IMPROVING AWARENESS OF

Coastal Storm Hazards, Stormwater Runoff, and Risk Reduction Strategies

IN THE SAGINAW BAY WATERSHED

SURVEY SUMMARY

Prepared by the Michigan Sea Grant College Program

MICHU-16-705

Flood debris in Midland County, 1996. Photo: Midland County Office of Emergency Management

SURVEY COLLABORATIVE

Bay County Emergency Management Division

East Michigan Council of Governments

Michigan Sea Grant College Program

Michigan State University Extension

Midland County Office of Emergency Management

Saginaw Bay Coastal Initiative

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1986 flood downtown Midland, Mich. Photo: Midland County Office of Emergency Management

EXECUTIVE SUMMARY

Extreme storms across the Great Lakes region have increased in frequency and intensity over the last century. This trend is expected to continue in coming years with serious implications for community health, safety and economic stability. Communities in the Saginaw Bay watershed are particularly vulnerable to extreme storm impacts as a result of the watershed's unique topography and land-use patterns.

This survey was designed to assess decision-makers' perceptions of extreme storms and their impacts in the Saginaw Bay watershed — with the ultimate goal of informing future resiliency outreach and education efforts. This report provides an overview of the survey process and participants, summarizes key results and outlines recommended outreach actions based on those results.

The survey targeted key decision-makers working in fields impacted by extreme storm events who had the potential to influence community resiliency practices. A total of 265 decision-makers participated in the survey in the fall of 2015 representing all 22 counties in the Saginaw Bay watershed. A majority of respondents work in local and county government.

Survey questions were designed to gather information on three core topics:

- Perceptions of extreme storm hazards
- Resource, knowledge and capacity needs
- Support for existing and potential risk reduction strategies

PERCEPTIONS OF EXTREME STORM HAZARDS

To better understand which storm hazards had the most significant impact on communities in the watershed respondents were asked to rate the degree to which specific storm consequences impacted their community on a scale of 1 to 4 (with 1 corresponding to "does not impact" and 4 corresponding to "impacts greatly").

- **Storm hazards were not viewed as greatly impacting watershed communities.** None of the storm consequences rated on average above 3, indicating that while respondents recognized most storm consequences as impacting the communities they worked in none of the consequences were perceived to have a major impact on average.
- **Storm hazards viewed as the most impactful reflected the region's historic struggle with water quality concerns.** Combined Sewer Overflows (CSOs) and agricultural runoff pollution were rated among the most impactful storm consequences. Both have been major regional sources of water pollution in the past. Water quality concerns such as stormwater runoff pollution and overflow of septic systems rated lower in impact but received more support as future risk reduction strategies. This likely stems from the fact that major resources have already been invested and significant improvements made in addressing CSOs and agricultural runoff pollution in the watershed.
- **Stormwater flooding of critical infrastructure was perceived to have a relatively low impact.** With an impact rating of 2.33, damage to critical infrastructure was second to last among the listed storm consequences.

Flooding at Sanford Village Park. Photo: Midland County Office of Emergency Management

Based on these results recommended outreach actions include:

- **Increase awareness of extreme storms and their consequences** as a significant threat to community health, safety and economic stability particularly among community leadership.
- **Promote tools that help local communities assess risks to their critical infrastructure.** There are several tools available to help communities determine if the actual risk of damage to critical infrastructure is as low as the perceived impact would suggest.
- **Provide additional information on the "next generation" of water pollution concerns** in the watershed including urban runoff and septic system failures. Highlight the progress achieved in addressing major historic pollution sources in the watershed.

RESOURCE, KNOWLEDGE AND CAPACITY NEEDS

In order to assess community resources, knowledge and capacity in preparing for and responding to extreme storm events, respondents were asked a series of questions focused on the importance of specific data, tools and trainings. In addition, they were asked to identify the most significant barriers in implementing existing plans that prepare for extreme storm hazards in their communities.

- **Most of the resources consulted for information on extreme storms were focused on forecasting** storm events rather than long-term resiliency planning.
- **High importance was assigned to data, tools and training** related to flood and wind forecasting, public health issues and storm water management.
- **Lack of awareness or interest was a major barrier in preparing for and responding to extreme storms.** Respondents singled out lack of awareness as a greater impediment to implementing existing hazard mitigation plans than either lack of technical expertise or lack of staff and 12% of respondents believed that storm hazards did not greatly affect their communities. This result runs contrary to a review of emergency management plans in the watershed which found that most plans recognize flooding, severe weather and other related hazards as a priority.

