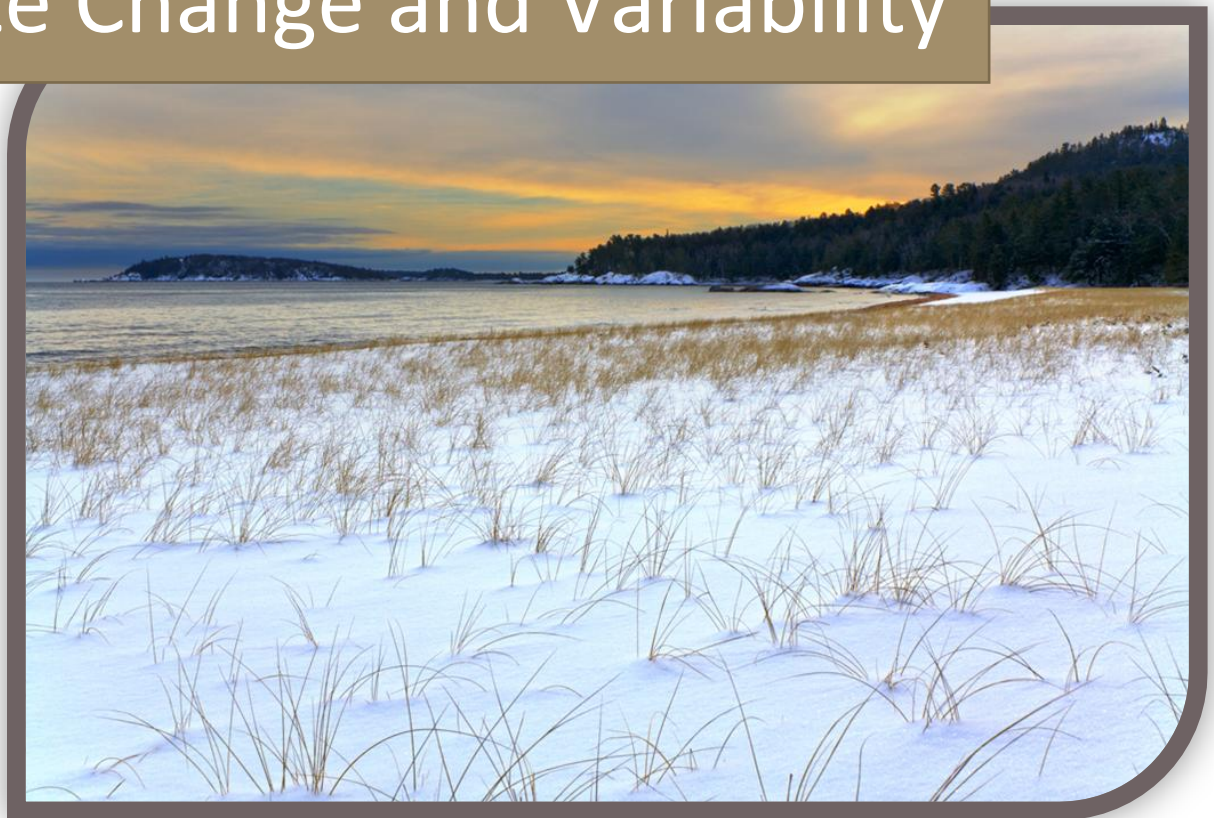


Adapting to Climate Change and Variability

Marquette, Michigan

September 2013



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Lake Superior Ice Coverage-March 2013 Photo: NASA
Cover Photo courtesy of Daniel Brown



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Executive Summary

The City of Marquette is the largest city in the Upper Peninsula and one of the most economically diverse in the state. Residents are employed in the timber and mining industries, and in health care, higher education, and high tech manufacturing. Tourism accounts for a significant amount of revenue every year, with visitors coming each January for the Noquemann Ski Marathon, each February for the Sled Dog Races, and in the summer months for the Ore to Shore Bike Race. In addition to regional festivals, hiking and mountain biking take place on the extensive trail network surrounding the City.

Yet Marquette is especially vulnerable to environmental, economic and social impacts of climate change largely because it borders Lake Superior. Record high surface water temperatures, declines in ice cover, and decline of rare sub-arctic plant species are just a few of the related impacts already documented on the Lake. In 2012, Marquette closed a public beach due to high bacteria levels, a condition that is exacerbated by warmer water. Record low Lake Superior water levels mean that freighters must reduce their tonnage. Despite significant progress, the City is not on schedule for the replacement of roads, bridges, and drains; and this infrastructure may be unable to cope with increased floods and a longer thaw/frost cycle.

A team of Michigan State University Extension specialists and educators received funding from the Great Lakes Integrated Sciences and Assessments Center (GLISA) to collaborate with GLISA researchers, relevant decision-makers, and stakeholders in two Michigan local governments units to increase community resilience through incorporating climate variability and change adaptation strategies into local land use master plans and policies.

The Project Team chose the City of Marquette, in partnership with the Superior Watershed Partnership (SWP) and Landtrust, because of the City's vulnerability, but also because of the community's readiness and resources to support a climate adaptation plan.

The MSU Extension Project Team worked with the City, the SWP, and GLISA to design a process that enlisted community members to identify and prioritize their climate change concerns. Key stakeholders in the agriculture, forestry, natural resources, health, planning, and tourism fields then reviewed and added to these concerns and strategies. Overwhelmingly, residents and local leaders wanted to protect the natural environment that makes Marquette such a desirable place to live.

This report details the process and results of this community-driven process. It also contains specific, detailed Geographic Information System (GIS) maps of the region that reflect the climate vulnerabilities and concerns of the residents and leaders in the Marquette region.

Introduction

Purpose

Certain towns and regions in Michigan are more vulnerable to the effects of a changing climate. Those bordering the Great Lakes, or with local economies heavily dependent on tourism or agriculture, have a more pressing need to plan for increased variability in lake levels, temperature, flash floods, droughts, or severe storms.

Yet local decision makers find it difficult to plan for climatic changes, given the nature of the issues: the political polarization and public controversy surrounding it, the fact that long-term weather patterns affect nearly every aspect of community life, and a scarcity of model policies and plans that are appropriate for that community. Given this, the purpose of this project is to increase community resilience by incorporating community-driven, locally generated climate variability and change adaptation strategies into the City of Marquette's Master Plan and related documents.

The process included two community forums to identify and prioritize climate concerns; collaboration between MSU, GLISA, and the Superior Watershed Partnership to generate adaptation strategies; interviews with key stakeholders; the completion of a climate adaptation assessment tool; and the creation of multiple GIS maps.

Process

The City of Marquette was one of two community partners selected to receive MSU Extension's technical assistance in creating a climate adaptation plan. Six communities applied for assistance, but Marquette was chosen based on its unique climate vulnerabilities in forestry, water resources, and tourism, as well as its capacity to implement the final plan.

MSU Extension and GLISA held an initial organizational contact meeting in January, 2013. The first community forum was held in February, during which participants identified local climate concerns. At the second community-wide forum, held in May, participants took in a presentation by a GLISA researcher on the local climate, and then worked in small groups to prioritize adaptation strategies and identify trade-offs to these strategies. Following this, the Project Team conducted interviews with key stakeholders in the areas of transportation, tourism, agriculture, land use, natural resources, and public health. The purpose of the interviews was to gather expert input on the adaptation strategies.

During this time, staff members from the City of Marquette completed a climate change audit tool, which served as a detailed assessment of the city's overall capacity to mitigate the effects of floods, extreme temperatures, severe storms, and other climate hazards. The MSU Project Team also worked with the City and the MSU Remote Sensing and Geographical Information Science staff to create a series of maps that will aid the City in its adaptation planning.

Methodology

Climate change is a complex scientific process that affects how we eat, work, and live. So preparing for its impacts can be overwhelming. And any discussion about climate change can provoke conflict: despite widespread scientific agreement about climate change's occurrence and causes, it remains a divisive issue for the public (IPCC, 2013).

Education on climate science is one way to help inform decisions. But scientific education alone ignores the complexity of opinion-formation. Research in cognitive psychology reveals that emotions filter and interpret information based on prior experiences and deeply-held values and beliefs. People often make snap judgments and decisions about complex problems based on the trustworthiness of the messenger and the degree to which the data confirms or disconfirms their prior knowledge (Kahneman, 2011). Therefore, while science can increase our understanding of how the world works, it cannot tell us how to act.

A solid body of literature recommends using facilitated dialogue to solve complex, value-laden community problems. The National Research Council, in its publication *Public Participation in Environmental Decision-Making* (2008),

recommends using “deliberation with analysis” as the method that best supports decision-making around complex environmental and social issues such as climate change. Deliberation with analysis is a type of facilitated dialogue where diverse stakeholders share their expertise and their values to collectively decide “what should be done.” The objective of the process is not necessarily consensus, which is the *minimum* amount of agreement needed for action, but rather a shared understanding of the community's values and the nature of the problem, in order to move forward.

