Wayne County Resilience Hub Network

Wayne County, Sustainability & Innovation Division

2025 Dow Sustainability Fellows

Final Report

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Executive Summary

Background

The Wayne County Sustainability & Innovation Division aims to expand the connectivity of its climate resilience initiatives through comprehensive programs that serve the diverse needs of its municipalities. In order to achieve this goal, the division needs evidence-based recommendations to guide its climate resilience funding and programming strategy, and the development of its resilience hub network model. Our team utilized a multidisciplinary approach to develop tools that guide how the County structures its resilience hub network, prioritizes climate resilience issues and funding, and communicates with its communities on issues of climate change and resilience.

Activities

We engaged in the following activities to complete our project: literature review, research and writing, data collection and analysis, stakeholder engagement, and document development.

Deliverables

Our team produced three deliverables for the project: Resilience Hub Network Case Studies, a Climate Resilience People Tool Framework, and Wayne County Resilience Hub Network Community Portraits. We compiled case studies of ten (10) resilience hub networks, highlighting models that operate on a similar scale. Next, we developed a people tool framework that identifies the most vulnerable communities by measuring the sensitivity, exposure, and adaptive capacity indicators that impact their resilience to climate change. Finally, We conducted stakeholder interviews and site visits to inform community portraits of Wayne County Resilience Hub Network member organizations and communities.

Anticipated Impact

In the short term, we anticipate that this project will guide the development of Wayne County's current climate resilience programs and initiatives. In the long term, this project will increase the connectivity and cohesion of community-based climate resilience efforts throughout the County.

Recommendations

Looking to the future, we recommend that the County (1) prioritize partnerships with community-based organizations in order to increase connectivity of their resilience efforts, (2) utilize the people tool framework to develop a comprehensive, multi-use climate resilience map, and (3) create a publicly-available multi-media art installation that highlights community responses to climate change.

Introduction and Background

Over the past decade, the municipalities and townships of Wayne County have experienced a dramatic increase in extreme weather and climate change-related events. Across Southeast Michigan, average temperatures have risen by 2.3°F (1.3°C), and climate models project more frequent and intense heat waves in the coming decades. The urban heat island effect is particularly strong in paved areas with few trees.

Flooding is another major concern for Wayne County. The Great Lakes region's rainfall patterns are changing, with annual precipitation events increasing by more than 14% since 1961. Heavy storms have caused repeated basement flooding and sewage backups, particularly in communities served by older combined sewer systems such as Dearborn Heights, Melvindale, and parts of Detroit's east side. Many of these neighborhoods sit on low-lying land near the Rouge and Ecorse Rivers, where stormwater infrastructure struggles to handle intense rainfall. Flooding not only damages homes and roads but can also expose residents to contaminants when floodwaters mix with industrial runoff or household waste.

These climate impacts often hit the hardest in the same areas that already experience environmental injustice and economic stress. Communities near industrial corridors or with aging infrastructure face a double burden: exposure to pollution and heightened climate risks. Extreme heat can worsen air-quality problems, while flooding can spread pollutants from nearby industrial sites or brownfields. County and regional agencies have begun mapping these combined vulnerabilities through resilience plans, highlighting the need for more tree canopy restoration, updated stormwater systems, and equitable investment in both urban and suburban areas. Therefore, addressing climate resilience in Wayne County means tackling both social and environmental inequality, and ensuring that adaptation efforts protect the most vulnerable communities first.

Key Concept	**Definition**
Climate Resilience	Climate resilience is the ability of a community, ecosystem, or system to anticipate, cope with, and recover from the impacts of climate change and extreme weather events.

The Wayne County Sustainability & Innovation Division (WCSID) is a newly established office within Wayne County's Department of Economic Development that leads the County's climate resilience strategy. The division aims to expand the reach and connectivity of Wayne County's climate resilience resources through comprehensive programs that serve the diverse needs of

its municipalities. To that end, the WCSID partners with departments like Homeland Security and Health & Human Services to provide resources and services that build the adaptive capacity of its municipalities.

In 2025, WCSID launched the Wayne County Resilience Hub Network (WCRHN) – a dynamic, vibrant network designed to build strength and unity in the face of climate-related challenges across the County. The inaugural WCRHN cohort includes 11 community-based organizations who will participate in training to co-develop governance and emergency planning frameworks that strengthen resilience in their neighborhoods before, during and after climate emergencies. These organizations are located in Wayne County communities that are increasingly vulnerable to climate resilience issues such as flooding and extreme heat.

Key Concept	**Definition**
Resilience Hub	A resilience hub is generally defined as a community-serving facility that operates year-round as a neighborhood center and can also pivot to supporting people during emergencies. They provide normal services and programs that enhance quality of life and neighborhood cohesion and become a safe haven offering essential support like shelter, food and other resources during times of crisis.

The network builds the capacity of community-based organizations through fiscal awards, in-kind resources, and peer-learning engagements that encourage communities to work cohesively to bolster their climate resilience and address shared climate-related issues. WSCID also envisions the resilience hub network as a way to build trust between community organizations, county residents, and the county itself. This trust would allow the County to increase the connectivity and cohesion of climate resilience efforts throughout its communities across the County.

To achieve its goals, WCSID needs evidence-based tools that help them identify levels of climate vulnerability through the county and prioritize where climate resilience funding is spent. Developing these tools necessitated an interdisciplinary approach that incorporated expertise from multiple fields. Our team drew on our experience in the fields of environmental sustainability, medicine, public health, public policy, and urban planning to develop tools that will help WCSID finalize its resilience hub network model and address climate resilience in the County more broadly. By integrating and synthesizing knowledge and methods from different disciplines, we were able to create Resilience Hub Network Case Studies, a Climate Resilience People Tool Framework, and Community Portraits that holistically approach climate resilience.

Methods

We employed various methods and processes to develop the deliverables requested by our client, including literature review, data collection and analysis, secondary research, and community interviews. Please see the specific methods used for each deliverable below.

Resilience Hub Network Case Studies

The purpose of the Resilience Hub Network Case Studies is to highlight the strategies and best practices utilized by initiatives in peer localities that have effectively established networks with multiple independent hub partner organizations. We began the development process by defining the criteria required for a resilience hub network to be included in our research; this list included the geographic size and scope of the network, resilience issues addressed by the hubs, and the number of resilience hubs included in a given network. After defining our criteria, we honed in on our audience for these case studies – government departments, community-based organizations, funding institutions, and community stakeholders interested in supporting Wayne County's climate resilience efforts.

With those details cemented, we began the process of researching resilience hub networks across the United States. We leveraged data provided by the Urban Sustainability Directors Network, the Atlantic Council's November 2023 Resilience Hubs Report, and the CRSO-EED National Resilience Story Map to identify ten (10) resilience hub networks that fit our criteria for inclusion in the case study. The final step of our research involved interviewing the network leads from the Resilient Minneapolis Project and Seattle Emergency Hubs in order to learn more about their establishment, governance, and growth strategies.

Upon completing our research and analysis of each resilience hub network, we presented our findings to the the Wayne County Sustainability & Innovation Division and developed a written report outlining the following information for each of the networks:

- Name and Location
- Network Lead
- Number of Resilience Hubs
- Network Description & Background
- Funding
- Governance & Growth Strategy
- Resilience Issues
- Services & Resources

Climate Resilience People Tool Framework

The purpose of the People Tool Framework is to holistically and equitably define climate vulnerability in the context of Wayne County. We began the development process by defining the geographic scales most relevant to Wayne County - districts, census tracts, and community areas - so that subsequent data work aligned with real decision-making boundaries. Next, our team conducted a literature review of the social, historical, and environmental context of Wayne County. With this essential background information, then came the inventory of indicators commonly used in resilience assessments.

This process started through an examination of indicators in existing climate and environmental tools such as the EPA's MIEJ screen, the Detroit Climate Vulnerability Analysis, and SEMCOG's Southeast MI Healthy Climate Plan. Indicators needed to (1) have an evidence-based connection to climate change, (2) be relevant to Wayne County, and (3) have a numerical or binary outcome. Given that this report is an initial stage of a framework, the inclusion of criteria for indicators within the framework was very broad. These indicators were then refined under our conceptual model of resiliency around sensitivity, exposure, and adaptive capacity. Finally, these indicators were synthesized into the People Tool Framework, a structured framework for evaluating resilience in Wayne County. Lastly, our team identified limitations and future steps for improving the tool as new data and community feedback become available.

Wayne County Resilience Hub Network Community Portraits

The purpose of the Community Portraits is to uplift how the resilience hub network's member organizations and the residents they serve have experienced climate change, and how they envision increasing the resilience and adaptive capacity of their communities. We began this process by researching how similar climate resilience and community-focused initiatives have used community portraits to share their stories. After identifying the preferred portrait format, we conducted group and individual interviews with two of the Wayne County Resilience Hub Network's (WCHRN) inaugural cohort members to learn about the climate change-related vulnerabilities their communities were facing. This interview process was coupled with site visits to the resilience hubs themselves.

The process culminated with the development of a written report outlining recommended next steps for the Community Portraits project – including additional cohort interviews and site visits, the development of an interactive story, and the creation of a multimedia art installation that can be exhibited to the public next year.

Deliverables

Wayne County's Sustainability & Innovation Division requested three deliverables to inform and support its climate resilience strategies: Case Studies, a People Tool Framework, and Community Portraits. Together, these deliverables will help the County understand and prioritize resilience needs across its 96 municipalities, townships, and localities.

Resilience Hub Network Case Studies

Our team developed case studies that analyzed ten resilience hub networks in peer counties and metropolitan areas across the United States.

Location	Name
Austin, Texas	Austin Resilience Network
Baltimore, Maryland	Baltimore City Community Resilience Hub Network
Bay Area, California	NorCal Resilience Hubs Initiative
Miami-Dade County, Florida	Miami-Dade Countywide Resilience Hub Network Strategy
Minneapolis, Minnesota	Resilient Minneapolis Project
New Orleans, Louisiana	Community Lighthouse Project
Oahu, Hawaii	Vibrant Hawaii Resilience Hub Network
San Leandro, California	City of San Leandro Resilience Hubs Initiative
Seattle, Washington	Seattle Emergency Hubs
Washington, District of Columbia	Ward 7 Resilience Hub Community Coalition

These studies identified how each network approached governance, growth, funding, community engagement, and climate resilience resource provision. These studies provide background information and local context for each network and outline how each network approaches funding, governance and growth, resource and service provision, and emergency preparedness.

These case studies were compiled into a Final Report that details our approach and findings. The report will inform the Wayne County Resilience Hub Network's governance and growth strategy, and educate WCRHN organizations and partners regarding resilience hub best practices. Please see the appendix for the full report.

Climate Resilience People Tool Framework

We developed a climate resilience People Tool Framework to measure the resilience of Wayne County's 96 municipalities, townships, and localities. This information will be used to inform (1) the County's strategy for deploying climate resilience dollars, and (2) residents of key factors impacting the resilience of their communities. The framework measures a community's vulnerability to climate impacts based on indicators falling under the following areas: Sensitivity, Exposure, and Adaptive Capacity. Those indicator groups include the following subcategories:

Sensitivity	**Exposure**	**Adaptive Capacity**
Sociodemographic Characteristics Health Occupation & Industry	Baseline Climate Indicators Flooding Air Pollution Water Quality Temperature Toxics Infrastructure	National Funding & Programs Community Support Economic Resilience Environmental Resilience

Please see a snapshot of some of our indicators in the table below.

Sensitivity Indicators	**Definition**	**Explanation**
Housing Cost Burden	Percentage of households spending more than 30% of their annual household income on housing costs.	This indicator represents the number of households that spend a substantial amount of their income on housing.
Disability	Percentage of residents with a disability	This indicator represents how many people have a physical or cognitive disability in an area.
Exposure Indicators		
Extreme Heat	Annual number of days with a daily maximum temperature above the 95th percentile.	A period of abnormally hot and usually humid weather.
Floodplains	Percent of area in a floodplain, defined as an area with at least 1% chance of flooding annually.	Floodplains are land areas adjacent to rivers and streams that are subject to recurrent flooding when water levels rise.
Adaptive Capacity Indicators		
Flood Insurance	Percentage of housing units covered by	The National Flood Insurance Program

	the National Flood Insurance Program.	aims to reduce the impact of flooding on private and public structures.
Walkability Score	National Walkability Index	The NWI assigns every U.S. census block group a score based on ranked measures of intersection density, proximity to transit, and land-use diversity

The People Tool Framework report will be used internally to guide further actions and shared with the Wayne County Resilience Hub Network's member organizations and partners as a capacity building tool. Please see the appendix for the full report.

Wayne County Resilience Hub Network Community Portraits

Our team began the process of developing community portraits that tell the stories of the Wayne County Resilience Hub Network's member organizations and their communities. We mapped the locations of each organization, interviewed organizational leaders and residents impacted by their work, and conducted site visits of the resilience hubs themselves. The oral interviews and information collected during this process will be packaged and provided to a new team that will build upon it to develop an interactive story map and art installation. That final product will highlight (1) how Wayne County's communities and stakeholders experience climate change, and (2) residents' visions for bolstering climate resilience in their neighborhoods.

Recommendations

Resilience Hub Network Case Studies

Through our analysis, we learned that strong resilience hub networks focused on transforming existing community spaces into resilience hubs. By working with organizations that already served residents and had community trust, these networks were able to effectively connect with and serve the community before, during, and after times of climate-related crisis. We also found that many networks prioritized solar power installation and community emergency response team training as key components to building the resilience and capacity of their resilience hub partners.

Climate Resilience People Tool Framework

The indicators in our report lay the foundation for a more comprehensive framework. Most of the data sources found provided information at the census tract level. Finding data at the community level was rare. We recommend estimating this data by aggregating census tracts. Data sets measuring proximity to adaptive resources such as cooling centers and resilience hubs were limited. Considering the importance of these resources in evaluating adaptive capacity, we recommend creating such a data set for Wayne County. Additionally, metrics for water and energy efficiency were limited. We recommend the County calculate data sets for water and energy efficiency using total units consumed by a building divided by the total floor area.

