

EXAMINING DECISION-MAKERS' PERSPECTIVES ON CLIMATE CHANGE
AND CLIMATE PREPAREDNESS IN THE LAKE SUPERIOR
BASIN OF MINNESOTA

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Abstract

This study explores characterizations of climate change and climate preparedness within two subwatersheds of the Lake Superior basin. Twenty-seven key informant interviews were conducted with local decision makers, resource managers, and other leaders active in the subwatersheds. Study participants' experiences, beliefs, and attitudes were documented and analyzed using qualitative methods. Findings indicate strong convergence around climate change beliefs and concerns and divergence on perspectives on climate preparedness. Further analysis revealed specific challenges and current actions associated with climate preparedness. A better understanding of climate change beliefs and perceived preparedness will provide insight into the resources and activities that can be leveraged for further climate preparedness. This study also reveals challenges that may need to be addressed to make efforts more effective. Study findings offer a framework for climate preparedness planning and provide evidence for a strategic approach to building adaptive capacity in the study communities. Findings will inform community engagement, outreach, education, and communication programming on climate preparedness.

Keywords climate change, adaptation, climate preparedness, Great Lakes, decision makers

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CHAPTER 1

INTRODUCTION

Climate change is altering climatic conditions on a global scale, and impacts such as ocean warming and acidification, sea-level rise, extreme heat, and extreme precipitation and flooding are affecting socio-ecological systems around the world (Field et al., 2014). The United States is currently experiencing impacts and will continue to do so in the years to come, with different regions of the country impacted in different ways. In the US Midwest, changing climatic conditions include higher temperatures, more intense episodes of extreme heat, increased frequency and intensity of precipitation, and increased flooding (Karl, Melillo, & Peterson, 2009; Melillo, Richmond, & Yohe, 2014).

Climate impacts to the Great Lakes and the Great Lakes basin are documented. Coastal regions are considered climate-sensitive domains (Füssel, 2007), which means they readily experience climate change phenomena, such as declining Great Lakes water levels. Changes to Great Lakes water levels are largely the result of precipitation and evaporation changes. As temperatures in the region have increased, winters have become shorter with longer periods free of frost and ice (Karl et al., 2009; Mackey, 2012). A decrease in lake ice on the Great Lakes has already been reported (Gronewold et al., 2013; Karl et al., 2009). As lake ice reduces, evaporation on the lakes increases, leading to a reduction in lake levels. In Lake Superior, lake levels may drop between 0.5–1 foot by end of the century (Karl et al., 2009). Even a water-level drop of 1 foot can impact ecosystems, infrastructure, shipping, and tourism sectors.

An additional change in hydrologic patterns is increased precipitation frequency and intensity, which can produce more flooding. Extreme rainfall and flooding events

overwhelm aging stormwater infrastructure in urban areas; damage buildings, roads, and individual property; impact ecosystems through increased erosion; deteriorate water quality; and drain emergency management resources (Czuba, Fallon, & Kessler, 2012; Melillo et al., 2014). Extreme rainfall occurrences already affect Great Lakes coastal communities, which are increasingly vulnerable to the social, economic, and environmental impacts of such events.

In June 2012, Duluth, Minnesota, and the surrounding communities experienced an extreme precipitation and flood event, which damaged infrastructure, residences, businesses, and recreation areas and facilities. As a result of the extreme event, approximately \$55 million of damage were incurred in Duluth alone (Eastern Research Group Inc., 2014). Water quality was negatively affected when erosion led to increased sediment in rivers and Lake Superior, and sewage infrastructure overflow caused sewage to flow into Lake Superior, the source of the community's drinking water.

With the aim of examining interactions between environmental risk and community readiness and response, the University of Minnesota (UMN) and the Natural Resources Research Institute (NRRI) partnered on the "Integrative social and hydrologic models for enhanced resiliency of coastal communities under extreme weather events" project. This project was implemented in two subwatersheds in the Duluth area with three objectives: 1) compare the combined effects of urbanization, green infrastructure, and extreme climate events (e.g. storms and droughts) on stream peak flow and discharge in urbanized and rural watersheds; 2) assess the adaptive capacity of social systems, including governance, to anticipate and respond to impacts of extreme climate events at a watershed scale; and 3) model scenarios of environmental risk and the efficacy of

mediating strategies (e.g., green infrastructure, development policies) and deliver results and options through outreach to community leaders and decision makers (Host, Davenport, Enzler, & Johnson, 2013).

University of Minnesota Twin Cities research personnel focused on the second objective, investigating environmental planning and conservation programming within the community as well as the community's anticipation and response to climate change. Specific research questions within this objective included:

1. What are the local perspectives on community assets, community needs, environmental planning, and water conservation programming?
2. What is the adaptive capacity of communities, community leaders, and land use/water resource professionals—specifically, what is their ability to anticipate and respond to climate-related impacts?

Since climate impacts will inherently be experienced at the local level, climate change adaptation will need to happen at the local scale as well (Adger et al., 2009; Adger, Arnell, & Tompkins, 2005; Agrawal, McSweeney, & Perrin, 2008; Füssel, 2007).

Community decision makers and leaders will play key roles in adaptation planning efforts at the local scale. Understanding these stakeholders' perspectives on climate change preparedness will assist in the identification of constraints to and opportunities for adaptation that exist.

The social science study presented in this thesis has the overarching goal to identify and examine constraints and opportunities associated with climate preparedness. Qualitative research methods were used to explore the problem in an in-depth manner

and from the perspectives of those within the study area (Charmaz, 2006; Creswell, 2013). The following research questions were investigated in the study:

1. How do decision makers in the study subwatersheds characterize climate change and climate change preparedness?
2. What do decision makers perceive drives and constrains preparation for and adaptation to climate change?
3. How can this new understanding help the community build climate preparedness and adaptive capacity?

Climate preparedness is defined as the actions taken to prepare for and adequately respond to current and future climate change phenomena and their impacts (Heidrich, Dawson, Reckien, & Walsh, 2013). Climate preparedness demonstrates how systems or communities are prepared to handle climate change impacts. The terminology is similar to adaptation, which is defined as the actions that are implemented to adjust to actual or potential climate change impacts to prevent harm and take advantage of any opportunities that may arise from climate change (Field et al., 2014). Adaptive capacity indicates a system's ability to adjust to climatic changes. The two concepts are related: a community that has adapted or adjusted to climatic changes often indicates a system with high adaptive capacity. Similarly, a community that is well prepared for climate change likely has high adaptive capacity.

The research contributes to the community climate adaptation and adaptive capacity literature that seeks to understand how and why communities do or do not adapt. Specifically, the research holds practical implications for the Duluth area community's ability to adapt to climate change. Findings will indicate areas of strength and

opportunities for further adaptation efforts, such as a strong sense of place in the community, as well as adaptation constraints that may need to be addressed.

The next chapter introduces relevant climate change and adaptation literature that serves to outline relevant theoretical frameworks as well as position the study in the current literature on coastal communities and adaptation. The third chapter reviews the study's methodology, which includes the study area, study design, instrument development, participant recruitment, data collection, participant profile, data analysis, anticipated outcomes, and study quality, and study limitations. Chapter four entails a full academic article ready to submit for publication and draws upon material written in the other chapters of this thesis. The final chapter concludes with the study discussion and implications.

CHAPTER 2

LITERATURE REVIEW

A review of climate adaptation literature indicates that while several articles outline frameworks for assessing adaptive capacity or climate preparedness, few studies apply these frameworks to decision making in Great Lakes coastal communities. Ground-truthing or “community-truthing” of these frameworks is even less common in the literature. This literature review serves two purposes. First, the review examines studies regarding decision-makers’ perspectives on climate preparedness in coastal communities, indicating the gap and need for continued social science and qualitative research in this domain. Second, it reviews concepts of climate preparedness and adaptation and the frameworks of adaptive capacity, vulnerability, and adaptation barriers from which to examine perspectives of climate change preparedness. These frameworks allow for the assessment of barriers, assets, and opportunities that prevent or promote climate preparedness and adaptation.

Climate preparedness describes the measures taken to prepare for and to respond to current and future climate change phenomena and their impacts (Heidrich et al., 2013). The terms preparedness and adaptation are often used interchangeably in climate change action communities. However, preparedness has its roots in the emergency and disaster risk assessment literature (e.g., flood and wildfire preparedness) and the origin of adaptation lies in biology, ecology, and related fields (e.g., species adaptation). Adaptation is commonly used within the international climate science community (e.g., Adaptation Committee of the United Nations Framework Convention on Climate

Change). For this study we adopted the term preparedness because we believed it was a more accessible term for decision makers and practitioners participating in this study.

Several studies investigate decision-maker perspectives on climate preparedness in coastal communities (Kahl & Stirratt, 2012; Mozumder, Flugman, & Randhir, 2011; Scally & Wescott, 2011), with a common thread throughout to be some adaptation progress amidst multiple adaptation challenges. Scally and Wescott (2011) explored perceptions of climate change and adaptation responses in an Australian coastal community and found that stakeholders perceived climate change impacts were occurring in the community but they differed on adaptation perceptions, beliefs, and response. Additionally, financial and resource constraints, lack of cross-sector/interagency coordination, and unclear responsibilities were barriers to adaptation (Scally & Wescott, 2011).

Kahl and Stirratt (2012) investigated challenges and motivations for adaptation planning by decision makers in Great Lakes coastal communities, finding that although coastal communities are making good progress regarding climate knowledge and adaptation, challenges to adaptation decision making and planning include using available resources effectively, cross-sector coordination and communication, lack of political will, and lack of time. Similarly, Mozumder et al. (2011) found that while decision makers in the Florida Keys were increasingly aware of the social and ecological impacts and risks of climate change to their communities, adaptation was often constrained by social and institutional barriers, such as insufficient budget and staff time, lacking public demand for action, and few perceived solutions.

Determinants of Climate Preparedness

Several factors enable or constrain community climate preparedness, including adaptive capacity, vulnerability, and adaptation barriers. Adaptive capacity elaborates upon components that support or hinder adaptation. The framework of vulnerability incorporates adaptive capacity with exposure and sensitivity to obtain a fuller picture of potential climate impacts. The literature on adaptation barriers serves a helpful examination of climate preparedness based on the specific hindrances of adaptation planning and implementation.

Adaptive Capacity

Adaptive capacity in the climate change literature is defined as the ability of natural and human systems to adjust to climatic changes (Field et al., 2014). Adaptation can be understood as “manifestations of adaptive capacity” (Smit & Wandel, 2006, p. 286), so adaptations that have or have not occurred may be understood as a reflection of the adaptive capacity of the individual, community, institution, or region. A review of the literature demonstrates adaptive capacity research incorporates research from psychology (Gifford, Kormos, & McIntyre, 2011; Grothmann, Grecksch, Wings, & Siebenhüner, 2013; Torsten Grothmann & Patt, 2005; Reser & Swim, 2011), vulnerability and resilience (Engle, 2011), institutions and governance (Agrawal et al., 2008; Gupta et al., 2010), and organizational theory (Berkhout, 2012).

A large portion of adaptive capacity literature focuses on assessment (Engle, 2011; Füssel, 2007). Researchers have developed several frameworks to understand and assess adaptive capacity across scales, institutions, and fields (Grothmann et al., 2013; Gupta et al., 2010). From Gupta et al. (2010), dimensions of assessment are variety of

perspectives, learning capacity, allowance for and promotion of autonomous behavior change, leadership, mobilization of resources, and fair governance. Other authors have incorporated the social and cognitive factors that researchers increasingly contend are needed for adaptation and obtaining high adaptive capacity (Adger et al., 2009; Gifford, Kormos, & McIntyre, 2011; Gifford, 2011; Grothmann & Patt, 2005a). Social factors and capacities that have often been underrepresented in adaptive capacity and adaptation frameworks include values, norms, beliefs, motivations, perceptions, human and social capital, knowledge, experience, behaviors, interests, and customs (Adger et al., 2009; Clayton et al., 2015; Grothmann et al., 2013). Grothmann et al. (2013) added adaptation belief and adaptation motivation to Gupta et al.'s framework. These two components incorporate political will, perceptions of climate change and risk, perceived behavioral control (Ajzen, 1991), and self- and response efficacy (Ajzen, 2002), aspects researchers have noted are integral in adaptive capacity and adaptation implementation (Adger et al., 2009; Clayton et al., 2015; Gifford, 2011, 2014; Reser & Swim, 2011).

Vulnerability

The IPCC defines vulnerability as “the propensity or predisposition to be adversely affected” by climate change (Field et al., 2014, p. 5). Vulnerability can also be understood as a function of exposure and sensitivity (Fussler, 2007; IPCC, 2007; Smit & Wandel, 2006). Exposure indicates the degree to which a system is exposed to climatic variations and often is a function of geography or physical location. Sensitivity specifies the degree to which a system is affected by climatic change and climate impacts. Therefore, one approach to reducing vulnerability to climate change is by addressing

exposure and sensitivity to decrease risk of potential climate impacts (Fussel, 2007; IPCC, 2007; Smit & Wandel, 2006) (Figure 1).

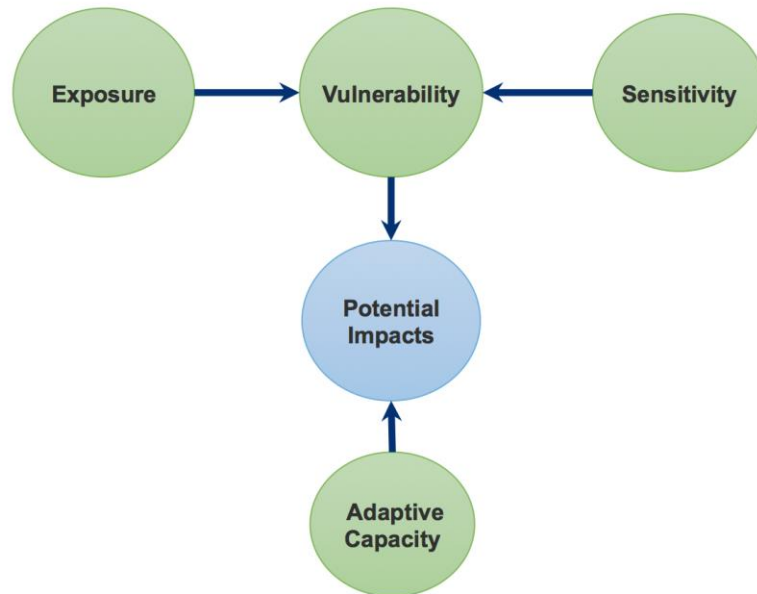


Figure 1. Model of Climate Vulnerability. Adapted from Fussel, 2007; IPCC, 2007; Smit & Wandel, 2006.

Factors that influence vulnerability include age, socioeconomic status, ethnicity, class, gender, and health (Field et al., 2014). Socioeconomic status, inequality, and inequity within a community may be the main factors that influence vulnerability (G. R. Biesbroek, Klostermann, Termeer, & Kabat, 2013). While individual sociodemographic factors largely affect vulnerability, community-related factors also play a role. For example, social support, including social networks and social capital, can increase coping abilities and therefore decrease vulnerability (Duarte, 2007). Social support can also allow an individual greater access to information and economic resources (Smit & Wandel, 2006). Social resources that aid in coping include community attachment (sense

of community and place identity) and social cohesion (community turnover and socializing) (Wall & Marzall, 2006). Generally, the greater a person's connection to community is, the less vulnerable a person is. If an individual has strong coping capabilities and good connections to the community to draw upon if circumstances of emergency or disaster, vulnerability will be reduced (Reser & Swim, 2011).

Barriers to Adaptation

Adaptation barriers—the factors that impede development and implementation of adaptations—are a key determinant of climate preparedness and a robust research domain. Although climate change adaptation is or will be needed in most communities, it is often hindered for various reasons, including limited resources (Biesbroek et al., 2013; Moser & Ekstrom, 2010; Mozumder, Flugman, & Randhir, 2011), cognitive barriers (Gifford, 2011; Moser & Ekstrom, 2010; Reser & Swim, 2011), lack of leadership (Moser & Ekstrom, 2010), institutional and governance constraints (Biesbroek et al., 2013; Measham et al., 2011), and social factors (Adger et al., 2009; Jones & Boyd, 2011a).

Research indicates barriers arise from three areas: factors relating to individuals, policy, and implementation (Biesbroek et al., 2013; Moser & Ekstrom, 2010). After noting there could be innumerable barriers to adaptation, Biesbroek et al. (2013) found that only three barriers are climate change specific: 1) “the long-term impacts of climate change versus the short-term dynamics of politics and decision-making,” 2) “the reliance on scientific models to identify, understand, and communicate the problem and propose solutions,” and 3) “the inherent uncertainties and ambiguities of climate change” (p. 1124). Barriers that are non-climate change specific are those that can also be found in

other environmental, policy, and decision-making realms, such as lacking resources, technical skill, or leadership.

Early adaptation-barrier research primarily focused on biological and technical barriers; however, recent studies have broadened barrier research to include more social science disciplines, finding that social factors play an integral role in influencing adaptive capacity and adaptation implementation (Bennett, Dearden, Murray, & Kadfak, 2014; Jones & Boyd, 2011b; Scally & Wescott, 2011; Wall & Marzall, 2006). Social barriers include institutional, governance, cultural, political, informational, and cognitive dimensions of adaptation (Biesbroek et al., 2013; Biesbroek et al., 2011; Gifford, 2011; Measham et al., 2011).

