Climate Resilient Communities

Improving stormwater management in the Huron River watershed

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Creating Climate Resilient Communities

The familiar patterns of rainfall, snow, and our four seasons are becoming less recognizable.

County officials, public works directors, municipal planners, and natural areas managers in the Huron River watershed are noticing how the increase of extreme temperature and precipitation events is challenging how they do business and assess risk. Many feel ill-equipped to respond to this "weirdness" that results in overtaxed infrastructure, changes to natural systems, public health risks and costs to already-stressed community budgets.

In response, the Huron River Watershed Council (HRWC) is bringing together community partners up and down the river to examine the topic of a changing climate and how communities in the watershed, and Michigan, can maintain quality of life under projected scenarios.

Creating Climate-Resilient Communities is an effort to address local climate change impacts by building resiliency in the watershed. Over the course of a year, HRWC convened interested stakeholders to determine information needs and climate adaptation strategies. An opening plenary session in December 2011 was held to share current climate science and identify project participants. Participants then attended a series of working group sessions to develop and begin implementation of priority climate adaptation strategies. Three working groups were established for key sectors. These sectors are particularly likely to be impacted by climate change, and also able to reduce risks created by these changes.

WATER INFRASTRUCTURE

for practitioners involved with water utilities, wastewater treatment facilities, stormwater management

IN-STREAM FLOWS

for dam operators, fisheries biologists, and hydrologists

NATURAL INFRASTRUCTURE

for land managers involved with natural areas preservation, restoration, and management

HRWC partnered with the Great Lakes Integrated Sciences and Assessments Center (GLISA)—a collaboration of the University of Michigan and Michigan State University whose goals are to contribute to the long-term sustainability of the region in the face of a changing climate, and facilitate smart decision-making backed by scientific knowledge. GLISA provided data and technical expertise on climate change to the project. Over the course of a year, HRWC, GLISA and project participants reviewed various climate scenarios, discussed best practices and case studies on adaptation strategies and gained commitments for action. The project contributes to the creation of "climate-resilient communities" that know how to reduce their vulnerability and risk associated with current and forecasted conditions.

In this report we detail the outcomes of the Water Infrastructure Workgroup.

1 Climate adaptation is any action that leads to a reduction in harm or risk of harm, or realization of benefits, associated with climate variability and climate change.

Climate Change in the Huron River Watershed

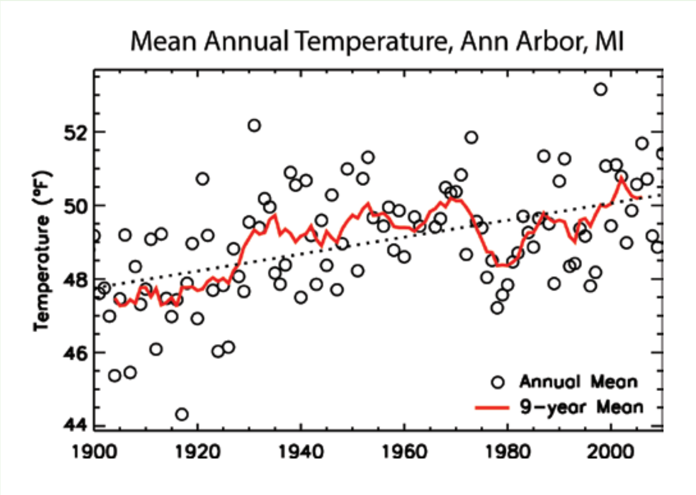
Climate influences daily, seasonal, annual and longer-term weather patterns. History serves as a benchmark for what to expect and what to plan for. In a changing climate, history no longer reliably indicates what is possible or likely. Changes in temperature, precipitation and everything these factors influence are creating a new normal for communities, with implications for planning, development and emergency preparedness.

The Huron River and its watershed, is already experiencing the effects of climate change in the form of more intense and frequent storms, rising temperature and changing precipitation patterns. Winters have shortened, and snow and ice cover have declined. These trends are predicted to continue. These physical changes, among others, will exacerbate existing environmental concerns in Southeast Michigan. Of particular interest in the Huron River watershed are the changing form, frequency and intensity of precipitation events that could drive changes in the distribution and quality of water resources.

The following summary is based on data analyzed by GLISA. The source of the data is the National Climatic Data Center (NCDC) GHCN Daily dataset. GLISA provided the most localized assessment of current and future climate trends that can be made given the availability and quality of source data, reliability and resolution of model projections and appropriateness of scale for a particular climatic variable. Given these limitations, they present results at three geographic scales. Results may be presented for Ann Arbor (as a representative location in the Huron River watershed with good data availability), for the local climatic zone (10 county region in Southeast Michigan), or for the entire Great Lakes region.

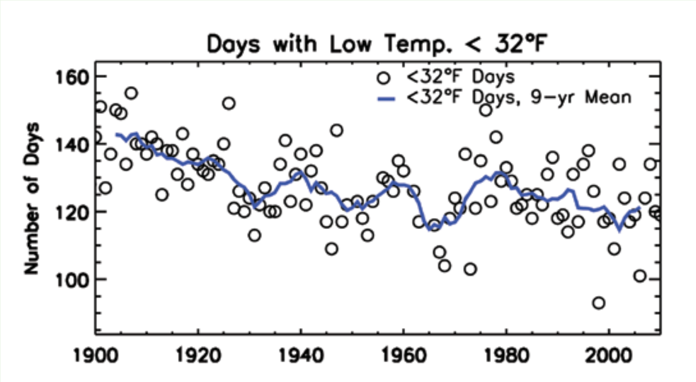
Temperature

Increased air temperatures have already been observed in the region. Between 1968 and 2002 the average annual air temperature in the lower Great Lakes basin increased by 2.3°F (1.3°C) (Dobiesz and Lester, 2009). Ann Arbor has seen only a modest increase in annual temperature since the 1951-1980 period. The greatest warming has occurred in winter, where the average temperature for 1981-2010 was 1.0°F higher than the average for 1951-1980.



Mean annual temperatures from 1900 to 2010 for Ann Arbor, MI. The solid line represents the 9-year running mean. The dotted line is the linear trend over the period of record.