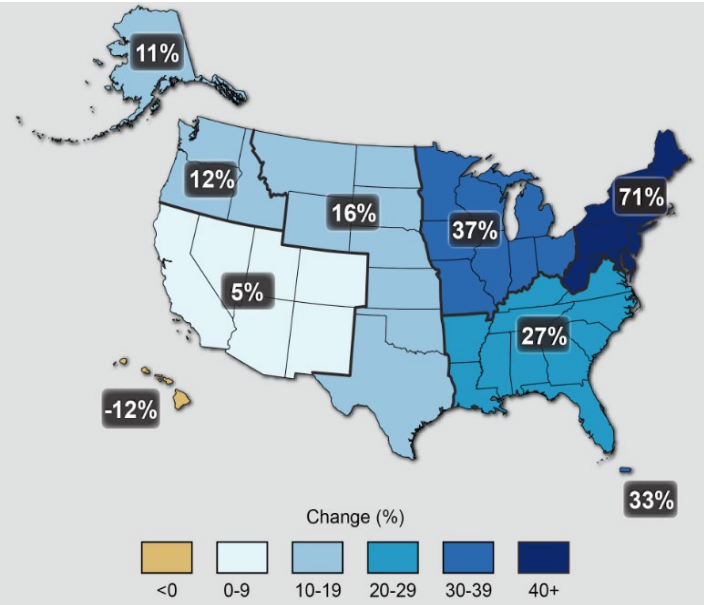
Based on these results recommended outreach actions include:

- **Organize workshops to provide an overview of available planning tools** specifically related to Saginaw Bay watershed needs including public health impacts of extreme storms, stormwater management and accurate forecasting for flooding and high winds.
- **Increase awareness of extreme storms as a significant hazard in the watershed,** particularly among leadership and provide accurate information about projected future changes in the frequency and intensity of storm events.

SUPPORT FOR EXISTING AND POTENTIAL RISK REDUCTION STRATEGIES

In collecting information on the viability of future risk reduction strategies, respondents were asked to identify which strategies have already been implemented in their communities and which strategies they would support for future implementation. Risk reduction strategies were subdivided into categories including pollution prevention, emergency preparedness and policy strategies.

- **Policy strategies received less support.** Policy related strategies were less likely to have been already implemented in communities or supported for future implementation within the watershed.
- **Strategies addressing septic system failures and storm water management have received the most support.** The most popular strategies included developing plans to update and repair failing septic systems and storm water management efforts.



Percent increases in the amount falling in the heaviest 1% of daily precipitation events from 1958 to 2012. Most significant increases in the Midwest and Northeast. Figure from the Third National Climate Assessment, US Global Change Research Program.

Participants had comparatively little knowledge about green infrastructure strategies. Green infrastructure measures had the highest percentage of participants selecting "Don't know" both when asked if green infrastructure strategies were already in place in their communities and when asked if they would support future implementation of green infrastructure measures.

Based on these results recommended outreach actions include:

- **Explore options for helping local communities develop plans** to deal with failing and outdated septic systems.
- **Support stormwater management trainings and workshops** and incorporate green infrastructure education elements.

Next steps following this survey will include working with community stakeholders within the Saginaw Bay watershed to refine, prioritize and implement recommended outreach efforts.

PROJECT OVERVIEW AND CONTEXT

Across the Great Lakes region increasing frequency and intensity of extreme storm events represent a growing threat to community health, safety and economic stability. Since 1900 total annual precipitation in the Great Lakes has increased by 10.8% and much of this increase has been due to large storm events.[1] Between 1958 and 2012 the amount of precipitation falling in the heaviest 1% of storms increased by 37% in the Midwest.[2] These trends are expected to continue in coming years with further increases in average annual precipitation and more frequent and intense storms across the region.[3]

This rise in extreme storm events will have significant impacts including property damage and safety threats, loss to agricultural yields, disruption of trade and transport, damage to critical infrastructure, increased erosion, degraded water quality from urban and agricultural runoff as well as combined sewer overflows and septic system failures and increased phosphorus and nitrogen loading in waterways contributing to hypoxia and harmful algal blooms.

This survey was designed to assess decision-makers' perceptions of extreme storms and their impacts in the Saginaw Bay watershed. The Saginaw Bay watershed is known regionally as a place where the connection between water quality and water quantity challenges is especially strong. The Saginaw Bay watershed is the largest in Michigan covering 8,700 square miles and including more than 7,000 miles of rivers and streams. Over the past two centuries, the watershed has lost more than 2,800 square miles of wetlands due to urban development and agricultural expansion.[4] This change in land use patterns combined with the unique topography of the Saginaw Bay watershed makes the region particularly vulnerable to extreme storm impacts. The region is dominated by clay heavy soils with low water retention capacity and there is very little elevation change across the watershed. Often water deposited by heavy precipitation events upstream takes days to move through the watershed exposing several different communities to flooding, erosion and

1.) Great Lakes Integrated Sciences and Assessments, 2014: Climate Change in the Great Lakes. glisa.umich.edu/media/files/GLISA_climate_change_summary.pdf

2.) Great Lakes Integrated Sciences and Assessments, Extreme Precipitation. glisa.umich.edu/climate/extreme-precipitation

3.) Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2. http://nca2014.globalchange.gov/highlights/report-findings/extreme-weather#intro-section-2

4.) Fizzal, Chad, 2015: Status and Trends of Michigan's Wetlands: Pre-European Settlement to 2005. Michigan Department of Environmental Quality, www.michigan.gov/documents/deq/DEQ-Water-Wetlands_-Status_and_trends_498644_7.pdf

runoff pollution along the way. While sharing a common vulnerability to storm hazards, communities in the Saginaw Bay watershed are highly diverse in other aspects ranging from industrialized manufacturing cities to small agricultural towns. Regional resiliency planning would allow these communities to leverage collective resources and knowledge.