Cognitive barriers are particularly powerful at impeding adaptation because cognitive constraints can hinder adaptation even if the community's physical or financial resources are enough for adequate adaptation implementation (Gifford, 2011; Grothmann & Patt, 2005; Reser & Swim, 2011; Swim et al., 2011). Specifically, researchers demonstrate beliefs, worldviews, values, norms, and perceptions of control, efficacy, risk, and uncertainty have constrained adaptation behavior (Adger et al., 2009; Clayton et al., 2015; Gifford, 2011, 2014; Grothmann & Patt, 2005; Moser & Ekstrom, 2010; Reser & Swim, 2011). Institutional and governance constraints such as lack of leadership throughout the understanding, planning, and managing phases of adaptation can prevent or impede adaptation (Moser & Ekstrom, 2010). Similarly, a lack of coordination and communication within institutions and between institutions and the public on climate change generally and adaptation specifically, along with a lack of public awareness, can constrain adaptation planning or implementation efforts (Adger et al., 2009; Jones &

Boyd, 2011a; Measham et al., 2011). As opposed to biological or technical barriers, social and cognitive barriers are difficult to directly measure. If decision makers report on their perspectives and experiences with adaptation, barriers can be better identified and evaluated (Biesbroek et al., 2011).

Based on adaptation literature and policy reviews, several frameworks have been proposed for categorizing, organizing, and understanding social barriers to adaptation (Adger et al., 2009; Biesbroek et al., 2011; Moser & Ekstrom, 2010). Adger et al. (2009) indicates ethics, knowledge, risk, and culture are categorical barriers to adaptation, while Biesbroek et al. (2011) proposes seven clusters of barriers to adaptation, which include both climate-specific and non-climate-specific barriers (Table 1).

Table 1. Categories of Barriers to Adaptation (Biesbroek et al., 2011).

Barrier Category	Description
Lack of awareness and communication	<ul style="list-style-type: none"> • Lack of communication between scientists, practitioners, and public • Lack of awareness a result of lack of communication
Fragmentation	<ul style="list-style-type: none"> • Institutions, organizations, agencies, policies and individuals not connecting or coordinating
Resources	<ul style="list-style-type: none"> • Human (staff, time, skilled individuals) • Financial • Information (applied, local, credible) • Physical (technological measures) • Natural (access to land)
Conflicting timescales	<ul style="list-style-type: none"> • Conflict between long-term scale of climate change and more short-term scale of planning and decision making • Other more immediate issues higher priority
Motives and willingness to act	<ul style="list-style-type: none"> • Cognitive decision making factors, such as attitudes, beliefs, norms, and values may inhibit acting on adaptation • Lacking leadership may also prevent adaptation action
Institutional crowdedness and institutional voids	<ul style="list-style-type: none"> • Many institutions working on problem, leading to confusion about tasks, responsibilities, and goals • Few institutions working on adaptation
Substantive, strategic, and institutional uncertainty	<ul style="list-style-type: none"> • Uncertainty about climate change phenomenon and impacts

	<ul style="list-style-type: none">• Uncertainty about human behavior• Uncertainty about decision making
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Conclusion

The climate preparedness and adaptation literature demonstrates barriers that impede adequate climate adaptation exist in many communities. From the adaptive capacity literature, building capacity may serve as an opportunity to overcome these barriers and increase climate preparedness. This literature, along with the studies on decision-makers' perspectives on climate preparedness, are particularly relevant for this study because it indicates constraints to and potential opportunities for climate preparedness that may be applied in the Duluth area communities. Specifically, this literature often illustrates climate change beliefs and concern exist, but barriers to climate adaptation impede community preparedness, findings that are likely relevant and helpful to understand the Duluth area decision-makers' perspectives on climate change and climate preparedness.

While this literature helps set the stage for the study, it also demonstrates a need for further place-based research on climate preparedness. Few studies focus on climate preparedness perceptions within Great Lakes coastal communities, and those that do often aggregate findings from several communities, making it difficult to understand what specifically is happening in the Duluth region. The study will illuminate place-based constraints and opportunities around adaptation and adaptive capacity building in the Duluth community. Place-based findings will benefit Duluth area resource professionals, planners, policy makers, and program designers interested in better preparing their communities for climate change and extreme weather.

CHAPTER 3

METHODS

This study is based on data collected for a broader, interdisciplinary project about integrative social and hydrologic resiliency of coastal communities under extreme weather events. The larger research project was implemented in the Mission Creek and Miller Creek subwatersheds in Duluth, Minnesota, and surrounding communities and in partnership between the University of Minnesota Twin Cities (UMN) and the Natural Resources Research Institute (NRRI) (Host et al., 2013).

The study investigated how participants in the Duluth area community characterize climate change and climate preparedness as well as drivers and constraints for adapting to climate change. This study investigated three research questions:

1. How do decision makers in the study subwatersheds characterize climate change and climate change preparedness?
2. What do decision makers perceive drives and constrains preparation for and adaptation to climate change?
3. How can this new understanding help the community build climate preparedness and adaptive capacity?

The study applied qualitative methods for study design, data collection, and data analysis. The subsequent sections in this chapter describe the research study area, study design, instrument development, participant recruitment, participant profile, data collection, data analysis, anticipated outcomes, study quality, and study limitations.

Study Area

The study area for the research is in the Mission Creek and Miller Creek subwatersheds within the Lake Superior basin. These two subwatersheds are part of the larger St. Louis River watershed (Figure 2), which comprises 3,584 square miles in Northeastern Minnesota, spanning from the Mesabi Iron Range in the north to the Lake Superior harbor in Duluth in the south. UMN and NRRI researchers formulated the research as a paired watershed study to represent subwatersheds on the opposite ends of the development spectrum, with Miller Creek subwatershed largely developed and Mission Creek subwatershed largely undeveloped (Figure 3), as well as because the two subwatersheds experienced disruption to the coupled social, ecological, and hydrologic system during the 2012 flood.



Figure 2. The St. Louis River Watershed in Northeastern Minnesota. (Credit: Minnesota Pollution Control Agency)

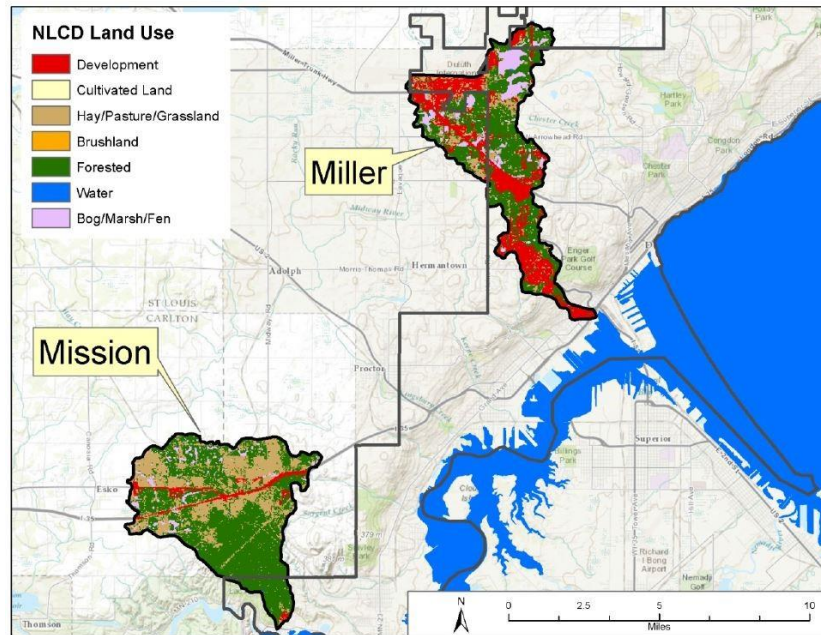


Figure 3. Miller Creek and Mission Creek Subwatersheds. (Credit: National Land Cover Dataset)

The Miller Creek subwatershed cuts through the central part of Duluth, and the northeastern tip of the city of Hermantown is also located in this subwatershed. The Miller Creek subwatershed is highly impacted and highly developed, with 60% of the land in the subwatershed considered urban use (Fitzpatrick, Peppler, DePhilip, & Lee, 2006). Igneous rock underlies much of this subwatershed, and in the lower parts of the subwatershed bedrock reaches the surface. Therefore, stormwater is not readily absorbed in many areas with these geologic characteristics, and it continues moving down the subwatershed as runoff. Miller Creek runs through much of the heart of the city of Duluth, but was enclosed and built over and runs underground through downtown.

The Mission Creek subwatershed includes the southwest corner of Duluth. In contrast to the Miller Creek subwatershed, Mission Creek has a much smaller amount of developed or barren land—only 21% is urban use—and is primarily forested (Fitzpatrick et al., 2006). Beneath the Mission Creek subwatershed lies sedimentary rock, which allows for greater stormwater absorption and leads to less erosion than igneous bedrock.

In June 2012, northeastern Minnesota experienced a record-breaking precipitation and flood event, resulting in economic, ecological, and infrastructure damage to the region (Czuba et al., 2012). The extreme weather event resulted in a large amount of damage to the Lake Superior coastal community of Duluth. Specifically, the Miller Creek and Mission Creek subwatersheds were heavily impacted by the extreme weather. Stormwater runoff and flooding in Miller Creek caused damage to residences, infrastructure, and recreation areas and facilities (Czuba et al., 2012). Mission Creek experienced erosion along the creeks and damage to the natural ecosystems that are predominant in the subwatershed.

Study Design

A qualitative informed grounded theory approach was used for the study. Qualitative research methods aim to study issues in their natural settings and capture meaning through the participants involved in the research (Creswell, 2013), while grounded theory methodology consists of “systematic, yet flexible guidelines for collecting and analyzing qualitative data to construct theories grounded in the data themselves” (Charmaz, 2006, p. 3). A qualitative informed grounded theory approach utilizes “rigorous data collection procedures” (Creswell, 2013, p. 53).

Researchers explored the broader study research questions through in-depth interviews with residents of the Duluth area community. Interviews allow for rich, thick description (Corbin, 2008) and detailed information to be gathered from participants around questions about community, climate change preparedness, and adaptive capacity. This rich, textual data provides researchers with detailed information from which to explore emergent themes.

Researchers also conducted two focus groups in the study area. Focus group data was not used as a primary data source for this thesis research. Instead, focus groups served a primary role in triangulation and member checking to ensure credibility of the broader study.

Instrument Development

UMN researchers developed an interview protocol aimed at exploring participants' perspectives regarding the study topic and research questions (Appendix E). Several interview questions aimed at uncovering participants' perspectives on climate change and climate preparedness perceptions and beliefs. Examples of interview questions include:

1. What are your perspectives on climate change?
2. In your opinion, is the community doing what it needs to do to prepare or plan for climate change or extreme weather events? Please explain.

NRRI reviewed the interview protocol and provided feedback to UMN researchers. UMN researchers then piloted the interview protocol with watershed professionals and resource managers within the Twin Cities.

Since the nature of grounded theory often rests on allowing participants to discuss what they think is important regarding the study area, the protocol was used in a semi-structured way. Researchers asked follow up questions that were not in the protocol or led the interview in another direction in order to explore further emergent topics or if otherwise deemed necessary. The interview protocol was reviewed by the University of Minnesota's Institutional Review Board (IRB), which determined the research was exempt from further human subjects review.

Participant Recruitment

Researchers recruited participants using a purposeful sampling approach. For grounded theory methodology, this means selecting participants who “can purposefully inform an understanding of the research problem and central phenomenon of the study” (Creswell, 2013, p. 156). Participants included community decision makers, leaders, and other key informants with influence within the subwatersheds. NRRI used spatial analysis to identify municipalities and agencies with jurisdiction within the Miller Creek and Mission Creek subwatersheds. Using this information, UMN researchers compiled a stakeholder list that focused particularly on stakeholders that had land and water management authority within the paired watersheds. Then UMN researchers identified and contacted the individual or individuals in each unit who would be most likely to speak to the research topic and questions (Appendix C).

Researchers also used a chain referral sampling approach for participant recruitment. Researchers asked initial stakeholder participants if there are others in the community who could contribute to the research questions. From this approach, researchers identified and interviewed other key stakeholders and community members

who were not identified in the original list. Chain referral sampling is a beneficial approach to seek out lesser known or hidden stakeholders, and while researchers strived for maximum variation of stakeholders, certain individuals outside the networks of participants may be missed. All participation by interviewees was voluntary.

Data Collection

Researchers conducted 27 semi-structured, in-person interviews with local decision makers, resource managers, and key community informants. Intensive interviewing allows “an in-depth exploration of a particular topic or experience and, thus, is a useful method for interpretive inquiry” (Charmaz, 2006, p. 25). The initial goal of the project was to interview 20 to 30 participants, which is consistent with grounded theory methodology (Charmaz, 2006; Creswell, 2013). After 27 interviews, researchers obtained data saturation, which indicates no new data about the research questions were obtained from interviewees.

Interviews were conducted between March and August of 2015. The location of interviews was selected by the participants and took place in either participants’ work places or coffee shops. Before an interview was conducted, researchers reviewed the consent form and allowed the participant to read it fully and ask any questions before signing (Appendix D). Interviewers took field notes on printed copies of the interview protocol, and the notes were used to clarify interview data and to assist in chain referral sampling procedures. Once the interview was complete, researchers asked the participant to fill out a demographic form that included questions about socio-demographic information and his or her role and time spent in the community (Appendix F). Demographic information was collected so researchers ensured they were interviewing a

variety of participants. Participants' names were kept confidential and no personally identifying data were linked to participant response in the analysis. Researchers employed all efforts to ensure confidentiality among participants was maintained.

Participant Profile

After each interview, the participant completed a demographic information sheet, which had open-ended questions about the participants' socio-demographic characteristics as well as their occupation, years lived in community, and associated community groups. This information was aggregated (Table 2).

Table 2. Interview Participant Profile

Socio-demographic Characteristics		N	Percent
Gender	Male	11	41
	Female	15	56
	Not reporting	1	4
Age	Minimum	28	-
	Median	48	-
	Maximum	66	-
Race/Ethnicity	White/Caucasian	25	
	Not reporting	2	
Years lived in community	Minimum	3	-
	Median	17	-
	Maximum	41	-
Highest level of formal education	Completed high school	1	4
	Some college but no degree	2	7
	Undergraduate degree	9	33
	Graduate or professional degree	15	56

Data Analysis

All interviews were audio recorded and transcribed. The interview transcriptions were analyzed according to coding procedures described by grounded theorists Charmaz, Glaser, and Strauss (Charmaz, 2006; Glaser & Strauss, 1967). Coding is a process by which researchers name “segments of data with a label that simultaneously categorizes, summarizes, and accounts for each piece of data” (Charmaz, 2006, p. 43). Throughout data analysis, I used the constant comparative method, as described by Glaser and Strauss (1967). In this method, coding data and continually analyzing for theory development happen concurrently.

The coding procedures I used are those of Charmaz, who defines two primary steps in coding: open coding and focused coding. Open coding involves tagging each segment of the data, which can mean a word, phrase, or paragraph (Charmaz, 2006). During this step, the researcher reads the data closely and remains open to all potential theoretical directions, tagging each segment of data without incorporating a theoretical framework. In the focused coding stage, researchers select the most significant or frequent codes that emerged during the open coding stage to further organize the data (Charmaz, 2006). In this step, researchers synthesize larger segments of data and begin integrating theory in the analysis process (Appendix G).

The intent of collecting interview data within the Mission Creek and Miller Creek subwatersheds was to be able to compare and contrast the paired watersheds. However, during the interview process researchers discovered participants often worked in both subwatersheds or were familiar enough with both to inform on both study areas. Therefore, a critical mass of interviewees distinct to each subwatershed was not obtained.

Interview data was aggregated during analysis procedures and comparisons between subwatersheds were not made.

The organization software QSR NVivo 11 was used for analysis. This software allows for coding and categorization of emergent themes within the data. I used memo writing—”a crucial method in grounded theory”—during analysis as a way to capture my ideas about the coding and analysis process in real time (Charmaz, 2006, p. 72). I also used diagramming and conceptual mapping to visually display data and to discover connections among codes and emergent themes (Charmaz, 2006). Two additional researchers coded the data, and we met frequently to discuss the analysis process. Multiple coders allow for consistency checks and audits of coding as well as the discussion of emerging themes and theoretical frameworks.

Study Quality

Researchers have taken steps to ensure the quality, or trustworthiness, of the study. Trustworthiness aids in evaluating the worth of qualitative research and has four constructs: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985; Marshall & Rossman, 1999). Credibility demonstrates confidence in the “truth value” of the study and that researchers have collected and analyzed the data accurately (Lincoln & Guba, 1985, p. 290). To assure credibility, three researchers analyzed the data and met frequently to discuss emerging themes and theoretical frameworks. As noted earlier, researchers conducted two focus groups, which serve an important method for member checking and triangulation (Charmaz, 2006; Creswell, 2013). Through focus groups, researchers checked analysis and findings by presenting study findings to participants and other pertinent stakeholders and community members

and obtaining feedback. Focus groups are an additional method of data collection, which allows for triangulation and corroboration of interview data. Participation in the focus groups was voluntary and all efforts were taken to maintain participants' confidentiality.

The second construct, transferability, indicates a study's ability to be applied in other contexts. Findings from this study will provide build understanding to applied community adaptation and decision making. The study findings may extend to other coastal communities and provide insight and lessons learned from the perspectives and experiences of those involved in this research. The third construct, dependability, indicates study findings could be repeated. Researchers wrote memos and constructed theme tables and concept maps to keep a record of the analytical process and recorded themes as they emerged. The final construct of trustworthiness, confirmability, indicates the data lead to the study findings and the findings are not a result of biased interpretation. Multiple researchers assisted in data analysis. Throughout the analysis process, researchers met to discuss emerging themes and negotiate interpretations to assure confirmability.

Study Limitations

Common limitations associated with qualitative research are generalizability and researcher bias. The purposeful and chain referral sampling approaches used to identify participants for the study do not lead to a statistically representative (i.e., probability) sample of participants, and therefore the study is not necessarily generalizable to a broader population. However, the intent of qualitative research is not generalizability but rather exploration and explanation within the particular study area (Creswell, 2013). Still, while study findings are not generalizable, transferability of findings is warranted.

