home damaged by heavy rain and flooding would likely increase due to more frequent and intense storms.

With aging sewer infrastructure, the capacities of pipes and water treatment plants may be overwhelmed by an increase in stormwater. When this happens, cities are forced to release untreated water into nearby water sources, possibly contaminating drinking water. Areas with higher percentages of impervious surfaces also are more likely to experience negative impacts to water quality. Impervious surfaces disrupt the natural filtration system and enable contaminated water to flow into water bodies. Rural areas with aging septic tanks could be impacted by extreme rain events, causing negative impacts to drinking water sources and inland lakes and/or watersheds. The Michigan Department of Health and Human Services has identified

"Solving environmental issues through policy change is best served through a multi-disciplinary approach."

Elaine Sterrett Isely,
Water and LID Programs Director,
West Michigan Environmental Action Council (WMEAC)

CASE STUDY

Macomb Health Department Addresses Recurrent

The Macomb County Health Department received grant funding to address climate impacts on vulnerable populations. The nationwide project is called the Climate Change and Public Health Learning Collaborative for Urban Health Departments and is funded by the Kresge Foundation. The purpose of the Kresge program is to develop models that demonstrate a variety of ways urban local public health departments can develop, integrate, scale up and replicate approaches that simultaneously address climate change, community health and health equity.

Macomb County will focus on addressing flood-prone neighborhoods in the county that were hit particularly hard during the summer of 2014's extreme rain and flooding event in southeast Michigan. Key health issues reported from this event included respiratory problems from mold and mildew, mental health issues from economic distress, and issues with getting people to safety who lack mobility (e.g., elderly, disabled, living alone).

A concurrent process in Macomb County is the Resilient Macomb planning effort. The Coastal Resilience Plan is a collaboration among four communities along Lake St. Clair, including St. Clair Shores, Harrison Township, Chesterfield Township, and New Baltimore. A Vulnerability Assessment was conducted, with the goal of identifying and reducing exposure to hazards for vulnerable communities and preparing for the aftermath of an adverse event. The plan also investigates the greater community's ability to provide basic services to residents in the event of extreme heat or flooding. This type of analysis helps to ensure that all residents have access to potentially life-saving services. For example, during a heat wave, residents should be able to reach a cooling center within a 15-minute walking radius. A longer walk could induce heat stress other heat-related health issues.

aging septic tanks as a high concern as precipitation events increase in frequency and intensity.

Heavy rain also has an impact on the natural environment. Heavy rain falling on developed land (including agricultural lands) leads to a correspondingly heavy amount of runoff discharged into waterways. This abrupt influx of runoff increases the erosive force of the water, eating away at banks and shorelines. The increase in sediments can smother aquatic habitats, such as the gravel beds many fish spawn in, and also increase sedimentation in ports and marinas, which impairs commercial and recreational navigation.

ECONOMY: Since 2002, the Federal Emergency Management Agency (FEMA) has given Michigan over $160 million in public funds to restore infrastructure, save people in crisis during a flood, and provide household assistance to disaster victims. Michigan's "Blue Economy" (jobs or activities that depend on water) provides nearly 1 million jobs (or one out of every five jobs in the state), with an annual economic impact of $60 billion. Climate change has the potential to degrade the quality of Michigan's vast freshwater resources and have an enormous impact on the state's economy.

CASE STUDY

Putting a Monetary Value on Green Infrastructure

A new online tool has been developed to help planners, public works officials, policy makers, and the general public calculate the costs and benefits of ecosystem services. Created by the West Michigan Environmental Action Council (WMEAC) in partnership with Grand Valley State University and Michigan Technological University, the Rainwater Rewards tool helps users calculate the value of green infrastructure practices such as rain gardens, tree pits and planters, porous pavement, green roofs, rain barrels, bioretention and infiltration ponds, and the conservation of natural areas.

Rainwater Rewards is an online and mobile friendly stormwater calculator that shows the value of green infrastructure investments. Green infrastructure includes a number of stormwater management practices that allow rainwater to soak into the ground close to where it falls. The calculator was developed to help municipalities, planners, developers, and homeowners understand the investment value of green infrastructure beyond dollars and cents by looking at the value of reducing flood risk, reducing water and air pollution, increasing property values, storing CO2, and saving energy. This value-based approach help users make investment decisions with a complete picture of the costs and benefits associated with that investment.

Developed for small- to medium-sized cities in the Great Lakes basin, the calculator is designed to be used by professionals and laypeople alike. A property owner can enter three pieces of information describing the site and the proposed green infrastructure practice(s) to calculate an annual baseline stormwater runoff, as well as the costs and benefits of implementing the practice(s) at the block level. An advanced user, such as a municipal environmental services manager, can enter more specific information about the site and proposed green infrastructure practice(s). The calculator is available at rainwaterrewards.com.

Severe Winter Storms

According to GLISA, severe winter storms in Michigan are likely to be characterized by more destructive forms of precipitation such as freezing rain, sleet, and hail in the place of light, fluffy snow. However, cold snaps will not disappear. Communities will need to continue to respond to cold weather events.

PEOPLE: Homeless people are especially vulnerable to cold temperatures. Low-income people, the elderly, and the sick are vulnerable to colder temperatures if they cannot afford heating and if they have ailments that worsen with lower temperatures, such as arthritis and multiple sclerosis.

BUILT AND NATURAL ENVIRONMENT: Warmer winter conditions will likely cause an increase in "mixed" precipitation, including heavy wet snow, sleet, ice and hail. Compared to lighter cold snow, these conditions do more damage to power lines, infrastructure and vegetation such as crops and trees. Depending on what time a storm hits and the temperature that day, a layer of slippery ice can form on asphalt and increase the amount of injuries and deaths due to vehicular accidents.

ECONOMY: The economic impacts of power outages and disrupted transportation caused by severe winter storms can be calculated by the number of hours missed of productive work time. In a modern economy, little work can be completed without electricity or effective transportation.

CASE STUDY

What About the "Polar Vortex?"

While average temperatures are rising in the State of Michigan, it is also likely that longer durations of extreme cold will continue in parts of the Upper Peninsula and northwest Lower Peninsula. In 2013, communities throughout the state experienced a record-breaking number of days below freezing. Marquette, for example, experienced 79 consecutive days of freezing temperatures! Many climate researchers believe this was due to a sustained change in the jetstream that allowed cold, polar air to travel farther south. Some researches believe this trend may reoccur in the state due to changes to the ice mass in the arctic, despite an overall rise in temperature.[1] Even as Michigan and the Great Lakes Basin experienced record-breaking cold in 2013, most of the United States experienced record-breaking warmth.

Resorts like Marquette Mountain could experience reduced revenue as the winter season becomes more variable. Many resorts are exploring other activities to market to users.

[1] See Cornell University's Climate Change research at: http://climatechange.cornell.edu/what-is-a-polar-vortex/

Coastal Dynamics

Water levels in the Great Lakes naturally fluctuate, and those fluctuations can be rapid and dramatic. Since records began, Lake Michigan's water level has fallen by as much as four feet in as little as two years. In recent years, lake levels have risen. Climate change may cause even greater extremes in Great Lakes water levels. Inland lakes may also experience lower water levels if drought conditions dry up wetlands and tributaries that contribute to lake water levels.

PEOPLE: Warmer water harms water quality. Natural drinking water sources may become tainted with increased contamination and algal blooms, with Lake Erie as a prime recent example. However, other municipal drinking sources have been compromised by algal blooms as well.

Climate change may cause even greater extremes in Great Lakes water levels. Photo: Chicago Tribune

NATURAL & BUILT ENVIRONMENT: It is projected that lakes in Michigan will experience less ice coverage and warmer water temperatures. Warmer water tends to spawn algal blooms that turn lakes green and harm the ecosystem. Warmer water coupled with increased runoff changes the chemistry of the water to produce dead zones, areas with no oxygen where organisms struggle to survive. This also disrupts the timing of naturally occurring processes such as feeding and migration patterns.

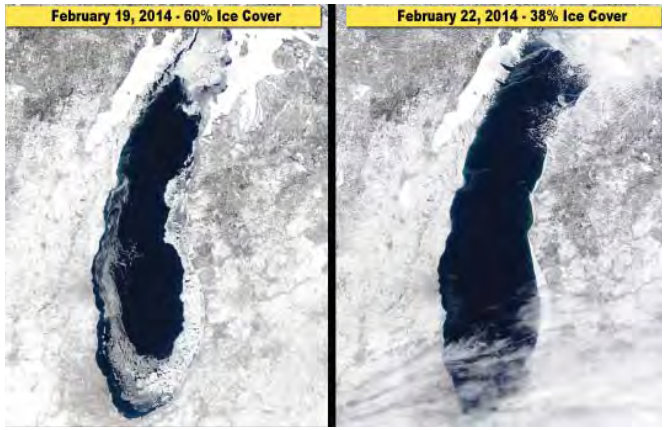
Lower summer water levels may also reduce groundwater recharge. Groundwater is the water used most commonly in agricultural areas and is drawn up through a well.

Property built along the water is also under threat from erosion and flooding. These properties are at greater risk of suffering from erosion, storm surges, and changes in water levels.

ECONOMY: When water levels fall, some ships cannot carry as much cargo, and water depths at docks may not accommodate deeper draft vessels. On the other hand, less ice coverage may increase the number of shipping days possible on the Great Lakes.

As noted earlier, extreme precipitation events carry more sediments into rivers and lakes, which increases the need (and costs) for dredging. Problems also arise in industries that rely on the lakes and their beautiful coastline, impacting tourism, recreation, and fishing.

Poor water quality and fewer lakeside property options could hurt communities whose economic base relies on tourism.



It is projected that the Great Lakes will experience less ice coverage and warmer temperatures. Warmer water tends to spawn algal blooms that turn the lake green and harm the ecosystem.

CASE STUDY

Local Coastal Ordinance in St. Joseph

In 2011, Bruce Jones applied for a permit to build a large seawall to protect his property from rising water levels on Lake Michigan. However, neighboring property owners quickly expressed concern that a seawall would contribute to erosion and limit public access to the beach. Private donors stepped up to fund an engineering study.

After analyzing 100 years of Lake Michigan's water level data, the engineering firm recommended a construction setback of 130-180 feet in order to prevent "irreversible and irreparable" erosion, and to protect property owners from rising lake water. In fact, data from close to 40 years earlier shows that Jones' property would have been underwater.

Due to broad public interest, the City of St. Joseph arranged for a portion of five public meetings to be dedicated to engineer-led discussions about coastal hazards, potential impacts of seawalls, the process to decide where to place the setback line, and the short- and long-term water level cycles. Through the use of maps, diagrams and accessible terminology, the city and the consulting engineers facilitated two-way communication and understanding among the public.

In 2012, the St. Joseph City Commission passed a "no-build" zoning ordinance that is the first of its kind in Michigan. Taking the engineer's advice, the city created an Edgewater Beach Overlay District (EB-OD) that prohibits permanent construction within approximately 200 feet of the water's edge. Another recommendation from the engineering firm was that the setback be reviewed at a minimum of every 10 years, or after a 4-foot change in the lake level. The EB-OD not only served a technical purpose, but also ensured that the public keeps uninterrupted access to the shoreline, a treasured public asset.

Zoning is a powerful tool. In this case, zoning ordinances protected the coastline, property owners, and access to a public resource. This example serves as a reminder that historic development practices aren't always the best guides for an uncertain and changing future. Nevertheless, research, education and community engagement can lead to effective new approaches.

A St. Joseph resident captures a photo of a storm rolling in to the pier in 2013.

Natural Ecosystems

Forests

Forests are also likely to be impacted by climate change. Drier summers and variable precipitation would increase the likelihood of drought. Warmer temperatures will also stress native species that are adapted to cooler temperatures, and a drier environment makes it easier for wildfires to spread. In 2016, fires burned over 3,000 acres of land in Michigan.

PEOPLE: Trees provide huge benefits to people. Trees sequester carbon, help to improve air quality, and provide recreational refuge. However, those who live near natural areas are also at a higher risk of experiencing the negative effects of wildfires. In 2012, the Duck Lake Fire in Luce County destroyed 136 structures. Smoke from wildfires affects the eyes and the respiratory system, and those with heart and lung disease are at greater risk of adverse health effects.

NATURAL & BUILT ENVIRONMENT: As temperatures increase, iconic trees native to Michigan will have trouble surviving in a new climate. Paper birch, quaking aspen, balsam fir, and black spruce are expected to decline. The EPA notes that longer periods of hot weather make trees more vulnerable to wildfire, disease, and damage from insect infestation. To maintain forestland, it may be necessary to plant types of trees that traditionally have grown in southern climates.

Warmer weather also bring an increased risk of wildfires. In dry summers, wildfires spread quickly. Most attention for wildfires has been placed on the Western United States, but Michigan has one of the highest percentages of connected forest land and is therefore vulnerable to wildfires. The MDNR estimates that each year wildfires damage or completely destroy about 100-200 homes or buildings. Natural wildfires do have some positive effects, such as regenerating the soil and signaling certain tree species to produce seeds.

ECONOMY: Forests provide a huge, largely unquantified economic benefit in the fight against climate change by producing oxygen and purifying the air. Forests, when properly managed, can also sustainably supply valuable resources like lumber and biomass, a renewable energy source.

In northern Michigan, forests draw in visitors and generate strong seasonal economies. With a loss of forested area, backcountry travelers, hikers, and mountain bikers may no longer flock to these areas to meet their recreational needs.

CASE STUDY

Adaptation by the Leelanau Conservancy

The Leelanau Conservancy is a non-profit land trust located on northwest Lower Michigan's Leelanau Peninsula. The organization focuses on protecting forests, farms, lakeshores and riparian areas through conservation easements. With a portfolio of 23 established natural areas and preserves, one of its signature properties is the 110-acre Krumwiede Reserve. Conservancy staff used the Adaptation Workbook, developed by the Northern Institute of Applied Climate Science (NIACS), to investigate the potential impacts of climate change on the Krumwiede Reserve. Based on the most recent data on climate change, some of the potential impacts identified were: Altered hydrology patterns (due to: different precipitation patterns, longer growing seasons, drier conditions); Invasive species (due to longer growing seasons, warmer temperatures, shifting disturbance regimes); Habitat suitability (ash, beech, and hemlock species are likely to decline); and Temperature increases (due to proximity to Lake Michigan)

NIACS has worked with public, private and tribal leaders to assess and consider adaptive responses into natural resource management and conservation endeavors.

The basic steps are:

- Define goals and objectives
- Assess climate impacts and vulnerabilities
- Evaluate objectives considering climate impacts
- Identify adaptation approaches and tactics for implementation
- Monitor effectiveness of implemented actions

Upon identify where the reserve is most vulnerable, the Conservancy can create adaptation actions that meet their goals of maintaining a habitat for native plants and animals in a diverse, all-aged forest, producing wood products, and protecting water quality.

Krumwiede Reserve. Source: Ken Scott Photography

Plant and Animal Species

Climate change will stress native plants and animals, providing a new window of opportunity for invasive species to become established. Warmer water temperatures will result in a change in species composition, and a likely decrease in biodiversity.

As habitat zones shift northward, many animal species may also need to migrate north as well. The Great Lakes will be a barrier to migration for many species. Fish populations will be impacted, especially coldwater fish species that will have nowhere to migrate from the Great Lakes.

If expected drought conditions cause streams and wetlands to dry up, there would be huge impacts to animal and plant species that rely on these ecosystems for breeding. If habitats change, some organisms may not be able to adapt in time to survive, sending a shock through the food chain. Shifts in phenology — the timing of periodic biological events, such as migration, flowering or mating — are also occurring in the Great Lakes region as climate trends continue to shift.[1]

Wetlands

Wetlands support a wide variety of biodiversity in terms of plant and animal species in Michigan. Shifts in temperature, precipitation, and hydrologic regimes are expected to alter the character and functions of existing wetlands. If surface water levels decline significantly, there will be impacts on the type and quality of wetlands, and a reduction in hydrologic connections to riparian zones and groundwater recharge. Increased drought also has the potential to reduce wetland habitat and migration corridors.

[1] Mortsch, L., J. Ingram, A. Hebb, and S. Doka (eds.). 2006. Great Lakes Coastal Wetland Communities: Vulnerability to Climate Change and Response to Adaptation Strategies. Final report submitted to the Climate Change Impacts and Adaptation Program, Natural Resources Canada. Environment Canada and the Department of Fisheries and Oceans, Toronto, Ontario.

CASE STUDY

Using Data and Education to Implement Voluntary Wetland Restoration

In 2014, the Michigan Department of Environmental Quality's Coastal Zone Management Program (CZMP) asked the Land Information Access Association (LIAA) to identify options for helping Michigan's local governments better preserve and protect their wetlands. The project team conducted a series of in-depth interviews and focus group discussions with wetland researchers, land managers, and others working on wetland preservation and restoration efforts in Michigan. The final results of this project were summarized in a white paper that identifies key impacts of climate change on coastal wetlands along with a series of policy options. This project also included the development of several short videos that highlight the efforts of land managers, nonprofit groups and local governments to preserve and restore wetlands, providing useful how-to information as well.

One case study and video highlights Voluntary Wetland Restoration. In southwest Michigan, land managers from the Van Buren Conservation District are working with property owners to target voluntary wetland restoration in high priority areas. Project partners found that conservation districts, regional planning entities and local governments can work together to assess the values and functions of their wetlands, educate landowners about the benefits of wetlands, and work collaboratively to find funding to preserve and protect wetlands that have the potential to provide important ecosystem services like flood control and sediment retention.

Another video published by LIAA describes a new approach to placing an economic value on the ecosystem services provided by a given wetland complex. This information can help guide efforts to protect and restore wetlands by helping to set priorities. Wetland assessments also suggest ways of sharing both restoration costs and benefits across several local government jurisdictions.

To view the videos and for more information about wetland preservation and restoration at the local level, visit the project website at greatlakeswetlandadaptation.org.

Wetlands provide a diverse array of ecosystem services including flood control, sediment retention, habitat, water filtration, natural beauty, and erosion control.

Agriculture and Food Systems

Drier summers may have a negative long-term effect on agriculture, Michigan's second-largest industry, despite possible short-term benefits.

PEOPLE: Drier, warmer summers will change the growing season for farmers. A longer growing season may be financially beneficial in the short term, as it could produce larger yields of crops such as corn and soybeans. In the long run however, drought and pests that thrive in warmer climates could reduce yields, increasing the price of staple crops. Reduced yields could affect Michigan's food security, although that is difficult to predict given a highly globalized food market.

NATURAL & BUILT ENVIRONMENT: With increased temperatures comes the chance of drought. Also, with increased heat, it is easier for crop-destroying pests to breed and spread. The increased growing season will force Michigan to reconsider how to irrigate, and how to protect animals and crops from extreme heat.

Changes in the averages, extremes, and timing of the seasons will have consequences for many agricultural crops throughout the state, especially fruit crops. Photo courtesy of Michigan State University Extension

ECONOMY: In Michigan, fruit production could be heavily impacted. Fruits like cherries, apples and blueberries are temperature dependent and are highly susceptible to temperature variations. As the time period between early spring warming and the final frost lengthens due to climate change, fruit crops are increasingly more susceptible to reductions in yield. Smaller yields will have negative financial impacts on farmers, distributors, vendors, and ultimately end consumers.

Farmers may have to diversify their crops in order to adapt to climate variability. Additionally, some farmers are exploring other economic development strategies to supplement their operations. For example, wind and solar energy installations support a resilient energy future and can be well-suited for agricultural land.

CASE STUDY

Exploring the Economic Benefits of Wind Energy in Michigan's Agricultural Communities

Wind Works Michigan was a 2016 initiative that hosted interactive community conversations about the benefits and relative burdens of wind energy in Michigan's agricultural communities. The meetings were all in areas with established wind farms and attracted audiences of local citizens who live near operating wind farms. Wind Works Michigan presented information in four themes or sections:

1. Economic benefits of wind energy
2. Wind farms and agricultural values
3. Energy choices for Michigan
4. Wind myths, facts and collaboration

Each section was presented by the project team and local wind stakeholders, who were recruited for each meeting leveraging relationships with local leaders. After the presentation of each section, Wind Works Michigan used Audience Response System (ARS) hardware (handheld keypads) for direct participant engagement and real-time surveys. The survey data also showed that most attendees believed wind projects benefited landowners, the local economy and agriculture in general. Majorities indicated that wind projects help preserve agricultural land and open spaces. Large majorities favored more investment in wind and solar energy, the replacement of fossil fuel-based electric generation resources with wind and solar energy, and expressed concern about the health and environmental impacts from burning fossil fuels.

"Michigan communities possess great potential to build community resilience. Planning at the local and regional level offers a key opportunity for Michigan to take climate action."

Jamie Kidwell-Brix, Michigan Green Communities Network Coordinator

Chapter {3}

Civic Engagement

Planners serve as a convening body to bring together a diversity of sectors and interest groups. It is our job to foster meaningful conversations on community resilience and bring community members to the table.

Based on data and observations, we know that the most vulnerable members of our communities will likely bear an inequitable burden from the impacts of climate change. These populations often have less capacity and fewer resources to respond and recover. Therefore, special emphasis should be placed on mitigating negative impacts to the most vulnerable members of our communities. Because a master plan serves as a comprehensive vision for the community, we will focus on the points of influence in the planning effort that result in a truly resilient master plan. The three key components of a successful resiliency planning process include education, community input, and data. Education and community input will be explored in greater detail in this chapter, while data will be explored in Chapter 4.

"As with any planning effort, understanding the local perspective is key. With this in mind, we make a strong effort to work with local experts and small focus groups during our projects. This allows for a meaningful two-way educational exchange and collaborative problem solving. Education and working together are essential to tackling the vast and complicated issues of climate change. We also use various versions of a design approach that integrates the expertise of multiple disciplines. In particular, we are working closely with engineers to address ways to improve and adapt infrastructure to the quickly changing conditions."

Heather Seyfarth, Senior Planner at OHM Advisors

TWO-STEP COMMUNITY RESILIENCY CIVIC ENGAGEMENT PROCESS

Education

Community education is paramount to any successful comprehensive planning effort. Local officials and other members of the community are often unsure of how a plan will be implemented, and may be skeptical about how their vision and goals will get translated into physical projects and new policies.

This uncertainty is often amplified when undertaking a resilience or climate adaptation planning effort. Because climate change has been politicized at the national level, communities are often divided on the subject. It is especially important to listen to all members of the community, understand their concerns, and identify solutions that will foster positive outcomes in light of projected trends. Education is an important first step in that process.

Bringing in State and Local Experts

At the beginning of the planning process, it is helpful to bring in local and state experts to speak about issues that relate to community resilience. By investing in community education upfront, misconceptions and doubts about the process can often be avoided.

"In partnership with numerous state- and local-level organizations, Michigan Municipal League has refocused the conversation about Michigan communities to one about the importance of quality places and investing in them. Now we must continue to push innovative solutions to help our community leaders take advantage of that positive momentum."

Luke Forrest, Director, Civic Innovations at MML

In addition, education and community conversations early on in the planning process will foster buy-in from community members, ensuring a better final product that represents a broad range of stakeholders.

The following experts and sectors have been used in resiliency planning to provide community education. It is important to note that because each community is different, educational experts will vary based on the needs and conditions of each community. A list of expert contacts can be found in the Appendix.

- *Climate Scientist*
- *Public Health Official*
- *Placemaking and/or Economic Development Expert*
- *Natural Resource Manager*
- *Public Works Official or Engineer*
- *Agricultural Specialist*
- *Energy Expert*

Topic area experts can help provide relevant data and information, and can provide ideas for implementing positive community outcomes in light of changing trends. It is especially helpful to have speakers who have worked with other communities in the Great Lakes basin to hear about success stories and lessons learned.

CASE STUDY

Community Action Teams Provide a Systems Perspective in St. Joseph

In St. Joseph, residents, business leaders and other stakeholders mobilized to frame their resiliency master planning process by convening a series of working groups to develop topic-specific resiliency recommendations. A total of 85 participants joined one of six Community Action Teams (CATs). CAT topics included:

- Access and Transportation
- Business and Economy
- Buildings and Neighborhoods
- Agriculture and Food
- Human and Social
- Natural and Environmental

The CATs met a total of three evenings. Each team had the opportunity to learn about how the topic or system functions in the greater community, and how climate trends and other impacts may increase the vulnerability of the system. The participants identified key goals that would address community-wide issues and concerns. These goals were further developed by each CAT to include underlying objectives and specific task lists. The CAT participants then submitted a full report to the City of St. Joseph Planning Commission. The report served as the foundation for the action plan included in the final master plan. Learn more about this process at resilientmichigan.org.

TIPS FOR TALKING ABOUT CLIMATE CHANGE IN YOUR COMMUNITY

- Be open and learn from community members
- Focus on data, not politics; talk about what is happening, not why it's happening
- Focus on local solutions to global issues
- Use visual reminders of recent events (e.g., flooding damage)
- Bring in local stakeholders to describe how the climate is impacting their job (e.g., farmers, public works officials)
- Focus on identifying actions that have multiple community benefits
- Acknowledge the uncertainty inherent to climate projections

Michigan State Climatologist Dr. Jeff Andresen presents on climate trends in southwest Michigan as a part of the Resilient St. Joseph master planning effort.

Talking About Climate Change

The politicization of climate change can make it difficult for communities to have productive conversations on these issues. However, community resilience is broader than just climate mitigation and adaptation. Communities can talk about resiliency outside the framework of climate change by focusing on other benefits of resiliency planning.

When discussing climate, it is most important to discuss what is happening and what could happen to a local community. Global trends with vast natural and social causes can feel vague and abstract. Instead, communities should focus on areas of agreement and actions of no regret (e.g., "flooding is bad and we should mitigate against flood damage in our community").