Throughout the Great Lakes region, winters have typically become shorter as well. Compared to start of the 20th century, the frost-free seasons today are about one week longer, primarily due to earlier dates for the last spring freeze. In Ann Arbor, there are about 3 fewer days per year seeing freezing temperatures when compared to the 1951-1980 average. This trend is consistent with other stations throughout the region. By 2100, the frost-free season is projected to be 4-8 weeks longer (Wuebbles and Hayhoe, 2004).



Open circles represent the number of days per year in which the daily low temperature dropped below 32°F. The solid line is the 9-year running mean.

Temperatures will continue to increase over most of the Great Lakes region, but projections vary widely on how much. Recent projections suggest that average annual air temperatures in the region will increase by 1.8°F to 5.4°F (1 to 3°C) by 2050 (Hayhoe et al., 2010; Lofgren et al., 2002). Estimates for 2100 range between increases of 3.6 and 11°F (2 and 6.2°C) (Hayhoe et al., 2010; Scheller and Mladenoff, 2005; Wuebbles and Hayhoe, 2004).

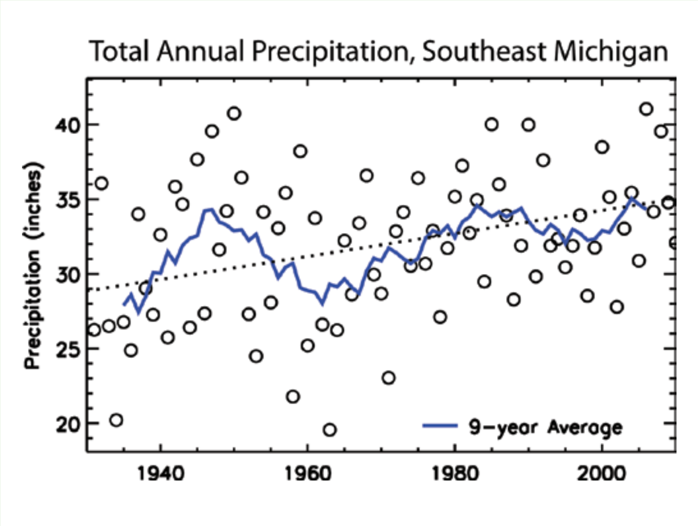
Increases in temperature will not be evenly distributed, however. Nighttime temperatures may warm more than daytime temperatures, and winters will probably warm more than summers during the early 21st century. Later in the century, summer and spring temperatures may rise more than temperatures in the winter and fall.

As average temperatures rise, so will daily maximum temperatures, increasing the probability of more frequent summer heat waves. The number of days that exceed 90°F (32°C) could increase from 15 per year (in 2010) to between 36 and 72 days per year, and events as intense as the 1995 Chicago heat wave are projected to occur as frequently as once every two years to three times in a single year (Vavrus and Van Dorn, 2010; Hayhoe et al., 2010).

Precipitation

The frequency, form, and intensity of precipitation falling in the Great Lakes region will continue to change, but model projections vary on exactly how precipitation will change and on what areas will experience the largest changes. Most researchers expect the amount of precipitation in the Midwest to increase overall. Others expect that the amount of total annual precipitation will remain relatively stable as the seasonal distribution of the precipitation changes. Most models project an increase in winter precipitation of up to 20-30 percent, with potential increases in the autumn and spring as well (Hayhoe et al., 2010).

So far, total annual precipitation has increased in Ann Arbor and southeastern Michigan, mostly due to increases in winter and fall totals. From the 1951-1980 period to the 1981-2010 period, annual precipitation increased by 11% in southeastern Michigan. Ann Arbor saw a more dramatic increase of 25% over the same time period, but local factors may have played a role.



Annual precipitation totals for southeastern Michigan (Climatic Division 10) for 1931 to 2010. An open circle represents the total precipitation for a single year. The solid line represents the 9-year running mean. The dotted line is the linear trend over the period of record.

Snow cover in the Great Lakes region has already experienced one of the most dramatic declines in North America. Since the mid-1970s, the number of days that had snow on the ground decreased at a rate of five days per decade, and the average snow depth across the region dropped by 2 inches (Stewart et al., 2007). As spring temperatures warm, the snowfall season will become shorter and lake-effect rainstorms may replace some lake-effect snowstorms.

The frequency and intensity of extreme storm events has been increasing in this region, and this trend will likely continue as the effects of climate change become more pronounced. Over the Midwest as a whole, the number of 24 hour, once-in-5-year storms was found to have increased by about 4% per decade since the beginning of the 20th century (Changnon, 2009a; Changnon, 2011; Changnon and Westcott, 2002; Hejazi, 2009; Wilson and Sousounis, 2000; Vavrus and Van Dorn, 2010).

The Great Lakes region could experience more frequent droughts despite increases in total annual precipitation. As more precipitation is delivered disproportionately in more intense events, the probability for dry periods may also increase. The region may also become drier overall due to increasing temperatures, increased evaporation, and reduced soil moisture (Frelich et al., 2009; Hayhoe, 2007; Hayhoe and Weubbles, 2008; Karl et al., 2009; Wuebbles, 2006). Droughts and dry periods would be felt most strongly in summer, when groundwater recharge is reduced and there are more low-flow periods (Hayhoe, 2007; Karl et al., 2009).

Great Lakes

The Great Lakes dominate the climate of the region. Changes to the Great Lakes have implications for the weather experienced locally. An increase in lake temperatures and decrease in ice cover are already measureable on the Great Lakes. Lake levels have also continued to decline in recent years, but it is unclear that the observed lake level drops are solely the result of climate change. Taken together, these changes have the potential to impact regional climate patterns and the water cycle responsible for maintaining the natural systems of the area.

