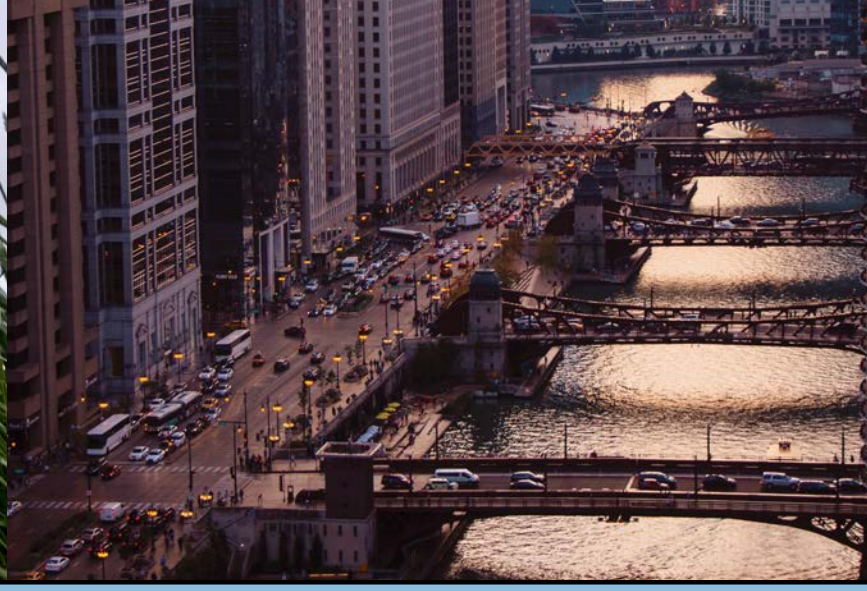
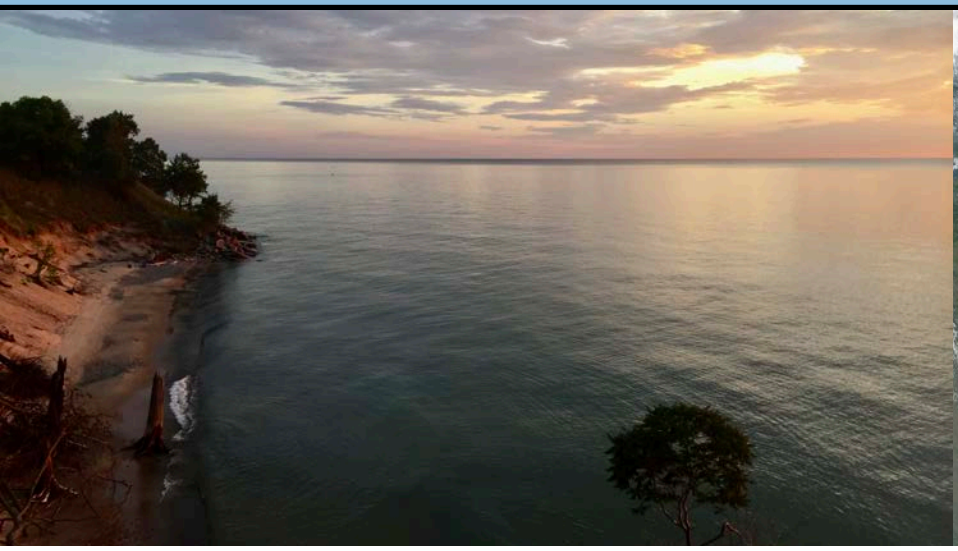


Socioeconomic Inequality and Climate Change Hazards: A Focus on the Great Lakes Region



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Socioeconomic Inequality and Climate Change Hazards: a Focus on the Great Lakes Region

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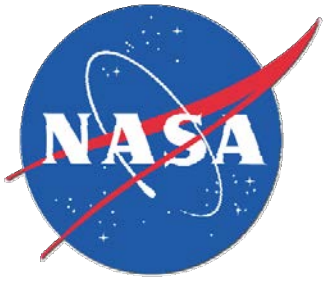

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Executive Summary

Society is reaching an inflection point on two critical issues: 1) a growing risk of climate change hazards, including disaster events due to changes in weather trends and ecological disruption, and 2) socioeconomic injustices and inequality, as illustrated by the impacts of the ongoing COVID-19 pandemic and recent racial unrest. Due to increasing societal awareness and momentum to address both climate change and socioeconomic issues, the combination of these forces presents an opportunity for substantial change aimed at creating a safer and more equitable society. Failing to simultaneously consider climate hazards and socioeconomic inequity risks worsening one issue in an attempt to redress the other.

The impacts of climate change are growing, widespread, and detrimental, and they exacerbate existing inequalities. Individuals and communities that are already experiencing socioeconomic vulnerability, perhaps inherited from past unjust practices, are less likely to have the resources to proactively build resilience against future climate risks and to recover from them. Therefore, when climate hazards do occur, these individuals and communities are exposed at a greater frequency and intensity than those of high socioeconomic status (SES). This results in further diminished resources and increased susceptibility to future risks for those affected. Yet, these hazards are becoming more intense and occurring more often due to climate change, increasing the chances that these low SES communities are exposed to climate risks.

Climate change and socioeconomic inequality are two "wicked problems." Wicked problems lack clarity in approach and solution; every action and choice implemented against these problems will have lasting consequences that cannot be undone. Working within the wicked problems framework, there are three steps that can address the systems-level approach that such immense and complex issues require: 1) implementation of numerous pilot projects to assess various action options, 2) rapid detection of success and failure, and 3) rapid dissemination of the information discovered and lessons learned.

Given the interconnectedness of climate risk with societal well-being, this report embarks on a review of this relationship, bounded by a particular geographic region: the American Great Lakes Region (GLR). The GLR is experiencing and will continue to experience the interaction of socioeconomic inequality and climate change due to the region's reliance on natural resources for its industries, employment, and income. The American Meteorological Society (AMS) Policy Program conducted an in-depth Intern Report on this topic that analyzes the region's socioeconomics and climate change risks and hazards separately and how these elements integrate in the region. Using this Intern Report as background knowledge, the AMS Policy Program sought to promote collaboration, open lines of communication, and discuss policy options across various sectors in order to address the interaction of socioeconomic inequality and climate change in the GLR. This conversation took place during a two-part workshop that gathered participants from academic, public, nongovernmental organization (NGO), and other sectors with ties to the GLR.

This study focuses on four aspects of addressing and exploring solutions for climate change, socioeconomic inequality, and their interactions that reflect the core values, lessons, and ideas that emerged from the workshop discussions: 1) community engagement, 2) partnerships and networks, 3) funding and grant systems, and 4) policy.

1. Community engagement, the process of approaching the community in a manner that is conducive to member participation, centers around the idea that community members are most familiar with their own wants and needs in response to climate and socioeconomic inequities. This idea acknowledges that the first step to successful engagement is to ensure accessible participation. Additionally, the incorporation of place-based knowledge and tailored solutions are helpful because they address challenges in a manner that is community led. Transitions of power, resources, or places at the table to marginalized groups may encourage greater participation of better suited yet underrepresented groups in the decision-making process.
2. Partnerships and networks, the vehicles for inter- and intracommunity collaboration, are empowered by sustained relationships rather than short-term, one-off projects. Communities and experts may be better supported by incorporating accessible information, value systems, and cooperation between technology, engineering, natural sciences, and social sciences into the decision-making framework, instead of prioritizing the accrual of additional knowledge. This approach may support existing networks and individuals who are already working to address a designated problem, leading to more mutually beneficial outcomes.
3. Funding and grant systems are designed to provide resources to a community, yet place constraints on already limited resources by requiring time, expertise, and money to apply to funds and grants. This creates a bottleneck and prevents some communities form receiving the resources they need.
4. Policy better captures the nuance of challenges and opportunities when tailored to a community in a bottom-up approach. This contrasts the implementation of top-down polices that rely on current systems in place—systems that are founded on and perpetuated by outdated ideologies. Therefore, building frameworks for solutions for climate change and socioeconomic inequality within these systems can be challenging.

While these frameworks outline opportunities for more intentional and detailed engagement, there are complexities and particularities at every scale that require awareness and analytical consideration. Local, small-scale approaches are not automatically superior approaches; they still empower a certain subset of people to overshadow less-powerful groups. Additionally, it cannot be assumed that the community shares a unified agenda, or that this agenda is congruent with social justice. To make these assertions risks a fall into the Local Trap—assuming an inherent positive quality of small-scale efforts that may or may not be present. Effective methods for societal progress exist at all scales.

Part I: Introduction

5. Background

Society is reaching an inflection point on two critical issues: 1) a growing risk of climate change hazards, including disaster events due to changes in weather trends and ecological disruption, and 2) socioeconomic injustices and inequality, as illustrated by the impacts of the ongoing COVID-19 pandemic and recent racial unrest. Due to increasing societal awareness and momentum to address both climate change and socioeconomic issues, the combination of these forces presents an opportunity for substantial change aimed at creating a safer and more equitable society.

