

Climate Vulnerability and Adaptation Report for Kalamazoo

2022



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Introduction

The effects of climate change are already being experienced in Kalamazoo and will continue for decades to come. These changes include more extreme heat events, increased intensity and frequency of storm events, increased drought, and shifts in the timing of precipitation. Climate-related impacts, coupled with pre-existing challenges such as racial inequity and white supremacy, homelessness and lack of affordable housing, contaminated water supplies, food security challenges, and loss of wildlife habitat and biodiversity, have significant implications for the people, infrastructure, and environment of Kalamazoo.

The purpose of this report is to improve understanding about local climate change impacts and vulnerabilities and present adaptation responses that can help reduce community vulnerability and/or increase resilience. The report synthesizes the results of a three-part virtual workshop series held in February 2022. This workshop brought together more than 30 stakeholders from across Kalamazoo to evaluate community vulnerability and develop adaptation strategies for three focus areas of importance to the community: (1) connected communities, including housing and transportation, (2) food security and agriculture, and (3) habitat conservation and biodiversity.

The subsequent sections in this report are described below:

- **Project Methods and Workshop Activities** – Provides an overview of the climate adaptation planning process, workshop series, and selection of pre-existing conditions and climate stressors.
- **Overview of Climate Projections and Impacts** – Presents a summary of current and projected climate changes for the community.
- **Vulnerability Assessment and Adaptation Planning Results** – Summarizes vulnerability and adaptation information for each of the three focus areas.
- **Conclusions** – Highlights common concerns, impacts, and adaptation strategies across the different areas.

Project Methods and Workshop Activities

Climate Adaptation Planning Overview

Climate change adaptation refers to how we prepare for, respond to, and recover from changes we are already experiencing and/or are expected to experience. *Adaptation*, which focuses on managing the impacts of climate change, can be distinguished from *mitigation*, which refers to efforts intended to decrease the potential for climate change itself (e.g., by reducing greenhouse gas emissions or enhancing carbon sequestration). The adaptation planning process (Figure 1) intentionally integrates the consideration of climate change into plans, programs, projects, and operations and is meant to be iterative.

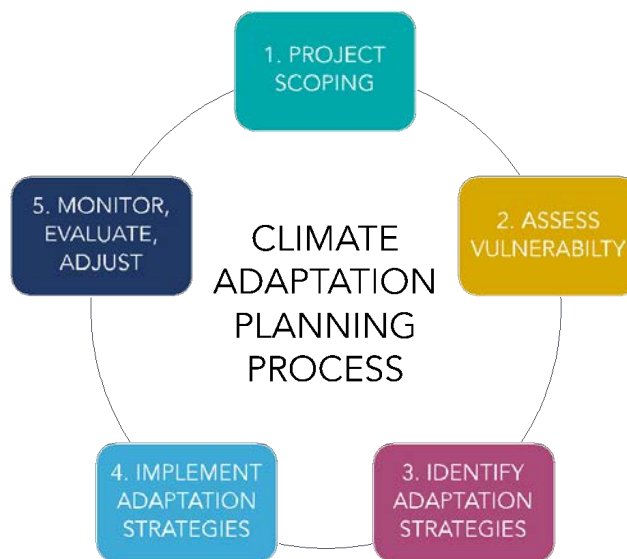


Figure 1. Steps in a basic climate adaptation planning process.

While there are many different climate adaptation planning frameworks, they generally consist of the same steps: (1) project scoping, (2) assess vulnerability, (3) identify adaptation strategies, (4) implement those strategies, and (5) monitor, evaluate, and adjust strategies, as needed. These steps are described below:

- (1) **Project scoping.** This step includes identifying goals and desired outcomes of the process, establishing the geographic boundaries and timeframe of interest (e.g., near-term: 10–20 years; mid-term: 25–50 years; long-term: 50+ years), identifying and engaging with key stakeholders and partners, and identifying key climate stressors and pre-existing conditions (i.e., stressors that already impact a community). Completion of this step is critical to provide the foundation for a clear and efficient adaptation planning process.

- (2) **Assess Vulnerability.** Vulnerability assessments improve understanding of how climate change is likely to impact a community and its ability to respond to those impacts. Vulnerability assessments include consideration of the likelihood of exposure to climate change, the consequence of that exposure, and the community's capacity to adapt to those impacts. These assessments include consideration of the following three components of vulnerability:
- o **Likelihood** is the degree to which a community is exposed to significant changes in climate and considers both the anticipated direction and magnitude of change.
 - o **Consequence** is the degree to which a community is affected by exposure to a changing climate and considers both the anticipated impacts of climate stressors as well as the impacts of pre-existing conditions.
 - o **Adaptive capacity** is the ability to adjust to climate change to minimize potential damages, take advantage of opportunities, or cope with consequences.

Likelihood and consequence together give an estimation of risk which, when combined with adaptive capacity, provides an overall picture of vulnerability (Figure 2). It is important to evaluate all three components – likelihood, consequence, and adaptive capacity – to gain a holistic perspective of the factors that are driving vulnerability.

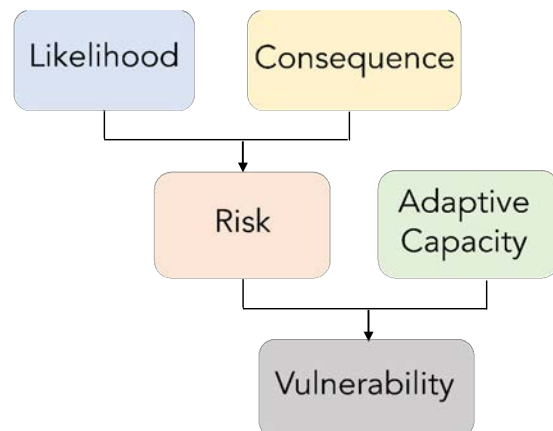


Figure 2. Components of vulnerability.

The vulnerability assessment step of the adaptation planning process includes evaluating the impacts of climate change on a community; characterizing the community's ability to minimize or cope with impacts; assigning likelihood, consequence, and adaptive capacity rankings; and summarizing overall vulnerability based on rankings, impacts, and adaptive capacity information.

- (3) **Identify Adaptation Strategies.** Adaptation strategies aim to reduce the negative effects or take advantage of the opportunities provided by climate change. The goal of this step is to identify adaptation strategies that reduce risk (limit exposure or minimize consequence) and/or enhance resilience (increase adaptive capacity). Understanding what drives vulnerability to climate change

(e.g., likelihood, consequence, adaptive capacity, or some combination of these) provides a good starting point for identifying possible adaptation strategies. General types of adaptation strategies that may be considered include programmatic; capital improvements and infrastructure; coordination and/or collaboration; knowledge and evaluation; and plans, regulations, and policies. To help decide which actions to prioritize for implementation, it can be helpful to articulate co-benefits (e.g., greenhouse gas reduction, public health improvement, water quality improvement, etc.) and conflicts or challenges (e.g., unintended consequences on people or community assets).

- (4) **Implement Adaptation Strategies.** When a list of adaptation strategies has been generated and prioritized, they must be put into action. Developing an adaptation implementation plan for each prioritized strategy helps communities articulate how and when (e.g., immediately, within the next 5 years, etc.) the strategy should be implemented, leads and partners responsible for implementation, existing resources and those that are still needed, and potential barriers to implementation.

- (5) **Monitor, Evaluate, and Adjust.** Climate change adaptation planning should be an iterative process, and monitoring and evaluation are essential components that allow communities to make progress while also adjusting actions based on project outcomes and new information. For instance, post-implementation monitoring of adaptation strategies helps to determine whether the strategies are having their intended effect and when or where adjustments might be needed. Developing a monitoring and evaluation plan is critical to minimize wasted time, money, and effort. These plans should include identification of desired outcomes, parameters to monitor and the method to do so, thresholds that may signal desired outcomes are not being met, and possible alternative strategies to pursue if these thresholds are crossed.

Tools Used in the Workshop

Climate Change Adaptation Certification Tool¹

The Climate Change Adaptation Certification Tool (CCAC)¹ is intended for use during regulatory or procedural review processes being carried out as part of routine community functions. The CCAC can be applied to decisions about any project or proposal that will involve the use of public funds, has a life cycle of greater than 5

¹ <http://ecoadapt.org/data/documents/EcoAdaptCCACToolFillableKalamazoo.pdf>

years, and can impact public good (e.g., fiscal expenditures, capital planning, permitting, infrastructure design, and siting). Applying the CCAC to these decisions allows explicit evaluation of future conditions on project function and longevity, increases understanding of the long-term sustainability of a project at the funding or permitting phase, and considers how to reduce community risk that could arise from actions that become a liability under future conditions. The CCAC process includes three steps:

1. identification of climate change risk factors,
2. evaluation of climate impact on a project, and
3. determination of project review.

Rapid Vulnerability and Adaptation Tool²

The Rapid Vulnerability and Adaptation Tool (RVAT) for Climate-Informed Community Planning was developed to make climate adaptation planning a simple, direct, and feasible process for communities. The purpose of the tool is to improve understanding of community vulnerability to climate impacts and to develop implementable solutions that reduce vulnerability and/or increase resilience. The RVAT is designed to cover the major steps of a basic climate adaptation planning process, which include:

1. project scoping,
2. vulnerability assessment,
3. adaptation strategy development, and
4. adaptation implementation.