Water Resources

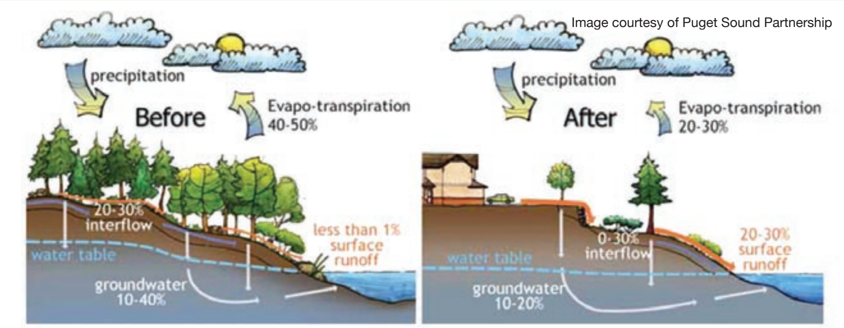
Climate change will influence the water resources in the Great Lakes region. The region is expected to experience more extremes in precipitation patterns with wet periods getting wetter and dry periods drier. The timing and duration of these wet and dry periods is also expected to change impacting the hydrologic cycle and the availability of water resources.

Warming winter temperatures shorten the freeze period, reduce snow cover and replace some snowfall with rain. Between 1920 and 1995, input into Lakes Michigan and Huron has shifted to autumn and winter, resulting in less runoff and lake-level rise in the spring. A similar shift in timing can be expected in SE Michigan. Warmer winter temperatures are also expected to lead to earlier peak flows, increased runoff in fall and winter and decreased runoff in the spring. Runoff will likely become more variable, decreasing during dry periods and increasing during spells of more intense precipitation.

While total annual precipitation will likely increase, dry periods may last longer, reducing soil moisture and available surface waters. These effects would be felt most strongly during the summer, when groundwater recharge is expected to decrease most severely and droughts are most probable. As severe precipitation events become more intense, summer streamflows are expected to increase in flashiness and variability.

Climate Impacts to Water Infrastructure

The observed changes in the seasonality, form, frequency, and intensity of precipitation are expected to continue in the near future. Stronger, more frequent storms will amplify existing stormwater management challenges, potentially increasing the risk of flooding, damage to infrastructure, and water contamination. Prolonged dry periods reduce water quantity impacting hydropower production, location and depth of groundwater wells, and availability of surface water supplies.



Before development, almost all rainfall is taken up by plants, evaporates or infiltrates through the ground. After conventional development, surface runoff increases significantly while evaporation and infiltration into the ground decrease.

Stormwater Management

A higher frequency of severe precipitation events will increase the risk of flooding and erosion, damaging infrastructure, interfering with transportation, and causing economic disruption. Much of the current stormwater infrastructure is approaching or past its life expectancy and was designed to accommodate storms under the old climate regime. When coupled with more severe storms, this aging infrastructure, the use of impervious surfaces and inappropriate land use practices amplifies flooding risks by diverting stormwater into concentrated flows.

A number of stormwater management practices could help reduce these impacts by diverting flows away from vulnerable areas and into treatment facilities. Urban forests and "green" spaces can reduce both concentrated flows and erosion by infiltrating rain water deeper into the soil. Ann Arbor has implemented large, subsurface detention and infiltration tanks in some areas, and in other areas the city has provided incentives for private entities to install smaller, inexpensive stormwater detention systems and to use pervious surfaces. Broader planning for implementation of these "green infrastructure" practices in areas where they will be most effective could significantly reduce stormwater runoff impacts.

Equipping decision makers with precipitation and streamflow information is essential to identifying vulnerabilities in water infrastructure. More robust monitoring of waterways, soil moisture, and precipitation would help planners understand the current climate of their jurisdiction. Updated climate projections should be included in assessments of flood risk to help guide future infrastructure strategies.

Water Quality

Flooding can increase erosion and overload sewage systems, reducing water quality in lakes and rivers and increasing the risk of waterborne disease. Increased erosion adds sediments and pollutants to surface waters. Wetlands are known for their ability to filter sediment and contaminants from water, but are predicted to decline in area due to rising temperatures and evaporation rates and declining stream levels.

In lakes, warmer waters and more stratification can mobilize bottom-sediment nutrients like phosphorus and lead to increased algae growth.

Future land use changes are likely to have a far greater impact on water quality than climate change, but changes in temperature and precipitation can amplify the effects of land use. For example, the construction of impervious surfaces (such as pavement and roads) can increase runoff from more intense rainstorms. Increased runoff from urban and agricultural lands is a major source of pollution and excess nutrients in surface and ground waters.

Water Supply and Availability

Climate change will have an impact on water supplies throughout the region. Particularly during the summer months, longer dry periods, warmer temperatures and greater evaporation rates could lead to reduced soil moisture, surface water, and groundwater supplies. In some cases, the changing seasonal distribution of water resources is likely to exacerbate conflicts over the management of lakes and waterways. Mandated lake levels that were suitable for sustaining both recreation and natural aquatic environments under past climate conditions may be inadequate in the future. Restricting flows to preserve lake depths in some areas may further stress wetland areas that are at the same time experiencing greater evaporation. Holding lake levels during drought conditions will also stress river systems due to lowered baseflows or in some cases, dry river beds. New compromises between human use and wetland and riverine protection may need to be found to address these tensions.

Many communities of the Huron River watershed get their drinking water from surface and groundwater sources within the watershed. While the area is blessed with significant water resources, periods of extended drought and private land owners. Increased demand during low rainfall periods along with declining water quality taxes water treatment facilities.

Stormwater Management in a Changing Climate

Water infrastructure sectors include drinking water, wastewater treatment, and stormwater management. Each of these industries will be impacted as climate change alters water quantity and quality. A climate ready community will implement strategies to mitigate impacts on each of these. For the purposes of this project, the workgroup was tasked with addressing a small number of priority issues in order to initiate a process for developing adaptation strategies across sectors. The team chose to focus on stormwater management.

Paradigms governing stormwater management in the watershed need to shift if the sector is to possess the agility necessary to employ innovative practices and adapt to changes in climate. Currently, stormwater is most often addressed at the pipe rather than where it falls. Additionally, planning and infrastructure decision are made based on historical context and out-of-date data, rather than using the most current data and anticipated future conditions. As a result watershed communities are vulnerable to larger, more frequent storm events risking increased flooding as system capacity is taxed and aging infrastructure fails. These risks are exacerbated by increased development in the watershed with increased impervious surface, all designed to manage smaller storms than are expected currently and in the future.