Society is reaching an inflection point on two critical issues

The impacts of climate change are growing, widespread, and detrimental, and they exacerbate existing inequalities. Individuals and communities that are already experiencing socioeconomic vulnerability are less likely to have the resources to proactively build resilience against future climate risks and hazards. Therefore, these individuals and communities are exposed to climate risks and hazards at a greater frequency and intensity than those of high socioeconomic status (SES) when these events occur. This results in further diminished resources and increased susceptibility to future risks for those affected. Yet, these hazards are occurring at more frequent or intense rates due to climate change, increasing the chances that these low SES communities are exposed to climate risks. Although issues of socioeconomic inequality and climate change are complex, there are opportunities to make progress in both areas, beginning with the recognition that these phenomena are inherently linked, and therefore actions can be taken to address both issues together. This interaction greatly affects multiple stakeholders and populations.

When addressing this inflection point, there is an opportunity to create intentional responses by considering both climate risk *and* socioeconomic inequity when planning and implementing actions to address either. Failing to simultaneously consider climate hazards and socioeconomic inequity risks exacerbating one issue in an attempt to redress the other. It is seemingly impossible to turn a knob on one issue and have no effect on the other. For example, transitioning to clean transportation, such as electric vehicles or increased public transit, could influence job security for laborers or blue-collar individuals who work in the automobile manufacturing industry, resulting in unintentional socioeconomic impacts. Therefore, the overlap of issues creates a need for carefully constructed societal responses (e.g., policies) that have the potential to simultaneously reduce hazards of and vulnerability to climate change and to promote equity for people of all socioeconomic statuses.

Given the interconnectedness of climate hazards with societal well-being, this report embarks on a review of this relationship, bounded by a particular geographic region: the American Great Lakes. The American Meteorological Society (AMS) Policy Program

aims to facilitate engagement between scientists and the broader society with the hopes of expanding scientific understanding to advance societal benefit. Through this report, the Policy Program aims to inform policy makers and decision-makers of the challenges and opportunities at the intersection of issues in the Great Lakes Region (GLR).

The Policy Program previously conducted an in-depth Intern Report on this topic that analyzed the region's socioeconomics and climate change risks and hazards separately and explored how these elements integrate in the region (Sullivan 2021). Using this Intern Report as background knowledge, the AMS Policy Program sought to promote collaboration, open lines of communication, and discuss policy options across various sectors in order to address the interaction of socioeconomic inequality and climate change in the GLR. This conversation took place through a two-part workshop in May 2021 where participants were asked to consider effective methods of knowledge sharing and communication as well as how to address issues of socioeconomic inequality and climate change risks and hazards in the GLR successfully and simultaneously. Drawing on the expertise of key stakeholders, the discussions facilitated a better understanding of this complex interaction and opportunities for advancing toward a more equitable future. Participants from the Great Lakes Region were drawn from backgrounds spanning the public, NGO, and academic sectors and representing expertise in climatology, urban planning, social science, federal government, local government, small business, and Indigenous perspectives. While efforts were made in the planning stages of the workshop to be inclusive, we acknowledge that through both the format of the workshop and our outreach efforts we unintentionally failed to include a portion of perspectives that should be elevated: we intend to build on this learning experience by drawing in a wider range of perspectives in future conversations.

2. How Does Climate Change Affect SES?

Multiple independent lines of evidence demonstrate that people are rapidly causing the climate to change (Stocker et al. 2013; NASA 2021; Angel et al. 2018). These changes in the climate have impacts on the physical environment, biological systems, and the social and economic institutions that rely on these now-altered environments (Knutson et al. 2017; Higgins and Miller 2019). As a result, the effects of a changing climate will cause disruptions for individuals and communities that rely on these natural and socioeconomic systems. For example, there is high confidence that the increased global temperatures caused by high levels of greenhouse gases (GHGs) in the atmosphere will increase precipitation in seasons and regions that already experience wet spells and will decrease precipitation in seasons and regions that experience dry spells (Collins et al. 2013). This change in atmospheric and climatic trends, in conjunction with anthropogenic activities such as land management, infrastructure builds, and environmental degradation, can intensify or culminate in hazardous events such as floods, droughts, heat waves, wildfires, and other adverse impacts. These factors may also alter the frequency of such adverse events (e.g., coastal flooding occurring more often), increasing exposure and vulnerability to risk in a manner for which society has not historically had to prepare (NOAA Office for Coastal Management 2021). This may

result in additional negative societal outcomes (e.g., disruptions in transportation; damages to life and property).

Numerous interacting factors may determine the intensity of climate hazard impacts. These factors can include, but are not limited to, 1) type of impact, 2) magnitude of impact, 3) rate of change as a result of impact, and 4) existing institutionalized structures (Sullivan 2021). These factors all influence the way a particular impact is distributed throughout society and who feels the impact most intensely.

Available evidence suggests that in most circumstances, climate change tends to exacerbate inequalities (Substance Abuse and Mental Health Services 2017; Stocker et al. 2013). Preexisting low socioeconomic status 1) increases vulnerability to risks and hazards; 2) increases exposure to risks and hazards; 3) increases likelihood of exposure affecting other compounding stressors (poor water or air quality, malnutrition, preexisting health conditions, etc.); and 4) decreases adaptive capacity, or ability to recover, to a given hazard. The limitations on adaptive capacity subsequently increase vulnerabilities and the cycle persists. In some cases, life skills (e.g., familiarity with adversity and adaptability) may be useful for dealing with the impacts of climate change; however, power and political clout can be more influential factors in determining how severely a community's resources are impacted by climate and weather events. Those with more power and influence are usually in a position to proactively protect themselves from potential hazards and recover more quickly from impacts while those with low socioeconomic power often do not have the wealth and influence for such built resilience. This cycle of socioeconomic inequality is maintained when climate change impacts aggravate preexisting inequalities (Fig. 1). For example, individuals living in a coastal area with financial means may elevate or retrofit their house to preemptively protect it from flood events. Conversely, other individuals in the same region facing the same hazards may not have the upfront capital to take such measures, subsequently facing the need to pay for damages after the hazard. This becomes especially burdensome as climate hazards occur more frequently and more intensely: recurring hazards, like coastal flooding, are especially troublesome for communities with limited resources. This existing relationship in which climate change risks and hazards exacerbate socioeconomic inequalities is reinforced over time.

Climate change tends to exacerbate inequalities

While this study is focused on how climate change exposes and exacerbates socioeconomic inequalities, it is important to acknowledge that the relationship between climate change and socioeconomic inequality is bidirectional. Existing inequalities support systems and policies that allow the advantaged individuals and communities to continue with GHG-producing and environmentally disruptive behaviors at rates higher than those with low SES (Fig. 1). Such examples include more frequent use of private vehicles, travel, and engagement in the consumption economy. J. Timmons Roberts, an environmental policy expert at Brown University, expresses worry over this

exacerbating relationship and how to produce an adequate societal response. He states that this scenario is “almost the worst possible setup for trying to solve the problem, to have some group that’s already rich and powerful actually getting some boost from this effect, while the poor sufferers are suffering even more”(Borunda 2019).

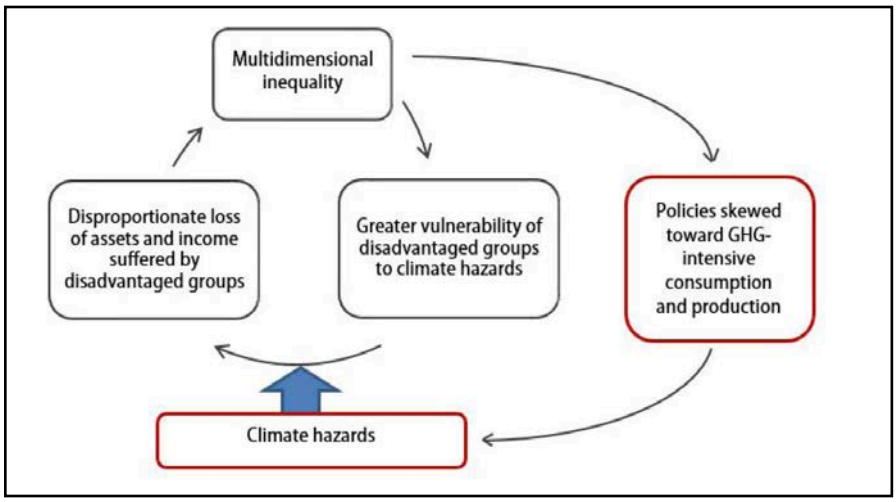

Figure 1: The reinforced cycle between inequality and climate change. Islam, S. N. and J. Winkel, 2017: Climate change and social inequality. United Nations Department of Economic & Social Affairs. Figure reproduced with permission

3. Issues for the Great Lakes Region

The GLR spans the Midwest and Northeast regions of the United States and includes five freshwater lakes that cover an area of over 94,000 square miles (U.S. Census Bureau 2012). The lakes contain over 5,500 cubic miles of water and extend for nearly 10,000 miles of coastline, holding 95% of the United States’ liquid freshwater and 21% of the world’s freshwater (Breffle et al. 2013; Great Lakes Commission 2017; The United Nations 2016). Over 25 million people in the United States depend on the lakes’ water for drinking (Breffle et al. 2013). Although definitions for the region vary, this report considers only the U.S. states that border the Great Lakes: Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York (Fig. 2) (U.S. Climate Resilience Toolkit 2019).