The stakeholder feedback gathered during this survey will provide a picture of the Saginaw Bay watershed's regional capacity to prepare for and respond to extreme storm events. Survey results will directly inform development of outreach and education efforts designed to improve community resiliency to extreme storm impacts across the watershed.

SURVEY METHODOLOGY

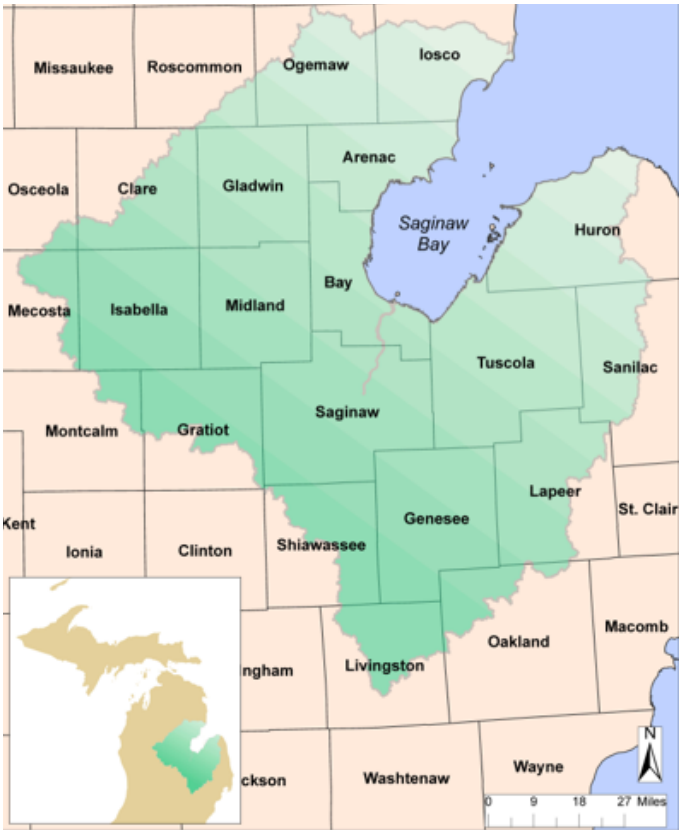
This survey targeted key decision-makers working in fields impacted by extreme storm events who have the potential to influence community resiliency practices. This included planning commissioners, drain commissioners, road commissioners, city planners, city and county commissioners, metropolitan planning organizations, county transportation corporations, public health officials, zoning commissioners, stormwater authorities, emergency managers, Red Cross staff, fire departments, utility providers, tribal authorities, port authorities and major industry representatives. Survey participation was limited to those working within the boundaries of the Saginaw Bay watershed.

This survey built off of the efforts of the *Great Lakes Planning and Mitigation Needs Assessment of Coastal Storm Hazards* led by the University of Wisconsin Sea Grant Institute. The *Great Lakes Planning and Mitigation Needs Assessment of Coastal Storm Hazards* surveyed coastal planners, however, only 4% of respondents worked on Lake Huron, which includes Saginaw Bay. This Saginaw Bay watershed survey builds on the questions and themes of the *Great Lakes Planning and Mitigation Needs Assessment of Coastal Storm Hazards* but with a more narrow geographic focus and a broader range of targeted participants.

A project Steering Committee made up of representatives from the targeted population was assembled to lead survey development and distribution. The Steering Committee agreed on three overarching themes to guide survey questions. Survey questions were designed to supply critical information related to these broad themes:

- Perceptions of extreme storm hazards
- Resource, knowledge and capacity needs
- Support for existing and potential risk reduction strategies

Photo: David Sommers



The Saginaw Bay watershed includes all or part of 22 counties and covers 15% Michigan's land area. Figure from Michigan State University Land Policy Institute .

Figure 1

Position	# of Respondents	% of Respondents
Fire/Police	41	11%
Environmental Specialist	30	8%
Planner	24	7%
County Commissioner	24	7%
Emergency Services Manager	20	5%
Drain Commissioner	18	5%
Public Health Official	16	4%
Building Official	11	3%
Harbor, Parks, or Beach Manager	9	2%
Utility Provider	9	2%
Road Commissioner	5	1%

Figure 2

An online survey was distributed in the fall of 2015 through email and promoted by members of the project Steering Committee as well as county level emergency management officials. The online survey was also promoted through several regional newsletters and list serves. Concurrently, an identical mail-back paper survey was sent out to ensure a diverse range of participants were included in the assessment and to provide access for respondents less comfortable with an online format.