For this reason, the MSU Project Team designed a process that incorporated climate science education with facilitated dialogue. During the community conversations, participants were given the chance to talk with one another at small groups, sharing their observations, interests, and beliefs. Later, the Project Team interviewed technical experts for their feedback on the priorities and issues identified by the community. In this way, local expertise on changes observed in their physical climate was gathered at the meetings, and technical expertise was gathered during the interviews.

Interest in the issue still seems to be at its peak, with many residents at the second forum indicating an interest in staying informed and engaged.

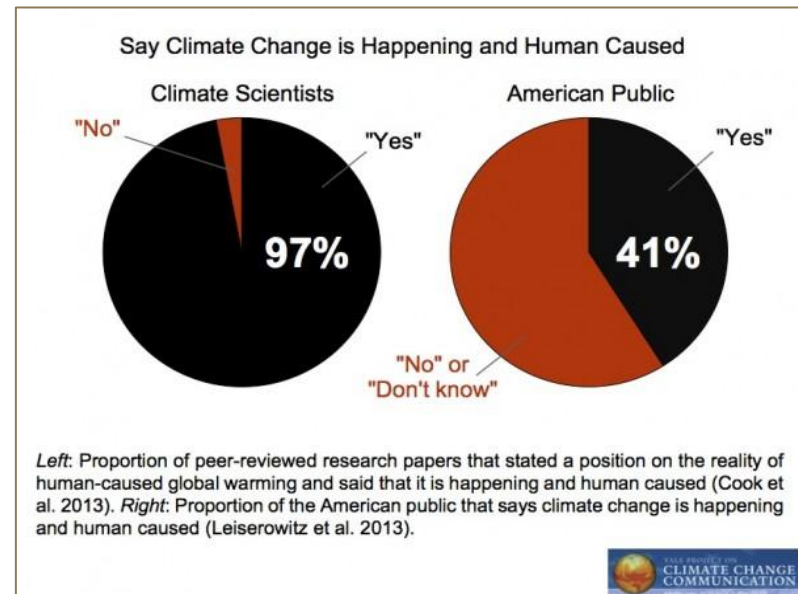


Figure 1: The Yale Center on Climate Communication, 2013

Issue Identification

Meeting One Overview

The first community meeting was held on February 13, 2013 at the community meeting room in Lakeview Arena. The event was advertised in the newspaper, on the radio, Facebook and email as well as the Superior Watershed Partnership networks. Approximately 80 participants were in attendance.

At the beginning of the event, five flip charts were placed around the room, each one posing a different question:

1. How has the change in climate affected the local economy?
2. How has the change in climate affected the area's natural resources?
3. How has the change in climate affected you and your family?
4. What is the difference between weather and climate?
5. What else would you like to know about climate change?

Following a brief presentation about the objective of the project and this particular meeting, participants sat in small groups at tables. Then they were asked to respond individually in writing to two questions:

1. What are some potential benefits from a changing climate?
2. What are some potential losses from a changing climate?

Participants then shared their responses with their small group, and their discussions were summarized into themes at a report-out to the whole group. These summaries were captured on a flipchart pad in the front of the room.

After the meeting, the individual responses on flip chart paper and cards, and the small group responses on the computer were collected, summarized and analyzed for themes. The following issue areas emerged:

1. Land Use (infrastructure and zoning regulations)
2. Water (Lake Superior water level, extreme amounts of precipitation, and the shipping industry)
3. Forest health (increased risk of pest infestation, fire due to drought)
4. Public Health (extreme temperature effects, increases in pests, and pathogens)
5. Food (food access and security)
6. Tourism (changes in snowfall, ice cover, and summer tourism, as affected by Lake Superior water level)

Climate Data Summary

To understand the specific climate change and variability implications facing the City of Marquette, researchers from the Great Lakes Integrated Sciences and Assessments Center (GLISA) collected and analyzed local climate data on *Lake Levels, Precipitation, Snow and Ice Cover, Lake Temperature and Stratification, and Temperature*. The researchers then compared this data with historical climate data in order to determine the extent and variability of climate change that Marquette is currently experiencing. The following section summarizes these findings.

Precipitation

Figure 2 depicts annual precipitation from 1930 up to 2012 in the Western Upper Peninsula. The dashed line represents the average amount of rain, as measured between 1951 and 1980 and is set to zero in order to measure changes above and below it. The blue line shows a nine-year running average as measured from 1935 to 2008. Ultimately, Figure 1 tells researchers that below-average amounts of rain are becoming more common.

- In contrast to most of the Great Lakes region, annual total precipitation over the U.P. has declined since the 1951-1980 period (GLISA, 2012).
- Spring and summer precipitation has decreased while fall and winter precipitation has increased (GLISA, 2012).
- Warmer temperatures will lead to less precipitation falling as snow and more falling as rain (GLISA, 2012).
- Lake-effect precipitation has increased in some areas (Burnett, 2003; Wright, 2004).

Lake Levels

Water levels in the Great Lakes have been decreasing since a record high was reached in 1980 (Pendleton, 2010). In addition, lake levels are rising and falling a month earlier than during the 19th century (Lenters, 2001). Other factors, such as land use and lake regulations also affect lake levels, however, it is still unclear how much of the recent trend in lake levels may be attributed to climate change (Lamon, 2010; Lofgren, 2011).

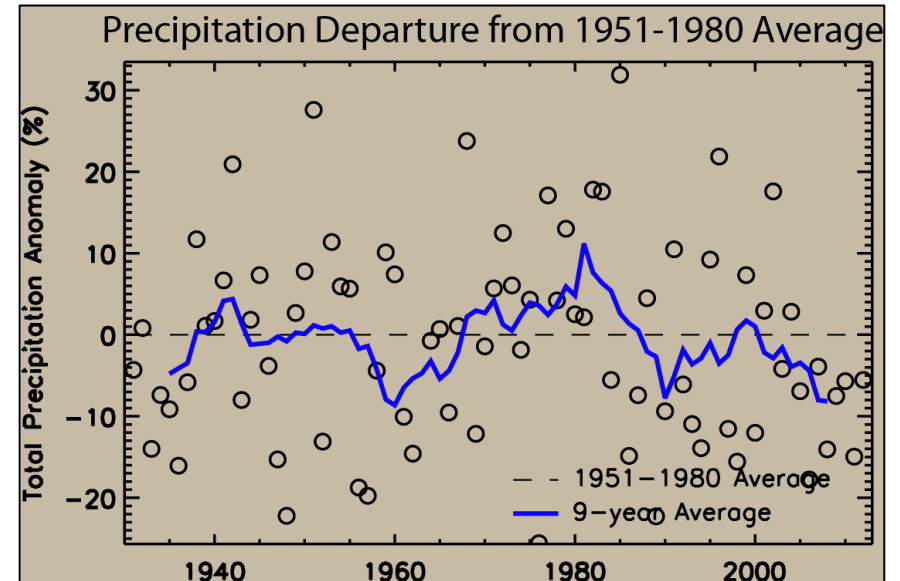


Figure 2: Precipitation: Departure from Average (GLISA)

Lake Temperature and Stratification

Lake temperatures have been increasing faster than surrounding air temperatures (Dobiesz, 2009). From 1979 to 2006, Lake Superior’s summer surface temperatures increased by 4.5°F.

Warmer water surface temperatures increase the stratification of the lakes, decrease vertical mixing in the spring-winter, and increase the occurrence of low-oxygen “dead zones” and toxic algal blooms during periods of increased nutrient loading. The length of the summer stratification on Lake Superior has increased from 145 to 170 days over the last century.

Ice Coverage

From 1973 to 2010, annual average ice coverage on the Great Lakes declined by 71% (Wang, 2011).



Lake Superior Ice Coverage- March 2013 Photo: NASA

Snow Depth

Figure 3 depicts the average snow depth for Marquette between the years 1940-2010, with the results averaged over 9-year increments to display average accumulation of snow. The winter average snow depth in Marquette has decreased by 4.8 inches since 1959 (NCDC, 2012).

Temperature

Figure 4 depicts the average temperature for the Western Upper Peninsula from 1951-1980 and illustrates the changes in degrees Fahrenheit, also using 9-year averages.

- The 30-year average temperature over the Western Upper Peninsula has increased by about 1.0°F since the 1951-1980 period (GLISA, 2012).
- Winter temperatures have increased faster than temperatures during the rest of the year (GLISA, 2012).
- These observed warming trends are projected to continue or accelerate in the coming decades (GLISA, 2012).