The region’s reliance on the Great Lakes for its industries, employment, and income create an opportunity to understand and examine on a regional level the relationship between socioeconomic inequality and climate change. Historically, the lakes’ navigable waterways have encouraged settlement, trade, resource mining, and manufacturing (Vacarro and Read 2011). This has shaped the economic landscape of the region by positioning it as a central trade location beginning in the seventeenth century (Council of the Great Lakes Region 2017). The region is often associated with its manufacturing industry, although tourism, recreation, shipping, and agriculture generate substantial business for the region as well (Desjardins 2017). An analysis of data from the 2009

Bureau of Labor Statistics demonstrates that more than 1.5 million jobs are directly connected to the Great Lakes (Vacarro and Read 2011). Therefore, the region's economy is vulnerable to climate change as changes to the region's natural resources are directly related to its economic well-being.

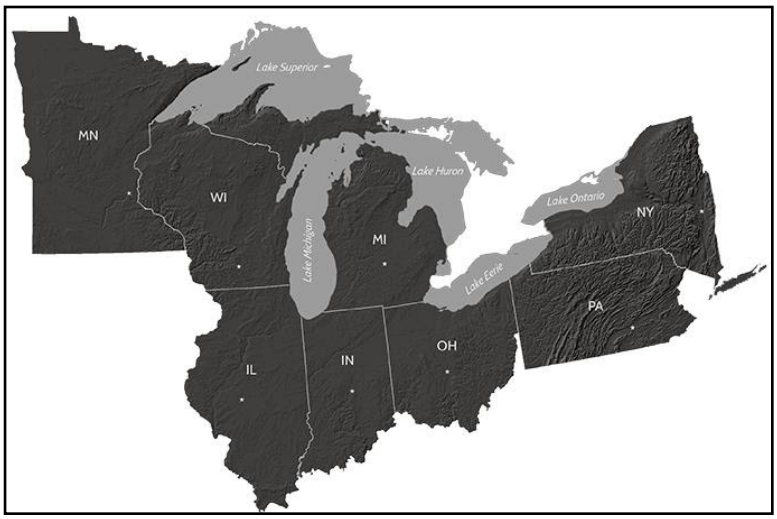

Figure 2: A map of the Great Lakes Region including all five of the Great Lakes. U.S. Climate Resilience Toolkit, 2019: Great Lakes. Image reproduced with permission.

The GLR will continue to face various challenges as a result of climate change; these obstacles include a trend of higher air temperatures and an increased precipitation rate, double that of the national average (Angel et al. 2018; Wuebbles et al. 2019). The increased temperature is predicted to cause a rise in premature heat-related deaths in the region, possibly up to 2,000 deaths by 2090, when models are run using high carbon emissions scenarios (Angel et al. 2018). Additionally, an increase in precipitation, including more regular rain events exceeding six inches, may lead to an increase in the frequency of rural and urban flooding, creating greater concern of increased contamination events (Patz et al. 2008; Wuebbles et al. 2019). Further, changes to climate and the environment will affect the flora and fauna that inhabit the GLR. As environmental disruption occurs under fluctuating temperatures and precipitation events, invasive species will become more common and cause further stress on native species throughout the region and in the lakes as well (Kling et al. 2003). The decreasing productivity and presence of lake diatoms is also attributed to climatic changes and the presence of more invasive species. Diatoms are the primary producer of the aquatic food chain and without these algae, other aquatic species will lack sufficient calories and the food web will be at risk; Lake Erie has already experienced a 90% decrease in diatom population in the past 35

The Great Lakes Region will face challenges as a result of climate change because of its reliance on natural resources

years (Folger 2020). Additionally, warmer water temperatures combined with increased nutrients from agricultural runoff can lead to harmful algal blooms (HABs). HABs are particularly destructive to other aquatic life as they deplete oxygen levels in the lake and, in the case that these blooms enter drinking water, can cause shortages in available water for regional residents as well as necessary services like hospitals (Folger 2020).

The environment, and subsequently economics, of the GLR are characterized by the lakes themselves; therefore, the impacts to the freshwater system are of significant interest. The Great Lakes have historically followed a cycle of high and low lake levels influenced by global climate variability, the regional hydrological cycle, precipitation, evaporation, and climate events (Gronewold and Rood 2019). Climate change has and will continue to alter these interactions and create a complex and unfamiliar dynamic, ultimately leading to rapid shifts in lake levels (Gronewold and Rood 2019). Recent evidence suggests that the influences of climate change on the lakes will create a "new normal" for water levels, defined by rapid transitions between extreme high and low water levels (Gronewold et al. 2021). These transitions can be thought of as a "tug-of-war" between evaporation and precipitation within the region, resulting in extreme oscillations between record high and record low water level (Gronewold et al. 2021). For residents in the region, a drastic and continued fluctuation between low and high water levels may result in coastal erosion, flooding, and threats to public health and safety.

Within recent years, Chicago has experienced challenges as a result of both low and high lake levels. In 2013, Lake Michigan reached a low not seen since the mid-1800s (Egan 2021). Cargo ships could not be fully loaded, causing havoc on the shipping industry. In contrast, a series of storms and increased precipitation led to an emergency situation in May 2020 where both lake and river levels were so high that parts of the city flooded, and Chicago's sewer plants and river systems were so overwhelmed that waste and sewer water overflowed into Lake Michigan (Egan 2021).

Although the region will face unique and difficult challenges, much of the region's northern latitude will experience cooler temperatures and higher water availability compared to a majority of the United States. Though the region will likely experience the effects of a globally changing climate, hurricanes and wildfires, which have become more frequent in other regions, are unlikely to play a major role in the GLR (Schneider 2021; Brown 2020). Consequently, the GLR may serve as a destination for climate migrants who were previously vulnerable to such hazards. While many other regions may experience an exodus, the GLR may be met with an influx of people: Duluth, Minnesota, has recently been rebranded as "climate-proof Duluth" as an illustration of its resilience and an incentive for incomers (Pierre-Louis 2019). It may be that climate migrants who move into the region are able to do so because they have the wealth and resources to escape hazards while low SES families in vulnerable locations may be unable to migrate. This potential influx of wealth and influence is a cause of concern in the community, specifically inciting fears that low SES residents will be displaced or that incomers may exert disproportional power over local political or socioeconomic community decisions. This influx of residents will likely result in an increase in demands for land and resources, a struggle that historically has been oppressive of the

existing Indigenous communities. Indigenous culture and cultural identity are deeply connected to landscape and reciprocity with the environment; the loss of these places and ecosystems challenge cultural practices and identity (Norton-Smith 2016). It is essential that Indigenous people across the GLR remain practicing native people despite challenged access to resources and land that may occur as a result of the changing climate and environment across the country.

Part II: Addressing Wicked Problems

Climate change and socioeconomic inequality are two "wicked problems" as defined by Rittel and Webber (1973). As opposed to "tame problems" that have set solutions reached through the application of set formulas, wicked problems lack clarity in approach and solution. Wicked problems necessitate numerous non-uniform approaches. These approaches strive to uncover steps toward progress while simultaneously requiring an understanding that many of these attempted solutions, in a trial and error fashion, will not be successful. However, unlike tame problems that allow unrestricted inconsequential trials in search of a solution (e.g., solving an algebraic equation), every action and choice implemented in response to wicked problems will have lasting consequences that cannot be undone. Such illustrations include public policy decisions that address education, poverty, or public health. Though the approach to addressing wicked problems may seem to instigate fear of failure, without an attempt toward forward progress the wicked problem will persist.

Without an attempt toward forward progress, wicked problems will persist

The previous sections outlined the interconnectedness of two relevant wicked problems that affect many aspects of society. Working within the wicked problems framework, there are three steps to address the systems-level approach that such immense and complex issues require: 1) implementation of numerous pilot projects to assess various action options, 2) rapid detection of success and failure, and 3) rapid dissemination of the information discovered and lessons learned. With these steps in mind, Part II will reflect the core values, lessons, and ideas that emerged from the workshop discussions that the AMS Policy Program has synthesized into frameworks for solutions.