Actions of no regret are projects and investments where the benefits are clear, regardless of the impact of climate variability. For instance, investing in green stormwater infrastructure, such as rain gardens and green roofs, reduces water pollution and beautifies the built environment. By focusing on projects that most residents can support, communities can bypass heated climate change debates and instead enact practical improvements.

"A robust and inclusive public process is an essential component to any resilience planning effort. Without it, it is really hard to secure community buy-in and bring about transformative change."

Harry Burkholder
Executive Director, LIAA

Public Input

The quality of your plan is directly tied to the richness of perspectives that inform the effort. Each member of the community has something unique to offer, and the importance of fostering an authentic planning process cannot be overstated.

Residents are looking for confirmation that their leaders care about a democratic, transparent process, and are willing to put in extra effort to listen to the needs and desires of all residents. Open, inclusive engagement requires an intentional and well thought-out approach.

Stakeholder Engagement

The table on the next page provides a list of stakeholders that may be appropriate to meet with when identifying vulnerabilities, opportunities, goals, and actions for your community. Given the intersectoral nature of resiliency planning, the list of key stakeholders will likely be quite long. Social services providers, public health officials, emergency managers, and natural resource managers all have jobs that require a detailed understanding of how climate trends and changing circumstances in the community are impacting residents and the natural and built environment. When meeting with more traditional stakeholders like the Chamber of Commerce and public works officials, it is useful to ask about how trends in the community are changing and what types of solutions may be required to respond proactively to these trends. By engaging key stakeholders early in the process, these individuals will be more likely to serve as champions for the effort as the process progresses.

Stakeholder	Sample Questions	Data & Documents to Request
Business Leaders/Chamber of Commerce	Have severe weather events impacted tourism or your bottom line?	Number of locally-owned businesses
Communications Provider	Do you have a plan for disruption in communications? Is broadband available to all residents?	Map of service areas
Community Organizers	What are the primary needs of the populations you serve?	
Community Foundation	Do climate adaptation or resilience come up as goals for funding community projects? What do you see as the critical or unmet needs in your community?	Strategic Plan, funding priorities
County Emergency Manager	Does the community have adequate capacity to respond to weather-related emergencies? Do you collaborate with neighboring jurisdictions? Are there designated cooling centers and warming centers?	Natural Hazard Mitigation Plan
Drain/Water Resources Commissioner	What are the projects on the horizon? Have you noticed greater variability in water flow throughout the year?	Drain Map, Floodplain Map
Emergency Responders (e.g., wildfire fighters, police)	Has the nature of wildfires changed in recent years? How equipped do you feel to handle extreme heat events or other weather-related emergencies?	Community Wildfire Protection Plan
Energy Provider	Is there opportunity to participate in a PACE (property-assessed clean energy) Program or a similar program? Are you diversifying your energy portfolio?	Local energy use data and trends
Farmers	Have climate events/trends impacted your yield? What crops are most impacted by climate trends? Have you had to change your approach to farming in any way?	
Health Department	What are the key health-related issues in the community? Are households reliant on well water and/or septic? What relevant health codes are in place?	Community Health Assessment
Housing Official or Advocate	What is the overall quality of the housing stock? What are the rental trends? Are there neighborhoods with recurrent flooding, mold or other issues?	Housing inventory or affordability index data
Land Conservancy	Do climate adaptation considerations inform your strategic land acquisition priorities? Have you noticed changes to the natural landscape in this region?	Map of preserve and protected areas
Hospital	Is the hospital able to operate without electricity/water? Have heat events caused an uptick in hospitalizations?	Hospitalization rate
Large Institutions (e.g., military base, college)	Is there capacity for temporary shelter in the event of emergency? Do you have an emergency operations plan in place?	Future Land Use plan
Mayor/Village Manager/ Township Supervisor	Would you be willing to advocate for a GHG emissions or a clean energy benchmark for your community? What is the level of civic engagement in your community? How do you foster government transparency?	Budget and Capital Improvement Program
Public Transportation Provider	Are you reliant on a daily replenishment of fuel? What are the needs of the populations you serve?	Long-Range Transit Plan
Public Works Director	Are there areas of the community with recurring flooding? What are your planned projects? Is the stormwater system disconnected from the sanitary sewer system?	Map of municipal infrastructure
Social Services Organizations	What services do you provide? How have demands for those services changed in recent years? Who in the community is most vulnerable? What are their needs?	Community Needs Assessment
Tribal Members	Have you witnessed changes to the region's natural resources over time? Have climate trends impacted your population and/or activities?	Resource Management Plans
Watershed Councils	Have extreme rain events negatively impacted water quality? Have changes in the water temperature and water chemistry resulted in any noticeable changes?	Watershed Management Plan

Public Meetings

Although community engagement is often a required component of planning projects, it is important to be intentional in how the broader community is engaged. At the first large public gathering, it is useful to engage community members in asset mapping or a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis. The SWOT process is a way of opening up a dialogue to identify what makes a community unique, what changes or threats could impact current conditions, and what types of activities or investments would reduce the community's vulnerabilities. A community vulnerability assessment will be explored in greater detail in Chapter 5.

Similar to the SWOT analysis, asset mapping provides information about the strengths and resources of a community and can help uncover solutions. Once community strengths and resources are inventoried and depicted in a map, solutions for addressing community needs and reducing vulnerabilities can be identified. Asset mapping and SWOT are well suited to feed into goals, objectives and actions.

A professional facilitator can bring a neutral presence to public meetings and can facilitate the conversation to ensure that residents are actively engaged and being heard. This is particularly important when potentially divisive issues like climate change are being discussed.

There are a variety of strategies for engaging the public, from traditional community meetings to outreach in the community.

The More the Merrier

Be thoughtful about when people are most likely to be able to attend a meeting, and offer a variety of dates and times to ensure optimal participation. Some service sector workers are busy during the evening, when public meetings are often held. By diversifying the time and location of public meetings, underrepresented members of the community may be more likely to participate in a resiliency planning effort.

Make it Fun!

When planning a public meeting, think about strategies for making it fun and inviting. Public meetings that also provide educational information on resiliency can bring together knowledge and perspectives while also presenting enjoyable activities such as entertainment, food, and public speakers. Interactive games for prioritizing goals are also a way of getting the information you need in a fun and engaging way.

"Bay City is blessed with a beautiful riverfront and easy access to the Saginaw Bay, which provides our residents and those of our surrounding townships access to the largest freshwater coastal wetlands in the country. The riverfront has been a major influence in the past and will be for the future of our communities. Bay City is planning for the future by undertaking a new Master Plan with an emphasis on environmental resiliency as one of the major themes that impacts the quality of life on our residents and visitors. Bay City is fortunate to have a variety of community partners acutely aware of and actively engaged in providing recommendations for resiliency strategies. No one community can or should do it alone — collaboration and education is key."

Terry Moultane, AICP,
Bay City Planning & Zoning Manager

Members of the Holland community provide input on the Resilient Holland Master Plan at a popular local coffee shop. By going out into the community to collect input, it is easier to connect with individuals who do not generally attend public meetings.

Non-traditional Meetings

There is a growing understanding in planning of the importance of bringing a public meeting out into the community. Every community has unique public gathering spaces, and often the City or Township Hall is not a place that all residents feel comfortable. The following are a few ideas for innovative ways to engage residents in a community resilience discussion:

- *A walking tour is a moving conversation, informed and stimulated by looking around. Typically on foot or bike, moving around the community allows participants to better understand their neighborhood, document key assets, and generate ideas for new projects and solutions. Identifying locations for green infrastructure is one resiliency activity that is well suited for a walking tour.*
- *Pop-up meetings are often a popular alternative to a traditional meeting because they are less of a time commitment for participants and are held in a location where people are already gathering. Pop-up meetings generally consist of one or two questions and can be held at local breweries, festivals, coffee shops, grocery stores, or community centers.*
- *A design charrette involves a multi-day process where a site-specific design issue is explored in a community. The National Charrette Institute defines a charrette as an accelerated, collaborative, design-based process that harnesses the talents and energies of all interested stakeholders to create and support a feasible plan. As part of the Department of Defense resiliency planning effort, the Michigan Army National Guard hosted three charrettes on three military installations in Michigan as a way of fostering an open dialogue between the installations and the community.*

CASE STUDY

Engaging Youth in Resiliency Planning in Monroe

As a part of an interjurisdictional resiliency master planning process in Monroe, students from both public high schools were engaged to help develop a vision for the future of their community. Community leaders wanted to learn what young people believed would make their community a vibrant and attractive place to live.

The Youth Initiative was designed as a two-day asset mapping, community visioning, and goal-setting project involving approximately 60 students from Monroe High School and Jefferson High School. The project team spent half-days with the students on two consecutive weeks.

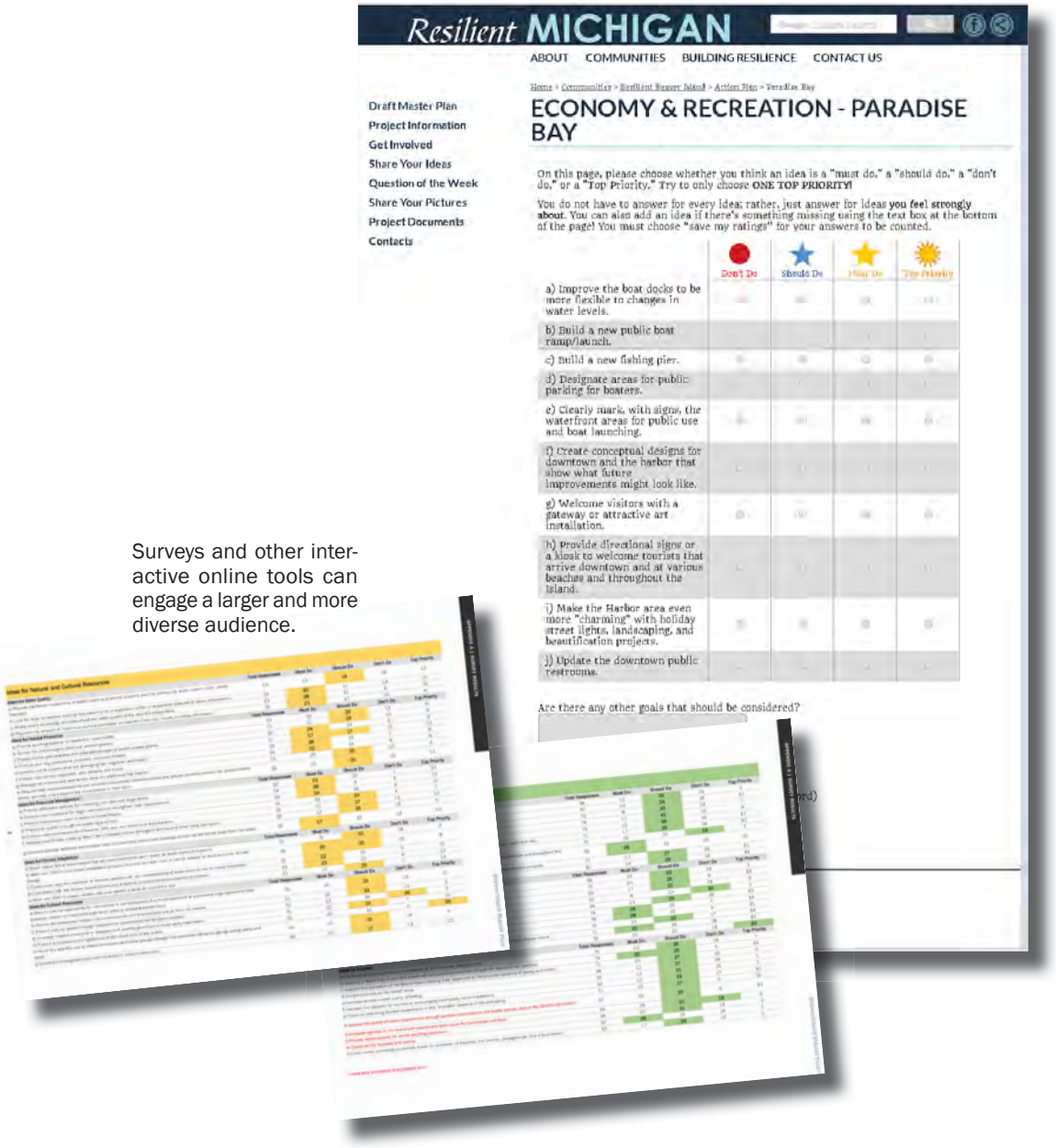
The curriculum consisted of interactive, hands-on, and group-focused planning activities. On the first day, after discussing the importance of local government and land-use planning, students worked together to identify the most important assets in the Monroe Community in an activity called Crayon your Community. Following that, students used aerial photographs to envision the best possible scenarios for their community, assuming no monetary or political constraints. The second session focused on challenges that the Monroe Community faces, and innovative, community-driven ideas for overcoming those challenges. Students were asked to brainstorm ways to thrive with an aging population, a transitioning economy, and a variable climate.

The students compiled a listing of their recommended community projects. Then, the students conducted a survey to find out how highly the proposed projects would be rated among their peers. Approximately 100 participants at these schools were asked to rate the importance of each proposed project. Final results and recommendations were presented to the Community Planning Committee, a group comprised of elected officials and planning commissioners from the City of Monroe, Monroe Charter Township, and Frenchtown Charter Township.

Technology

Civic technology has attracted considerable attention by planners and policy makers in recent years. There are a variety of online tools and platforms that can be used for engaging residents who might be less likely to attend public meetings. At its core, online civic engagement is a method of connecting with local residents, and can be a powerful tool for soliciting feedback and engaging your community in a productive conversation about important issues. The following is a summary of the key benefits online civic engagement can have in a resiliency planning effort:

- *Helps planners hear from a broad base of opinions and backgrounds.*
- *The relatively low cost allows a planner to reach more people.*
- *Novel engagement techniques may be more appealing to new audiences, such as young people*
- *Data and metrics can be used to gauge the overall temperature of the constituency on important topics.*
- *Online tools at public meetings can help a meeting run more efficiently.*
- *Using technology is often more fun for participants, and may increase the chance that they will participate in future planning efforts.*



Surveys and other interactive online tools can engage a larger and more diverse audience.

Grassroots and Community Organizers

Community organizers often work at the neighborhood level, and are uniquely positioned to engage residents that may not otherwise engage in a traditional government-sanctioned planning process. Neighborhoods are considered to be the basic building blocks of a community and, when engaged in a meaningful way, can greatly contribute to establishing neighborhood-specific goals and priorities that will strengthen the greater community.

Additionally, engaging residents at the neighborhood level is a great way to identify tangible projects that will contribute to community resiliency. For example, in the City of Detroit, the

Volunteers worked hard and had fun installing the beautiful vegetation and artwork that make up the rain gardens at the Detroit Library's Duffield Branch.

"Over the course of the planning process, Detroiters Working for Environmental Justice and its Detroit Climate Action Collaborative partners have launched several flagship climate change pilot programs. The Youth Climate Summit, now in its third year, has educated over 350 high school students about climate change, and is this year supporting youth climate projects in their respective schools. The Detroit Smart Neighborhoods program trains residents in weatherization and energy auditing. In addition, the Detroit Climate Ambassadors Program is a network of residents who are working together on their blocks to address issues like flooding, transportation, and extreme heat."

Kimberly Hill Knott, Policy Director, DWEJ

non-profit Freshwater Future worked with community organizers to establish a program for residents to purchase rain barrels and install rain gardens to reduce the pressure on the city's stormwater system. Not only did this solution benefit residents by reducing flooding in their homes and basements, the project also provided an alternative to investing in the city's wastewater treatment facility, thus reducing the cost burden of public infrastructure investments on city residents. Green infrastructure is often less costly than gray infrastructure and can provide a wider variety of benefits, like urban greenscaping and increased property values.[1]

Volunteers work to create rain gardens to protect the Rouge River and Detroit River from sewage overflows. Photo: Friends of the River Rouge.

1 Freshwater Future http://freshwaterfuture.org/wp-content/uploads/2014/08/DetroitStory.pdf

Local Liaison

When working as a consultant in a community with a polarized constituency, it can be helpful to consider hiring a local liaison. This is a person who is well-respected and trusted by community members. The local liaison could help facilitate a public process where residents are engaged in places where they are most comfortable. Additionally, local liaisons are often well positioned to keep the project momentum going after the consultant leaves.

Inter-jurisdictional Collaboration

Working across municipal boundaries is helpful when working to develop a comprehensive resiliency strategy. Natural systems do not begin or end at jurisdictional lines, so policies that protect water quality, watersheds, and other critical natural resources will be most impactful with a larger geographic scope. Additionally, emergency response to severe weather events generally spans multiple communities, so coordinating plans and policies will improve response to natural disasters. There have been a number of successful interjurisdictional resiliency planning efforts in Michigan between neighboring communities. A few examples include:

- *City of Monroe, Monroe Charter Township, Frenchtown Charter Township*
- *City of Grand Haven, Grand Haven Charter Township*
- *City of Ludington, Pere Marquette Charter Township, Hamlin Township*

Political Considerations

It is important to have a good handle on the political landscape of the community before beginning a resilience planning process. A few key questions to consider include:

1. *What are the hot-button or divisive issues?*
2. *What issues will the community come together on and rally behind?*
3. *Is the elected board in line with community needs and desires?*
4. *Do elected officials collaborate with neighboring communities?*
5. *Is there a general trust of government?*

Besides delivering a better product, another benefit of broad community engagement is that the resulting resiliency plan will be more likely to be backed by elected officials. Elected officials want to feel confident that plans and policies represent the needs and desires of the entire community. Because resiliency and adaptation are relatively new concepts in some communities, a well-backed public process will give courage to the elected officials to adopt the plan and stand behind it.

"It is important to make the science accessible to all audiences, including decision-makers, community members, and students."

Elaine Sterrett Isely, West Michigan Environmental Action Council (WMEAC)

Chapter {4}

Gathering Data

This chapter provides a detailed description of the data that is useful to collect when undertaking a resilience planning effort. Climate projections, health statistics, demographic trends, natural resources, and public infrastructure all have implications for the overall resiliency of a community. These maps and data sets help us better understand vulnerabilities and inform priority goals and policies.

Much of the data and mapping that informs a resiliency planning process is similar to that of a traditional planning process. However, there are some important additional data sets that should be collected. For example, demographic information should include data sets that help identify any sensitive populations in the community that may be most impacted by climate change. Health data and trends are also useful in identifying issues in the built environment that may be amplified by climate change. Finally, a detailed inventory of the natural and built environment will help in identifying infrastructure deficiencies and natural ecosystem services that could be enhanced through better land use policies.

The data and mapping discussion in this chapter is the foundation for conducting a community vulnerability assessment, which is detailed in Chapter 5.

SIX AREAS OF DATA CONCENTRATION FOR RESILIENCY PLANNING

1 CLIMATE

2 PEOPLE

3 MAPPING AS A RESILIENCY TOOL

4 DATA SOURCES

5 THE BUILT ENVIRONMENT

6 ECONOMIC RESILIENCY

Climate

When planning for resiliency, it is important to become familiar with the most up-to-date climate trends and projections to understand the potential effects for your region. This will help inform appropriate adaptation and mitigation policies and implementation strategies.

The Great Lakes Integrated Sciences and Assessments Program (GLISA) is an organization of climate science and social science experts who focus on the impacts of climate change in the Midwest. It is a collaborative effort between the University of Michigan and Michigan State University, and is one of the 10 regional centers funded by NOAA. Through maps, videos, presentations and handouts, GLISA's approach is to spread pertinent climate information to an array of stakeholders in a user-friendly way.[1]

GLISA has divided the Midwest into smaller regions, typically a cluster of counties with similar landscapes and/or climate. GLISA's website, www.glisa.umich.edu, provides information on the following categories in a downloadable format with data from 1900 to today:

- *Watersheds*
- *Changes in precipitation*
- *Annual precipitation*
- *Changes in temperature*
- *Annual temperature*
- *Seasonal precipitation*
- *Seasonal temperature*

"GLISA works to provide stakeholders with the best available climate information to facilitate informed decision-making in the Great Lakes region."

Jenna Jorns, PhD, Program Manager, The Great Lakes Integrated Sciences & Assessments Program (GLISA)

The GLISA website also provides projections on the following topics in the Midwest:

- *Average annual temperature*
- *Number of days per year over 90 and 95 degrees Fahrenheit*
- *Number of days per year falling below 32 degrees Fahrenheit*
- *Change in frost-free season length*
- *Change in cooling degree days*
- *Number of days per year with heavy precipitation*
- *Number of consecutive dry days per year*

This type of information is important to disseminate to a variety of stakeholders in a community, as each of these climate changes affect multiple sectors. For example, a change in frost-free season length will affect farmers, and the days per year with heavy precipitation may inform how a developer will landscape new construction.

[1] http://glisa.umich.edu/function/glisa-approach

CASE STUDY

Data-Driven Climate Action Planning in Detroit

Detroiters Working for Environmental Justice (DWEJ) convened the Detroit Climate Action Collaborative (DCAC) out of the recognition that climate change planning is necessary to foster a healthy, thriving city. In addition to climate preparedness, there are multiple co-benefits to climate change mitigation and adaptation that will benefit Detroiters, who are already overburdened in many ways due to their environment.

The DCAC initiative has persevered despite many of the challenges that face Detroit and other cities like it, including emergency management, limited funds, and the lingering effects of disinvestment. A grassroots-led initiative convening a broad array of stakeholders, the DCAC demonstrates the power and importance of working together on a crosscutting issue like climate change. The DCAC has developed Detroit's first Climate Action Plan, which is expected to be released in 2017, with several climate change pilot programs already moving ahead.

The DCAC is composed of six workgroups: Homes and Neighborhoods; Parks, Public Spaces, and Water Infrastructure; Businesses and Institutions; Public Health; Solid Waste; and Energy. DWEJ Policy Director Kimberly Hill Knott convened experts to the workgroups from a variety of fields. These individuals created mitigation and adaptation goals, short- and long-term action steps, and methods of assessment for their issue area in the context of Detroit. The frameworks, as they are called, have been extensively reviewed internally via the workgroups, externally via outside technical experts, and by Detroiters in a series of community meetings. The frameworks form the basis of the climate action plan. A steering committee, including participants from the City of Detroit, has helped guide the process.

Partnerships with the University of Michigan School of Natural Resources and Environment (UM SNRE), UM Taubman School of Architecture and Urban Planning, and the Great Lakes Integrated Sciences and Assessments Program (GLISA) have provided DCAC and other practitioners with the data to make informed decisions about climate change. The team from UM SNRE developed a greenhouse gas (GHG) inventory, which lists sources of GHG emissions and provides a baseline from which to measure GHG reductions toward overall reduction targets. GLISA provided a climatology for Detroit, which shows historical climate data and how the climate is expected to change in the future, with an introductory note into the public health effects of those changes. A team from the UM Taubman School of Architecture and Urban Planning created a vulnerability assessment for Detroit, which helps identify who will be the most impacted by climate changes and why.

Participants at the Detroit Youth Climate Summit. Photo Courtesy of DWEJ

Over the course of the planning process, DWEJ and its DCAC partners have launched several flagship climate change pilot programs. The Youth Climate Summit, now in its third year, has educated over 350 high school students about climate change, and is this year supporting youth climate projects in their respective schools. The Detroit Smart Neighborhoods program trains residents in weatherization and energy auditing. In addition, the Detroit Climate Ambassadors Program is a network of residents who are working together in their blocks to address issues like flooding, transportation, and extreme heat.

DCAC has completed the initial phases of planning and building momentum toward increased resilience. As DCAC enters the implementation phase of the climate action plan, it is realizing the full promise of what it has been building.

Content for this case study was generously provided by DWEJ's Leila Mekia, Program Coordinator; Guy Williams, President and CEO; and Kimberly Hill Knott, Policy Director. Learn more at dwej.org.

People

Everyone will experience the negative effects of climate change, but not equally. Overall vulnerability to climate change is a function of the surrounding environmental conditions (exposure) combined with the degree to which a given community or ecosystem is affected by climatic stresses (sensitivity). Collecting data on population attributes provides a picture of overall community sensitivity and is an essential component of a vulnerability assessment. Because climate change will disproportionately affect vulnerable groups, it is worthwhile to conduct a sensitivity assessment with a focus on where these groups are concentrated.

When beginning a sensitivity assessment, it is important to understand the community's demographic makeup in order to determine the scale of a community's vulnerable populations. The assessment must not only account for the number of people who meet these criteria, but also where they are located in the community. For example, mapping the spatial distribution of a specific population reveals whether it is largely concentrated in certain areas of the community or if it is more or less distributed evenly throughout. This can be helpful, for instance, in planning for evacuation. An up-to-date map identifies areas for priority assistance and informs what type of assistance is needed.

Children are among the vulnerable populations in a community.

Vulnerable Populations

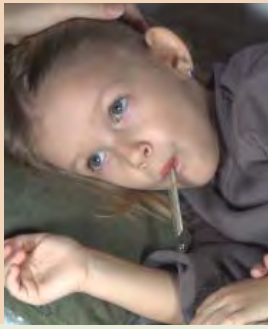
The Michigan Department of Health and Human Services has identified populations it considers generally vulnerable. Consider these demographic attributes as indicators of a person's relative ability to respond to and recover from a major weather event or other stressor. These indicators are not all-inclusive, meaning it is possible if not likely that a 67-year-old is physically and mentally fit enough to take care of him/herself in a severe storm or heat wave. However, historical health and census data show that overall, these groups are generally less able to respond appropriately to an extreme event due to lack of education on the topic, lack of resources to act, or a compromising health condition.

ELDERLY

THE ELDERLY DISPROPORTIONATELY SUFFER FROM DECLINING HEALTH AS EVIDENCED BY HIGHER HOSPITAL ADMISSION RATES AND HIGHER DISABILITY RATES.

CHILDREN

CHILDREN 17 AND UNDER ARE MORE SUSCEPTIBLE TO ILLNESS, AND ARE DEPENDENT ON ADULTS FOR THE MAJORITY OF THEIR NEEDS.