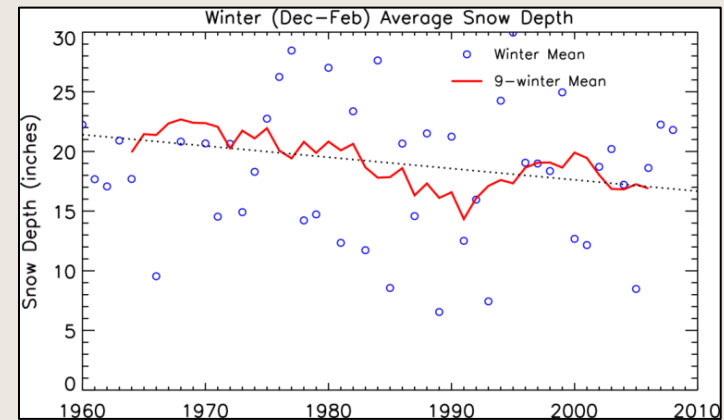


Figure 3: GLISA Average Snow Depth

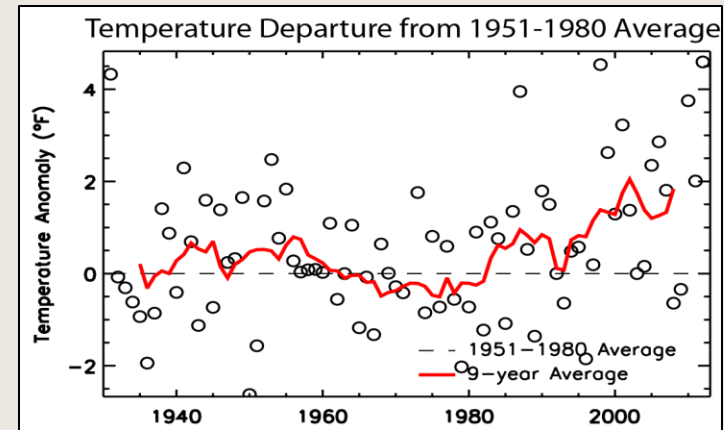


Figure 4: Temperature: Departure from Average (GLISA)

Change in mean temperature (°F) in the Western Upper Peninsula from 1951-1980 to 1981-2010

Annual	1.0
Winter	2.0
Spring	1.1
Summer	0.6
Fall	0.2

Recommendations

Meeting Two Overview

This meeting's objective was to elicit feedback on proposed adaptation strategies to climate vulnerabilities identified at the first meeting. The gathering took place on April 24, 2013 at the community meeting room within Lakeview Arena, in Marquette. While this meeting drew less than half the number of participants as the first, the approximately 25 community members who attended were focused and committed.

To provide context necessary for the meeting's objective, Dan Brown, a climate scientist from the GLISA, presented climate data for the Western Upper Peninsula that covered past trends in temperature, seasonality, snow depth, ice coverage on Lake Superior, and Lake levels.

The MSU project team then used electronic survey technology (i.e. clickers) to ask participants questions about their

climate attitudes. These questions are identical to some asked in an annual national survey by the Yale Project on Climate Communication. The Yale Project seeks to understand the diverse concerns and attitudes of Americans regarding climate change, and has found six relatively distinct groups exist (Marlon, 2013). The survey finds that about 12% of Americans currently find themselves alarmed about climate change, while about the same percentage are dismissive of it. Most Americans are somewhere between these polarities.

The majority of Marquette participants responded to the survey questions as "alarmed." This indicates that they do not need to be convinced of the evidence, but rather are looking for ways to engage at the political level. The MSU Project Team recommends using this group's momentum to engage more residents or take action on some of the recommended policies that require citizen engagement.

After taking the attitude survey, participants then self-selected into small groups, based on their interest in one of the six adaptation themes. These strategies described best practices that

have been used by other local units of government to plan for and adapt to changes in weather patterns. Individually, group members ranked the best practices according to their own preferences. They then came together as a group and agreed on one high-priority strategy. They wrote this strategy on a flip-chart pad and listed some possible trade-offs that might accompany that strategy.

Each small group then presented to the whole group their high priority strategy and the list of trade-offs that might accompany that strategy.

Participants also used the electronic voting system to evaluate the session, and 96% indicated they felt their opinions were being taken seriously, and they intended to stay engaged with the climate adaptation process. A summary of the priority actions is listed later in the Implementation section.

The following recommendations were presented and discussed at Meeting Two. Six categories including: *Land Use, Public Health, Tourism and Economy, Water Resources, Agriculture and Food, and Forests*, were identified during Meeting One as focal points. The recommendations were drawn from a number of best practices (sourced from local, regional, state, and national documents-- including the SWP Plan. A complete list of citations is included in the appendix.), and they address the participants' identified areas of concern while relating them to regional goals outlined by the Superior Watershed Partnership's *Lake Superior Climate Change Adaptation, Mitigation and Implementation Plan* discussed during Meeting One.

Identified Water Concerns

Changes in Lake Levels

Increased Algae, Invasive Species, and Pathogens

Increased Lake Temperatures

Buying and Selling of Water

Population Growth

A decrease in Great Lakes ice cover may lead to increased water evaporation and lower water levels. An increase in Lake temperature may result in increased algae (among other contributing factors), invasive species, and health impacts from water-borne pathogens. Additionally, as water resources become scarcer and regional populations fluctuate, importing and exporting water may become an increasingly important issue.

Regional Goal

Protect the Lake Superior shoreline from damage due to fluctuating lake levels, increased lake storm action, habitat loss, and poorly regulated human development.



Source: http://www.cbsnews.com/8301-201_162-57567851/two-great-lakes-at-shallosest-levels-ever-recorded/

Water Recommendations

- Identify and acquire critical habitat, including beach/dune areas, to be protected along the Lake Superior shoreline.
- Remove structures that harden coastlines, impede natural regeneration of sediments, and prevent natural inland migration of sand and vegetation.
- Develop and maintain State-of-Michigan approved watershed management plans for priority watersheds.
- Devise grey water storage and reuse systems to recycle and utilize water resources more efficiently.

Identified Food and Agriculture Concerns

Flood/Drought

Changes in Growing Season

Availability/Access

Changes in Ecosystems

Ability to Import/Export

New Pests

Climate change in the Upper Peninsula could cause a number of serious problems relating to food and agriculture. Extended periods of drought and changes in the usual growing season are among the most pressing issues. Changes in the local ecosystem may bring in new pests and diseases that could destroy crops. The effect would be a lack of access to and availability of food as well as economic losses due to a decreased ability to export and a greater reliance on importing.

Regional Goal

Develop a food security plan and work to increase local food production by working with farmers, protecting soils, and encouraging farmer's markets and food co-ops.

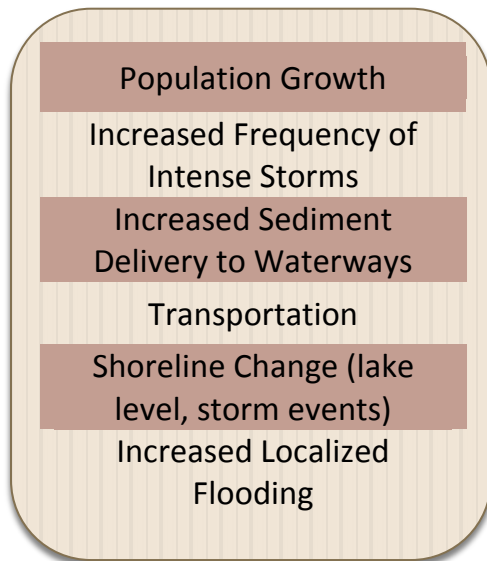


Source: <http://orlandobuzz.com/page/5>

Food and Agriculture Recommendations

- Strengthen the relationship between Marquette, the Michigan Food Policy Council and regional food security programs (e.g. UP Food Exchange).
- Amend ordinances and plans to encourage food production on City property (e.g. urban orchards, community gardens).
- Identify areas within the City that could be used for additional Farmer's Markets and seek out additional community, municipal, and regional collaborators.
- Consider participating in the further development of the Local Food Supply Plan of Marquette County.

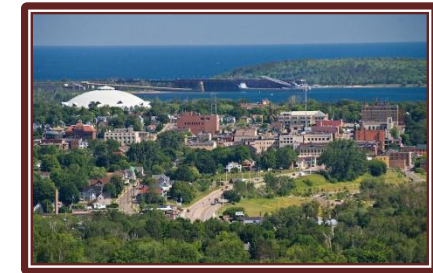
Identified Land Use Concerns



A population influx may result from a scarcity of water resources in other regions. Land use strategies are necessary to address both the potential of a growing population and the human and development impacts from severe storms, flooding, and shoreline erosion. All of these can be devastating without proper preparation. By protecting crucial floodways and shorelines through effective land use management, the impacts of climate change may be lessened.

Regional Goal

Assist communities to prepare their infrastructure, built environment, health and human services for predicted climate changes.



Source: <http://aaronpeterson.photoshelter.com>

Land Use Recommendations

- Revise conservation subdivision regulations to create incentives for developers to provide greater densities and community services, while achieving open space conservation.
- Protect sensitive land from development (including river corridors and floodplains) to preserve vegetation, retain hydrologic features, and ecological services using: land acquisition through purchase, conservation easements, and purchase of development rights.
- Promote green storm water management (by adapting the utility fee rate structure currently in place) to incentivize rates in conjunction with the amount of impervious area on a property (e.g., Ann Arbor).
- Adopt Low Impact Development (LID) standards such as requirements of pervious pavement, construction of bio swales (drainage with gently sloped sides), and green roofs for new development.