4. Community Engagement

When referring to socioeconomic inequality in communities, there is no sole definition of a "low SES community"; instead, there are factors that interact to contribute to one's SES. These factors include but are not limited to geographical region (urban, suburban, rural; coastal or inland), wealth, income, education level, and race and ethnicity. In the American context, race and ethnicity are factors that influence SES because BIPOC (Black, Indigenous, and People of Color) individuals and communities have historically

been marginalized and restricted from economic gains—a result of unconscious bias and purposefully inequitable institutions and structures (e.g., redlining policies) (Aaronson et al. 2021).

a. Frameworks for inclusive approaches

Prior to engaging in conversation with communities, scientists and decision-makers may find value in creating a space or method for community voices to be heard in order to strengthen the partnership and allow for more diverse inputs. Communities of low SES historically lack political power; therefore, intentional engagement with these groups may provide another avenue for the amplification of underrepresented voices in decisions and create an improved understanding of the full perspectives of the community. Conversations are shaped by the perspectives and the background that participants bring to the discussion. Therefore, the consideration of which voices are invited, who is given a platform to speak, and if those voices reflect the communities directly impacted by the issue affect the discussion's outcomes and the decisions made. In order to increase community participation, researchers and decision-makers could focus on eliminating barriers to participation for individuals who are affected by complex issues, such as climate change and socioeconomic inequity, and creating welcoming environments for diverse perspectives. Such practices can allow complicated issues, like the overlap of socioeconomic inequality and climate change, to be addressed in a more holistic approach led by the community.

Conversations are shaped by the perspectives and the background that participants bring to the discussion

Attuned individuals within the community have years of first-hand experience and observations that researchers and decision-makers from outside the community often cannot replicate with a short-term project or evaluation. This is not to say that every community member is an expert on the scientific or technical mechanisms underpinning certain issues, but rather that the members of a community are knowledgeable in their own perceived needs, wants, and values as they relate to the problem at hand. Outside individuals coming into community spaces may find that spending time understanding how these communities' needs and interests interact with the science, systems, and potential solutions aids in the process of advancing toward a common goal. Projects that incorporate listening, centering voices of the community, and understanding the community's vision of success at the beginning stages of the process are likely better able to address the nuances of the issue in relation to that community, as opposed to projects that do not seek early community input. Cookie-cutter or "one size fits all" approaches are likely insufficient and exclusionary of certain groups. Accepting that community members' knowledge and opinions will influence decision-making (without overruling scientific and technical processes) can lead to progress as opposed to stagnant disunity. Community input is one component of

decision-making: science, politics, ethics, and value systems are also involved in making decisions.

In order to listen to all voices in a community, researchers and other partners can create opportunities to enable methods of hearing these voices. The ability to interact with outreach events is a privilege for some: surveys, town hall meetings, listening sessions, or other interactive approaches to community engagement may exclude residents that do not have resources or time to participate. Meetings held between 9 a.m. and 5 p.m. may exclude those who hold jobs within those hours; meetings held after work may exclude people who need to provide a meal for their family or transport children to extracurricular activities; a digitally circulated survey may exclude responses from individuals who do not own electronics or have reliable internet access. Providing community members with the resources they need to become active participants may allow for more comprehensive community feedback. If a meeting is held during dinner hours, event organizers may consider providing food if funding allows; if community members have responsibilities to care for young children, the provision of childcare for the duration of the meeting may lead to a larger event turnout; if individuals need better access to the internet in order to fill out a survey, surveyors that provide non-digital formats may find that their data collection attempt is more representative of the community as a whole. A request of a community's time, attention, and expertise may be better received if accompanied by resources that will ease the burden of participation. This intent of broadening and making the process of participation easier can be facilitated by tapping into established community systems such as schools, libraries, places of employment, or other areas that people frequent. These existing structures in people's everyday lives may provide an opportunity to seek feedback, input, or other methods of participation.

Individuals are shaped by personal perspectives that can include but are not limited to age, gender, socioeconomic class, geographic location, religion, and field of study. When conflicts surrounding information and decision-making arise, it may be beneficial to consider how these perspectives influence an individual's opinion on or approach to a specific issue. Open communication with individuals and an understanding of their priorities and perspectives may allow external entities to better tailor their communication tactics to particular audiences for mutually beneficial outcomes. This ability to tailor information begins with the practice of intentionally listening to community members and acknowledging their value systems. Values and ethics are one factor among many that determine what information is accepted or rejected within communities. Outside organizations and individuals may look to the concept of Shared Intentional Engagement to better understand how to communicate with residents. The theory argues that an audience's personal experience and subsequent use of certain language influences participation between in-groups and out-groups (Durt 2014). This idea further explores how words, projects, or presentations may be interpreted differently by various groups or individuals based on their shared ethics and values, thus highlighting that method and means of communication are connected to the success of community engagement.

Although community engagement is often focused on place-based initiatives, some individuals may not feel a connection to the particular place. A place-based solution approach can be helpful, but solely relying on such a framework may exclude those without emotional, historical, or cultural ties to the location or community. Discussing the effectiveness of place-based initiatives with community members may help identify if these initiatives feel empowering or disconnecting for individuals. Some of these individuals may include immigrants, climate migrants, or people who break with established community norms. Engaging with these perspectives may present the opportunity to enable broader participation in the community when addressing issues.

Inequality inherently means that there are advantaged and disadvantaged groups; so far, this paper has only discussed those negatively affected by the challenges of socioeconomic inequality and climate change. However, advantaged communicates have the opportunity to acknowledge the unfair systems that have granted them advantages and hold themselves accountable for their role in these unfair systems. This involves not allowing the overwhelming scope of complex challenges such as the overlap of climate change and socioeconomic inequality to be paralyzing; these are two issues that many advantaged groups continue to exacerbate and can take critical actions to mitigate. Wealthy, influential, or well-off individuals and communities can use their advantages (e.g., access to resources, political influence) to address equity gaps that could possibly be a greater burden (e.g., more time, greater share of resources) to disadvantaged individuals and communities.

Another potential avenue for successful community engagement includes the conscious involvement of youths. The effects of climate change are intensifying and will likely be more harmful to younger generations (Machemer 2021). Including and supporting youth perspectives on the climate crisis may bring vitality and nuance to climate solution movements as well as prepare them with skills for the future. The effort to educate and inspire youths to be knowledgeable about this rapid global change can be accomplished through a variety of methods. Such approaches may involve altering school curricula, investing in K-12 education, or empowering and championing scientists through storytelling or leading by example.

To illustrate, the Great Lakes Steward Initiative (GLSI) focuses on K-12 education in order to contribute to environmental quality throughout the region (Great Lakes Stewardship Initiative 2020). As part of this initiative, schools engage teachers, students, and staff in place-based learning: GLSI provides professional development for educators, networking to community-based organizations, and funding. While working with GLSI, the Detroit Institute of Technology (DIT), a high school in Detroit, Michigan, incorporated land stewardship into their curriculum (Nielsen et al. 2016). Students worked alongside teachers to restore Rouge Park, a nearby park with a history of water quality, littering, and pollution problems, as part of the ninth-grade English, social studies, and science curriculum. This experience allowed students to learn about and connect to broader themes such as “nature as a commodity” and environmental stewardship. This incorporation of real-life climate and environmental issues in school curricula is a successful case of youth engagement, encouraging young members of the

community to become involved in complex yet critical issues without demanding extra time or work from the students.

b. Transitions of power

Arnstein's Ladder of Citizen Participation is a social science theory that encourages a successful transition of power or control over decision-making. This proposed transition moves from power allocated in institutions alone to all citizens. It can be used as a helpful framework for altering power dynamics as they relate to the nexus of climate change and socioeconomic inequality. This idea demonstrates an efficacious power structure that incorporates community involvement and the sharing of planning and decision-making responsibilities in the transition from institutional power to citizen power (Organizing Engagement 2021). This framework allows for the discussion of assets beyond financial by focusing on developing social and human capital as they relate to and are defined by community priorities.

Individuals and groups with power can shift their power, and other available resources, to disadvantaged communities in an act of allyship. This can include giving up a seat at the table, literally and metaphorically, to support the amplification of better suited yet marginalized voices in discussions and decisions. In general, shifting other resources may be effective in empowering communities; equipping individuals with money, knowledge, skills, or other abilities may result in a more fruitful outcome.

Transitions of power may alleviate some pressure for researchers and decision-makers, as individuals cannot attempt to accurately speak from any perspective besides their own. However, some individuals belong to multiple spaces and identify with many groups; therefore, these individuals are often asked to bear an additional burden of time and energy in order to share their experience for the education of others. This is often felt by minority individuals (e.g., a scientist who also identifies with a particular underrepresented group). Many individuals have this capability to navigate multiple environments; however, underrepresented groups are more often asked to reflect and share their experience doing so. Thus, effective transitions of power are an opportunity to replace these one-off requests for time and attention with sustainable incorporation of underrepresented voices. Especially when considering underrepresented communities, it is essential that those involved in the conversation recognize a direct benefit for themselves, if they choose to participate.