A natural next step for the People Tool Framework is to involve communities in determining assets and concerns in their areas that are not reflected in this tool. Community involvement in these decision-making tools ensures that local knowledge, priorities, and lived experience shape both how risks are understood and how adaptive solutions are developed and implemented. Involving community leaders and environmental advocates will help the County develop a tool that is contextually relevant, trusted, and effective in addressing real community needs. Once these pieces of the comprehensive framework are completed, this work can be visualized by the County's GIS team in a multi-layer map – allowing users to explore the climate resilience of Wayne County's 96 communities.

Wayne County Resilience Hub Network Community Portraits

Through our research we found the usage of story maps in concert with art installations is an effective, engaging way to present community perspectives and experiences. We recommend the Wayne County Sustainability & Innovation Division work with a team skilled in those areas to complete the community interview process, and transform the information and insights from those engagements into an interactive story map and physical art installation that can be presented to its target communities and the public next year.

Impact

Short Term Impact

In the short term, the tools we have developed will help Wayne County Sustainability & Innovation Division's climate resilience priorities and strategies. The case studies will influence the final Wayne County Resilience Hub Model, while the people tool framework will help the team identify and address the specific climate resilience needs of vulnerable communities, ensuring that resources are allocated where they are most needed. Finally, these tools will provide useful insight and data to students, professionals, and other stakeholders tackling issues of climate resilience in Wayne County and similar metropolitan areas.

Long Term Impact

In the long term, the tools we have developed will catalyze cohesion and connectivity throughout Wayne County, providing the roadmap needed to create shared resilience strategies and resources that increase the self-sufficiency and emergency preparedness of every community. These tools will also equip residents and grassroots leaders with the knowledge needed to bolster their resilience and ability to withstand and adapt to climate-related challenges. Finally, these tools will increase public access to key climate resilience data.

United Nations Sustainable Development Goals

Our project addresses the following United Nations Sustainable Development Goals:

#3 - Good Health & Well Being

The project addresses this goal by promoting climate resilience strategies that protect communities from climate hazards.

#11 - Sustainable Cities & Communities

The project addresses this goal by increasing the communities adopting climate change mitigation and adaptation plans, and protecting vulnerable populations from climate disasters.

#13 - Climate Action

The project addresses this goal by strengthening resilience and adaptive capacity to climate-related hazards and natural disasters, and raising capacity for effective climate change-related planning.

#17 - Partnerships for the Goals

The project addresses this goal by encouraging multisector partnerships that promote sustainability and climate resilience across communities.

Acknowledgements

Our work on this Wayne County Sustainability Project would not have been possible without the support of our project partners, Dow Mentor, and a few other special stakeholders. Thank you to Erin Kelly and Cara Dietz from the Wayne County Sustainability & Innovation Division for the expertise and guidance they provided while working with us to complete this project. We would also like to thank our Dow Mentor, Han Zhang, for providing key insights that enhanced our project management approach. Finally, we would like to thank the Graham Sustainability Institute team – especially Bridget Gruber, Shelie Miller, and Carly Silverman – for the training, resources, and constant support shown to us throughout the fellowship. This work was supported by the Dow Company Foundation through the Dow Sustainability Fellows Program at the University of Michigan.

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Appendix

Appendix A. Resilience Hub Network Case Studies

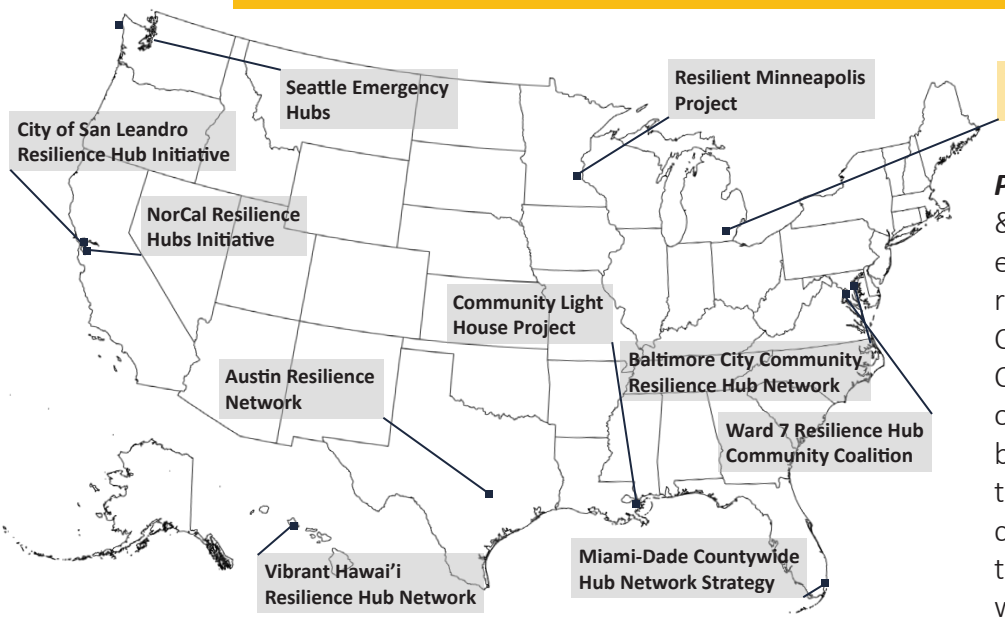
Appendix B. Climate Resilience People Tool Framework

Appendix A.

What is a Resilience Hub?

A Resilience Hub is generally defined as a community-serving facility that operates year-round as a neighborhood center and can also pivot to supporting people during emergencies. In practice, resilience hubs are trusted local places. For example, community centers, libraries, or faith-based centers, that are augmented with resources and plans to help residents before, during, and after disasters. They provide normal services and programs that enhance quality of life and neighborhood cohesion, and when a crisis happens, they become a haven by offering essential support like, information, electricity, shelter, food, medical aid, and other resources. In short, a resilience hub strengthens community resilience daily and serves as a lifeline during times of need. By reducing the burden on traditional emergency responders and meeting people where they are, resilience hubs help communities become more self-sufficient, connected, and prepared for whatever comes their way.

Resilience Hub Network Case Studies



The following example shows how through color coordination each ***resilience issue*** highlighted in the case studies corresponds to direct ***service or resource*** that seeks to mititgate the effects of the climate stressor.

Crosswalking Resilience Issues to Services and Resources.

Extreme Storms

Power Outages

Solar Power and Backup Generators

Food and Water Distribution

Purpose. The Wayne County Sustainability & Innovation Division is a newly established office that seeks to expand the reach and connectivity of existing Wayne County programs through the new Wayne County Resilience Hub Network. The office aims for the network to build trust between community organizations joining the network, county residents, and the county itself – by building the capacity of these organizations and working cohesively with them to bolster climate resilience in their communities.

This document highlights ten unique resilience hub network case studies to identify resilience hub models across the United States effectively working at a similar scale to Wayne County. In addition to background information each case study includes funding, governance and growth strategy, resilience issues, and services and resources. These projects provide valuable insights that can inform the development of future hubs.

COLLECTIVE RESILIENCE

City of San Leandro Resilience Hub Initiative

Background. The San Leandro Resilience Hubs Initiative is a community-led initiative designed to strengthen local neighborhoods by providing safe, trusted spaces that serve residents year-round and during times of crisis. With equity and community care at its core, the network aims to build social cohesion, enhance disaster preparedness, and address climate adaptation by transforming community spaces into hubs of connection, resources, and support.

Funding. The initiative has been awarded funding from the following sources to support energy and water efficiency appliance upgrades, emergency preparedness supplies, ADA compliance, youth programming, and energy back ups:

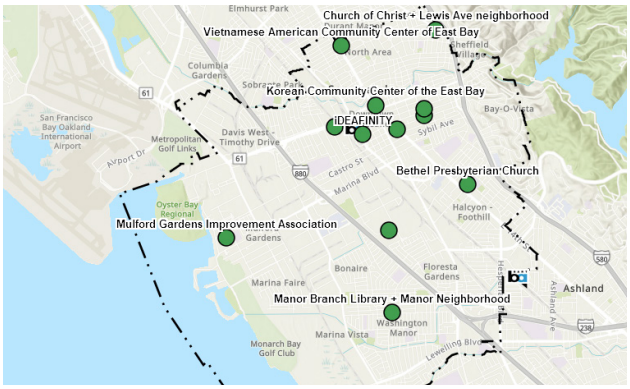
- Unspecified Amount - Urban Sustainability Directors Network (2021)
- $73,965 - Federal Funding (2023)
- $4,803 - City of San Leandro (2023)

Governance and Growth Strategy. The initiative is governed through a Collaborative Stakeholder Structure that allows for cross-site exchange and pollination, collective decision-making and partnership building with the City and regional groups. These stakeholders hold bi-monthly governance meetings to identify projects and funding opportunities – and provide hub partners with technical assistance re: finding contractors, grant writing, project management, and climate resilience technical resources.

Location. San Leandro, California

Resilience Hubs. 12

Network Lead. City of San Leandro



The map above shows the locations of the twelve resilience hubs that are a part of the San Leandro Resilience Hub Initiative.

Crosswalking Resilience Issues to Services and Resources.

Wildfires	*Solar Power and Backup Generators*
Extreme Heat	*Warming and Cooling Centers*
Flooding	*Weatherization*
Power Outages	*Food and Water Distribution*
Emergency Preparedness	*Social Services*
Community Engagement	*Health and Wellness Services*

Ward 7 Resilience Hub Community Coalition

Background. Ward 7 Resilience Hub Community Coalition is leveraging the District of Columbia's climate adaptation plan to build the community's resilience to weather emergencies and Anacostia River-related flooding. The coalition is developing a network of community resilience hubs where residents can access information, social support services, and other community resources year-round. They opened their pilot hub at the F.H. Faunteroy Center & Resilience Incubator in 2020.

Funding. The coalition's pilot hub has secured funding from the following sources to support build out, solar power installation and battery storage, and a solar power controller.

» $540,000- Department of Energy and Environment (2024)
» $100,000- M&T Charitable Foundation (2024)

Governance and Growth Strategy. The coalition is composed of 16 members who meet regularly to identify key criteria for designing resilience hubs, service that should be offered at hubs, potential sites for hubs, community partners and community assets that could support hubs and potential funding sources. They have published their findings and plans in the Ward 7 Resilience Hub proposal.

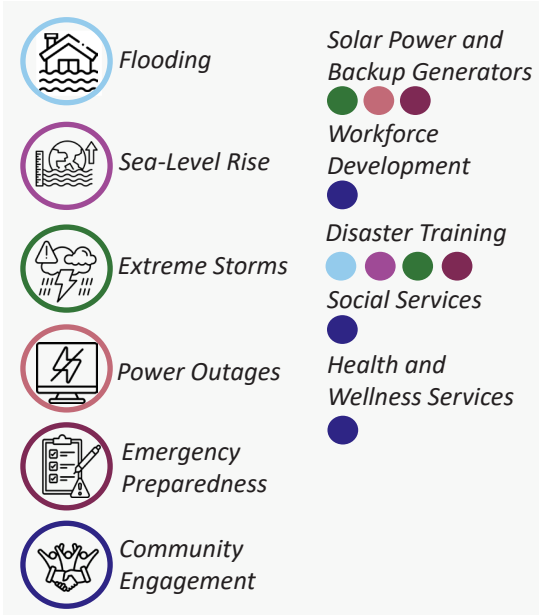
Location. Washington, District of Columbia

Resilience Hubs. 1

Network Lead. Dennis L. Chestnut, Board Chair

The image above portrays the F.H. Faunteroy Center & Resilience Incubator, the first pilot community led resilience hub in the District.

Crosswalking Resilience Issues to Services and Resources.



Atlantic Council | Climate Resilience Center

Miami-Dade Countywide Hub Network Strategy

Background. The Miami-Dade Countywide Resilience Hub Network Strategy is a community-led strategy to develop a sustainable network of local hubs and pods to make our neighborhoods more resilient to shocks and stressors, including day-to-day needs and response to emergencies and natural disasters. The network will support and strengthen the existing social infrastructure that is vital to communities. The first prototype of their mobile resilience hub, a community resilience pod, is a forty-foot shipping container equipped with solar power was deployed in 2020. These mobile and scalable resilience centers can provide food and water, financial literacy, mental health support and general aid in times of extreme weather events and public health emergencies.

Funding. Funding information not available at this time.

Governance and Growth Strategy. The initiative is governed through a Collaborative Stakeholder Structure that allows for cross-site exchange and pollination, collective decision-making and partnership building with the City and regional groups. These stakeholders hold bi-monthly governance meetings to identify projects and funding opportunities – and provide hub partners with technical assistance re: finding contractors, grant writing, project management, and climate resilience technical resources.

Location. Miami, Florida

Resilience Hubs. 1

Network Lead. Atlantic Council, Climate Resilience Center

The image above portrays the first community resilience pod which has connected with over 500,000 people after more than four years.

Crosswalking Resilience Issues to Services and Resources.

Flooding	*Mobile Resilience Hubs*
Extreme Heat	*Solar Power and Backup Generators*
Extreme Storms	*Warming and Cooling Centers*
Power Outages	*Weatherization*
Emergency Preparedness	*Food and Water Distribution*
Community Engagement	*Health and Wellness Services*
	Social Services

Vibrant Hawai'i Resilience Hub Network

Background. Vibrant Hawai'i Resilience Hub Network is a climate resilience initiative that builds community organizations' capacity to serve residents during climate emergencies. The network achieves this by

- increasing social cohesion by facilitating cross-sector communication, training and certification, peer-to-peer learning, and resource sharing,
- identifying and infusing resources to advance community-designed strategies that meet resilience goals within a hyper-local context; and
- evaluating outcomes to drive continuous improvement, ensure alignment with changing conditions, and promote asset based community development.