Workshop Series

The Kalamazoo Climate Change Adaptation Workshop series³ was held on February 8, 10, and 14 2022, from 1 pm – 5pm each day. The first day of the workshop focused on discussing climate impacts, the second on assessing vulnerability, and the third on developing adaptation strategies. Workshop activities for each day are discussed in more detail below.

Climate Adaptation Workshop Activities: Day 1

The first day focused on orienting participants to the workshop series, introducing climate adaptation planning and the steps involved, identifying and prioritizing pre-existing conditions (i.e., stressors that currently impact the community), presenting climate change projections and discussing impacts, introducing and completing the first step of the CCAC, and completing the first step of the RVAT (project scoping,

² http://ecoadapt.org/data/documents/RVAT_Kalamazoo.pdf

³ The workshop support page (<http://ecoadapt.org/workshops/kalamazoo-adaptation-workshop>) includes links to presentation slides and all other workshop materials.

including prioritizing pre-existing conditions and climate stressors and evaluating adaptive capacity). To aid in the adaptive capacity evaluation, workshop participants were provided with a network mapping tool (<https://network-mapping-41fb1.web.app/>), which shows the existing relationships among local government departments/agencies and/or community organizations and how each links to different focus areas.

Workshop activities were divided between presentations, large group discussions, and breakout group activities. Workshop participants were divided into breakout groups to address three focus areas:

- Group 1: Connected communities (housing and transportation)
- Group 2: Food security and agriculture
- Group 3: Habitat conservation and biodiversity

Workshop participants, including affiliations and breakout group assignments, can be found in Appendix A.

Pre-Existing Conditions and Climate Stressors

As part of the first step of the RVAT, project scoping, workshop participants were asked to identify pre-existing conditions for Kalamazoo (i.e., stressors that already impact the community). Participants identified more than 30 pre-existing conditions which, through group discussion and ranking, was narrowed down to a list of 9 priority conditions. These included racial inequity, white supremacy, homelessness, housing costs and gentrification, urban sprawl and habitat loss, biodiversity loss, food security and supply chain issues, water contamination and toxicity, and lack of safe non-motorized transportation options.

Focus area groups also identified additional pre-existing conditions of particular importance to their group's work, including:

- Poor home performance (e.g., does not perform well in terms of temperature and humidity control)
- Access to green space and natural areas
- Loss of quality native plant communities/assemblages
- Training/capacity for farmers and growers and working conditions and jobs for farmworkers.

Key climate stressors for Kalamazoo were pre-identified by workshop facilitators and included rising temperatures and more extreme heat; precipitation shifts; more winter precipitation falling as rain/freezing rain rather than as snow; extreme precipitation

events, including more intense storms and increasing flooding frequency; and drought. The identified pre-existing conditions and climate stressors provided the basis for the second step of the RVAT, vulnerability assessment.

Climate Adaptation Workshop Activities: Day 2

The second day focused primarily on assessing the vulnerability of all three focus areas to pre-existing conditions and climate stressors. Much of the time was spent in small groups applying the second step of the RVAT, which included discussing the impacts of pre-existing conditions and climate stressors on a given focus area, identifying impacts of greatest concern, and assigning vulnerability rankings to priority impacts. Participants then engaged in a large group discussion to share the findings of the vulnerability assessment. Facilitators also gave presentations on developing adaptation strategies and introducing the second step of the CCAC. Workshop participants were asked to complete the second step of the CCAC as homework and send it to workshop facilitators prior to the start of the third day.

Climate Adaptation Workshop Activities: Day 3

The third day focused on small group work to identify adaptation strategies that would reduce impacts of greatest concern for each focus area and then develop implementation plans for priority strategies (the third and fourth steps of the RVAT, respectively). The food security and agriculture group shifted the focus of their breakout towards a more holistic discussion of the ways in which the RVAT's structure was and was not sufficient for addressing their group's priorities in the context of racial inequity and white supremacy, and what next steps they might take as a group to continue working on these issues.

Overview of Climate Projections and Impacts

The following summaries provided foundational information for the workshops about current and projected future climate changes. A table of observed and projected climatic changes can be found in Appendix B.⁴

Air Temperature and Extreme Heat

By 2050, average daily minimum temperatures (minimum daily temperatures averaged across the whole year) in Kalamazoo are projected to increase by 4.8°F above the historical average of 39°F from 1961–1990. Average daily maximum temperatures are projected to increase by 5.2°F above the historical average of 59.2°F. By 2100, minimum and maximum temperatures are likely to have increased by 11.1°F and 11.6°F above historical averages, respectively.

Extreme heat events are also likely to increase significantly. The number of days with maximum temperatures over 90°F are likely to increase from the current average of 10.2 days per year to nearly 45 days per year by 2050 and nearly 91 days per year by 2100 (representing a 340% and 791% increase, respectively).

Precipitation and Drought

Changes in annual precipitation in Kalamazoo are expected to be relatively insignificant by mid-century, with model projections suggesting increases of 3.5% from the historical average of 36.9 inches per year (to 38.2 inches per year). By 2100, annual precipitation is projected to have increased by 10.6%, to 40.8 inches per year. More significant shifts are expected in how precipitation is distributed within the course of the year, with significant increases expected in winter and spring precipitation (up to 20%–30%). Very slight increases in precipitation may occur in the fall, and slight decreases in rainfall are expected in the summer months.⁵

Snow

The Lake Michigan snowbelt has seen a significant increase in lake-effect snow since about 1900, likely due to warmer surface temperatures and reduced lake ice cover.⁶

⁴ Projections for air temperature, extreme heat, and annual precipitation were obtained from the U.S. Climate Resilience Toolkit Climate Explorer (<https://crt-climate-explorer.nemac.org>), generated using the high-emissions scenario for 2050/mid-century (average of 2035–2064) and 2100/late-century (average of 2070–2099) time periods compared to average conditions between 1961–1990.

⁵ D. R. Easterling et al., in *Climate Science Special Report: Fourth National Climate Assessment, Volume I*, D. J. Wuebbles et al., Eds. (U.S. Global Change Research Program, Washington, DC, pp. 207–230 (2017).

⁶ K. E. Kunkel et al., *Journal of Great Lakes Research*. 35, 23–29 (2009).

Increases in temperatures past the freezing threshold will likely result in more precipitation falling as rain or freezing rain.⁷

Extreme Precipitation and Flooding

Extreme precipitation, which is strongly associated with severe flooding events, has been increasing over the last several decades. The amount of rain that falls on the wettest 1% of days increased by 42% in the Midwest between 1958 and 2016,⁸ and this trend is expected to continue, with the intensity of extreme precipitation events increasing by another 40% by 2100.⁹ The frequency of extreme precipitation events is also projected to increase, with the number of 2-day events when rainfall totals exceed the 5-year return interval expected to increase 150% by 2100.¹⁰

There are relatively few studies that model future changes in extreme weather such as thunderstorms or tornados. In general, it is likely that changes in temperature and humidity will support more extreme weather events, including days with conditions supportive of tornadic storms. One study projected an increase in the frequency of thunderstorms (up to 2.4 additional thunderstorm days per season) by 2100, with the most significant increases occurring in the likelihood of spring storms.¹¹

Drought

The Kalamazoo area is likely to see increasing periods of drought, particularly towards the end of the century.¹² This trend is due, in part, to increased evapotranspiration as temperatures increase, which drives greater water loss. Relatively small projected changes in annual precipitation, combined with significant increases in winter rainfall and the frequency and intensity of extreme precipitation events, suggest that dry periods will become more intense when they do occur.

Summary of Potential Impacts

Examples of potential impacts of the projected climate changes mentioned above are summarized below for the three focus areas chosen for this workshop. These

⁷ GLISA, Snow in the Great Lakes: Past, present, and future. <https://glisa.umich.edu/resources-tools/climate-impacts/snow-in-the-great-lakes-past-present-and-the-future/>. Accessed Jan 2022.

⁸ D. R. Easterling et al., in Climate Science Special Report: Fourth National Climate Assessment, Volume I, D. J. Wuebbles et al., Eds. (U.S. Global Change Research Program, Washington, DC. pp. 207–230. (2017).

⁹ Z. Feng et al., Nature Communications. 7, 13429 (2016).

¹⁰ Easterling et al. op.cit.

¹¹ N. S. Diffenbaugh, M. Scherer, R. J. Trapp, PNAS. 110, 16361–16366 (2013).

¹² GLISA, Extreme Precipitation (<https://glisa.umich.edu/resources-tools/climate-impacts/extreme-precipitation/>). Accessed Jan 2022.

generalized changes are summarized below; the more specific intersection of these impacts with climate and pre-existing conditions that were discussed by workshop participants are explored in the following section that presents the vulnerability assessment for Kalamazoo.