One example of a community effort that exhibits this commitment to the transition of power is the Duluth Citizens' Climate Action Plan (Duluth CCAP) (Ecolibrium3 2021). The initiative was led by community members through a network of concerned citizens, united by their shared interest and engagement in energy and climate-related work. This citizen-led effort to inspire community-wide action works collaboratively with various sectors and is funded by nonprofits that envision a sustainable and equitable future for the city. This effort resulted in the City Council of Duluth declaring a Climate Emergency, which encouraged the city to exceed their goal to reduce greenhouse gas emissions of city operations and buildings by 80% by 2050. CCAP recognized that city emissions only composed 4% of the community's emissions and are working across food

and agriculture, transportation, infrastructure, and energy production sectors to meet that goal for the rest of the community. CCAP engages with these sectors in a multitude of ways. The organization included food and agriculture as a focus area, by encouraging development of a local and ecologically sound food system infrastructure with local organization. Niiwin Indigenous Foodmarkets, numerous farmers markets and Community Supported Agriculture (CSA) partners are promoted within CCAP's work in order to achieve this goal. Partner organizations have helped to spread awareness of the citywide composting program and the "Superior Grown" label, which identifies locally grown food and local businesses for consumers. This initiative exemplifies that these ideas are possible to carry out and many communities are beyond the theorizing stage and have already begun implementing them.

Individuals and groups may shift their power or resources to disadvantaged communities in an act of allyship

When considering who, or what, is affected by climate challenges and which voices are included in the discussions surrounding solutions, nonhuman lives and the environment in general can often be neglected. Individuals with the resources to advocate on behalf of clean water, clean air, animals, plants, and the ecosystems as a whole may find that such environmental advocacy will support environmental justice as well. There are opportunities to look outside traditional Western thought processes and incorporate other frameworks for decision-making. For example, Indigenous cultures have demonstrated respect and consideration for the environment and other nonhuman life from which society at large can learn.

5. Partnerships and Networks

Building and solidifying inter- and intracommunity partnerships based on respect, common values, and open communication may help in reaching community and societal goals. Collaboration between and amongst various fields and sectors in an interdisciplinary manner may enable communities to holistically respond to the dual-pronged challenges of socioeconomic inequality and climate change risks and hazards.

a. Existing partnerships and networks

The GLR has a number of existing organized networks specifically pertaining to climate science. The Great Lakes Integrated Sciences and Assessments (GLISA) is an academic-public partnership through universities in the state of Michigan and the National Oceanographic and Atmospheric Administration (NOAA) striving to enhance communities' capacity for decision-making surrounding climate issues. The Great Lakes Climate Action Network (GLCAN) is another regional partnership with local governments that aims to collaborate and support one another in their communal efforts to mitigate and adapt to climate change. These networks share resources, data,

and other necessary tools in a synergistic capacity, allowing for more rapid and integrated action to be taken together rather than as individual entities.

Communication within scientific fields is fairly cohesive: individuals that study similar niches are often aware of colleagues' work. However, an existing communication gap between technology, engineering, and natural, and social sciences makes such cohesion less common across different fields of expertise. Since these disciplines do not share the same base of knowledge, academic infrastructure, set of policies and standards, or workforce, it can be difficult to ameliorate the disconnect. For these reasons, existing networks like the aforementioned GLISA and GLCAN exemplify collaborative successes that bridge this gap.

Interdisciplinary collaboration may offer holistic responses to complex issues

Despite a traditional disconnect between social and physical/life sciences, there are individuals and organizations who work in such interdisciplinary spaces. For some, this interdisciplinary work is less of a choice and more of a necessity of circumstances. Individuals of marginalized communities, such as immigrants, people of color, and especially Indigenous people, are held to Western standards in addition to their own ties of personal culture. These standards demand these individuals to navigate within and across more than one contextual environment, a process that can result in effective and interdisciplinary work; however, it also further increases the burden on these individuals. As more decision-makers pivot their attention to the importance of interdisciplinary collaboration, opportunities arise for sectors and enterprises to provide support to the individuals and organizations that are already doing this work. Participants of the AMS workshop affirmed that having one entity strengthen its relationship with members of the community is preferable to having multiple entities all vie and compete for community members' time, attention, and resources.

b. Factors for decision-making

Ethics and value systems are some of many factors that influence decision-making, especially when such systems interact with the scientific process or scientific knowledge. Ethics and value systems were previously discussed in the context of communication (section 4a); however, value systems are also reflected in the opinions people hold and who they interact with, creating social in-groups and out-groups. Differences of opinions regarding approaches to global issues that require global mobilization, such as taking action on climate change and social equity, can commonly become politically or emotionally charged. Existing inequalities hinder efforts to build unity and the shared vision needed to adapt to or mitigate for a changing climate. With drastically different backgrounds, individuals may be unable or unwilling to approach the other group to join efforts in addressing issues, often due to preconceived notions. Participants of either in- or out-groups can become disenfranchised with the other. Individuals may wonder if it would be more productive to communicate with the outsiders in an attempt

to persuade them of a different opinion, or to rally one's in-group and speak solely to like-minded individuals. This disconnect challenges the promotion of a productive partnership. However, when two or more parties come together and identify a common value, this value can act as a base for constructing a common vision or goal. This foundation of understanding is powerful and may help individuals reach across barriers or misunderstandings in order to make advances through shared decisions.

Certain priorities may also influence decision-making, especially when considering priorities that span short- versus long-term time scales. For individuals and families of low SES, priorities may run in the short-term given restriction of resources: the need for food, shelter, and immediate well-being may be prioritized over carbon emission reduction actions that will only prove fruitful with collective action and time. Not every community has the privilege that allows contribution to collective action on large time scales.

Information and scientific data are also instrumental in the decision-making process and have enabled the scientific community to inform the broader society of our current climatic status. Current investments in scientific data will ultimately allow society to better address future problems and to neglect support for science now may leave future generations at a disadvantage, less able to make novel discoveries and continue scientific advancement. While there are still gaps in the knowledge base and while basic research is still a valuable endeavor, the growing sentiment in the climate community is that additional scientific knowledge is not currently the most crucial aspect of decision-making. The specifics of scientific data may be beneficial for targeted adaptation actions; however, until there is consensus and collective action against climate change, the details are not productive in conversation with the general public. Instead, communicating the core science related to climate change at a more generalized scale can effectively illustrate the threats posed to the environment and society.

The "Last Mile Problem" defines a barrier to incorporating science in decision-making: it encompasses the idea that the last step in the value chain is not fulfilled. In this case, the scientific information is observed, gathered, synthesized, and analyzed, but perhaps the science is not communicated effectively to the public, communities that are presented with data are unsure how to apply it to their operations and actions, or the information is not translated into relevant policy. There are two areas of focus that may be able to address this Last Mile Problem: supporting the communication skills of scientists and encouraging communication across organizational boundaries. The accessibility of scientific information is important in decision-making. If the information is not usable it may hold less immediate value to decision-makers. The ability to package and present data in an accessible manner for target audiences is currently treated as an "add-on" to the scientific process but could be viewed as a necessary skill in order to bridge the disconnect between science and decision-makers and the public in general. Additionally, hydrological, meteorologic, climatic, and limnological events radiate beyond human-imposed boundaries, making communication across such divisions essential to understanding local environments. Scientific information and data, including climate and weather data, that are accessible

across municipalities, organizations, and sectors, are often useful and therefore have value in the decision-making process. Scientists and decision-makers have noted the importance of these information networks and succeeded in setting up some effective lines of communication, as evidenced by GLISA and GLCAN.

Climate Change Vulnerability Assessments (CCVAs) are one tool that may enable successful engagement with communities on complex issues through usable and accessible science. CCVAs can be used in the beginning stages of the adaptation planning process by highlighting the greatest risks climate changes pose to communities, species, or other systems of interest (University of Wisconsin-Madison 2020). These assessments pinpoint factors that lend to vulnerability, including but not limited to direct and indirect effects of climate change and nonclimate stressors (e.g., socioeconomic inequity, institutional constraints, habitat fragmentation, pollution). The Minnesota Pollution Control Agency conducted a climate vulnerability assessment for the City of Duluth that recommends prioritizing community resilience and mitigation responses by considering specific geographic and socioeconomic features of the community such as habitats, city infrastructure, and neighborhoods (The City of Duluth, Minnesota 2018). The assessment highlights the importance of adapting responses to community needs; specifically, when resource limitations restrict implementation capacity, projects that address and protect Duluth's most vulnerable populations should be prioritized (those living in economic stress, older adults, and individuals with disabilities represent those with the most significant vulnerabilities). The CCVA also focused on the way climate change may change the community: warmer winters result in additional ice and freeze-thaw that in turn increase salt concentration and more permanent damage to local water bodies; increased storms may result in an increase of combined sewer overflows. This specialized assessment allowed for specific recommendations. For example, to increase food security for residents, especially those most vulnerable to food insecurity, the prevalence of community gardens and family gardens should be expanded through the continued development, improvement, and communication of the city's urban agriculture policies and ordinances at a low cost. A CCVA can be a great beginning step to identify and prioritize climate action planning in a community.