A second limitation of the study is the possibility of researcher bias, which relates to the aforementioned trustworthiness construct of confirmability. Bias based on researchers' experience or worldviews can enter the study at several different stages in the research, including during design, data collection, or data analysis. Bias can also result from a researcher leaning too heavily on an existing theoretical framework and not letting a theory emerge from the data (Creswell, 2013). Researchers have taken precaution to be reflexive and aware of where bias may occur. One way of doing this was for researchers to reflect on how they are a part of and positioned within the research process, as well as being conscious of and noting any "biases, values, and experiences" that are brought to the research (Creswell, 2013, p. 216). Grounded theory methodology is systematic and rigorous, and researchers must work their best to prevent their own preconceptions from influencing data analysis. I have had interest and experience in climate change mitigation and adaptation prior to conducting this research. As a result, I aimed to be continually aware of my potential biases during the study and took cautions to ensure these biases did not influence data collection or analysis procedures. Furthermore, the study had multiple researchers analyzing data and performing audits of coding to ensure interpretations are credible and as accurate as possible.

CHAPTER 4

EXAMINING PERSPECTIVES ON CLIMATE CHANGE AND PREPAREDNESS IN THE HEADWATERS OF LAKE SUPERIOR

Abstract

This study explores characterizations of climate change and climate preparedness within two subwatersheds of the Lake Superior basin. Twenty-seven key informant interviews were conducted with local decision makers, resource managers, and other leaders active in the subwatersheds. Study participants' experiences, beliefs, and attitudes were documented and analyzed using qualitative methods. Findings indicate strong convergence around climate change beliefs and concerns and divergence on perspectives on climate preparedness. Further analysis revealed specific challenges and current actions associated with climate preparedness. A better understanding of climate change beliefs and perceived preparedness will provide insight into the resources and activities that can be leveraged for further climate preparedness. This study also reveals challenges that may need to be addressed to make efforts more effective. Study findings offer a framework for climate preparedness planning and provide evidence for a strategic approach to building adaptive capacity in the study communities. Findings will inform community engagement, outreach, education, and communication programming on climate preparedness.

Keywords climate change, adaptation, climate preparedness, Great Lakes, decision makers

Introduction

Climate change is altering climatic conditions on a global and regional scale. In the US Midwest, climate change phenomena include higher temperatures, more intense

episodes of extreme heat, increased frequency and intensity of precipitation, and increased flooding (Karl, Melillo, & Peterson, 2009; Melillo, Richmond, & Yohe, 2014). Coastal regions such as the Great Lakes basin are considered climate-sensitive domains (Füssel, 2007), which means they readily experience climate change phenomena. One predicted change to hydrologic patterns is increased precipitation frequency and intensity, which can produce more flooding. Extreme rainfall and flooding events overwhelm aging stormwater infrastructure in urban areas; damage buildings, roads, and individual property; impact ecosystems through increased erosion; deteriorate water quality; and drain emergency management resources (Czuba et al., 2012; Melillo et al., 2014).

Extreme rainfall occurrences already affect Great Lakes coastal communities, which are increasingly vulnerable to the social, economic, and environmental impacts of such events. In June 2012, Duluth, Minnesota, experienced an extreme precipitation and flood event, which damaged infrastructure, residences, businesses, and recreation areas and facilities. As a result of the extreme event, approximately \$55 million of damage were incurred in Duluth (Eastern Research Group Inc., 2014). Water quality was negatively affected when erosion led to increased sediment in rivers and Lake Superior, and sewage infrastructure overflow caused sewage to flow into Lake Superior, the source of the community's drinking water.

Since climate impacts such as these will be experienced at the local level, climate change adaptation will need to happen at the local scale as well (Adger et al., 2009; Adger, Arnell, & Tompkins, 2005; Agrawal, McSweeney, & Perrin, 2008; Füssel, 2007). Community decision makers will play key roles in adaptation planning at the local scale, and understanding these stakeholders' perspectives on climate change and climate

preparedness is integral to effective adaptation efforts. The purpose of this study was to establish a framework for assessing and building climate preparedness in Lake Superior basin communities. The framework developed is based on local decision makers' experiences, beliefs, and attitudes about climate change and climate preparedness. The framework is also informed by participants' perceptions of key drivers of and constraints to climate preparedness. Specifically, this study investigated three research questions:

1. How do decision makers in the study subwatersheds characterize climate change and climate change preparedness?
2. What do decision makers perceive drives and constrains preparation for and adaptation to climate change?
3. How can this new understanding help the community build climate preparedness and adaptive capacity?

Climate Preparedness Related Literature

Climate preparedness describes the measures taken to prepare for and to respond to current and future climate change phenomena and their impacts (Heidrich et al., 2013). The terms preparedness and adaptation are often used interchangeably in climate change action communities. However, preparedness has its roots in the emergency and disaster risk assessment literature (e.g., flood and wildfire preparedness) and the origin of adaptation lies in biology, ecology, and related fields (e.g., species adaptation). Adaptation is commonly used within the international climate science community (e.g., Adaptation Committee of the United Nations Framework Convention on Climate Change). For this study we adopted the term preparedness because we believed it was more accessible term for decision makers and practitioners.

Several studies investigate decision maker perspectives on climate preparedness in coastal communities (Kahl & Stirratt, 2012; Mozumder et al., 2011; Scally & Wescott, 2011), with a common thread throughout to be some adaptation progress amidst multiple adaptation challenges. Scally and Wescott (2011) explored perceptions of climate change and adaptation responses in an Australian coastal community and found that stakeholders perceived climate change impacts were occurring in the community but they differed on adaptation perceptions, beliefs, and response. Additionally, financial and resource constraints, lack of cross-sector/interagency coordination, and unclear responsibilities were identified as barriers to adaptation (Scally & Wescott, 2011).

Kahl and Stirratt (2012) investigated challenges and motivations for adaptation planning by decision makers in Great Lakes coastal communities, finding that although coastal communities are making good progress regarding climate knowledge and adaptation, challenges to adaptation decision making and planning include using available resources effectively, cross-sector coordination and communication, lack of political will, and lack of time. Similarly, Mozumder et al. (2011) found that while decision makers in the Florida Keys were increasingly aware of the social and ecological impacts and risks of climate change to their communities, adaptation was often constrained by social and institutional barriers, such as insufficient budget and staff time, lacking public demand for action, and few perceived solutions.

Determinants of Climate Preparedness

Several factors enable or constrain community climate preparedness, including adaptive capacity, vulnerability, and adaptation barriers. Adaptive capacity elaborates upon components that support or hinder adaptation. The framework of vulnerability

incorporates adaptive capacity with exposure and sensitivity to obtain a fuller picture of potential climate impacts (Fussel, 2007; IPCC, 2007; Smit & Wandel, 2006). The literature on adaptation barriers serves a helpful examination of climate preparedness based on the specific hindrances of adaptation planning and implementation.

Adaptive Capacity

Adaptive capacity in the climate change literature is defined as the ability of natural and human systems to adjust to climatic changes (Field et al., 2014). Adaptation can be understood as “manifestations of adaptive capacity” (Smit & Wandel, 2006, p. 286), so adaptations that have or have not occurred may be understood as a reflection of the adaptive capacity of the individual, community, institution, or region. A review of the literature demonstrates adaptive capacity research incorporates research from psychology (Gifford et al., 2011; Grothmann et al., 2013; Torsten Grothmann & Patt, 2005; Reser & Swim, 2011), vulnerability and resilience (Engle, 2011), institutions and governance (Agrawal et al., 2008; Gupta et al., 2010), and organizational theory (Berkhout, 2012).

A large portion of adaptive capacity literature focuses on assessment (Engle, 2011; Fussel, 2007). Researchers have developed several frameworks to understand and assess adaptive capacity across scales, institutions, and fields (Grothmann et al., 2013; Gupta et al., 2010). From Gupta et al. (2010), dimensions of assessment are variety of perspectives, learning capacity, allowance for and promotion of autonomous behavior change, leadership, mobilization of resources, and fair governance. Other authors have incorporated the social and cognitive factors that researchers increasingly contend are needed for adaptation and obtaining high adaptive capacity (Adger et al., 2009; Gifford,

Kormos, & McIntyre, 2011; Gifford, 2011; Grothmann & Patt, 2005a). Social factors and capacities that have often been underrepresented in adaptive capacity and adaptation frameworks include values, norms, beliefs, motivations, perceptions, human and social capital, knowledge, experience, behaviors, interests, and customs (Adger et al., 2009; Clayton et al., 2015; Grothmann et al., 2013). Grothmann et al. (2013) added adaptation belief and adaptation motivation to Gupta et al.'s framework. These two components incorporate political will, perceptions of climate change and risk, perceived behavioral control (Ajzen, 1991), and self- and response efficacy (Ajzen, 2002), aspects researchers have noted are integral in adaptive capacity and adaptation implementation (Adger et al., 2009; Clayton et al., 2015; Gifford, 2011, 2014; Reser & Swim, 2011).

Vulnerability

The IPCC defines vulnerability as “the propensity or predisposition to be adversely affected” by climate change (Field et al., 2014, p. 5). Vulnerability can also be understood as a function of exposure and sensitivity (Fussel, 2007; IPCC, 2007; Smit & Wandel, 2006). Exposure indicates the degree to which a system is exposed to climatic variations and often is a function of geography or physical location. Sensitivity specifies the degree to which a system is affected by climatic change and climate impacts. Therefore, one approach to reducing vulnerability to climate change is by addressing exposure and sensitivity to decrease risk of potential climate impacts (Fussel, 2007; IPCC, 2007; Smit & Wandel, 2006) (Figure 4).

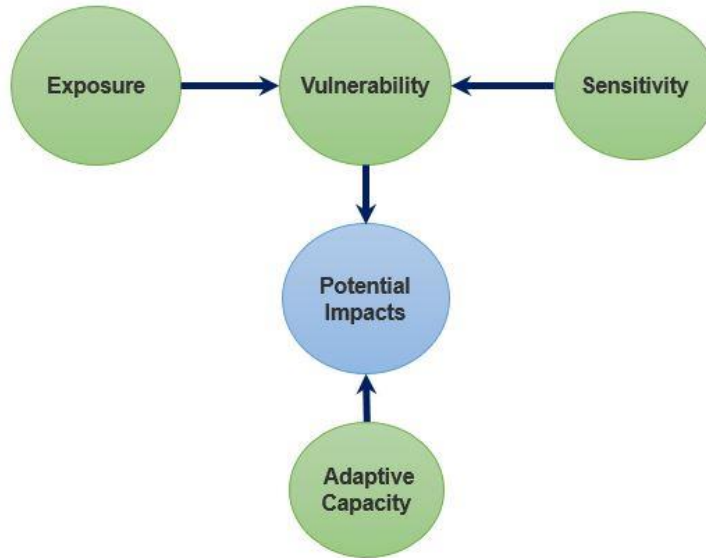


Figure 4. Model of Climate Vulnerability. Adapted from Fussel, 2007; IPCC, 2007; Smit & Wandel, 2006.

Factors that influence vulnerability include age, socioeconomic status, ethnicity, class, gender, and health (Field et al., 2014). Socioeconomic status, inequality, and inequity within a community may be the main factors that influence vulnerability (G. R. Biesbroek et al., 2013). While individual sociodemographic factors largely affect vulnerability, community-related factors also play a role. For example, social support, including social networks and social capital, can increase coping abilities and therefore decrease vulnerability (Duarte, 2007). Social support can also allow an individual greater access to information and economic resources (Smit & Wandel, 2006). Social resources that aid in coping include community attachment (sense of community and place identity) and social cohesion (community turnover and socializing) (Wall & Marzall, 2006). Generally, the greater a person's connection to community is, the less vulnerable a person is. If an individual has strong coping capabilities and good connections to the community

to draw upon if circumstances of emergency or disaster, vulnerability will be reduced (Reser & Swim, 2011).

Barriers to Adaptation

Adaptation barriers—the factors that impede development and implementation of adaptations—are a key determinant of climate preparedness and a robust research domain. Although climate change adaptation is or will be needed in most communities, it is often hindered for various reasons, including limited resources (Biesbroek et al., 2013; Moser & Ekstrom, 2010; Mozumder, Flugman, & Randhir, 2011), cognitive barriers (Gifford, 2011; Moser & Ekstrom, 2010; Reser & Swim, 2011), lack of leadership (Moser & Ekstrom, 2010), institutional and governance constraints (Biesbroek et al., 2013; Measham et al., 2011), and social factors (Adger et al., 2009; Jones & Boyd, 2011a).

Research indicates barriers arise from three areas: factors relating to individuals, policy, and implementation (Biesbroek et al., 2013; Moser & Ekstrom, 2010). After noting there could be innumerable barriers to adaptation, Biesbroek et al. (2013) found that only three barriers are climate change specific: 1) “the long-term impacts of climate change versus the short-term dynamics of politics and decision-making,” 2) “the reliance on scientific models to identify, understand, and communicate the problem and propose solutions,” and 3) “the inherent uncertainties and ambiguities of climate change” (p. 1124). Barriers that are non-climate change specific are those that can also be found in other environmental, policy, and decision-making realms, such as lacking resources, technical skill, or leadership.

Early adaptation-barrier research primarily focused on biological and technical barriers; however, recent studies have broadened barrier research to include more social science disciplines, finding that social factors play an integral role in influencing adaptive capacity and adaptation implementation (Bennett et al., 2014; Jones & Boyd, 2011b; Scally & Wescott, 2011; Wall & Marzall, 2006). Social barriers include institutional, governance, cultural, political, informational, and cognitive dimensions of adaptation (Biesbroek et al., 2013; Biesbroek et al., 2011; Gifford, 2011; Measham et al., 2011).

Cognitive barriers are particularly powerful at impeding adaptation because cognitive constraints can hinder adaptation even if the community's physical or financial resources are enough for adequate adaptation implementation (Gifford, 2011; Grothmann & Patt, 2005; Reser & Swim, 2011; Swim et al., 2011). Specifically, researchers demonstrate beliefs, worldviews, values, norms, and perceptions of control, efficacy, risk, and uncertainty have constrained adaptation behavior (Adger et al., 2009; Clayton et al., 2015; Gifford, 2011, 2014; Grothmann & Patt, 2005; Moser & Ekstrom, 2010; Reser & Swim, 2011). Institutional and governance constraints such as lack of leadership throughout the understanding, planning, and managing phases of adaptation can prevent or impede adaptation (Moser & Ekstrom, 2010). Similarly, a lack of coordination and communication within institutions and between institutions and the public on climate change generally and adaptation specifically, along with a lack of public awareness, can constrain adaptation planning or implementation efforts (Adger et al., 2009; Jones & Boyd, 2011a; Measham et al., 2011). As opposed to biological or technical barriers, social and cognitive barriers are difficult to directly measure. If decision makers report on

their perspectives and experiences with adaptation, barriers can be better identified and evaluated (Biesbroek et al., 2011).

Based on adaptation literature and policy reviews, several frameworks have been proposed for categorizing, organizing, and understanding social barriers to adaptation (Adger et al., 2009; Biesbroek et al., 2011; Moser & Ekstrom, 2010). Adger et al. (2009) indicates ethics, knowledge, risk, and culture are categorical barriers to adaptation, while Biesbroek et al. (2011) proposes seven clusters of barriers to adaptation, which include both climate-specific and non-climate-specific barriers (Table 3).

Table 3. Clusters of Barriers to Adaptation (Biesbroek et al., 2011).

Barrier Category	Description
Lack of awareness and communication	<ul style="list-style-type: none"> • Lack of communication between scientists, practitioners, and public • Lack of awareness a result of lack of communication
Fragmentation	<ul style="list-style-type: none"> • Institutions, organizations, agencies, policies and individuals not connecting or coordinating
Resources	<ul style="list-style-type: none"> • Human (staff, time, skilled individuals) • Financial • Information (applied, local, credible) • Physical (technological measures) • Natural (access to land)
Conflicting timescales	<ul style="list-style-type: none"> • Conflict between long-term scale of climate change and more short-term scale of planning and decision making • Other more immediate issues higher priority
Motives and willingness to act	<ul style="list-style-type: none"> • Cognitive decision making factors, such as attitudes, beliefs, norms, and values may inhibit acting on adaptation • Lacking leadership may also prevent adaptation action
Institutional crowdedness and institutional voids	<ul style="list-style-type: none"> • Many institutions working on problem, leading to confusion about tasks, responsibilities, and goals • Few institutions working on adaptation
Substantive, strategic, and institutional uncertainty	<ul style="list-style-type: none"> • Uncertainty about climate change phenomenon and impacts • Uncertainty about human behavior • Uncertainty about decision making

Methods

An informed grounded theory approach was used for the study (Charmaz, 2006). Qualitative research methods aim to study issues in their natural settings and capture meaning through the participants involved in the research (Creswell, 2013), while grounded theory methodology consists of a systematic and flexible approach to data collection and analysis that leads to constructing theory from the data itself (Charmaz, 2006). A qualitative informed grounded theory approach uses a rigorous data collection process (Creswell, 2013).

Researchers developed an interview guide that included questions aimed at documenting participants' perspectives on extreme weather, climate change, and climate preparedness perceptions and beliefs and explored the study research questions through in-depth interviews with residents of Duluth and the surrounding communities (Appendix E). Interviews allow for rich, thick description (Corbin, 2008) and detailed information to be gathered from participants around questions about community, climate change preparedness, and adaptive capacity. This rich, textual data provided researchers with detailed information from which to explore emergent themes.