SURVEY POPULATION

A total of 265 decision-makers participated in the survey representing all 22 counties in the watershed. A majority of respondents (59%) worked in counties completely within the watershed, 31% worked in counties with a majority area in the watershed and 10% of responses came from counties with less than half of their area in the watershed. The county with the most representation was Bay County, 84 respondents (15%) worked in Bay. The county with the least representation was Mescota County, 7 respondents (1%) worked in Mescota. See Figure 1 for a map of counties within the watershed and a more detailed breakdown of participation by county.

Survey participants included all of the targeted stakeholder groups with a majority of participants coming from county government (38%) and municipal/city/village/township government (33%). See Figure 2 for a list of the most common positions held by participants.

SURVEY RESULTS AND OUTREACH RECOMMENDATIONS

Key survey results are summarized according to the central survey themes:

- Perceptions of extreme storm hazards
- Resource, knowledge and capacity needs
- Support for existing and potential risk reduction strategies

Also included in this section are recommendations for potential outreach and education efforts based on survey results and feedback from the project Steering Committee. The original survey questions can be found in the appendix.

PERCEPTIONS OF EXTREME STORM HAZARDS

To better understand which storm hazards had the most significant impact on communities in the watershed, respondents were asked to rate the degree to which specific storm consequences impacted their communities based on a scale of 1 to 4 (1 = Does Not Impact, 2 = Impacts Somewhat, 3 = Impacts and 4 = Impacts Greatly). Respondents identified "damage to crops and interference in agricultural production" as the most significant hazard with a 2.96 average impact rating. This was closely followed by "agricultural runoff pollution" with an average impact rating of 2.88 and "overflow of combined sewer and stormwater systems" with an average impact rating of 2.83. (Figure 3)

Photo: David Sommers

Storm Consequences	Average Impact Rating
Damage to crops and interference in agricultural production	2.96
Agriculture runoff pollution (e.g., pesticides, nutrients)	2.88
Overflow of combined sewer and stormwater systems	2.83
Stormwater flooding of residential and commercial developments	2.67
Erosion of lake shoreline and river banks	2.65
Stormwater runoff pollution (e.g., heavy metals, petroleum)	2.6
Overflow of septic systems	2.59
Destabilization of critical transportation infrastructure (e.g., roads, bridges)	2.58
Ice shoves and jams	2.4
Flooding or contamination of wells	2.39
Stormwater flooding of critical infrastructure (e.g., utilities, fire stations, hospitals, schools)	2.33
Drownings or injuries resulting from flooding or dangerous currents	1.07

Figure 3. Average Impact Rating based on a scale of 1 to 4 with 1 = Does not Impact and 4 = Impacts Greatly.

Respondents' perceptions of the most impactful storm hazards reflect the fact that historically agricultural runoff pollution and CSOs have been major sources of water quality degradation in the watershed. Over the past 40 years a great deal of effort and resources have been dedicated to addressing these issues. Indeed results presented later under the section *Support for Existing and Potential Risk Reduction Strategies* (Page 2) demonstrate that while CSOs and agricultural runoff may still be perceived as having a major impact on communities within the watershed, the bulk of support for future hazard reduction strategies focuses on other issues such as stormwater management and failing septic systems. These contaminant sources have received comparatively less attention and resources in the past.

OUTREACH RECOMMENDATION: Provide additional information on the "next generation" of water pollution concerns in the watershed including urban runoff and septic system failures. Highlight the progress achieved in addressing major historic pollution sources in the watershed.

Overall none of the storm consequences had a mean rating above 3 indicating that respondents did not feel any of these hazards had a high impact on the communities they work in. Respondents did recognize most storm consequences as having some impact, only "drownings or injuries resulting from flooding or dangerous currents" received an average impact rating below 2.

OUTREACH RECOMMENDATION: Increase awareness of extreme storms and their consequences as a significant threat to community health, safety and economic stability particularly among decision-makers.

It is also notable that flooding of critical infrastructure was close to the bottom of the rating scale. Further research is needed to determine if the risk to critical infrastructure in the region is indeed low or if communities are underestimating this storm consequence.

OUTREACH RECOMMENDATION: Promote tools that help local communities assess risks to their critical infrastructure. There are several tools available to help communities determine if the actual risk of damage to critical infrastructure is as low as the perceived impact would suggest.

Data, Tool or Training	# Rating Very Important & Important	% Rating Very Important & Important
Predictions about public health impacts	203	89%
Improved flooding and forecast warnings	201	89%
Improved high winds forecasting	198	89%
Stormwater management trainings and workshops	195	88%
Flood inundation maps	183	84%
Erosion mapping and predictions	164	75%
Improved storm surge forecasting	155	71%
Multi-scale economic assessment of damage to private and public property	191	70%
Local ordinance, zoning, and building code assessment and analysis	150	67%

Figure 4

RESOURCE, KNOWLEDGE AND CAPACITY NEEDS

In an effort to assess the current state of community resources, knowledge and capacity in preparing for and responding to extreme storm events respondents were asked to rate the importance of specific data, tools and trainings. They identified "improved flooding forecast warnings," "improved high winds forecasting" and "predictions about public health impacts" as most important, with 89% of respondents rating these as important or very important in planning for and responding to storm hazards. "Stormwater management trainings and workshops" followed closely with 88% of respondents rating it as important or very important. "Local ordinance, zoning, and building code assessment and analysis" was rated lowest, with 67% of respondents reporting it was important or very important. (Figure 4)

Participants were evenly divided in their familiarity with existing data, tools and training related to storm hazards. Half said they were unfamiliar or very unfamiliar with these resources and half said they were familiar or very familiar.