ASTHMA & ALLERGIES

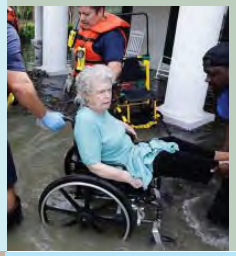
HOSPITALIZATIONS FOR ASTHMA AND ALLERGIES USUALLY SPIKE IN WARMER WEATHER. WITH TEMPERATURES RISING, THE LIKELIHOOD AND SEVERITY OF ATTACKS WILL INCREASE.

POVERTY AND EDUCATION

THESE TWO INDICATORS ARE HIGHLY CORRELATED. IN GENERAL, A LOWER LEVEL OF EDUCATIONAL ATTAINMENT TRANSLATES TO A GREATER LIKELIHOOD OF LIVING IN POVERTY. THESE TWO SOCIOECONOMIC FACTORS ARE ASSOCIATED WITH REDUCED ACCESS TO HEALTHCARE, TRANSPORTATION, AND OTHER NECESSARY SOCIAL SERVICES.

DISABILITY

PERSONS WITH PHYSICAL AND MENTAL DISABILITIES CAN FACE ADDITIONAL CHALLENGES IN RESPONDING TO AND RECOVERING FROM AN EXTREME EVENT OR OTHER STRESSORS.



MINORITY STATUS

STATISTICALLY, NONWHITE POPULATIONS ALSO FACE REDUCED ACCESS TO HEALTHCARE, TRANSPORTATION, AND OTHER NECESSARY SOCIAL SERVICES.

OUTDOOR WORKERS

OUTDOORS WORKERS HAVE HIGHER EXPOSURE TO THE ELEMENTS. WITHOUT A CLIMATE-CONTROLLED ENVIRONMENT, OUTDOOR WORKERS ARE AT A HIGHER RISK OF WEATHER-RELATED ILLNESS.

NO ACCESS TO A VEHICLE

RESIDENTS WITHOUT A VEHICLE HAVE REDUCED MEANS TO SEEK MEDICAL ATTENTION, OR AS SEEN DURING HURRICANE KATRINA, HAVE LIMITED MEANS TO EVACUATE BEFORE OR DURING A NATURAL DISASTER.

ISOLATION

THOSE WHO LIVE ALONE OR LIVE IN ISOLATED PARTS OF A COMMUNITY ARE AT INCREASED RISK DURING AN EXTREME WEATHER EVENT. SOCIALLY ISOLATED INDIVIDUALS ARE MORE DIFFICULT TO REACH WITH CRITICAL INFORMATION, AND THEY MAY NOT RECOGNIZE THEIR OWN SYMPTOMS OF WEATHER-RELATED ILLNESSES TO SEEK PROPER MEDICAL ATTENTION.

CASE STUDY

Public Health and Environmental Justice Issues

The State of Michigan's budget for environmental regulation has decreased 75 percent since 2002,[1] but not for a lack of issues. The 48217 zip code in southwest Detroit is the most polluted area in the state, according to environmental scientists from the University of Michigan. Moreover, the Detroit-Warren-Livonia region is the second most toxic area in the nation, with 68 Superfund sites and 281 facilities releasing toxic pollutants. Adjusted for age, Detroit's cancer rate of 533 cases per 100,000 has exceeded the state's rate of 488 per 100,000 as of 2006.

In 2015, the American Lung Association gave Wayne County a failing grade in its "State of the Air" report. Wayne County also leads the state in pediatric and adult asthma cases, and chronic obstructive pulmonary disease admission rates are about three to six times higher than the rest of the state. Hospitalizations are expected to increase as warmer climates exacerbate the effects of pulmonary conditions.

Despite increased healthcare needs due to these environmental stressors, Detroiter's uninsured rate is over 83%, compared to almost 10% statewide.

Photo:http://www.hourdetroit.com/Hour-Detroit/October-2016/Clearing-The-Air/

1 http://www.sierraclub.org/compass/2015/05/fighting-right-breathe-detroit-and-beyond

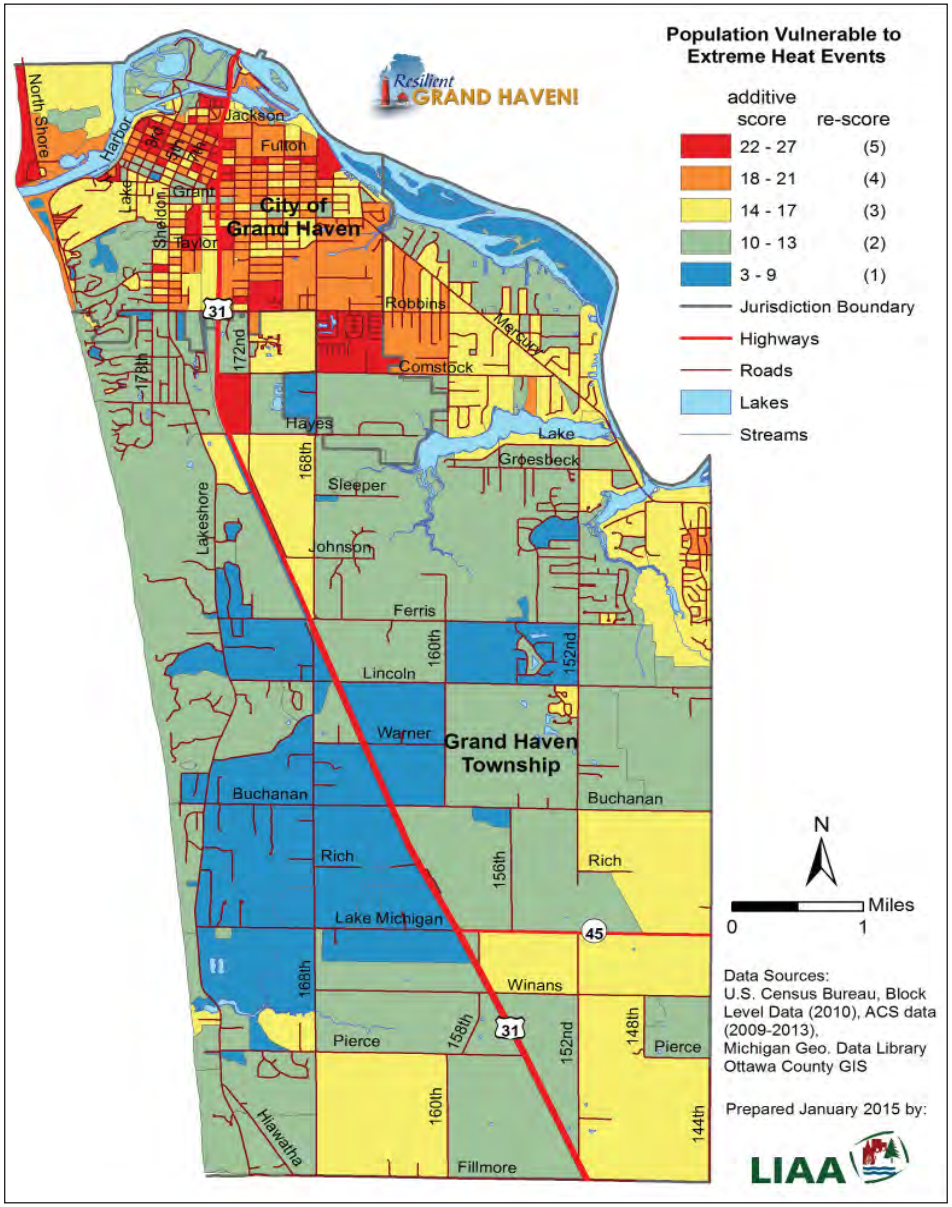
Mapping as a Resiliency Tool

As previously mentioned, using geographic information system (GIS) software to map the location of vulnerable groups is valuable for determining where to prioritize resiliency planning and policy efforts.

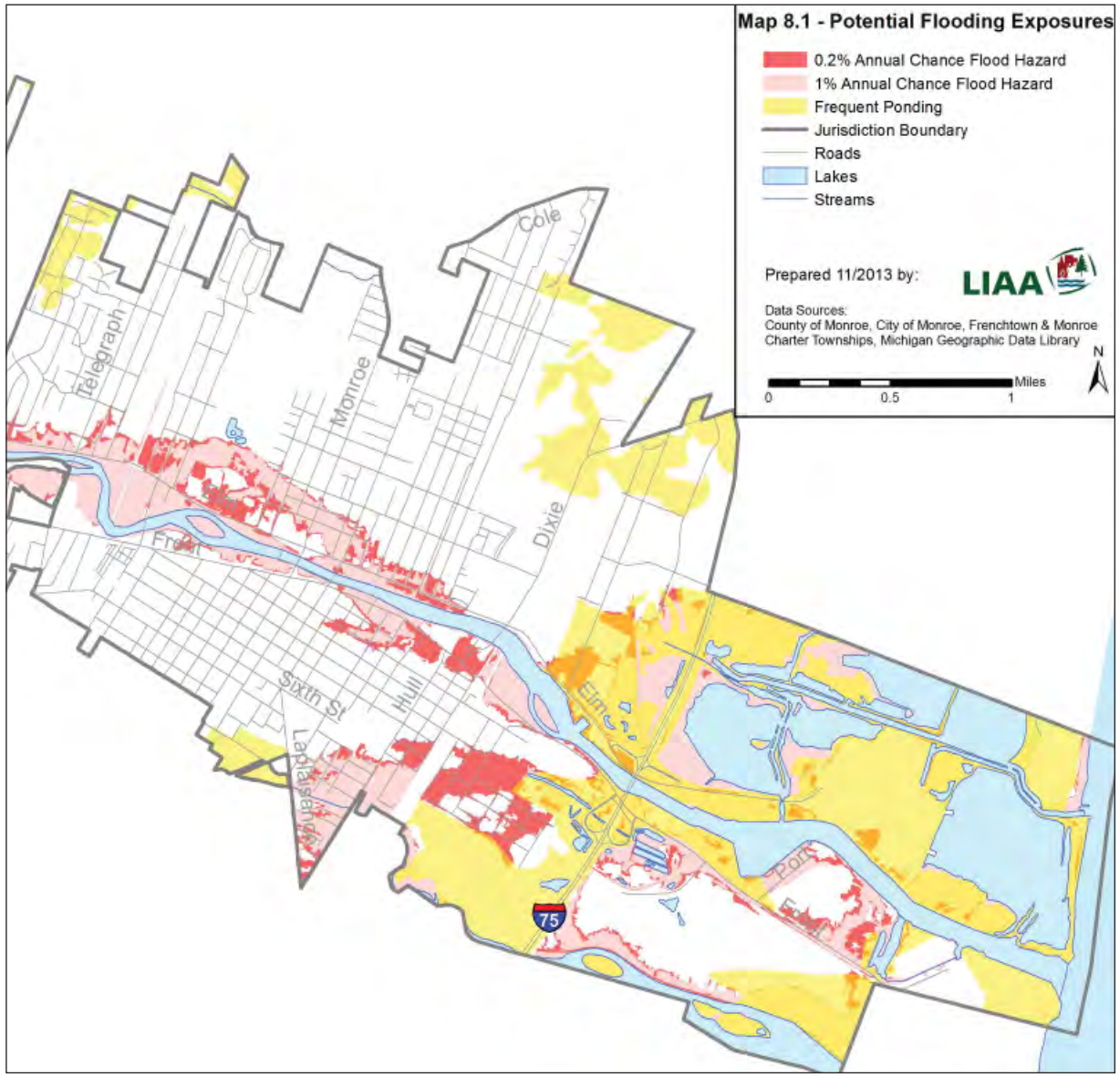
Usually, one indicator does not fully capture the vulnerabilities in a community. A composite map can be necessary to layer several different indicators and find overlap. Instead of assigning a weight to each variable, these maps often use a GIS feature called Natural Breaks.

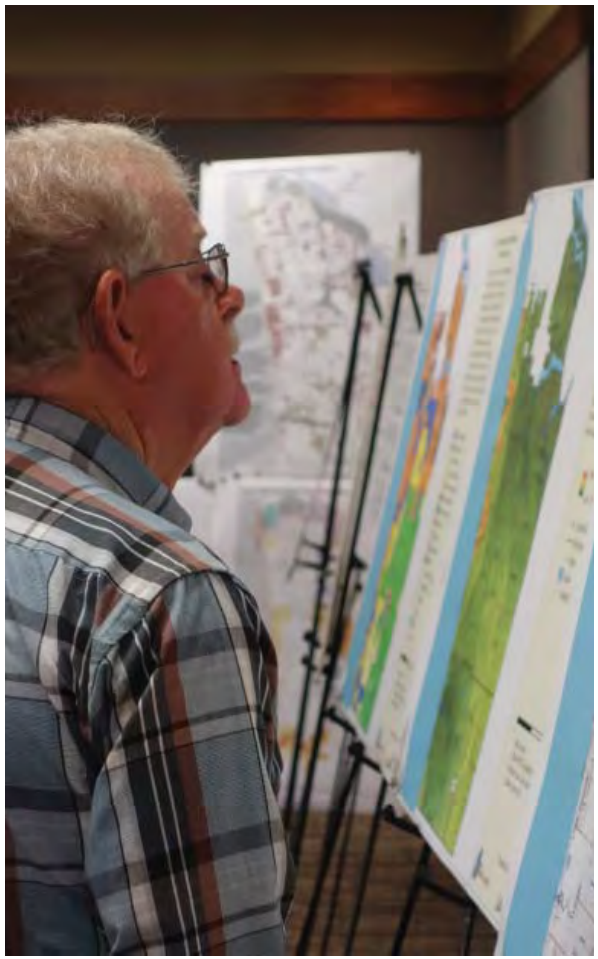
Natural Breaks is an algorithm that groups data into classes based on the distribution of values (and/or clusters of values), as opposed to squeezing data into certain categories (such as quintiles). Census blocks are then assigned a point value based on the proportion of a particular demographic group; those Census blocks with higher concentrations of one group receive more points than those with lower concentrations. This is how ranges found on the legend are determined.

Once all the indicators are included, the results provide a clearer starting point for targeting resiliency programming (the darkest red color in this example from Grand Haven Charter Township). Upon locating the most vulnerable groups and where they reside, these areas can be prioritized for resiliency best practices.



An example of a map that has layered several different indicators and applied a Natural Breaks algorithm to find concentrations of vulnerable populations.





(Above) In Grand Haven, maps were used in public meetings to assist with planning and education on the community's vulnerabilities. (At left) A map of the Monroe community shows flood zones. This overlay was used by the community to determine which structures were most vulnerable to flood damage.

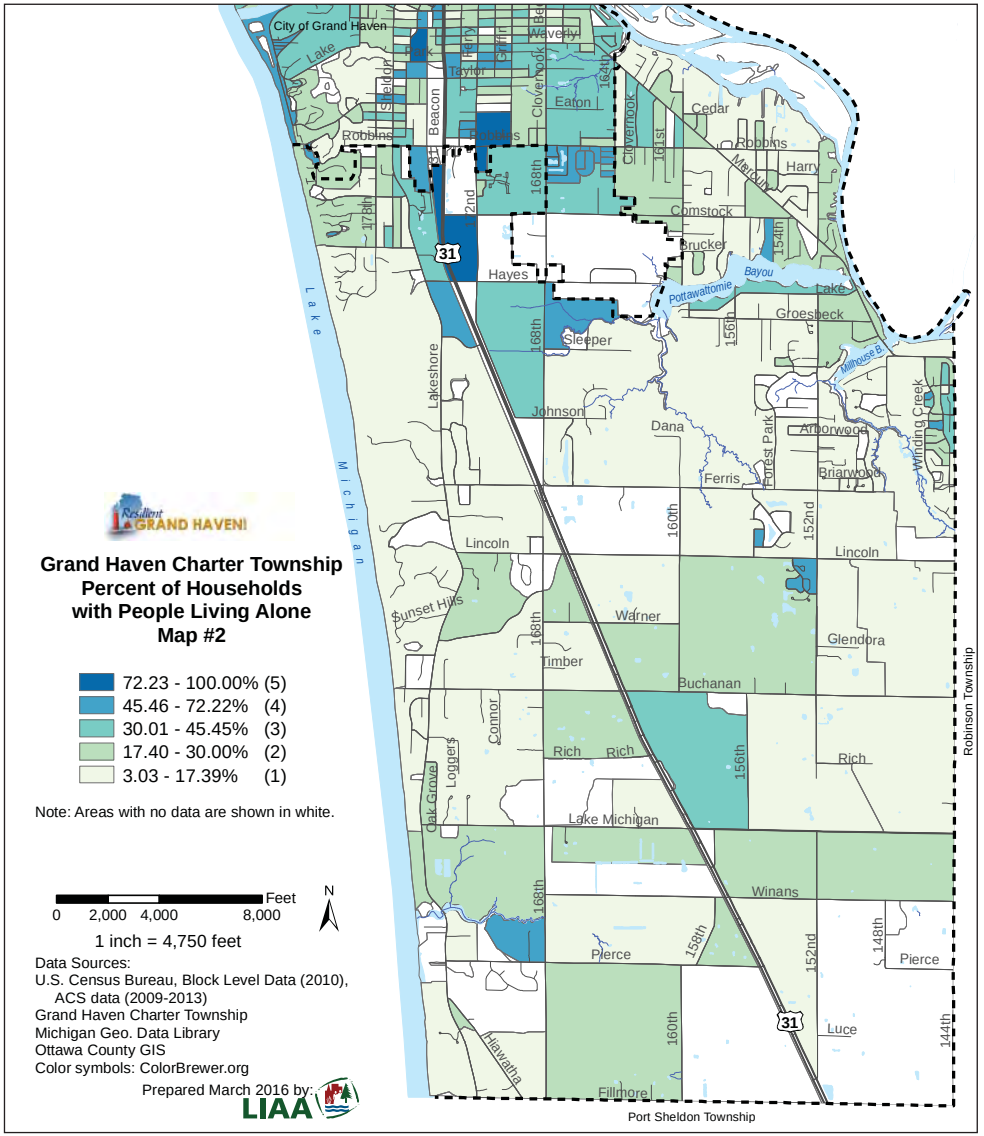
Data Sources

People

Fortunately, most of the data needed for resiliency planning is easily accessible through the U.S. Census Bureau (www.census.gov) at the city level and smaller geographic units, such as tracts and block groups. The Census now completes rolling surveys between the decennial surveys. Below is a description of the two types of surveys and the advantages and disadvantages of each.

2010 US CENSUS: This is the gold standard for demographic data. It measures 100% of the population and offers comparable data at regular intervals throughout most of the United States' developed history. However, available data is limited to population and housing information, and the 10-year collection interval means the data is rarely "fresh."

1-3-5-YEAR AMERICAN COMMUNITY SURVEY (ACS): The ACS program replaced the "long form" Census questions beginning in 2000, asking the same types of detailed questions about social, economic, and housing conditions on a rolling basis instead of once per decade. Statistical validity of the ACS depends on sampling. In larger communities (those with populations of 65,000 or more), it is possible to gain a valid sample within 12 months, which the ACS calls a "one-year estimate." For mid-size communities (population 20,000-65,000), it takes 36 months of data collection to achieve a valid sample size. For communities smaller than 20,000, it takes 60 months. This system exposes the statistical tradeoff between the reliability gained by a large sample size and the immediacy that is sacrificed in the time it takes to do so.



Health Data

Health data is typically reported at the county level. Health data can be found through the Michigan Department of Health and Human Services (MDHHS). The MDHHS website (www.michigan.gov/mdhhs) includes statewide data on major health problems such as asthma, diabetes, cancer, and cardiovascular health. Once you chose a category on the website, data may be further broken down by years, ages and gender. MDHHS also maintains finer-grain data from the county, city or hospital network level.

Health problems are important indicators for resiliency because they provide perspective on the extent of a community's vulnerabilities, and in what ways vulnerabilities may worsen over time. This type of information can help local governments get in front of a problem, instead of reacting to it after the fact.

Emergency Management Data

The Michigan State Police, Emergency Management and Homeland Security Division (MSP/EMHSD) coordinates state and federal resources to assist local governments in response and relief activities in the event of an emergency or disaster. Under the Michigan Emergency Management Act (Public Act 390 of 1976,

The Michigan Department of Health and Human Services (MDHHS) is a good source of health data.

as amended), each Michigan county is required to appoint an emergency management coordinator. In addition, some municipalities also have emergency management coordinators.

Emergency management coordinators have responsibilities that include planning for hazard mitigation, preparedness, response and recovery in local communities. These contacts can be good sources of local data for resilience planning.

Natural Resource Data and Mapping

When examining the resiliency of a community, it is crucial to understand its existing landscape of natural and built environments. Where are the natural resources? Which natural resources can absorb environmental damage and which are more vulnerable? What elements of the built environment can reduce the pressures of environmental damage, and what elements exacerbate these pressures? Considerations like these are essential to understand a community's ability to proactively plan for and respond to changing conditions.

Tree Canopy

Tree canopy coverage relates to the overall health of a community. Urban forests — identified by the U.S. Forest Service as urban parks, street trees, landscaped boulevards, river promenades, wetlands, nature preserves, natural areas, greenways and greenbelts, and even trees on industrial brownfield sites — can all have an impact on the health of a

This is an aerial photo of Ann Arbor. When the city conducted a tree canopy study in 2010, it found that Ann Arbor has 33% tree canopy coverage. Photo credit: https://sites.lsa.umich.edu/bardwell-lab/about-ann-arbor/

CASE STUDY

Tree Canopy in Ann Arbor

Between 2010-2014, the City of Ann Arbor undertook an Urban and Community Forest Management Plan with a grant from the Michigan Department of Natural Resources (MDNR) and the US Forest Service. The plan provides a framework to sustainably manage the city's urban forests in line with the community's needs and values.

First, a tree inventory was conducted that counted the number of each species, rated tree condition, and recorded the land use category in which the tree is located. The study also compiled all the ordinances that relate to tree management. Upon knowing the diversity and age of its tree stock, the city can monitor when to prune, when to remove dying trees, and how to better keep a healthy balance of different species to build resilience against disease and storm events.

Aerial imagery was used to determine that the city's total tree canopy coverage is 33%. The tree canopy is estimated to provide $4.6 million in benefits per year by reducing stormwater runoff, improving air and water quality, and moderating summer temperatures, among other benefits.

As a part of the goal-setting portion of the process, tree canopy targets were set for to each land use category, so that within the next 30 years, canopy cover can be increased by 5-30% (depending on the land use zone).[1]

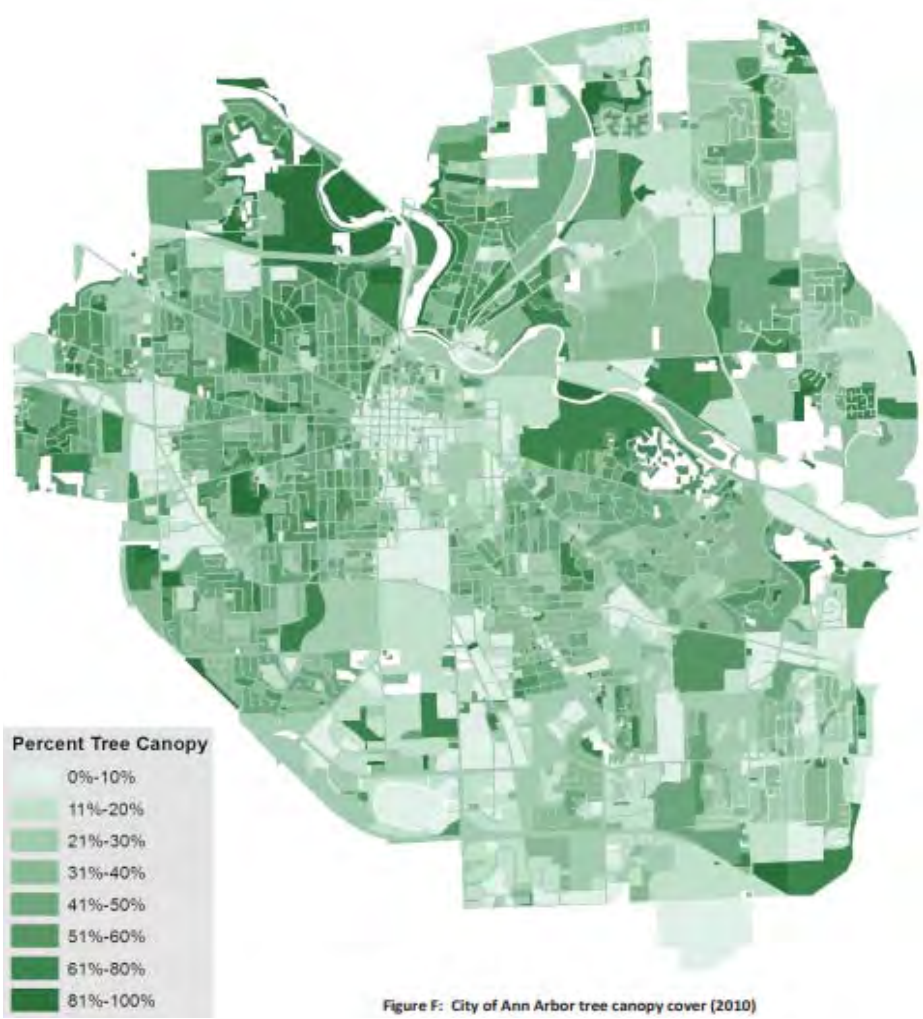


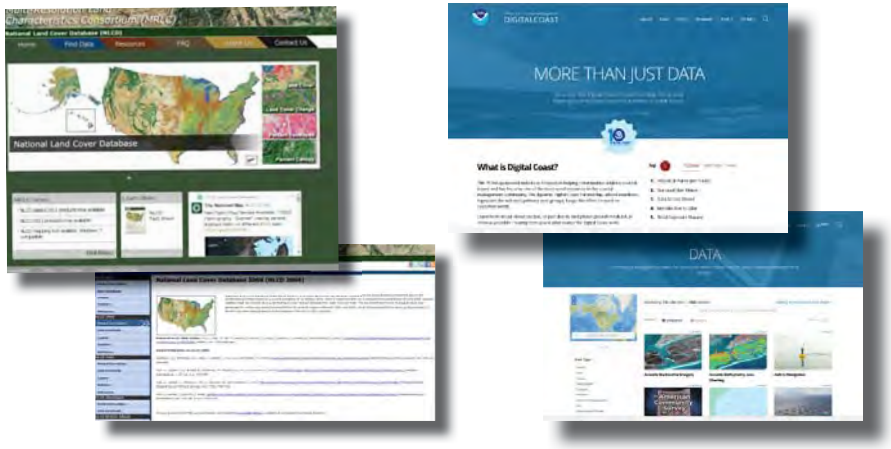
Figure F: City of Ann Arbor tree canopy cover (2010)

[1] http://www.a2gov.org/departments/forestry/Documents/UCFMP_FINAL_022515.pdf

community. For example, higher tree canopy coverage has been shown to reduce overall expenditures for mental health by reducing stress and depression levels. Treed sites are major community assets that enliven neighborhoods, provide parks, offer community gathering spaces, and are capable of enhancing property values. Their uses range from providing a beautiful setting to absorbing shock from extreme weather and climatic events, and therefore are an important consideration as a natural resource.