Likely impacts of projected climate changes on **connected communities** may include the following:

- Increased risk of damage to housing, roads, and other critical infrastructure (e.g., utilities) following extreme events
- Road blockages and loss of access following extreme events, impacting evacuation routes, emergency access, and other emergency responses
- Loss of electricity due to flooding or heat waves, limiting use of electric vehicles and impacting public transit
- Increased heat stress in developed areas, exacerbated by impervious surfaces and lack of vegetation

Likely impacts of projected climate changes on **habitat conservation and biodiversity** may include the following:

- Reduced growth and productivity of native vegetation
- Expansion of non-native plants and insect pests with increasing temperatures
- Increased soil erosion and nutrient runoff into rivers and streams during heavy rainfall, thereby reducing water quality
- Increased concentration of contaminants and increased risk of algal blooms in water sources during hot/dry periods
- Increased risk of wildfire during severe droughts

Likely impacts of projected climate changes on **food security and agriculture** may include the following:

- Increased length of the growing season and potential increases in heat stress, disease, and pests, impacting crop growth
- Unsuitability of current crops for new conditions, requiring changes in crop types and equipment needed
- Economic impacts of crop failures and damage to agriculture operations following extreme events (e.g., floods), which may increase cost of food
- Increased health risks for agricultural workers

Vulnerability Assessment and Adaptation Strategies

The following sections summarize the vulnerability and adaptation information for each of the three focus areas addressed in this workshop series: Connected Communities, Food Security and Agriculture, and Habitat Conservation and Biodiversity. The information presented is based on the discussions and input of workshop participants during breakout group activities.

Connected Communities

This working group focused on the goal of ensuring sustainable, affordable, equitable, healthy housing for Kalamazoo that is well-connected by transit (non-motorized, public, and single-occupancy vehicle) to jobs, schools, natural spaces, and goods and services. The time frame considered for this assessment was 50 to 100 years. Much of the housing and transportation infrastructure that supports this goal lasts for several decades, so planning decisions have a long horizon for implementation and consequences.

VULNERABILITY ASSESSMENT

Summary of observed and/or anticipated effects of climate stressors and pre-existing conditions

Increasing temperatures, extreme storm events and flooding, and drought were identified by breakout group participants as the climate stressors that have the most significant impacts on connected communities.

Racial inequity, lack of safe non-motorized transportation and public transit, housing affordability and gentrification, and poor home performance were identified by participants as primary pre-existing conditions that impact connected communities and are described further below.

Climate stressors

Increasing temperatures are likely to impact older housing stock, which is designed for past conditions and may not be able to adequately cope with increased heat. There will likely be an increased need for air conditioning, which most houses in the community do not currently have. Because homes and infrastructure are not well-equipped for higher temperatures, heat-related illnesses are likely to increase.

Extreme storm events and flooding are likely to impact neighborhoods and major roads and intersections along the Kalamazoo River, as well as those in several other

vulnerable locales, which will likely create traffic issues (particularly in the southern portion of the community). Residential flooding is likely to impact housing integrity, increase costs due to flooding damage, decrease power reliability, and exacerbate a large variety of health-related concerns such as mold and mosquitoes. Flooding events could also compromise water quality due to the remobilization of contaminants.

Drought is likely to affect local crops and food production, ultimately impacting the local food network. Drought might also reduce water quantity and impact water-based recreational opportunities that allow residents to seek relief from heat on the Kalamazoo River.

Pre-existing Conditions

Racial inequity can reduce the financial and technical resources available for black, indigenous, and people of color (BIPOC) communities to adapt to climate change, which can affect an enormous range of issues, from home weatherization and flood protection to accessing health care resources and property insurance. Lower levels of homeownership in marginalized communities often means homes have received fewer upgrades for energy efficiency or weatherization. Gaps in affordability and a legacy of redlining also means there are more people in these communities living in older homes with lead in water and paint, poor insulation, and other home health and safety issues.

Houselessness and affordability/poor performing housing exacerbates existing patterns of housing inequity (i.e., who gets to live in well-performing housing). Kalamazoo has insufficient housing stock, rents can be very high, and median home prices are high compared to the average income. Affordable rental housing is often far away from downtown and schools, thus lowering walkability and forcing those with less income to spend more on transportation. Owners of rental homes often do not participate in free remediation programs, which deprives their tenants of needed home improvements.

Lack of safe and usable mass and non-motorized transit options limits connections between residents and their jobs, schools, and services. This is particularly true for lower-income residents because affordable housing is typically located in less walkable areas. Current road infrastructure exacerbates the lack of connectivity because it can isolate neighborhoods and create barriers to mass transit, although participants noted that the recent adoption of Complete Streets policies in Kalamazoo may help address some of these issues. Workshop participants also noted a correlation between higher mortality rates in marginalized communities and pollution from heavy traffic in proximity to these neighborhoods.

Combined impacts of pre-existing conditions and climate stressors

Climate change is likely to exacerbate the impacts of or be exacerbated by these pre-existing conditions. Participants identified several ways in which climate stressors and pre-existing conditions can intersect to affect connected communities:

Extreme storm events and flooding are likely to intersect with pre-existing conditions to exacerbate impacts in several ways, including the following:

- A high proportion of impervious surfaces in downtown Kalamazoo and the legacy of paving decisions, such as the building over of Arcadia Creek, leads to increased flooding risks when water cannot easily infiltrate into soils.
- The proximate location of contaminated sites, including capped landfills, means that flooding can remobilize contamination close to residential areas and expose residents to these toxic materials.
- Flooding is likely to exacerbate existing inequities related to housing and public health in marginalized communities, particularly for communities proximate to the Kalamazoo River, as well as those with older housing stock in poor condition that may be more heavily damaged by flooding. These homes may also be impacted to a greater degree by mold and pests after flooding, thus exacerbating public health inequities.
- Greater damages in substandard housing will, in turn, decrease livability and increase costs for populations who can least afford these added burdens.
- Extant issues with reliability of power are likely to be exacerbated by storm events and flooding. This issue could be of special concern where residents have medical needs that require a reliable source of power (e.g., keeping medicines refrigerated).

Impacts of *increasing temperature* are likely to intersect with pre-existing conditions to exacerbate impacts in several ways, including the following:

- Because Kalamazoo has a substantial amount of older housing stock that is designed for past, rather than future or even current climate conditions, there will likely be an increasing need for HVAC (heating, ventilation, and air conditioning) changes (e.g., installation of air conditioning) which in turn contributes to climate change as well as bringing additional costs to bear on homeowners and renters. If larger climate change patterns lead to climate migrants to the Kalamazoo area, this could put additional pressure on housing prices and availability.
- Enhanced heat island impacts in highly urbanized areas of Kalamazoo can be expected to increase, which is likely to drive greater use of single-occupancy

vehicles (among people for whom that is an option) and decreased use of non-motorized transportation use.

- Impacts of excessive heat are likely to be disproportionately realized in marginalized communities that have fewer resources to avoid extreme heat and where more residents may live in housing that is in poorer condition to withstand these temperature changes.
- As a result of increased temperatures and extreme heat, co-morbidities can be expected to rise in vulnerable populations, including pregnant women, children, and senior citizens.

Drought is likely to intersect with pre-existing conditions to exacerbate impacts in several ways, including the following:

- As Kalamazoo is reliant on groundwater for its drinking supply, drought is likely to increase issues with both water quantity and quality. In turn, reductions in water supplies are likely to raise the cost of water and sewage treatment, which could disproportionately impact marginalized communities that have fewer resources to absorb such cost increases.
- Climate migrants into the Kalamazoo area could further increase pressure on existing water supplies, thus raising costs and reducing water availability.
- Declines in discharge of the Kalamazoo River could reduce water-based recreational opportunities that allow residents to seek relief from extreme heat.
- Drought could affect the urban tree canopy and roadside vegetation, which in turn could exacerbate heat island effects and lead to issues such as increased erosion and/or risk of wildfire where roadside vegetation is in poor health.
- Potential power issues may arise with nuclear energy provided by the Palisades Power Plant if lake levels are affected by drought.
- Although this was more centrally addressed in the food security and agriculture group, this group also noted the importance of drought's impacts on the local food network and the integrity of local food in the community as an issue of concern for connected communities.

Summary of Adaptive Capacity

Overall, breakout group participants evaluated the adaptive capacity of Kalamazoo departments and organizations relevant to connected communities as **moderate to high**. Organizations identified as playing an important role in supporting connected communities include the City of Kalamazoo's Community Planning and Economic Development Department, Kalamazoo County government (including the Land Bank),

affordable housing organizations (including Kalamazoo neighborhood housing services and Kalamazoo Valley Habitat for Humanity), the construction sector and contractors, (including Better World Builders, the Green Home Institute), Western Michigan University and their Office for Sustainability, and homelessness services organizations¹³.

Organizational potential

Organizational potential considers factors that contribute to ability of an organization to be a resource to its community and includes staff capacity, particularly with respect to staff with training, expertise, and bandwidth for planning and responding to climate change; organizational responsiveness to needed adjustments in managements and structure; the integrity of stakeholder relationships; and the stability and longevity of the organization, including its planning horizon and governance structures.

Overall, the organizational potential of Kalamazoo was evaluated as moderate to high. Existing staff capacity was rated as moderate to high for most of the organizations considered. Organization responsiveness, existing stakeholder relationships, and stability/longevity were all evaluated as moderate-high for most of the organizations considered, except for the construction and contracting sector, which received low rankings for these factors.