Funding. This network is funded through the following grants:

- $3,164,972 (2023)
- $1,245,894 (2022)

Governance and Growth Strategy. The initiative itself is managed and led by Vibrant Hawai'i, who raises and distributes funds to support the community hubs within the network. The hubs are powered by trusted community leaders who provide access to services, programs and resources – and opportunities for community members to implement place based, culturally informed strategies that increase individual and islandwide resilience.

Location. Oahu, Hawai'i

Resilience Hubs. 18

Network Lead. Vibrant Hawai'i

The image above showcases Vibrant Hawai'i's essential partners in Hawai'i's disaster management system.

Crosswalking Resilience Issues to Services and Resources.

Flooding	*Solar Power and Backup Generators*
Sea-Level Rise	*Holistic Wellness Resources*
Extreme Storms	*Technological Resources and Charging Stations*
Power Outages	*Food and Water Distribution*
Emergency Preparedness	*Community Emergency Response Teams*
Community Engagement	*Emergency Shelter and Communications*
	Social Services

TOGETHER NEW ORLEANS

Community Light House Project

Background. The Community Lighthouse Project is a network of 86 congregations and community New Orleans institutions that will be transformed into resilience hubs. Each hub will be equipped with commercial-scale solar power and back-up battery capacity to bolster their resilience during power outages, natural disasters, and other climate emergencies. The project aims for every New Orleans resident to be able to access a resilience hub within 1.5 miles of their home during climate emergencies.

Funding. This network is funded through the following public-private partnerships and philanthropic awards:

- $3.8 million (congressional ear-mark)
- $1 million (Greater New Orleans Foundation)
- $2 million (City of New Orleans – ARPA and Wisner Grant)
- $806,000 (U.S. Department of Energy)

Governance and Growth Strategy. The project is governed by Together New Orleans, a broad-based organization led by individuals from NOLA religious congregations, unions, neighborhood associations, and community organizations. The project has identified 86 Together New Orleans organizations and congregations that will be transformed into the network's resilience hubs – and is currently piloting the program with 16 of those organizations.

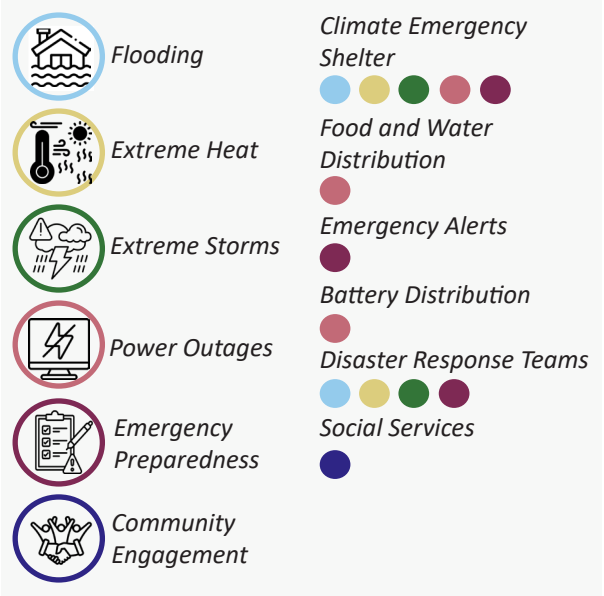
Location. New Orleans, Louisiana

Resilience Hubs. 16

Network Lead. Together New Orleans

The image above is one of sixteen operating lighthouses, the Trinity Community Center.

Crosswalking Resilience Issues to Services and Resources.



Baltimore City Community Resilience Hub Network

Background. This network is an innovative and impactful community-centered initiative that increases community capacity to prepare for, withstand, and respond to natural hazard impacts and emergency situations. The goal of this program is to better connect front line community organizations with focused support and resources so that, in the event of a natural disaster or emergency, there is an improved provision of emergency response and recovery services to under-resourced neighborhoods and their most vulnerable residents.

Funding. The coalition's pilot hub has secured funding from the following sources to solar power installation and battery storage at active resilience hubs:

» Maryland Energy Administration (MEA) Resilient Maryland Grant

Governance and Growth Strategy. The network is governed by the City of Baltimore's Office of Sustainability, Office of Emergency Management, and Department of Health – in partnership with service-based community organizations in Baltimore's most climate-vulnerable neighborhoods. The Office of Sustainability is the lead agency responsible for managing the program as a key strategy of Baltimore's Disaster Preparedness Plan (DP3).

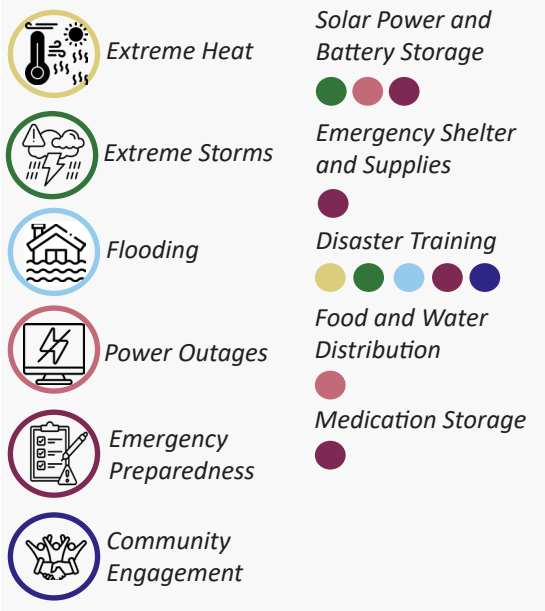
Location. Baltimore, Maryland

Resilience Hubs. 17

Network Lead. City of Baltimore, Office of Sustainability

The image above shows participants of the Office of Sustainability led Disaster Preparedness and Planning Project (DP3) to ensure citizens are prepared in the event of an emergency situation or disaster.

Crosswalking Resilience Issues to Services and Resources.



Resilient Minneapolis Project

Background. The Resilient Minneapolis Projects aim to strengthen communities during times of crisis and in daily life – with a focus on low-income communities that are often first and hardest hit by climate events. The project addresses climate change and health equity through the development of resilience hubs that support adaptation, mitigation, power building and shifting with Minneapolis' communities during times of normalcy, disruption, and recovery.

Funding. The project is funded through the following sources:

- $9,000,000- DOE GRIP Grant
- $125,000- MPCA Community Resilience Planning Grant

Governance and Growth Strategy.
This network is governed in partnership between the City of Minneapolis' Health Department and Xcel Energy. The city manages operations and programming for the project, while Xcel Energy manages the installation and maintenance of solar microgrids on the resilience hubs.

Hub locations are identified through an open request for proposals, and selected based on their present importance as spaces for the community to gather, share resources, and aid community members during emergencies.

Location. Minneapolis, Minnesota

Resilience Hubs. 3

Network Lead. City of Minnesota; Excel Energy

The image above is of the Sabathani Community Center, one of three Minneapolis community centers that were approved by the Minnesota Public Utilities Commission to receive resiliency investments.

Crosswalking Resilience Issues to Services and Resources.

Extreme Heat and Cold	*Solar Power, Battery Storage, and Microgrids*
Extreme Storms	*Emergency Communications*
Power Outages	*Climate Emergency Response Team*
Emergency Preparedness	*Emergency Supply and Resource Distribution*
Community Engagement	*Food and Water Distribution*
	Medical Supply and Medication Storage
	Charging and Power Stations

Austin Resilience Network

Background. The Austin Resilience Network (ARN) leverages city and community resources that equitably empower individuals to prepare for, endure, and bounce back stronger from community-wide shocks, stressors, and emergencies. The network's goal is to connect communities and public resources to help prepare for, respond to and recover from disasters.

Funding. The network has been awarded funding from the following sources:

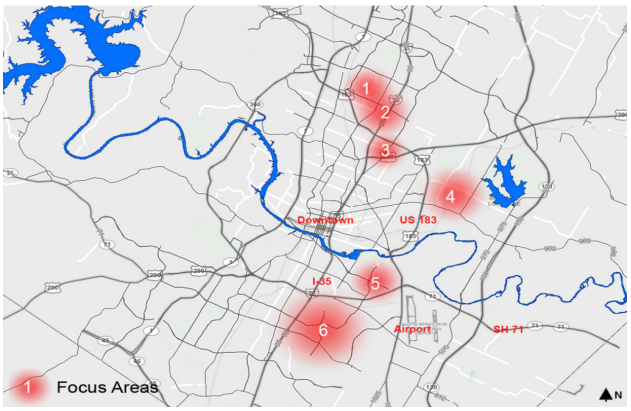
» $3 Million- American Rescue Act Plan
» $60,000- City of Austin Mini-Grants

Governance and Growth Strategy. The network is governed and managed by the City of Austin's Office of Resilience. Hubs are identified and selected based on an equity analysis, mapping of climate hazards and social vulnerability, and assessment of facilities' ability to offer resilience hub services such as shelter and food distribution. Community input is also incorporated into this analysis.

Location. Austin, Texas

Resilience Hubs. 6

Network Lead. City of Austin, Office of Resilience



The map above shows the six City-owned facilities that were chosen as part of the pilot program through input from residents and collaboration with community organizations.

Crosswalking Resilience Issues to Services and Resources.

Extreme Heat and Drought
Extreme Storms
Wildfires
Emergency Preparedness
Community Engagement

Emergency Shelter
Food and Water Distribution
Community Resources
Community Connectivity

Seattle Emergency Hubs

Background. Seattle Emergency Hubs is a coalition of separate Seattle neighborhood hubs with a shared mission of preparing for, responding to, and being resilient after a major disaster. This mission is accomplished through policy advocacy for the hubs, development of best practices, community education and training, and peer sharing.

Funding. This work is supported solely through volunteer efforts.

Governance and Growth Strategy. This coalition is managed and governed by community volunteers throughout the city of Seattle – with some focusing on the work of the network as a whole, and others representing the community hubs that make up the coalition.

Location. Seattle, Washington

Resilience Hubs. 60

Network Lead. Community Volunteers

The image above showcases a simulation mirroring the challenges of a 6.1 magnitude earthquake hitting Seattle during a major event, one of many regular practice exercises

Crosswalking Resilience Issues to Services and Resources.

NorCal Resilience Hubs Initiative

Background. The NorCal Resilience Hubs Initiative is a network of community centers, neighborhoods, places of worship, and other trusted community sites that are models for resilience and better prepared for natural disasters, climate change, and other stressors in the community.

Funding. This network is funded through awards from:

- The Urban Sustainability Directors Network
- Non-profits
- The Cities of Oakland, San Leandro, Fremont, San Rafael, Alameda
- The County of Santa Clara.

Governance and Growth Strategy. This coalition is managed and governed by the NorCal Resilience Network – which works to strengthen relationships between governmental agencies and the community-based organizations serving as resilience hubs. Their approach includes utilization of a resilience hub scorecard, provision of MOUs and partnership agreements, resource sharing, and cross-sector working groups.

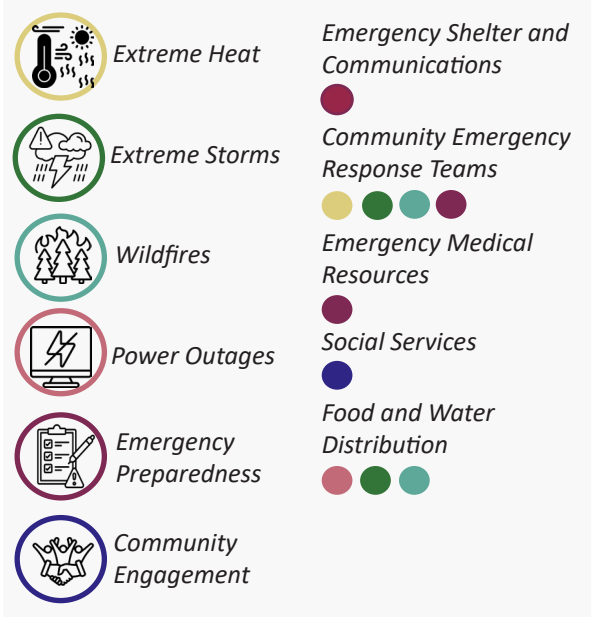
Location. Oakland California; Berkeley, California

Resilience Hubs. 20

Network Lead. NorCal Resilience Network

The image above is of an event hosted by NorCal Resilience Network that involved community building through planting of native species.

Crosswalking Resilience Issues to Services and Resources.



Appendix B.

Dow Sustainability Fellowship

The People Tool Report

2025

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Acknowledgements

We would like to acknowledge our partners in this endeavor without whom this project would not have been possible:

Thank you to our client, the Wayne County Sustainability and Innovation Division – especially **Erin Kelly** and **Cara Dietz** – for guiding us through our research and providing expert knowledge and encouragement.

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Executive Summary

Purpose of the Report

The main objective of this report is to provide a foundation for a framework to holistically and equitably define climate vulnerability in the context of Wayne County. This analysis aims to provide a preliminary framework to support the Wayne County Resilience Hub Network in identifying priority sites, informing hub design and services, as well as to guide grant proposals and community investment strategies. This report outlines the initial stages of this process and therefore still requires extensive validation with communities across Wayne County to ensure it accurately captures the experience of residents.

Overview of Climate Resilience and Relevance to Southeast Michigan

Climate resilience is the ability of social, economic, and environmental systems to prepare for, withstand, respond to, and recover from the impacts of climate change. Resilience is more than handling a single emergency; it's also nurturing the everyday connections and capacities that allow for strategic responses to climate and industrial hazards effectively, with minimal harm. This framework emphasizes that resilience is built before disaster strikes through proactive planning and community engagement, ensuring that when challenges arise, the Wayne County Resilience Hub Network provides coordinated support and care.