Given the significance of tree canopy coverage, there are several data sources that monitor and track tree canopy around the United States. One of the most accurate (and free) sources of tree canopy data originates from the Multi-Resolution Land Characteristics Consortium (MRLC), a leader in land cover studies that is frequently used by scientists, spatial analysts, and a variety of folks in the private, public, and academic sectors. The MRLC is a group of federal agencies charged with the task of mapping land coverage using Landsat satellite imagery. The massive consortium of agencies includes the Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), U.S. Forest Service (USFS), U.S. Geological Survey (USGS), Bureau of Land Management (BLM), U.S. Department of Agriculture National Agricultural Statistics Service (USDA NASS), National Parks Service (NPS), National Aeronautics and Space Administration (NASA), U.S. Fish and Wildlife Service (USFWS), and the U.S. Army Corps of Engineers (USACE). While this group is responsible for several datasets that may be beneficial for understanding natural resources, this section focuses on tree canopy coverage.

The MRLC has an interactive "map viewer" platform at www.mrlc.gov that allows users to zoom in on any place in the United States (and even Puerto Rico) to examine various datasets, including tree canopy, land cover, and impervious surfaces.[1] Geospatial data is available for download directly from this map viewer or elsewhere on the MRLC website, and is free of charge with proper source citation. This GIS data is useful for making maps and assessing tree canopy coverage; its advanced software and analytical tools can determine the exact amount of tree canopy coverage in any geographic boundary. Another interesting source for tree canopy data is the "Urban Tree Canopy Assessment" program from the USFS. The USFS conducts individual studies in certain cities and geographies, but also empowers those interested to conduct their own studies, laying out the precise methodology and resources to do so. Limitations for replicating one of these studies would be based on available GIS data; layers needed to complete this type of assessment include building footprints, roads, right-of-ways, high-resolution imagery, parcels, community geographies such as neighborhoods, and LiDAR data.[2] While most of these GIS layers are publicly available in Michigan, some may be hard to find. Roads and geographies are available from the Michigan CGI



1 https://www.mrlc.gov/viewerjs/
2 https://www.nrs.fs.fed.us/urban/utc/

Data Library, but building footprints and parcels may be unavailable altogether, or potentially found within the applicable County GIS Department for a cost. High-resolution imagery may be found at the appropriate regional council of governments and possibly at no charge, but not all COGs in Michigan will have this imagery. LiDAR datasets for limited areas of Michigan are available free of charge from NOAA's Office for Coastal Management Digital Coast Data Portal.[3]

Lastly, another excellent resource for identifying tree canopy, particularly for those with limited access to GIS software or spatial resources, is the i-Tree Canopy website at canopy.itreetools.org. This website allows users to identify trees in any given geographic area to calculate tree canopy.[4]

Compiling information from the above resources will help inform the resiliency planning process. Communities with high tree canopy coverage are likely to be better equipped to handle extreme weather events, because green spaces help absorb shock both by filtering stormwater runoff and providing shade and better air quality in the heat. Because trees have been shown to increase property values, they could also increase the chances of proper home maintenance, which can protect residents from the effects of severe storms.

Soil Characteristics

Soil characteristics recorded by county soil surveys throughout the United States form the base of knowledge on a variety of development-related factors. Understanding soil profiles and compositions is key when evaluating development needs, even those regarding emergency preparedness and climate resilience. For instance, structural development should rarely occur on soils that are known to contain high proportions of water, such as wetlands or

Soils develop their unique properties and become different from one another through the actions of climate, organisms, relief, parent materials, and time.

3 https://coast.noaa.gov/dataregistry/search/collection/info/coastallidar

4 http://canopy.itreetools.org/resources/iTree_Canopy_Methodology.pdf

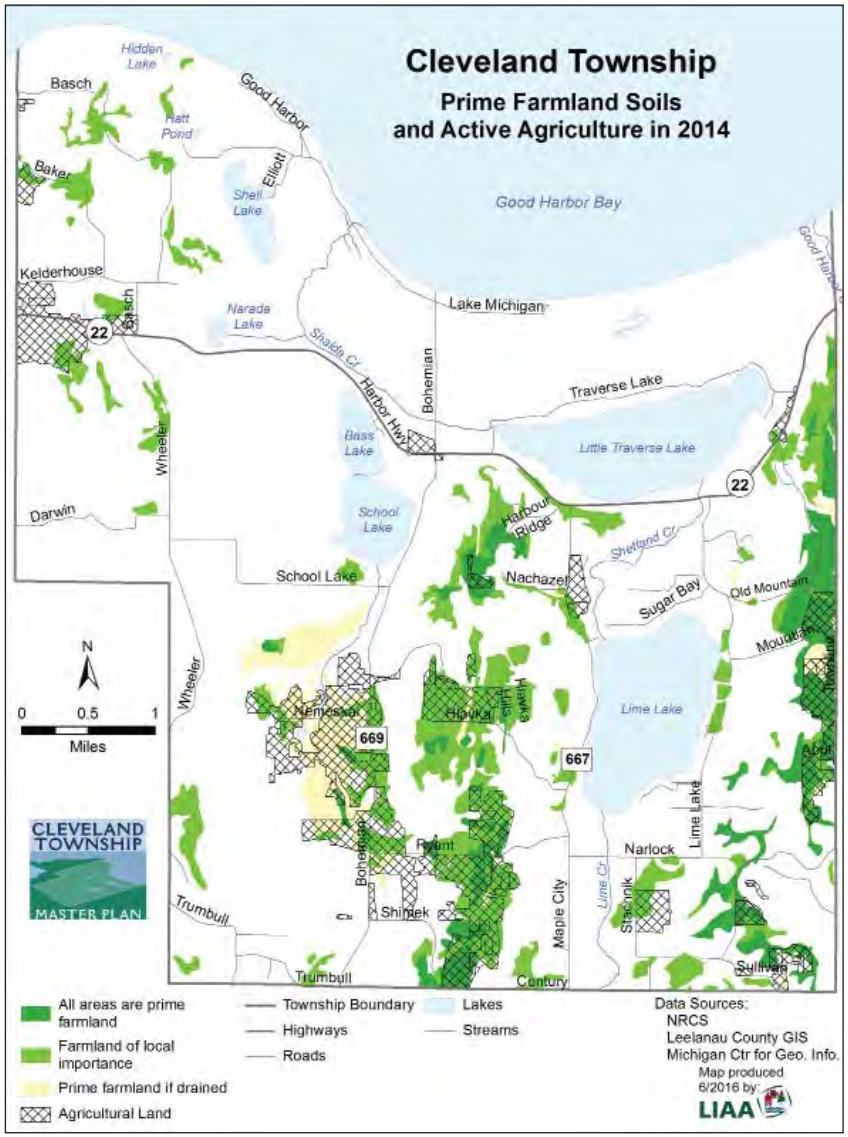
ponding soils, to avoid structural damage in any storm or flooding event. Knowing the location of limiting soils, as well as the types of features that cause limitations, are necessary considerations in resiliency planning.

Several online maps exist that showcase these characteristics and provide information either through online "map viewers" or for direct download for robust GIS analysis. An excellent starting point for researching these map resources begins with the ArcGIS Resources "Soils" Gallery. GIS analysts with access to the ArcGIS Desktop software have additional options, as all related map layers can be displayed in the software for advanced analysis.[5]

Another online resource is the Web Soil Survey from the USDA Natural Resources Conservation Service, which allows users to download soil geographic data by county, along with associated tabular data for further GIS analysis.[6]

Agricultural Capability

An extremely important soil characteristic pertains to the soil's suitability for agricultural uses. This can influence land uses, preservation of natural resources, and conservation of land with fertile soils. Although this soil factor may not be a major consideration for urban areas, it certainly is a helpful resource for rural areas and, more generally, communities with open spaces. The ArcGIS Resources "Soils" Gallery has assembled a map of the United States that defines soils related to their capability for agricultural uses, dividing them into eight categories, with a value of 1 representing the best soils and a value of 8 representing the worst soils. Soils ranked 1 through 4 are capable of producing common crops when properly managed. A variety of soil characteristics are used to inform this rating system, including slope,



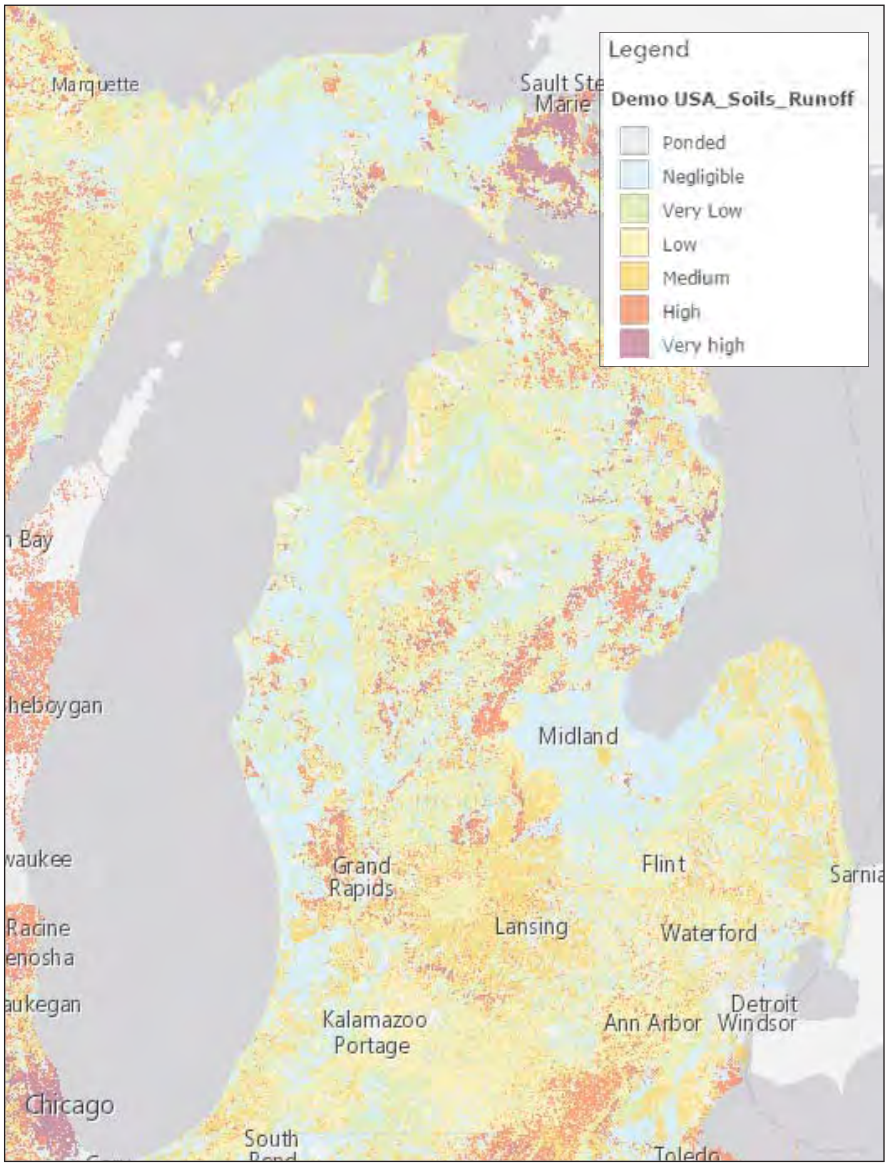
5 http://resources.arcgis.com/en/communities/soils/
6 https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

depth and texture, among others. Launching the interactive online map for Agricultural Capability will allow users to search for any place in the United States and click on any point on the map to pull up soil information.[7]

Soil Runoff Rates

Whenever it rains or floods, soils only have two options to handle rainfall: water can be absorbed by soils, or it can be rejected, as it often will be if soil has reached its saturation point and its capacity to hold water has been exceeded. When soil no longer absorbs liquids, those liquids are free to "run off" into bodies of water, flowing downhill and following topography and local waterways within the affiliated watershed. On average, about one-third of precipitation is not absorbed by soil and travels instead as surface runoff, which can have major implications on the surrounding environment and natural resources.[8]

Runoff can be damaging. When water travels along the surface of the Earth, it tends to pick up materials, pollutants, and substances along its path. It alters the landscape causing erosion issues, or it is accelerated by paved surfaces (see the section on The Built Environment later in this chapter). For these reasons, it is important to understand which soils can hold a high amount of moisture, and which soils are likely to contribute to surface runoff. Luckily, the ArcGIS Resources "Soils" Gallery contains a free map for public use that identifies the likelihood of soils to contribute to runoff, ranging from a negligible amount to a high amount of runoff.[9]



7 http://www.arcgis.com/apps/OnePane/basicviewer/index html?appid=ff3af737ebb942d99bc-f2140a8ec2082

8 https://water.usgs.gov/edu/watercyclerunoff.html

9 http://www.arcgis.com/home/webmap/viewer.html?webmap=8bae11aef0d14406b6c4d-0d3a021de31

A team of wetland researchers collects data for a climate adaptation research project in Luna Pier. The project was aimed at evaluating data needs to help coastal wetlands better adapt to climate change.

Hydric Soils and Wetlands

Hydric soils are formed under saturated conditions, are commonly saturated with water, and assist in the identification of wetlands. Another type of "wet" soil includes ponded soils, which are saturated at least 50% of the time and likely to "pond," or hold water at the surface. These two soils, along with known wetlands, are critical for determining areas that are likely to flood. Another ArcGIS Online interactive web map has been created to show the presence of hydric soils for the entire United States and emphasizes where the presence of these soils is likely, and therefore areas that are likely to be prone to flooding. Another interactive map identifies areas where ponded soils are found, with similar implications. Finally, a compilation of these types of factors produced an overall flooding frequency map, which identifies areas based on the probability that a soil will flood during any given year, ranging from very rare to very frequent.[10]

Another resource for understanding the likelihood of flooding is the Federal Emergency Management Agency (FEMA) Flood Maps. FEMA has recently reorganized flood information and datasets in its Flood Map Service Center at msc.fema.gov, allowing website users to immediately download maps and datasets for flood management and planning. Similarly, FEMA hosts its floodplain GIS datasets on ArcGIS Online as well, which, like the other soil-related maps, can be pulled into ArcGIS Desktop software for further analysis.[11]

[10] http://www.arcgis.com/home/webmap/viewer.html?webmap=ed1bdc9451394244a07f76e72b5303ff
[11] https://www.arcgis.com/home/item.html?id=cbe088e7c8704464aa0fc34eb99e7f30

Wetlands

Although wetlands vary widely across the United States, three defining features help to identify them. Certain types of plants, the presence of hydric soils (as discussed above), and the frequency of flooding are all used to locate and assess wetlands. Wetlands strengthen a community's resilience to flooding and extreme precipitation events, capable of absorbing shock from major storms, trapping surface runoff as it travels through watersheds, and breaking down and/or keeping pollutants from reaching other bodies of water. For instance, a flooded one-acre wetland can hold 330,000 gallons of water in just one foot of saturated material.[12] Wetlands also help recharge groundwater and serve important functions in their respective ecosystems. Michigan has a tragic history of destroying wetlands; over 50% of coastal wetlands have been lost, and a massive 4.2 million acres of wetlands have disappeared altogether.[13] When wetlands are destroyed, everyone loses. Resilient communities identify their wetlands, preserve wetland geographies, and understand the contributions of wetlands to the surrounding area.

There are some good GIS data sources for wetland identification and mapping. The Michigan Department of Environmental Quality (MDEQ) maintains an online Wetlands Map Viewer that displays several types of wetland layers (www.mcgi.state.mi.us/wetlands). Included on the map are wetland (hydric) soils, the National Wetlands Inventory of 2005, potential wetland restoration areas, and the Final Wetlands Inventory as identified through the Michigan Resource Inventory

These are photos of wetlands in southwest Michigan, where up to 40% of wetlands have been lost. While this is a tremendous loss, other regions have lost nearly 100% of their wetlands.

12 http://www.michigan.gov/dnr/0,4570,7-153-10370_22664-61132--,00.html#Types

13 http://michiganradio.org/post/mapping-michigan-wetland-loss

System (MIRIS). Among the several datasets, users can develop a comprehensive perspective of wetlands in Michigan, including wetlands mapped by the U.S. Fish and Wildlife Service, wetlands determined by the Michigan Department of Natural Resources (MDNR) through interpretation of aerial imagery, soils identified by the USDA Natural Resource Conservation Service, and potential wetland restoration areas. This particular Map Viewer also offers several "basemaps," allowing users to overlay wetland data on a street map, high-resolution aerial imagery, or topographic map, including several years of historical imagery. One can search for specific areas in Michigan, export maps directly as PDFs, or even export a wide variety of GIS shapefiles to use for further analysis. Shapefiles that can be downloaded at any particular map extent include the National Wetlands Inventory, Potential Wetland Restoration areas, Michigan watersheds, Michigan ecoregions, DEQ conservation easements, and several combinations of data packages that include the above layers. This Map Viewer is robust, easy to use, allows users to do basic viewing and exporting to PDFs, and can serve as a repository of GIS data sources for immediate download.[14]

Open Space and Parks

Open spaces and parklands serve vital functions in every community. They are used for recreational purposes, but also have positive effects on the environment and people that use these spaces, providing a vital connection between people and land.

Data sources for open spaces and parks, however, can be difficult to find. Some GIS layers exist that include parklands at national, state, and local levels, but they are often incomplete when compared to local knowledge, and they require advanced GIS software to use without any interactive online map viewers. This limited information may only be useful for those with a background in GIS and access to software.

The Michigan Center for Geographic Information (CGI) Data Library and Open Data Portal (www.mcgi.state.mi.us/mgdl) provides a tremendous amount of

[14] http://www.mcgi.state.mi.us/wetlands/mcgiMap.html

data for direct download, including Michigan State Park boundaries and Michigan Forest Stewardship Plan boundaries. However, these only include state parks and forests, so local or regional open spaces are likely to be excluded. Another source involves the ArcGIS Online USA Parks layer, created by the team at Esri, but again, this is likely to miss many local and regional parks.[15]

When drilling down to local resources for this type of information, it may be helpful to check with the following agencies/organizations when searching for information:

- *Any local municipalities and their Parks & Recreation Departments*
- *County governments, and specifically, their GIS Departments, Parks and Recreation Departments, or Planning Departments*
- *Any regional park systems, such as the Huron-Clinton Metroparks System in southeast Michigan*
- *Local conservancy groups, like the Legacy Land Conservancy in southern Michigan or the Grand Traverse Regional Land Conservancy in northwest Michigan*

Often, a simple email inquiry or phone call can track down the local open space and park information you need.

15 http://www.arcgis.com/home/item.html?id=578968f975774d3fab-79fe56c8c90941

The Built Environment

People rely on the built environment to complete day-to-day tasks, such as a road to get them to the grocery store, or electricity to type this Handbook. With increased heat and more frequent and severe storms, infrastructure will take a hit. It is critical to understand the condition of the built environment and whether it can withstand changing weather patterns.

Stormwater and Sewer

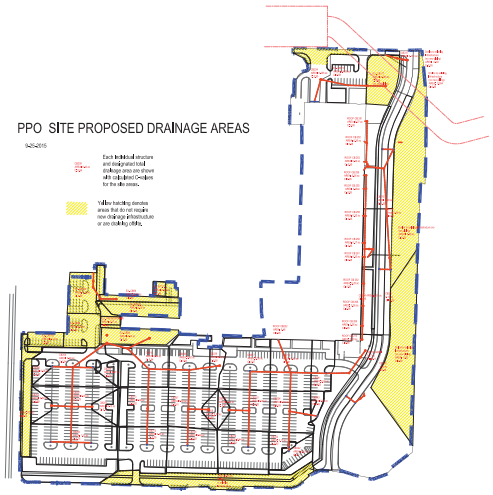
Stormwater and sewer systems are important infrastructure to map and assess. Public infrastructure data of this type can be difficult to track down, and it may not even exist for smaller, rural areas in Michigan. Good sources to initially check include regional Councils of Government, such as the Southeast Michigan Council of Governments (SEMCOG). SEMCOG has a 2005 GIS shapefile layer that shows the sewer service area for its seven-county region.

Below are some suggested sources to contact when looking for stormwater and sewer information:

- *Local municipalities and their Engineering/Building Departments*
- *County Drain Commissioners and Road Commissions*
- *County/Local GIS Departments*
- *Regional Councils of Governments*

Stormwater and sewer information, even if not easily mapped, is worthwhile to include in resiliency planning. Stormwater and sewer systems serve a primary function in storm events and help prevent flooding. When these systems cannot keep pace with major storms, the risk of flooding increases, which can cause damage to infrastructure and be dangerous for residents.

The image at right is an engineering rendering of a proposed drainage system denoting where additional infrastructure is needed.



Septic Systems

In the less urbanized areas of Michigan, septic tanks and drain fields are often the primary method for handling wastewater. If improperly managed, septic systems can have damaging results on water quality and the environment. Failing septic systems allow excessive pollutants and bacteria to seep into waterbodies or be carried away by surface water runoff, conditions that are likely to be accelerated by an increase in the frequency and intensity of heavy precipitation events.

Although public GIS data does not typically exist for septic tank usage (as they are usually privately maintained), it is still helpful to reach out to any local officials in the community who can provide you with some context regarding local usage of septic tanks and the amount of properties with private tanks. Recommendations related to private tank maintenance are useful in resiliency planning.

CASE STUDY

Sebewaing Fosters Energy Resilience Through a Community Planning Process

The Village of Sebewaing recently partnered with Sebewaing Light and Water to develop a resiliency plan for Sebewaing, with a special focus on public utilities. Funding for the project was provided by the Michigan Association of Planning (MAP) with a grant secured through Michigan's Coastal Zone Management Program, and Delta Institute provided consultant services. The plan will be used to primarily safeguard the village utility, Sebewaing Light and Water, as changes in the climate impact the community at large and specifically its utilities.

The Sebewaing area is primarily agricultural, and crop land comprises one of the most vulnerable assets in the community, particularly as extreme weather events increase and average temperatures rise. The village's utility provides power to the Michigan Sugar Company's operations and processing station, which produces 925,000 tons of sugar annually, as well as producing dried beets, pressed pulp and molasses. Beet processing is seasonal in nature, adding unique energy requirements to the village-owned utility.

A primary purpose of the resiliency plan is to provide reliability in the utility sector that supports the agricultural, residential and industrial community. Sebewaing has learned that the best way to ensure reliability is through redundancy and publicly-owned generation. While self-sufficiency is not a solution for all communities, it has become clear to Sebewaing that due to its distance from the generation source and its unique energy needs, generating and distributing its own energy, as well as modifications in site planning, will provide the most reliable and cost effective approach to its own resiliency.