Researchers recruited participants using a generated stakeholder list and a purposeful sampling approach. Researchers aimed to recruit participants with decision-making authority or influence within the subwatersheds (Appendix C). For grounded theory methodology, purposeful sampling means selecting participants who can inform the central purpose of the study (Creswell, 2013). Researchers also used chain referral sampling to seek out stakeholders who may not be originally identified by the research team. Researchers conducted 27 semi-structured, in-person interviews with local decision

makers, resource managers, and key community informants. Intensive interviewing allows for in-depth investigation into an issue, which is helpful in interpretive study (Charmaz, 2006). Interviews were conducted between March and August of 2015.

Participant Profile

Demographic information, including socio-demographic characteristics as well as occupation, years of residency in community, and organization membership, was collected so researchers ensured they were interviewing a variety of participants who could speak to the research topic. Participants' names were kept confidential and no personally identifying data were linked to participant response in the analysis. Of the 27 participants interviewed, 15 were female, 11 were male, and one was not reported (Table 4). Median age of participants was 48, while median number of years lived in the community was 17. Most participants had obtained a bachelor's degree or higher. A vast majority of participants identified as white.

Table 4. Interview Participant Profile

Socio-demographic Characteristics		N	Percent
Gender	Male	11	41
	Female	15	56
	Not reporting	1	4
Age	Minimum	28	-
	Median	48	-
	Maximum	66	-
Race/Ethnicity	White/Caucasian	25	
	Not reporting	2	
Years lived in community	Minimum	3	-
	Median	17	-
	Maximum	41	-
Highest level of	Completed high school	1	4

formal education	Some college but no degree	2	7
	Undergraduate degree	9	33
	Graduate or professional degree	15	56
Occupation category	Natural resource professional	14	52
	Decision maker	8	30
	Community influencer	5	18

Study Area

The study area for the research was the Mission Creek and Miller Creek subwatersheds within the larger St. Louis River watershed in the Lake Superior basin of Minnesota (Figure 5). The Miller Creek subwatershed cuts through the central part of Duluth, and the northeastern tip of the city of Hermantown is also located in this subwatershed. The Miller Creek subwatershed is highly impacted and highly developed, with 60% of the land considered urban use (Fitzpatrick et al., 2006). Igneous rock underlies much of this subwatershed, and in the lower parts bedrock reaches the surface. Therefore, stormwater is not readily absorbed in many areas with these geologic characteristics, and it continues moving down the subwatershed as runoff. Miller Creek runs through much of the heart of the city of Duluth, but was enclosed and built over and runs underground through downtown.

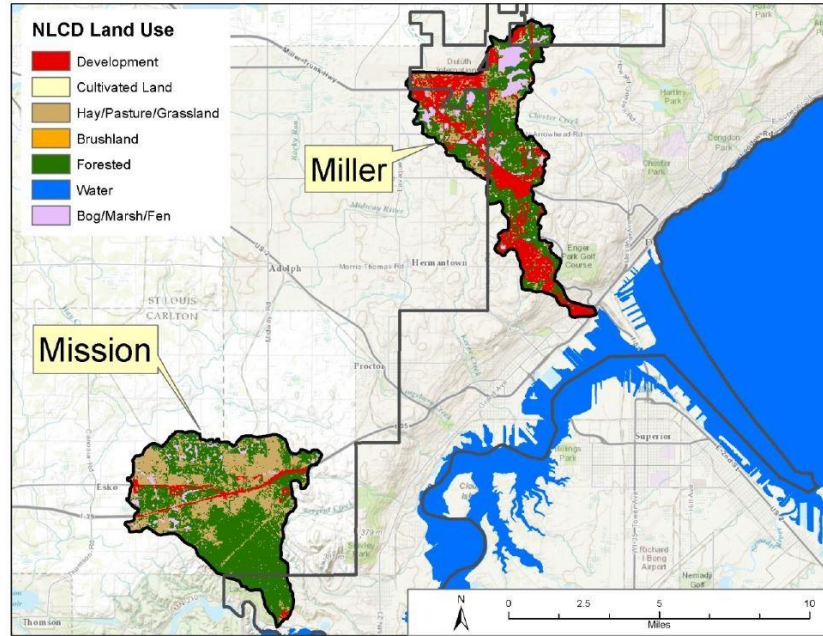


Figure 5. Miller Creek and Mission Creek Subwatersheds. (Credit: National Land Cover Dataset)

The Mission Creek subwatershed includes the southwest corner of Duluth. In contrast to the Miller Creek subwatershed, Mission Creek has a much smaller amount of developed or barren land—only 21% is urban use—and is primarily forested (Fitzpatrick et al., 2006). Beneath the Mission Creek subwatershed lies sedimentary rock, which allows for greater stormwater absorption and leads to less erosion than igneous bedrock.

In June 2012, northeastern Minnesota experienced a record-breaking, 500+ year precipitation and flood event, with 7.25 inches of rain falling in Duluth in two days (Czuba et al., 2012). The storm resulted in economic, ecological, and infrastructure damage to the region. The extreme weather event resulted in a large amount of damage to the Lake Superior coastal community of Duluth and surrounding communities. Specifically, the Miller Creek and Mission Creek subwatersheds were heavily impacted

by the extreme weather. Stormwater runoff and flooding in Miller Creek caused damage to residences, infrastructure, and recreation areas and facilities (Czuba et al., 2012).

Mission Creek experienced erosion along the creeks and damage to the natural ecosystems and stormwater control infrastructure.

Data Analysis

Interviews were audio recorded and transcribed, and the transcriptions were first analyzed through coding, a process that entails naming “segments of data with a label that simultaneously categorizes, summarizes, and accounts for each piece of data” (Charmaz, 2006, p. 43). Two primary steps were involved in the coding process: open coding and focused coding. Open coding involves tagging each segment of the data, which can be a word, phrase, or paragraph. During this step, the researcher reads the data closely and remains open to all potential theoretical directions, tagging each segment of data without incorporating a theoretical framework. In the focused coding stage, researchers select the most significant or predominant codes that emerged during the open coding stage to then organize the data around (Charmaz, 2006). In this step, researchers synthesize larger segments of data and begin integrating theory into the analysis process.

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Findings

Researchers asked participants to discuss their overall perspectives on climate change, whether they have any concerns about climate change and extreme weather, and if they consider the community prepared to handle future climate and extreme weather impacts. Three primary themes emerged through data analysis. First, convergence around climate change beliefs was found. Second, participants largely perceived the region to be exposed and sensitive to climatic changes. Third, participants indicated multiple constraints to and actions for climate preparedness.

Climate Change Beliefs

Researchers asked participants, “What are your perspectives on climate change?” Generally, participants believed that climate change is happening in their community. One participant responded, “I totally believe that we’ve been experiencing it for a decade at least for sure, and it’s getting bigger and bigger and bigger. I have no doubts about it whatsoever.” Another participant acknowledged, “Do I believe in it? Hell yes. Yeah, I think it’s right in front of us.” In contrast, one study participant expressed skepticism that

climate change is or will be happening, commenting “I’m still formulating my opinions from the people who are studying it.”

Perceptions of Community Vulnerability

An Exposed System

Many participants perceived their community to be an exposed system to climate change including extreme weather, largely as a result of having seen or personally experienced impacts and extreme weather events. Some participants have lived in the Duluth region for decades, and this longevity in the community has allowed them to see climate change phenomena occurring. One participant observed,

I’ve been living here 25 years, and I do feel like the climate has changed since I’ve been here. I feel like the moisture patterns, the way we get snow, the way it comes our way, the temperatures, I mean, I feel like that’s a very natural assumption to make: that that’s partly impacted by climate change.

Another interviewee who has lived in the community for 20 years stated, “I see the impacts on the ground here. I’ve been around just long enough to think of a before and think of an after of what we’ve been through.” Similarly, a participant calls out time spent in the community before indicating he has seen an increase in extreme weather: “One of the things that is discussed a lot is the frequency of storms, and in my time here, without looking at the data, I believe that the frequency of high intensity rainstorms has increased.”

While participants also discussed hotter weather and the lake level changes they observed, many participants’ climate change beliefs were largely influenced by seeing and experiencing precipitation changes in the region. One participant summarized,

I have noticed that our precipitation events are more intense and more frequent. Whereas the measured slow precipitation events that we used to

have even ten, fifteen, twenty years ago are much more rare. So, instead of getting soaking, slow, steady rains we're getting these flash flood runoffs that seem to be out of control.

Particularly, participants expressed that experiencing the 2012 flood led to increased awareness of climate change and understanding of the region's exposure to extreme weather. One participant expressed, "That flood a couple of years ago blew everybody's mind as far as I could tell. It was a hell of a thing to live through. If that's a 100 year flood that's going to become a 20 year flood or whatever."

A Protected System

In contrast, participants who viewed the region to be protected highlighted the geography as shielding the area from storms, impacts to be less severe than other regions, and the long time horizon for climate impacts to occur. For example, participants remarked that the lake shields the community from obvious shifting weather patterns and extreme weather. One participant observed, "Living right by the lake I think that we're a little bit buffered from it, so people aren't immediately jumping on board and saying, we have to fix a, b, and c." Another stated, "Tornado risk isn't great here. I don't see that changing that much."

Some interviewees believed the community will not be exposed to the type of severe impacts that other regions may experience. One participant explained, "We are not a community that's like California or Las Vegas where there's this potential for drought at any time and no drinking water." Similarly, another participant observed,

It's fair to say intellectually that an area like Duluth-Superior will quantitatively see less impact from climate change over the long run than a lot of other places, where we're drastically less likely to be impacted by hurricanes, we're drastically less impacted by things like sea level increases and that sort of thing.

Other interviewees believed the community is protected due to their perceived temporal distance of climate change. Perceived temporal distance indicates the perception that climate change phenomena and impacts will occur a long time from now. One participant perceived this to exist among the broader community: “I think that a lot of times people see climate change as something way off into the future, and so I think there’s a mindset that this is a distant thing.” Similarly, some participants indicated the community was protected because they understood the 2012 flood to be a once-in-a-lifetime event, demonstrating they do not see extreme weather as likely to happen more frequently in their community.

A Sensitive System

Water Resources

Most interviewees characterized their community as sensitive to a changing climate, meaning their region is affected by climatic stimuli and will experience climate change impacts. Participants viewed community members as being sensitive to climate change and climate change impacts. Community members are sensitive because water plays a significant role in their lives and they hold a water ethic, which indicates participants’ connection to and value of water. They value this relationship with water and are concerned climate change may affect the resource or their relationship with water.

Participants noted water is very visible within the Duluth and surrounding communities. People can see Lake Superior, the St. Louis River, and neighborhood streams throughout the community. One participant commented, “Everybody can see the lake. It’s the thing, you know? It’s a very complex and deeply intimate connection to

your water.” The community has a strong physical and emotional connection to water, and participants stated how people in the community value being near the water. One participant captured this sentiment: “People want to be by the water. They want to live by the water. They want to hear it running. They want to see it in its different moods.” Water resources also serve as a way to connect people and neighborhoods. With this continual connection to water, many interviewees stated water as being a part of their identity, both individually and as part of the community. Participants described water as being “everything,” “life,” and “lifeblood.” One participant described, “It’s the foundation of us being here, right. We wouldn’t be here without water. So it’s our life force. Like I said, if we didn’t have it, we wouldn’t be here.”

Participants viewed the water system itself to be sensitive in significant ways, including to the 2012 flood and related events. Participants described how the flood affected water quality in Mission and Miller Creeks and Lake Superior and how it altered Mission Creek’s stream course. One participant detailed her fear of drought-experiencing regions wanting to pipe out water from the Lake Superior and the Great Lakes, commenting, “Yeah, this is going to be a huge problem in the not-too-distant future because already there’s a town in Wisconsin that wants to put a pipeline to Lake Michigan because the groundwater of that area is gone.” In this way, participants expressed concern about a sensitive system in which they hold strong attachment.

Plants, Fisheries, and Wildlife

Many participants were also attached to the biological systems of the community. Participants who were attached to regional ecosystems and species perceived biological

systems to be sensitive to climate change and were concerned about impacts to these systems. One interviewee described this attachment in terms of system changes:

It seems just maybe with that connection with the resource people in this area are extremely knowledgeable about kind of the cycles that this area naturally goes through. And so they're able to see when something's different or when something is not the way they're used to seeing it.

Interviewees pointed to large ecosystem impacts, such as warming water temperatures and its effect on fish and aquatic species. When discussing perspective on climate change, one participant stated, "There's certainly an issue with how is the water temperature going to impact the variety of fish in the river and in the lake and how does it impact it."

Participants indicated attachment to regional species. They noted climate change is impacting or may impact these components of the biological system, and they were particularly concerned about these impacts. One person noted,

Tying in the climate change element to it, you think of things like the moose population drastically declining, you think of things like warming weather changing flora and fauna in the area and that sort of thing. I would certainly say those things would concern me.

One interviewee captured the general sentiment about how climate change is and will be impacting tree species and fisheries:

We are already looking at how we might need to begin managing our forest resources differently. We are losing black ash, our hardwood wetland tree species. . . . Can we continue to manage for the same kinds of forest resources that have been traditionally used by the Ojibwe for many centuries? We don't know. We are going to lose some of it.

This participant continues to explicitly comment on the sensitivity of the natural system to climate change: "The implications for our fisheries and our wild rice are pretty profound. Wild rice is sensitive, exceptionally sensitive, to hydrologic changes. It has a really narrow optimum in terms of the hydrologic regime that it can handle."

Connection to biological systems led to concern about forest sensitivity emerging again and again. One participant stated directly, “I know that a changing climate will change the things that are growing in our forests. It will change the very nature of those forests.” In addition to the general concerns about current tree species in jeopardy, there was also concern about how the loss of current tree species would impact the larger ecosystem. One participant noted the link of healthy trees to healthy riparian areas, noting this system could be in jeopardy if vulnerable tree species cannot survive in their region. He then added, “I would be very concerned that as climate change happens, those trees are dying because of climate change and if nothing is being planted in replacement, you could end up with just a mud bath.”

Community Infrastructure, Economics, and Social Justice

In addition to attachment to water and biological systems, participants also indicated attachment to social and community systems in the region and perceived these as sensitive systems as well, specifying concern about climate change impacts on these systems. Explicitly, interviewees voiced concern about infrastructure, economics and finances, and vulnerable populations.

One participant captured the sentiment of many regarding the uncertainty of infrastructure handling changing precipitation patterns: “For this city, obviously with extreme weather events, it’s a concern. That is part of the issue, making sure we have the infrastructure in place to manage that.” Participants also stated concern about the financial and economic costs incurred by climate impacts. They noted that climate change will affect the cost of city services, local businesses, particularly those within the

tourist economy, and individuals and families who experience direct impacts of extreme weather, such as flooding. One interviewee captured the sentiment well:

If we have extreme winters, the financial cost of street maintenance and all of that here is enormous, and every year, they are over budget. And it's crazy. So it could very easily financially devastate. . . . And then building up a tourist economy in a place with extreme weather, when that's what your entire bread and butter is about, in a place when all summer it could look just like this.

A final sensitivity was of the social system. One person indicated that her main concern about extreme weather events was about their impact on people. After mentioning concerns about the 2012 flood, she shifted to discuss how future similar events may affect the community: "It's the financial impact on individual families that can't get to work and schools are canceled so now kids are home and they're not learning. So I think more about those factors than the actual weather event itself." Some participants were concerned about those most vulnerable, such as homeless populations, and how they will be disproportionately affected by climate change impacts. Since they are often outside, they will experience higher temperatures and related repercussions more often. One participant observed about climate change: "There are weeks in the winter and weeks in the summer where we have hundreds of people living outside who are in danger from one extreme or the other. So it's at the front of our mind."

A Resistant System

While many participants expressed system exposure, protection, or sensitivity as a lens through which to view regional climate impacts, the perception of a resistant system also emerged, specifically in regards to the social system. For one participant, a decrease in wildlife sightings will have little impact on day-to-day life in the community:

I've seen less than a handful of moose in thirty years of living in this area, so to what extent is that, it's more about existential change, than it is a, a change to my life. . . . Other areas of the world they might drastically have an effect on your day to day.

Perceptions of Climate Preparedness

Participants were asked, "In your opinion, is the community doing what it needs to do to prepare or plan for climate change or extreme weather events? Please explain."

Two predominant themes emerged as participants responded to this question. First, beliefs diverged on the community's climate preparedness. Some participants

acknowledged the community was prepared to cope with climate impacts: "Yes, for the most part [we are prepared]." Though, others vehemently described the community as

being unprepared: "Oh, no, no. No, communities are not [prepared]." Second,

participants described multiple challenges the communities face in preparedness, as well as opportunity areas for preparedness. Challenges include the nature of climate impacts, low levels of perceived efficacy, a lack of prioritization and coordination of actions, limited communication and awareness, and insufficient resources and requirements.

Opportunity areas emerging included activities that resulted from the 2012 flood response and recovery, and specific examples of planning-oriented actions. Explanation of the challenges and opportunity areas, along with supporting data, are detailed below.

Challenges Faced in Climate Preparedness

The Nature of Climate Impacts

A predominant challenge that emerged was related to the challenges around climate impacts, including uncertainty, lack of connection on climate impacts, and conflicting timescales. This is the one challenge that is climate-change specific, which signifies the issue of climate change itself in some way hinders climate preparedness.

When discussing climate change or climate preparedness, participants often spoke about the inherent uncertainty of climate impacts and how this uncertainty poses challenges for planning and preparedness. One participant succinctly said, “If you don’t know what you are planning for, how do you plan for it?” Another interviewee elaborated,

“My perspective on climate change is that we have no idea what is coming. What it does is it increases uncertainty and that’s going to be really difficult for human infrastructure because we designed things around events we expect and when we no longer know what to expect . . . you have no idea what you are designing to.”