Participants identified local news, weather sites, NOAA and the Federal Emergency Management Agency (FEMA) as the top resources they consulted for information on extreme storms, flooding and hazard mitigation. (Figure 5)

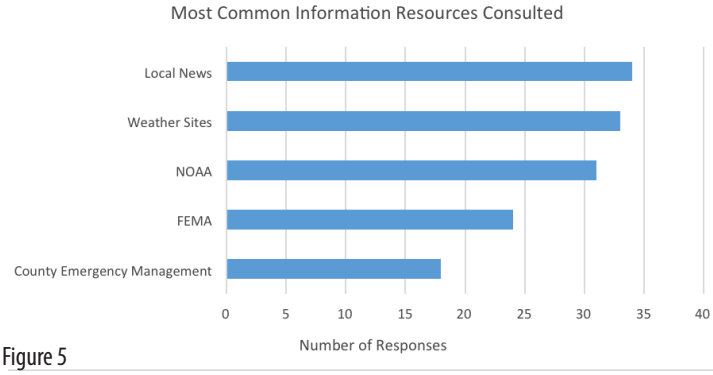


Figure 5

Most of the resources for information on extreme storms, flooding and hazard mitigation that respondents relied on focused on forecasting storm events. Very few consulted long-term resiliency planning resources.

OUTREACH RECOMMENDATION: Host workshops to introduce regional stakeholders to available planning tools related specifically to watershed needs including public health impacts of extreme storms, stormwater management and accurate forecasting for flooding and high winds.

Respondents identified lack of awareness as one of the most significant obstacles to efficiently preparing for and responding to extreme storms, even above lack of technical expertise and available staff. When asked about the most significant barriers to implementing existing plans that prepare for storm hazards in their area, 22% of respondents identified limited budget/lack of funding, 14% said other community issues are more pressing and 12% said storm hazards do not greatly affect the communities where they work. Other major barriers included lack of public support or political will (10%), lack of available staff (9%), lack of technical expertise (8%) and lack of interest from key leaders (8%). (Figure 6)

These results run contrary to existing emergency management plans for counties in the Saginaw Bay watershed. Most county emergency management plans recognize flooding, severe weather and related hazards as priority events. However, none of the emergency management plans reviewed included any reference to predicted future changes in the frequency and intensity of storm events in the region.

Barrier	# Placing in Top Three	% Placing in Top Three
Limited budget/lack of funding	141	22%
Other community issues are more pressing	87	14%
Storm hazards do not greatly affect the communities where I work	76	12%
Lack of public support or political will	61	10%
Lack of available staff	55	9%
Lack of interest from key leaders	50	8%
Lack of technical expertise	49	8%
Lack of accurate or relevant data	28	4%
Plans are too vague	22	3%
There are no barriers to implementing existing plans	21	3%
Existing development of property rights	14	2%
I am not aware of any existing plans that prepare for storm hazards in my area	14	2%
Other	13	2%
High staff turnover in the agencies/organizations/departments responsible for implementation	3	0%

Figure 6

OUTREACH RECOMMENDATION: Develop efforts to increase awareness of extreme storms as a significant hazard in the watershed, particularly amongst leadership and provide accurate information about projected future changes in the frequency and intensity of storm events.

Organized regional resiliency planning also appears to be limited, 46% of respondents were aware of their community engaging in regional efforts to address storm hazards. When asked to cite examples of regional resiliency planning most responses were very general. The most commonly cited examples of regional resiliency collaboration included inter-county cooperation, emergency management efforts, hazard mitigation plans, coordination between drain commissioners and homeland security regional planning.

In developing future partnerships to plan for and respond to storm hazards respondents were most interested in working with local government (29%) and state government (20%). Following that respondents said they would like to partner with business owners (8%), agricultural producers (8%) and homeowners (8%). The least popular partnership entities included federal government (2%), academic institutions (2%) and tribal government (1%). (Figure 7)