Identified Health Concerns

Disease/Pests

Increased Risk of Forest
Fires

Increased Disease Vectors,
Heat Stress

Increased Frequency of
Severe Storm Events

A changing climate could present numerous problems relating to human health and safety. Increasing ambient air temperatures during the day and night may lead to human health concerns such as: new pests and diseases, increased risk of wildfire, heat stress, and heat stroke. Proper education and preparation measures could help lessen the potential risks.

Regional Goal

Collaborate and promote public education and awareness of the effects of climate change and the benefits of taking action through adaptation and mitigation strategies.

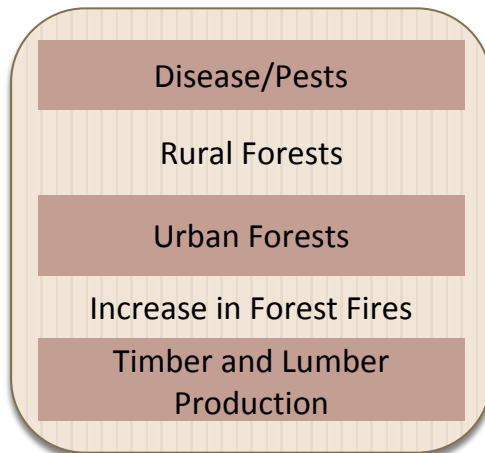


Source: <http://www.mlive.com/news/muskegon/>

Health Recommendations

- Increase and expand current beach monitoring activities to detect presence of pathogens that could affect human health.
- Prepare and implement emergency response plans (in concert with the County Hazard Mitigation Plan and coordination with the City Fire Chief) for extreme storms, floods, heat waves, poor air quality days, disease outbreaks.
- Work with other municipalities and the county to establish early warning systems (e.g. storm sirens) about evacuation routes or other information in the event of an emergency.
- Connect emergency centers with onsite renewable energy systems to reduce susceptibility to lapses in the conventional energy supply.
- Reduce the accumulation of fuel loads such as underbrush on city-owned, forest property (e.g. Presque Isle Park, woods north of Harlow Park).

Identified Forest Concerns



Forests face increased vulnerability due to climate change. Changes in temperature and weather patterns could attract new diseases and pests, which may adversely affect species distribution in rural forests. Development of urban forests will help mitigate fluctuations in climate. As heat waves increase in severity and frequency, the risk of forest fires will increase, thereby impacting timber production.

Regional Goal

Maintain forest ecosystem integrity, overall health, and resilience. Protect habitat for specific endangered and vulnerable plant and animal species, and minimize invasive species.

Forest Recommendations

- Form a temporary working group among interested stakeholders to create a five-year collaborative plan to address issues of forest infestations.
- Adjust the list of approved street trees (in concert with the Arborist and the USDA Forest Service for larger tracts) to include drought-resistant species and replace monocultures (one species of tree for an entire street or neighborhood) with polycultures (many species).
- Implement additional protections for high elevation areas to absorb extreme rain events before flooding occurs.
- Plant seedlings of high quality and at proper stand density for optimal growth and to reduce vulnerability to forest pests.



Source: <http://www.featurepics.com/>

Identified Tourism Concerns

Loss of Winter Recreation

Lack of Snowmobilers

Decrease in Tourism
(e.g. winter)

Decrease in Opportunities
for Youth

Lifestyle Changes

Loss of Cold Water Fisheries

Decline in Lake Superior's water level impacts deep water shipping lanes and cold water fisheries. Increased potential for shoreline erosion could limit marina access and opportunities for young people. Temperature changes could impact regional tourism activities, such as snowmobiling. These outcomes may decrease tourism opportunities. Finally, a decrease in tourism may force lifestyle changes upon the community.

Regional Goal

Strengthen the region's main economic bases, tourism and timber, by helping communities minimize negative impacts on these industries, and take advantage of positive opportunities.



Photo courtesy of David Stensaas

Tourism Recommendations

- Engage economic development organizations and tourism-dependent businesses in developing an economic development plan specific to tourism with specific goals to help local businesses minimize economic losses and take advantage of increased tourism opportunities.
- Adjust parks and recreation expenditures to support and capitalize on changes to outdoor recreation.
- Invest in dredging of harbors and other harbor improvements/adaptations to maintain access to water resources.
- Strengthen connectivity between coastal and non-coastal recreational areas to improve resilience of tourism economy.
- Capitalize on longer summer tourism season by developing and promoting spring and fall events.

Implementation

Priority Actions

Identified areas of concern about climate change and variability impacts were ranked in the second community meeting held April 24th, 2013 (Figure 4).

Table 1 shows the top ranking of the areas of concern as identified during the meeting. *Water Resources* was the top priority, followed by *Food and Agriculture*, and *Land Use and Development*. Priority actions are based on the participants' ranking of the identified areas of concern. While emphasis should be given to the top areas of concern as prioritized, each of the issue areas can provide guidance for further action. These priority actions are considered in reference to existing plans, with a primary focus on the Marquette Master Plan.

Public Input	
Climate Change Impacts	Rank
Water Resources	1
Food and Agriculture	2
Land Use and Development	3

Table 1: Public Input Climate Change Impact Rankings

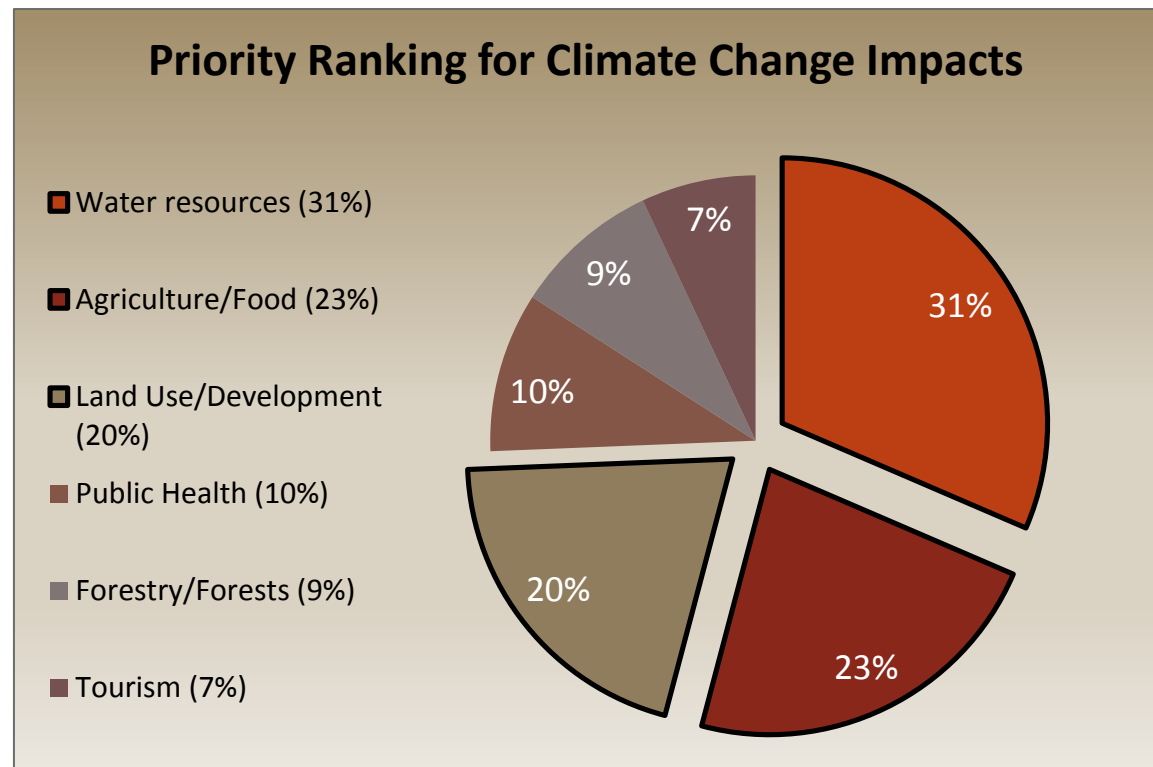


Figure 5: Priority Ranking for Climate Change Categories

Relationship to Existing Plans

The following section identifies the vulnerabilities and opportunities in existing plans. Furthermore, it relates these vulnerabilities and opportunities to climate change implications based on the priorities and recommendations addressed within each document

Existing Plans / Studies:

- The 2004 Marquette Master Plan
- Lake Superior Climate Adaptation, Mitigation and Implementation Plan (SWP)
- Marquette Engineering Department’s Climate Change Assessment (ED)
- Marquette County Hazard Mitigation Plan (HMP)

2004 Marquette Master Plan

Prioritized areas of concern relating to climate change are shown in Table 2. Each area is followed by potential impacts from climate change. The final column determines whether impacts are addressed within the Master Plan while identifying opportunities to integrate climate change adaptation strategies into the Plan.