Participants suggested the nature of climate impacts makes the issue of climate change difficult to connect on and think about regularly. Impacts may not always be visible or immediately concerning. One interviewee commented, “A lot of the temperature changes are again harder for us because it’s harder to talk about when you ask somebody if it concerns them that temperatures have risen a couple of degrees. You’re not going to get an overwhelming response of, ‘Yeah, I’m really concerned about that.’” Due to this challenge, some participants noted it takes an extreme event like the 2012 flood to bring home climate impacts, as one participant reflected, “Unfortunately with the climate adaptation piece it takes an event to really get that momentum and get that response going.”

Conflicting timescales between planning, which is relatively short-term, and climate impacts, which are longer term, pose a challenge to climate preparedness. One participant said, “We still only design most of our conservation practices on a ten-year or twenty-five year storm. We don’t try to take in a 100-year flood type of events no matter how often they may happen.” Another participant commented on the challenge of long term planning, framing the constraint as a broader societal issue: “That’s really difficult, especially because a lot of planning only goes out about five to ten years so thinking

really long term is something not just in this area but as a society we are not great at really planning multiple years out.” One participant also noted longer-term impacts are “harder impacts to address, they’re harder to promote, and they’re harder to fund.”

Low Levels of Perceived Efficacy

Low perceived efficacy, including both response efficacy and self-efficacy, was a common theme among participants. Many participants addressed low response efficacy, which indicates participants did not know how to prepare for climate change and did not perceive solutions available to them to prepare adequately for impacts. Participants said “I don’t know how you prepare for an event like that” and “I don’t think much is being done because no one knows what to do.” Another participant expressed, “I think people are starting to hear and see things about changes in plants, changes in biological community distributions and things, but they don’t necessarily have an idea of how to help or what to do.”

Similarly, low perceived response efficacy also includes the perception of participants that it is not possible to prepare for climate change. One participant said, “Well, boy some things I guess you can never be prepared for.” This relates to many participants’ expressing little or no control over climate impacts. One participant said this concisely, “Well certainly you can’t really do anything about more floods or severity of floods or droughts.” Another person expressed a lack of control amidst the community’s good intentions to act, “Sort of the pessimism comes in with some of the climate change applications—these things that are out of our control really. We can’t really change a lot of it.”

Participants who expressed low perceived self-efficacy indicated they perceive themselves or other individuals to have a limited ability to prevent, prepare for, or respond to climate impacts. When speaking about climate change, one participant said, “It is always in the back of our mind, that we need to think about this more and plan better and be more wise about our use of resources. But there is only so much we can do.” Several participants expressed that whatever individuals do is “never enough.” One participant captured the sentiment with this statement: “I feel like what they might do in their little individual sphere is not enough.”

Lack of Action Prioritization and Coordination

Participants noted prioritizing climate preparedness was a challenge among themselves as decision makers and resources managers, and within the broader community. One participant perceived little attention paid to climate change in planning processes: “Agency folks, I think they’re aware of it, but at this point I haven’t seen where it’s a primary concern or a primary consideration in planning.” Participants indicated that, generally speaking, non-environmental issues often take priority within the community:

“I think we could be doing what we need to do to be more resilient, and again I think the drive is there it’s just kind of getting beyond that. Delaying, letting other things kind of come in and just kind of putting the climate and environmental issues on the back burner over and over again.”

When environmental issues are prioritized, preparing for climate impacts is not the priority action item. Regarding climate change, one interviewee said, “I don’t lay awake at night worrying about it. I think there are other issues that are more pressing. Pollution and illegal dumping are things that are probably a much more urgent need that we are trying to address.”

Participants also perceived the broader public places climate impacts low on the list of priorities the community needs to address for several reasons. First, as the flood fades from people's minds, there is less community call for action and prevention of a future flood-like event. One participant said,

“The farther we're getting out from this event the less important it's becoming, and it's kind of getting put on the back burner and put on the back burner. So that is really definitely a challenge that we do deal with.”

Participants also noted other concerns trump action on climate change and readiness, particularly for vulnerable and poorer communities who have more pressing day-to-day concerns. One person said, “It's not fair of me to expect people, who have so many other things to think about, to discomfort themselves.” Also discussed were perceptions that members of the broader community have competing obligations with little time to advocate for climate preparedness.

While a lack of prioritization of climate preparedness is a key challenge, the related lack of connection and coordination specifically among decision makers also emerged as a constraint. Many participant decision makers expressed not knowing actions other decision makers were taking to prepare for climate change, as indicated by this statement by one decision maker about another agency: “I would say I don't pay real close attention to how they're managing for climate change.” Another participant discussed this through the lens of potential tree species changes and of the work his organization and others do with trees:

“I don't know what land managers are doing. I know we're pretty aggressively taking on emerald ash borer, but that's a different sort of change that's happening, a little more immediate. You know, is the city forester planting more oak trees now versus something else? I don't know.”

Another participant said, “I probably don’t have the best background or have my finger on everything that they are doing to know that.” Finally, participants noted a lack of clarity on what their specific roles or responsibilities were in regard to preparing the community for climate impacts. One interviewee said, “I feel as a city we’re just kind of scratching the surface on even understanding some of the potential for natural disaster and the impact it can have, or what our role is in either preventing it or preparing for it.”

Limited Communication and Awareness

Participants indicated limited communication and awareness about climate change and extreme weather. “Limited communication and awareness” includes participant decision makers indicating they do not frequently discuss climate change with the public and participants’ perceptions that the broader public is not discussing or aware of climate change.

Some decision maker participants mentioned they are not explicitly discussing climate change with the public. When asked if climate change was discussed with the public, one participant said,

“I would say no, because we are more thinking about watershed stuff that we are doing and programs that we are doing. Climate change is a much larger, dynamic topic, and we are not taking it and discussing that.”

Interviewees also perceived other decision makers did not discuss climate change enough with the public. This participant reflected on the lack of climate change discussion: “I think the very first thing that they are not doing is not having open and honest conversations with the citizenry about it.”

Similarly, participants perceived the broader public to lack conversation about and awareness of climate change issues. One participant said, “I don’t hear a lot of talk in

my private life. We talk about it internally because we have a lot of very passionate people on staff that are considering those things and very interested in the impacts, but I don't hear a lot of people discussing it in general." The perception that only some community members are thinking about it while most are not also emerged. One participant said, "I think there are subsets of the community that are certainly involved in that more. I think that the broader community is probably not thinking about it." Another participant expressed a similar sentiment,

"Some people are [thinking about climate change], especially if they do work in that environment and they're more aware of it. But if I wasn't involved, I wouldn't be thinking about it."

Likewise, participants also noted different landowners and residents understand climate change more than others and that much of the public may be unaware of potential changes coming.

Insufficient Resources and Requirements

A lack of resources and requirements emerged as a constraint among some participants. These participants noted limited funding, staff, and technical skills and expertise constrained adequate climate preparedness. One participant discussed how the unavailable money needed to update stormwater infrastructure made it necessary to manage future rainfall changes with the current system:

"If rainfall patterns over the next 50 years increase a little bit, even if they doubled, it is what it is, and it would take billions, with a b, to upgrade major parts of it. So we are better off managing the system we have . . . rather than to build a bigger system."

Finally, preparing for climate impacts is not required at the national, state, or local level, and this constrained preparation efforts. One participant said, "Well I I think there are

significant degrees of attention and systems that could be applied that we aren't doing, mostly because it's not required."

Opportunity Areas for Climate Preparedness

Though participants expressed several challenges hindered climate preparedness, they also discussed opportunity areas for building or leveraging climate preparedness, including those that stemmed from the 2012 flood response and some planning-oriented activities.

Post-2012 Flood Response and Recovery Efforts

As a result of the 2012 flood, emergency response has been improved, partnerships were built and knowledge shared, and infrastructure capacity was increased. Participants discussed how the 2012 flood response became a catalyst for improved response and recovery for future extreme weather events. One interviewee noted, "I think that the flood from 2012 helped the community kind of come back around to thinking about the natural environment and thinking about how do we prepare for future climatic events." This participant also noted the flood led agencies, departments, and organizations to improve their emergency response and hazard mitigation plans. Broadly speaking, the flood was an intensive learning experience for all involved and helped participants identify aspects of the response that could be improved for the future. One interviewee said, "I would think we now maybe have some more systems in place in terms of how the response will go for the next emergency." She noted the county instated an emergency management team and supervisor, and emergency management plans are now in place.

Another result of the 2012 flood immediate response and longer term recovery was agencies, departments, and organizations built partnerships and increased collaboration to respond to the community's post-flood needs. Cooperation between sectors and agencies increased as various stakeholders came together to mobilize resources, share knowledge and best practices for the response, and discuss who would take what roles and address future needs. After noting the nonprofits and government entities that worked together after the flood, one participant described, "We shared knowledge, understanding what funds were available through the state, the city, the county, the federal, where the gaps were, and identifying who's going to help address them."

Last, when the 2012 flood illustrated issues with the city's stormwater infrastructure and damaged or destroyed culverts and pipes, decision makers were able to think about how increased precipitation and flooding might impact the stormwater system and respond by making necessary upgrades where they could during the recovery. One participant captured the sentiment expressed by many:

The storm of 2012 did it to us, in terms of preparing us. I mean it wiped out the bridges that weren't built right. It wiped out the culverts that weren't built right. So, we got a real test in that event that people I think are responding appropriately too for the most part. . . . That taught us a lot about stormwater, essentially capacity, and where some of these issues might be.

Government agencies have incorporated green infrastructure where possible to improve infrastructure capacity. One interviewee commented, "We did a project that really focused on green infrastructure as a way to not only mitigate flood impacts and prepare for climate change but that also has all these different benefits."

Anticipatory Planning

Interviewees talked about the planning-oriented activities taking place that contribute to climate preparedness and can be leveraged for furthering climate preparedness. These activities include adjusting wildlife and stormwater management plans, making planning a priority in shipping, incorporating mitigation into planning, performing vulnerability assessments, and applying for federal resilience funding.

Other actions government agencies have taken include not building in sensitive, flood-prone areas and planting more diverse species for a changing climate. For example, participants who are local and regional planners and resource managers described how they are changing the trees they are selling and planting in order to be more resilient to future climatic conditions. One participant whose organization sells trees for an event commented,

We are offering more species for sale that we would have seen a little farther south when I first started. That's kind of the one area where we have made specific decisions and had specific discussions about climate change.

Participants also noted government agencies are considering adjusting wildlife management plans to be more adaptive to climate change. One participant described,

We need to think about what we can be doing in terms of harvest limits, and habitat improvements or protections, to maintain the kinds of species that are important, culturally and historically important. We are looking at potentially reintroducing elk because moose seem to be getting hammered by, among other things, climate change.

Other participant decision makers within the community described how they were thinking more often about water resources from a watershed-based management perspective. One interviewee summarized, "People are moving toward watershed based management, looking at things that are not easy to do, looking at how we cross political

boundaries and work together to address these issues that clearly don't have their own political boundaries." Climate change planning in other sectors is also underway.

Participants discussed how the port authority and harbor technical evaluation committee has been thinking about climate change for several years, considering "what climate change could mean for levels in the estuary and how that would impact shipping and shipping channels, excavation, making sure they had the right depths for the ships and seasonal effects on shipping."

Other actions that contribute to climate preparedness is that local tribal communities have not only been focusing on preparedness but have been incorporating climate mitigation actions into their long-term planning. One participant explained, "Our tribal council adopted the Kyoto Protocol some years ago, and we are working towards our goals of 25% renewables by 2020, or something like that, and we are going to get there." Communities in the study area have started performing community vulnerability assessments in order to learn what particular exposures and sensitivities exist and how communities can reduce these risks. Finally, interviewees were aware of and involved in a federal grant the city of Duluth was applying for that was aimed at bringing in funding for improving disaster resilience.

Discussion

This study investigated three research questions among decision makers and leaders in the Lake Superior headwaters community: 1) How do decision makers in the study subwatersheds characterize climate change and climate change preparedness? 2) What do decision makers perceive drives and constrains preparation for and adaptation to climate change? 3) How can this new understanding help the community build climate

preparedness and adaptive capacity? Through qualitative analysis, data revealed most participants perceive the community to be exposed and sensitive to climate change, largely based on seeing and experiencing changes and attachment to community systems. However, some participants viewed community systems as protected or were detached from climate impacts. Additionally, several challenges to and opportunities for building preparedness were identified.

Several other studies investigated decision-makers' perspectives on climate preparedness and adaptation in coastal communities, often finding adaptation challenges, such as lacking leadership (Petersen, Hall, Kahl, & Doran, 2013), resource constraints (Kahl & Stirratt, 2012; Scally & Wescott, 2011), lack of cross-sector coordination and communication (Kahl & Stirratt, 2012; Scally & Wescott, 2011), unclear responsibilities (Scally & Wescott, 2011), insufficient budget and staff time (Kahl & Stirratt, 2012; Mozumder et al., 2011), lacking public demand for action, and few perceived solutions (Mozumder et al., 2011). While other coastal studies have found constraints to climate adaptation, few have examined current actions and opportunities for adaptation. Additionally, few studies specifically on Great Lakes coastal communities' climate preparedness perceptions exist, and those that do often aggregate findings from multiple regions, making it difficult to understand what specifically is happening in certain communities. This study's findings confirm challenges found in other coastal climate preparedness research and highlight new challenges, further emphasizing prior research that climate adaptation barriers are often community specific. Challenges and opportunities identified within the study area and the resultant climate preparedness

framework will be instrumental in assisting Duluth area communities in building adaptive capacity for climate change.

One purpose of this study was to establish a framework for assessing and building climate preparedness in Lake Superior basin communities grounded in decision makers' climate change perceptions, concern, and revealed challenges to and opportunities for climate preparedness. Based upon the model of climate vulnerability (Figure 4), the climate preparedness framework (Figure 6) ties the study findings into a cohesive framework for understanding the components affecting climate preparedness within the community.

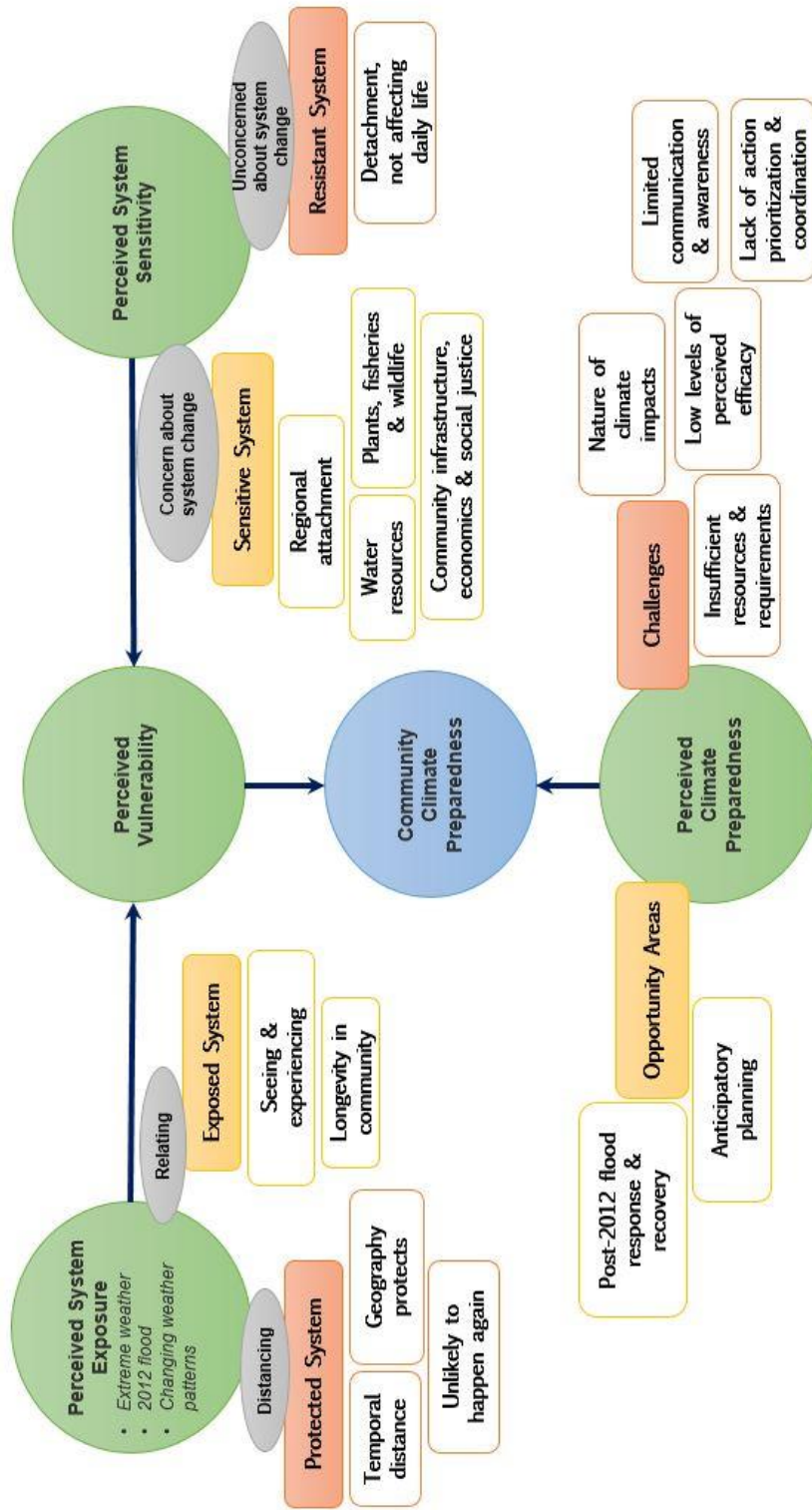


Figure 6. Climate Preparedness Framework for the Lake Superior Headwaters Community

This framework demonstrates how three key components—perceived system exposure, perceived system sensitivity, and perceived preparedness—contribute to or detract from climate preparedness in the community. Within perceived system exposure, two subthemes of distancing and relating emerged. Many participants related to system exposure because they have seen and experienced extreme weather and changing weather patterns (Weber, 2010, 2016). Few participants distanced themselves from exposure, indicating a protected system due to protection by physical location, temporal distance of climate impacts, or a lack of extreme weather occurring again. Within perceived system sensitivity the subthemes of concern and unconcern about system change emerged. In general, when participants perceived the water, biological, or social and community systems to be sensitive, they were concerned about system changes (Fresque-Baxter & Armitage, 2012). This concern often stemmed from regional attachment and connection to resources. A handful of participants perceived the system to be resistant to change, which was coupled with a detachment of impacts from daily life. Findings on perceived system sensitivity and perceived system exposure compose perceived vulnerability, which influenced participants' perspectives on community climate preparedness (Fussler, 2007; IPCC, 2007; Smit & Wandel, 2006). Perceived climate preparedness captures the challenges and actions participants expressed about the community's ability to adapt to or prepare for climate change. Challenges include the nature of climate impacts, low levels of perceived efficacy, a lack of action prioritization and coordination, limited communication and awareness, and insufficient resource and requirements. Actions to leverage include post-2012 flood activities and decision-maker leadership and actions.