Management potential

The management potential of an organization includes whether there is an existing mandate to include climate change planning in an organization's activities, the ability of the organization to learn and change, partner relationships that support inter-jurisdictional or inter-organizational coordination, and the presence of science and technology support in the organization.

Overall, the management potential for Kalamazoo was evaluated as moderate. Nearly all organizations considered, other than the construction industry, ranked high as having a strong existing mandate for climate work. Most remaining factors received moderate-high or high rankings, including having the organization's ability to learn and change, partner relationships, and monitoring and evaluation capacity. Mixed rankings were given for science and technical support because participants felt that while government and academic institutions had such resources, private industry and non-profit advocacy groups were less well equipped with this expertise.

¹³ Affordable housing and homelessness advocacy groups did not have representatives within the breakout group, so scores assigned to these organizations represent the other participants' best understanding of those organizations' capacity.

Overall vulnerability

Poor housing stock performance and **impacts of flooding on housing and transit** were ranked by breakout group participants as having **moderate to high vulnerability** due to extreme risk (*almost certain likelihood and major consequence*) and moderate to high adaptive capacity. **Adverse impacts on water quality and water supply, including mobilization of contaminants and lead in pipes** received a **moderate to high vulnerability** ranking (*likely and catastrophic consequence*). **Climate migration** both into and out of Kalamazoo could place additional stresses on Kalamazoo’s housing and water supplies and destabilize the agricultural sector if declines in food production leads to labor losses. This impact was ranked as having **moderate vulnerability**, viewed as being *likely* to occur with *major but uncertain* consequences, leading to a *high risk* ranking combined with a *moderate to high* adaptive capacity to respond to the impact (see Table 1 for a comparison of vulnerability rankings).

Table 1. Vulnerability Assessment Ranking Results for Effects/Impacts of Greatest Concern for Connected Communities

Effects/Impacts of Greatest Concern	Likelihood	Consequence	Risk	Adaptive Capacity	Vulnerability
The oldest and poorest performing housing stocks (occupied largely by Kalamazoo's traditionally marginalized and low-income residents) will be further compromised by climate change, making it more unaffordable and unhealthier.	Almost Certain	Major-catastrophic	Extreme	Moderate-High	Moderate - High
Flooding adversely affects housing and transit, disproportionately affecting (directly and indirectly) traditionally marginalized and low-income communities, often due to enduring patterns of racism such as redlining.	Almost Certain	Major	Extreme	Moderate-High	Moderate - High

<p>Adverse impacts on water quality and water supply, such as Superfund sites, lead in pipes, and other issues that will be exacerbated by extreme events, increasing temperature and drought, which can include:</p> <ul style="list-style-type: none"> • Impacts on natural systems and human communities--with pronounced health impacts on communities of color • Impacts on drinking water supply • Impacts on recreation, and • Impacts to pharmaceutical industry production. 	Likely	Catastrophic	Extreme	Moderate-High	Moderate - High
<p>Climate migration could increase stresses on systems (e.g., housing, transit), increasing housing prices, decreasing housing availability, increased transit use, and instability for agricultural systems and the people that maintain them.</p>	Likely	Major (but uncertain of how this will manifest)	High	Moderate	Moderate

PROPOSED ADAPTATION STRATEGIES AND IMPLEMENTATION PLANS

Adaptation strategies for effects of greatest concern

Breakout group participants identified several possible adaptation strategies for connected communities. The following table summarizes adaptation strategies in response to effects of greatest concern that were explored by breakout group participants (Table 2).

Table 2. Identified Effects of Greatest Concern and Possible Adaptation Strategies for Connected Communities.

Effects of greatest concern	Adaptation strategies to reduce vulnerabilities
<p>The oldest and poorest performing housing stocks (occupied largely by Kalamazoo's traditionally marginalized and low-income residents) will be further compromised by climate change, making housing more unaffordable and unhealthier.</p>	<ul style="list-style-type: none"> ● Increase access to more affordable energy (e.g., community solar) for low-income households to ensure long-term affordability. ● Increase energy efficiency (e.g., through insulation, behavioral education, decreasing interior humidity, weatherization) through reconstruction and retrofitting—"Make sure your house is loving you back." ● Conduct vulnerability assessments that can then be tied to funding mechanisms (tackle racial inequality by understanding location of most vulnerable housing and residents). ● Tie rent/ownership assistance to holding landlords more accountable to maintaining energy efficiency (e.g., energy bill disclosure prior to renting or providing rental assistance or ownership assistance). ● Provide community education on true cost (energy, maintenance) of rental or ownership of individual properties. <p><i>Co-benefits:</i> Empower decisions to decrease redlining by increasing awareness of disparity between properties and residents, identify areas where ownership is not accessible; health and financial benefits to residents; solar and energy efficiency efforts help reduce greenhouse gas emissions</p> <p><i>Potential challenges/unintended consequences:</i> Added regulations on developers and landlords could decrease investment and further diminish rental options; there are unknown implications of mixed-use development; increasing electrification could lead to increased greenhouse gas emissions (could offset with earlier solar)</p>
<p>Flooding adversely affects housing and transit, disproportionately affecting (directly and indirectly) traditionally marginalized and low-income communities, often due to enduring patterns of racism such as redlining</p>	<ul style="list-style-type: none"> ● Move roads out of harm's way or engineer differently (e.g., elevate, different drainage, more green infrastructure, flood diversion infrastructure). ● Increase intergovernmental/regional collaboration to work with upstream communities so low elevation sites receive less flow. ● Ensure access to/from all housing, services, goods, and work/education (e.g., complete streets that are flood smart). ● Implement flood protection for houses (e.g., siting, flood mitigation, engineer houses differently, flood smart landscaping). ● Increase affordability, availability, and awareness of flood insurance, and shape policies so that payments are prioritized toward not repeating problems.

	<ul style="list-style-type: none"> • Create buyouts for floodplains and for re-engineering sites. <p><i>Co-benefits:</i> Increased walkability, increased access, increased health, increased financial stability; prevention avoids cost of calamity, which increases durability and resilience (building to last).</p> <p><i>Potential Challenges/Unintended Consequences:</i> Displacement of people, business, connections (will require a strong attention to equity in process); more affluent community members have greater mobility in response.</p>
<p>Adverse impacts on water quality and water supply, including lead in pipes and remobilization of contaminants, and other issues that will be exacerbated by extreme events, increasing temperature and drought. Impacts on natural systems and human communities--with pronounced health impacts on communities of color.</p>	<ul style="list-style-type: none"> • Remove toxins because exposure to them becomes a greater risk (e.g., landfills built to hold 100-year flood projections). • Replace lead and copper service lines and incentivize removal in residences and schools, with "filtration stations" in the interim. • Increase educational programs and policies to address water conservation, recharge plans (tertiary recharge, green infrastructure water capture and recharge). • Develop alternative water supplies (catchments, transport). • Implement variable water rates (larger users pay more, financial support for low-income users). <p><i>Co-benefits:</i> Improve health of aquatic systems for biodiversity, downstream users; equity benefits (cost, health, access).</p> <p><i>Potential Challenges/Unintended Consequences:</i> Treatments could make water expensive; movement of PCBs to another community could result in harm to the new site.</p>
<p>Climate migration could increase stresses on Kalamazoo's systems (e.g., housing, transit) and cause impacts such as increasing housing prices, decreasing housing availability, increased transit use, and instability for agricultural systems and the people that maintain them.</p>	<ul style="list-style-type: none"> • The three impacts above in this table and their identified adaptation strategies will help support these needs. • Michigan's population has been declining in the recent past (at least since the 1990s) = carrying capacity has been higher in the past = lost investment in communities, Kalamazoo may be prepared to absorb new people without necessarily creating untenable stressors. • Opportunity to raise awareness on climate issues with new residents: welcoming service for new arrivals (community climate awareness and response training) and refresher course for locals <p><i>Co-benefits:</i> New residents can benefit the entire community, which could result in positives, not just be an added stressor.</p> <p><i>Potential Challenges/Unintended Consequences:</i> Other services will also be impacted (health systems, schools, food, etc.).</p>

Implementation plans for priority strategies

Connected communities participants selected five priority adaptation strategies and developed implementation plans for each:

1. Implement water management strategies: conservation, identifying alternative water supplies, and developing recharge plans (tertiary recharge, green infrastructure water capture, and recharge) while incorporating strategies to protect equity such as variable rates and assistance programs.

How to implement: These approaches will need to engage with changes to State of Michigan codes, but public education is possible. Water rates could be changed at the county level (Drain commissioner) after November 2022.

Leads and partners:

Leads: City, Kalamazoo River Watershed Council

Partners: State legislature, conservation district, drain commissioner

Resources and barriers: Rain barrel programs already exist; there may not currently be any water affordability programs for low-income residents.

Efficacy: High

Potential for Success: Low (requires state level action—re-evaluate next spring)

2. Increase energy efficiency (e.g., insulation, behavioral education [decreasing interior humidity], weatherization) through reconstruction and retrofitting.