Key	
Addressed*	✓
Not Addressed	

*While the Master Plan addresses these impacts, it does not necessarily discuss them in relation to climate change and variability

Area of Concern	Impact	Master Plan
Water Resources	Changing Lake Levels	✓
	Decreased Ice Cover	✓
	Increased Algae, Invasive Species	
	Increased Lake Temperature	
	Future Population Growth	✓
	Commoditization of Water	
	Increased Pathogens	
Food and Agriculture	Ability to Import/Export	
	Changes in Growing Season	
	Changes in Ecosystems	
	Flooding	
	Drought	
	Availability and Access	
Land Use and Development	Transportation	✓
	Shoreline Change	✓
	Increased Sediment into Waterways	✓
	Increased Frequency of Intense Storms and Flooding	
	Future Population Growth	✓
Public Health	Disease Vectors, Pests, Diseases	
	Increased Risk of Forest Fires	
	Heat Stress	
	Increased Frequency of Severe Storm Events	✓
Forests	Disease / Pests	
	Rural Forest	✓
	Urban Forest	✓
	Increase in Forest Fires	
	Timber and Lumber Production	✓
Tourism	Loss of Winter Recreation	✓
	Lack of Snowmobilers	✓
	Decrease in Tourism in General	✓
	Decrease in Opportunities for Young People	✓
	Lifestyle Changes	✓
	Loss of Cold Water Fisheries	

Table 2: Areas of Concern within the Marquette Master Plan

The frequency in which the identified issue categories appear throughout the existing Master Plan chapters is shown in Table 3. *Water Resources, Food & Agriculture, and Land Uses & Development* were prioritized by the participants. *Land Use & Development* is currently the only category with a dedicated chapter within the Master Plan. The relationship between the aforementioned categories and the Master Plan are presented below.

Water Resources: While *Water Resources* is mentioned in 14 out of the 15 chapters in the Master Plan there is an opportunity for the integration of climate change adaptation strategies into the document. For example, in Chapter 11 titled *Winter City Considerations*, there is discussion of outdoor recreational activities in the City. However, there is neither mention of how decreased ice cover could affect these winter activities nor possible solutions to address these problems (See Wang, 2011 for further analysis on ice cover).

Food and Agriculture: Currently the Marquette Master Plan lacks specific mention of climate change adaptation strategies in relation to *Food and Agriculture*. Climate change impacts regarding the ability to import/export food, changes in agricultural growing seasons, changes

in agricultural ecosystems, pests, flooding, drought, food access, and food availability could be addressed throughout the Master Plan both at the local and regional level.

Land Use and Development: The Master Plan dedicates a chapter to *Land Use and Development*. While the Plan addresses transportation, shoreline change, increased sediment into waterways, and future population growth, the addition of potential climate change implications on these categories would enhance the City’s climate resilience. For example there is an opportunity to include climate adaptation strategies in Chapter 12: *Master Land Use Plan*. The chapter discusses the importance of public access and protection of shorelines, but there is no mention of possible implications climate change could have on the waterfront.

Additional Areas of Concern: Although these additional areas of concern were not identified as top priorities by the participants, climate adaptation integration strategies should be included from the categories of *Public Health, Forests, and Tourism*. This would contribute to the community’s climate change preparedness.

Identified Concern	Frequency of Concern in the Contents of Existing Master Plan		
	Chapters (out of 15)	Appendices (out of 6)	Dedicated Chapter (Y / N)
Water Resources	14	3	N
Food and Agriculture	3	0	N
Land Use and Development	9	2	Y
Public Health	3	2	N
Forests	4	1	N
Tourism	8	3	N

Table 3: Public Input Reflected in Master Plan

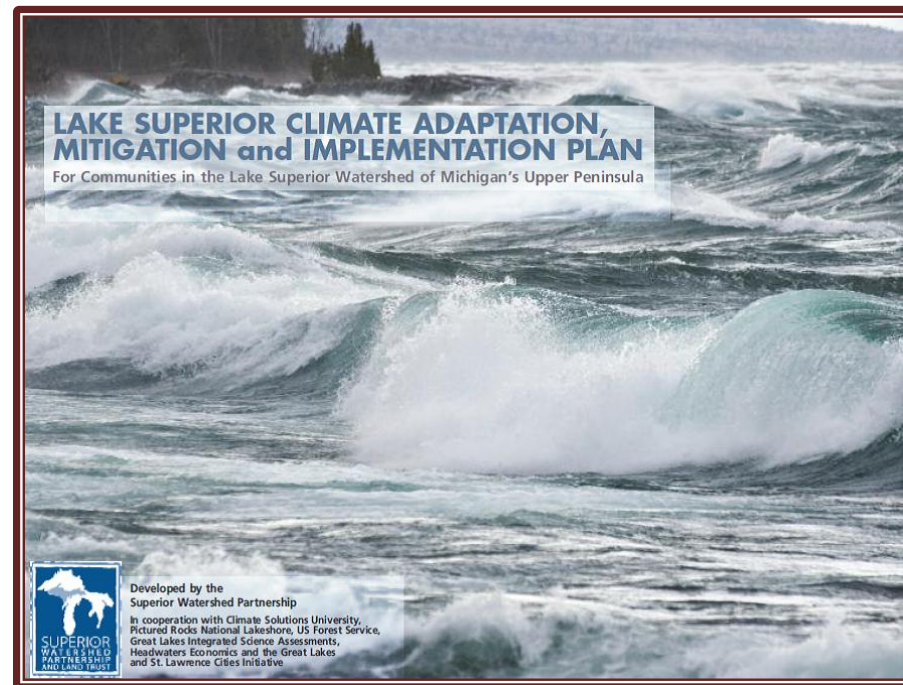
Related Documents

The Superior Watershed Partnership Climate Adaptation Plan:

The Superior Watershed Partnership's (SWP) Lake Superior Climate Adaptation, Mitigation and Implementation Plan provides content on the changes and impacts that are associated with climate change and variability related to wetlands, forests, the built environment, human health, and the economy.

The SWP Plan goes on to provide goal and action steps associated with the expected impacts. The Superior Watershed Partnership's Plan offers action steps that could be integrated into documents such as the Master Plan to address identified concerns from the community forum. The category of Water Resources was identified as a top concern by participants, and yet the Master Plan currently does not address the associated potential impacts such as increasing Lake Temperatures. The SWP's Plan indicates climate impacts that rising lake temperatures may bring, such as increased evaporation and ecosystem changes, and recommends strategies to adapt to this change.

In addition, the Marquette Master Plan does not discuss food and agriculture in great detail. The SWP's Plan recommends that municipalities support local food initiatives through state purchasing efforts and encourages the development of a food security plan that works to increase local food production, establishes new farmer's markets and new food co-ops. Finally, the SWP's Plan holds great merit for communities within the Lake Superior watershed to begin prioritizing specific projects and action steps.



Lake Superior Climate Adaptation, Mitigation and Implementation Plan, developed by the Superior Watershed Partnership

Engineering Department's Climate Change Assessment:

The Climate Change Assessment conducted by the Marquette Engineering Department considers infrastructure problems that are likely to occur and offers solutions to these challenges.

This Assessment should be considered valuable because it provides specific site locations where issues need to be addressed. For example, increased flooding is deemed a concern at Fifth Street from Washington Street to Spring Street, among other areas. Adaptation measures associated with infrastructure concerns are also provided. The Assessment recommends that City storm sewers be considered for expansion due to increased storm frequency and intensity. The workshop participants identified an increase of severe storms and flooding to be a top concern. The infrastructure adaptation recommendations by the Marquette Engineering Department could increase Marquette's readiness to address this issue.

A problem that is as complex as climate change and variability must be addressed in multiple ways. Pairing climate change efforts with infrastructure recommendations can offer a more holistic approach to the community identified impacts, and lead Marquette toward a greater level of resiliency. For example, this can be done as the Planning Commission makes recommendations to the Manager and City Commission for the annual street and utilities portion of the Capital Improvement Projects after evaluating the specific capital projects recommendations of the City Engineer.

Marquette County Hazard Mitigation Plan:

The Hazard Mitigation Plan covers how to prepare for and recover from key concerns such as structure fires, wildfires, storm surge, dam breaches, flash floods, ice storms, heat stroke, communicable disease, and more.

The workshop participants also identified greater concerns such as forest fires, drought, extreme heat, tornados, flooding, and disease. These are all issues that could affect the community regardless of climate change and variability. Therefore, it would be in the interest of Marquette to address these potential hazards, especially as climate change increases their potential.