Based on their perspectives on perceived system sensitivity and exposure and perceived climate preparedness, participants held a wide range of responses about the community's overall preparedness, ranging from the community is prepared to is not at all prepared to handle climate impacts. The preparedness framework, with its inclusion of the various responses on components of preparedness, indicate why these wide range of responses were found.

Implications for Planning and Management

The climate preparedness and adaptation literature demonstrates constraints that impede adequate climate adaptation exist in many communities, which this study confirms within the Duluth area community. Constraints may be an indication of limited adaptive capacity; therefore, building adaptive capacity is one approach to reducing adaptation constraints and increasing climate preparedness. The IPCC and Adger and colleagues identify capacity building as an opportunity for adaptation (Adger et al., 2005; Field et al., 2014). Researchers state capacity building includes research, education, training, resource provision, development of human capital, and development of social capital (Klein et al., 2014). Raising awareness, which includes positive stakeholder engagement and communication of risk and uncertainty, is a crucial component of capacity building as well (Adger et al., 2005; Klein et al., 2014).

This study's findings demonstrate that two specific actions may hold promise for building adaptive capacity in the Duluth area community. First, leveraging the strong water ethic and attachment to community systems is an inroad for further climate preparedness action. Research has shown place identity may be a key contributor to adaptation and capacity (Adger, Barnett, Iii, & Ellemor, 2011; Fresque-Baxter &

Armitage, 2012), and reframing climate impacts and communicating them as personal and local to a community has been shown to lead to increased motivation to take action (Marx et al., 2007). For a community that holds such strong community attachment and place identity, communicating local climate impacts and making climate change personally relevant for the public holds promise (Scannell & Gifford, 2013). If a community holds strong place identity and that place is threatened (e.g., due to climate change), there may be a stronger motivation to adapt to climate change since “a strong sense of shared identity within a community may act as impetus for engaging in community-level adaptation planning on a collective level” (Fresque-Baxter & Armitage, 2012, p. 261).

Specifically, the community’s identity and values around water and natural resources are key leverage points for furthering climate preparedness because measures that protect water resources may double as climate preparedness practices. For example, green infrastructure and restoration of river and stream banks and wetlands. As participants discussed, these activities are ongoing in the community. Scaling up these efforts, while indicating to the community they will protect valued water and biological systems and also help the community handle future extreme weather events similar to the 2012 flood may help gain increased buy-in for further adaptation practices (Fresque-Baxter & Armitage, 2012).

Second, this research lays the foundation for the creation of a cross-sector, interagency, and cross-cultural climate preparedness task force aimed at increasing adaptation by addressing challenges, such as low prioritization, limited resources, few discussions with the community, lack of coordination on adaptation efforts, and low

levels of perceived efficacy (Adger, 2003). This task force could serve as a hub for synergy, resource mobilization, scientific and traditional knowledge sharing, and action coordination. It could also capitalize on the momentum from the post-2012 flood partnerships that have been built and knowledge that has been shared already between and across organizations.

A primary role of the task force could be to encourage or require some form of climate-scenario planning in all levels of government through ordinances, resolutions, or joint powers agreements. Climate change having low prioritization emerged as a key challenge from the study, and this approach would give climate change preparedness greater priority among competing interests. This task force could ensure regional climate data is useful and disseminated to all applicable parties. Communicating best available science and localized hazard impacts may help in decision making and addresses the uncertainty constraint participants expressed (Pidgeon, 2012).

Another role of the climate preparedness task force could be increasing public discourse about climate impacts and weather changes in the region, since lack of discussion with the public was noted as an adaptive capacity challenge. Relaying climate information and stories in ways that resonates with those who may be skeptical of climate science is important (Scannell & Gifford, 2013; Weber, 2010, 2016). Linking a changing climate and weather patterns to current and potential negative impacts to the region's areas of strong identity—natural and cultural resources, water, community systems—will assist in this method. Demonstrating how areas of attachment and aspects of identity may be harmed or disrupted may mobilize community members to call for increased adaptation.

This approach will also increase awareness and concern about climate change more broadly. To effectively do this, research indicates addressing issues of efficacy alongside climate information. When people felt personal efficacy about climate change impacts—meaning they have the ability to address climate outcomes—they are more likely to have concern about climate impacts and a sense of responsibility to address it (Kellstedt, Zahran, & Vedlitz, 2008; Patt & Weber, 2014). Addressing individual self-efficacy to act is absolutely essential when building public awareness and support for adaptation practices. Based on this research, communicating stories of adaptation solutions from within the community and from other coastal communities similar to the Duluth area will demonstrate how specific steps can be taken to increase preparedness.

Conclusion

Other communities could learn lessons from this study and the Duluth area community. The study design and methods hold promise for other communities interested in examining their own climate preparedness. Additionally, findings and the constructed climate preparedness framework may assist other communities with similar geography, coastal location, and natural resource dependence in thinking about their climate preparedness efforts and the challenges and opportunities at play for them. For example, directing adaptation efforts at leveraging current actions for adaptive capacity while addressing and minimizing challenges is one such lesson.

Future research extending beyond decision makers and exploring the broader Duluth area community's perspectives on climate change and preparedness may glean additional insight into the community's adaptive capacity. Furthermore, community climate preparedness research often emphasizes adaptation barriers and challenges (Kahl

& Stirratt, 2012; Mozumder et al., 2011; Scally & Wescott, 2011) and focuses little on adaptation opportunities or capacities within communities that support or lead to effective adaptation planning or implementation. More research on adaptation capacities may provide other lessons regarding opportunities that communities can leverage.

CHAPTER 5

DISCUSSION

Climate change has affected and will continue to affect the Upper Midwest in the form of higher temperatures, more intense episodes of extreme heat, increased frequency and intensity of precipitation, and increased flooding (Karl et al., 2009; Melillo et al., 2014). Coastal communities in the Great Lakes basin that are reliant on water resources for industry, tourism, and recreation are particularly vulnerable to extreme weather and climate impacts. The 2012 extreme precipitation and flood event and its detrimental effects in the Duluth area illustrates this point. Now and in the future these coastal regions will need to prepare for potential climatic changes and extreme weather. This study sought to investigate climate change and climate preparedness by asking the following questions to community decision makers and key influencers:

1. How do participants characterize climate change and climate change preparedness in the Duluth community?
2. What drives and constrains preparation for and adaptation to climate change in the Duluth community?
3. How can this new understanding help the community build climate preparedness and adaptive capacity?

Key Findings

Through qualitative analysis, data revealed most participants perceive the community to be exposed and sensitive to climate change, largely based on witnessing changes and having attachment to community systems. However, variability was found, with some participants indicating the community was protected from and resistant to

climate change. Additionally, several challenges to and action opportunities for increasing climate preparedness emerged. Challenges include the nature of climate impacts, low levels of perceived efficacy, a lack of action prioritization and coordination, limited communication and awareness, and insufficient resource and requirements. Preparedness actions consist of activities that resulted from the 2012 flood response and recovery as well as planning-oriented actions.

The study findings helped establish a climate preparedness framework based on the revealed climate change perceptions and concerns as well as the opportunities for and challenges to climate preparedness that emerged (Figure 6). This framework demonstrates how three key components—perceived system exposure, perceived system sensitivity, and perceived climate preparedness—contribute to or detract from preparedness in the community. The intent of the framework is to assist decision makers in adaptation planning aimed at better preparing the community for climate change, because the framework illustrates what decision makers are currently thinking about regarding regional climate change, what opportunities can be capitalized on, and what constraints may need to be addressed.

Implications for Planning and Management

The literature states that building adaptive capacity is one important approach to reducing adaptation challenges and increasing climate preparedness (Adger et al., 2005; Field et al., 2014). Capacity building includes research, education, training, resource provision, development of human capital, and development of social capital (Klein et al., 2014). Raising awareness, which includes positive stakeholder engagement and communication of risk and uncertainty, is a crucial component of capacity building as

well (Adger et al., 2005; Klein et al., 2014). Based on study findings, two primary recommendations hold promise for building adaptive capacity:

1. Create a cross-sector, interagency, and cross-cultural climate preparedness task force that could leverage adaptation opportunities and address challenges, such as low prioritization, limited resources, few discussions with the community, lack of coordination on adaptation efforts, and low levels of perceived efficacy.
2. Leverage the strong water ethic and attachment to community systems as an inroad for further climate preparedness action.

To implement these recommendations, the community's Regional Stormwater Protection Team (RSPT), which is aimed at protecting and enhancing regional water resources as well as providing education and technical assistance to reach these goals, may be helpful to explore. The RSPT works with public and private sectors to coordinate water resource protection, and it leverages the community's water value and identity to achieve its mission. In these ways, the RSPT provides a solid model for implementing these two recommendations. Many participants in this study brought up the RSPT when discussing water resource management and positive water activities in the community, indicating general awareness of the group and effectiveness. With some of RSPT's actions aligning with those of climate preparedness—such as the role of green infrastructure in both stormwater management and climate adaptation—forming a climate preparedness task force alongside or out of this group may be an effective method for increasing climate preparedness through already known channels and effective collaborative models in the community.

Connecting Findings to the Broader Project

The study findings and recommendations fit with the broader scope of the full interdisciplinary project as well. The broader interdisciplinary project included hydrologic modeling aimed at predicting how future changes in land use and climate may increase peak flows in regional watersheds and how stormwater best management practices (BMPs) can be used to offset these increases. Generally, results of the modeling demonstrate that increasing BMPs leads to more effective stormwater management. However, the additional BMPs are less effective for high stormwater flow rates, and higher flow rates are predicted in the future. These results indicate adding BMPs in the community will likely be helpful during extreme precipitation events, but they do not completely prepare the community for handling extreme weather events.

This study's social science findings also play a key role in preparing the community for extreme weather by identifying preparedness challenges that may need to be addressed and action opportunities that can be maximized. Together, the social science and biophysical modeling findings paint a picture of the current status of preparedness and opportunities for moving toward further preparedness. To enhance the utility of this study's findings for the Duluth community, a fact sheet with study findings, implications, and recommendations has been disseminated to community decision makers and leaders during a community workshop (Appendix I). It is our hope that this research will assist the Duluth area community in furthering their preparedness efforts.

Future Research

The intent of this research was to analyze the climate change and preparedness perspectives of those community members who have authority to make decisions or

influence in decision making regarding climate change planning and preparedness within the community—decision makers, resource managers, and key influencers. It is essential to understand how these types of people are thinking about climate change and preparedness; however, decision makers are not the only actors in community preparedness efforts. It is also important to explore the broader community's perspectives to glean additional insight into the community's adaptive capacity constraints and opportunities. For example, while the majority of participants in this study believed climate change is occurring in their region and are concerned about impacts, interviewing broader community members may yield new perspectives that should be included in the developed climate preparedness framework (Figure 6). For the framework to be as robust as possible and for preparedness planning to be as effective as possible, the inclusion of all perspectives is warranted.

Furthermore, while other coastal studies have found barriers to climate preparedness, few have identified or examined current actions and opportunities for climate preparedness. This is demonstrated by the lack of existing frameworks for classifying adaptation opportunities as opposed to the several frameworks for assessing and categorizing adaptation barriers. It is imperative that adaptation constraints be addressed, but it is also helpful for communities to recognize what current capacities and opportunities exist to leverage for climate preparedness. Further investigation into opportunities for increasing climate preparedness within the Duluth area community and Great Lakes coastal communities more broadly may lead to additional insights for building adaptive capacity. Applying the climate preparedness framework (Figure 6) in other coastal communities may serve a useful guide for exploration.

Conclusion

This study reveals the Duluth area community has several capacities that are enabling it or will assist it to further prepare for climate change impacts, including participants' convergent climate change beliefs and concerns as well as strong place attachment and connection to resources. Still, challenges are hindering adequate climate preparedness in a number of ways. Specifically, decision makers, resource managers, and community influencers noted the nature of climate impacts, low levels of perceived efficacy, a lack of prioritization and coordination, limited communication and awareness, and insufficient resource and requirements as reasons why the community may not be fully prepared to cope with extreme weather events or climate change.

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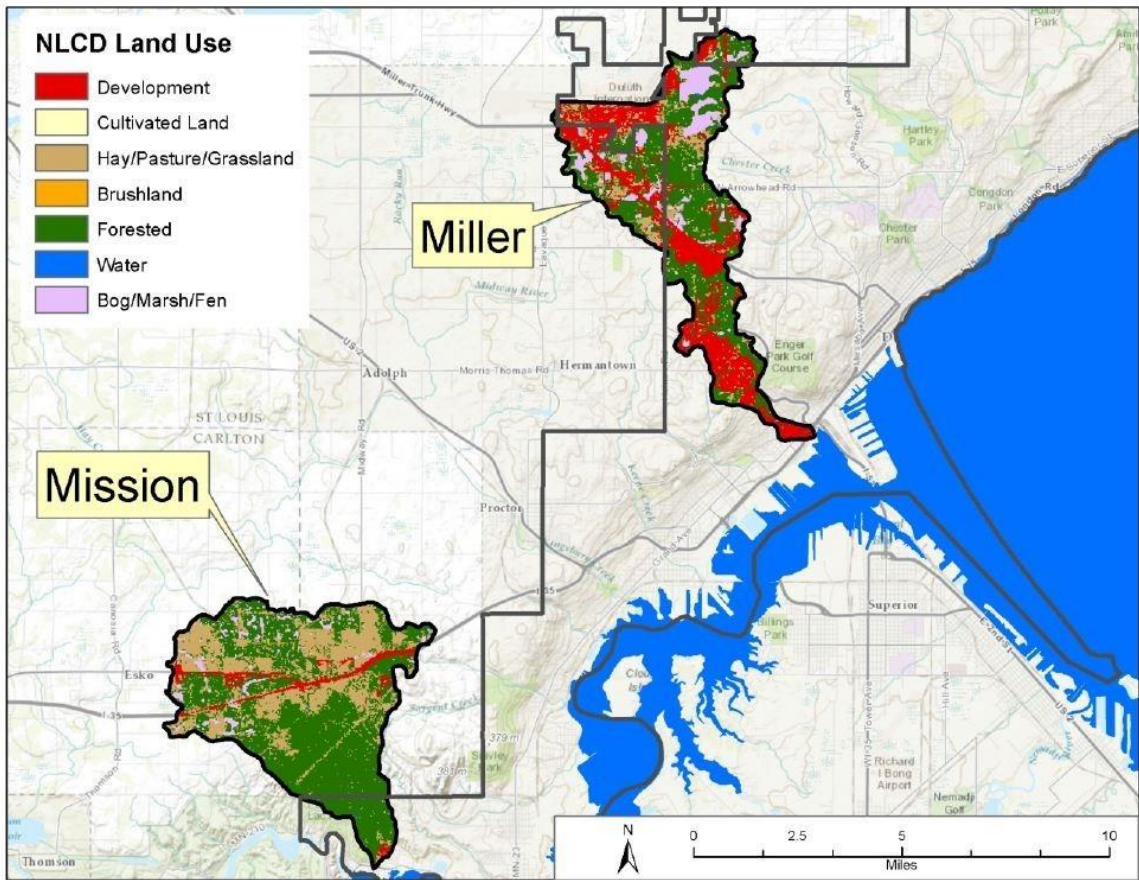
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Appendix A. Map of St. Louis River Watershed



Credit: Minnesota Pollution Control Agency

Appendix B. Miller Creek and Mission Creek Subwatersheds



Credit: National Land Cover Dataset

Appendix C. Interview Recruitment Script

Hello [name],

My name is [X]. I am a [position] conducting research on communities and water resources for Mae Davenport, Associate Professor in the Department of Forest Resources at the University of Minnesota. This study involves community residents, local leaders, and natural resource professionals in the [Mission Creek; Miller Creek] watershed. One goal of this study is to identify different resources communities need and strategies they can use to enhance their ability to respond to water resource impacts. To do this, we'll be conducting interviews with local residents and professionals in the watershed.

I am hoping you would be able to assist me by participating in the study and sharing your perspectives with me. The interview takes about one hour. Would you be willing to participate?

If yes: "Thank you. I am available on _____ (days of week, times, have alternates ready) is there a time that would work best for you? [Set date, time, location (get directions)]. I would like to send you a confirmation email with date, time, and location information. The email will include all of my contact information, in case you have any questions or concerns. Do you have an email address I can send the confirmation to?"