> "We worked with Delta Institute to develop a resiliency plan centered on our local utility, which will become one chapter in the village's master plan. It was a wonderful process. Because our public utility provides electric and water, climate trends and environmental changes are huge. Regardless of the causes, we are seeing changes in our community. We used a matrix to help the community identify the major changes, the key impacts, and policy options for addressing the issues."
>
> *Melanie McCoy, Superintendent of Sebewaing Light and Water, Village of Sebewaing*

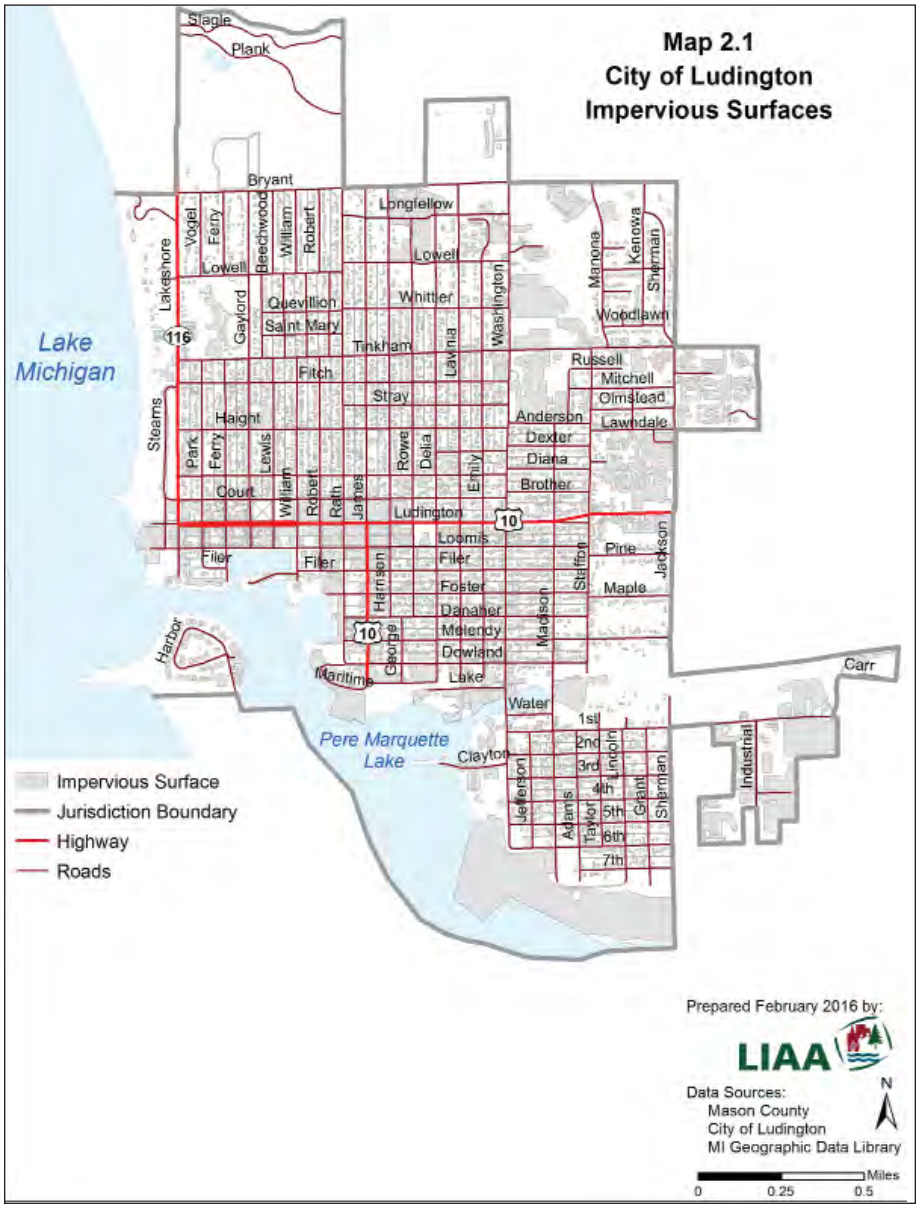
The resiliency planning experience highlighted the need to address climate change through education. One of the most meaningful aspects of this process was a presentation to the community by Jeff Andresen, the State Climatologist, regarding climate change and its impact on the agricultural sector and how these changes ripple through a community such as Sebewaing.

This case study was reprinted from the November-December 2017 edition of the MAP Newsletter. The Michigan Association of Planning (MAP) is a non-profit membership organization, dedicated to promoting sound community planning that benefits the residents of Michigan.

Impervious Surfaces

Impervious surfaces play a significant role in the built environment. These surfaces are responsible for a variety of factors that can influence the environment and the vulnerability of sensitive groups, including runoff, pollution and increased urban temperatures. The "urban heat island effect" is intensified by roof and pavement surfaces, making urban areas hotter than surrounding rural areas. In extreme summertime heat waves, this additional trapped heat can be dangerous, particularly for vulnerable populations such as senior citizens, young children, people with medical conditions, and people without access to air-conditioned environments.[1] For both social and environmental reasons, it is important to understand the relationship between impervious surfaces, the environment, and the community in general.

As discussed in the Tree Canopy section, the primary source for impervious surface data also originates from the Multi-Resolution Land Characteristics Consortium (MRLC). The same MRLC interactive "map viewer" platform that allows users to zoom in on any place in the United States (and even Puerto Rico) to examine tree canopy coverage also includes impervious surface information. Geospatial data is available for download directly from this map viewer or elsewhere throughout the MRLC website, and is free of charge with proper source citation. This GIS data is useful for making maps and assessing the geographic distribution of impervious surfaces.[2]



1 https://www.epa.gov/heat-islands/heat-island-impacts
2 https://www.mrlc.gov/viewerjs/

Energy and Redundancy

As discussed throughout this Handbook, power outages are one of the major dangers of adverse weather events. A resilient future calls for an updated energy system that prevents or reduces the instances of outages. While it is administratively efficient to have a centralized power system, it is also risky; one storm can knock out a large portion of a community's electrical grid. The infamous 2003 power outage that left millions without power across the Midwest and Northeast is an excellent example of the need for energy redundancy.

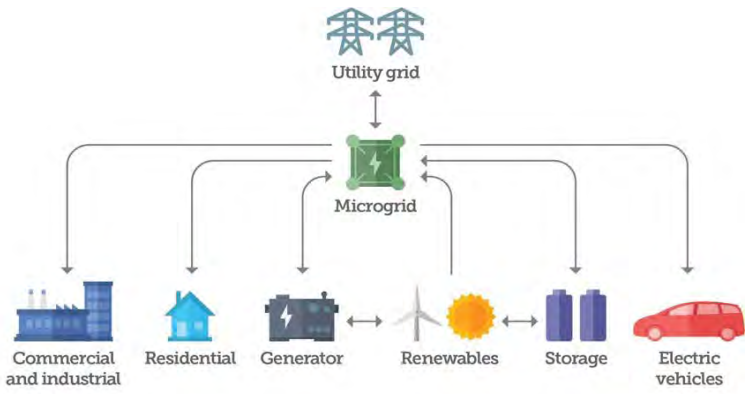
The term "redundancy" may seem misplaced when discussing energy efficiency, but in this context, redundancy means having reliable backup facilities, ideally a network of decentralized power stations that are connected and can transfer stored power. This translates into multiple smaller power stations located throughout the community, each of which are only responsible for a portion of the community's power provision. This type of energy system makes a community more resilient because it is more likely to succeed in providing critical services in the event of a power outage. In the meantime, it is important to make sure that essential buildings and services like hospitals and fire stations can run on backup generators in the event of a power outage. For resiliency planning, an inventory of which buildings have backup generators and which still need them is a good start.

To push it one step further, a community could consider developing microgrids. A microgrid is just what it sounds like, a mini-version of an electrical grid that can operate within, or even independent of, a larger grid. Microgrids are being employed in Michigan and have been in use at institutions like universities for decades. Microgrids are easier to scale up or down, and they can combine and distribute both renewable and nonrenewable sources of energy.

3 http://www.catf.us/fossil/problems/power_plants/

The Costs of Producing Energy

Planners are increasingly incorporating human health costs and benefits into community development decisions. When human health is considered, the costs of producing energy through conventional methods increase. The nonprofit Clean Air Task Force (CATF) has kept a record of mortality effects from existing power plants on a county-wide scale.[3] The U.S. overall has made huge strides since 2004 in reducing the negative health impacts caused by the emission of fine particulate matter from power plants. Unfortunately, Michigan still suffers from high rates of death and hospitalizations. Some of the highest rates from 2012 were located in the Thumb, in Sanilac and Huron counties, with a combined seven deaths, nine heart attacks, and 65 asthma attacks (among other hospitalizations) in one year.



Source: LG CNS

Photo credit: http://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2016/02/why-and-how-microgrid-technology-is-a-good-power-source

Photo credit: http://www.mtu.edu/news/stories/2012/july/michigan-tech-faculty-researchers-endorse-michigans-25-2025-renewable-energy-initiative.html

Renewable Energy

The State of Michigan has outlined plans to have 40% of its energy come from energy waste reduction, increased natural gas use, and renewable sources by 2025. This is the first step toward a diverse energy portfolio that will strengthen the state's adaptive capacity against the likely increase in power outages. Even more important to long-term resiliency, renewable energy also has mitigating effects because it reduces emissions and our reliance on foreign oil. The technology needed to run buildings completely by renewable sources is available; it is not a question of scientific advancement, but rather of policy and cultural acceptance.

Photo credit: http://www.mlive.com/business/mid-michigan/index.ssf/2011/07/a_real_power_house_but_is_midl.html

Economic Resiliency Data

Job Diversity

Source: U.S. Census, NAICS codes

One quick estimate of a community's transition from the "old economy" to the "new economy" is the ratio of jobs in each category as reported by the U.S. Census's American Community Survey (ACS). "Old economy" jobs are related to the production and distribution of goods. ACS categories reflecting them include:

- *Construction*
- *Manufacturing*
- *Transportation, warehousing, and utilities*
- *Mining, quarrying, oil and gas extraction*

"New economy" jobs focus on the delivery of knowledge and services. ACS categories reflecting them include:

- *Information*
- *Educational services, and health care*
- *Finance and insurance; real estate*
- *Professional, scientific, and management*

In Michigan, an old-to-new-economy jobs ratio that is greater than 1 likely means that the job market skews towards manufacturing. While some manufacturing jobs are well-paid and meant to be permanent, they have also been declining in number and are therefore less secure than jobs in other sectors of the economy. Manufacturing jobs also rely on heavy equipment and are less mobile, making them vulnerable to physical threats such as flooding, while knowledge-based jobs can go on over a connected network. Trends suggest economic resiliency rests on the growth of "new economy" jobs.

A more detailed breakdown can be accessed through the North American Industry Classification System (NAICS), which provides information on specific sub-industries and an explanation of what types of jobs each category includes. For example, the "Information" industry includes 31 more specific sub-industries such as music publishers, radio networks, and satellite telecommunications.

A resilient economy has diverse job opportunities. As seen in Michigan and across the Midwest, heavy reliance on manufacturing caused economic devastation when the economy shifted to new industries. When studying industry data for your community, watch out for these concentrations and look for opportunities to diversify.

Labor Participation

Source: U.S. Census

The unemployment rate is a commonly-used gauge of a community's economic health, but it doesn't always capture the full economic picture. For example, the unemployment rate does not include workers who have stopped looking for jobs (those labeled "discouraged workers"), and therefore may underestimate the scale of joblessness in a community.

The labor participation rate, which counts all noninstitutionalized persons over the age of 16 who have jobs, can supplement this picture. For example, if the labor participation rate is 60%, that tells us that 40% of working-aged people are not working. If the unemployment rate is 10%, we have identified 30% of the potential workforce for whom we do not know a precise employment status. These may not all be persons who are looking for a job; they may be retired, attending school, homemaking, or in an otherwise employment-free economically stable situation. Some of those figures, such as retired populations or those in school, can be cross-referenced through other data to help determine the demographic makeup of those not in the labor force.

Educational Attainment

Source: U.S. Census

"New economy" jobs require a bachelor's degree. On average, people with college degrees earn higher wages and less frequently fall into poverty. Therefore, a community can increase its economic resilience by encouraging its students to pursue higher education and by working to attract and retain college graduates as residents.

Photo: Paul Jaronski

Income and Benefits

Source: U.S. Census

Income is typically measured by the median household income (MHI). Median income is considered a better indicator than average income because it is not skewed by low or high outliers, showing instead the amount earned at the 50th percentile of residents. This number is a good point of comparison with similarly-situated or neighboring communities, and it is also a useful number to track over time. In some instances in Michigan, wages have stagnated or declined. When taking inflation into account, even a stagnated wage represents a loss of purchasing power.

Income is also a useful indicator of the affordability of housing. Housing and the economy are closely linked. It is possible for a local economy to suffer because it does not have housing stock that is affordable to its workers, with "affordable" defined as spending 30% of gross monthly income on housing expenses. One simple calculation is to check if the median local rent is 30% of the median household income. This provides some indication of housing affordability and how it relates to the workforce. The American Community Survey also provides some more direct measures, such as selected monthly owner costs as a percentage of household income (SMOCAPI) and gross rent as a percentage of household income (GRAPI).

A "good" job means more than just the wage. Jobs that contribute to a resilient economy also provide employee benefits such as healthcare, paid time off, and disability insurance.

10 LARGEST INDUSTRIES (NAICS 3-DIGIT)

SECTOR	JOBS
Local government	14,018,125
Food services and drinking places	9,868,967
Professional, scientific, and technical services	7,902,269
Administrative and support services	7,638,499
Ambulatory health care services	6,325,855
State government	5,131,014
Federal government	5,003,071
Hospitals (private)	4,759,747
Specialty trade contractors	3,433,421
Nursing and residential care facilities	3,185,378

TOP 10 GROWTH OCCUPATIONS ABOVE MEDIAN WAGE ($20.15)

SECTOR	JOB CHNG.
Registered nurses	516,654
Elementary school teachers	203,114
Postsecondary teachers	187,492
Sales reps, wholesale and manufacturing	174,940
First-line supervisors, office and admin support	147,107
Accountants and auditors	144,746
Software developers, applications	134,313
Software developers, systems software	118,930
Market research analysts and marketing specialists	118,421
Management analysts	115,538
U.S. total	**14,784,454**

The top 10 industries in Michigan were reported at the 2013 Governor's Economic Summit as a way to develop strategies to align talent with available jobs. Credit: http://www.michiganbusiness.org/cm/Files/Events/2013_Governors_Economic_Summit/GES-Packet.pdf

Financial Security

Source: ESRI Business Analyst

Financial security is a multi-faceted topic. When determining the economic resiliency of a community, financial security may matter more than median household income. Income alone does not tell you how well-off a person is, because it does not consider where that money goes once it is earned. ESRI Business Analyst, a proprietary software system that collects demographic, lifestyle and expenditure data, compiles data on other important indicators such as:

- *Retirement plans*
- *Savings accounts*
- *Loans*

Along with income, these indicators help to flesh out the economic preparedness of a community. An aging population with low levels of retirement plans and savings accounts points to problems in the future, even if the population is earning high wages now. It is important to understand the extent of any precarious economic situations in a community, so proactive steps can be considered and taken to mitigate negative impacts.

Michigan Income Inequality Fast Facts:

- 11th most unequal state in nation, 2nd most unequal in the Midwest
- Top 1% makes 22 times more than the bottom 99%
- Most/least unequal counties: Charlevoix/Baraga
- Median earnings for full-time working males/females: $50,157/ $37,419
- Michigan ranks among the worst in gender pay disparities
- In 2012, workers of color made $3 less per hour than white workers
- Racial disparities in average hourly wages exist regardless of educational attainment

Photo credit: http://www.mlpp.org/time-to-end-income-inequality

Poverty

Source: U.S. Census

Poverty is an indication that people are struggling to successfully participate in the economy. Some may be unemployed, and others could be working full time at a low wage. Either way, a high poverty rate suggests several different issues could be taking place:

- *There is a lack of accessible opportunities*
- *People are not properly trained or educated for accessible jobs*
- *The jobs do not pay a livable wage*

A resilient community strives to reduce its poverty rate because impoverished groups do not have the resources or access to resources that help them respond to or recover from economic or environmental stressors.

Commercial Enterprises

A successful commercial sector is a strong sign of economic resilience. Low commercial vacancy and thriving retail and entertainment options create a positive feedback loop of ambiance that attracts consumers and private investment. On the other hand, desolate storefronts and unimproved infrastructure are difficult to reverse. In a report called "Retail Market Potential," ESRI Business Analyst compiles annual household purchases to give an idea of overall economic demand. Another report titled "Retail MarketPlace Profile" shows the supply and demand for different industries within a given jurisdiction. It also calculates the retail gap, showing which industries are "leaking" money because consumers must leave the community to find what they need. With this information, a community can guide development that meets residents' commercial needs. A strong commercial sector will have smaller retail gaps and fewer "leaky" industries.

Downtown Holland has several features that contribute to a strong commercial center. There are pedestrian amenities, wide sidewalks, and attractive, filled storefronts.

"Resilience is tricky. Managing natural and cultural systems for long-term adaptive capacity is easier said than done."

Chris Hoving, Adaptation Specialist, Wildlife Division of the MDNR

Chapter {5}

A Resiliency Planner's Toolbox

This chapter explores a number of tools available to planners to help evaluate the relative risk and vulnerability communities face, and to track changes over time. Read on to learn about assessing vulnerability, weighing risk, developing scenarios, and tracking metrics.

While many of the principles of resiliency are not new, the resiliency framework is a new way of thinking for many practitioners. Resiliency thinking requires a systems approach that considers all the interrelated components of the community and natural systems.

Systems Thinking

To truly address the complexities of community change and vulnerabilities, it is helpful to take a systems approach to community resiliency.

Communities and their associated parts are interconnected. According to Donella Meadows, author of Thinking in Systems, "A system is an interconnected set of elements that is coherently organized in a way that achieves something; [it] must consist of three kinds of things: elements, interconnections, and a function or purpose."[1] A stress to a community's energy system impacts the food system and the transportation system, as well as buildings, neighborhoods and the people living and working in those buildings.

Additionally, these interconnections do not stop and start at jurisdictional lines. There are over 1,800 units of local government in Michigan, and in order to effectively respond to these complex challenges, collaboration is necessary.

1 Meadows, D. Thinking in Systems

KEY RESILIENCY PLANNING TOOLS

1

VULNERABILITY ASSESSMENTS

Vulnerability assessments are aimed at collecting a wide variety of useful information to increase community resilience by reducing human and community vulnerabilities. Combining measures of sensitivity and exposure, the assessment generally includes consideration of factors such as demographics, environmental conditions, locations of critical facilities and essential services, and the built environment.

2

WEIGHING RISK

Because local communities have significant constraints on funding and resources, it is useful to identify the relative risk that impacts of climate change could pose to a community. Some impacts are very unlikely, but would have catastrophic effects on a community if they were to occur. On the other hand, some impacts are less severe, but are much more likely to occur. A Risk Assessment can help communities plan for an uncertain future.

3

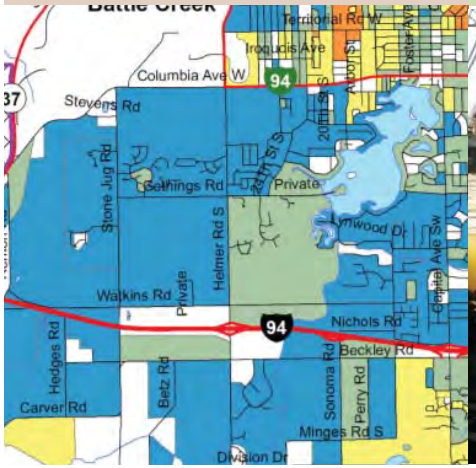
SCENARIO PLANNING

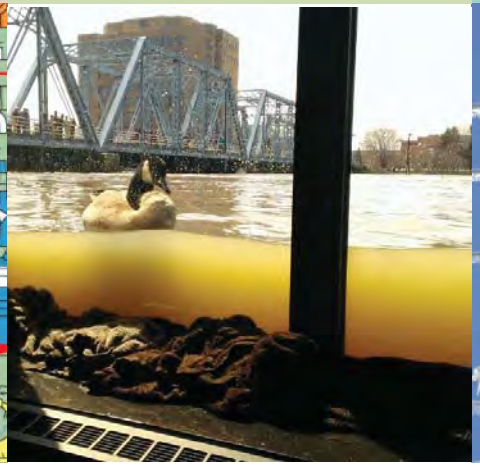
Scenario planning is a method that helps participants look forward in time and consider a series of plausible futures that the community may be forced to respond to. While there is inherent uncertainty associated with scenario planning, it is generally informed by considering social, economic, environmental, and political trends.

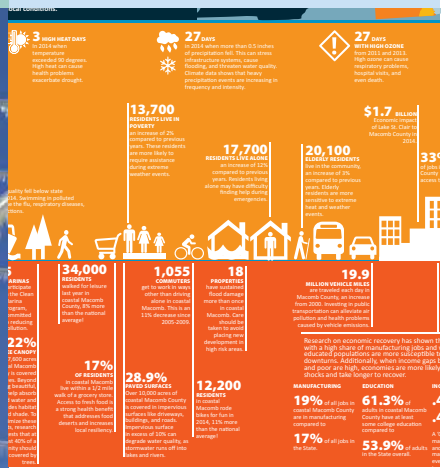
4

TRACKING METRICS

Communities that set ambitious goals and track their progress are more likely to achieve beneficial changes. The metrics that are most useful to track will differ from community to community, depending on the issues that are most relevant to the community, the goals prioritized by the community, and the data that is most readily available in the community.







Conducting a Vulnerability Assessment

As discussed in Chapter 4, a community vulnerability assessment is an important step for defining the risks posed by climate-related impacts to the community. Vulnerability assessments are aimed at collecting a wide variety of useful information to increase climate resilience by reducing community vulnerabilities. The assessment generally includes consideration of factors such as demographics, environmental conditions, locations of critical facilities and essential services, and the built environment. In working through the assessment process, a community can gain valuable information to inform goals and prioritize actions. It allows the community and decision-makers to identify the most vulnerable areas, sectors, and social groups.

A vulnerability assessment can be one of the most research-intensive phases of the climate adaptation and resiliency planning process. However, the scope of your community's vulnerability assessment is scalable. Your community's assessment can be quantitative, qualitative, or a combination of the two. Much of the value of conducting a vulnerability assessment comes from the conversations that are cultivated as the community reviews preliminary findings of the assessment and makes adjustments based on internal community knowledge.

As outlined by ICLEI USA – Local Governments for Sustainability, there are three key components that together determine the vulnerability

"A systems perspective to urban governance is a lens by which we might see more clearly through the fog of change, and potentially better manage the complex cause-and-effect relationships between social and ecological phenomena."[1]

[1] www.resilience.org

"Climate change is already impacting our lives and changing our world. We have no choice but to adapt to these changes, and also to work to reduce future climate impacts. Making smart choices now to make our communities more resilient to climate impacts and to transition to renewable energy will bring so many benefits. We simply can't afford to wait."

Kate Madigan, Director of Michigan Climate Action Network and Energy Policy Specialist for Michigan Environmental Council

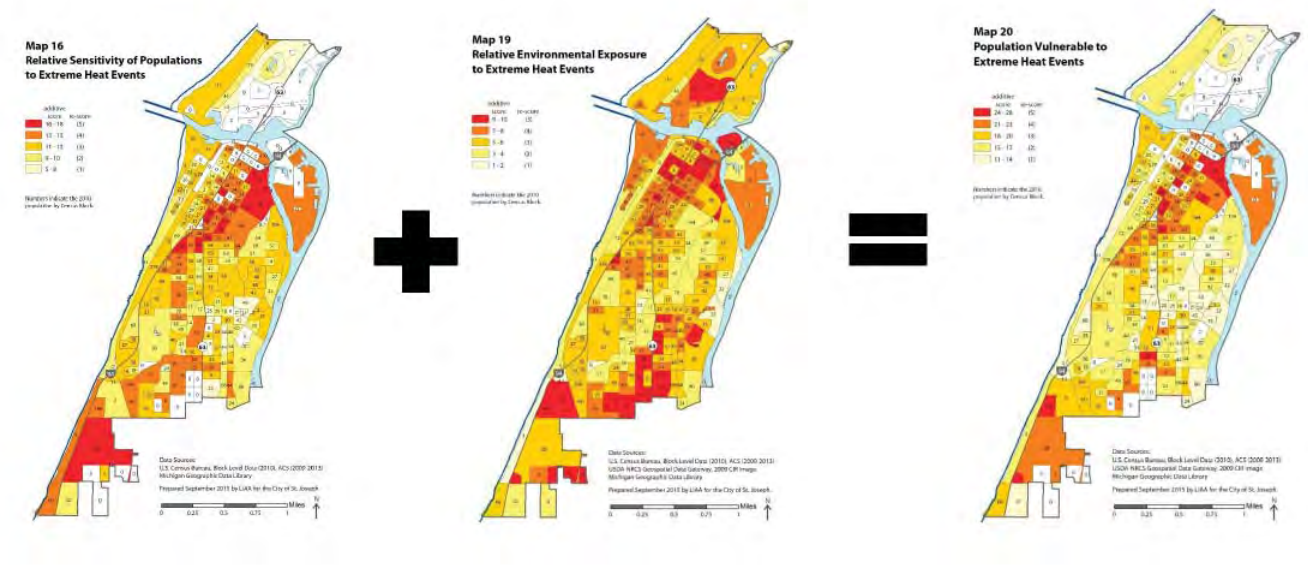
of a system. These components include exposure, sensitivity, and adaptive capacity. The extent of the impact depends on the magnitude of climatic changes affecting a particular system (exposure), the characteristics of the system (sensitivity), and the ability of people and ecosystems to deal with the resulting effects (adaptive capacities of the system).

Sample Heat Vulnerability Assessment

Although the following sample assessment is focused on extreme heat events, many of the considerations and societal impacts identified would be present under other stresses and shocks within the community. Note that although adaptive capacity is a critically important component of overall vulnerability, there is not readily available demographic or environmental data to map adaptive capacity. Later in this chapter, we will discuss ideas for measuring adaptive capacity.

EXPOSURE + SENSITIVITY = VULNERABILITY

To begin the vulnerability assessment mapping process, start with sensitivity. Mapping populations that are known to be more sensitive to extreme heat (such as discussed in Chapter 4) provides a reasonably detailed picture of locations where the highest percentages of at-risk residents live. Of course, this does not necessarily mean these community residents are in immediate danger. Rather, the map



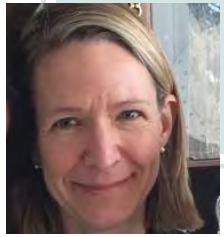
An illustration of the additive process of mapping community vulnerability in the City of St. Joseph. The first map (sensitivity) is combined with the second map (exposure) to get a composite vulnerability assessment.

provides planning officials with a new way of identifying areas where heat waves could present serious problems for a significant number of citizens. That is, these are populations that could be sensitive to extreme heat events.

The second step is to map exposure to extreme heat in the community. The exposure map is actually a composite, created by overlaying two separate exposure maps. The first map displays the percentage of impervious surfaces in the community; the second map displays the percentage of tree canopy cover. The results of the two exposure maps are then combined to provide a single Excessive Heat Exposures Map, which provides a reliable depiction of where the Urban Heat Island Effect would be most and least intense during a heat wave. Community planners can use this map to better assess where new vegetation and tree canopy would be helpful to reduce heat impacts.