What is a Resilience Hub?

A Resilience Hub is defined as a community-serving facility that operates year-round as a neighborhood center and can also pivot to supporting people during emergencies. In practice, resilience hubs are trusted local places. For example, resilience hubs can be community centers, libraries, or faith-based centers that are augmented with resources and plans to help residents before, during, and after disasters. They provide normal services and programs that enhance quality of life and neighborhood cohesion, and during times of crisis, they become a haven by offering essential support like information, electricity, shelter, food, medical aid, and other resources.

In short, a resilience hub strengthens community resilience daily and serves as a lifeline during times of need. By reducing the burden on traditional emergency responders and meeting people where they are, resilience hubs help communities become more self-sufficient, connected, and prepared for the impacts of climate change.

Eastside Community Network's Stoudamire Wellness Hub

Wayne County Resilience Hub Network Overview

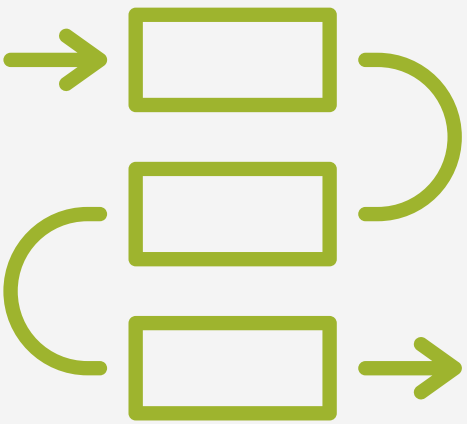
The Wayne County Sustainability & Innovation Division is a newly established office within Wayne County's Department of Economic Development that leads the County's climate resilience strategy. The division aims to expand the reach and connectivity of Wayne County's climate resilience resources through comprehensive programs that serve the diverse needs of its municipalities. To that end, the Sustainability & Innovation team works with departments like Homeland Security and Health & Human Services to identify points of vulnerability throughout the community and develop initiatives that build the adaptive capacity of its municipalities.

The Sustainability & Innovation Division is spearheading its climate resilience efforts through the Wayne County Resilience Hub Network (WCRHN) – a dynamic, vibrant network designed to build strength and unity in the face of climate-related challenges across the County. The division launched the concept in 2025, with an inaugural cohort of 11 community-based organizations participating in training to co-develop governance and emergency planning frameworks for neighborhood resilience hubs.

The network builds the capacity of community-based organizations through fiscal awards, in-kind resources, and peer-learning engagements that encourage communities to work cohesively to bolster their climate resilience and address shared climate-related issues. Through this network, the team aims to build trust between community organizations, county residents, and the county itself.

Our Process

The People Tool Framework process began by defining the geographic scales most relevant to Wayne County, districts, census tracts, and community areas, so that subsequent data work aligned with real decision-making boundaries. Next, our team conducted a literature review of the social, historical, and environmental context of Wayne County. With this essential background information, then came the inventory of indicators commonly used in resilience assessments. This process started through an examination of indicators in existing climate and environmental tools such as the EPA's MIEJ screen, the Detroit Climate Vulnerability Analysis, and SEMCOG's Southeast MI Healthy Climate Plan. Indicators needed to (1) have an evidence-based connection to climate change, (2) be relevant to Wayne County, and (3) have a numerical or binary outcome. Given that this report is an initial stage of a framework, the inclusion of criteria for indicators within the framework was very broad. These indicators were then refined under our conceptual model of resiliency around sensitivity, exposure, and adaptive capacity. Finally, these indicators were synthesized into the People Tool Framework, a structured framework for evaluating resilience in Wayne County. Lastly, our team identified limitations and future steps for improving the tool as new data and community feedback become available.



Recommendations

The next phase of the People Tool focuses on filling key data gaps, incorporating community knowledge, developing a weighting system, expanding and refining data sources, and ultimately compiling the elements into a comprehensive, multi-layer resilience map for Wayne County. The following are our recommendations for future next steps:

Addressing Data Gaps

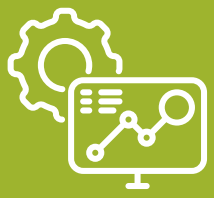
- Aggregate census tract-level data to approximate community-level indicators where direct community-level data is unavailable.
- Develop new datasets that measure proximity to adaptive resources, including cooling centers, resilience hubs, and other public facilities essential to adaptive capacity.
- Create or refine datasets on water and energy efficiency using building level-consumption divided by floor area and integrate Detroit Energy Benchmarking Ordinance data to strengthen energy-related indicators.

Community Input

- Conduct community-based workshops and listening sessions to capture assets, vulnerabilities, and priorities that are not reflected in existing datasets.
- Consult community organizations, climate leaders, and residents to ensure the tool reflects diverse lived experiences and aligns with locally understood risks.

Weighing the Indicators

- Test multiple weighting scenarios (equal weight, risk-focused, equity-focused, community-prioritized) to examine how results shift under different assumptions.
- Document how weighting choices impact resilience rankings to ensure transparency and align final choices with community priorities and policy goals.



Compiling Data Sources

- Expand the existing data inventory (Appendix A) by adding new datasets identified through community input and agency partnerships.
- Establish a pipeline for routine data updates, so the tool remains current as new datasets become available.

Compiling a Map

- Develop a multi-layer, interactive map that visualizes sensitivity, exposure and adaptive capacity metrics across Wayne County
- Pilot test the map with county staff and partners to ensure usability and clarity.
- Design the map to support future expansion, including customizable layers, downloadable data, and options for scenario testing.

Contextual Background

Geographic Scope and Focus

Multi-scale Analysis: District, Census Tract, and Community

Wayne County, Michigan, encompasses forty-three unique municipalities including Detroit. Wayne County faces several key challenges including decreased water quality, extreme heat, reduced air quality, as well as extreme weather events such as intense rain and subsequent flooding that overwhelm an aging infrastructure.[1] For example, in 2019, Wayne County declared a state of emergency due to heavy rainfall and the flooding of over 3,000 homes and basements.[2] These hazards have disproportionately affected communities of color. A study in Wayne County found that "heat wave days increased the odds of hospitalization for kidney disease by 37 percent for people of color from 2000 to 2009."[3] Wayne County was ranked the 13th highest county for annual particulate pollution with over 43.9 million people living in areas with failing air quality grades, with most of the individuals experiencing these conditions from communities of color.[4]

To adequately evaluate climate vulnerability across Wayne County and to understand spatial and social contexts, it is critical to use a multi-scale analysis across indicators at the district, census tract, and community levels. At the district level, analysis aligns with how the county organizes planning and decision-making, providing a practical framework for policy implementation and resource allocation. The census tract level allows for more detailed comparisons across the county and is often used in large-scale data reporting, offering valuable quantitative insights into demographic and environmental trends. However, at the community level, data is often limited or unavailable, making this scale best understood through storytelling, lived experience, and qualitative insights that capture the nuances of resilience on the ground. Collectively, these three levels create a more comprehensive and human-centered picture of resilience, ensuring that both data-driven and experience-based perspectives are taken into consideration when informing future resiliency planning efforts.

Social and Historical Context

Demographic and Socioeconomic Trends

Wayne County is Michigan's most populous county and the 13th most populous in the United States, home to approximately 1.75 million residents spread across 43 cities, townships, and villages.[5] The county's population reflects both rich diversity and deep divisions: about 48% of residents identify as White, 36% as Black, with the remainder identifying as Hispanic, Asian, Native, or multiracial.

In the mid-20th century, Wayne County's economy was heavily reliant on the automotive and manufacturing industries. However, as factories automated or relocated to other states and countries, the region lost tens of thousands of middle-class jobs. This economic shift, combined with suburbanization, dramatically reshaped the population landscape. While the City of Detroit experienced sharp population declines, many suburbs, including Canton, Westland, and Dearborn Heights, grew as families and businesses moved outward. The county's overall population peaked in the 1970s and has since fluctuated, reflecting a complex mix of urban decline and suburban expansion.

Today, Wayne County displays pronounced social and economic contrasts. Detroit, with a predominantly Black population, continues to face long-term challenges related to economic disinvestment and population loss. In contrast, many surrounding suburbs are more affluent and have historically been majority-White. This uneven development has produced a patchwork of prosperity and hardship. While some western and northern suburbs benefit from strong tax bases and modern infrastructure, older industrial corridors near Detroit and River Rouge struggle with aging utilities, brownfield sites, and limited reinvestment.[6]

Although the county's median household income stands at around $59,000, and the poverty rate hovers near 20%, these averages mask wide disparities between communities.[7] Cities such as Grosse Pointe, Northville, and Livonia report median household incomes above $90,000, while communities like Highland Park, River Rouge, Detroit, and Inkster report incomes below $40,000.[8] These economic divides are deeply connected to inequalities in education, housing stability, and healthcare access, which are the factors that continue to shape unequal opportunities and living conditions throughout Wayne County.[9]

History of Environmental Injustice and Disinvestment

The history of environmental injustice and disinvestment in Wayne County is the result of decades of overlapping housing, land-use, and transportation policies that placed heavier environmental burdens on some communities than others. In the mid-20th century, practices such as redlining and racially biased mortgage lending limited where Black families could buy homes, while urban renewal projects and highway construction displaced entire neighborhoods. These actions created lasting patterns of segregation and steered public and private investment away from many working-class and minority areas.[10]

At the same time, industrial development was often concentrated near these same neighborhoods. Oil refineries, steel plants, rail yards, and heavy trucking routes were built alongside residential areas in cities such as River Rouge, Ecorse, and southwest Detroit. Communities living near these sites, especially ZIP code 48217, have faced some of the highest levels of air pollution in Wayne County, along with higher rates of asthma and other respiratory illnesses.[11] [12] The Detroit metropolitan area was ranked sixth worst in the nation for year-round average levels of particle pollution in 2024, receiving a failing grade and recording pollution levels above the federal standard. Decades of economic decline added to these problems: property abandonment, tax foreclosures, and aging infrastructure left many areas with limited green space, poor stormwater drainage, and deteriorating housing quality. These conditions increase residents' exposures to both industrial pollution and climate-related risks.

Local community organizations have played a crucial role in documenting these environmental problems and advocating for change. Their work has led to stronger air monitoring and raised awareness about unequal environmental impacts. However, enforcement remains inconsistent, and investment in cleanup and infrastructure renewal has been uneven. As a result, environmental and economic challenges continue to reinforce one another, leaving many neighborhoods in Wayne County more vulnerable than others to health and climate risks.

Environmental Context

Current and Projected Climate Risks

Wayne County faces growing risks from climate change, especially extreme heat and flooding. Across Southeast Michigan, average temperatures have already risen by 2.3°F (1.3°C)[13], and climate models project more frequent and intense heat waves in the coming decades. The urban heat island effect is particularly strong in paved areas with few trees.[14]

Flooding is another major concern for Wayne County. The U.S. Great Lakes region's rainfall patterns are changing, with annual precipitation events increasing by more than 14% since 1961.[15] Heavy storms have caused repeated basement flooding and sewage backups, particularly in communities served by older combined sewer systems such as Dearborn Heights, Melvindale, and parts of Detroit's east side. Many of these neighborhoods sit on low-lying land near the Rouge and Ecorse Rivers, where stormwater infrastructure struggles to handle intense rainfall. Flooding not only damages homes and roads but can also expose residents to contaminants when floodwaters mix with industrial runoff or household waste.[16]

These climate impacts often hit the hardest in the same areas that already experience environmental injustice and economic stress. Communities near industrial corridors or with aging infrastructure face a double burden: exposure to pollution and heightened climate risks.[17] Extreme heat can worsen air-quality problems, while flooding can spread pollutants from nearby industrial sites or brownfields. County and regional agencies have begun mapping these combined vulnerabilities through resilience plans, highlighting the need for more tree canopy restoration, updated stormwater systems, and equitable investment in both urban and suburban areas. Addressing climate risk in Wayne County therefore means tackling social and environmental inequality at the same time, ensuring that adaptation efforts protect the most vulnerable communities first.

Conceptual Model

Key Components of Resilience

The climate resilience of a community is measured by its vulnerability to climate-related challenges. Here, vulnerability is defined as the degree to which a community is likely to experience harm due to climate and environmental hazards. This vulnerability is shaped by three factors: Sensitivity, Exposure, and Adaptive Capacity.

01

Sensitivity

refers to the characteristics and conditions of people and systems that make them more likely to be affected by environmental or climate emergency-related stressors. These vulnerabilities may include high poverty rates, language barriers, cost-burdened households, and aging communities.

02

Exposure

refers to the extent to which people, infrastructure, and systems are in direct contact with environmental hazards such as flooding, extreme heat, and air pollution. These vulnerabilities may be exacerbated by factors such as population density, industrial siting, and flood plains.

03

Adaptive Capacity

refers to a community's ability to prepare for, respond to, and recover from climate-related events – such as extreme heat, extreme cold, heavy precipitation, flooding, and power outages. Resources such as hazard mitigation plans, back-up generators and power sources, emergency response training, and social connectivity increase a community's adaptive capacity.

People Tool Framework

Metric Selection Methodology

Indicators were characterized based on the conceptual framework of climate resilience above. An “indicator” in this framework is a measurable and quantifiable characteristic of a population or the environment. This process started by examining indicators in existing climate and environmental tools. Using the U.S. Climate Vulnerability Index, we identified indicators within each of these three categories above for which measures varied across Wayne County. We then utilized region-specific climate vulnerability tools such as the EPA’s MIEJ screen, the Detroit Climate Vulnerability Analysis, and SEMCOG’s Southeast MI Healthy Climate Plan to refine these indicators. Given that this is an initial stage of a framework, the inclusion of criteria for indicators within the framework was very broad. Indicators needed to (1) have an evidence-based connection to climate change, (2) be relevant to Wayne County, and (3) have a numerical or binary outcome. The selection of indicators was further validated with peer-reviewed literature as well as news articles, community organization reports, and policy briefs.