- a. **If yes,** take it down or confirm we have the correct email address for them. "Thank you. I look forward to meeting with you on ___(agreed upon date)___."
- b. **If no,** "Is ___(phone # you contact them with)___ the best way for me to get a hold of you? In case you need to get a hold of me with questions or concerns, my phone number is _____. I look forward to meeting with you on ___(agreed upon date)___."

If no: "Ok, thank you for your time. Good bye."

If they seem unsure: "Just to be clear, participation is completely voluntary and if you decide to participate you can withdraw at any time. Your identity will remain confidential, and we won't include any information that would make it possible to identify you in the final report. We're only talking to a limited number of key representatives, so capturing your perspective is important. Can I ask what your concerns about participating are?" [Try to address their concerns]

If they want to know why they are being asked to participate: "We're interviewing a variety of stakeholders in the watershed to try to get diverse perspectives and a range of experiences. We've been conducting a stakeholder inventory in your community and

your name came up as someone who would be a good person to talk to. Since we are only able to conduct a limited number of interviews, capturing your perspective is important.”

If they want to know how the information will be used: “We are trying to better understand people’s perspectives on community resources, conservation practices, and programs to determine the capacity of communities to respond to environmental risks. We’ll be putting together a final report that describes how participants view these issues to share with community leaders, educators, and resource professionals. Your information will be kept confidential and there will not be any identifying information in the report.”

If they want to know what the study is for: “This project is aimed at better preparing communities to respond to water resource impacts and building community readiness.”

If they want to know who is supervising the research: “Mae Davenport is the supervisor for this study. She is an assistant professor in the Department of Forest Resources at the U of M. If you would like to contact her directly I can give you her phone number [612-624-2721] or email address [mdaven@umn.edu].”

If they ask about IRB: The research project has been reviewed by the IRB/Human Subjects Committee.

Appendix D. Interview Consent Form

Community Climate Readiness: Duluth Study Consent Form

You are invited to participate in a research study that explores community responses to water resource impacts. You were selected as a possible participant for an interview because you currently live, work, or engage in water resource management in either Miller Creek watershed or Mission Creek watershed. We ask that you read this form and ask any questions you may have before agreeing to be in the study. This study is being conducted by: Mae Davenport, Associate Professor at Department of Forest Resources, University of Minnesota.

Background Information:

The purpose of this study is to better understand community responses to water resource impacts and to build community capacity for engaging in water resource management.

Procedures:

If you agree to be in this study, we would ask you to do the following things:
Participate in an interview, lasting approximately 60 minutes. The interview will be audio recorded and transcribed.

Risks and Benefits of being in the Study:

Risks associated with this study are minimal. Responses are confidential and names will not be linked to any information in any publications. Benefits of participation include increased awareness of watershed and community issues. Study results will be made available to the public and all participants will have access to them.

Confidentiality:

The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records. Your responses to the interview questions will be audio recorded, transcribed, and kept for three years in a locked office. Afterward, these tapes will be destroyed. Only those directly involved with the project will have access to the audio tape of the interview notes.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researcher conducting this study is: Mae Davenport. You may ask any questions you

have now. If you have questions later, **you are encouraged** to contact her at address: 115 Green Hall 1530 Cleveland Ave. North, St. Paul, MN 55108-6112, phone: 612-624-2721, email: mdaven@umn.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read the above information. I have asked questions and have received answers. I consent to participate in the study.

"I agree _____ I disagree _____ to have my responses audio recorded."

"I agree _____ I disagree _____ that Mae Davenport may quote me anonymously in her papers."

Signature: _____ Date: _____

Signature of Investigator: _____ Date: _____

Appendix E. Interview Guide

Community Climate Readiness: Duluth

Interview Guide (updated 02/25/15)

*Questions in bold are high priority questions

First, I have some general questions about you and your community. Many people have different definitions of community ranging from a geographic area to a community that is based in social relationships. So, before I ask you questions about your community, I would like to know how you define it.

1. **When you think of “your community,” what comes to mind?**
2. **What is your connection to the community?**
 - a. How would you describe your role in the community [as a professional/landowner/activist]?
3. What would you say are the best things about [working in/being a member of] the community?
4. **Do you have any concerns about your community? Please explain.**
 - a. **What challenges do you face in working/engaging in this community?**
5. Can you describe any situations in which the community came together to respond to a problem or opportunity? Please explain.
 - a. How did the community respond?
 - b. What things led to success (or failure) of community action?

Next, I'd like to ask some specific questions about natural resources and the environment in the community. For clarity, I'll just generally refer to “natural resources” but that may include all aspects of the natural environment including water.

6. **What significant changes or impacts to natural resources have occurred in the community in the past 5 years? Please explain.**
7. What were the effects of these changes/impacts on the community?
8. How would you characterize the response of the community?
9. What things led to success (or failure) of community action?
10. **When events like this happen, who typically gets involved?**
 - a. **Community members?**
 - b. **Businesses? Owners?**
 - c. **Community groups?**
 - d. **What about government officials at local, tribal, state, or federal levels?**
 - e. **How about non-government (non-profit) organizations?**
11. What types of resources are typically used to address the impacts?
12. Are you concerned about changes or impacts to natural resource into the future? Please explain.
 - a. *[If list multiple]* Which of these is your biggest concern?
13. **In your opinion, are there ways in which the community could better avoid, prepare for, or respond to these types of events? Please explain.**

We are focusing our research project on water in this watershed [refer to the watershed map]. Next, I have some general questions about water.

14. When you think of water in this area, what comes to mind?
 - a. How do you use water here?
 - b. What about water is important to you?
 - c. What about water is important to your community?
- 15. Do you have any concerns about water in this area? Please explain.**
 - a. Are you concerned about your drinking water?
 - b. Are you concerned about flooding or drought?
 - c. Are you concerned about lakes, rivers, or wetlands?
16. Have you ever talked to anyone specifically about water in this area or protecting water before? Please explain.
 - a. If you had a question or concern about water in this area, who would you go to?
17. Do you think the community is concerned about water in this area? Please explain.
- 18. Are there success stories of protecting water in this area? Please explain.**

One issue local resource professionals are particularly concerned about is stormwater runoff.

19. First of all, how familiar are you with stormwater runoff issues?
20. Many people have different things in mind when they think about stormwater runoff [flooding]. When you think about stormwater runoff, what comes to mind?
- 21. Have you observed any problems with rainwater, snowmelt, or stormwater runoff in the area? Please explain.**
- 22. Who do you think should be responsible for addressing these types of water resource problems in this area?**

Some people we have talked to in the area are concerned specifically about climate change, extreme weather events, and effects on the natural environment.

- 23. First, what are your perspectives on climate change?**
- 24. Are you concerned about the impacts of [climate change or] extreme weather events on this area? Please explain.**
- 25. In your opinion, is the community doing what it needs to do to prepare or plan for [climate change or] extreme weather events? Please explain.**
26. If you were in charge of planning for climate related impacts in the community, what actions would you prioritize?

Now just a few final wrap-up questions:

- 27. What do you see as the 3 biggest challenges to protecting water in this area?**
- 28. What do you see as the 3 most promising opportunities to protecting water in this area?**
- 29. Is there anything else you would like to share with me about your community, natural resources or water in the area?**

Appendix F. Interview Sociodemographic Form

ID#: _____ Date: _____

Community Climate Readiness: Duluth

Participant Demographic Information

Age:

Highest level of formal education:

Years lived in community:

Occupation:

Gender:

Race/Ethnicity:

Community groups/organizations:

Appendix G. Analysis Theme Tables

Tables illustrate key themes that emerged during the analysis process. One quote that succinctly summarizes findings is included for each category.

Theme Table 1. Climate Change Perspectives

<i>Theme</i>	<i>Sub-theme</i>	<i>Quote</i>
Climate change belief	climate change is happening	Well my personal perspective is that it's real, and that it does exist, and I have I mean, you know, I haven't kind of gone over the whole science of it, I don't really feel like I need to. It's like a no brainer to me.
	perception that others know climate change is happening	I don't think there are a lot of people around here walking around going, "Climate change isn't happening." I don't think that's happening too much. I think people get it.
	still formulating opinion	I'm still formulating my opinions from the people who are studying it. And I think there's a lot of, I think there's more popular and opinion that's communicated by those who feel that what we do and we don't do has major influence and that we should change it. But I don't know that that's the majority opinion, I think that's the vocal opinion.

Theme Table 2. Perceived System Exposure

<i>Theme</i>	<i>Sub-theme</i>	<i>Quote</i>
Exposed system	see impacts daily	I just believe that that is true, and happening, and I think we can see every day.
	observed changes over time	I've been living here twenty-five years, and I do feel like the climate has changed since I've been here. I feel like, you know, just the, just the moisture patterns, the way we get snow, the way it comes our way, the temperatures, I mean I feel like that's a very natural jump, a very natural assumption to make that that's partly impacted by climate change.
	2012 flood	Yeah, that flood a couple of years ago blew everybody's mind as far as I could tell. It was a hell of a thing to live through. If that's a 100 year flood that's going to become a 20 year flood or whatever.
Protected system	geography keeps protected	It is a rural community, and so because of the lake for a variety of other topographical reasons, we don't experience that much wind activity. It would happen certainly. If we had more tornados, I won't say no to that. Because the tornado risk isn't great here, I don't see that changing that much or drastically.
	geographical distance - unexposed compared to other regions	It's fair to say intellectually that an area like Duluth-Superior will quantitatively see less impact from climate change over the long run then a lot of other places, where, we're drastically less likely to be impacted by hurricanes, we're drastically less impacted by things like, you know, sea level increases and that sort of thing, and so, I would say that I have a lot less

		reason to be concerned about that personally, then a lot of other area of the world might.
	temporal distance	I think that a lot of times people see climate change as something way off into the future and so I think there's a mindset that this is a distant thing, I think they're concerned about it but it's a distant thing.
	flood once in a lifetime event - not indicative of anything larger	Some people are wearing thin on patience, but overall, people are understanding that it's just a one-in-a-lifetime event that takes time to recover from.

Theme Table 3. Perceived System Sensitivity

<i>Theme</i>	<i>Sub-theme</i>	<i>Quote</i>
water system and ethic		Why it's also important to me, water is life. And creeks and streams have a different mood every season, year on them. And they're just beautiful to be by. People want to be by the water, they want to live by the water, they want to hear it running, they want to see it in it's different moods, when it's iced up and quiet, and you don't hear a thing to when the falls are rushing like they are now as the snow melts to a quiet gentle flow in the spring.
biological system		The implications for our fisheries and our wild rice are pretty profound. Wild rice is sensitive, exceptionally sensitive, to hydrologic changes. It has a really narrow optimum in terms of the hydrologic regime that it can handle.
social and community systems	infrastructure	If we have extreme winters, the financial cost of street maintenance and all of that here is enormous, and every year, they are over budget and it's crazy. So it could very easily financially devastate.
	economics and finances	what are people doing with this, this is now all the food in their refrigerator spoiling, this is, and so the impact of natural weather events isn't just about how are we going to plow out, where is this water going to go, it's the financial impact on individual families that can't get to work, schools canceled so now kids are home and they're not learning, you know. So to me that's, I think more about those factors than the actual weather event itself.
	vulnerable populations	There are weeks in the winter and weeks in the summer where we have hundreds of people living outside who are in danger from one extreme or the other. So it's at the front of our mind, and I think from most of our communities' existence that concern has been mostly about the winter and extreme cold and people getting frost bite, and it's increasingly being about people have access to water outside and shade.

Theme Table 4. Perceived Resistant System

<i>Theme</i>	<i>Quote</i>
not affecting daily life	I've seen less than a handful of moose in thirty years of living in this area, so to what extent is that, it's more about existential change, then it is a, a change to my life ... Other areas of the world they might drastically have an effect on your day to day. You know, you're not able to grow crops or that sort of thing.

Theme Table 5. Challenges to Climate Preparedness

<i>Category</i>	<i>Theme</i>	<i>Sub-theme</i>	<i>Sub-sub-theme</i>	<i>Quote</i>
Limited communication and awareness	Lack of communication	decision makers not talking about with public		I think the very first thing that they are not doing is not having open and honest conversations with the citizenry about it. I understand that it will be difficult to plan for that financially; you are raising taxes and not allowing certain people to build in certain places and all of this where it's very hard stuff to do, but at least start the conversation.
		public not discussing		I don't hear a lot of talk in my private life, we talk about it internally because we have a lot of very passionate people on staff that are considering those things, and very interested in the impacts, but I don't hear a lot of people discussing it in general.
	Lack of awareness	perceived misperceptions among public		Okay. It's like Santa Claus, it doesn't exist. No, I'm just joking. I guess the thing that is kind of concerning, the biggest challenge is people's perception of it. Because it's always like, "Oh, it's global warming." Well, it's not global warming, because it's not just about our climate getting warmer. "Oh, okay, so now it's called climate change." I think people, their idea is just government wanting more money for

		various things, and I think the uphill battle is probably just public perception about what climate change is. Is it real, is it Santa Claus? That's the hardest stuff, because when you talk to people about it, they are just like, "No, it's Santa Claus." So I think that's the biggest challenge when you are talking to people.
	lack of awareness among the broader community	not thinking about climate change if not working in related field But again I don't have enough knowledge of what is actually happening, so I'm going to say things are being done to help prepare for that. Individually, some folks, again I'm just speculating, sorry, I would think some people are, especially if they do work in that environment and they're more aware of it. But if I wasn't involved, I don't, I wouldn't be thinking about it. But again, this is all speculation. I don't have any data to go on there, sorry.
		different levels of understanding among public I mean if again going back to the community being the county and other resource agencies, certainly some landowners get it to different degrees more than others.
		public not aware of changes coming People come to the North Shore thinking it's going to be a certain way and its always cool up here and there's resorts all the way up the shore that are dealing with skiing and different things like that, well things will change.
	unaware of how much community thinks/cares about climate	In terms of how concerned they are in what they are doing, I don't have a great handle on that, I think there does seem to be a lot of interest, sometimes we will go and talk with lake associations or just, kind of, community groups that they pull together, I mean there is a lot of interest in climate and what is going on, especially related to forests, a lot of people are really interested in what is

			going on with forest change and the species in this area. I don't have a great handle on how much of the population that is, that's really engaged in this, sometimes you get the usual suspects to the table when you talk about climate change and it is a lot harder to identify and really know where the rest of the population is. So that is something I'd be really interested in. There's a group of folks who work on climate in this area and I think they are all pretty interested in that or where are the communities as a whole because I don't think we really know that.
	Political nature of climate change	climate change and relevant actions politicized so people disregard	The second challenge, you know, would clearly be an issue around conflicting, you know, political outlooks. And so in other words, I think the fact that so many of these things are hyper politicized, that it prevents reasonable people from absorbing a reasonable message of integrity from someone because it might contradict the political views that they sort of own
		hesitation to discuss climate change because issue is politically charged	I don't know if I can go down that road of climate change, because I know that's a hot topic, but I think that was a wakeup call for the community
Low levels of perceived efficacy	Lack of perceived solutions and response efficacy	don't know what to do/how to prepare for climate change	And so, no I don't think much is being done because no one knows what to do, because you don't know how to change.
		only so much individuals can do (lack of self-efficacy)	Or I think feel like what they might do in their little individual sphere is not enough.
		can never really prepare for climate change	Well, um, boy some things I guess you can never be prepared for.

		have no control over climate change impacts		Sort of the pessimism comes in with some of the climate change applications, these things that are out of our control really, that we can only, we can't really change a lot of it. But I think, that's gonna endanger some of the paths we're on. If we really want, if we really want wild rice to thrive in the Harprey area, what's gonna happen when water levels, or water temperatures get to high or whatever, that hasn't been, that's not in our control, we could have a nice vision, but (laughs).
	Behavior change challenges	better response but little daily behavior change		I would think we now maybe have some more systems in place in terms of here's how the response will go for the next emergency, or here's how. But I'm not sure that there's been a lot of change in how people are practicing their, you know, daily life or systemic life.
		difficult to change property owner behavior		However, we haven't changed their actions. We haven't stopped people from driving more, or from them thinking about their own private lot and having the water run off their own private lot as fast as possible.
lack of prioritization and coordination	Prioritization challenges	low priority for vulnerable and poorer communities who have more pressing day-to-day concerns		It's not fair of me... we can try to model some of those things here, but it's not fair of me to expect people, who have so many other things to think about, to discomfort themselves so we can live an ecologically pure life.
		low priority for decision makers	other environmental issues more pressing	I don't lay awake at night worrying about it. I think there is other issues that are more pressing. Pollution, illegal dumping are things that are probably a much more urgent need that we are trying to address.