Acknowledging that there is uncertainty as to how the climate will change and at what rate, the team developed strategies that are built upon three principles which ensure that their recommended actions make sense under any scenario:

- **Triage:** Avoiding efforts that are unlikely to succeed and concentrating on areas where improved management can have the biggest impact;
- **Precautionary principle:** Not waiting for certainty to act where the consequences of potential impacts are high; and
- **No regrets:** Focusing on actions that provide benefits regardless of how the climate changes (Wisconsin Initiative on Climate Change Impacts, 2011).

The Water Infrastructure group put forward two initial recommendations to improve the resilience of this sector to climate change:

1) Improve accuracy of rainfall frequency curves adopted by the State and local governments, which are used as the basis of stormwater-related decisions; and

2) Implement a series of high priority "no-regrets" actions to improve the practice or stormwater management in the watershed.

Recommendations are intended to be implemented throughout the watershed by appropriate entities which may include state, county, township, city and/or village staff and officials that establish policies and regulations pertaining to stormwater, development and emergency management. What follows is a description of each recommendation.

Rainfall Frequency History and Recommendations

Many of the stormwater professionals in the Huron River Watershed are concerned that with climate change the storm size definitions should be getting larger. The storm size definitions currently used to make stormwater-related decisions are based on outdated data and have been generalized too broadly to reflect what is experienced in this watershed. Rainfall frequency curves are used to determine pipe sizing, detention and retention standards and other regulations governing development. Updating these curves so that they reflect current climatic conditions will ensure the most appropriate design standards and infrastructure are in place. Considering future trends in rainfall would go a step further to make our communities climate-resilient.

Within Michigan all floodplain maps and analyses are based on table 3.1 in the Michigan Department of Environmental Quality's (MDEQ) Computing Flood Discharges for Small Ungaged Watersheds (Sorrell 2010). The Federal Emergency Management Agency's (FEMA) regulations do not allow for consideration of future events, such as Master Plan land use conditions or future trends in precipitation. The precipitation data on which the table is based do not include the most recent 30-year period. Most communities utilize that table for their stormwater management regulations and storm drain sizing. So, local infrastructure planning is based on this information.

The rainfall depths included in "Computing Flood Discharges..." were originally published by the NOAA National Weather Service Midwest Climate Center (Huff and Angel, 1992). This report, commonly known as "Bulletin 71" (http://www.isws.illinois.edu/pubdoc/B/ISWSB-71.pdf), presents rainfall by "zones" within the state. Michigan's Zone 10 encompasses Southeast Michigan, from Monroe and Lenawee Counties northward to Genesee, Lapeer, and St. Clair Counties. The 1% annual chance, 24-hour rainfall depth for Zone 10 is 4.36 inches.

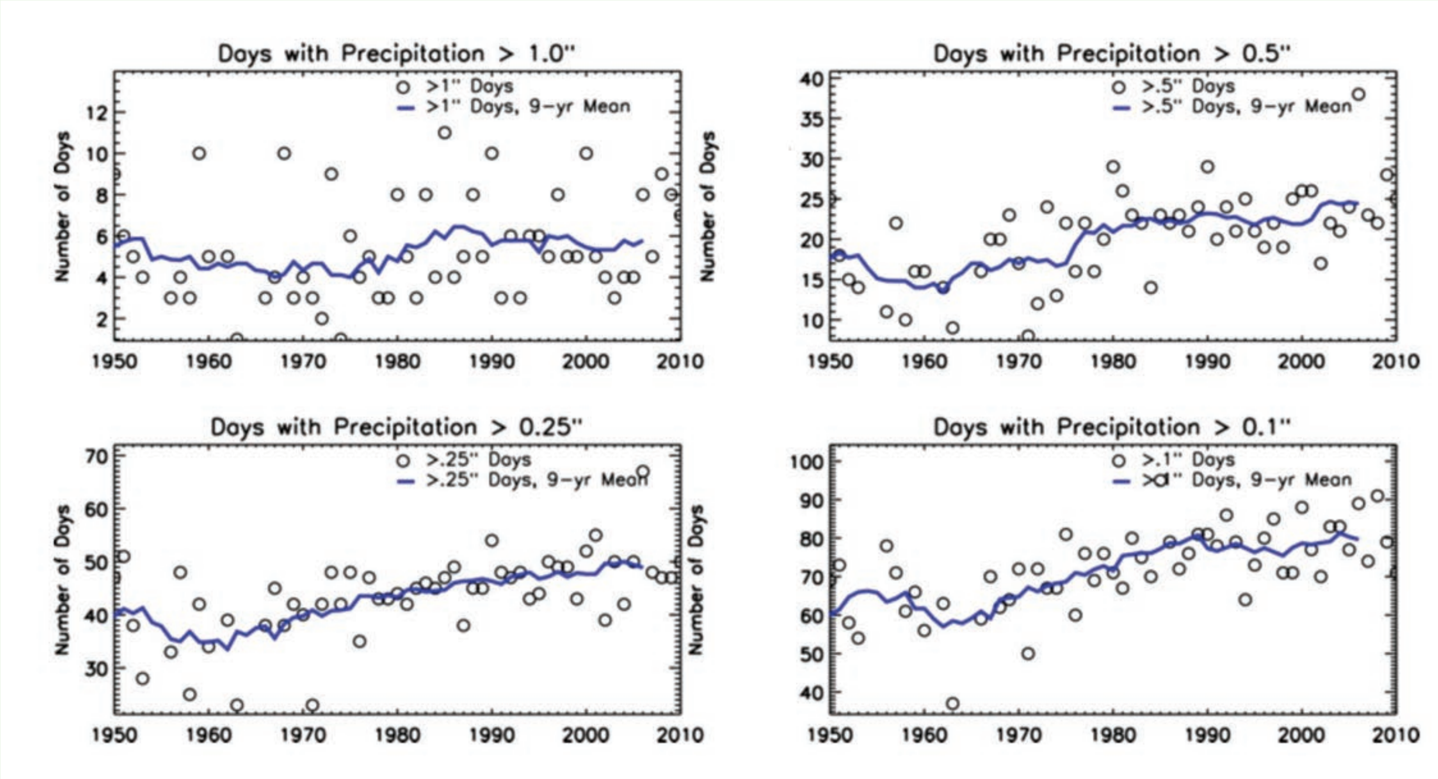
Further examination of the spatial distribution maps in Bulletin 71 shows that most of the watershed falls between the 4.5 and 5-inch boundaries for the 1% annual chance (labeled 100-year) 24-hour event. However, since multiple counties were lumped together in Zone 10, an average value for storm depth of 4.36" was assigned. This means counties of the watershed have been assigned a regionally generalized rainfall depth for this frequency of event between 0.14" and 0.64" (3 to 13%) below the actual storm depth. In other words, decisions are being made based on a rainfall value for a 100-year event that is less than data actually predicts for the counties of the Huron River watershed.