For example, the Master Plan currently does not address forest fires as a concern. However, The Master Plan does recognize that forests are a crucial asset to the region. Therefore, Marquette could consider adding a section about how to be prepared in the event of a forest fire using recommendations from the County Hazard Mitigation Plan and the Marquette County Community Wildfire Protection Plan (currently under development).



Source: www.continuitycompliance.org

Audit Summary

Marquette was provided with a self-assessment tool designed to evaluate climate change readiness. This climate change readiness assessment was designed by Minnesota Sea Grant specifically for communities in the Great Lakes Region and provides community leaders with a method to review vulnerabilities regarding climate change. This readiness assessment indicates your community’s ability to restore and maintain an acceptable level of functionality following impacts related to climate change.

Once completed, the assessment provides Marquette with a low, medium, or high rating for each category. Results of the audit, according to category, are displayed in Table 4. The medium and high readiness ratings do not necessarily equate to low potential for impact. A low readiness rating is not the only determinant in deciding priorities for further vulnerability assessments. Other determinants could include: cost, public support, and political will. The full assessment and additional tools can be found at www.glisa.umich.edu.

**Note: The Business Plans & Equipment and Community Plans categories refer to preparedness rather than vulnerability. Hence, a higher rating in these two categories indicates greater readiness.*

**** Interpreting Readiness Index:**

LOW: Indicates this category is a high priority for implementing a vulnerability assessment to help further define climate change impacts.

MEDIUM: Indicates that work could be done to improve community climate adaptation readiness as opportunities arise.

HIGH: Indicates your community is either prepared or not highly affected by projected climate trends. It does not indicate lack of impact.

Category	Readiness Rating**	Readiness Ranges		
		Low	Med	High
Critical Infrastructure Flooding	8	18 - 13	12 - 7	6 - 0
Critical Facilities Flooding	0	24 - 17	16 - 9	8 - 0
Built Environment & Infrastructure	7	7 - 6	5 - 3	2 - 0
Operations & Maintenance	1	6 - 5	4 - 2	1 - 0
Water Resources	0	7 - 6	5 - 3	2 - 0
Ecosystems & Habitats	8	8 - 6	5 - 3	2 - 0
Tourism & Recreation	2	4 - 3	2	1 - 0
Business Plans & Equipment*	0	0 - 1	2 - 3	4
Community Plans*	3	0 - 2	3 - 5	6 - 8

Table 4: Readiness Levels by Rating and Category

Low Readiness

Built Environment &
Infrastructure

Ecosystems & Habitats

Business Plans & Equipment

Low Readiness

Built Environment & Infrastructure

The readiness of Marquette's *Built Environment & Infrastructure* has been assessed as low because roads (Lakeshore Blvd., U.S. 41, CR553, and Grove Street) and other critical infrastructure (storm sewers, culverts, ports, marinas, piers, and break-walls) are vulnerable to extreme storms and 100-year flood events. Lakeshore Blvd., in particular, is subject to both land subsidence and extreme storms.

Ecosystems & Habitats

Marquette's *Ecosystems & Habitats* has been assessed as low-readiness. The City notes that inland or coastal aquatic habitats (estuaries, wetlands, beaches) supporting animal populations (aquatic, terrestrial) could be impacted by drought, higher temperatures, and/or extreme storm events that lead to erosion of valuable soils and sedimentation into waterways. Considering that Marquette draws its drinking from Lake Superior, potential impacts to local water quality are a concern. The movement of new and/or invasive species into the area could lead to further water quality impacts. Unregulated development and resource extraction within the region could prevent native species (both land and aquatic) from moving out of danger when they are faced with extreme weather events.

Business Plans & Equipment

According to the self-assessment, less than 50% of businesses currently possess: backup generators; backups for basic needs like water, food, & communications; and re-stocking & re-opening plans. Therefore, *Business Plans & Equipment* readiness is rated as low according to the assessment.

Medium Readiness

Critical Infrastructure Flooding

Tourism & Recreation

Community Plans

High Readiness

Critical Facilities Flooding

Operations & Maintenance

Water Resources

Medium Readiness

Critical Infrastructure Flooding

The sewage treatment plant and parts of the power grid are located in the FEMA-designated flood plain. Roadways are also vulnerable to flooding.

Tourism & Recreation

Negative impacts to winter tourism opportunities have been observed. Parks and Recreation facilities may require more maintenance due to climate change.

Community Plans

Currently, storm water, land use, transportation, tourism, open space, business, and forest management plans do not include climate adaptation language.

High Readiness

Critical Facilities Flooding

Police and fire stations, communications and emergency service centers, the hospital, public works facilities, and City Hall are not vulnerable to flooding.

Operations & Maintenance

The need for storm sewer, road, and urban forest maintenance has not increased but an increase in beach closures has been observed. Combined sewer overflows (CSOs) are not a risk.

Water Resources

Surface and ground water volume and quality is high. An increase in Total Maximum Daily Load of pollutants into Lake Superior is not expected. Shoreline erosion is normal but wildfire could increase erosion from slopes. Incursions of invasive species in dune areas have been observed.

Stakeholder Interviews

Local experts in the fields of agriculture, forestry, land use, natural resources, and community development were contacted by the Project Team and asked to take part in a 30-minute telephone interview. During the interview, the experts were asked to review and comment on the priorities and actions identified at the two public meetings, as well as add their own additional issues and actions. They also were asked to identify opportunities or barriers in implementing these actions. Overall, the interviewees agreed with the community concerns and the preferred best practices to adapt to these concerns. Some noted that the City's sustainability efforts should be more consistent, connected, and allow for additional citizen engagement opportunities.

Agriculture stakeholders noted the recent difficulties in crop scheduling, due to the changes in seasonality. One observed that maple syrup production has been erratic for the same reason. This stakeholder suggested that the City collaborate with the Natural Resources Conservation Service and continue to engage citizens in climate adaptation planning.

Several interviewees noted the importance of growing, buying, and eating local food. They saw this as a way to both slow down and adapt to climate change, as less fossil fuels are used in the growth, transport, and storage of locally-grown food. To maximize these benefits, a food processing facility would have to be located near the City. Greater food security would result from having more food grown and processed close to home.

Forestry stakeholders cited an increase in pests and disease as a result of fewer cold temperature extremes. One stakeholder believed that more forest fires may occur because of high fuel loads due to current forest management policies. Collaborating with Marquette County, which owns approximately 14,000 acres of forest, was suggested. It was also suggested to create a citizen-watch volunteer program to report invasive pests.

Some identified lack of resources as a barrier to implementing adaptation plans, particularly those that are long-range and need to be supported by taxpayers. Some interviewees identified short political cycles as barriers in passing and enforcing

sustainability policies. The area's rich natural resources and northern location, however, led some to believe that Marquette would make the region more resilient to climate change.

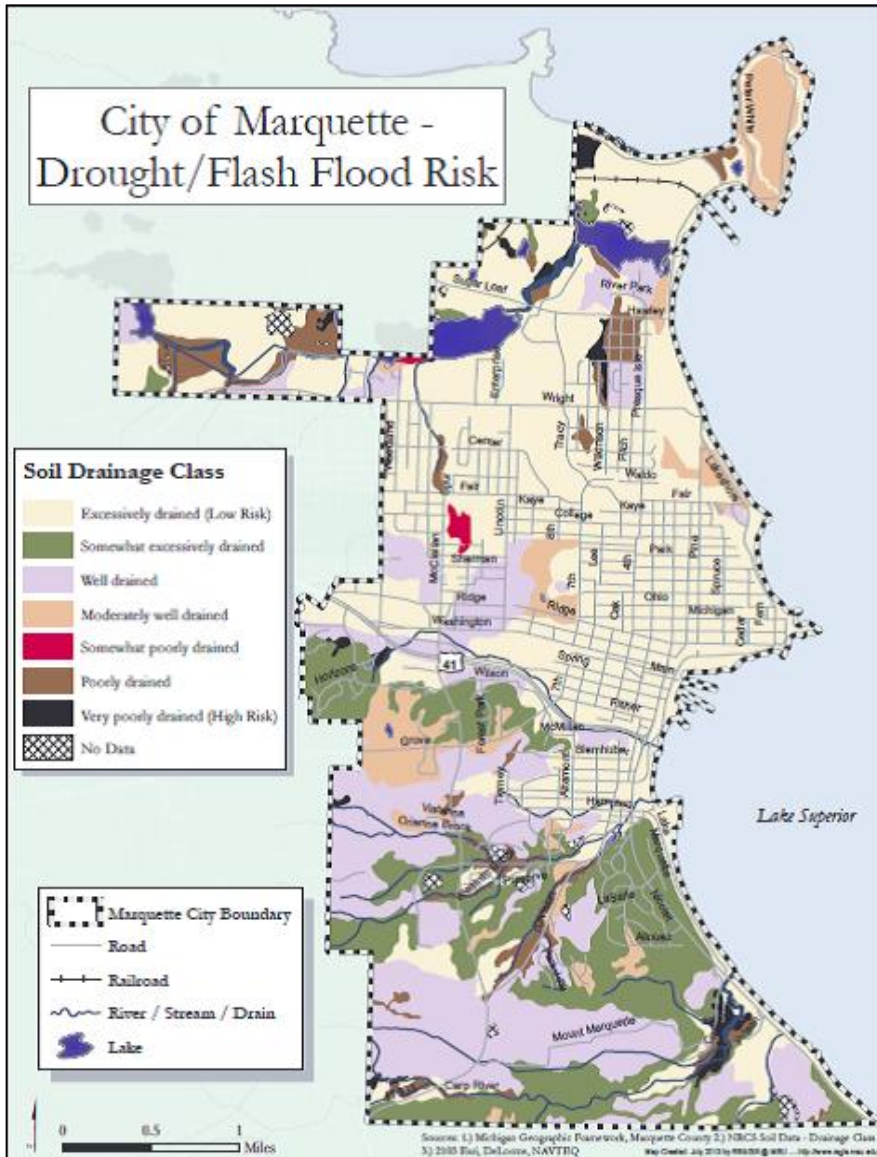
Land Use stakeholders agreed that the list of best adaptation practices were on target. One noted that the City needs to follow through on its "Complete Streets" initiative. Although the City has recently adopted Complete Streets provisions including amended site plan review for non-motorized connections, another stakeholder noted that implementation is needed to provide commuters and cyclists with more connected bikeways within the City itself, rather than relegating them to outside the City. Stakeholders also identified water territorialism as an additional issue to consider.