How to implement: Use energy efficiency upgrade rebates and tax credits for residential and commercial; leverage infrastructure bill funding; work through all 70,000 houses in the county.

Leads and partners:

Leads: Local government planning departments, Better World Builders

Partners: Kalamazoo neighborhood housing, Power Michigan, Helios solar, Habitat of Humanity, Community HomeWorks

Resources and barriers: Existing energy incentives (federal, state, utility), including Michigan Saves (low interest loans to complete projects) and Publicly Assessed Clean Energy program adopted by counties (for commercial building loans), but they need more funds to implement at scale.

Efficacy: High

Potential for Success: High

3. Vulnerability assessments tied to funding mechanisms, which enables the community to tackle racial inequality by allocating resources based on locations of the most vulnerable housing and residents.

How to implement: Conduct a community greenhouse gas inventory, home audits, and utility bill audits; co-develop this effort with millage funds from Homes for All and vulnerable local community members. Rebuilt trust with communities around energy decision-making. Start soon, but plan to develop and expand incrementally across neighborhood associations.

Leads and partners:

Leads: Kalamazoo County official charged with this effort through Homes for All, possibly Mothers of Hope

Partners: Black Wall Street Kalamazoo, Black Lives Matter Battle Creek, Eliminating Racism and Creating/Celebrating Equity (ERACCE), Truth, Racial Healing & Transformation Kalamazoo (TRHT Kzoo), neighborhood associations, Kalamazoo Community Foundation (tiny home funding), and Western Michigan University (WMU) student support

Resources and barriers: Existing ICLEI¹⁴ membership— can use their community tool to apply to this project. Need a methodology and technical support partner or group to build local capacity to undertake this work and will need to get data from residents where state laws limit access to such data.

Efficacy: High (if done right)

Potential for Success: High (wheels are in motion, need to connect pieces, no deep barriers)

4. Re-engineering road and transportation infrastructure (e.g., elevate, different drainage, more green infrastructure, flood diversion)

How to implement: Flood diversion opportunities as described in strategy 1, such as recharge and storage, may help solve this issue. Imagine Kalamazoo's New Complete Streets policy 2019¹⁵ and manual 2022 helps guide better street design and engineering. For the reasons described in the resources and barriers, direct re-engineering of road systems is not generally considered a feasible option.

¹⁴ ICLEI is an international coalition of local and regional governments committed to sustainable development. They offer a range of resources to jurisdictions including greenhouse gas inventory development and monitoring tools.

¹⁵ <http://www.imaginekalamazoo.com/projects/>

Leads and partners:

Leads: County Drain commissioner, road commission of Kalamazoo County

Partners: Local municipalities

Resources and barriers: It is difficult to move roads without demolishing frequently flooded housing low in the floodplain and abandoning local roads that served these homes. The Federal Emergency Management Agency (FEMA) provides so little buy-out money that owners are unable to afford another place to live. Barriers also include a transportation network legacy: changing from a city you drive through to a destination that prioritizes the safety of all users, rather than the convenience of a few.

Efficacy: Medium

Potential for Success: Medium to High

5. Rental and ownership assistance tied to holding landlords more accountable to maintaining energy efficiency

How to implement: Mechanisms to achieve this goal could include energy bill disclosure prior to renting or providing rental assistance or ownership assistance.

Leads and partners:

Leads: Kalamazoo Climate Crisis Coalition

Partners: Better World Builders, community educators

Resources and barriers: State laws prohibit some of these approaches (especially in relation to landlords). Landlords do not have to disclose energy efficiency of their buildings, requires negotiation for past year's energy bills. Requires community advocacy to build political will.

Efficacy: High

Potential for Success: Low (requires state level action—re-evaluate next spring)

Habitat Conservation and Biodiversity

This group focused on a goal of conservation, restoration, and management of natural areas and biodiversity in the Kalamazoo area over a range of planning horizons, including near-term (5-year organization planning cycles), intermediate (50-year conservation goal planning), and long term (100-year significant climate change impact planning).

VULNERABILITY ASSESSMENT

Summary of observed and/or anticipated effects of climate stressors and pre-existing conditions

Drought, extreme heat, and extreme storm events and flooding were identified by participants as the primary climate stressors that impact Habitat Conservation and Biodiversity.

Racial inequity/white supremacy, exclusion of indigenous peoples and values, and underrepresentation of marginalized communities and other inequities that have made it difficult for these communities to engage; urban sprawl and habitat loss; and soil degradation and loss were identified by group participants as the primary pre-existing conditions that have the most significant impacts on Habitat Conservation and Biodiversity.

Climate stressors

Drought is likely to have impacts on phenology (cyclic and seasonal natural phenomena), such as availability and timing of nectar sources and other critical aspects of insect life-cycle timing, loss of sensitive species, increasing water demands when there is the least capacity to supply them, increased vulnerability to diseases during periods of stress, and significant impacts to aquatic species.

Extreme heat is likely to increase vulnerability of wildlife and vegetation to diseases during periods of stress, increase fungal infections in wildlife, and shift or change ecosystems (e.g., untenable conditions for cold water species).

Extreme storm events and flooding are likely to contribute to increased soil loss via erosion; seasonal hydrologic cycle changes; wetland system changes; flooding impacts to sensitive species; and faster runoff/less time for water to infiltrate, percolate, and enter the water table.

Pre-existing conditions

Racial inequity/white supremacy, exclusion of indigenous peoples and values, and underrepresentation of marginalized communities and other inequities that have made it difficult for these communities to engage interfere with habitat conservation and community efforts supporting biodiversity. How the social landscape is managed is impacting the natural landscape. Racism and exclusion affect a community's ability to come together to support solutions, and the benefits of and access to natural areas is not equitable. A wide range of adaptive ideas are lost without full inclusion. Significantly, the exclusion of indigenous people and knowledge has also led to a loss of inclusion of original instruction and traditional ecological knowledge in land stewardship.

Urban sprawl and habitat loss bring challenges to connectivity and genetic flow/exchange between natural areas. Both size and function of core habitats are compromised, ecosystems can become imbalanced, and management becomes fragmented. These factors put pressure on endangered species and can lead to extirpation (local extinction) of sensitive species. Ecosystem services are decreased. Urban sprawl also disconnects people from natural areas.

Soil degradation and loss occurs when farming practices and land use do not take precautions to protect soil, which can impact aquatic systems as well as undermine the health of vegetation and wildlife that depends on it. A good soil community supports adaptive ecosystems. Poorly managed soils require more herbicides and fertilizers, which can then run off and create additional water quality problems.

Combined impacts of pre-existing conditions and climate stressors

Climate change is likely to exacerbate the impacts of or be exacerbated by all three pre-existing conditions. Breakout group participants identified the following challenges:

- Drought can intersect with racial inequity because inequitable allocation and accessing to water supply will be exacerbated by declines in supply.
- Drought, extreme heat, and extreme storm events are all disruptions that will further strain limited funding for and attention to natural resources. Communities marginalized by racial inequity may continue to be sidelined as funding and resources are strained due to extreme climate events.
- Extreme heat, drought, and extreme storm events are all climate stressors that can intersect with racial inequity because communities that are already facing racial inequity are more likely to shoulder disproportionate stress from climate

events, making it difficult for these communities to access and connect with nature.

- Urban sprawl and habitat loss causing fragmentation and reduced connectivity can result in low resilience of natural habitats, thus decreasing the ability of these habitats to recover from increasing drought, extreme/prolonged heat, and extreme precipitation. This loss of resilience is especially detrimental for high value ecosystems such as beech/maple forest communities.
- Drought and extreme precipitation can sequentially intersect with soil degradation and loss as drought exacerbates soil structure loss and compaction, thereby increasing the likelihood of erosion associated with extreme precipitation events and in turn impacting local river and stream water quality.
- Extreme heat and increasing temperatures can intersect with soil degradation by further reducing soil capacity to absorb water and recharge groundwater.

Summary of adaptive capacity

Overall, breakout group participants evaluated the adaptive capacity of Kalamazoo agencies and organizations relevant to Habitat Conservation and Biodiversity as **high**. Organizations that were considered include the Kalamazoo River Watershed Council, the Michigan Department of Natural Resources, Michigan Natural Resources Inventory, Michigan State University Extension, Southwest Michigan Land Conservancy, Kalamazoo Area Wild Ones, and the Kalamazoo Nature Center¹⁶. Additional organizations not ranked for adaptive capacity but considered important to this focus area included the Asylum Lake Preservation Association, the Kalamazoo Climate Crisis Coalition, and Stewards of Kleinstuck.

Organizational potential

Overall, the organizational potential of Kalamazoo was evaluated as high, including responsiveness, stakeholder relationships, and stability and longevity. Staff capacity was thought to be limited for some organizations and overall was ranked as moderate.

Management potential

Overall, management potential for Kalamazoo organizations was evaluated as high. Multiple factors received moderate-high or high rankings, including having an existing mandate, the organization's ability to learn and change, partner relationships, and science/technical support. Monitoring and evaluation capacity received a moderate adaptive capacity ranking.

¹⁶ The Natural Resources Inventory and the Extension Service did not have representatives within the breakout group, so scores assigned to these organizations represent the other participants' best understanding of those organizations' capacity.