It is important to note that this methodology is only sufficient to provide a preliminary framework for climate resilience. A comprehensive set of indicators needs to be developed and validated in conjunction with communities across Wayne County to fully reflect the unique vulnerability and assets of each community.[18] [19] These methods lay the groundwork for identifying themes that can be strengthened through community discussions. Additionally, assessing data availability (at the district, census tract, and community levels) and quality (validity, accuracy, consistency) will be important in final inclusion and tool development.

People Tool Framework Diagram

Baseline Climate Indicators: Extreme Heat, Rainfall, and Wildfire PM 2.5

Sensitivity

Sociodemographic Characteristics
- Older Adults Living Alone
- Children
- Women
- Immigrant Status
- People of Color
- Educational Attainment
- Limited english proficiency
- Unemployment
- Low Household Income
- Housing Age – Energy Efficiency
- Housing Age – Lead Exposure
- Housing Code Violations
- Housing Cost Burden
  - Homeowner Housing Cost Burden
  - Renter Housing Cost Burden
  - Energy Burden
- Renters
- Mobile Homes
- Homelessness
- Vehicle Access
- Internet Access
- Historic Underinvestment Score

Health
- Life Expectancy
- Self-Reported Physical Health
- Asthma
- Other Respiratory Illnesses
- Cardiovascular Disease
- Diabetes
- Obesity
- Cancer
- Mental Health
- Low Birth Weight
- Access to Primary Care
- Uninsured

Occupation and Industry
- Agriculture
- Manufacturing
- Natural Resources, Mining, Construction
- Transportation, Warehouse, Utilities

Exposure

Flooding
- Floodplains
- Impervious Surfaces
- Flood Risk – Housing
- Flood Risk – Roads

Air Pollution
- Ground Level Ozone
- Particulate Matter 2.5 ($PM_{2.5}$)
  - Diesel PM 2.5
- Nitrogen Dioxide (NO_2)
- Traffic Volume

Water Quality
- Wastewater Discharge
- Stream Toxicity Risk
- Underground Storage Tanks and Releases
- Drinking Water Quality

Temperature
- Urban Heat Island Effect

Toxins
- Formerly Used Defense Sites (Legacy Pollution)
- Superfund Sites (Legacy Pollution)
- Brownfields (Legacy Pollution)
- Abandoned Mine Land (Legacy Pollution)
- Hazardous Waste Facilities
- Toxic Release Inventory (TRI) Facility (Current Pollution)
- TSCA Facilities
- Facilities with Enforcement or Violation
- Lead Paint Indicator

Infrastructure
- Utility Outage
- Road Quality

Adaptive Capacity

National Funding & Programs
- Hazard Mitigation Spending
- Flood Insurance

Community Support
- Religious Organizations
- Civic or Social Organizations
- Emergency Shelters/Centers
- Community Food Services

Economic Resilience
- Expected Annual Loss: Agriculture
- Expected Annual Loss: Buildings
- Expected Annual Loss: Population

Environmental Resilience
- Local Food Suppliers
- Walkability Score
- Flood Buffers

Metric Selection and Justification

1. Sensitivity Metrics

Table 1A: Sociodemographic Characteristics

Indicator	Definitions	Explanation
Older Adults Living Alone	Percentage of residents who are adults age 65 and older and living alone	Percentage of residents who are adults age 65 and older and living alone
Children	Percentage of residents who are children age 5 and younger	
Women	Percentage of residents who are female	
Immigrant Status	Percentage of residents who were not born in the United States	
People of Color	Percentage of residents who list their racial/ethnic status as a category other than non-Hispanic White alone (i.e. Black, American Indian/Alaskan Native, Asian, Native Hawaiian-Other Pacific Islander, and two or more races)	
Educational Attainment	Percentage of residents age 25 or older with less than a high school education	
Limited English Proficiency	Percentage of limited English-speaking households, defined as a household in which all members aged 14 and older speak a non-English language and also speak English less than "very well"	

Indicator	Definitions	Explanation
Unemployment	Percentage of residents who are unemployed	
Low Household Income	Percentage of households living below the federal poverty line	
Housing Age – Energy Efficiency	Percentage of housing units built before 1940	
Housing Age – Lead Exposure	Percentage of housing units built before 1970	
Housing Code Violations	Number of housing code violations per year as determined by local city/township governments, including property maintenance, unsafe structures, and health/safety concerns	
Housing Cost Burden	Percentage of households spending more than 30% of their annual household income on housing costs	This indicator represents the number of households that spend a substantial amount of their income on housing.
Homeowner Housing Cost Burden	Percentage of owner-occupied housing units spending more than 30% of their monthly household income on housing costs	Housing costs for homeowners include mortgage principal and interest, insurance, utility costs, taxes, and any other cost that must be met in order to maintain ownership of their home.
Renter Housing Cost Burden	Percentage of renter-occupied housing units spending more than 30% of their monthly household income on housing costs	Housing costs for renters include contract rents and utility costs.
Energy Burden	Average household annual energy cost in dollars divided by the average household income	This indicator is the share of a household's annual income that goes toward energy costs. Energy burdens above 6% are considered high and above 10% are considered severe.

Indicator	Definitions	Explanation
Renters	Percentage of renters in a census tract	
Mobile Homes	Percentage of residents living in mobile homes	A mobile home is defined as a dwelling structure built on a steel chassis and fitted with wheels to be transported to a specific site for installation.
Homelessness	Percentage of unhoused residents	An unhoused resident includes those in emergency shelters, transitional housing, institutions, or living in spaces not meant for human habitation, such as streets or tents.
Vehicle Access	Percentage of households without access to a vehicle	
Internet Access	Percentage of households without access to Internet	
Historic Underinvestment Score	Historic redlining score based on a categorical Home Owners' Loan Corporation (HOLC) rating of a given census tract. The HOLC historically graded neighborhoods using race as a determinant of higher mortgage risk	Historic redlining refers to discriminatory process of denying mortgage to racial and ethnic minority groups, reinforcing racial neighborhood segregation and leading to underinvestment in these communities.

Rationale for inclusion in this category:

These indicators refer to those sociodemographic factors that increase the social vulnerabilities related to environmental risk factors. These include social determinants of health (minority status, income status, education, housing) relevant to the communities of Wayne County that produce social vulnerabilities and decrease the ability of a population to prepare for, confront, recover from, and adapt to climate-related events. An increase in value for each of these indicators represents increased vulnerability.

Relevance to climate change:

Elderly populations are more vulnerable to the health effects of environmental exposures due to reduced ability to metabolize pollutants, increased likelihood of having comorbidities like heart disease or diabetes, increased likelihood of functional limitations, and financial barriers that reduce the ability to respond to climate stressors.[20] Children are also more vulnerable to the effects of climate change due to their immature physiological systems, increased surface area to body weight ratio, reliance on adults, and repeated exposure to climate events over time.[21] Women experience unique biological and social factors that increase their risks to climate change, including pregnancy complications, domestic and sexual violence, and increased likelihood of living in poverty.[22]

Due to cultural, economic, and societal factors, immigrants and refugees are more vulnerable to climate change. Studies have reported higher environmental exposures in immigrants compared to nonimmigrants,[23] and immigrants/refugees may live in high-risk areas and have increased cultural and linguistic barriers to accessing resources.[24] Systemic racism can affect climate-related exposures, access to and/or quality of resources, and other social determinants of health for people of color. 51.8% of Wayne County residents identified as any race other than non-Hispanic White. Communities of color often face disproportionate health risks linked to cumulative exposures to environmental hazards and are more vulnerable to the health effects associated with climate-related impacts due to discriminatory policies and disinvestment in access to quality housing, education, and food.[25] [26]

Low educational attainment is linked to climate vulnerability through decreased knowledge of environmental or climate hazards as well as health information, health care services, and climate adaptation.[27] [28] Limited English proficiency increases climate vulnerability by serving as a barrier to accessing health information and information on environmental and climate-related risks.[29]

Unemployment and low household income represent barriers to resources for resilience. Individuals with lower incomes are more likely to reside in poorly built housing that are subject to increased climate risks and are more likely to have poorer health outcomes.[30]

The age of the home was included as proxies for energy inefficiency (built before 1940) and lead exposure (built before 1970). Houses built before 1940 are more vulnerable to climate change due to lack of modern insulation, absence of central air conditioning, and more porous material for basement construction increasing flooding risk.[31] Houses built before 1970 are highly likely to contain lead paint, which was not banned until 1978. Lead-based paints pose serious health risks, particularly to children, and include slowed growth and development, behavioral issues, and cognitive and motor deficits.[32] Housing code violations are linked to climate vulnerability because poorly maintained homes, often cited for code violations, are less resilient to climate events, leading to increased health risks for residents including increased asthma-related emergency department visits and hospitalizations among children.[33] [34]

Housing cost-burdened communities are impacted by a reduced economic capacity to respond to climate-related events and tend to be in areas with higher environmental hazards. Climate change further directly reduces the supply of affordable housing, puts a strain on housing payments following disasters, or increases costs for maintenance and repairs.[35] We further divided this category into housing cost-burden by homeowners vs. renters to highlight the increased vulnerability of renters who are more likely to live in poorer quality, less energy efficient units and are vulnerable to displacement and forced moves from climate-related disasters.[36] Furthermore, the inability to afford increased rent and bills associated with heating and cooling may lead to utility shut-offs, which can result in evictions and loss of housing for renters.[37] Finally, energy costs rise with extreme temperatures and disproportionately affect lower-socioeconomic status households and communities of color.[38]

Residents of mobile homes are disproportionately vulnerable to climate impacts as mobile homes tend to be energy inefficient, difficult to heat and cool, difficult to relocate, and are often located on hazardous land with poorly maintained infrastructure.[39] Residents experiencing homelessness represent the most vulnerable to extreme weather conditions and the social and economic challenges that increase baseline social vulnerability.

Lack of vehicle access increases climate vulnerability by limiting an individual's ability to evacuate from climate disasters and access baseline resources, healthcare services, etc.[40] Lack of internet access decreases the ability to receive critical warnings and other information in the event of climate-related disasters, limiting communication during emergencies, and creating gaps in knowledge about adaptation strategies.[41]

Finally, studies have shown associations between historic redlining and elevated air pollution, power plants, flooding, urban heat islands, and overall poorer environmental quality.[42] Due to environmental racism, people residing in redlined neighborhoods demonstrate higher rates of adverse health outcomes, including cancer, cardiovascular disease, asthma, and diabetes.[43] Systemic underinvesting in these communities has also resulted in poorer infrastructure, increasing vulnerability to climate-related events. Historic disinvestment is particularly relevant to Wayne County as it heavily contributed to racial segregation/discrimination through environmental injustices in Detroit and the establishment of surrounding wealthier suburbs.[44]

Table 1B: Health

Indicator	Definitions	Explanation
Life Expectancy	The average number of years a person is expected to live (inversed)	Life expectancy can be considered an indicator of overall population health. Lower life expectancy indicates higher vulnerability.
Self-Reported Physical Health	Age-adjusted prevalence of adults who report 14 or more days during the last 30 during which their physical health was not good	This indicator is a measure of how individuals perceive their own health and is correlated with objectively assessed physical functioning.
Asthma	Age-adjusted prevalence of adults with asthma	Asthma is an obstructive airway disease characterized by airway hyperreactivity and inflammation.

Indicator	Definitions	Explanation
Other Respiratory Illnesses	Age-adjusted prevalence of adults with COPD, emphysema, chronic bronchitis, or other chronic respiratory conditions	This indicator refers to all other obstructive and restrictive airway diseases other than asthma.
Cardiovascular Disease	Age-adjusted prevalence of adults with coronary artery disease, congestive heart failure, valvular heart disease, cerebrovascular disease, and peripheral arterial disease	This indicator represents how many people are living with diseases affecting the heart and blood vessels in an area.
Diabetes	Age-adjusted prevalence of diagnosed type 1 or type 2 diabetes among adults aged 18 years or older	This indicator represents how many people are living with diabetes in an area.
Obesity	Age-adjusted prevalence of adults with a BMI of 30 or greater	This indicator represents how many people are living with obesity in an area.
Cancer	Age-adjusted prevalence of adults with any type of cancer (besides skin)	This indicator represents how many people are living with cancer other than skin cancer in an area.
Mental Health	Age-adjusted prevalence of adults with a mental health condition	This indicator represents how many adults are living with depression, anxiety, and other psychiatric diagnoses.
Low Birth Weight	Percentage of singleton births with low birth weights	Low birth weight refers to babies weighing less than 2,500 grams at birth, often caused by intrauterine growth restriction or prematurity.

Indicator	Definitions	Explanation
Disability	Percentage of residents with a disability	This indicator represents how many people having a physical or cognitive disability (i.e. mobility, hearing, vision, etc.) in an area
Access to Primary Care	Age-adjusted prevalence of adults who report having been to a doctor for a routine check-up in the past year	This indicator represents annual primary care visits. Lower percentage of annual routine doctor visits indicates higher vulnerability.
Uninsured	Percentage of residents without health insurance	This indicator represents how many people do not have health insurance in an area.

Rationale for inclusion in this category:

These factors refer to characteristics of sensitive populations, particularly relating to underlying health conditions, that increase the risk of negative health outcomes due to climate change. People with pre-existing health conditions are disproportionately represented in low socioeconomic groups with poor access to infrastructure, contributing to (and compounding) their increased vulnerability to health impacts from climate change.