Lack of effective communication of science with the public poses a barrier to the incorporation of science in decision-making

c. Academic–community relationship

In relation to academic studies, communities often express an interest in participating as collaborators instead of being viewed as research subjects. There is little emphasis on participatory action research in traditional academia—research that purposefully engages the community during all aspects of a research inquiry, from the scope of topic, research question, and all the way through communication of results and actionable

steps. There are steps that communities subject to research would like to see practiced by academics including pursuing participatory action research, exposing the community to resources, acting as a liaison, and taking a backseat in conversations. These practices are sometimes difficult to carry out, as funding structures for academics and decision-makers often include few incentives for in-depth community engagement, even for projects where this approach is appropriate and requested by all parties. Additionally, researchers have not always acknowledged the privilege of their position that comes with observing and critiquing systems happening to others and not themselves. Some researchers are able to exit the spaces they enter and distance themselves from their work, while most community members living *in* these systems cannot so easily exit the "researchable" inequities, injustices, or climate hazards. This does not discount the work of various researchers who may be from a particular community and have chosen to address issues that affect their community.

The stress of research fatigue is settling in communities, putting further strain on the relationships between these communities and academics or other researchers. Research fatigue is described as community members feeling the weariness or exhaustion that comes from being over-researched, over-engaged, or over-questioned by a research team, especially when few tangible results are seen (Way 2013). This burden of over-engagement is most often placed on minority or underserved communities when outside researchers, with the intent to aid a perceived community concern and focus on addressing injustices and inequality, ask too much of an already under-resourced community. Community members additionally find concern in the perception that some researchers prioritize their academic interests above the focus on direct community benefits—adding to the widespread feeling of exploitation. While this may not be the intention of the research community, their actions will be perceived within the greater context of social, cultural, and political history of the "researched" community.

The stress of research fatigue is settling in communities, putting further strain on this relationship

A perceived lack of available tangible results for the community in which research is conducted adds to the weariness of research fatigue. Drawing on the idea of "community as an expert", some residents who live in the spaces being researched have daily interactions with and an intimate understanding of the issues at hand such that proposals for more research, studies, and papers may be unwelcome. Especially when research has already been collected and conducted on the issue, these proposals for more in-depth or specific information may be a source of frustration. Actionable steps are often the priority of these communities, and yet the implementation path from academic paper to the application of science to actions and policies can be unclear. A few factors behind communities' uneasiness with research include an acknowledgement that academic studies are typically housed behind paywalls for the general public, a perceived lack of communication of study results to the community at large, and a fear

that once the research team leaves so will all the resources needed to address the issue at hand. These frustrations culminate and lead to an important question: Who is responsible for applying and implementing the results of the research?

The workshop participants expressed that it is important that existing relationships and networks are strengthened between the community and individual researchers, institutions, or organizations in order to create sustained meaningful and equitable partnerships. Among participants, this approach was preferable to forging new networks and lines of communication that would spread thin community resources and capacity to interact. However, collaborators may want to consider that by solely supporting existing partnerships, interested yet currently uninvolved stakeholders could be inadvertently excluded.

6. Funding and Grant Systems

a. Background

Grants and other funds are a common source of financial support for community projects and interests, including efforts to address climate hazards and socioeconomic inequity. Grants are also competitive and require time, training, and resources in order to create a successful application. These necessities act as a bottleneck for a community's access to grant resources: communities that do not have access to individuals with the experience and time to create competitive grant proposals are at a disadvantage compared to organizations and entities that can hire or train grant writers to apply for funds (this is in and of itself one symptom of socioeconomic inequity). Additionally, the methods by which one applies to various funds and grants are not uniform. To understand the timelines, requirements, and application structure for various institutes, agencies, and networks that offer grants requires large amounts of time and attention. This is part of the job for hired grant writers, but for local governments, small NGOs, or volunteer members of the community without designated grant teams, these applications require time and attention in addition to their other daily responsibilities.

Further, the industry that has arisen around funding has created a circuitous movement of money throughout the grant system: money is used to hire employees to write grant applications, host and attend grant-writing training seminars, develop grant-writing skills, hire individuals to review applications, and for other activities that result in the grant process. Despite the amount of money being spent on these endeavors, when the benefits of the grants trickle down to the community members, often through the organization that applied on the community's behalf, the sums are not always large enough to support the scale of project or program for which communities exhibit a need. This dichotomy presents an ironic view of the grant and overall funding system and urges individuals to review how to best spend and distribute funds in an effective and sufficient manner.

b. Frameworks for addressing concerns

Local governments and other entities vying for funding have expressed that their staff are overwhelmed and that a "navigator" to guide these departments through the funding process would be helpful. For entities with the available space and salary, this could take the form of an individual hired to only work with grants and funding opportunities. For entities such as local governments or NGOs where another hire may not be possible, this navigator may take the form of a regional or otherwise designated point person, perhaps state or federally funded, to act as a guide through numerous applications. Since the possibility of so many projects and initiatives rests on the outcomes of grants and other funds, a serious look and investment into the grant application process to identify areas for improvement has a chance for greater returns. Beyond a navigator, less time- and salary-intensive options are possible such as training courses for grant writing that can be a useful exercise for multiple applicants to learn at the same time. During training sessions, the use of relevant grant applications as the case study may serve to achieve two goals at once: learning how to apply for a grant and actively doing so. The issues with the funding system are so circular that even the proposed solutions play into these identified problems (section 6a). This can be thought of as another wicked problem that requires intentional action.

7. Policy

a. Large scale

Systems at a large scale have historically operated disproportionately to negatively affect marginalized communities (Hui 2021; American Psychological Association 2017; National Research Council 2004). The current systems in place (government, housing, education, health care, etc.) are founded on and perpetuated by these outdated ideologies. Therefore, building frameworks for solutions for climate change and socioeconomic inequality within these systems can be challenging. To only utilize current policies that rely on such systems would continue to entrench these flaws. In order to draw inspiration for policies to address the intersection of two relevant systematic failures, socioeconomic inequality and climate change, policy makers and advocates may look to movements outside the status quo. Society may find it prudent to take care not to excuse continuing inequalities for the sake of climate adaptation or mitigation to avoid perpetuating socioeconomic injustice. To illustrate, individuals that relocate onto Indigenous lands continue colonial practices, even if these migrants were displaced due to climate hazards. When wicked problems arise, such as the displacement of climate migrants, it may be to the benefit of the most socioeconomically marginalized communities that solutions be considered through the lens of both climate change and socioeconomic inequality. Without recognizing the relatedness of these two wicked problems, impacts are likely to be most

The current systems in place are founded on and perpetuated by outdated ideologies

intensely felt by marginalized communities, and yet the solutions for these problems will likely not support those who most need them (Islam and Winkel 2017).

Political, social, and cultural upheaval have resulted in more polarized political ideologies; swaths of the population exhibit disillusionment with the American political system, feeling that it does not work for them and that attempts to engage in policy will be hopeless and unsuccessful (DeVeaux 2018). However, when groups do not participate in politics at any level, unequal representation in government worsens. Political engagement is an avenue through which citizens can influence policies and advocate for issues they believe in: policies passed by any level of government have direct and indirect effects on individuals in the district including their socioeconomic potential and vulnerability to climate hazards. Less misinformation and more education surrounding the workings of the political system and how policies are enacted may benefit those who feel discouraged and even disenfranchised.

Top-down approaches have far-reaching impacts with the potential to make large-scale changes toward certain goals. They may set frameworks or goals for state or local authorities to design and implement solutions. These approaches require less community feedback than the process of community engagement, despite citizens being impacted in either scenario; therefore, large-scale solutions require less overall legwork to create greater change. This contributes to an accelerated timeline that is possible because top-down approaches do not take time or attention to address the diversity of situations that bottom-up approaches do. Top-down policies are unlikely to capture the nuances that are extant across geography and demographics. To illustrate, non-specific policies will affect the rural poor differently than the urban poor and will affect coastal shipping communities differently than inland agricultural communities. As a result, this type of blanket approach risks neglecting socioeconomic injustice and inequality when addressing climate change.

b. Small scale

The GLR consists of a plethora of situational and circumstantial experiences that require tailored, localized solutions rather than blanket policies. Bottom-up approaches to policy have the potential to incorporate local nuances and priorities by centering community engagement in the policy-making process. This is not to say that access to funds and other resources supported through federal or state programs are not beneficial, but rather to point out that these programs are usually broad and may not encompass all elements a community may need.

Pilot projects with local implementation, monitoring, and review processes are opportunities to test solutions to climate change and socioeconomic inequality in specific locales. Small-scale projects can undergo a tweaking process and then potentially be scaled up to be iterated across larger geographical areas with consideration of these adjustments. This process of conducting pilot projects, learning to adjust the implementation project based on local differences, and disseminating this information widely and rapidly follows the aforementioned approach to wicked

problems.