Design rainfalls currently used for stormwater management were derived from Bulletin 71 which computed frequencies from rainfall data up to 1986. Precipitation data from Global Historical Climatology Network observing stations in Southeastern Michigan indicate that the frequency and severity of storms have increased in recent years. For both

Zone	Annual probability storm depth, 24-hour duration (rainfall in inches)					
	50%	20%	10%	4%	2%	1%
1	2.39	3.00	3.48	4.17	4.73	5.32
2	2.09	2.71	3.19	3.87	4.44	5.03
3	2.09	2.70	3.21	3.89	4.47	5.08
4	2.11	2.62	3.04	3.60	4.06	4.53
5	2.28	3.00	3.60	4.48	5.24	6.07
6	2.27	2.85	3.34	4.15	4.84	5.62
7	2.14	2.65	3.05	3.56	3.97	4.40
8	2.37	3.00	3.52	4.45	5.27	6.15
9	2.42	2.98	3.43	4.09	4.63	5.20
10	2.26	2.75	3.13	3.60	3.98	4.36

Rainfall depths corresponding to climatic zones from Michigan Department of Environmental Quality's Computing Flood Discharges for Small Ungaged Watersheds (Sorrell 2010). The Huron River watershed is in zone 10.

Spatial Distribution Map of the 100-yr, 24 hr event from Bulletin 71. Counties of the Huron River watershed are highlighted.



Number of days per year from 1950 through 2010 that exceeded the indicated total daily precipitation thresholds for Ann Arbor, MI. Open circles are the number of days exceeding the threshold for individual years. The solid blue line represents the 9-year running mean.

Ann Arbor and Adrian, Michigan, the number of days per year exceeding moderate to high precipitation thresholds (> 0.25 to > 1.0 inches) has increased gradually over the past 30 years. The total annual precipitation for both observing stations has also increased dramatically since the 1951-1980 period. Rainfall analyses that do not include the most recent 30 years of record do not represent current precipitation conditions and associated flood risks.

Local infrastructure decisions are being made based on data that are both out-of-date and averaged across a large area. The standard sources for expected precipitation need to be updated to reflect the best available data. Moreover, data should not be averaged across areas with distinctly different rainfall characteristics. These two improvements will allow communities to make well informed decisions about additions and changes to current stormwater infrastructure. Predicted changes to the future climate in the Huron River watershed only add to this need.

The Hydrometeorological Design Services Center (or HDSC) of NOAA's National Weather Service is in the process of updating the nation's "precipitation frequency", or "PF", data. The new publication is called "NOAA Atlas 14", and consists of multiple volumes covering different regions of the U.S.

The volume covering Michigan is in progress with a current completion date projected for Spring 2013. Once NOAA Atlas 14 is available for Michigan, the MDEQ will review the data and, most likely, begin using the new rainfall depth values.

It is the recommendation of this group to:

1) Be involved in the peer review of NOAA's Atlas 14 conducted by Hydrometeorological Design Services Center in 2012-2013. Verify that the new storm frequencies take into account accurate data from the most recent 30 years.

2) If counties are aggregated into broad zones again, consider recommending that individual counties look further into the data and have Drain/Water Resources Commissioners adopt frequencies that are appropriate for their counties (e.g. Washtenaw County should currently be 3 to 13% higher for the 1% annual chance event).

3) Since the storm frequencies published by NOAA only take into account the past and we are planning infrastructure for the future, consider locally adopting storm frequencies that take into account the expected changes due to climate change or build in a "margin of safety."

In November 2012, this group convened experts and provided peer review during the public comment period for NOAA's Atlas 14 revision of precipitation frequency data, Volume 8 which includes Michigan (http://hdsc.nws.noaa.gov/hdsc/pfds/). NOAA will publish the final report and data in 2013. Additionally, and dependant on the final storm frequencies published by NOAA, this group will make recommendations to state and local governments on how to enhance federal products with localized and forward looking information.

Priority No-regrets Actions

No-regrets actions are those that provide benefit under both current climate conditions and potential future climate conditions. No-regrets options increase resilience to the potential impacts of climate change while yielding other, more immediate economic, environmental, or social benefits (Heltberg et al, 2008). The no-regrets approach is considered "proactive adaptive management" which is based on the development of a new generation of risk-based design standards that take into account climate uncertainties. There are a wide variety of no-regrets actions that improve the adaptive capacity of the watershed to handle stormwater. The group conducted a thorough review of no-regrets actions for stormwater management. The team then identified high priority actions for the communities of the Huron River watershed. What follows is a list of the highest priority actions and a brief description of each.

Green Infrastructure and design standards. Green infrastructure is an approach to stormwater management that uses aspects of natural systems (such as soil and vegetation) to allow for infiltration of precipitation where it falls. More traditional grey infrastructure solutions aim to convey water away from where it falls, via drains and pipes, quickly and deliver that precipitation directly to receiving waters. The Green Infrastructure approach systematically uses a network of infiltration practices or Low Impact Development (LID) to capture and store a portion of the precipitation in the ground water, plant tissue, or surface water features before it enters conveyance pipes. Green infrastructure is becoming increasingly common and valued as a best practice in stormwater management. Examples of practices that can be part of a green infrastructure menu of LID practices are: bio-retention areas (rain gardens), green roofs, vegetated swales (depressions to capture water) and the use of vegetation or pervious materials instead of hard, impervious surfaces. Additionally, protection of forests, wetlands and other natural areas is a strong first defense against stormwater runoff reducing the need for engineered solutions.