The Heat Vulnerability Map is a simple additive combination of the overall sensitivity map and the overall exposures map. The resulting vulnerability map depicts where concentrations of exposures and sensitive populations create a higher risk for community residents. In general, those areas with a higher composite score have residential populations that may be particularly vulnerable to extreme heat events.

Planners can advocate for creative solutions in these high-risk areas. For example, these are areas where more trees could be planted, more parks could be established, and incentives like rebates on energy-efficient retrofits could be provided for homeowners.



"To me, community resilience is the ability of a community to anticipate and minimize the damage and disruption from both short-term crises and long-term changes. Critical to the planning challenge is recognizing that some members of the community are more vulnerable than others, and we need to recognize and prioritize our efforts to address these residents."

Larissa Larsen, PhD, AICP, CEP, Associate Professor of Urban and Regional Planning, University of Michigan

Web-based Vulnerability Resources

There are a number of resources on vulnerability assessments. While each tool uses a different set of social and environmental indicators to feed into the vulnerability assessment, the basic framework remains the same. A few examples include:

- *The Socioeconomics and Climate Change in the Great Lakes Region Tool is an interactive application that demonstrates select social and economic impacts of climate change.*
- *The Cities Impacts and Adaptation Tool is a climate adaptation planning support tool for decision makers, providing demographic and socioeconomic data and climate trends.*
- *The U.S. Health and Human Services emPOWER Map displays populations of Medicare beneficiaries with electricity-dependent equipment in order to identify vulnerable communities.*
- *The U.S. EPA Environmental Justice Screening and Mapping Tool integrates environmental and demographic indicators to identify vulnerable areas in the United States*

"Since 2009, Michigan Green Communities has helped communities track progress towards sustainability initiatives. Offered annually, the Michigan Green Communities Challenge is a roadmap for communities looking to benchmark and advance sustainability progress."

Jamie Kidwell-Brix, Michigan Green Communities Network Coordinator

Adaptive Capacity

According to the International Panel on Climate Change (IPCC), "adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both behavior and in resources and technologies." The presence of adaptive capacity is an important component of resilience. For example, more air conditioning equates with a reduced likelihood of negative impacts from severe weather events and other stressors.

Measuring adaptive capacity is difficult, and is generally done using qualitative methods. Similar to attributes that increase overall resilience, communities with a greater degree of adaptive capacity have attributes such as:

- *Connected social networks and strong social capital*
- *Political stability and strong leadership*
- *Economic diversity*
- *Innovation and entrepreneurship*
- *Healthy ecosystems*

The following self-assessments are available online and can help communities think through their adaptive capacity.

Climate Equity Community Assessment

The National Association for the Advancement of Colored People (NAACP) created a useful tool for evaluating measures of vulnerability and resilience from a social equity perspective. Many of the tracking indicators suggested by this tool are useful for communities interested in ensuring that their most vulnerable populations are not bearing an inequitable burden from climate impacts. This assessment helps launch a community into identifying tools and policies that will ensure that support systems are developed to protect the most vulnerable and marginalized members of the society.

Coastal Resilience Index Self-Assessment

NOAA's Coastal Storms Program and the Mississippi-Alabama Sea Grant Consortium partnered to create a Community Self-Assessment for coastal communities to evaluate their relative resilience to a series of potential storms events and natural hazards. The purpose of the self-assessment is to provide community leaders with a simple and inexpensive method of predicting if their community can reach and maintain an acceptable level of functioning after a disaster. The assessment is intended to help identify issues that a community should address before the next disaster, and where resources should be allocated.

ICLEI'S CLIMATE RESILIENT COMMUNITIES PROGRAM

In the fall of 2005, ICLEI-Local Governments for Sustainability launched its Climate Resilient Communities program to protect people, property and resources and help communities become more resilient to climate change. The program helps local governments develop tools to assess their vulnerabilities and prepare their communities for the impacts and costs associated with predicted global climate change. ICLEI works with NOAA's Regional Integrated Sciences and Assessment offices, including GLISA, to utilize the best climate science available for forecasting weather events.[1]

1 www.iclei.org

This self-assessment begins by helping community members develop two scenarios. The first scenarios uses a benchmark storm based on historical events to articulate wind speeds, inches of rain, duration, and other relevant weather-related variables for the community. The second scenario describes a storm that is 50% more intense and damaging than the benchmark storm. Once the scenarios are articulated, participants are led through a series of questions regarding the presence and general state of:

- **Critical facilities and infrastructure:** *In this section, locals are asked if any roads, hospitals, fire stations, or municipal utilities are located in the floodplain, and if there are emergency shelters and other emergency infrastructure in place.*
- **Transportation facilities and services:** *This category focuses on the availability of public transportation services and the presence of emergency evacuation routes.*

- **Community plans and agreements:** *This category asks questions about cooperative agreements and other cross-jurisdictional support available in the event of emergency, and also asks about overall training and capacity of local officials.*
- **Mitigation measures:** *In this section, locals are asked about hazard mitigation measures in place such as building codes, flood-proofing, land acquisition, ecosystem services, and restoration projects.*
- **Business plans:** *This category asks about the presence of backup generators and plans for food and water distribution in the private sector.*
- **Social systems:** *In this section, locals are asked about cultural identity, the presence of neighborhood associations, civic organizations, and other social groups.*

Once the self-assessment is complete, communities receive a Resilience Index score. Communities with cooperative agreements in place, zoning ordinances that protect infrastructure and property from flooding, etc., receive a high score, while communities with fewer resilient attributes receive a lower score. The results provide communities with tangible ideas and guidance for how they can increase their resilience.

"At GLISA, our goal is to bring the most relevant and usable climate information to partners who are planning for the future."

Laura Briley, Research Associate for the Great Lakes Integrated Sciences & Assessments Program (GLISA)

Weighing Risk

Because local communities have significant funding and resource constraints, it is useful to identify the relative risk that impacts of climate change pose to a community. Some impacts are very unlikely, but would have catastrophic effects on a community if they were to occur. On the other hand, some impacts are less severe, but are much more likely to occur. In a risk assessment tool kit developed by ICLEI-Local Governments for Sustainability, it is recommended that planners and policymakers use qualitative and quantitative information to evaluate the relative risk that various impacts of climate change may have on their communities. ICLEI defines risk as:

RISK = CONSEQUENCE x PROBABILITY[2]

Consequence

Consequence refers to the overall impact an event would have on a community. These impacts could be environmental, social, economic, and political.

For example, if a flood took out a retaining wall, how long would it take to replace that wall? How much property damage would occur? If the flood caused widespread mold in homes, what would be the degree or intensity of public health impacts?

Probability

Probability refers to the overall likelihood that a projected impact will occur. For example, the likelihood that temperatures will rise is virtually certain. On the other hand, the likelihood that long-term Great Lakes water levels will continue to decline is much less certain. Probability can be assessed in a qualitative manner, using historical events and climate patterns to rate events as low, medium, and high probability.

A community uses a risk assessment to prioritize responses to events that have a high consequence and a high probability. A community conversation about risk tolerance is also useful. Individuals will likely differ in the degree to which they are willing to tolerate the risk of climate events, which should also inform policies.

Fiscal Impact Assessment

As a means of weighing short-term gain against long-term loss, researchers at the University of Michigan developed a methodology for coastal communities to evaluate the relative risk of allowing development in coastal areas in Michigan. Coastal communities often benefit from allowing development along the coastline, particularly since coastal areas often have higher property values, and local governments benefit from local property tax revenue. However, there is inherent risk associated with coastal development. As was discussed in Chapter 2, Michigan's coastal areas are constantly changing. Water levels rise and fall annually and decadally, while storms, wind, waves, and currents are constantly reshaping the shoreline. To learn more about using a Fiscal Impact Assessment to evaluate coastal risk, see www.resilientgreatlakescoast.org.

[2] Snover, A.K. et al. 2007. Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments. In association with and published by ICLEI – Local Governments for Sustainability, Oakland, CA

Building Scenarios

Scenario planning, also called scenario thinking or scenario analysis, is a planning method that allows communities to look forward in time and consider a series of plausible futures that the community may be forced to respond to. Although there is inherent uncertainty associated with scenario planning, it is generally informed by considering social, economic, environmental, and political trends.

According to the Lincoln Institute of Land Policy, the three key benefits of scenario planning in a community planning setting are:

- *collaborative problem solving that facilitates open dialogue about interrelated issues;*
- *capacity building; and*
- *an open environment for information sharing and education to engage diverse stakeholders and the public.*[3]

Using Scenarios for Exploration

According to the Lincoln Institute, which specializes in scenario planning methods, the traditional planning paradigm of predict-and-plan is not adequate for addressing the uncertainty of climate change. Instead, communities must beginning embracing a model of anticipatory governance, using data and public input to monitor changing circumstances and adapt.

The are a number of different ways of engaging in scenario planning. Resiliency planning fits best under the category of "explorative scenario planning." An explorative process allows participants to work through a number of different potential futures without definitively articulating future conditions.

"Scenario Planning fosters Collaboration, Capacity Building, and Creation of an Open Environment for Engagement."

Lincoln Institute of Land Policy

Community members work through a set of future climate scenarios tailored to the Battle Creek region during the Fort Custer Michigan Army National Guard Resiliency Charrette.

3 Holway, Gabbe, Hebbert, Lally, Matthews, and Quay. Open Access to Scenario Planning Tools. (2012) Lincoln Institute of Land Policy

Working through Scenarios in a Community Setting

Scenario tabletop exercises have long been used by emergency managers to work through a potential community emergency with emergency responders, communications personnel, and other key stakeholders in the community.

A community-driven scenario exercise is also useful for planners looking to prepare their communities for an uncertain future. Scenario exercises foster preparation and adaptation, and allow decision makers to work through potentially stressful situations in a collaborative, low-stress environment.

Communities in Michigan have used a used a scenario framework developed by the Land Information Access Association (LIAA) to identify solutions for a series of climate-change challenges. Participants are asked to think through the short-term response and long-term recovery needs of their community for the following scenarios:

- *Severe heat event coupled with changes to long-term averages;*
- *A severe winter storm with widespread electrical outages;*
- *A long-term drought that impacts agriculture and increases wildfire incidences; and*
- *Extreme precipitation that results in widespread flooding and damage to public infrastructure and homes.*

To make the scenarios as realistic as possible, LIAA developed the scenarios using regional climate data from GLISA and historic climate events documented in County Hazard Mitigation Plans. At right is a sample of the scenarios and questions posed to participants in a statewide Michigan Climate Health Adaptation Training. Depending on the audience and the region of the state, these scenarios and discussion questions can be adjusted to ensure the most relevant and productive conversations.

Activity 2: *Using Scenarios to Develop Solutions*

Climate Health Adaptation Planning in Michigan

A: EXTREME HEAT SCENARIO

The year is 2050. Average air temperatures in your Michigan community have risen approximately 5 degrees F. It's early August and 30 days have already exceeded 90 degrees this year – 11 of those occurred consecutively, culminating in a county-wide heat emergency. The past two days have climbed above 100 degrees. Nighttime cooling has diminished, with evening lows in the mid-80s, making it very difficult for residents to cool down. A number of residents have been hospitalized due to heatstroke and heat exhaustion.

Warmer temperatures have increased electricity demand for cooling and are causing a significant financial burden on families and businesses. Coupled with the heat, a partial power outage has knocked out air conditioning systems, putting the county's most vulnerable residents, from the elderly to the young, at risk. Unfortunately, many of the most vulnerable populations do not live or work in air-conditioned environments.

B: HEAVY RAIN AND FLOODING SCENARIO

It is the year 2050 and average annual precipitation in your Michigan community has increased by 3 inches, with the majority of the increase concentrated in the spring and fall. Twenty-five year storms now occur on average every other year, exceeding the capacity of storm sewer infrastructure and allowing polluted runoff into nearby rivers and lakes.

This February, an early thaw due to unusually warm weather was compounded by a heavy precipitation event, leading to urban flooding. Ten inches of rain fell, 5 of which came in the first six hours. Runoff resulting from this intense rainfall, compounded by heavy snow-pack melt and frozen soils, has flooded areas of the community that have not been flooded for decades.

So far, your county has incurred $60 million in road and bridge damage alone and another $6 million in property damages. Nearly 500 homes and over 20 businesses were damaged by floodwaters. There have also been reports of cars stuck in flooded underpasses and businesses having to pump water out of their stores. Much of your community is without power due to the wind and lightning impacts connected with the severe storm system that passed through the area. The majority of the 80,000 electricity customers lost power.

C: SEVERE DROUGHT AND WILDFIRE SCENARIO

The year is 2050 and recent droughts have been longer and more severe than in the past. This summer's drought has resulted in a decline of water quality in lakes and streams and increases in insect infestations and plant disease, stressing forests and native species. Droughts as well as invasive species have increased the risk and prevalence of wildfires in the region. Over 90 percent of your rural county is forested. With longer wildfire seasons, the existing firefighting capacity is being stressed.

It is April and a large wildfire is ripping through the community. Three weeks in, the wildfire has already burned 25,000 acres, destroying 70 homes and multiple power lines, with total damages estimated at almost $50 million. All county fire departments have responded, as well as fire departments from neighboring counties and MDNR.

Required evacuation is in effect for portions of several townships. Unfortunately there is only one active siren in the county, but broadcasts have also been made over television and radio. County wide, the particulate matter due to smoke is of particular concern for residents with pre-existing health conditions.

D: WINTER STORM SCENARIO

It's March 2050 and the average number of days below freezing has declined steadily. However, the severity and damage resulting from winter storms has increased. Reduced lake ice coverage and lake warming has resulted in more lake-effect snow, ice and sleet for your Michigan community.

Eight of the past 10 winters have seen severe winter storms, resulting in economic disruptions, power outages, high costs of cleanup, and business disruption. Primary roads, including major arterials, are in poor condition due to an increase in freeze-thaw events. Some local roads are even impassable.

In the past week, an ice storm hit your community, downing tree limbs and power lines, blocking roads, and causing widespread power outages. Approximately 1,000 homes and 40 businesses sustained damage or are without power, with losses estimated at nearly $1 million. A nearby nursing home has been using backup power now for 18 hours and is without running water.

Note: Scenarios used in this exercise were developed based on GLISA regional climate summaries and historic severe weather events in Michigan.

Climate Health Adaptation Planning in Michigan
Training for Local Planners and Decision Makers

LIAA

ing Scenarios to Develop Solutions

Adaptation Planning in Michigan

Discussion Questions

1.) Identify short-term concerns and solutions. Please consider the following:

1a) What are the most immediate needs to address?

- What are the primary public health concerns?
- Who are the most vulnerable populations?
- Is there critical infrastructure at risk?

1b) Are there overlapping areas of responsibility? How can resources, personnel, and communications be maximized to avoid duplication of services and maximize their effectiveness?

2. Identify strategies for increasing resilience and long-term recovery. Please consider the following:

2a) What key infrastructure investments are necessary to reduce vulnerabilities?

2b) What community initiatives are already addressing these types of issues?

- How can these efforts be expanded?
- Who else should be included?

2c) Are there opportunities for new efforts? Consider a range of options, such as natural resources, economic impacts, health, energy, and infrastructure opportunities.

2d) How can our hazard mitigation planning and land use planning be better integrated?

3. Report Out!
Select one team member to:

- Read your group's scenario.
- Quickly summarize key strategies for increasing resilience and long-term recovery.
- List the top 3-5 projects based on your group's prioritization.

Climate Health Adaptation Planning in Michigan
Training for Local Planners and Decision Makers

LIAA

LIAA developed scenarios as realistic as possible by using regional climate data from GLISA and historic climate events documented in County Hazard Mitigation Plans.

Scenarios for Coastal Areas

Coastal jurisdictions along the Great Lakes face a unique set of challenges that require careful long-term management and sensible policy solutions. While the Great Lakes provide enormous aesthetic and economic value, they are also dynamic systems that sometimes endanger people and property along their shores. As the water levels of the Great Lakes fluctuate annually and decadally, homes and infrastructure built along the shoreline can be at risk during times of high standing water levels and during coastal storm events. Amid prolonged periods of low standing water levels, encroaching shoreline development can restrict the natural movement of wetlands, dunes, and other coastal systems, causing irreparable environmental damage.

A range of government staff and departments are needed to fully protect development, human health, and sensitive natural resources in near-coastal shorelands. Yet local officials often do not have access to the depth of information and data needed to make wise land management decisions, nor a sense of the range of policy options available to them. Planning for coastal areas at the local level requires knowledge of the dynamic coastal systems of the Great Lakes and, increasingly, an understanding of how global climate change is altering this system. Researchers at the University of Michigan and Michigan Technological University, in partnership with the Land Information Access Association (LIAA), developed a scenario-based planning framework to help communities in Michigan think through a series of "what-if" scenarios to help them plan for land use and development in an uncertain future (see the case study on the next page).

"A community seeking to increase its resiliency not only has to consider the types of weather that caused problems in the past; it also has to be ready for the weather events of the future."

Matt Smar, Coastal Community Development Specialist, Michigan Coastal Zone Management Program

CASE STUDY

Multi-Disciplinary Team Works with Great Lakes Coastal Communities to Enhance Resilience through Local Planning Scenarios

In an effort to help local officials make planning decisions based on known information about Great Lakes systems, a multi-disciplinary project team composed of planners and researchers from the University of Michigan (UM), Michigan Technological University (MTU), and the non-profit Land Information Access Association (LIAA) have been working to integrate both scientific knowledge and best management practices to identify and analyze hazard areas, and to engage community groups to improve their coastline management. These researchers and planners developed a set of methods to help local planners analyze shoreland dynamics, potential fiscal impacts, environmental vulnerabilities, and various other land-use impacts. In addition, they have developed a variety of tailored regulatory and infrastructure policy options that local governments can consider adopting in order to better protect their coastal areas and to address challenges related to changing water levels on the Great Lakes.

The team recently completed full reports summarizing these efforts for the City of Grand Haven and Grand Haven Charter Township, both located on the shores of Lake Michigan. The hope is that as local communities explore these methods, ideas, and regulatory options on their own, they will become more adaptive and resilient to climate shocks along their coastlines.

The website www.resilientgreatlakescoast.org presents planning methods, techniques, regulatory policy options, and other resources that have been developed to help Great Lakes coastal communities plan for and manage their shoreland areas to become more resilient coastal communities, along with the final reports prepared for the Grand Haven community.

Materials on this website have been developed through multiple collaborations between the University of Michigan's Urban and Regional Planning Program and School of Natural Resources and Environment; LIAA; Michigan Technological University's Great Lakes Research Center and the Michigan Tech Research Institute; the University of Michigan Graham Sustainability Institute; and the Michigan Department of Environmental Quality's Coastal Zone Management Program.

A view of the rivermouth of the Grand River in Grand Haven just after a flood. Grand Haven was a focus of considerable research by University of Michigan coastal researchers.

This work has been supported through grants from the Michigan Office of the Great Lakes, Michigan Coastal Zone Management Program; the National Oceanic and Atmospheric Administration; the University of Michigan Graham Sustainability Institute; and the University of Michigan Taubman College of Architecture and Urban Planning. Case study content provided by Zachary Rable and Dr. Richard Norton.

Tracking Metrics

Communities that set ambitious goals and track their progress are most likely to achieve beneficial changes in their community.

It is important to make sure the resiliency goals you develop are SMART (specific, measurable, attainable, realistic, and time-bound), and it is important to make sure you are continually tracking community progress while working toward those goals.

Indicators of a Resilient Community

The indicators you decide to track will differ from community to community. Indicators will depend on the issues that are most relevant to your community, the goals the community has prioritized, and the data that is most readily available in the community.

Generally there are two main types of indicators a community is interested in:

- *The first type are those indicators that a community can actively work toward improving upon. For example, trees can be planted to increase tree canopy, or miles of sidewalks can be built to increase the non-motorized transportation network. These indicators are often used to set future targets.*
- *The second type of indicators are those that help inform policy, but the community is not actively looking to change the trends. For example, it is important to track community demographic shifts and extreme weather patterns, but these are generally not the basis for formulating targets.*

CASE STUDY

Tracking Sustainability Benchmarks and Metrics in Grand Rapids

Leaders at the City of Grand Rapids understand that the next 20 years will likely bring significant changes to their city, along with both challenges and opportunities. The City of Grand Rapids has embarked on an aggressive undertaking to rethink its internal operations and set ambitious sustainability benchmarks.

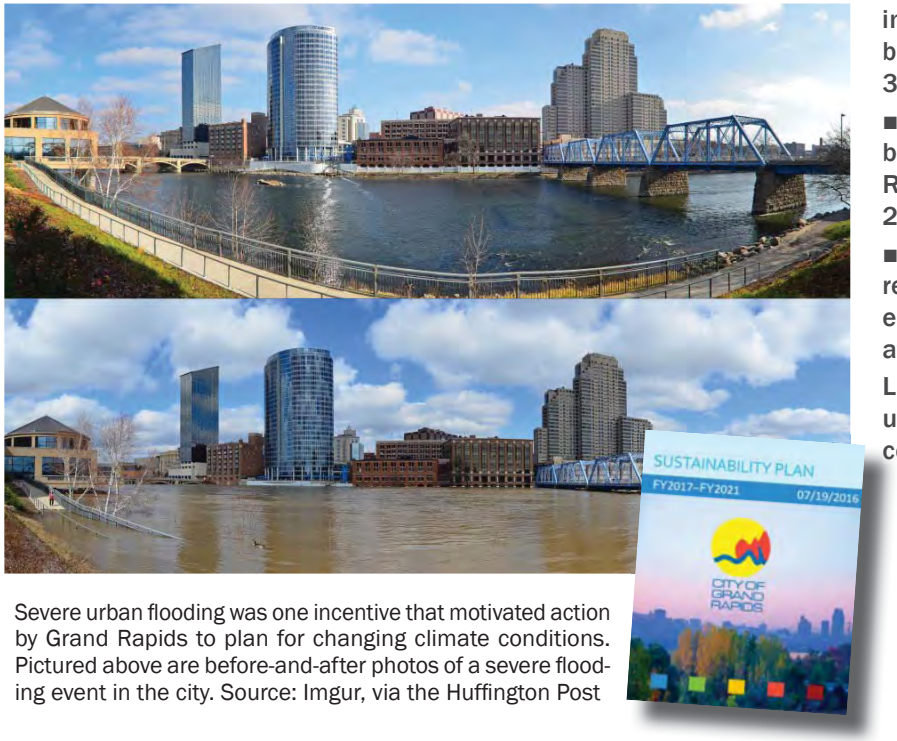
In 2011, the City adopted a plan using the "triple bottom line" as a framework to move toward economic, social, and environmental sustainability. Now, its 2017-2021 Sustainability Plan has moved to a "quadruple bottom line" with the addition of governance to the framework. By integrating governance into its metrics and benchmarks, the City of Grand Rapids is working to increase transparency, enhance civic leadership, and foster diversity.

Each year, the City issues a progress report as a way of documenting improvement and identifying goals and actions that still need work. The progress report holds city staff accountable for specific targets, and also identifies areas where the city needs assistance. Collaboration and partnerships are critical for Grand Rapids to reach its benchmarks and to truly foster a more sustainable and resilient community.

Each department has specific goals and metrics based on the quadruple bottom line. Although many are qualitative, they are still measurable, which is important to ensure adequate tracking. Examples of metrics included in the Grand Rapids Plan include:

- Increase urban tree canopy to 40% by June 30, 2021.
- Achieve 20% of energy use for City-owned buildings from renewable sources such as solar, wind, and geothermal by June 30, 2025.
- Increase timeliness and effectiveness of response to customer request calls to 311 by June 30, 2021.
- Increase private business investment by $500 million between July 1, 2017 and June 30, 2021.
- Increase the number of new businesses located in Grand Rapids by 35 by June 30, 2021.
- Adopt a policy to promote redevelopment of vacant property for urban agriculture and affordable housing.

Learn more at www.grcity.us/enterprise-services/officeofenergyandsustainability



Severe urban flooding was one incentive that motivated action by Grand Rapids to plan for changing climate conditions. Pictured above are before-and-after photos of a severe flooding event in the city. Source: Imgur, via the Huffington Post

Building off the data sources identified in Chapter 4, samples of the types of indicators your community could decide to track are listed below. This is by no means an exhaustive list, but it provides a starting point. For a description of where to find different data sources, please revisit Chapter 4.