Bottom-up approaches to policy have the potential to incorporate local nuances and priorities

While the intent to implement pilot projects is a step toward progress, the process of choosing policies or programs to prioritize and funnel resources into can be difficult for local governments. When faced with both climate change, socioeconomic inequality, and the intersection of the two wicked problems, the number of specific issues to address can be overwhelming. When such pilot projects are carried out by local communities, governments, and organizations, they are responsible for implementing, monitoring, and communicating the results. The communication aspect includes both communication with entities that can scale up the projects (regional or federal networks), but also with neighboring communities. There are certain responses to socioeconomic inequality and climate change that can profit from joint action across multiple communities. To illustrate: neighboring coastal communities may benefit from understanding what adaptation actions others are taking in response to coastal erosion in order to collaboratively act on an issue that spans municipal but perhaps not ecological boundaries.

c. A balancing act

In order to achieve progress on all scales, policy makers and decision-makers may benefit from thinking about approaches to wicked problems as a balancing act in which 1) localized support, 2) large-scale solutions, and the 3) assurance of progress are all considered. A balancing act between small-scale and large-scale actions may provide an effective blend: bottom-up actions can provide attention to nuance due to community engagement, while top-down leadership can arrange broader collective action through authoritative powers. Efforts to balance these factors may have different outcomes when working on different projects; for example, adaptation efforts may require more localized support than large-scale actions, and the opposite may be true for meeting national mitigation goals. Further, without viewing the third factor, a sense of forward progress, as a priority, decision-makers risk inaction on climate change and socioeconomic inequality. Inaction is still a policy decision and affects who does and does not benefit from current situations. Additionally, waiting to confront a problem will likely allow it to establish itself further throughout societal systems and will require more resources to address it in the future.

8. Beyond Community Engagement

Although much of this report focuses on community engagement and place-based responses, this detailed approach is one aspect of a multitiered framework aimed at advancing society toward a more equitable future. The small-scale nature of community engagement on its own does not make this method superior: this assumption is the

danger of the Local Trap (Purcell and Brown 2005). The transition of the solution framework from globalization to nationalization to localization does not eliminate inequalities. This localized scale still empowers a certain subset of people to overshadow less powerful groups (e.g., someone will always be louder than another, even when there are fewer people speaking). It cannot be assumed that the community shares a unified agenda, or that this agenda is congruent with social justice, conservation, or other movements that are equipped to address equity in the face of wicked problems. Additionally, the goals and missions of groups may fluctuate as dynamics and power shift. There are complexities and particularities at every scale that require intentional and analytical consideration. Scales may be based on many different criteria: resident population, population density, geography (rural–urban), government hierarchy, etc. Community engagement remains an effective method for decision-makers and policy makers to consider; it may be most effective when complemented with engagement on multiple scales.

Approaching wicked problems on local, regional, national, and international scales may all prove effective

The local community scale is not the only scale of engagement that can prove to be beneficial when addressing wicked problems. There are advantages to having large, centralized data centers and providers such as NOAA and NASA, federal agencies with satellite and other global observation systems that supply data, information, and maps, for the decision-making process. Regionally scaled organizations, such as GLISA, can provide a geographically specific focus while still maintaining a broad perspective (Great Lakes Integrated Sciences and Assessments Program 2021). Such organizations can address unique needs and issues on a large scale: for example, the Great Lakes region has different environmental and socioeconomic needs than the Southwest region of the United States; this is where GLISA is helpful. These larger-scale organizations can facilitate small-scale engagement through establishing consistency in data formats, messages, and other communication methods. Additionally, the techniques previously mentioned are not exclusive to community engagement, many of these methods can be implemented on large scales and remain effective (e.g., power transitions, incorporating a diversity of perspectives).

9. Key Takeaways

Climate change and socioeconomic inequality are reaching an inflection point that presents an opportunity for society to concurrently address both of these wicked problems. The impacts of climate change exacerbate socioeconomic inequalities due to existing systemic injustices, while this gap in equity allows advantaged populations to continue to disproportionately produce GHG emissions. Without simultaneously considering climate hazards and socioeconomic inequity, decision-makers risk worsening one issue in an attempt to redress the other. Through discussions with

experts and further analysis, we have identified frameworks for solutions and other considerations that may be useful for addressing these complex issues. Although this study focuses within the Great Lakes Region of the United States and how the nexus of these issues may affect the area and its residents, many of its key takeaways can be applied more broadly to other regions of the country.

We identified 10 overarching key takeaways:

1. The Great Lakes Region is reliant on the lakes as a natural resource to which many industries, jobs, and cultures are connected. Therefore, climate impacts on the environment and geography of the region will have widespread socioeconomic implications.

2. "Low SES" communities are diverse in their demographics and the challenges they face but are commonly the most burdened by climate change.

3. Community engagement, used as a process of approaching groups in a manner that is conducive to member participation, acknowledges that the first step to successful engagement is ensuring accessible participation.

4. Community members are most familiar with their own interests and needs in response to climate and socioeconomic inequities: place-based knowledge and tailored solutions are helpful because they address challenges in a manner that is community led.

5. Transition of power, resources, or place at the table away from individuals already in power to marginalized groups may encourage or allow greater participation of better suited yet underrepresented groups in the decision-making process.

6. The prioritization of sustained partnerships, rather than short-term, one-off projects, may empower existing networks and individuals who are already working to address a designated problem, leading to more mutually beneficial outcomes. These lasting partnerships and networks are the vehicle for inter- and intracommunity collaboration.

7. Communities and experts may be better supported by incorporating accessible information, value systems, and cooperation between technology, engineering, and natural and social sciences into the decision-making framework, instead of prioritizing the accrual of additional knowledge.

8. Resources such as time, expertise, and money needed to apply to grants create a bottleneck preventing some communities from receiving the resources they need, although funding and grant systems are designed to provide resources to a community.

9. Residents advocate for tailored policy solutions, which are informed by community input throughout the participant engagement and partnership processes. Such an approach may benefit the diverse communities and demographics of the Great Lakes Region.

10. Local, small-scale approaches are not automatically superior approaches; effective methods for societal progress exist at every scale, and combined approaches may complement each other.

9. References Cited

Aaronson, D., J. Faber, D. Hartley, B. Mazumder, and P. Sharkey, 2021: The long-run effects of the 1930s HOLC "redlining" maps on place-based measures of economic opportunity and socioeconomic success. Regional Science and Urban Economics. [Available online at https://www.sciencedirect.com/science/article/abs/pii/S0166046220303070?casa_token=KelDfJe8e50AAAAA:CL8KjI5zSlMqRs5cftRxCtZ_xSYpb6EbZkgie5myACWDWcAoJmwbdMdbK1vkV9cq-U9b5Ql9JpY]

American Psychological Association, 2017: Ethnic and racial minorities & socioeconomic status. [Available online at https://www.apa.org/pi/ses/resources/publications/]

Angel, J., C. Swanston, B.M. Boustead, K.C. Conlon, K.R. Hall, J.L. Jorns, K.E. Kunkel, M.C. Lemos, B. Lofgren, T.A. Ontl, J. Posey, K. Stone, G. Takle, and D. Todey, 2018: Midwest. In Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC, USA, pp. 872–940. doi: 10.7930/NCA4.2018.CH21

Borunda, A., 2019: Inequality is decreasing between countries- but climate change is slowing progress. National Geographic. [Available online at https://www.nationalgeographic.com/environment/2019/04/climate-change-economic-inequality-growing/]

Breffle, W. S., D. Muralidharan, R.P. Donovan, F. Liu, A. Mukherjee, and Y. Jin, 2013: Socioeconomic evaluation of the impact of natural resource stressors on human-use services in the Great Lakes environment: A Lake Michigan case study. Resources Policy. [Available online at https://doi.org/10.1016/j.resourpol.2012.10.004.]

Brown, A., 2020: Rising waters threaten Great Lakes communities. Pew Research Center [Available online at https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2020/09/30/rising-waters-threaten-great-lakes-communities]

Collins, M., R. Knutti, J. Arblaster, J.L. Dufresne, T. Fichefet, P. Friedlingstein, X. Gao, W.J. Gutowski, T. Johns, G. Krinner, M. Shongwe, C. Tebaldi, A.J. Weaver, and M. Wehner, 2013: Long-term climate change: Projections, commitments and irreversibility. In: Climate change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Council of the Great Lakes Region, 2017: The Great Lakes economy: The growth engine of North America. [Available online at https://councilgreatlakesregion.org/the-great-lakes-economy-the-growth-engine-of-north-america/]

Desjardins, J., 2017: The Great Lakes economy: The growth engine of North America. Visual Capitalist. [Available online at https://www.visualcapitalist.com/great-lakes-economy]

DeVeaux, F., 2018: Democracy perception index. Rasmussen Global. [Available online at https://www.allianceofdemocracies.org/wp-content/uploads/2018/06/Democracy-Perception-Index-2018-1.pdf]

Durt, C., 2014: Shared intentional engagement through language and phenomenal experience. Frontiers in Psychology. [Available online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4189324/]

Ecolibrium3, 2021: Duluth's citizens' climate action plan. [Available online at https://www.ecolibrium3.org/duluthclimateaction/]

Egan, D., 2021: The climate crisis haunts Chicago's future: A battle between a great city and a Great Lake. The New York Times. [Available online at https://www.nytimes.com/interactive/2021/07/07/climate/chicago-river-lake-michigan.html?campaign_id=9&emc=edit_nn_20210708&instance_id=34831&nl=the-morning&regi_id=63864342&segment_id=62908&te=1&user_id=46c56ecca1c3c7211de35fbb994cc110]