Relevance to climate change:

Lower life expectancy correlates with increased climate vulnerability because it often indicates a population with lower income, less access to healthcare, education, and resources, limiting their ability to adapt to climate change impacts. Climate change further decreases life expectancy through numerous mechanisms, including directly (weather variables and natural disasters) and indirectly (alterations to the environment and economic systems).[45] Self-reported physical health is a strong predictor of future health outcomes, including morbidity and mortality, as well as healthy behaviors. Individuals with poor baseline health are more likely to develop climate-related illnesses and have decreased ability to adapt to climate risks.

Patients with asthma are particularly vulnerable to the environmental alterations associated with climate change, including extreme temperatures, environmental pollutants, and allergens that act as symptom triggers. High temperatures, levels of particulate matter, and aeroallergens can precipitate symptoms, increasing the frequency of asthma exacerbations and emergency visits.[46] Patients with other chronic respiratory conditions, such as COPD, are also vulnerable to high temperatures and air pollutants that can trigger exacerbations and worsen baseline decreased lung function.[47]

Patients with cardiovascular diseases are also vulnerable to climate-related exposures, including heat, extreme weather events, and wildfire smoke. Increased cardiovascular morbidity and mortality have been associated with extreme temperatures and further amplified by ground-level ozone.[48] Impaired responses to heat stress, including compromised vasodilation and sweating, diabetes-related comorbidities, insulin resistance, and chronic low-grade inflammation make people with diabetes particularly vulnerable to climate-related risk factors, such as extreme weather events and air pollution.[49] Finally, obesity further amplifies the physiological burden of climate-related stressors, such as heat waves, due to reduced heat dissipation. Higher body mass index can also decrease adaptive capacity and has been associated with increased greenhouse gas emissions, further increasing climate-related exposures.[50]

Patients with cancer are particularly vulnerable to the impacts of climate change due to decreased immunity from cancer treatment, which increases risk of infectious diseases that are becoming more prevalent due to rising temperatures and changing rainfall patterns.[51] Additionally, extreme weather events can impede patients' access to cancer care and hinder cancer treatment facilities' ability to deliver care.[52]

Traumatic experiences due to extreme weather events can also increase the risk of affective and anxiety disorders such as PTSD. Extreme heat can increase mental illness-related morbidity and mortality, and stressors such as drought, food insecurity, and displacement can be risk factors exacerbating underlying mental health conditions.[53]

Low birth weight is associated with increased risk of developing chronic health conditions such as asthma, coronary heart disease, and type 2 diabetes. Air pollution and heat exposure have been associated with low birth weight, and health conditions linked with low birth weight can predispose the child's sensitivity to

climate-related stressors.[54]

Living with a disability increases climate vulnerability due to disrupted medical care, inaccessible infrastructure during climate-related disasters, pre-existing social and economic marginalization, and reduced adaptive capacity to the impacts of climate change on food, water, housing, etc.[55]

Access to primary care is crucial for climate resilience as routine primary care visits can result in early treatment and preventative care, resulting in increased baseline health. Climate change further disrupts healthcare systems, limiting primary care access through damaged infrastructure, power outages, and supply chain disruptions.[56] Lack of health insurance increases climate vulnerability by decreasing access to healthcare and treatment for climate-exacerbated health issues like asthma, cardiovascular disease, diabetes, etc.

Table 1C: Occupation and Industry

Indicator	Definitions	Explanation
Agriculture	Percentage of workers working in agriculture	This indicator reflects the extent to which a workforce is engaged in crop or livestock production, often involving seasonal, outdoor, and physically intensive labor.
Manufacturing	Percentage of workers working in manufacturing	This indicator shows the proportion of the workforce involved in the production of goods, including food, machinery, chemicals, vehicles, and other industrial products, typically in factory or plant settings.

Indicator	Definitions	Explanation
Natural Resources, Mining, Construction	Percentage of workers working in natural resources, mining, and construction	This indicator captures employment in extractive, land-altering, or building occupations, which include work such as logging, quarrying, excavation, and construction of residential, commercial, or public infrastructure.
Transportation, Warehouse, Utilities	Percentage of workers in transportation, warehouse, utilities	This indicator represents jobs involved in the movement and storage of goods, freight, and services, as well as the operation and maintenance of essential systems such as electricity, water, and waste services.

Rationale for inclusion in this category:

Occupations in agriculture, natural resources, construction, and mining were selected because of their vulnerability to climate events. These fields are more likely to have outdoor workers, making them more vulnerable to extreme heat, extreme precipitation, and more.[57] Manufacturing and transportation, warehouse, and utility occupations are also commonly affected by extreme weather, as conditions can block transportation routes, strain utilities, and interrupt supply chains.[58]

Relevance to climate change:

Climate change has the potential to influence labor markets and worker health.[59] [60] Supply chain shocks from extreme events can result in labor reallocation to less climate vulnerable areas. Economies that rely heavily on interconnected supply chains are more likely to experience heightened unemployment when there are major interruptions to the system.[61] Increased worker vulnerability to climate-related health impacts can reduce labor supply, lower productivity, increase absenteeism, and worsen employment precarity.[62] They also may lead to job insecurity, disproportionately affecting workers with temporary, informal, or precarious employment.[63] Combined, these effects can lead individuals to move out of these vulnerable sectors. [64]

2. Exposure Metrics

Baseline Climate Indicators

Indicator	Definitions	Explanation
Extreme Heat	Annual number of days with a daily maximum temperature above the 95th percentile	A period of abnormally hot and usually humid weather
Rainfall	Average annual precipitation	The precipitation of water that falls from clouds to the earth's surface
Wildfire PM 2.5	Estimated annual average PM 2.5 concentrations attributed to wildfire events	Wildfire-generated airborne particulate matter 2.5 micrometers and smaller

Rationale for inclusion in this category:

These variables were selected as baseline indicators because they reflect climate exposures present in Wayne County yet show little geographic variation across the county. It is important to consider these exposures given their importance in contributing to climate vulnerability.

Relevance to climate change:

Hot ambient temperatures and associated heat stress have been linked to cardiovascular morbidity and mortality, respiratory disease, cerebrovascular disease, chronic kidney disease, adverse pregnancy outcomes, and negative mental health effects.[65] High heat stress can also reduce physical work capacity and motor-cognitive performance. Heat-related morbidity and mortality are projected to increase further as climate change progresses, increasing vulnerability to other climate-related stressors.

Climate change leads to more frequent and intense extreme rainfall events, increasing flooding risk, damage to infrastructure, and public health risks such as mold and waterborne infectious disease. Rainfall events have also been associated with increased daily all cause, cardiovascular, and respiratory mortality.[66]

Climate change has also driven more frequent and intense wildfires, which produce substantial amounts of fine particulate matter (wildfire PM 2.5). Wildfire PM 2.5 is more toxic than equal doses of ambient PM 2.5, exacerbating a range of health conditions including cardiovascular and respiratory disease.[67] Short-term wildfire PM 2.5 exposure has been linked to increased ED admissions for asthma exacerbations and all-cause mortality, and long-term wildfire PM 2.5 exposure has been associated with all-cause mortality. [68] [69]

Table 2A: Flooding

Indicator	Definitions	Explanation
Floodplains	Percent of area in a floodplain, defined as an area with at least 1% chance of flooding annually	Floodplains are land areas adjacent to rivers and streams that are subject to recurrent flooding when water levels rise.
Impervious Surfaces	Percent of area covered by impervious surfaces, such as parking lots, roads, and buildings	Impervious surfaces prevent rainwater from soaking into the ground, causing more water to run off into storm drains and waterways.
Flood Risk – Housing	Percent of properties at risk of flooding occurring in the next 30 years from tides, rain, riverine, and storm surges	This indicator represents flood risk at the building level, representing the combined effect of housing conditions, flood types, land composition, elevation, etc.
Flood Risk – Roads	Average flooding risk to roads in a census tract, taking into consideration the amount of floodwater reaching the centerline of a road, the percent of the length of a road covered by water, and the depth of that water	This indicator represents the likelihood and depth of flooding that reaches a road's centerline, considering factors like flood types, geographic factors, etc.

Rationale for inclusion in this category:

Flooding refers to the overflow of water onto normally dry land. Living in a floodplain increases the risk of exposure to flooding by as much as 2–5 times more frequently,[70] made worse by increasing frequency and intensity of precipitation associated with climate change. Household flooding is a major concern in Wayne County, particularly in Detroit and Dearborn, and can occur through stormwater overland flooding, water infiltration or seepage through walls, and sewer backups.[71] Road flooding is another concern in Wayne County, influenced by factors like topography, drainage, and road surface.[72] Impervious surfaces increase flooding risk by limiting the absorption of rainwater into soil and increase pollutant loads transported to downstream channels, resulting in stream degradation and increased flood damage costs.[73]

Relevance to climate change:

Climate change intensifies flooding by increasing atmospheric moisture that leads to more intense rainfall and surface level flooding. More frequent rain events can increase the risk of flash floods that overwhelm drainage systems. Increased precipitation, changes in streamflow, and changes in the timing of snowmelt can affect the size and frequency of river flooding. Flooding can cause significant damage to infrastructure, including homes, businesses, and roads, leading to high economic losses and increasing susceptibility to other climate events. Road flooding in particular can block access to utilities and emergency services and affect the ability to escape during climate events.

Floods can also pose public health risks, including drowning, injuries, spread of infectious diseases, failure of wastewater infrastructure, poisoning (from exposure to chemicals in floodwater), gastrointestinal disease, and respiratory illness.[74] Mental health conditions such as anxiety, depression, and PTSD are common among people who have experienced a sudden flooding event.[75] Household flooding is furthermore associated with the development of mold, which worsens respiratory problems including asthma and allergic rhinitis.[76]

Table 2A: Air Pollution

Indicator	Definitions	Explanation
Ground Level Ozone	Daily average ground-level ozone concentration in a census tract.	Ground-level ozone is formed through photochemical reactions involving nitrous oxides and volatile organic compounds. It is a major component of smog and acts as a greenhouse gas.
Particulate Matter 2.5 ($PM_{2.5}$)	Daily average PM 2.5 concentration in a census tract.	PM 2.5 is a measure of airborne particulate matter 2.5 micrometers and smaller, produced from fossil fuel burning, vehicle exhaust, fires, and various industrial processes.
Diesel PM 2.5	Daily average diesel PM 2.5 concentration in a census tract.	Diesel PM 2.5 refers to airborne particulate matter 2.5 micrometers and smaller originating from diesel engine exhaust. Diesel PM 2.5 is particularly high in black carbon, nitrates, sulfates, and toxic metals.
Nitrogen Dioxide (NO_2)	Average number of nitrogen dioxide air pollutants per year.	NO_2 is a product of fossil fuel burning and vehicle exhaust and a precursor of ground-level ozone, particulate matter, and acid rain.
Traffic Volume	Traffic density within a buffered (150 meters) census tract, normalized vehicles per day/adjusted length-based road (miles)	Vehicles emit air pollutants including nitrogen oxides and particulate matter.

Rationale for inclusion in this category:

Air pollution refers to hazardous substances in the atmosphere that can harm human health and the environment. This category includes three of the six criteria air pollutants that are regulated in the National Ambient Air Quality Standards (ground level ozone, $PM_{2.5}$, and NO_2). Ozone and PM2.5 were included because Wayne County has recently or currently had levels that are above the national standards.[77] [78] While NO2 is below the national standards, it was included because it is a byproduct of vehicle emissions, which has been a concern for residents within Wayne County.[79] [80] For the same reason, this category also includes traffic volume, which is a source of traffic-related air pollution from vehicle emissions.

Relevance to climate change:

Air pollution is a critical driver of cardiopulmonary disease and respiratory illnesses such as asthma, COPD, and lung cancer.[81] These conditions can make communities more vulnerable to changes in air quality associated with climate change (eg. from wildfires or from pollen).[82] Communities already burdened by industrial and traffic-related air pollution face heightened risks as climate change further degrades air quality and increases their vulnerability to additional pollution exposures.[83] Living close to high traffic volumes can further increase exposure to noise, vibration, and local land use changes, exacerbating pollution-related vulnerabilities.[84]

Table 2C: Water Quality

Indicator	Definitions	Explanation
Wastewater Discharge	Toxicity-weighted concentrations in stream segments within an area	This indicator measures how much pollution is released into the water from industrial facilities and wastewater plants. Discharge of more toxic chemicals is weighted more heavily.
Stream Toxicity Risk	Sources of toxic chemicals within 500 meters (over 1,600 feet) of a stream segment.	Sources of toxic chemicals closer to streams pose a higher risk for contamination.

Indicator	Definitions	Explanation
Underground Storage Tanks and Releases	Weighted formula of the density of leaking underground storage tanks and the number of all active underground storage tanks within 1,500 feet of the census tract boundaries	Underground storage tanks store petroleum or toxic substances. These risk contaminating groundwater, which is a source of drinking water for many.
Drinking Water Quality	Number of drinking water violations within the last two years.	The Wayne County Water and Sewer Authority measures 18 contaminants and water characteristics that represent discharge from industry, erosion of natural deposits, lead plumbing, and soil runoff.[85]

Rationale for inclusion in this category:

Water quality broadly refers to the biological, chemical, and physical characteristics of water for a particular use. Changes in water quality can affect public health (e.g. drinking water safety and toxic algae events),[86] contaminate food chains (e.g. mercury in fish),[87] damage ecosystems, and lead to economic impacts (e.g. decreased property value or clean-up costs).[88] This category includes waste water discharge to represent the pollution that is entering surface waters. It also includes underground storage tanks and releases to reflect groundwater contamination.[89] Stream toxicity risk was included due to the high density of industries near surface water across Wayne County, increasing risk for the contamination of these waters. Lastly, drinking water quality was included because it has been a concern for residents in Wayne County. Underinvestment in updating aging infrastructure within the county increases the risk of drinking water violations, main breaks, and flooding.