Overall vulnerability

Participants focused on identifying the effects and impacts of greatest concern and possible adaptation strategies (see Adaptation Strategies below) and did not have an opportunity to fully analyze the vulnerability to create an assessment table like Table 1 above. The group did decide that all the impacts described below were already occurring or were almost certain to occur, and that the adaptive capacity of organizations working in this focus area is high, which puts these groups in a good position to meet the challenges they are likely to be facing.

PROPOSED ADAPTATION STRATEGIES AND IMPLEMENTATION PLANS

Adaptation strategies for effects of greatest concern

Breakout group participants identified adaptation strategies for Habitat Conservation and Biodiversity ranging from **programmatic** (e.g., expand green infrastructure implementation, enhance ecological connectivity through habitat corridor improvements, and increase green jobs and internship opportunities) to **improving knowledge** (e.g., receive and integrate indigenous perspectives) to **creating new policies** (e.g., establish minimum standards for low impact development; adjust land development policy to integrate conservation planning). Table 3 summarizes possible adaptation strategies in response to effects of greatest concern identified by breakout group participants for habitat conservation and biodiversity.

Table 3. Identified Effects of Greatest Concern and Possible Adaptation Strategies for Habitat Conservation and Biodiversity.

Effects of greatest concern	Adaptation strategies to reduce vulnerabilities
Development pressure, driven by human migration and population growth, on natural habitats and resulting impacts on fragmentation and loss of habitat resilience	<ul style="list-style-type: none">● Improve ecological connectivity between conserved areas through habitat corridors, genetic flow/exchange.● Include connectivity within and through developed areas.● Improve habitat health, including revisiting extant management plans through the lens of understanding likely climate impacts.● Adjust land development policy and planning at both county and township levels and establish minimum standards for low impact development and integration of conservation planning.● Coordinate with adjacent and outlying communities on minimizing sprawl, and work together on natural land management and shared solutions.

<p>Growing stress on people further challenges equity, inclusion, and ability to make connections to, access, and perceive relevance of nature and natural resources</p>	<ul style="list-style-type: none"> ● Increase diversity in existing organizations, including strategic inclusive recruitment, and thinking longer term and more intentionally about inclusion and representation. ● Improve relevance and representation in outreach and education. ● Seek and leverage partnerships with existing diversity and equity groups. ● Leverage Natural Features Protection Board activities. ● Help everyone know that nature is for everyone and reduce barriers (fees and perceived). ● Increase green jobs and internship opportunities with better coordination for seasonal workers (add off-season activities).
<p>Growing stress on ecosystems, and people, reduces ecosystem services while demand increases, challenging equitable distribution (e.g., air quality; growing demand on water and inequitable distribution of supply)</p>	<ul style="list-style-type: none"> ● Improve ecosystem resilience, including consideration of species migration when conducting restoration. ● Partner with adjacent land management entities for collaborative effectiveness. ● Expand green infrastructure implementation. ● Improve management of existing green spaces.
<p>Scale and effectiveness of current policy and funding mechanisms are inadequate and insufficiently explored</p>	<ul style="list-style-type: none"> ● Amplify and nudge funding mechanisms to help cover needed resilience (e.g., leverage, shift Foundation for Excellence resources). ● Adjust land development policy and planning at county and township level to integrate conservation planning. ● Embrace creative development planning. ● Increase low impact development and establish minimum standards. ● Consider changing funding mechanism from old model (hunting/fishing license fees) to across-the-board tax. ● Restructure funding match mechanisms and requirements.
<p>Lack of inclusion of indigenous, cultural, historical, and novel land stewardship perspectives in responding to climate stressors</p>	<ul style="list-style-type: none"> ● Improve collaborative conversations and idea flow. ● Create and expand collaborative events. ● Integrate indigenous perspectives. ● Actively incorporate traditional ecological knowledge into stewardship.

Implementation plans for priority strategies

Breakout group participants discussed three of their highest priority adaptation strategies for habitation conservation and biodiversity. There was not time to develop rankings for feasibility and efficacy, but participants did identify some of the leads and partners as well as resources and barriers that might be involved in strategy implementation.

1. Expand collaborative conversations and idea flow, better integrate indigenous perspectives, and actively incorporate Traditional Ecological Knowledge into stewardship.

How to implement: The National Guard is eager to work together with organizations and agencies to expand tribal inclusion and facilitate regional collaboration in habitat biodiversity and conservation efforts. Funding already exists this kind of work, and this process is starting soon.

Leads and partners:

Leads: National Guard/Department of Defense

Partners: Local tribes including Potawatomi (Gun Lake), Pokagon, Nottawaseppi Huron Band of the Potawatomi, and others; Kalamazoo Nature Center, Kalamazoo Watershed Council, Southwest Michigan Land Conservancy

Resources and barriers: There is strong interest from local conservation groups, and tools and resources are available from entities such as the Institute for Tribal Environmental Professionals and the Northern Institute of Applied Climate Science.

2. Increase job and internship opportunities for underrepresented communities in habitat biodiversity and conservation work.

How to implement: Develop a collaborative funding proposal using an AmeriCorps-type approach for the region, and together reach out to colleges, high schools, and underrepresented communities.

Leads and partners: Workshop participants; an existing organization focused on inclusion would make a good lead, such as Outdoor Afro, the Merze Tate Foundation, the Institute of Public Scholarship.

Resources and barriers: Leverage existing AmeriCorps momentum and fill critical gaps. Recent AmeriCorps program efforts have stalled because of lack of sufficient housing and transportation.

3. Develop conservation networks to improve ecological connectivity between conserved areas.

How to implement: Collaboratively develop habitat corridors that support genetic flow/exchange and include connectivity opportunities both within and through existing and new developed areas.

Lead: Southwest Michigan Land Conservancy

Partners: Western Michigan University

Resources and barriers: Initial surveys and analysis to identify conservation corridors and biodiversity hubs have been completed by Western Michigan University.

Food Security and Agriculture

This focus area considers Kalamazoo residents' access to healthy and local food choices, as well as the health and vitality of the community's agricultural sector. The timeframe used for this assessment ranged from near term (5 years) to long term (50 to 100 years), while recognizing the need for an enduring and accessible food system to support the community immediately as well as for many decades to come.

VULNERABILITY ASSESSMENT

Summary of observed and/or anticipated effects of climate stressors and pre-existing conditions

Extreme heat, changes in precipitation patterns, and increased extreme precipitation events/flooding were identified by breakout group participants as the climate stressors that have the most significant impacts on food security and agriculture.

White supremacy, urban sprawl and habitat loss, and food security and supply chain issues were identified by participants as the primary pre-existing conditions that impact food security and agriculture.

Climate stressors

Extreme heat is likely to affect the suitability of certain crops to the area, create heat stress for livestock, reduce water supplies and increase the need for irrigation. Extreme heat could also drive changes in pests and diseases and impact soil structure. Excess heat is likely to create heat stress for farmworkers and could lead to shifts in the timing of when work needs to be done (e.g., earlier, or later in day).

Changes in precipitation patterns are likely to affect the suitability of certain crops to the area, drive changes in pests and diseases, and impact soil structure. It is also likely to alter the timing and/or reduce the predictability of planting and harvesting.

Increased extreme precipitation and flooding is likely to cause more crop failures, topsoil erosion and changes in soil structure, changes in pests and diseases, water and soil contamination, and loss of farmable lands.

Pre-existing conditions

White supremacy contributes to gender-based and racialized health disparities (e.g., infant mortality, anemia), higher rates of incarceration among people of color, and

many other power imbalances that impact equitable access to and participation in agriculture (e.g., land ownership) and healthy food systems.

Urban sprawl and habitat loss contributes to the loss of farmland near the city's population centers, as well as loss of biodiversity (including pollinators).

Food security and supply chain issues have been exacerbated by the Covid pandemic, which has caused illness and changes in employment, food insecurity, and loss of infrastructure to support access to available food.

Combined impacts of pre-existing conditions and climate stressors

Climate change is likely to exacerbate the impacts of or be exacerbated by all three pre-existing conditions. Breakout group participants identified the following challenges:

- In the context of white supremacy, the impacts of climate changes (such as increased temperatures, changes in precipitation, and increased flooding) are likely to exacerbate existing stressors for people who already have fewer resources. For instance, opportunities may be reduced and pressure may be increased for individuals who need accommodations due to injury, ability, or age. Over time, these factors are likely to contribute to reduced access to land and civil unrest, or even the potential for forced agricultural labor from marginalized populations.
- Increases in fascism and white supremacy and associated periods of civil unrest are likely to be exacerbated by increased fears of food security associated with climate change.
- Disruptions brought by climate change impacts to growing local, healthy foods might exacerbate already inequitable access to nutrients. Increased costs of food production are likely to be passed along to residents, with greater impacts on low-income populations.
- Increased temperatures and extreme heat may place additional development pressure on farmlands as more affluent residents move away from the heat island effects of the city center. Where urban sprawl and habitat loss occur, pollinator populations (and biodiversity in general) may be impacted to a greater degree to climate changes, particularly if diversified farms are lost.
- Changes in precipitation patterns can lead to reduced water supplies, which would likely have disproportionate impacts on BIPOC and low-income communities.