Throughout the watershed, stormwater infrastructure is aging. These systems are more vulnerable to failures that can result in significant and damaging floods. Current systems may also lack the capacity to support the type of severe rain events that are becoming more common in the area. As communities consider how to upgrade stormwater systems, green infrastructure provides an intelligent, complimentary set of alternatives that improve the capacity of stormwater systems to deal with rainfall, prolong the life of hard engineering solutions, reduce cost of upsizing or replacing existing infrastructure, and protect our water resources from pollution and habitat degradation.

Green infrastructure can complement grey infrastructure systems in multiple ways. Green infrastructure can:

- significantly reduce expenses associated with replacing aging infrastructure,
- prolong the life of current system by removing some of the burden on pipes and drains,
- reduce runoff and stormwater flows that may otherwise exceed system capacity,
- slow overland and stream flow velocities and reduce erosion,
- lessen impacts of stormwater on receiving waters by reducing rapid peaking in discharge, filtering out pollutants and sediment, and
- mitigate the impacts of extreme events which are predicted to be more common as climate changes.

Several communities in the Huron River watershed are already implementing or planning for the use of green infrastructure. Ann Arbor's Environmental Commission is developing recommendations to make green infrastructure the city's default stormwater management practice. They are establishing new technical standards to help engineers implement infiltration practices. They are drafting a "Green Streets" policy to require the inclusion of green infrastructure designs during road reconstruction. The Village of Dexter compiled an inventory of stormwater assets and is conducting a needs assessment to determine the best comprehensive strategy for managing stormwater using conventional and green infrastructure. As part of this analysis, Dexter is also assessing the cost of needed investment and considering their options for financing the system over the long term. Ann Arbor Township instituted a stormwater ordinance that requires increasing amounts of green infrastructure in developments that exceed impervious cover limits. Finally, Pittsfield Township included "Green Pittsfield" recommendations in a recent revision of their Master Plan.

Existing resources can help communities starting thinking about and planning for stormwater solutions that incorporate green infrastructure. Here are a few recommendations:

Examples of coalitions in Michigan planning across jurisdictional boundaries to complete landscape-scale green infrastructure plans.

- Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers. SEMCOG 2008
- Washtenaw County Low Impact Development Fact Sheets http://www.ewashtenaw.org/government/drain_commissioner/dc_webPermits_DesignStandards/dc_lid
- The Green Infrastructure website developed by the U.S. Environmental Protection Agency: http://water.epa.gov/infrastructure/greeninfrastructure/
- Economic Benefits of Green Infrastructure: Great Lakes Region. ECONorthwest 2011.

Community planning and regional collaborations. Local governments are responsible for land use and development planning. Each municipality has its own set of plans guiding land use, public health, transportation and stormwater. Most planning frameworks have not yet incorporated climate change as a factor influencing decisions. These plans determine how a community will develop over time. The Huron River watershed is already experiencing measurable changes in the timing and severity of precipitation. It is increasingly important for communities to work together to find efficient and effective solutions for stormwater management and responses to these changes.

Water resource issues often transcend political boundaries. For aspects of municipal management influenced by factors outside of their boundaries, regional collaboration and coordinated planning efforts provide a vast improvement over the more traditional approach. Stormwater is such an issue. Watershed boundaries, not municipal ones, govern water movement. The Huron River watershed encompasses over 60 municipalities. Even smaller sub-basins often encompass two or more municipalities. Broad, multi-jurisdictional planning is the key to successful Green Infrastructure implementation.

Several improvements to current planning practices could improve the readiness of the communities of the Huron to manage stormwater in a changing climate.

1. Working across political boundaries helps groups arrive at solutions that work for all the communities involved. The participatory process generates the buy-in necessary to implement improvements to standards and practices throughout the watershed where the greatest gains in stormwater management can be made.
2. Changes to land use, stormwater practices and infrastructure in adjacent or upstream communities can have positive and negative effects on downstream communities. Coordinating across boundaries helps collective action add up to significant gains in our ability to manage stormwater and mitigate the negative impacts of system failures.
3. A coordinated plan of action over a broad area may enhance opportunities for funding or influence state-level policies and regulations that constrain options for local governments to better manage stormwater.
4. Broad planning provides greater opportunity to utilize land features (such as slopes and soils) that are more conducive to infiltration and treatment.

Efforts are underway that are working outside the constraints of typical planning approaches. The Middle Huron Stormwater Advisory Group (SAG), Livingston Watershed Advisory Group (WAG) and the Alliance of Downriver Watersheds (ADW) are associations of municipal representatives working together to address stormwater management collectively. Each group has the structure in place to collectively plan and implement broad projects to address stormwater impacts from changing climate scenarios. Several other similar associations exist across Michigan that could provide the networking to establish comprehensive Green Infrastructure planning. Municipalities in Ohio are working through sewer districts to plan and fund gray and green infrastructure projects across broader areas.

For two examples of communities in Michigan who are working together to develop green infrastructure visions see The Greening Mid-Michigan Project (www.greenmidmichigan.org) and the West Michigan Strategic Alliance (http://www.wm-alliance.org).

Education on flooding and mitigation. Climate projections for this area indicate flooding will be more common and more severe in the future. At the same time, citizens typically expect complete protection from any and all flooding. Flooding is a natural process that can be managed for public safety and property protection. However, not all flooding can or should be stopped. This 'no flooding' expectation is unrealistic, expensive, and also comes at a cost to riverine ecosystems. There are additional options that achieve a more realistic response to flood events. Educating community members, planners and developers on these options can help municipalities arrive at flood mitigation solutions that keep people and property safe, keep costs down, and allow low lying areas to hold water when necessary.

Education efforts should result in the understanding that:

1. Some flooding is to be expected
2. Development in floodplains should be compatible with occasional flooding
3. Natural floodplains play an important role in mitigating the impacts of large storm events
4. There are options to support individuals or businesses that would like to relocate out of floodplains.

Stormwater and flooding education is clearly a "no regrets action" because flood events are predicted to increase in frequency and severity, most communities currently lack appropriate ordinances to limit floodplain development and any actions taken to improve resilience to severe storms and the resultant flooding requires the support of the community.