Folger, T., 2020: North America's most valuable resource is at risk. National Geographic. [Available online at https://www.nationalgeographic.com/magazine/2020/12/north-americas-most-valuable-resource-is-at-risk-feature/]

Great Lakes Commission, 2017: An agenda for Great Lakes restoration and economic revitalization. [Available online at https://www.glc.org/wp-content/uploads/2017/03/GLC-LegPri-2017-FINAL-web.pdf]

Great Lakes Integrated Sciences and Assessments Program (GLISA), 2021: Great Lakes integrated sciences and assessments. [Available online at https://glisa.umich.edu/]

Great Lakes Stewardship Initiative, 2020: Learning for the greater good. [Available online at https://greatlakesstewardship.org/]

Gronewold, A.D., H.X. Do, Y. Mei, and C.A. Stow, 2021: A tug-of-war within the hydrological cycle of a continental freshwater basin. Geophysical Research Letters. [Available online at https://doi.org/10.1029/2020GL090374]

Gronewold, D. and R. Rood, 2019: Climate change is driving rapid shifts between high and low water levels on the Great Lakes. The Conversation: Academic rigor, journalistic flair. [Available online at https://theconversation.com/climate-change-is-driving-rapid-shifts-between-high-and-low-water-levels-on-the-great-lakes-118095]

Higgins, P.A.T & A. Miller, 2019. Empowering Efforts to Make Local Communities Stronger & More Secure. An AMS Policy Program Study. The American

Meteorological Society, Washington, D.C. [Available online at https://www.ametsoc.org/ams/assets/File/Stronger_Communities_Final.pdf]

Hui, A., S. Rennick-Egglestone, D. Franklin, R. Walcott, J. Llewellyn-Beardsley, F. Ng, J. Roe, C. Yeo, E. Deakin, S. Brydges, P.P Moran, R. McGranahan, K. Pollock, G. Thornicott, and M. Slade, 2021: Institutional injustice: Implications for system transformation emerging from the mental health recovery narratives of people experiencing marginalisation. [Available online at https://doi.org/10.1371/journal.pone.0250367]

Islam, S. N. and J. Winkel, 2017: Climate change and social inequality. United Nations Department of Economic & Social Affairs. [Available online at https://www.un.org/esa/desa/papers/2017/wp152_2017.pdf]

Kling, G. W., K. Hayhoe, L.B. Johnson, J.J Magnuson, S. Polasky, S.K. Robinsom, B.J. Shuter, M.M. Wander, D.J. Wuebbles, and D.R. Zak, (2003): Confronting climate change in the great lakes region. The Union of Concerned Scientists and The Ecological Society of America. [Available online at https://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/greatlakes_final.pdf]

Knutson, T., J.P. Kossin, C. Mears, J. Perlwitz, and M.F. Wehner, 2017: Detection and attribution of climate change. In: Climate science special report: Fourth national climate assessment, volume I. U.S. Global Change Research Program, Washington, DC, USA, pp. 114-132, doi: 10.7930/J01834ND.

Machemer, T., 2021: United Nations report shows that climate change is accelerating. Smithsonian Magazine. [Available online at https://www.smithsonianmag.com/smart-news/united-nations-report-shows-climate-change-accelerating-180977860/]

NASA, 2021: The causes of climate change. [Available online at https://climate.nasa.gov/causes/]

National Research Council, 2004: Cumulative disadvantage and racial discrimination. In Measuring Racial Discrimination. The National Academics Press. [Available online at https://www.nap.edu/read/10887/chapter/16#225]

Nielsen, R., C. Segrist, E. Lowenstein, and L. Marckini-Polk, 2016: The Cody youth ambassadors: Voices for change and hope in the Cody Rouge community. Great Lakes Stewardship Initiative. [Available online at https://greatlakesstewardship.org/wp-content/uploads/2017/12/DIT_SEMIS_Final-1.pdf]

NOAA Office for Coastal Management, 2021: High tide flooding. [Available online at https://coast.noaa.gov/states/fast-facts/recurrent-tidal-flooding.html]

Norton-Smith, K., K. Lynn, K. Chief, K. Cozetto, J. Donatuto, M.H. Redsteer, L.E. Kruger, J. Maldonado, C. Viles, and K.P. Whyte, 2016: Climate change and

Indigenous peoples: A synthesis of current impacts and experiences. United States Department of Agriculture. [Available online at https://www.fs.fed.us/pnw/pubs/pnw_gtr944.pdf]

Organizing Engagement, 2021: Ladder of citizen participation. [Available online at https://organizingengagement.org/models/ladder-of-citizen-participation/#:~:text=In%20Arnstein%27s%20words%3A%20%E2%80%9CAt%20this,and%20mechanisms%20for%20resolving%20impasses]

Patz, J. A., S.J. Vavrus, C.K. Uejio, and S.L. McLellan, 2008: Climate change and waterborne disease risk in the Great Lakes Region of the U.S. American Journal of Preventive Medicine. [Available online at https://www.ajpmonline.org/article/S0749-3797(08)00702-2/fulltext]

Pierre-Louis, K., 2019: Want to escape global warming? Cities promise cool relief. The New York Times. [Available online at https://www.nytimes.com/2019/04/15/climate/climate-migration-duluth.html]

Purcell, M. and J.C. Brown, 2005: Against the local trap: Scale and the study of environment and development. Progress in Developmental Studies. [Available online at http://faculty.washington.edu/mpurcell/pds.pdf]

Rittel, H. W. J. and M.M Webber, 1973: Dilemmas in a general theory of planning. Policy Sciences. [Available online at https://urbanpolicy.net/wp-content/uploads/2012/11/Rittel+Webber_1973_PolicySciences4-2.pdf]

Schneider, K., 2021: Water could make the Great Lakes a climate refuge. Are we prepared? Great Lakes Now. [Available online at https://www.greatlakesnow.org/2021/02/water-great-lakes-climate-refuge-prepared/]

Substance Abuse and Mental Health Services, 2017: Disaster technical assistance center supplemental research bulletin: Greater impact: How disasters affect people of low socioeconomic status. [Available online at https://www.samhsa.gov/sites/default/files/dtac/srb-low-ses_2.pdf]

Sullivan, K., 2021: Intersection of Socioeconomic Status and Climate Change Risks and Hazards in the United States Great Lakes Region: An Intern Report. The American Meteorological Society, Washington, D.C. [Available online at https://www.ametsoc.org/index.cfm/ams/policy/studies-analysis/the-intersection-of-socioeconomic-status-climate-change-risks-hazards-in-the-united-states-great-lakes-region-an-intern-report/]

Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midgley, 2013: Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

The City of Duluth, Minnesota, 2018: Population vulnerability assessment and climate adaptation framework. Minnesota Pollution Control Agency. [Available online at https://static1.squarespace.com/static/53fbb928e4b0eafa4734317f/t/5b75b4238a922d0db065c8c6/1534440516909/Duluth+Vulnerable+Populations+Report+053118.pdf]

The United Nations, 2016: World economic and social survey 2016: Climate change resilience—an opportunity for reducing inequalities. [Available online at https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/WESS_2016_Report.pdf]

U.S. Climate Resilience Toolkit, 2019: Great Lakes. [Available online at https://toolkit.climate.gov/regions/great-lakes]

U.S. Census Bureau, 2012: Statistical abstract of the United States. [Available online at https://www2.census.gov/library/publications/2011/compendia/statab/131ed/tables/12s0360.pdf]

University of Wisconsin-Madison, 2020: Climate change vulnerability assessments (CCVAs). Wisconsin Initiative on Climate Change Impacts. [Available online at https://wicci.wisc.edu/plants-and-natural-communities-working-group/climate-change-vulnerability-assessments-ccvas/]

Vacarro, L., and J. Read, 2011: Vital to our nation's economy: Great Lakes jobs. NOAA Michigan Sea Grant College Program. [Available online at https://www.michiganseagrant.org/wp-content/uploads/2018/10/11-203-Great-Lakes-Jobs-report.pdf]

Way, E., 2013: Understanding research fatigue in the context of community-university relations. Clark University. [Available online at https://commons.clarku.edu/cgi/viewcontent.cgi?article=1018&context=localknowledge#:~:text=Research%20fatigue%20is%20the%20process,research%20(Clark%2C%202008)]

Wuebbles, D., B. Cardinale, K. Cherkauer, R. Davidson-Arnott, J. Hellmann, D. Infante, L. Johnson, R. de Loë, B. Lofgren, A. Packman, F. Seglenieks, A. Sharma, B. Sohngen, M. Tiboris, D.Vimont, R. Wilson, K. Kunkel, and A. Ballinger, 2019: An assessment of the impacts of climate change on the great lakes. Environmental Law & Policy Center. [Available online at https://elpc.org/wp-content/uploads/2020/04/2019-ELPCPublication-Great-Lakes-Climate-Change-Report.pdf]


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