- Flooding could impact water quality in low-lying neighborhoods and where water sources are in agricultural lands and may have higher levels of contaminants, including pesticides.
- Increases in flooding may disproportionately affect communities located in floodplains and high-risk areas, including impacts to both home and community gardens as well as the Kalamazoo farmer's market, which is located in a low-lying area vulnerable to flooding. Severe flooding could additionally disrupt food transport due to road damage and loss of storage facilities or other supply chain infrastructure.
- Kalamazoo is also likely to be vulnerable to extreme events in other places that disrupt the food supply or limit food availability locally.
- Solutions to problems associated with flooding, extreme heat, or other climate changes run the risk of reinforcing existing structures that are focused on profits rather than people (e.g., using more chemicals to address losses in crop productivity, despite their negative impacts on water quality), thus exacerbating existing patterns of inequity within the community.

Summary of adaptive capacity

Overall, breakout group participants evaluated the adaptive capacity of Kalamazoo departments and organizations relevant to food security and agriculture as **moderate**. Organizations considered included Can Do Kitchen, Farmworker Legal Services, Kalamazoo Climate Crisis Coalition, Kalamazoo College, Kalamazoo Loaves and Fishes, Kalamazoo Conservation District, People's Food Co-op, Kalamazoo Valley Community College, Zoo City Farm and Food Network, and Michigan State University Extension.

Organizational potential

Overall, the organizational potential of Kalamazoo was evaluated as moderate. Organization stability/longevity was evaluated as high, while responsiveness and stakeholder relationships received a moderate ranking. Staff capacity was also ranked as moderate overall, but there was substantial variability from low to high across organizations.

Management potential

Overall, the management potential for Kalamazoo was evaluated as moderate to high. Participants identified partner relationships as strong and ranked them as high. Organizations' existing mandate for climate change work, monitoring and evaluation capacity, ability to learn and change, and science/technical support were ranked as moderate.

Overall vulnerability

Crop failure/loss due to extreme events and **supply chain and food access disruptions following extreme events** were ranked by breakout group participants as impacts to which the community has **high vulnerability** due to extreme risk (*almost certain likelihood and major to catastrophic consequence*) and moderate adaptive capacity. **Increases in fascism/white supremacy group activity/civil unrest as food insecurity increases and people become more fearful** was identified as an impact to which the community has **moderate vulnerability** due to high risk (*almost certain likelihood and moderate consequence*) and moderate adaptive capacity, with participants noting that the consequence of this impact is dependent on how effective the tactics of these groups are. (See Table 4 for comparison of vulnerability rankings).

Other effects/impacts of greatest concern identified but not ranked by breakout group participants include **supply chain and food access disruptions following extreme events (due to power outages, flood damage, etc.)** and **increased flooding in community gardens and home gardens, particularly in low-income community that are disproportionately located in floodplains/high flood-risk areas.**

Table 4. Vulnerability Assessment Ranking Results for Effects and Impacts of Greatest Concern for Food Security and Agriculture.

Effects/Impacts of Greatest Concern	Likelihood	Consequence	Risk	Adaptive Capacity	Vulnerability
Increases in fascism/white supremacy group activity/civil unrest as food security increases and people become more fearful	Almost certain	Moderate (but depends how effective they are)	High	Moderate	Moderate
Increased cost of food production passed along to community members, with disproportionate impacts on low-income populations	Almost certain	Major	Extreme	Moderate	High
Crop failure/loss due to extreme events (e.g., heat waves, flooding)	Almost certain	Catastrophic	Extreme	Moderate	High

PROPOSED ADAPTATION STRATEGIES

Adaptation strategies for effects of greatest concern

After identifying and evaluating effects of greatest concern for food security and agriculture, the breakout group participants oriented their conversation to broader discussions of whether/how equity can be centered within conversations about climate change vulnerability and food security/agriculture, as well as within the vulnerability assessment and adaptation planning process itself. Following that conversation, participants focused on identifying multiple adaptation strategies that could address one of the high-priority vulnerabilities that arose out of the assessment process, which was **increases in fascism/white supremacy group activity/civil unrest as food security increases and people become more fearful**. Those adaptation strategies and corresponding notes are listed below:

- Black people need to own their own stuff—businesses, land.
- Build strong networks of people who are connected to each other (interdependence) and are organized in a way such that people feel that they have control over their lives and decisions (ideal democracy).
 - How do you create new institutions of power if the old ones are broken?

- Increase capacity of community to be cooperative and collaborative—share power, share resources.
- Help ensure livable wages for the population to ensure that people's basic needs can be met.
- Consider a universal basic income.
- Build shared abundance into systems to alleviate fear of scarcity (e.g., think strategically about where food is grown and who has access to it and make sure that everyone in a community is connected to farm or garden where food—or land, water, housing, etc.—is freely available).
- White people need to show up differently—anyone working in environmental/ecological/climate space needs to be amenable to sitting through anti-racism and white supremacy trainings (and ideally every white person in Kalamazoo).
- Increase institutional/board accountability—required training and guidelines/stipulations/policies for decision-makers around systemic racism (anyone who is responsible for disseminating community resources like political/institutional leaders or foundations/funders).
 - It is critical for this to have outcomes attached in order to get and/or continue to receive funding and for leaders to maintain their positions.
 - Leaders should expect protests/pushback from people who haven't been served.
 - Examples:
 - Data Driven published reports aligned with mission and funding streams.
 - Make it mandatory for Boards to post their meeting times and hold them accountable.
 - Attach all requirements to outcomes.
- Implement a local policy that ensures equitable ownership of property and other resources.
- Revisit zoning policies and all other policies influenced by/created by institutional racism.
 - Push for policy shifts that support small, local commerce over bigger, profit-driven companies.
- Locate what the political ecology of sovereignty is re: the food system—what are the tools of sovereignty?
 - Examples:
 - Owning land
 - Sector identification
 - Food systems literacy

- Risk factor/Social Determinants of Health screening
- Break down de facto processes (e.g., around zoning regulations, water access) and then build them back up into clearly defined processes.
 - Make sure everyone knows the rules and can fully participate (these are currently highly prohibitive systems).
 - Examples:
 - How to start a farm in your neighborhood tool-kit (Zoo City)
 - How to get a Use Variance
 - After the process becomes clear and known to everyone, need to question the processes themselves—are they equitable? (Need to ensure that processes are naturally funneled toward equity so that they don't maintain white supremacy.)
 - Can Do Kitchen is there to help people navigate through business-related zoning issues (they would learn how).
 - Advocates are needed around zoning and other resources for sovereignty—to help a person navigate complex systems and get what they need to survive.
- Identify progressive pathways to agency and self-sufficiency—we don't yet know what that looks like (includes education).
 - Examples:
 - Education as a pathway through Career and Technical Education
 - Overhaul of the non-profit industrial complex
- Community organizing—Partner institutions/larger entities that aren't ready for change with community-based organizations that have more autonomy to actualize goals.
- Divest from organizations that don't share the community's values or equity.

Conclusions

The virtual workshop series and resulting report aimed to improve the understanding of how Connected Communities, Habitat Conservation and Biodiversity, and Food Security and Agriculture in Kalamazoo are vulnerable to changing climate conditions. This report summarizes possible adaptation strategies that were identified and discussed by the breakout groups as well as adaptation implementation plans designed to minimize vulnerabilities and/or increase resilience of the focus areas.

Participants also expressed serious concerns and criticisms as to whether the tools presented in this workshop were sufficiently applicable or equitable to their community needs. Participants named and engaged with the fact that the workshop was a white-dominated space and recognized the need for more conversations that are led by BIPOC community members and include greater participation from these communities, while also not making those communities feel that they bear an unfair burden of representation or problem-solving. The need for tools that more explicitly bring anti-racist and social equity components into the front end of working through climate adaptation was also raised. Kalamazoo participants expressed a commitment to engaging with these deep questions and moving forward together on these critical issues.

Similarities were found across focus areas in terms of stressors, pre-existing conditions, and the combined impacts of these effects emerged across focus areas, including the following:

- *Climate stressors:* Extreme storm events and flooding, drought, and extreme/prolonged heat were the most selected climate stressors.
- *Pre-existing conditions:* White supremacy, racial inequity, urban sprawl and habitat loss, local agriculture and food systems/food security, and climate migration were discussed across multiple focus areas.
- *Combined impacts of pre-existing conditions and climate stressors in a framework of racial inequity:* Racial inequity and white supremacy were identified as both legacy and current conditions that increase impacts in combination with climate stressors. Participants across all three focused areas identified multiple ways in which racial inequity and white supremacy underlies not only magnification of climate stressors but also intersects with multiple other pre-existing conditions in ways that further amplify both climate and non-climate stressors, such as:
 - Increased impacts of flooding in traditionally marginalized communities, particularly those in floodplain and high-risk areas, that often have older and

poorer performing housing stock and fewer resources to respond to flooding on properties or in personal or community gardens.