Tourism stakeholders agreed that planning for more erratic snowfall is important to tourism in the area, as residents pride themselves on offering "silent winter sports." Overall, community support for sustainability measures is a major strength of the region.

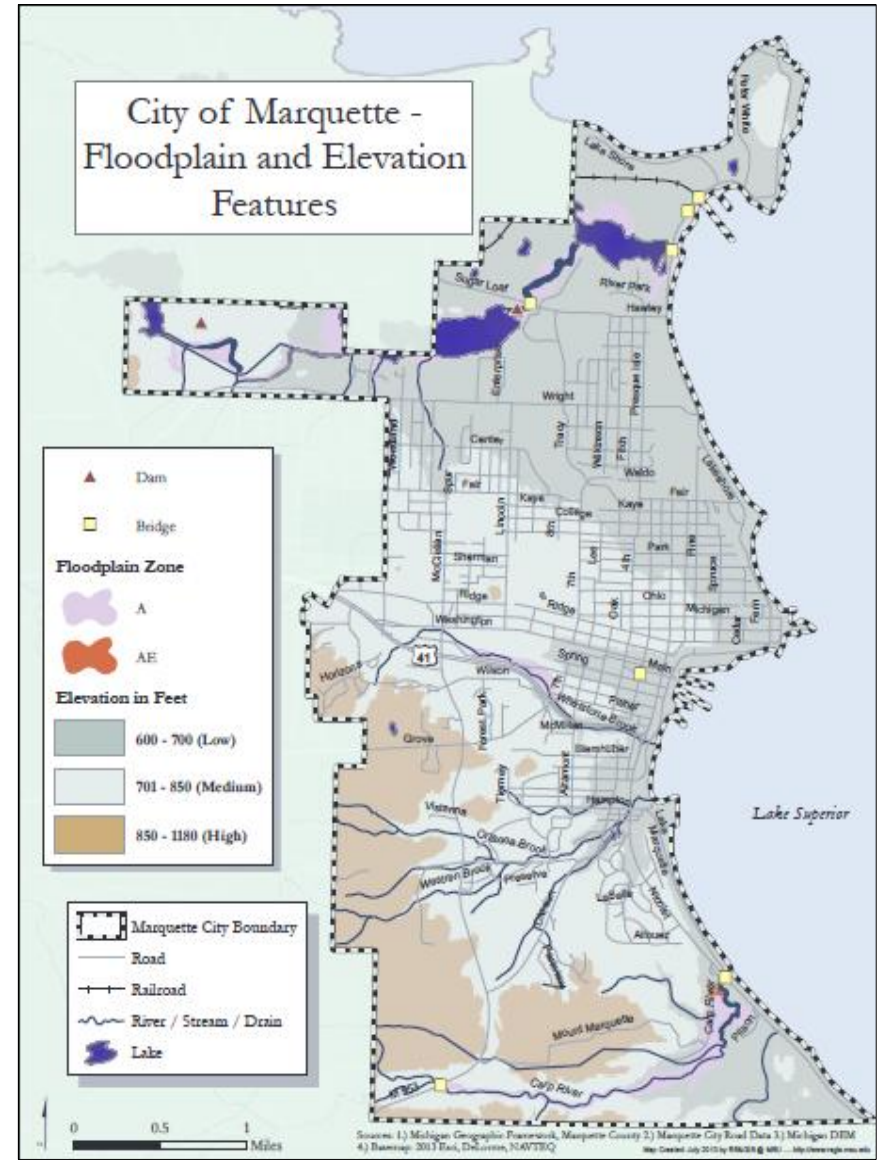
Appendices

Appendix A: Maps – City of Marquette

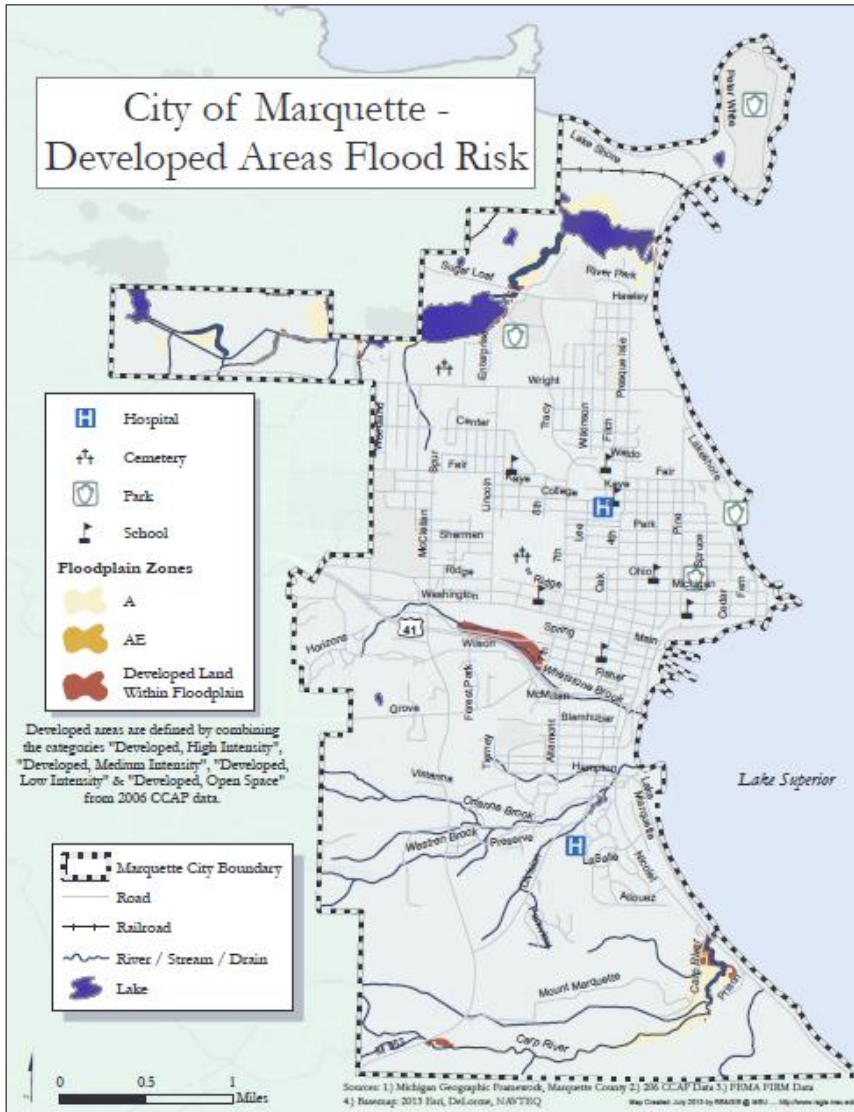
- i. Drought / Flash Flood Risk
- ii. Floodplain and Elevation Features
- iii. Developed Areas Flood Risk
- iv. Flood Risk Features
- v. Fire Susceptibility
- vi. Shoreline Elevation