		non-environmental issues take priority	I think we could be doing what we need to do to be more resilient and again I think the drive is there it's just kind of getting beyond that, delaying, letting other things kind of come in and just kind of putting the climate and environmental issues kind of on the back burner over and over again.
		not primary consideration in planning	Agency folks I think, I think they're aware of it and, but I don't think it's, at this point I haven't seen where it's it's a primary concern or a primary consideration in planning.
	people are busy with other obligations		And I'm talking not just in terms of the city but of residents of business owners you know they're dealing with tons of stuff everyday and so the farther we get out from it, the harder it is to talk about it.
	lower priority as flood fades from community's mind		The farther we're getting out from this event the less important its becoming and it's kind of getting put on the back burner and put on the back burner so that is really definitely a challenge that we do deal with and it comes back to that capacity issue if the community, if it's not immediately in front of them they have a lot of other things to do.
Lack of agency connection and coordination	don't know what other decision makers are doing to prepare		I don't know if like, land managers, what they're doing, in terms of, I know we're pretty aggressively taking on our old ash bore, but that's more of a, that's a different sort of change that's happening, a little more immediate. You know, are the, is the city forester planting more oak trees now versus something else, I don't know.
	unsure what role is in climate preparation		But I just, I feel like as a city we're just kind of scratching the surface on even understanding some of the potential for natural disaster, and the impact it can have, or

				what our role is in either preventing it or preparing for it, you know.
		people thinking about climate change from only their organizational perspective rather than from systems view		It almost doesn't, it sort of depends on what you're, you know if you're, if the only tool you have is a hammer, every problem looks like a nail, right. If you're the regional stormwater protection team, you know, you're looking at stormwater, and you don't really, you don't have a dog in the fight for the carbon dioxide emissions. Some people are, people end up in their silos.
Insufficient resources and requirements	Resource constraints	funding		But if rainfall patterns over the next 50 years increase a little bit, you know, even if they doubled, it is what it is, and it would take billions with a b to upgrade major parts of it, so we are better off managing the system we have, controlling the flows, utilizing BMPS, development ponds and things to control the rate rather than to build a bigger system.
		staff		They have limited budgets, they have limited personnel they tend to just band aid things and so the adaptation conversation does become a little bit challenging sometimes.
		technical skills and expertise		Sometimes a lot of it comes back to capacity when talking specifically about climate and climate adaptation you know the biggest barriers that I've seen communities run into is that they see changes are happening, they want to do something, they lack a capacity, or really a link to funding, technical support, tools and resources, expertise to really address the issues.
	Lack of requirements			Well I think there's significant degrees of attention and systems that could be applied that we aren't doing. And I would say mostly because it's

				not required.
nature of climate change and climate impacts	Conflicting timescales	planning time scale does not match climate impacts time scale		We don't, we still only design um most of our conservation practices on a ten year or twenty-five year storm. We don't try to take in a 100 year flood type of events no matter how often they may happen um so...
		long-term climate impacts harder to promote, talk about, get funding for		Things like that are the harder impacts to address, they're harder to promote and they're harder to fund and doing anything about them because its less obvious what you can do with warming stream temperatures, warming surface water temperatures on Lake Superior, changing lake levels, invasive species. So a lot of the temperature changes are again harder for us because it's harder to talk about when you ask somebody if it concerns them that temperatures have risen a couple of degrees, you're not going to get overwhelming response of "yea I'm really concerned about that."
		society focuses on short-term planning and lacks in long-term planning		That's really difficult, especially because a lot of planning only goes out about 5 to 10 years so thinking really long term is something not just in this area but as a society we are not great at really planning multiple years out.
	Lack of connection (nature of climate change impacts makes issue challenge to connect on)	not linking personal experience or local events to climate change		Certainly we've had the flooding in Duluth in 2012, certainly, you know as I've observed the huge rise in the Rainy River up in International Falls last summer. You know, but again, to what extent is variability, variability and to what extent is it related to climate change, you know, so I wouldn't necessarily say that I can tie our local weather events to a more broad, you know, association with climate change.

	impacts of climate change not always visible	inconsistent weather makes connection on climate change difficult	I think Duluth's weather is so fickle that there is no consistent movement of climate change, I mean 2012 we had a super early spring, and warm, and then other than the flood event, we had very little rain, so we had a lot of dryness, and then the next 2 years, we had tons of snow, and lots of snow falling and staying all the way through April, so late, wet springs. So the inconsistency of our weather, which I'm sure has a lot related to Lake Superior, I don't think it gives the same impact to people on how climate change is really happening.
		rising temperatures more difficult to notice	I mean we've talked a lot about extreme events and the flood but what's harder to talk about and what we haven't talked about a ton is more the long term impacts of temperature change.
	not affecting daily life		I've seen less than a handful of moose in thirty years of living in this area, so to what extent is that, it's more about existential change, then it is a, a change to my life ... Other areas of the world they might drastically have an effect on your day to day. You know, you're not able to grow crops or that sort of thing.
	takes an extreme event like 2012 flood to affect daily life and make impacts more visible		So it does and unfortunately with the climate adaptation piece it takes an event to really get that momentum and get that response going
Uncertainty	of climate impacts		We don't know if we are going to have more intense storms or less intense storms, or more rain or less rain, or whatever's going to happen and so we don't know.

		makes planning difficult	My perspective on climate change is that we have no idea what is coming and what it does is it increases uncertainty and that's going to be really difficult for human infrastructure because we designed things around events we expect and when we no longer know what to expect ... you have no idea what you are designing to.
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Theme Table 6. Action Opportunities for Preparedness

<i>Category</i>	<i>Theme</i>	<i>Sub-theme</i>	<i>Quote</i>
Post-2012 flood	Emergency response improved		I think that what we are going to do is a lot of reflecting on what we can learn from this. I think that was one of the biggest things that we were able to take out of this. The community had a lot to respond to. It's a unique situation that many of us have never had to respond to before. We are able to look back and say, "What did we learn and how can we improve on this?" Right now, there is a lot of or a couple different projects going on that would help set the community up for a more organized response to something like that flood event.
	Partnerships built and knowledge sharing		So we brought together after the flood, funders, direct service providers to non profit organizations, government entities, so state, county, city, and we all...it was this collective knowledge of understanding again, it wasn't just philanthropic agencies, it was really kind of this collective, how is everyone involved and engaged? Again, shared knowledge, understanding what funds were available through the state, the city, the county, the federal, what weren't, where the gaps were, and identifying again, who's going to help address them.
	Recovery, improved infrastructure capacity		
		addressing runoff problems	We've taken care of the runoff problems into Lake Superior, so that's all done. It took us years. And so that's good.

		more green infrastructure	We did a project that really focused on green infrastructure as a way to do, not only mitigate flood impacts and prepare for climate change but has all these different benefit so this project was done through the NOAA office for coastal management partnered with us partnered with the City of Duluth DNR, Pollution Control Agency, our engineering
Planning-oriented actions	Not building in sensitive areas		To be able to look at hey, you've got a school here that's flooded a couple of times, and they filed bankruptcy not too terrible long ago, maybe they need to consolidate with another school district. Moose Lake, they are done. They are building up on a hill, actually. Obviously, they flooded 3 or 4 times so they got the money from the State to rebuild, and they were right down there by the lake, and now they are going to build up over here.
	Planting different more diverse species		We are also thinking about it in terms of what we plant today. So, what kind of trees are we planting today? And if there is significant climate change, will that tree be able to survive in 20 years, or whatever, until full maturity? Or will the weather have changed enough where that tree won't survive anymore? So, we are being more intentional about what species we plant, and we are also planting more diversity, and we might be planting some trees that maybe 50 years ago, nobody would have ever thought of planting up in our area, and now we are planting. So, that's kind of the involvement we've had.
	Adjusting natural resource management	Adjusting wildlife management plans	We need to think about what we can be doing in terms of harvest limits, and habitat improvements or protections, to maintain the kinds of species that are important, culturally and historically important. We are looking at potentially reintroducing elk. Because moose seem to be getting hammered by, among other things, climate change. Direct and indirect impacts of climate change. So, if we can't keep moose, can we reintroduce elk, who were historically present here, who were extirpated?
		More thinking at watershed scale	People are moving toward watershed based management, looking at things that are not easy to do, looking at how we cross political boundaries and work together to address these issues that clearly don't have their own political boundaries and have to be looked at formalistically and it feels like a lot of people are willing to try and meet that goal.
Mitigation actions		Our tribal council adopted the Kyoto Protocol some years ago, and we are working towards our goals of 25% renewables by 2020, or something like that, and we are going to get there. This building is LEED certified. We've got a rain garden and green roof and all that kind of stuff just as demonstration. The chairwoman served on President Obama's climate change adaptation task force, and there is no doubt about the concerns.	

	Performing community vulnerability assessment		Basic community vulnerability assessment so not just talking about climate change on this national on this global scale because that doesn't really hit home for a city that's updating their comprehensive plan and if you're talking super generally about it that information is not incredibly helpful so we have one tool that we've used here and a couple of others that have been used nationally at the Great Lakes to really help a community tear down their particular vulnerabilities.
	Applying for grants		If we had endless funds, endless energy, endless time, of course there's so much we can do. So it's really kind of focusing what is the impact, how can we help to kind of itch away our nicks towards progress. So gosh, if we were able to get this grant for the city, it would be so huge.
	Adaptation planning in shipping		One example of considering climate change and how it would affect business and resources would be the community around the harbor. The port authority and those involved in what's called the harbor technical evaluation committee, I guess it was five years ago started really talking about what climate change could mean for levels in the estuary and what that would, how that would impact shipping and shipping channels, excavation, making sure they had the right depths for the ships and seasonal effects on shipping.

Appendix H. Glossary of Terms

adaptation

The adjustments made to human and natural systems to reduce vulnerability to climate change, to cope with external stresses caused by actual or potential climate change impacts, and to take advantage of any opportunities that may arise from a changing climate (Adger et al., 2009; Christopolos et al., 2009; Field et al., 2014; Smit & Wandel, 2006)

adaptive capacity

A system's ability to adjust to climatic changes.

attitude

A person's evaluation about an object, event, person, etc., which can be negative or positive.

climate preparedness

The actions taken to prepare for and adequately respond to current and future climate change phenomena and their impacts (Heidrich, Dawson, Reckien, & Walsh, 2013). Climate preparedness demonstrates how systems or communities are prepared to handle climate change impacts. The terminology is similar to adaptation, which is defined as the actions that are implemented to adjust to actual or potential climate change impacts to prevent harm and take advantage of any opportunities that may arise from climate change (Field et al., 2014).

coping

The process of responding to climate change impacts, often reactive and motivated by crisis, in a shorter-term time scale than longer-term adaptation.

exposure

The degree to which a system is exposed to climatic variations and often is a function of geography or physical location.

human capital

The knowledge, skills, and experiences of an individual or community.

mitigation

In the context of climate change, reducing or stopping greenhouse gas emissions so as to prevent the further accumulation of emissions in the atmosphere and climate change.

norm

An action that describes typical or usual social behavior.

perceived behavioral control

A person's "perception of the ease or difficulty of performing the behavior of interest" (Ajzen, 1991, p. 183).

place identity

A person's relationships, values, beliefs, and feelings in relation to the physical environment.

response efficacy

The belief that a particular behavior will have the intended outcome (Bandura, 1977).

risk perception

A subjective judgment an individual makes about the severity, likelihood, and general characteristics of a particular risk.

self-efficacy

A person's belief or perception of his or her ability to enact a behavior.

sensitivity

The degree to which a system is affected by climatic change and climate impacts.

social capital

The networks of relationships among people in a community that allow for effective functioning.

value

A person's principles about or judgment of what is important and worthy in life.

vulnerability

The "propensity or predisposition to be adversely affected" by climate change (Field et al., 2014, p. 5). Vulnerability can also be understood as a function of exposure, sensitivity, and adaptive capacity (Fussler, 2007; IPCC, 2007; Smit & Wandel, 2006).

worldview

A person's particular conception or framing of the world.

Appendix I. Fact Sheet

Note: Due to margin constraints, the fact sheet in this thesis is formatted differently from the original publication. The original fit on two pages.

2017 Perspectives on Climate Preparedness

A Study in the Lower St. Louis River Basin, Minnesota, USA*

Holly Meier, Vanessa Perry, M.S., and Mae Davenport, Ph.D., Center for Changing Landscapes, University of Minnesota

In partnership with the Natural Resources Research Institute (NRRI), researchers from the Center for Changing Landscapes, University of Minnesota, interviewed 27 local government officials, natural resource professionals, and other community leaders active in the Miller Creek and Mission Creek watersheds of the Lower St. Louis River Basin in Minnesota to examine community climate preparedness. Leaders from the watershed communities, including Duluth, Hermantown, and Fond Du Lac Reservation, were invited to reflect on extreme weather events, impacts to water and other community assets, and climate preparedness. Interview data were analyzed for convergent and divergent themes.

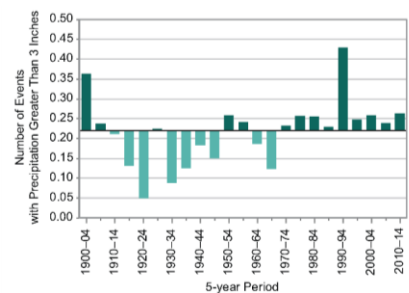
WHAT IS CLIMATE PREPAREDNESS AND WHY IS IT IMPORTANT?

Climate preparedness enables communities to anticipate, plan for, and effectively respond to climate change impacts. Climate change in Minnesota has meant an increase in extreme precipitation events and higher seasonal temperatures (MN State Climatology Office, 2016). Extreme rain events already have had ecological, economic, and social impacts in the northeastern part of the state. For example, increased stormwater runoff in the Duluth area contributes to sediment pollution in the St. Louis River estuary, and in June 2012, a catastrophic



flood caused more than \$55 million in damages. To be prepared for climate change, communities must understand both their vulnerability to climate change and their capacity to anticipate and adapt to a changing environment.

Observed Number of Extreme Precipitation Events in Minnesota



Credit: NOAA National Centers for Environmental Information

WHAT DID PARTICIPANTS SAY ABOUT CLIMATE CHANGE?

“I’ve been living here 25 years, and I do feel like the climate has changed since I’ve been here. I feel like the moisture patterns, the way we get snow, the way it comes our way, the temperatures—I feel like that’s a very natural assumption to make: that that’s partly impacted by climate change.”

Study participants largely believed climate change was real and were concerned about impacts to the region. Participants expressed concern about ecosystem integrity, financial

costs, infrastructure damage, and effects on vulnerable populations. Few participants expressed skepticism or apathy about climate change or its impacts.

WHAT DRIVES CLIMATE PREPAREDNESS IN THE WATERSHEDS?

The 2012 flood was considered a “wakeup call,” both in terms of how intense extreme rain events can be and how unprepared the community was for extreme weather. The flood triggered emergency response and hazard mitigation planning for future events. The flood also catalyzed collaboration and partnerships among organizations, agencies, and departments both within and across public and private sectors, leading to resource mobilization and knowledge sharing.

“I think that people were just so taken by surprise that that could even happen here. So it was really a big wakeup call. A ton of attention has come in and a ton of funding and trying to plan for future events like that. But before that, we just had no preparedness built in. I think that’s one thing that’s really been a lesson learned: that this type of thing can happen in this area.”

A water ethic emerged as integral to preparedness. Interviews revealed powerful physical and emotional connections to water and strong water values among participants. Participants characterized water as being “everything,” “our life force,” and “lifeblood” to their communities. Participants also described communities as highly motivated to protect water and engaged in water protection actions such as green infrastructure development, regional cross-sector stormwater planning, and St. Louis River corridor restoration projects.

Awareness and leadership in the communities is an asset. Participants were attentive to climate change, current and projected impacts to the region, and the need for increasing readiness in communities. Participants also acknowledged that several local decision makers have shown strong leadership in climate change preparation—agencies have adapted the tree species sold and planted, the City of Duluth applied for a national disaster resilience grant, and local communities are incorporating emergency response and sustainability into comprehensive planning.

WHAT CONSTRAINS CLIMATE PREPAREDNESS?

Climate impacts are inherently challenging, including unpredictability, conflicting timescales of planning (shorter term) and climate impacts (longer term), perceived distance of climate change (i.e., it will happen far into the future and far from us), and invisibility of many climate impacts (i.e., impacts are often incremental, difficult to notice, and don’t affect daily life).

“If you don’t know what you are planning for, how do you plan for it?”

Low levels of perceived efficacy appear to constrain action. Participants questioned their own ability to respond to climate change and were skeptical about the feasibility and efficacy of possible solutions.

“People are starting to hear and see things about changes in plants, changes in biological community distributions, but they don’t necessarily have an idea of how to help or what to do.”

Lack of prioritization and coordination were viewed as barriers to preparedness. Some participants acknowledged that climate preparedness is a low priority among decision makers and the broader public. Participants noted examples in which climate change is not integrated into planning, climate response actions are inconsistent across jurisdictions, other environmental issues (e.g., illegal dumping, pollution) or community issues take precedence, and community leaders appear to overlook the toll of the 2012 flood. Additionally, participants acknowledged being uninformed of what other departments, agencies, or sectors were doing for climate preparedness.

“Agency folks, I think they’re aware of [climate change], but at this point I haven’t seen where it’s a primary concern or a primary consideration in planning.”

Limited discourse and understanding has sweeping effects on climate actions and preparedness efforts. Participants observed that communication about climate change among decision makers, between decision makers and the public, and within the broader public was uncommon. Participants also perceived that the general public was not thinking about climate change on any regular basis.

Insufficient resources and requirements emerged as constraints to preparedness efforts. Participants identified inadequate funding, limited staffing, and a dearth of technical expertise as hindering climate preparedness. Preparing for climate impacts is not required at the federal, state, or local level, and participants remarked that funding programs generally target disaster response (e.g., infrastructure repair) versus increasing community readiness and resilience.

“The biggest barriers [are] that communities see changes happening, they want to do something, but they lack a capacity, or a link to funding, technical support, tools, and resources . . . to really address the issues.”

HOW CAN COMMUNITIES BUILD CLIMATE PREPAREDNESS?

“[Water] is the foundation of us being here, right? We wouldn’t be here without water. So, it’s our life force. Like I said, if we didn’t have it, we wouldn’t be here. So it needs to be protected.”

Leverage the strong water ethic in the region. Climate preparedness activities framed as a way to protect water and its myriad benefits will resonate because water is integral to community identity and member values.

Create a climate preparedness task force. A cross-sector, interagency, and cross-cultural climate preparedness task force can serve as a hub for synergy, resource mobilization, scientific and traditional knowledge sharing, and action coordination.

Disseminate actionable information and success stories. Create a safe space for climate discourse that acknowledges cultural and ecological impacts and opportunities and stories of success.

Make climate preparedness a part of all planning processes. Encourage or require some form of climate-scenario planning in all levels of government through ordinances, resolutions, or joint powers agreements.