Ann Arbor Township adopted a Natural Features Setback ordinance in 2009 (7-2009) that effectively keeps development out of the floodplain and away from other natural features that provide environmental and public safety benefits.

Several resources that are useful when considering education and support pertaining to flooding and floodplain management include:

- FEMA's Pre-Disaster Mitigation Grant Program and Hazard Mitigation Grant Program provide support to floodplain property owners at www.fema.gov
- Riparian Corridor Protection in the Huron River Watershed is a comprehensive guide on floodplains of the Huron and provides sample buffer ordinance language at www.hrwc.org.

Inventory of current infrastructure. Stormwater infrastructure is reaching or exceeding its useful life throughout the nation. Cities are challenged by aging infrastructure and the costs associated with repair and replacement. Before a solid plan for improving stormwater management can be devised, municipalities need to know the status of existing infrastructure assets. Considering that much of this infrastructure is underground and was installed at different times under the management of changing staff, this is a challenging task for most communities.

This is the case for municipalities throughout the Huron River watershed. Too many municipalities in the watershed do not have an accurate inventory of stormwater infrastructure assets, their age and status. Only one has assessed the cost of needed repair and maintenance and developed a comprehensive and sustainable system for financing it. System failures are increasing in number and magnitude. Capital for improvements is woefully inadequate. These issues promise to be exacerbated as storm severity increases further taxing the integrity and capacity of current systems.

Knowing the status of a community's assets is an essential first step toward prioritizing repairs and upgrades. Asset Management Plans identify the location, age, material, size and condition of infrastructure. These and other parameters are used to determine risk, priorities, life cycle costs and capital needs. This information can also be used to model different solutions and evaluate trade-offs, costs and benefits of infrastructure options such as green infrastructure solutions and changes in pipe sizing.

Recently, the City of Ann Arbor completed a comprehensive inventory of its stormwater infrastructure. The City now has detailed information on their 23,000 catch basins and the entire pipe network that connects them. A Geographic Information System and a work order management system (CityWorks) are now used to manage maintenance of the stormwater infrastructure. A preliminary Stormwater Management Model was developed that is in the process of being calibrated that will allow the City to evaluate stormwater management solutions.

The Village of Dexter is initiating a process to inventory the location, status and capacity of current stormwater assets. This assessment, along with an analysis of drainage patterns and outfalls will be used to plan future development and maintenance and to determine costs and benefits of various stormwater management solutions for the Village. Dexter is applying for a SAW (Stormwater, Asset Management and Sanitary Fund) grant to fund a significant portion of this work.

Once assets are inventoried, necessary upgrades and repairs can be funded via a stormwater utility. Ann Arbor has a stormwater utility to which customers pay a fee to convey stormwater from their properties. Funds are used for needed maintenance and system upgrades. Customers are charged based on impervious area, which was determined to be the best indicator of stormwater runoff. The current Stormwater Utility budget is approximately six million per year. For additional information: www.a2gov.org/storm

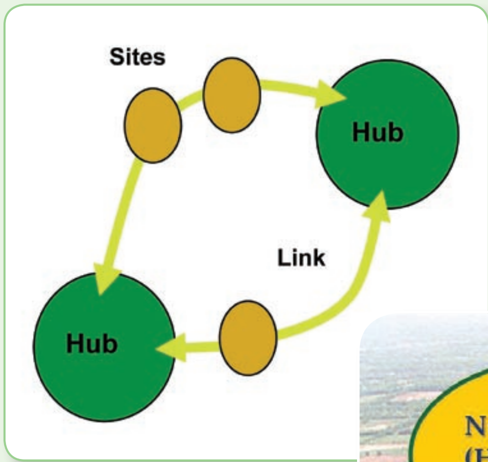
The Michigan Department of Environmental Quality has grant and loan funding available through its State Revolving Fund (SRF) program for nonpoint source stormwater infrastructure improvements. In addition, Beginning in October 2013, the Stormwater, Asset Management and Sanitary fund (SAW) grant and loan program will provide 450 million dollars for sanitary and stormwater infrastructure asset management, planning and construction.

The Environmental Protection Agency's Sustainable Infrastructure program has a wealth of resources available to support stormwater infrastructure inventory, planning and financing at http://water.epa.gov/infrastructure/sustain/

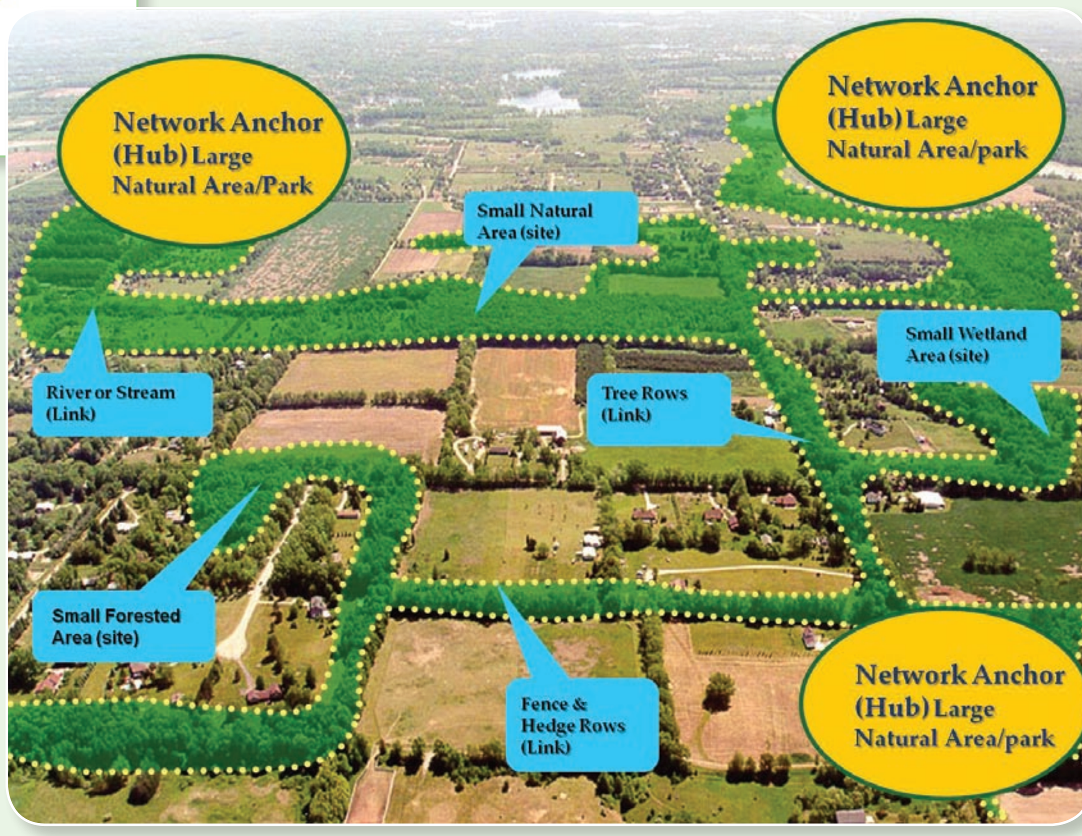
Acquire and manage ecosystems to regulate runoff. Natural areas (forests, wetlands and grasslands) provide significant stormwater benefits. Floodplain forests and wetlands provide infiltration and storage capacity during rain events and slow the movement of overland flow. Upland areas absorb and hold rainwater and snowmelt, slowly releasing it as groundwater springs into surface waters, keeping them cool and pure. Other ecological services natural areas provide include soil erosion control, and buffering of receiving waters from high water volumes that can impact water quality, wildlife and habitat, lead to residential and commercial flooding, and cause stress to infrastructure such as dams, roads, culverts and bridges.