- Increased public health disparities that already exist because of racial inequity may be further exacerbated by climate stressors, including extreme heat and flooding
- Impacts to a community's capacity that is already burdened by racial inequity and white supremacy to come together to support solutions and be recognized and empowered in decision-making in the face of climate stressors
- Disproportionate impacts of drought and limited/contaminated water supply to BIPOC and low-income communities who have less access to resources and less ability to absorb rising water costs or reduced water quality
- Disproportionate impacts of extreme precipitation and extreme temperatures on farm workers who already suffer from inequitable access to resources, including health care

Several combined impacts of pre-existing conditions and climate stressors listed above were also identified across breakout groups as impacts of greatest concern, including:

- Changes (both potential positives in the framework of new ideas and community members and negatives in terms of increasing pressure on natural resources, water supply, and other resources, by climate migration/climate refugees) compounded by racial inequities that could give affluent climate migrants unequal access to resources while disenfranchising less affluent and marginalized communities
- Increased costs and diminished capacity for access, compounded by racial inequity, of community members to important resources, including housing, water supply, nutritious food, and open spaces
- Increased risk of contamination to food and water supply from extreme storm events and flooding, compounded by racial inequity and already unequal burdens in public health

The similarities in impacts of greatest concern also resulted in many overlapping and intersecting adaptation strategies, such as:

- Prioritizing allocation of resources to marginalized communities through mechanisms such as tying resource allocation to vulnerability analyses, increasing property ownership, shifting policies to support locally owned

businesses, and holding landlords accountable for energy and home health improvements

- Actively including, connecting, and empowering BIPOC communities to build networks and agency as well as ensuring that traditional and cultural knowledge is being integrated into planning and resource management
- Rethinking access to resources, including food systems and open space, and rethinking planning so that every community can be connected to farms, gardens, and natural spaces for recreation, stewardship, and connectivity to the natural world
- Implementing policy, regulatory, and programmatic measures to ensure that as climate change brings additional stressors to water quality and quantity, those impacts are mitigated and do not disproportionately impact traditionally marginalized and poorer communities
- Consciously integrating equity in response to climate impacts, including extreme heat and flooding, on transportation networks that connect people to their homes, jobs, and natural areas so that when re-engineering roads and infrastructure, choices are made that maintain and strengthen connections of marginalized communities to economic and ecological resources

This report can be used as a reference for decision-makers as they plan for and commit resources to create a more sustainable and resilient community. The adaptation strategies that participants have identified during this workshop can advance resiliency and may present opportunities to leverage resources across multiple focus areas. Because climate adaptation is an iterative process and new research and modeling on projected climate changes and impacts is regularly released, it is important to revisit and/or revise the vulnerability assessments and adaptation strategies on a regular basis (e.g., every 5–10 years), as well as when additional topics of concern become priorities.

Appendix A. Workshop Participants and Breakout Group Assignments

Participant Name	Affiliation	Breakout Group
Amy Newday	Kalamazoo College, Mellon Fellow for Experiential Learning	Food Security & Agriculture
Anyah Preston	Kalamazoo County Drain Commissioner's Office, Soil Erosion Agent	Habitat Conservation & Biodiversity
Ben Brown	Citizen and Community Activist	Connected Communities
Ben Bylsma	Kalamazoo Valley Community College, Food Innovation Center Production Manager	Food Security & Agriculture
Chris Dilley	People's Food Coop of Kalamazoo, General Manager	Food Security & Agriculture
Denise Keele	Western Michigan University Professor	Connected Communities
Don Poppe	Michigan Department of Natural Resources	Habitat Conservation & Biodiversity
Donna McLurkan	Kalamazoo Climate Crisis Coalition, Communications Team Lead	Food Security & Agriculture
Elizabeth Rochow	Kalamazoo Conservation District Manager	Habitat Conservation & Biodiversity
Emma Baratta	Western Michigan University Office of Government Relations, Graduate Assistant	Connected Communities
Isaac Bertman	Better World Builders	Connected Communities
Jacquelyn McShulskis	Stewards of Kleinstuck	Habitat Conservation & Biodiversity
Jamie McCarthy	City of Kalamazoo Community Planning and Economic Development, Sustainable Development Coordinator	Connected Communities
Jason Raddatz	Kalamazoo River Watershed Council Board Member	Habitat Conservation & Biodiversity
Jennifer Johnson	Kalamazoo Loaves & Fishes, Executive Director	Food Security & Agriculture

Jenny Doezema	Kalamazoo Nature Center, Vice President of Learning and Engagement	Habitat Conservation & Biodiversity
Jessica Simons	Kalamazoo Nature Center, Vice President for Conservation Stewardship	Habitat Conservation & Biodiversity
Kayla Carlson	Kalamazoo College student	Food Security & Agriculture
Lucy Dilley	Can-Do Kitchen, Executive Director	Food Security & Agriculture
Mark Lee	Better World Builders, President	Connected Communities
Mark Miller	Kalamazoo Charter Township, Township Clerk	Connected Communities
Michele Richards	Michigan Army National Guard, Natural Resources Manager	Habitat Conservation & Biodiversity
Nolan Bergstrom	City of Kalamazoo Community Planning and Economic Development, Community Planner	Connected Communities
Remi Harrington	Zoo City Farm and Food Network Administration	Food Security & Agriculture
Ryan Koziatok	Kalamazoo Nature Center, Stewardship Field Director	Habitat Conservation & Biodiversity
Shawn Ferrell	Better World Builders	Connected Communities
Tom Small	Kalamazoo Area Wild Ones	Habitat Conservation & Biodiversity

Appendix B. Climate Changes and Impacts Table for Kalamazoo



CLIMATE CHANGES	METRIC	TREND	OBSERVED/PROJECTED CHANGES
Air temperature	Minimum temperature AVG DAILY MIN TEMP (°F)	▲	43.9°F (+4.8°F) by 2050 and 50.2°F (+11.1°F) by 2100 ¹ COMPARED TO HISTORICAL AVERAGE OF 39.1°F FROM 1961–1990
	Maximum temperature AVG DAILY MAX TEMP (°F)	▲	64.4°F (+5.2°F) by 2050 and 70.8°F (+11.6°F) by 2100 ¹ COMPARED TO HISTORICAL AVERAGE OF 59.2°F FROM 1961–1990
Extreme heat	Days over 90°F # OF DAYS WITH MAX TEMPS >90°F	▲▲	44.9 days (+340%) by 2050 and 90.9 days (+791%) by 2100 ¹ COMPARED TO HISTORICAL AVERAGE OF 10.2 DAYS PER YEAR FROM 1961–1990
Precipitation	Annual precipitation AVG INCHES PER YEAR	—	38.2 in (+3.5%) by 2050 and 40.8 in (+10.6%) by 2100 ¹ COMPARED TO HISTORICAL AVERAGE OF 36.9 INCHES PER YEAR FROM 1961–1990
	Seasonality	▲▼	Significant increase in winter and spring precipitation (up to 20–30%); very slight increases are possible in fall and slight decreases in summer ²
Snow	Lake-effect snow	▲	Significant upward trend in lake-effect snow for the Lake Michigan snowbelt since ~1900, likely due to warmer surface waters and reduced lake ice cover ³ Increases in temperature past the freezing threshold would likely result in more precipitation falling as rain or freezing rain ⁴
Extreme precipitation	Intensity 99 th PERCENTILE DAILY PRECIP TOTAL	▲▲	+42% in extreme precipitation total from the heaviest rain events in the Midwest from 1958–2016 ² +40% or more additional increase by 2100 (compared to 1986–2015) ⁵
	Frequency # OF 2-DAY EVENTS THAT EXCEED THE 5-YEAR RETURN INTERVAL	▲▲	+150% or more in the number of extreme precipitation events between 2006 and 2100 ²
Severe storms	Frequency	▲	Increased likelihood of severe thunderstorms, particularly in the spring (up to +2.4 days per season by 2100) ⁶ Possible increase in days with conditions supportive of tornadic storms ⁶
Drought	Frequency & intensity	▲	Likely increase in prolonged dry periods, particularly by late century ⁷

¹ U.S. Climate Resilience Toolkit Climate Explorer (<https://crt-climate-explorer.nemac.org>), generated using the high-emissions (RCP 8.5) scenario for the average of 2041–2049 and 2091–2099 time periods compared to historical conditions (average of 1961–1990).

² D. R. Easterling et al., in Climate Science Special Report: Fourth National Climate Assessment, Volume I, D. J. Wuebbles et al., Eds. (U.S. Global Change Research Program, Washington, DC, 2017), pp. 207–230.

³ K. E. Kunkel et al., *Journal of Great Lakes Research*, **35**, 23–29 (2009).

⁴ GLISA, Snow in the Great Lakes: Past, Present, and Future (<https://glisa.umich.edu/resources-tools/climate-impacts/snow-in-the-great-lakes-past-present-and-the-future/>).

⁵ Z. Feng et al., *Nature Communications*, **7**, 13429 (2016).

⁶ N. S. Diffenbaugh, M. Scherer, R. J. Trapp, *PNAS*, **110**, 16361–16366 (2013).

⁷ GLISA, Extreme Precipitation (<https://glisa.umich.edu/resources-tools/climate-impacts/extreme-precipitation/>).