Photo: David Sommers

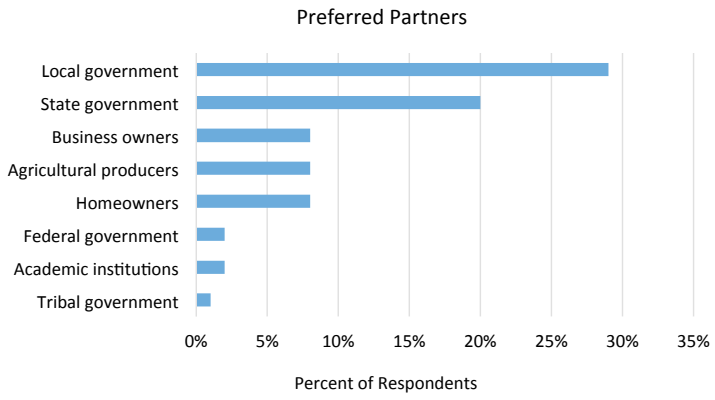


Figure 7

Pollution Prevention Strategy	# Already Implemented	% Already Implemented
Use of stormwater detention projects, buffer strips, and porous pavement to reduce erosion and runoff	109	50%
Best management agricultural practices (e.g., soil testing, two stage ditches, cover crops) to reduce erosion and runoff	95	44%
A plan to increase performance of water quality treatment systems	88	41%
A plan to replace and separate combined sewer systems	87	41%
Green infrastructure programs (e.g., rain barrels, rain gardens, bioswales, green roofs, porous pavement)	58	27%
A plan to update and repair failing septic systems	53	25%

Figure 8

SUPPORT FOR EXISTING AND POTENTIAL RISK REDUCTION STRATEGIES

Survey participants were asked about the implementation status and desirability of several different strategies for dealing with extreme storm impacts. These questions were designed to provide a picture of what strategies are already being used on the ground in the watershed and what potential future strategies have community support.

According to respondents the pollution prevention strategies most often used in the watershed currently include "use of stormwater detention projects, buffer strips and porous pavement to reduce erosion and runoff" and "use of best management agricultural practices to reduce erosion and runoff." The strategies identified as not often in place included "green infrastructure programs" and "a plan to update and repair failing septic systems." (Figure 8)

The strategy with the most support for future use was "a plan to update and repair failing septic systems" with 96% of answering respondents indicating they would like to see this strategy in place in the future. This was followed by the "use of stormwater detention projects, buffer strips, and porous pavement to reduce erosion and runoff" and the "use of best management agricultural practices to reduce erosion and runoff." (Figure 9)

OUTREACH RECOMMENDATION: Explore options for helping local communities develop plans to deal with failing and outdated septic systems.

Pollution Prevention Strategy	# Support Future Implementation	% Support Future Implementation
A plan to update and repair failing septic systems	72	96%
Use of stormwater detention projects, buffer strips, and porous pavement to reduce erosion and runoff	58	91%
Best management agricultural practices (e.g., soil testing, two-stage ditches, cover crops) to reduce erosion and runoff	54	90%
Green infrastructure programs (e.g., rain barrels, rain gardens, bioswales, green roofs, porous pavement)	70	85%
A plan to increase performance of water quality treatment systems	38	83%
A plan to replace and separate combined sewer systems	42	81%

Figure 9. The above chart does not include responses from participants who selected "Don't Know" or "Already Implemented" when asked about their support for implementing these strategies in the future. For example 96% support for future implementation indicates 96% of respondents who felt they had enough knowledge about the strategy to answer and had not yet seen the strategy implemented in their community.

Policy Strategy	# Already Implemented	% Already Implemented
Ordinances to prohibit in-fill of wetlands or lowlands	102	48%
Building setback requirements to move structures beyond expected erosion	63	30%
Floodplain restoration (e.g., purchase of land or development rights in floodplain areas, restoration of wetlands and lowlands	52	25%
Increased agriculture setbacks from drainage systems and waterways	36	24%
Ordinances that promote the use of green infrastructure (e.g., rain barrels, rain garden, bioswales, green roofs, permeable/porous pavement)	29	14%

Figure 10

Tittabawassee River Road under water. Photo: Midland County Office of Emergency Management

Photo: David Sommers

When asked about policy strategies addressing storm hazards the strategies most often already implemented included "ordinances to prohibit in-fill of wetlands or lowlands" and "building setback requirements to move structures beyond expected erosion." The strategy identified as least often in place was "ordinances that promote the use of green infrastructure." (Figure 10)

The strategy with the most support for future implementation was "increased agriculture setbacks from drainage systems and waterways" with 86% of answering respondents indicating they would like to see this strategy in place in the future. "Ordinances to prohibit in-fill of wetlands or lowlands" received 79% future support. It is notable that overall policy strategies were less likely to have been implemented and less likely to be supported for future implementation compared to other strategies included in the survey. (Figure 11)

Policy Strategy	Number Support Future Implementation	% Support Future Implementation
Increased agriculture setbacks from drainage systems and waterways	74	86%
Ordinances to prohibit in-fill of wetlands or lowlands	46	79%
Floodplain restoration (e.g., purchase of land or development rights in floodplain areas, restoration of wetlands and lowlands	59	77%
Ordinances that promote the use of green infrastructure (e.g., rain barrels, rain garden, bioswales, green roofs, permeable/porous pavement)	68	76%
Building setback requirements to move structures beyond expected erosion	42	74%

Figure 11. The above chart does not include responses from participants who selected "Don't Know" or "Already Implemented" when asked about their support for implementing these strategies in the future. For example 86% support for future implementation indicates 86% of respondents who felt they had enough knowledge about the strategy to answer and had not yet seen the strategy implemented in their community.