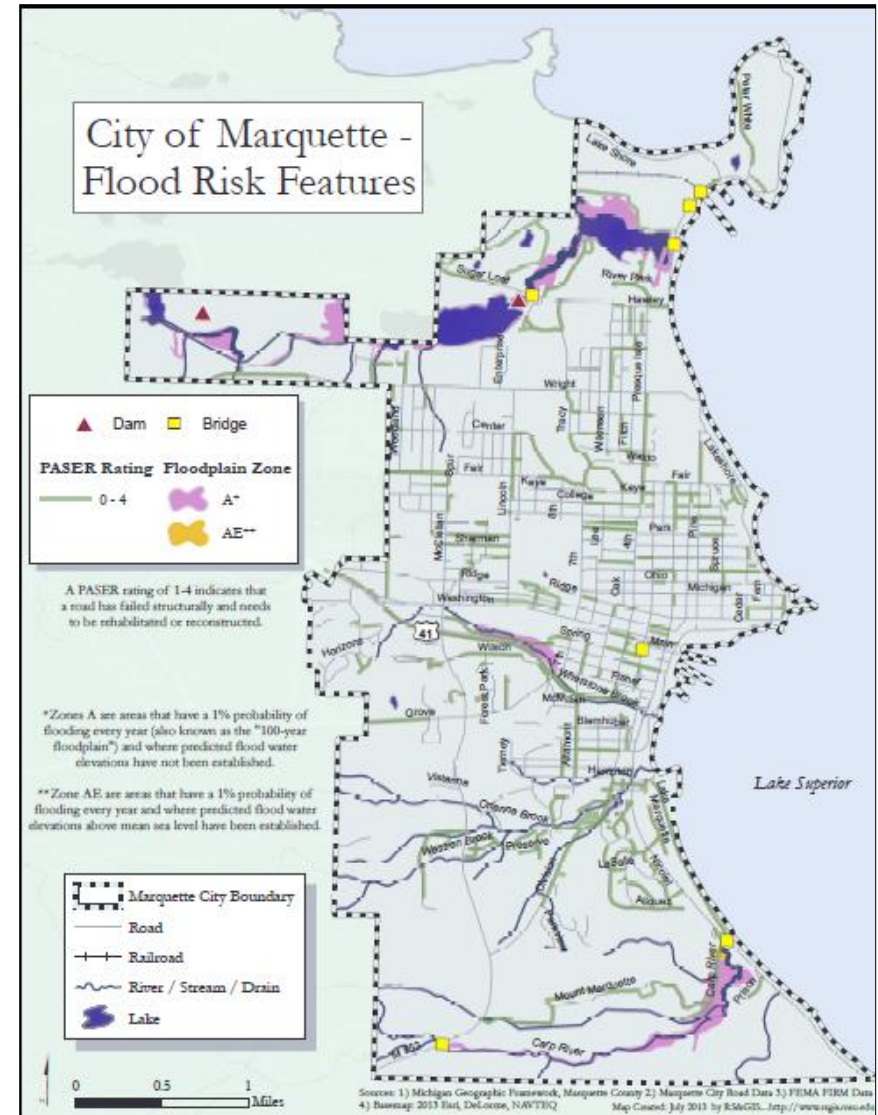
i.



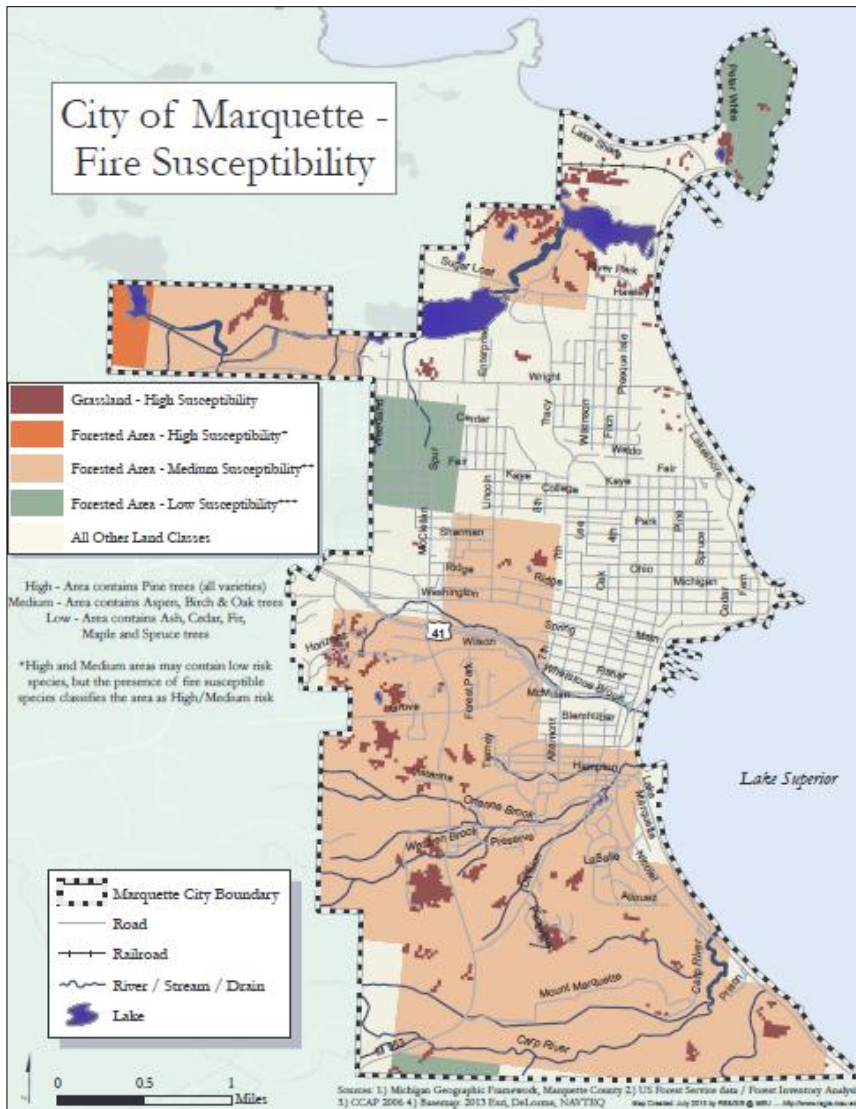
ii.



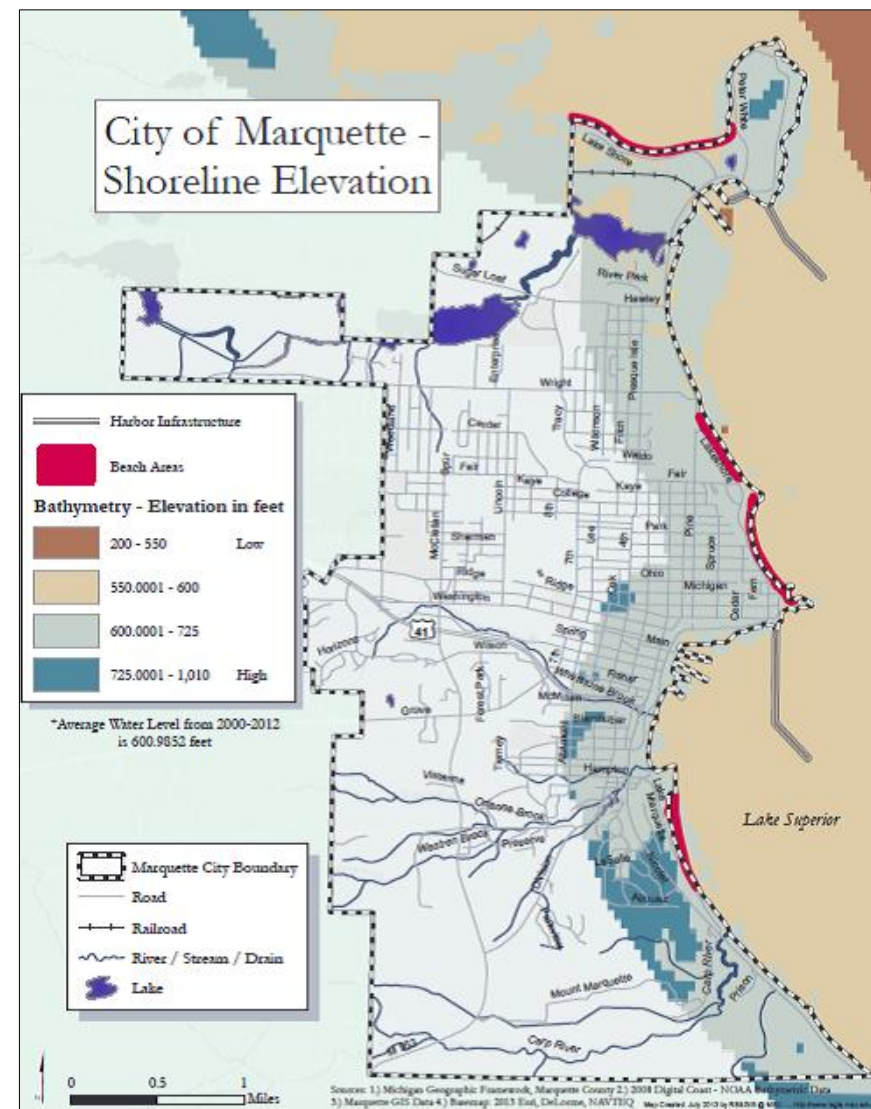
iii.



iv.



v.



vi.

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