Communities of the Huron River are blessed with extensive natural areas in the headwaters of the watershed. As development occurs, it is important to be strategic and protect these natural buffers so that they can continue to provide stormwater management services. The mid and lower reaches of the Huron have more urban land and impervious surface. Conserving or restoring the remaining natural areas in these more urban areas can improve capacity to weather large rain events and relieve some of the burden on grey infrastructure systems.

A well sited network of natural areas should be part of any stormwater management plan and is one of the major tools in the Green Infrastructure toolbox. A good plan includes the identification of key natural areas, determination of criteria that help prioritize lands that improve climate resiliency, the funding mechanism to support maintenance or acquisition of lands and adoption of appropriate policies to ensure protection.



Natural systems provide many services including stormwater benefits. Landscape-scale planning for the preservation of natural areas helps municipalities make informed decisions about master planning and development. Green Infrastructure plans at this scale identify a series of hubs, sites and links among remaining natural areas that together meet multiple quality of life and conservation goals. Oakland County has a plan for each townships through it's nationally recognized Green Infrastructure Initiative. See an example of a Green Infrastructure Plan from Lyndon Township at www.hrwc.org/the-watershed/features/huron-river-creeks/portage-creek/planning-portage/



Several communities in the watershed and elsewhere in Michigan have or are developing Green Infrastructure inventories and plans. Oakland County has a Green Infrastructure planning process that each of its municipalities have completed. The plans map out the natural areas (forest, wetlands, grasslands, and greenways) that provide green infrastructure benefits, and describe options and recommendations for planning for development in concert with that green infrastructure. HRWC has created a Bioreserve Map that maps and ranks the remaining natural areas in the watershed; and a field assessment method that allows for rapid assessment of those natural areas through a quick field survey. Several communities and natural areas preservation programs, including Ann Arbor, Scio, Dexter, and Webster townships include the map in their planning documents. Many preservation programs, such as the Ann Arbor Greenbelt, and the Washtenaw County Natural Areas Preservation Program, use the map in their programs. All the of the watershed's land conservancies use the map and the field assessment in their property acquisition and easement processes. HRWC has begun working with the communities in the Portage Creek watershed as part of the implementation of the Portage Creek watershed management plan to enact similar Green Infrastructure plans.

HRWC has produced a Bioreserve Map for the watershed identifying and ranking remaining natural areas. The map can be downloaded at http://www.hrwc.org/our-work/programs/bioreserve/bioreserve-map/.

Monitor weather and surface water conditions. Observations of precipitation, temperature, stream flow and lake levels are particularly important for identifying more accurate long-term trends that impact stormwater practices. Quality data records can be used to develop models to predict landscape and receiving water responses to precipitation events. Models can contribute to understanding the impacts of different types of precipitation events on factors such as water movement, overland flow and infiltration capacity. They can be used to test scenarios for different land use development and stormwater practice options. Understanding the implications, environmental and financial, of development scenarios will contribute to informed decision-making.

There are long-term records from some weather and surface water monitoring efforts. Most notably, the USGS collects stream flow data at several stations in the watershed. The National Weather service and the CoCoRaHS (Community Collaborative Rain, Hail and

Snow Network) citizen rainfall monitoring program have precipitation data available. A comprehensive census of data availability and quality will help determine what analyses are possible and what gaps in monitoring exist.

Conclusions

The Huron River watershed is experiencing a shift in the timing and severity of precipitation events. This departure from conditions under which stormwater systems were developed, along with land use change and the aging of infrastructure, puts pressure on municipalities to address stormwater systems. Improving the accuracy of data upon which decision-makers determine infrastructure needs is an important foundation for all future work. This includes ensuring rainfall frequencies are calculated using the best and most recent data and are interpreted appropriately for this region. Further, decision-makers should consider future climate projections when determining infrastructure needs. There are actions municipalities can take that will both improve the current status of stormwater management and prepare communities for the expected changes to the local climate. By taking these no-regrets actions, communities in the Huron River watershed will become more climate ready, reducing risk and mitigating threats that arise as the climate changes.

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HRWC is a nonprofit coalition of local communities, businesses, and residents established in 1965 to protect the Huron River and its tributary streams, lakes, wetlands, and groundwater. HRWC works to inspire attitudes, behaviors, and economies that protect, rehabilitate, and sustain the Huron River system. Services include hands-on citizen education, technical assistance in policy development, and river protection and monitoring projects. See www.hrwc.org for information.

Notes

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