Energy

- *How many solar arrays are in the community?*
- *What is the municipality's monthly/yearly energy consumption?*
- *How many businesses have committed to reducing their energy consumption and/or investing in clean power?*
- *How many businesses/schools/gas stations/etc. have a backup power supply?*

Local Food

- *How many people visit the Farmer's Market each week?*
- *How many pounds of local food are grown in the region?*
- *How many food processing centers are there in the region?*

Housing

- *How many homes are located within the floodplain?*
- *What percent of residents have access to air conditioning?*

Transportation

- *How many miles of bike lanes are there in your community? Miles of trails? Miles of sidewalks?*
- *What percent of the population has access to fixed-route transit service?*
- *What is the housing and transportation affordability index of your community?*

Population

- *What percent of the population has health insurance?*
- *What are the hospitalization rates for asthma, Lyme Disease, allergies, etc.?*
- *What percent of the population is living in poverty?*

Tree Canopy

- *What is the percent of tree canopy coverage in the downtown district? What about in the larger community?*
- *How many trees is the municipality planting per year?*

Parks and Open Space

- *How many acres of wetlands are there in the community?*
- *How many of acres of wetlands have been restored?*
- *What proportion of the population has access to parkland within a 10-minute walk from home?*

Stormwater and Water Quality

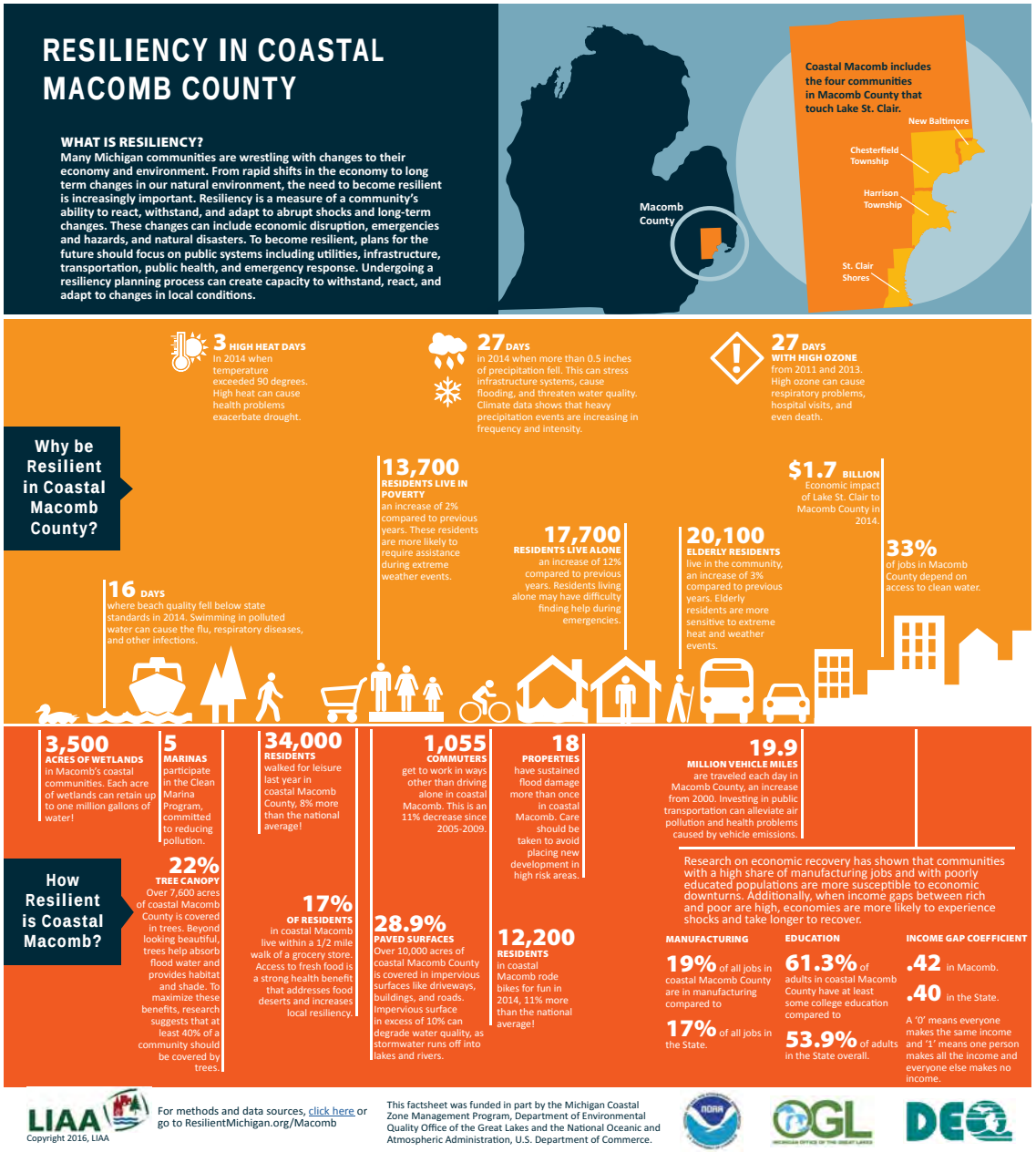
- *How many rain gardens, rain barrels, or green roofs does the community have?*
- *How many feet/miles of pipe still need to be disconnected from the sanitary sewer system?*
- *How many days per year does the sanitary sewer system overflow or discharge?*
- *What percentage of septic tanks have been inspected within the past five years?*

Setting Targets

At the time your plan is developed, a benchmark measurement should be collected for all the indicators you decide to monitor. The benchmark can be used as a point of reference against which measurements may be made in subsequent years.

Based on the initial benchmark, measurable targets can be set, informed by community goals. When selecting the targets, you want to make sure that the data required to track the target does not cause too much extra burden on municipal staff. Additionally, think about where the data is housed. A community dashboard could be used to keep the community engaged and communicate complex data about community progress with the public. Pictured to the right is an example of a dashboard that was created for Macomb County as a part of its resilient planning effort.

As a part of the Resilient Macomb planning effort, the project team developed an infographic that illustrated a number of indicators of resiliency in a graphical way. Pictured in yellow are indicators that help residents understand why resiliency is important to their community. Pictured in orange are indicators that the community can track over time and work towards improving to increase community resilience.



"The menu of tools that can help make a community more resilient to extreme weather includes many practices that are already widely used to achieve other objectives, such as placemaking and stormwater management. In many cases, increasing community resiliency adds another benefit and dimension to implementing a well-known practice."

Matt Smar, Coastal Community Development Specialist, Michigan Coastal Zone Management Program

Chapter {6}

Ideas for Implementation

This chapter summarizes planning and development tools that guide land-use decision making. Resiliency planning can be incorporated into any of them. Consistent strategies carried throughout a community's planning documents offer the best chance for full implementation.

At its best, community decision making is an orderly, well-documented process. The diversity of planning projects throughout a given jurisdiction will vary by timeframe, implementing entity and geographic scope, offering a fully comprehensive picture only when taken together. However, each of these efforts serves a specific purpose for the community, and understanding them both individually and as components of a whole is a key to using them effectively. This chapter reviews land-use planning and policy tools most suitable for integration with resiliency planning.

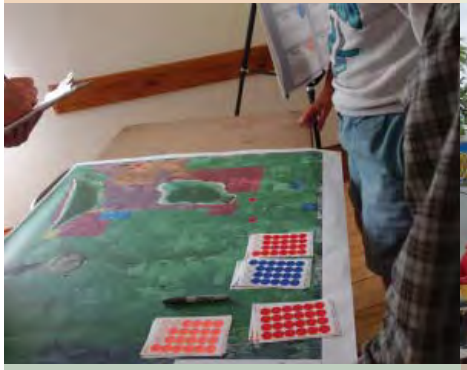
"What sets climate adaptation and resilience apart from sustainability is the integration of sound climate data that informs decision making. The integration of historic and future climate data forces us to recognize that we are living in a dynamic climate, that we can no longer rely on past thresholds and standards to build our communities today and tomorrow. While sustainability forms a three-legged stool of equity, economy, and environment, sound adaptation practice brings in a fourth leg of high quality, usable climate information that ensures our systems are both sustainable today and resilient to the changes of tomorrow."

Beth Gibbons, Managing Director,
The American Institute of Adaptation Professionals

INCORPORATING RESILIENCE INTO PLANS AND POLICIES

1

MASTER PLAN



2

ZONING ORDINANCES

3

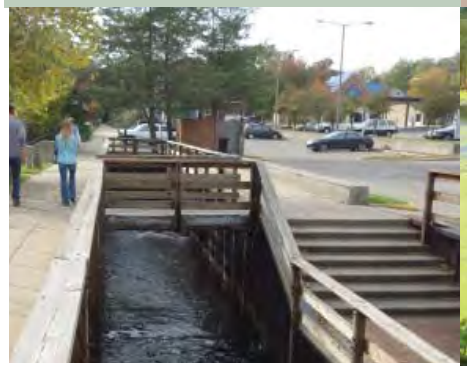
PARKS AND RECREATION PLAN

4

SITE PLAN REVIEW

5

CAPITAL IMPROVEMENT PLAN



6

WATERSHED MANAGEMENT

7

GHG EMISSIONS PLANS

8

NATURAL HAZARD MITIGATION

Master Plan

A Master Plan is a document that is meant to provide a periodic review of all of a community's systems, and to determine or reaffirm the values and goals upon which the community wishes to base its land-use decisions. Its preparation and adoption are guided by the Michigan Planning Enabling Act (MPEA), PA 33 of 2008, which assigns this task to a community's Planning Commission. Though the Master Plan itself does not constitute a law or regulation, it forms the advisory basis of the Zoning Ordinance, which is the set of local laws governing land use and intensity.

One feature of a Master Plan particularly suited to resiliency planning is its comprehensive scope. This holistic context gives a community an opportunity to review each of its systems through the lens of resiliency and to consider new practices. Equally important is the opportunity to review the community's many systems at the same time, looking for synergies that would be harder to detect in isolation. The process of convening diverse stakeholders provides an opportunity to ignite the community around a shared vision. Ideally, a Master Plan process is a stepping-off point for mobilizing diverse stakeholders to get behind making their community more resilient.

People

The MPEA calls for a Master Plan to provide for the "healthful and convenient distribution of population." In the context of resiliency, this means understanding the population segments within a community that are most vulnerable to adverse events. The location and extent of these populations should inform decision making on several levels, from the allocation of routine services to emergency and evacuation planning.

"One of the best outcomes from the resiliency master planning effort was that the City and Township planning commissioners and staff developed a respectful working relationship that will serve us well in future joint planning efforts."

Jennifer Howland
Community Development Manager
City of Grand Haven

MASTER PLANS

TIME HORIZON

Twenty-five years, to be reviewed every five years to consider updates.

GEOGRAPHIC COVERAGE

A local unit of government, such as city, township, village, or county.

TOPICAL FOCUS

Comprehensive.

RESPONSIBLE PARTY

The local unit of government.

VARIATIONS

Master planning may be done at any scale. Downtown or sub-area plans are smaller in scale, while regional plans are larger. Scale also influences a plan's time horizon; for example, regional plans may look further than 25 years into the future based on the projects and processes they address.

"The use of resources in accordance with their character and adaptability," as obligated by the MPEA, would go a long way toward resiliency if carefully and consistently applied. However, resources must first be fully understood before they can be used responsibly, beginning with a thorough description and analysis of a community's topography and hydrology. Mapping of these natural resources and features should be detailed enough to aid in decision making; for example, by indicating slopes that are too steep to accommodate development, or the extent of floodplains around waterbodies. Inclusion of nonhuman habitats is a less-common practice that would benefit from wider use. Here again, relationships among processes are a critical area of study.

Systems

The transportation, habitation, and economic systems of a community generally comprise its built environment. The focus has historically been on maximizing these systems from the viewpoint of their human users. The resiliency approach balances that focus with an understanding of the systems' impact on the land and environment. The MPEA, for example, specifically cites the provision of "light and air" as an appropriate subject for master planning, a reminder that density controls have their basis in alleviating in human suffering; however, sprawl-like development patterns now pose a different set of threats to people and environment alike.

Students at Monroe High School contributing to the Master Plan effort as a part of the Resilient Monroe planning process.

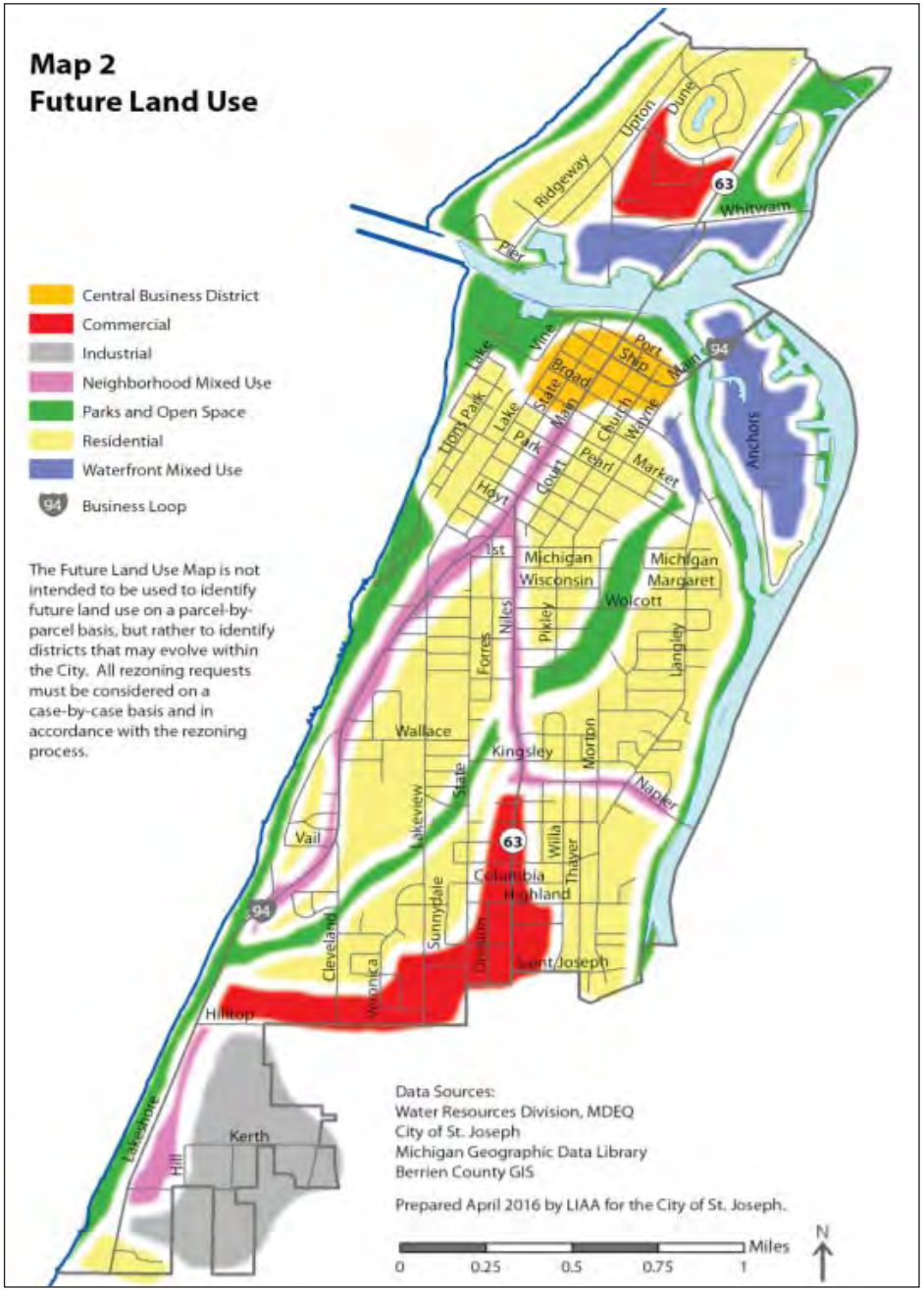
Photo: Anderson Ariel

Future Land Use Map

A Future Land Use Map is generally developed as part of a Master Plan. Categories of land use are defined in the text, and each category's spatial information — the location in the community where a land use should occur — is shown on a map. The text should explain the intended purpose of each category, and may include examples or descriptions of appropriate land characteristics and permitted uses. Resiliency planning may be incorporated into traditional land-use classifications, such as the application of a Preserve category on the basis of environmental sensitivity. It may also drive the creation of new Future Land Use categories in which development is envisioned to be permitted under specific processes and circumstances.

Zoning Plan

A Zoning Plan is a required element of a Master Plan for all communities governed by a zoning ordinance. The Zoning Plan defines and explains the relationship between the categories on the Future Land Use Map and the designations within the Zoning Ordinance. If new Future Land Use categories have been developed during a resiliency planning process, this section of the Zoning Plan explains how they will be applied. It may also introduce resiliency-based zoning concepts for consideration during a future amendment to the Zoning Ordinance.



The Future Land Use Map included in the City of St. Joseph resiliency master plan is a good example of considering future conditions when identifying preferred future development patterns. The City decided to create a Parks and Open Space buffer along the entire coastline of Lake Michigan and the St. Joseph riverfront to protect water quality and reduce impacts of severe weather events. Additionally, future easements for recreational waterfront pathways will contribute to the City's placemaking efforts.

Zoning Ordinance

ZONING ORDINANCES

TIME HORIZON

Undefined; laws stay on the books until removed, but should be reviewed after each Master Plan update.

GEOGRAPHIC COVERAGE

A local unit of government, such as city, township, village, or, less frequently, county.

TOPICAL FOCUS

Land use and intensity.

RESPONSIBLE PARTY

The local unit of government.

VARIATIONS

Supplemental ordinances addressing wetland protection or floodplain management strengthen a community's resiliency efforts.

As previously mentioned, a community's Zoning Ordinance is set of laws which regulate land use and intensity. Because it contains the immediate force of law, it is the community's most potent and direct tool for land management.

A Zoning Ordinance that is crafted on the basis of a thorough, thoughtful, resiliency-based Master Plan will automatically include some features that support resiliency, such as sufficient residential density to support multiple modes of transportation. Other tools may be more specific and best developed directly in the regulatory environment.

Setbacks, landscaping requirements, and parking provisions are three standard components of a Zoning Ordinance that are directly applicable to resiliency planning. Required setbacks can function as a buffer, as in the case of a mandatory vegetative zone surrounding surface water, or severe use restrictions in wellhead or groundwater recharge areas. Landscaping requirements in and of themselves frequently serve to reduce the amount of impervious surfaces overall and per parcel, allowing for natural disposition and cleaning of stormwater. Parking is a major land use in any community, and one that traditionally demands vast expanses of impervious surface. Strategies that reduce the area reserved for parking may include revised standards, shared parking arrangements, and the development of non-motorized and transit networks. Other strategies are aimed at reducing the impacts of parking spaces, such as requirements for pervious pavement, runoff swales, and tree canopy.

Overlay Districts

Overlay Districts consist of specific regulations that can be applied to otherwise diverse zoning districts, such as floodplain or hazard mitigation districts. These regulations commonly impose additional setback requirements, such as enforcing an undeveloped buffer on parcels that abut a waterway while leaving other parcels within the district untouched.

Natural Features Setback Ordinance

A Natural Features Setback Ordinance is a specific type of overlay district that grew out of a simple recognition: the same features that attract extensive human activity are often those that need protection from it. Waterbodies, wetlands, forests, groundwater recharge areas, steep slopes, animal habitats, and fragile ecosystems may be included in the definition of a "natural feature." From a resilience standpoint, many of the natural features that could be covered by this type of ordinance are already hazard-prone and problematic areas to develop, and/or provide valuable ecosystem services related to building community resiliency (such as flood mitigation and relief from the urban heat island effect).

Wetland Protection Ordinances

The State of Michigan regulates all wetlands that are greater than five acres in size or that are contiguous to a waterway. The state also permits local communities to adopt their own Wetland Protection Ordinances. To do so, the community must inventory its wetlands, decide on the level of additional protection it desires to commit to, and notify its residents and property owners. If a community wants to regulate wetlands smaller than two acres, it must show that the wetlands are "essential to the preservation of the natural resources of the local unit of government." Some of the criteria that can be used to support this determination are related to community resilience. For example, small wetlands that provide groundwater recharge, floodwater storage/absorption, water quality improvement, or sediment removal qualify as "essential" wetlands.

Floodplain Management Ordinances

In combination, a Natural Features Setback Ordinance and a Wetland Protection Ordinance will substantially constrain flood-prone development. However, if flood protection is the ultimate goal, it is best served by a specific ordinance. Floodplain Management Ordinances severely limit development of any kind, and may require any development that does occur to demonstrate that it will be unaffected by flooding.

"Environmental Preserve" Zoning Classification

This is the most potent of zoning tools, essentially prohibiting development on the grounds of environmental sensitivity. Such sensitivity must be well-documented in order to withstand potential legal challenges, as our current system privileges the right of economic return on a parcel of land. These sites are frequently paired with very low-intensity land uses, such as naturalized recreation.

"In the Clinton River watershed, we are building resilient communities through green infrastructure planning and implementation to help alleviate the human health impacts, combined sewer overflows, and flooding associated with climate variability."

Amanda Oparka, Watershed Planner
Clinton River Watershed Council

Parks and Recreation Plan

PARKS AND RECREATION PLAN

TIME HORIZON

Five years.

GEOGRAPHIC COVERAGE

A local unit of government, such as city, township, village, or, less frequently, county.

TOPICAL FOCUS

Parks and recreation.

RESPONSIBLE PARTY

A commission and/or staff designated by the local unit of government.

VARIATIONS

Few. This document is required by Michigan's Department of Natural Resources for grant funding, and the agency prescribes its format.

It may be surprising to learn that recreation lands are some of the hardest workers in our resiliency toolkit. Their natural features can absorb water, clean air, cool urban heat islands, provide animal habitat, and offer natural linkages through developed areas. Understood in this way, parks and recreation assets become part of a community's working infrastructure above and beyond their direct benefits to citizens.

Flood management is an area in which park and recreation planning can play a vital role. Two factors contribute heavily to this. The first factor is the relatively gentle land footprint of recreation development. By siting recreation land around volatile water boundaries, more-intense development that may be more damage-prone is necessarily pushed away from it. In addition to the spatial barrier, this naturalized boundary also offers physical protection, as vegetation and soil act like barriers and sponges to advancing waters. The second factor is the "nonessential" nature of parks in times of emergency. A park that is unvisitable due to flooding has far less serious consequences than a residence or business that is uninhabitable; this alone has the potential to downgrade the same weather event from a disaster to an inconvenience.

The confluence of parks and recreation planning with resiliency planning offers opportunities in several dimensions.

The Parks and Recreation Five-Year Master Plan is an implementation-oriented tool heavily tied to funding. Communities have the opportunity to plan for an increase in flooding events by protecting and restoring land within the floodplain for use as passive recreation. Pictured above is a public park in Monroe.

CASE STUDY

Protecting Dunes in Northwest Lower Michigan

The thought of vacationing in northwest Lower Michigan often evokes an image of hiking and exploring the dramatic topography offered by the region's sand dunes. Relatively unique to this region of the Great Lakes, dunes cover over 37,000 acres in northwest Lower Michigan.

With funding from the Michigan Department of Environmental Quality's Coastal Zone Management Program, Networks Northwest developed a guidebook to help local governments better understand tools available to protect their coastal dune resources.

Dunes in northwest Lower Michigan support diverse ecosystem habitats. The dunes are fragile and constantly changing, and need adequate space and protection to expand and retreat as water levels and coastal dynamics change.

Dunes also contribute to the economic engine of the region. Hundreds of thousands of visitors come each year to visit these unique ecosystems, spending time and money at area businesses.

However, in recent years, there have been increasing pressures on dunes. Extreme weather events, changing water levels, and development pressures have all impacted the natural dune ecosystems in the region.

The guidebook provides a variety of resources for local officials, including sample Master Plan language, ideas for zoning standards, case studies, and best management practices. The guidebook also helps local units of government better understand the state's regulatory framework in relation to critical dunes, and the tools that can be used at the local level to protect dunes.

This guidebook for managing coastal dunes was completed by Networks Northwest in 2017.

Siting

The co-location of parks and recreation lands with ecologically sensitive areas offers great benefit to both. As previously mentioned, the features that most need protecting are often the ones that are irresistibly attractive to people. By designing these sites so that they can be used without damage, they remain available for both purposes.

After a site has been identified as valuable for both recreation and resiliency, a community will want to determine how strongly to protect its restriction for those purposes. Some additional protection can be assumed if the community is the landowner, though it remains open to reconsideration by community decision-makers. Land that has a park or recreation zoning classification is protected unless it is rezoned, which usually requires a request from the landowner and approval by the Planning Commission and/or elected body of the community. Land that has an easement specifying park, recreation, or resiliency uses must accommodate those uses for the life of the easement contract, which is often "in perpetuity."

Planting and Maintenance

Park and recreation operations that are fully integrated with resiliency planning can include some less-conventional approaches. Plantings, for example, may be selected for their species nativity and their relationships to the fauna on the site. Irrigation and stormwater management needs may be seen as two parts of the same process. Decisions about mowing and compost may consider factors such as carbon emissions, fossil fuel use, and biological processes in addition to efficiency and aesthetics. Interpretive stations may focus on the connection between land and climate.

In Monroe, the River Raisin National Battlefield Park Plan sets out an ambitious strategy for placemaking and redevelopment at the National Park along the River Raisin. One strategy identified in the plan was to purchase private property located within the floodplain to increase parkland and reduce flooding risk to private residences.

CASE STUDY

Toledo Stormwater Management

Like many cities with aging and inadequate infrastructure, Toledo (Ohio) often releases untreated sewage into surrounding water bodies when rainfall exceeds the capacity of its stormwater system. In 2001, Toledo created a stormwater credit program. The program encourages non-residential property owners to apply for credits to reduce their stormwater fee in exchange for implementing on-site stormwater management practices.

Unfortunately, the program did not immediately attract heavy participation by non-residential properties owners. The City of Toledo asked University of Michigan graduate students to investigate how to improve stormwater practices and encourage greater participation in the stormwater credit program.

The students developed a methodology to identify areas in Toledo that are most vulnerable to flooding. Using GIS mapping software to overlay several common flooding indicators (such as the percent of impervious surfaces, flood event records, land use type, areas with unimproved streets, and topography), the students identified four priority zones to target the credit program.

Instead of charging a flat stormwater utility fee, the students suggested that the city could divide the fee into two parts: fixed fees and property fees. A fixed fee is a rate that all non-residential property owners must pay to cover administrative costs. The property fee would cover the cost of managing stormwater runoff from an individual property based on impervious surface area, meaning that non-residential property owners in priority zones would pay a higher fee. Credits could be applied to cover up to 100% of the property fee.

The students also recommended that the criteria for what constitutes approved stormwater management practices be narrowed. Previously, the City of Toledo had given credits for non-structural improvements that were less effective in improving the quality or reducing the quantity of stormwater. To receive credits, the students proposed that property owners must make structural changes that physically retain, detain or filter stormwater. This includes constructed, planted, excavated, or manufactured features.

Many of the interventions detailed above were adopted by the City of Toledo, including increased incentives and outreach, and stricter stormwater management policies.

An image of a pipe that runs into Stillhouse Creek in Toledo, Ohio. Toledo is working to incentivize green infrastructure like rain gardens and green roofs to reduce the demand on aging pipes. Photo courtesy of the City of Toledo.