Relevance to climate change:

Climate-related events such as increased flooding and extreme temperatures can increase the risk of spreading toxic chemicals more widely or to places they have not been before. Existing contaminated water and fragile water infrastructure can reduce a community's ability to be resilient in the face of extreme climate events.[90]

Table 2D: Temperature

Indicator	Definitions	Explanation
Urban Heat Island Effect	Positive temperature differential between an urban census tract and a nearby rural reference point	The urban heat island effect describes the phenomenon in which urban areas are significantly warmer than their suburban/rural counterparts.

Rationale for inclusion in this category:

The urban heat island effect occurs because of differences in solar radiation heating in urban areas that increase the air, surface, and ground temperature compared to the average temperature of suburban areas.[91] The urban heat island effect can be attributed to urbanization, structural and land cover changes, industrialization, etc. that decrease heat absorbing surfaces. Urban heat islands are associated with increased risk of heat waves.

Relevance to climate change:

The urban heat island effect disproportionately impacts communities of color and low-income communities, who are already vulnerable to the effects of climate change. The heat island effect also worsens health conditions like respiratory illness and increases risk of heat-related illnesses and death.[92] Climate change is likely to contribute to an increase in the urban heat island effect due to increased average temperatures, potentiating vulnerabilities.

Table 2E: Toxics

Indicator	Definitions	Explanation
Formerly Used Defense Sites	Number of properties that were owned, leased, or possessed by the United States, under the jurisdiction of the Secretary of Defense prior to October 1986.	The Department of Defense is responsible for investigating and, if necessary, cleaning up contamination from sites that it owned before 1986. These locations are known as Formerly Used Defense Sites (FUDS).[93]

Indicator	Definitions	Explanation
Superfund Sites	Number of superfund sites within 5 kilometers (or nearest one beyond 5 kilometers), each divided by distance in kilometers.	Superfund refers to sites that are regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) due to improperly managed hazardous waste.[94]
Brownfields (Legacy Pollution)	Number of brownfield sites within 5 kilometers (or nearest one beyond 5 kilometers), each divided by distance in kilometers.	Brownfield properties include land that was previously used for industrial purposes that may be contaminated. These sites typically have lower concentrations of hazardous substances than superfund sites. Brownfields are commonly found in urban industrial areas and tend to be disproportionately located in working class communities or communities of color. Soil from brownfields (especially mines and smelters) can also be a source of lead exposure within homes.[95] [96]
Abandoned Mine Land (Legacy Pollution)	Number of abandoned mines left by legacy coal mining operations.	Abandoned mine lands (AMLs) are soils, waters and surrounding watersheds where ores and minerals have been extracted, beneficiated or processed. The EPA conducts and supervises investigation and cleanup actions at a variety of mine sites.[97]

Indicator	Definitions	Explanation
Hazardous Waste Facilities	Hazardous waste facility within 5 kilometers (or nearest beyond 5 kilometers), each divided by distance in kilometers	This category includes hazardous waste management facilities (also known as TSDFs) which receive hazardous wastes for treatment, storage or disposal. It also includes large quantity generators, which generate large quantities of hazardous waste per month. These entities are regulated under the Resource Conservation and Recovery Act (RCRA).[98]
Toxic Release Inventory (TRI) Facility (Current Pollution)	Number of TRI sites within 5 kilometers (or nearest one beyond 5 kilometers), each divided by distance in kilometers	Toxic Release Inventories are required for companies working with hazardous materials by the Emergency Planning and Community Right to Know Act (EPCRA). This law requires industries to report on the storage, use, and releases of 799 chemicals and 33 chemical groups to federal, state, tribal, territorial, and/or local governments. EPCRA requires facilities to annually report the quantities of these chemicals that are released into the environment or managed as waste.[99]

Indicator	Definitions	Explanation
TSCA Facilities	Number of facilities regulated by the EPA Toxic Substances Chemical Act (TSCA) (or nearest one beyond 5 kilometers), each divided by distance in kilometers	Facilities regulated under the Toxic Substances Control Act (TSCA) are those that manufacture, process, import, distribute, or handle chemical substances that may present an unreasonable risk to human health or the environment. They are different from TRI facilities because TSCA facilities evaluate and control chemical risks before and during use while TRI facilities track and disclose toxic chemical releases. (Toxic Substances Control Act Facilities, EPA, 2025)
Facilities with Enforcement or Violation	Number of facilities regulated by the EPA that have had an air, soil or water violation and or an enforcement action, located within 5 kilometers from the census tract.	Facilities that violate air, soil, or water standards at the federal level are tracked on the EPA's online Enforcement and Compliance History Online tool.[100]
Lead Paint Indicator	% of housing units built before 1970	In 1978, the federal government banned commercial uses of lead-based paint. Houses built before this are more likely to have lead-based paint.[101]

Rationale for inclusion in this category:

Several forms of legacy pollution measures were included in this category, including formerly used defense sites, superfund sites, brownfields, and abandoned mine lands.[102] These metrics were included because areas that have experienced industrial divestment, such as in Southeast Michigan, tend to be at higher risk of legacy pollution as toxic chemicals.[103] Additionally, current polluting facilities, such as Hazardous Waste facilities, facilities that report to the Toxic Release Inventory, and TSCA facilities were added to represent the localized concentration of polluting sources across Wayne County. Facilities that have an enforcement or violation action were also included because of the concentration of such facilities in southeast Michigan.[104] Finally, a lead-based paint indicator was included given the prevalence of older housing stock in the area.[105]

Relevance to climate change:

Proximity to current and historical polluting sources can reduce climate resilience, as climate events, such as extreme flooding, can redistribute existing chemical pollution.[106] [107] [108] Additionally, exposure to chemical hazards from historical and current polluting facilities can increase the risk of poor health, which in turn increases one's vulnerability to climate events.[109] [110]

Table 2F: Infrastructure

Indicator	Definitions	Explanation
Utility Outage	Average cumulative outage duration for each household served	The length of utility outages is commonly used as a reliability index by electric power utilities.
Road Quality	Pavement surface roughness representing the sum vertical displacement measured across a road surface	Potholes, cracks, and other disturbances to a road decrease its smoothness and road quality.

Rationale for inclusion in this category:

Utility outages are related to strain on aging power grid infrastructure due to increased energy demand and extreme weather. Severe weather events, which are exacerbated by climate change, lead to increased weather-related outages. Michigan has been found to be the state with the longest average duration of outages annually.[111] Road quality is a measure of a road's condition, reflecting the pavement's structural integrity, presence of defects like cracks and potholes, and ability to provide a safe and smooth ride. Michigan ranked 40th in the 2025 National Road System Condition Assessment with significant economic losses in Detroit due to rough, congested, unsafe roads.[112] Asphalt road pavements are particularly affected by climate change through direct exposure to extreme heat, freeze-thaw cycles, and precipitation.[113]

Relevance to climate change:

Utility outages have been linked to health effects including carbon monoxide poisoning from improper generator use, exacerbation of existing cardiovascular and respiratory conditions, and anxiety.[114] Furthermore, outages that occur during extreme heat or cold spells can increase the risk of heat-related illness or hypothermia due to loss of the ability to use temperature-controlling devices.[115] Individuals using electricity dependent on durable medical equipment, such as ventilators, infusion pumps, and mobility devices, are at additional risk. Outages can also lead to food insecurity when refrigerators lack power and communication issues when phones and phone lines lose power.

Climate-related road damage can disrupt transportation options, particularly for low-income households and older adults, who are more likely to have transportation vulnerability. This can increase disruption to the supply of resources to vulnerable communities, particularly during climate-change related events.

3. Adaptive Capacity Metrics

Table 3A: National Funding & Programs

Indicator	Definitions	Explanation
Hazard Mitigation Spending	Number of Hazard Mitigation Assistance (HMA) grant programs	FEMA administers three programs that provide funding for eligible mitigation planning and projects to reduce disaster losses and protect life and property from future disaster damages. The three programs are the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA) grant program, and Pre-Disaster Mitigation (PDM) grant program.[116]
Flood Insurance	Percentage of housing units covered by National Flood Insurance Program	The National Flood Insurance Program (NFIP) aims to reduce the impact of flooding on private and public structures.[117]

Rationale for inclusion in this category:
The Hazard Mitigation Spending provides funding for mitigating the effects of future disasters, which directly supports adaptive capacity.[118] Flood insurance is a measure of financial preparedness to recover from extreme flooding.

Relevance to climate change:
As the frequency and intensity of disasters, such as flooding, increases with climate change, these funding programs can be important tools to build the capacity to respond to these events.

Table 3B: Community Support

Indicator	Definitions	Explanation
Religious Organizations	Religious organizations per 1000 people	Religious organizations refer to a wide variety of organizations including mosques, synagogues, and church groups.
Civic or Social Organizations	Civic or social organizations per 1000 people	Civic organizations aim to advance community welfare, public service, advocacy, and civic engagement through volunteering, education, and local improvement projects. Social organizations foster social ties, personal development, cultural activities, and support networks among their participants.
Emergency Shelters/Centers	Number of emergency/relief services per 1000 people	Emergency shelters are temporary accommodations and supportive resources provided to individuals or families experiencing homelessness or facing immediate danger, aiming to offer safety, basic needs, and a path toward permanent housing.
Community Food Services	Number of community food services per 1000 people	Community food services are entities that provide free or subsidized food to individuals or families facing food insecurity.

Rationale for inclusion in this category:
Faith-based organizations were included in this category because they are an important contributor to social connectivity in Wayne County. They can also be critical networks that provide social support and health promotion.[119] [120] Similarly, social and civic organizations within Wayne County foster social connectivity by sharing resources, advocating for social change, and organizing community-driven solutions.[121] Emergency shelters were included because they provide a safety net for residents who need extra support, especially during temperature extremes.[122] Finally, community food services were included because of their role as food providers during emergencies and times of uncertainty as well as hubs for mutual aid, volunteerism, and community empowerment.[123]

Relevance to climate change:
Social networks and community support systems are important determinants of adaptive capacity to climate-related events.[124] [125] During extreme climate events, strong social networks and existing support systems can enable collective action, facilitate the flow of information, and provide critical resources.[126]

Table 3C: Economic Resilience

Indicator	Definitions	Explanation
Expected Annual Loss: Agriculture	Average economic loss in dollars in agriculture resulting from natural hazards each year	This represents the average dollar amount of agricultural losses (like crops, livestock, or farmland) that a community is expected to experience each year due to natural hazards (floods, droughts, hurricanes, etc.). It combines how much agriculture is at risk, how often hazards are expected to happen, and how damaging they have historically been to agriculture.[127]

Indicator	Definitions	Explanation
Expected Annual Loss: Buildings	Expected building value at risk from losses due to natural hazards	This is the average yearly estimated dollar loss to buildings and structures (homes, businesses, schools, etc.) in a community from natural hazards. It combines how much building value is at risk, how often hazards are expected to happen, and how damaging they have historically been to buildings.[128]
Expected Annual Loss: Population	Expected cost from fatalities and injuries due to natural hazards each year	This represents the average yearly harm to human life and health from natural hazards. It converts this harm into a dollar amount using Value of Statistical Life of 11.6 million and combines it with how often hazards are expected to happen and how damaging they have historically been to human health.[129]

Rationale for inclusion in this category:

The National Risk Index metrics were included because they offer an economic lens on a community's capacity to withstand and recover from climate hazards.[130] Higher values indicate greater anticipated costs for rebuilding and maintaining resilience after a disaster.[131]

Relevance to climate change:

As climate change intensifies extreme weather events, these economic losses are expected to grow.[132] High expected annual losses may indicate areas that have less adaptive capacity to intensifying extreme climate events.

Table 3D: Environmental Resilience

Indicator	Definitions	Explanation
Local Food Suppliers	Number of locally sourced food suppliers	This indicator represents the concentration of local foods and farms (or sellers of local foods).
Walkability Score	National Walkability Index	The National Walkability Index assigns every U.S. census block group a score based on ranked measures of intersection density, proximity to transit, and land-use diversity.[133]
Flood Buffers	Percentage of land in wetlands	Wetlands are areas where water covers the soil or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season.[134]

Rationale for inclusion in this category:

A local food suppliers indicator was added to this category because of its relevance to Wayne County where there are many residents who experience food insecurity, especially with regards to locally grown, fresh produce.[135] Walkability is also a concern across Wayne County, such as pedestrian fatalities and minimal pedestrian-friendly infrastructure.[136] Lastly, natural flood buffers were added because Wayne County contains a significant number of wetlands.[137]

Relevance to climate change:

These aspects of the environment can be important measures of adaptive capacity to extreme weather events. Local food suppliers can increase resilience because they have shorter, more reliable supply chains (Community Economic Development, n.d.). Walkability means more connected routes, options for movement, and redundancy in access, so communities are not isolated if roads are blocked or resources are unevenly distributed.[138] Finally, wetlands can act as natural buffers and absorb excess water during flooding.[139]

Future Directions

The indicators provided in this report are intended to lay the foundation for a more comprehensive framework. In doing this work, there were several important data sources identified which have been listed in Appendix A below. Most of the data sources found provided information at the census tract level. Finding data at the community level was rare. However, it may be possible to estimate these by aggregating census tracts. This is one possible next step in the development of this tool. Data sets measuring proximity to adaptive resources such as cooling centers and resilience hubs were limited. Considering the importance of these resources in evaluating adaptive capacity, it would be beneficial to create such a data set for Wayne County. Additionally, metrics for water and energy efficiency were limited. A data set on water efficiency could be calculated using the total gallons of water consumed by a building divided by the total floor area.[140] A similar method can be used for energy efficiency, while integrating Detroit Energy Benchmarking Ordinance Data.

A natural next step for the People Tool Framework is to involve communities in determining assets and concerns in their areas that are not reflected in this tool. Community involvement in these decision-making tools ensures that local knowledge, priorities, and lived experience shape both how risks are understood and how adaptive solutions are developed and implemented. Because the research team does not reflect the full diversity of Wayne County, partnering with community members beyond government and academic circles is essential to ensure the tool captures risks as they are experienced by those most affected by climate change. Involving climate and environmental community leaders is essential to make the tool contextually relevant, trusted, and effective in addressing real community needs.[141] Participatory methods can also be useful in developing a weighting system for indicators identified. When viewed cumulatively, these indicators will hold more (or less weight) depending on community priorities.