Photo: David Sommers

Green infrastructure strategies received comparatively less support for future implementation. However, they also had a higher than average percentage of respondents selecting "Don't Know" indicating that there could be an opportunity to further educate stakeholders about green infrastructure options and their role in stormwater management.

OUTREACH RECOMMENDATION: Support stormwater management trainings and workshops and incorporate green infrastructure education elements.

Unlike other strategies surveyed, the emergency preparedness strategy most often already in use also received the most support for future implementation. "Use of public service announcements" was both the most commonly implemented strategy and the strategy with the most support for future implementation. "Use of social media in public education and outreach" was just slightly less favored for future implementation than "signage to inform public of hazards." (Figure 12)

Emergency Preparedness Strategy	# Already Implemented	% Already Implemented
Use of public service announcements in radio, television, and print media	147	67%
Use of social media in public education and outreach	116	54%
Signage to inform public of hazards (e.g., dangerous currents beach signage, road signage on vulnerable bridges)	101	48%

Figure 12

Emergency Preparedness Strategy	Number Support Future Implementation	% Support Future Implementation
Use of public service announcements in radio, television, and print media	36	90%
Signage to inform public of hazards (e.g., beach signage about dangerous currents, road signage on vulnerable bridges)	50	86%
Use of social media in public education and outreach	44	85%

Figure 13. The above chart does not include responses from participants who selected "Don't Know" or "Already Implemented" when asked about their support for implementing these strategies in the future. For example 90% support for future implementation indicates 90% of respondents who felt they had enough knowledge about the strategy to answer and had not yet seen the strategy implemented in their community.

Downtown Midland during 1986 flood. Photo: Midland County Office of Emergency Management

NEXT STEPS

The Michigan Sea Grant College Program will work in collaboration with stakeholders and leadership within the Saginaw Bay watershed to begin prioritizing and implementing recommended outreach and education efforts.

For more information about this report or if you are a member of a Saginaw Bay watershed community interested in partnering on resiliency efforts please contact:

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APPENDIX: SURVEY QUESTIONS

Please indicate the county (or counties) in which you work. Check all that apply:

- ❑ Arenac
- ❑ Bay
- ❑ Clare
- ❑ Genesee
- ❑ Gladwin
- ❑ Gratiot
- ❑ Huron
- ❑ Iosco
- ❑ Isabella
- ❑ Lapeer
- ❑ Livingston
- ❑ Mescota
- ❑ Midland
- ❑ Montcalm
- ❑ Oakland
- ❑ Ogemaw
- ❑ Osceola
- ❑ Roscommon
- ❑ Saginaw
- ❑ Sanilac
- ❑ Shiawassee
- ❑ Tuscola
- ❑ I do not work in any of the above counties

Rate how these storm consequences impact the community(ies) you work in:

	Does Not Impact	Impacts Somewhat	Impacts	Impacts Greatly	Don't Know
Erosion of lake shoreline and river banks	❍	❍	❍	❍	❍
Stormwater flooding of critical infastructure (e.g., utilities, fire stations, hospitals, schools)	❍	❍	❍	❍	❍
Stormwater flooding of residential and commercial developments	❍	❍	❍	❍	❍
Destabilization of critical transportation infrastructure (e.g., roads, bridges)	❍	❍	❍	❍	❍
Damage to crops and interference in agricultural production	❍	❍	❍	❍	❍
Drownings or injuries resulting from flooding or dangerous currents	❍	❍	❍	❍	❍
Ice shoves and jams	❍	❍	❍	❍	❍
Overflow of combined sewer and stormwater systems	❍	❍	❍	❍	❍
Overflow of septic systems	❍	❍	❍	❍	❍
Flooding or contamination of wells	❍	❍	❍	❍	❍
Stormwater runoff pollution (e.g., heavy metals, petroleum)	❍	❍	❍	❍	❍
Agriculture runoff pollution (e.g., pesticides, nutrients)	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍

How familiar are you with data, tools, and training in planning for and responding to storm hazards in your area?

- ❍ Very unfamiliar
- ❍ Unfamiliar
- ❍ Familiar
- ❍ Very Familiar

Please list the top resources (websites, printed materials, agencies, etc.) you go to for information on extreme storms, flooding, or hazard mitigation.

Select the top 3 barriers to implementing existing plans that prepare for storm hazards in your area:

- ❑ Storm hazards do not greatly affect the communities where I work
- ❑ Limited budget/lack of funding
- ❑ Lack of technical expertise
- ❑ Other community issues are more pressing
- ❑ Lack of public support or political will
- ❑ Existing development and property rights
- ❑ Lack of available staff
- ❑ Lack of interest from key leaders
- ❑ Lack of accurate or relevant data
- ❑ Plans are too vague
- ❑ High staff turnover in the agencies/organizations/departments responsible for implementation
- ❑ Other _____
- ❑ There are no barriers to implementing existing plans
- ❑ I am not aware of any existing plans that prepare for storm hazards in my area

Does the community(ies) you work with engage in any regional planning (e.g., cross-county) efforts to address storm hazards?