Site Plan Review

SITE PLAN REVIEW

TIME HORIZON

Review approval may take 1-6 months to secure, and often expires after 6-12 months if construction is not "diligently pursued."

GEOGRAPHIC COVERAGE

A single site or parcel.

TOPICAL FOCUS

Project development and construction.

RESPONSIBLE PARTY

The Planning Commission, staff, and/or elected body of a jurisdiction.

VARIATIONS

Clustered development, Planned Unit Development agreements, Special or Conditional Use permits.

The process of Site Plan Review can generally be described as "measuring a development proposal against the standards set forth in the Zoning Ordinance," so there is no doubt that effective use of a Site Plan Review (or other development approval process) to build resilience depends heavily on the Zoning Ordinance itself. For example, if a community's Zoning Ordinance does not require buildings or other disturbances to be set back from natural features, then this condition can't be required through the Site Plan Review process.

Site Plan Review is, however, the primary opportunity to ensure that every regulation a community adopts to promote resiliency is actually expressed in its built environment. References to each specific regulation can be inserted into the community's criteria for Site Plan Approval, making them easily locatable by applicants and reviewers alike. The practice of granting waivers from the Planning Commission (to reduce landscaping requirements, for example) may be formally discouraged or prohibited. Conversely, Planning Commissions and reviewers may be trained to identify opportunities to increase a site's resiliency and suggest them as appropriate.

Clustered Development

Clustered Development options allow for several sites to be developed together on smaller parcels than would normally be permitted by the ordinance, and to preserve the remaining space for communal use among the properties. This option can preserve both the economic return and the most sensitive natural features of a site, while better avoiding hazard-prone areas of a site. It generally requires an enabling ordinance to be in place before the development proposal is reviewed, but in cases where no such ordinance exists, it can be achieved through Planned Unit Development.

Planned Unit Development (PUD)

In a Planned Unit Development agreement, the community negotiates its zoning regulations with a developer in exchange for a the provision of a community benefit. Whether a proposal contains a "benefit" is determined by the community, which

Students in the City of Holland create their own site plan to express what they would like to see included during one of the Resilient Holland planning charrettes.

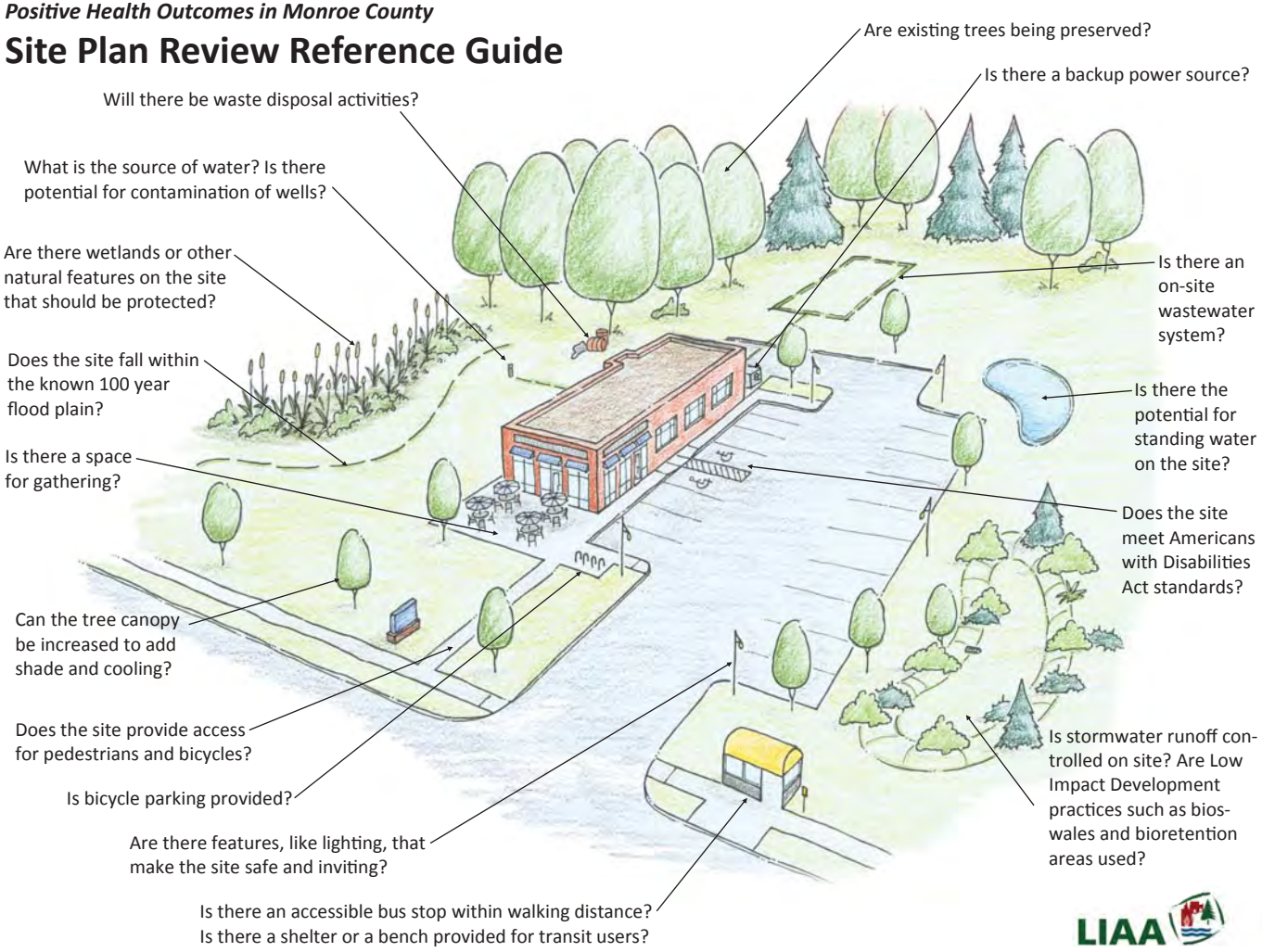
is free to decide that increased resiliency, or characteristics promoting resiliency, qualify as such. This is another tool that can be used to balance a site's economic return with its ecological sensitivity. It also requires an enabling ordinance in the community, which may be more common than an ordinance specific to Clustered Development.

Special or Conditional Use Permits

Special or Conditional Uses are those that are generally permitted in a given zoning district, but require additional oversight due to the impacts they generate. Uses that are inherently not resilient or may damage or impede resiliency efforts may be required to go through this process. A full Site Plan Review conducted by the Planning Commission usually accompanies a Special or Conditional Use permit, in addition to the permitting process.

Positive Health Outcomes in Monroe County

Site Plan Review Reference Guide



This Site Plan Review reference guide was developed through a collaborative effort in Monroe County between the Health Department, municipal planning staff, and planning commissioners. The goal was to develop a usable guide for planning commissioners to reference when reviewing site plans to ensure they made decisions that would foster positive health outcomes and a resilient community. Examples of considerations planning commissioners and health officials identified as important include low impact development and green infrastructure, proximity to transit, accessibility considerations, preservation of tree canopy, and public gathering spaces. A copy of the reference guide can be downloaded at www.liaa.org/health.

Capital Improvement Plan

CAPITAL IMPROVEMENT PLAN

TIME HORIZON

Six years, reviewed and updated annually,

GEOGRAPHIC COVERAGE

A local unit of government, such as city, township, village, or, less frequently, county.

TOPICAL FOCUS

Public infrastructure.

RESPONSIBLE PARTY

The local unit of government, especially administration and staff.

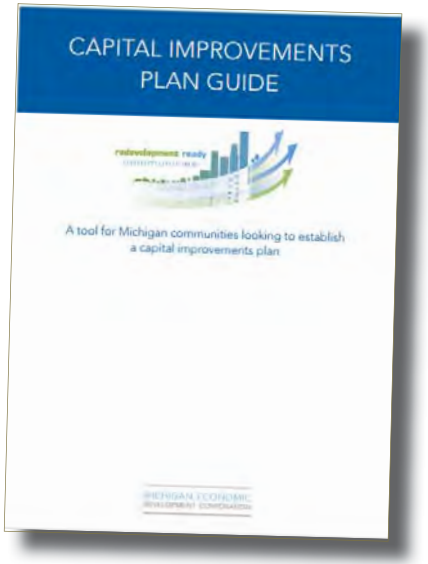
VARIATIONS

Technically none, though the process may be carried out less formally.

A Capital Improvements Plan details all anticipated public structures and improvements over the coming six years. The Michigan Planning Enabling Act specifies that it is to be created by the Planning Commission unless otherwise exempted, and updated annually. This is where theoretical improvements to the resiliency of systems explored in the Master Plan, alone and in combination, are realized in the community.

Stormwater Management

Perhaps the greatest change from business as usual in terms of resilient municipal systems is in stormwater management. The goal is shifting away from exporting stormwater offsite as quickly as possible, and toward its retention and management onsite. This entails a related shift from directing stormwater into waterbodies, and instead depositing it into soil. The second change may in fact be the more valuable one, because the soil both cleans and cools the water before returning it to the water cycle, in contrast to the warmer and dirtier water that arrives directly into surface waters via traditional methods. Implementation of strategies such as rain gardens, permeable pavements, green roofs, and bioswales can be substituted wherever possible for curbs and storm sewers.



As a part of its Redevelopment Ready Communities (RRC) Program, the Michigan Economic Development Corporation created a useful resource for local governments embarking on a Capital Improvement Plan. The guide outlines a step-by-step process and can be downloaded from the Web at www.michiganbusiness.org.

Sewers and Septic

The relationships between sewers and resiliency is deeper and more complex than might be expected. Individual septic systems, which are the alternative to sewer systems, do fail over time; the higher temperatures and water tables expected with climate change weaken such systems. A concentration of suboptimally functioning septic fields may compromise a community's drinking water, surface water, and wetlands.

Communities that provide sewer systems face a different set of challenges. Combined storm and sewer systems can result in the direct discharge of sewage into surface waters during heavy precipitation events, a condition that can be expected to increase in frequency and intensity. Since development in these communities is dependent on sewer service, careful siting and improvement of the sewer system can help direct growth to suitable locations.

Roads, Sidewalks and Trails

As with sewer infrastructure, roads are a public investment that creates a strong incentive for private development, so roads should only occur where such development is desired. Roads can also incorporate resiliency features in their

CASE STUDY

Reducing Health Impacts of Extreme Rain Events through Local Septic Ordinances

One issue of focus in the Michigan Climate & Health Strategic Plan is septic tank contamination, especially given increased frequency and intensity of rain events. Heavier rain events can exacerbate failing septic infrastructure.

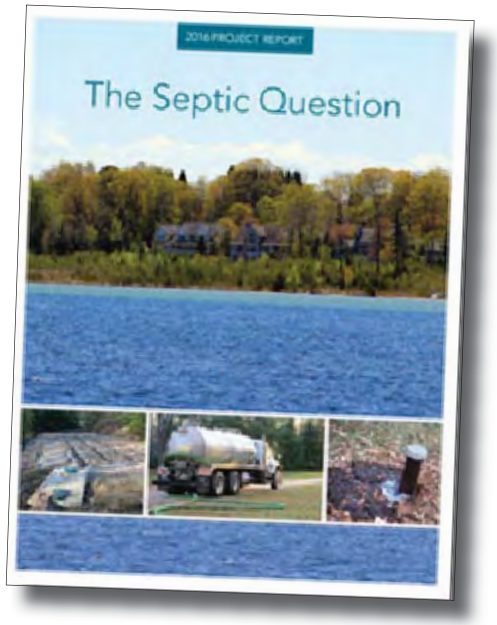
Surprisingly, Michigan is the only state in the nation without a comprehensive state septic code. A study by microbiologists at Michigan State University found that as many as 100% of inland lakes in Michigan are compromised by leaking septic tanks.

Tip of the Mitt Watershed Council has been proactively working on local environmental policy in northern Michigan and across the entire state for many years. In 2016, Tip of the Mitt completed a comprehensive septic study in Charlevoix County called "The Septic Question." The purpose of the study was to closely examine septic system policies for the entire watershed, identify any problems, and examine potential ways to solve them.

In reviewing local Health Department and Building Department records, Tip of the Mitt found a lack of information on where septic systems exist, any dates of servicing, their age, and their capacity. The final report identified three local policy options that could be adopted by local governments to improve the state of septic systems and ensure high water quality in the watershed. These ordinance types include:

- Time of Transfer Ordinance
- Mandatory Pumping Ordinance
- Mandatory Inspection Ordinance

In terms of next steps, Tip of the Mitt plans to continue to work with local governments to adopt septic ordinances, and work with policy makers at the state level to update the State of Michigan septic code. Additionally, they are exploring options for assisting local Health Departments with better tracking of septic information through digital databases.



design, most notably stormwater management ("green roads"), bike lanes and sidewalks. Street trees may make up a sizable portion of a community's urban canopy, and provide air cleaning and cooling benefits. Walkability (via sidewalks and trails) is an important aspect of any community, from health and equity benefits to economic benefits for downtowns and commercial nodes.

Public Facilities

Any building, site or facility has the potential to increase a community's resiliency. They may display exceptionally sustainable construction, host demonstration projects that test practices and educate citizens, or serve as shelters from extreme weather events. Collectively, their uses could be spread among sites in order to facilitate redundancy.

Watershed Management Plans

Watershed Management Plans are intended to protect and restore water quality. The very idea of a "watershed," which describes all of the land that drains into a single waterbody, highlights the deep and complex relationship that surface waters have with their environs. A lake may present an illusion of permanence because its geographic location does not change, but the water cycle tells us that the individual molecules within the lake come and go quite freely. Whether we call them clouds, precipitation, stormwater, groundwater, or surface water, we are simply describing the position of these molecules.

Watershed Management Plans may contain all manner of descriptive information, such as hydrology, topography, land uses, known pollutants, invertebrate biology, habitats, climate, and more. This information is useful at all times, but the reality is that the effort to collect and analyze it often only occurs in response to an existing threat or impairment to a waterbody. The nine elements of a Watershed Management Plan as prescribed by the U.S. Environmental Protection Agency are designed to promote an understanding of the relationship between land management and water quality, and an EPA-compliant Watershed Management Plan is required to receive certain funds through the Clean Water Act. The required elements are:

- *Identification of causes of impairment and pollutant sources*
- *Estimate of the reduction in pollutants that is expected from management measures*
- *Description of the management measures that will be needed to achieve such reduction*
- *Estimate of the technical and financial assistance needed to implement the plan*
- *Public information and education about the management measures*
- *Timeline for implementation*
- *Benchmarks*
- *Establishment of desired water quality standards and criteria*
- *Monitoring program*

WATERSHED MANAGEMENT PLAN

TIME HORIZON

Somewhat dependent on scope, but at least 10 years.

GEOGRAPHIC COVERAGE

All of the land area that drains to a specific waterbody (a watershed).

TOPICAL FOCUS

Hydrology, water quality, and associated factors.

RESPONSIBLE PARTY

Because watersheds are defined by hydrology rather than political boundaries, they nearly always require collaboration among local units of government; a nongovernmental agency such as a watershed council or lake association may be included.

VARIATIONS

Few. The contents of the document are prescribed by the U.S. EPA and Michigan's DEQ in order to be eligible for grant funding.

The Clean Michigan Initiative is a voter-approved bond that funds environmental efforts, including water quality improvements. The Michigan Department of Environmental Quality has its own Watershed Management Plan compliance standards, which generally align with the EPA's requirements so that the same plan can be used with each agency. One exception is that MDEQ requires an analysis of "designated and desired uses" of the watershed, including whether those uses are currently being met and outlining activities if they are not. This step further underscores the relationship between land and water.

Watershed Planning and Intergovernmental Collaboration

Water is frankly often incompatible with our typical official systems for decision-making. Given its primacy for human survival, water is a resource that we must treat collectively, even under the most capitalist of systems. Water also cannot be expected to respect jurisdictional boundaries; surface waters are often shared among jurisdictions, and water tends toward independent travel, propelled by gravity along self-leveling paths of least resistance, carrying conditions from its source to its destination. Finally, water quality conditions are diffusive, so a threat to any one geographic portion of a waterbody will swiftly spread throughout the extent of the waterbody.

Photo: Anderson Aerial

CASE STUDY

Bay View Association Rain Garden Initiative

The Bay View Association is an unincorporated historical enclave near downtown Petoskey that does not have its own stormwater infrastructure. Consequently, when it rains, "the property's roads sometimes turn into rivers." Also located on a slope, runoff from the Association travels directly into Little Traverse Bay.

Through a grant from the U.S. EPA's Great Lakes Restoration Initiative, the Tip of the Mitt Watershed Council and the Bay View Association are working together to install 25 rain gardens. Part of the grant money will help reimburse homeowners who install the gardens.

Tip of the Mitt notes that just one inch of rain from a common storm becomes 600 gallons of water across a 1,000 square foot roof. Rain gardens capture up to 30% more water than a traditional lawn and studies have shown that they remove up 90% of contaminants.

The best place to put a rain garden on a residential property is along the edge of a driveway or below a drainage spout. Using native plants with deep roots is most effective when constructing a rain garden; natives are best adapted to the local environment, and deep-rooted plants create deep channels for stormwater infiltration.

Requirements for low impact or green infrastructure can be a requirement for approval of certain developments or can be used to provide incentives for developers.

(At left) An example of a rain garden along the Indian River in northern Michigan. Photo courtesy of Tip of the Mitt Watershed Council. (Above) Bay View Association, courtesy of MichiganRadio.org

GHG EMISSIONS PLANS

TIME HORIZON

Varies. An inventory may cover a previous time period, while a Climate Action Plan may look 50-100 years into the future.

GEOGRAPHIC COVERAGE

An organization, which may be corporate, nongovernmental, or educational; may also include governmental agencies and units of government.

TOPICAL FOCUS

Greenhouse gas (GHG) emissions.

RESPONSIBLE PARTY

The organizational unit.

VARIATIONS

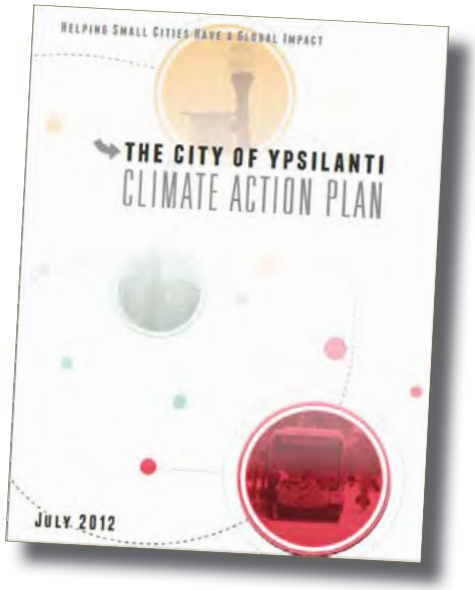
GHG Management Plan, GHG Mitigation Plan, Climate Action Plan.

Climate Action and Greenhouse Gas Emissions Plans

Organizations, including governments, may develop a Greenhouse Gas (GHG) Emissions Plan to understand and reduce their contributions to climate change. "Greenhouse gases" are those that trap heat in the Earth's atmosphere, causing the overall temperature of the planet to rise slowly but permanently. Carbon dioxide is the most common; other gases such as methane, nitrous oxide, and water vapor are also contributors. Many of these gases are emitted in large quantities by a variety of human processes.

A comprehensive inventory of GHG emissions from all sources — including power, transportation, various land uses, waste, and leaks — is the first step an organization may take in addressing its role in climate change. Such an inventory provides valuable information for risk management, addressing inefficiencies, and educating stakeholders. A GHG Mitigation Plan may then consider or mandate methods of reducing those emissions, usually over time. In this case, the Emissions Plan will set out policies to guide changes and identify benchmarks for achievement.

GHG Emissions Plans are often a fundamental requirement for participation in broader climate mitigation strategies, both voluntary and mandatory. Regulatory schemes such as carbon tax policies and cap-and-trade programs rely on accurate, consistent data to function. Though widespread political



In 2012, the City of Ypsilanti adopted a Climate Action Plan to guide municipal and city-wide goals and strategies to reduce greenhouse gas emissions and to move toward a more resilient future. The planning effort included a complete inventory of municipal and community greenhouse gas emissions.

support for such regulation has not materialized nationally, in 2009 the U.S. Environmental Protection Agency began mandatory reporting of greenhouse gases from sources that emit more than 25,000 metric tons of carbon dioxide equivalent per year. This "greenhouse gas registry" locates and describes 85-90% of our nation's emissions.

A Climate Action Plan may go a step further still, combining policies for reduction and efficiency with strategies to prepare for the impacts of climate change. It may also discuss implementing or promoting carbon "sinks," which are areas that use or accumulate carbon rather than produce it. Most carbon sinks are natural, including vegetation and oceans, but artificial sinks include the solvents and minerals found in coal stack "scrubbers."

"Many people think that resilience is just a fad, but we have found at the Michigan DNR that managing places for resilience forces us to ask the hard questions about adaptation and sustainability in a rapidly changing world."

Chris Hoving, Michigan Department of Natural Resources

NATURAL HAZARD MITIGATION PLAN

TIME HORIZON

Must be updated and approved every five years.

GEOGRAPHIC COVERAGE

State, local, or tribal unit of government.

TOPICAL FOCUS

Risks to life and property posed by likely natural disasters.

RESPONSIBLE PARTY

State, local, or tribal unit of government, including partners.

VARIATIONS

Few. The contents of the document are prescribed by the Federal Emergency Management Agency in order to be eligible for planning, project, and relief funding.

Natural Hazard Mitigation Plans

Natural Hazard Mitigation Plans are closely associated with the Federal Emergency Management Agency (FEMA). FEMA was formed in 1979 to merge and streamline various uncoordinated aspects of disaster management, from insurance administration to civil defense responsibilities. FEMA's overall goal is to deliver aid in times of need.

This coordinated approach has highlighted the value of prevention planning in disaster relief, and it allows the often staggering financial cost of a disaster to be aggregated. Strategies that could have averted a disaster are often painfully clear during a recovery process. Rebuilding offers a perfect opportunity to consider implementing those strategies and to "break the cycle of disaster damage, reconstruction, and repeated damage," according to FEMA.

A Natural Hazard Mitigation planning process consists of four parts. Organization of resources includes assembling local stakeholders and technical expertise. To assess risk, the state, tribe or community inventories likely hazards and assesses its vulnerability to those hazards. Based on this understanding, priorities and long-term strategies are developed to minimize undesired effects of the hazard. Finally, the mitigation strategies are implemented, and then periodically monitored to ensure their continued relevance amid changing conditions.

FEMA offers funding support for hazard mitigation in several

The Hazard Mitigation Plan for the State of Michigan provides comprehensive documentation of weather-related events that have occurred historically across the state and gauges the relative level of risk for each type of event. Prepared in 2014 by the Emergency Management and Homeland Security Division of the Michigan Department of State Police, the plan acknowledges the uncertainty of climate variability and supports adaptation strategies to reduce risk to human health and infrastructure.

ways. The mitigation planning program assists communities with the process of developing a FEMA-approved Natural Hazard Mitigation Plan, and a project program will assist in implementing long-term solutions to problems as long as the solution costs less than the damage ultimately would. A FEMA publication called "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards" (2013) offers potential relief measures for 16 individual types of threats, as well as a chapter on co-occuring threats.

After a disaster strikes, communities that have a FEMA-approved plan in place are eligible for services beyond debris removal and emergency protective measures, such as the rebuilding of roads, bridges, water control facilities, public buildings and utilities, and other facilities.

CASE STUDY

Habitat Restoration on the St. Mary's River

Coastal natural resource managers are taking a proactive approach to restoring ecosystem services in the St. Mary's River to protect water quality and restore habitat. Chippewa County is home to the St. Mary's, a uniquely positioned river that is bi-national and connects two of the largest freshwater lakes in the world, Lake Superior and Lake Huron. The river is 70 miles long and borders the Upper Peninsula and the province of Ontario, Canada. Its location was opportune for navigation, transport, and hydroelectric power, and since the 1800s extensive infrastructure has been built to facilitate industrial and commercial motives.

Manmade changes have destroyed habitats along several sections of the river. The ferry dock that connects Island No.1 to Sugar Island rests on two six-foot culverts that restrict the flow of water and have ruined habitat for fish and wildlife. The Main Rapids is the only section of the river that contains some of its natural habitat, but even so it receives less than 10% of the flow it did historically.

The St. Mary's River has been deemed an Area of Concern (AOC) under the 1987 Great Lakes Water Quality Agreement that Michigan holds with Canada. Due to steel plants, combined sewer overflows, and non-point source pollution, the St. Mary's River was listed as an AOC in 1987 because there was "a detrimental change in the chemical, physical or biological integrity of the Great Lakes System."[1]

Restoration of the river is underway through funding from a grant provided by the National Oceanic and Atmospheric Administration (NOAA). The culverts will be replaced with large box culverts that open up approximately 600 feet to improve water flow. Increased water flow is expected to increase fish-spawning habitats, increase spawning success rates, and restore about 70 acres of habitat for wildlife while also providing better recreational opportunities for people. The goal of the restoration is to remove this site from the AOC list.[2]

An aerial view of the Soo Locks on the St. Mary's River. Photo courtesy of uptravel.com

1 http://www.michigan.gov/documents/deq/AOC_Fact_Sheet_-_Little_Rapids_433534_7.pdf
2 http://www.mlive.com/news/grand-rapids/index.ssf/2015/07/st_marys_river_restoration.html


Chicago/Eastern Gateway Base Map
Data Sources
Michigan Geographic Data Library
City of Holland
Prepared May 2016 by
LIAA

Expert Contacts in Michigan

The following individuals and organizations are well suited to provide information, expertise, and data on a variety of topics related to community resilience and climate change. Each person listed has volunteered to serve as a resource for communities looking to increase their resiliency.

Andrea Brown

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Area of Expertise: Community Adaptation and Data Integration

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