Once a comprehensive framework is completed, and relevant data sets are created and aggregated, this work can be visualized in a multi-layer map, allowing users to explore the different forms of climate resilience across Wayne County.

Appendix I: Student Biographies

Camille Johnson

Born and raised in Detroit, MI, with social impact experience across the United States, Camille brings a unique lens to urban planning and design, having lived, advocated for, and organized across Detroit's many transitions. Camille is a multi-disciplinary strategist with a proven track record of transforming organizations by streamlining operations, building and leading high-performing teams, and creating compelling narratives to boost fundraising and development. She has designed and led impactful engagement strategies across the Eastside Community Network, the Bloomberg Center for Public Innovation, the National Memorial to the Underground Railroad, and numerous progressive campaigns. Camille received her Bachelor of Arts from the University of Michigan in 2012, and will complete her Master of Urban & Regional Planning from the Taubman School of Architecture and Urban Planning in April 2026.

Saj Elle McBurrows

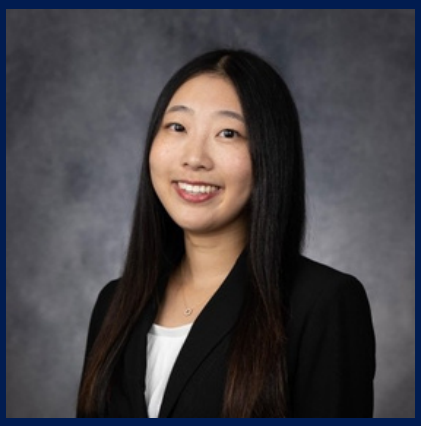
Saj Elle McBurrows is a dual Master's degree student in Urban and Regional Planning and Environment and Sustainability at the University of Michigan, specializing in Environmental Policy and Planning. She obtained a Bachelor of Arts in Sustainable Development with a concentration in Public Health from Columbia University in 2023. As an urban planning intern at McKenna, a local urban planning consulting firm, she has worked on master plans, parks and recreation plans, zoning amendments, and community engagement for communities across Wayne County. She recently completed her capstone project working with the Joe Louis Greenway Foundation and the City of Detroit, focusing on greenspace utilization. Her role in this project encompassed project management, team coordination, and deadline tracking.

Giuliana Motta

Giuliana Motta is a master's student studying Environmental Health Promotion and Policy at the University of Michigan School of Public Health. She also holds a dual bachelor's degree in Public Health Sciences and Environmental Chemistry from the University of Michigan. She is passionate about environmental health equity, with a particular interest in climate-related cumulative health impacts and Health in All Policies. Over the past three years, she has contributed to community-based environmental health research in Detroit through partnerships such as the Community Action to Promote Healthy Environments (CAPHE) and the Promotoras de Agua initiative. She has also worked at the intersection of public health and global climate policy, contributing to efforts that elevate health and equity within the United Nations Framework Convention on Climate Change.

Elisa Wang

Elisa Wang is a dual master's student in Public Policy specializing in economic policy and Environment and Sustainability at the University of Michigan. She also holds a double Bachelor of Arts in Economics and English Literature, along with a Law Program Certificate from National Tsing Hua University. Elisa has gained experience in asset management, where she supported mutual fund positioning and marketing through sector and industry research, and by monitoring macroeconomic trends and central bank policies to inform fund strategies. She also contributed to the launch of one of the first ESG funds in Taiwan. During her graduate studies, Elisa completed a fellowship in the U.S. Virgin Islands, where she initiated a federal climate justice grant proposal to establish a resiliency and emergency hub aimed at helping the island better prepare for hurricanes and other extreme weather events.



Amy Zhao

Amy is a medical student at the University of Michigan Medical School with a Bachelor of Sciences in Biology and Global Health from Duke University in 2021. She worked at the National Institute of Environmental Health Sciences after graduation investigating renal transcriptional responses to environmental exposures. She is particularly interested in children's environmental health and integrating climate-informed medicine into medical education and clinical practice. During medical school, she has worked on projects investigating prenatal and lactational PFAS exposures and birth and infant growth outcomes, efforts to add climate change and health content into the medical school curriculum, healthcare sustainability initiatives, and a needs assessment understanding patient perceptions of climate change. Amy is planning to pursue a career in pediatrics and will be starting pediatrics residency next summer.

Appendix II: Data Inventory & Sources

Sensitivity Indicators		
Indicator	**Potential Data Sources**	**At what level is this data available? (Census tract, county, zip code, community, etc)**
SOCIOECONOMIC		
Population Density	US Census	Census Tract
Older Adults Living Alone	American Community Survey Table B11010: Nonfamily Households by Sex of Householder by Living Alone by Age of Householder	Census Tract
Children	American Community Survey	Census Tract
Female Residents	American Community Survey	Census Tract
Immigrant Status	American Community Survey	Census Tract
POC	American Community Survey	Census Tract
Educational Attainment	American Community Survey	Census Tract
Limited English Proficiency	American Community Survey Table B15001: Sex by Age by Educational Attainment	Census Tract
Unemployment	American Community Survey	Census Tract
Low Household Income	American Community Survey	Census Tract

Indicator	Potential Data Sources	At what level is this data available? (Census tract, county, zip code, community, etc)
Population Density	US Census	Census Tract
Older Adults Living Alone	American Community Survey Table B11010: Nonfamily Households by Sex of Householder by Living Alone by Age of Householder	Census Tract
Children	American Community Survey	Census Tract
Female Residents	American Community Survey	Census Tract
Immigrant Status	American Community Survey	Census Tract
POC	American Community Survey	Census Tract
Educational Attainment	American Community Survey	Census Tract
Limited English Proficiency	American Community Survey Table B15001: Sex by Age by Educational Attainment	Census Tract
Unemployment	American Community Survey	Census Tract
Low Household Income	American Community Survey	Census Tract
Housing Age (proxy for access to energy efficiency and AC)	American Community Survey Table Table B25034: Year Structure Built	Census Tract
Housing Age (proxy for lead exposure)	American Community Survey Table Table B25034: Year Structure Built	Census Tract
Housing Code Violations	City or Township Government	Community

Indicator	Potential Data Sources	At what level is this data available? (Census tract, county, zip code, community, etc)
Housing Cost Burden	American Community Survey: Table B25106: Tenure by Housing Costs as a Percentage of Household Income	Census Tract
Home Owner Insecurity	American Community Survey	Census Tract
Renter Insecurity	American Community Survey	Census Tract
Energy Burden (subtab of homeowner and renter insecurity)	Census Reporter Low Income Energy Affordability Data	Census Tract
Renters	American Community Survey	Census Tract
Mobile Homes	ATSDR Housing Type: Mobile Homes	Census Tract
Homelessness	HUD: Annual Homeless Assessment Report	-
Vehicle Access	American Community Survey	Census Tract
Internet Access	American Community Survey: Table B25106: Tenure by Housing Costs as a Percentage of Household Income	Census Tract
Historic Disinvestment Score	Dataset of formerly redlined areas	Census Tract
HEALTH		
Life Expectancy	CDC PLACES Data CDC USALEEP Project	Census Tract

Indicator	Potential Data Sources	At what level is this data available? (Census tract, county, zip code, community, etc)
Self-Reported Physical Health	CDC PLACES Data	Census Tract
Asthma	CDC PLACES Data CDC National Environmental Public Health Tracking Network Asthma Tab	Census Tract
Other Respiratory Illness	CDC PLACES Data	Census Tract
Diabetes	CDC PLACES Data	Census Tract
Heart Disease	CDC PLACES Data	Census Tract
Obesity	CDC PLACES Data	Census Tract
Cancer	CDC PLACES Data	Census Tract
Mental Health	CDC PLACES Data (only Depression or self-reported Mental Health)	Census Tract
Low Birth Weight	Michigan Birth Files. Division for Vial Records and Health Statistics, MDHHS	-
Disability	American Community Survey Table B18101: Sex by Age by Disability Status	Census Tract
Access to Primary Care	American Community Survey CDC PLACES Data	Census Tract
Uninsured	American Community Survey	Census Tract

Indicator	Potential Data Sources	At what level is this data available? (Census tract, county, zip code, community, etc)
OCCUPATION/INDUSTRY		
Agriculture	SEMCOG Community Profiles	Community/City
Manufacturing	SEMCOG Community Profiles	Community/City
Natural Resources, Mining, Construction	SEMCOG Community Profiles	Community/City
Transportation, Warehouse, Utilities	SEMCOG Community Profiles	Community/City

Key
Baseline Indicator
Subindicator

Exposure Indicators

Indicator	Potential Data Sources	At what level is this data available? (Census tract, county, zip code, community, etc)
FLOODING		
Floodplains	FEMA US Flood Hazard Areas	Census Tract
Flood Risk Housing	Climate Risk Data Access	
Flood Risk Roads	SEMCOG Flood Risk Tool First Street Community Flood Methodology	Census Tract
Impervious Surfaces	CDC National Environmental Public Health Tracking Network Data Explorer	Census Tract
AIR POLLUTION		
Ground Level Ozone	Requia WJ, Di Q, Silvern R, et al. ATSDR EJI Explorer US EPA Bayesian Space-Time Downscaler Model	Census Tract
PM 2.5	van Donkelaar, A et al. ATSDR EJI Explorer US EPA Bayesian Space-Time Downscaler Model	Census Tract
Diesel PM 2.5 (subtab of PM 2.5)	ATSDR EJI Explorer	Census Tract

Indicator	Potential Data Sources	At what level is this data available? (Census tract, county, zip code, community, etc)
NO2	Goldberg, D L. et al.	Census Tract
Traffic Volume	ATSDR EJI Explorer	Census Tract
WATER QUALITY		
Stream Toxicity Risk	U.S Climate Vulnerability Index (Environmental Defense Fund)	Census Tract
Underground Storage Tanks and Releases	UST Finder	Only aggregated to county in layer, but can be aggregated to desired level
Wastewater Discharge	MIEJ Screen	Census Tract
Drinking Water Quality	Wayne County Water & Sewer Authority	Census Tract
TEMPERATURE		
Urban Heat Island Effect	EGLE Urban Heat Islands GIS Layer	Census Tract
TOXICS		
Formerly Used Defense Sites	Formerly used defense sites GIS	Data can be aggregated to desired level
Hazardous Waste Facilities	RCRAInfo Search US Climate Vulnerability Index (Environmental Defense Fund)	Census tract
Superfund Sites	EPA Search Superfund Site Information US Climate Vulnerability Index (Environmental Defense Fund)	Census tract

Indicator	Potential Data Sources	At what level is this data available? (Census tract, county, zip code, community, etc)
Lead Paint Indicator	MIEJ Screen US Climate Vulnerability Index (Environmental Defense Fund)	Census tract
Brownfield Sites	US Climate Vulnerability Index (Environmental Defense Fund)	Census tract
Toxic Release Inventory (TRI) Facility	EPA Toxics Release Inventory	Zip code
TSCA Facilities	US Climate Vulnerability Index (Environmental Defense Fund)	Census tract
Facilities with Enforcement or Violation	U.S. Environmental Protection Agency. Enforcement and Compliance History Online (ECHO). Database Data is already aggregated by US Climate Vulnerability Index (Environmental Defense Fund)	Census tract
Abandoned Mine Land	Abandoned Mine Land Inventory System	Data can be aggregated to desired level
INFRASTRUCTURE		
Utility Outage	request data here: Michigan Public Service Commission Distribution System Reliability Metrics	Zip code
Road Quality	MDOT pavement condition measures Highway Performance Monitoring System	Can be aggragated to desired boundary

Indicator	Potential Data Sources	At what level is this data available? (Census tract, county, zip code, community, etc)
CLIMATE & WEATHER		
Extreme Heat	CDC Indicators and Data CDC National Environmental Public Health Tracking Network	Census tract
Rainfall	US Climate Vulnerability Data (Environmental Defense Fund)	Census tract
Wildfire Smoke (Surface PM 2.5)	US Climate Vulnerability Data (Environmental Defense Fund)	Census tract

Key
Baseline Indicator
Subindicator

Adaptive Capacity Indicators

Indicator	Potential Data Sources	At what level is this data available? (Census tract, county, zip code, community, etc)
RESILIENCE PLANNING		
Hazard Mitigation Spending	FEMA Hazard Mitigation Projects Data Set FEMA Data	Zip Code
Flood insurance	OpenFEMA FEMA NFIP Total Dollar Amounts of Claims grouped by Census Tract	Census Tract
ENVIRONMENTAL RESILIENCE		
Walkability Score	National Walkability Index	Census Tract
Natural flood buffers	SEMCOG's wetland data	County, but can be overlayed with boudaries of choice
Locally-sourced food supliers	Local Difference	To be aggregated with boundaries of choice
COMMUNITY SUPPORT		
Religious or Faith-Based Organizations	National Neighborhood Data Archive	County, Census Tract, ZCTA
Civic Organizations	National Neighborhood Data Archive	County, Census Tract, ZCTA
Emergency Shelters/Centers	National Neighborhood Data Archive	County, Census Tract, ZCTA
Community Food Services	National Neighborhood Data Archive	County, Census Tract, ZCTA

Indicator	Potential Data Sources	At what level is this data available? (Census tract, county, zip code, community, etc)
Proximity to hospital emergency department	National Neighborhood Data Archive	County, Census Tract, ZCTA
ECONOMIC RESILIENCE		
Expected annual loss for agriculture	National Risk Index	County and Census Tract
Expected annual loss for buildings	National Risk Index	County and Census Tract
Expected annual loss for population	National Risk Index	County and Census Tract

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