- ❍ Yes, Please list an example _____
- ❍ No, planning is focused at the local scale only
- ❍ Don't know

Select the top three stakeholder groups you would like to partner with in planning for and responding to storm hazards in your area:

- ❑ Local government
- ❑ State government
- ❑ State legislators
- ❑ Federal government
- ❑ Federal legislators
- ❑ Tribal government
- ❑ Business owners
- ❑ Economic development organizations
- ❑ Homeowners
- ❑ Agricultural producers
- ❑ Academic Institutions
- ❑ Environmental and conservation non-governmental organizations
- ❑ Other _____

Rate the importance of these types of data, tools, and training in planning for and responding to storm hazards in your area:

	Very Unimportant	Unimportant	Important	Very Important	Don't Know
Improved flooding forecasts and warnings	❍	❍	❍	❍	❍
Improved storm surge forecasting	❍	❍	❍	❍	❍
Improved high winds forecasting	❍	❍	❍	❍	❍
Erosion mapping and predictions	❍	❍	❍	❍	❍
Flood inundation maps	❍	❍	❍	❍	❍
Predictions about public health impacts (e.g., waterborne illness and beach closings)	❍	❍	❍	❍	❍
Multi-scale economic assessment of damage to private and public property	❍	❍	❍	❍	❍
Local ordinance, zoning, and building code assessment and analysis	❍	❍	❍	❍	❍
Stormwater management trainings and workshops	❍	❍	❍	❍	❍

Please provide additional detail on the following pollution prevention strategies in your area.

	Has this strategy been implemented in your area?			If this strategy has not been implemented in your area, would you like to see it in place?			
	Yes	No	Don't Know	Strategy already implemented	Yes	No	Don't know
Use of stormwater detention projects, buffer strips, and porous pavement to reduce erosion and runoff	❍	❍	❍	❍	❍	❍	❍
Use of best management agricultural practices (e.g., soil testing, two stage ditches, cover crops) to reduce erosion and runoff	❍	❍	❍	❍	❍	❍	❍
A plan to replace and separate combined sewer systems	❍	❍	❍	❍	❍	❍	❍
A plan to update and repair failing septic systems	❍	❍	❍	❍	❍	❍	❍
A plan to increase performance of water quality treatment systems	❍	❍	❍	❍	❍	❍	❍
Green infrastructure programs (e.g., rain barrels, rain gardens, bioswales, green roofs, porous pavement)	❍	❍	❍	❍	❍	❍	❍

Please provide additional detail on the following emergency preparedness strategies in your area.

	Has this strategy been implemented in your area?			If this strategy has not been implemented in your area, would you like to see it in place?			
	Yes	No	Don't Know	Strategy already implemented	Yes	No	Don't Know
Use of social media networks in public education and outreach	❍	❍	❍	❍	❍	❍	❍
Use of public service announcements in radio, television, and print media	❍	❍	❍	❍	❍	❍	❍
Signage to inform public of hazards (e.g., beach signage about dangerous currents, road signage on vulnerable bridges)	❍	❍	❍	❍	❍	❍	❍

Please provide additional detail on the following policy strategies addressing storm hazards in your area.

	Has this strategy been implemented in your area?			If this strategy has not been implemented in your area, would you like to see it in place?			
	Yes	No	Don't Know	Strategy already implemented	Yes	No	Don't know
Building setback requirements to move structures back beyond expected erosion	❍	❍	❍	❍	❍	❍	❍
Ordinances that promote the use of green infrastructure (e.g., rain barrels, rain gardens, bioswales, green roofs, permeable/porous pavement)	❍	❍	❍	❍	❍	❍	❍
Ordinances to prohibit in-fill of wetlands or lowlands	❍	❍	❍	❍	❍	❍	❍
Increased agriculture setbacks from drainage systems and waterways	❍	❍	❍	❍	❍	❍	❍
Floodplain restoration (e.g., purchase of land or development rights in floodplain areas, restoration of wetlands and lowlands)	❍	❍	❍	❍	❍	❍	❍

Please indicate the governmental/organizational sector in which you work:

- ❍ Municipal/City/Village/Township
- ❍ State Government
- ❍ County Government
- ❍ Regional District or Association
- ❍ Non-Governmental Organization
- ❍ Private Industry
- ❍ Tribal Nation
- ❍ Other _____

Please indicate what type of position you hold in your organization:

- ❍ Planner
- ❍ Environmental Specialist
- ❍ Road Commissioner
- ❍ Drain Commissioner
- ❍ Harbor, Parks, or Beach Manager
- ❍ Community Development Coordinator
- ❍ Flood District Manager
- ❍ Emergency Services Manager
- ❍ Public Health Official
- ❍ Building Official
- ❍ Utility Provider
- ❍ Fire/Police
- ❍ Other _____

Additional comments or survey feedback: