Great Lakes Coastal Community Climate Adaptation Checklist

Evan Murdock and David Hart
University of Wisconsin Sea Grant Institute

As the scientific consensus on the reality of climate change continues to grow, planners and decision -makers are asking themselves how they can apply the information to better equip their communities for future conditions. These questions are compounded for coastal resource managers, who must address not only the issues common to all communities, but also the unique challenges that stem from their proximity to large water bodies: water level changes, increased wave action, and costal erosion, among others.

This document is intended as a guide to planners in coastal areas to help identify and address their vulnerabilities. The checklist items range from specific low- or no-regrets decisions (those that will result in a net positive outcome or a minimal net cost regardless of future conditions) to general vulnerability assessments.

Many of the items listed represent a significant capital investment, and should be considered as part of ongoing upgrades and maintenance, rather than as urgent matters. For instance, we would not expect a municipality to tear out functional fixed docks from a marina before the end of their useful lives to replace them with floating docks. Rather these changes should be considered when the time comes to replace infrastructure in the course of normal maintenance.

In each case, communities should evaluate the cost of taking action, the likelihood of losses without action, and along with the potential scale of those losses, how sudden or unpredictable a precipitating event might be, and the ability (or lack thereof) to respond in real time should an extreme event occur.

Ports and harbors

- ☐ Consider replacing fixed docks with floating docks or adaptable dock systems
- ☐ Ensure boat launch ramps are sufficient to provide access across the range of predicted water surface elevations, or plan a response to changing water levels.
- ☐ Select materials able to withstand increased weathering and wave action
- ☐ Assess the practicality and cost of maintaining harbor access under lower water conditions

Ports and harbors are at risk in several ways. Water surface elevations in the Great Lakes are likely to change as temperature and precipitation patterns shift; however there is no consensus regarding the magnitude or even the direction of that change, largely because of the many different feedbacks that impact the system.

Broadly speaking, most models predict a drop in mean water levels, with modeled decreases in mean water levels in Lake Michigan as high as 4.5 feet (e.g. Angel and

Kunkle, 2010; Hayhoe, 2010). This is a change on the order of the roughly 5’ total variation observed between 1860 and 2010. Changes of this magnitude would lead to an increase in the need for channel and harbor dredging, exposure of legacy infrastructure to increased weathering, and potentially could require redesigns as lake waters retreat.

A smaller but significant number of models predict water level rises, which could lead to problems with erosion, overtopping of fixed docks, and damage to shore infrastructure.

Given the uncertainty in the direction and magnitude of water level changes, the primary focus of harbor adaptation should be in building flexibility and resiliency, particularly for long-lived infrastructure. Additionally, any infrastructure planning should be carried out with an understanding of how changing water levels (particularly lowered levels) will impact harbor access.

Coastal ecosystems

- ☐ Select longer-lived plants (10+ years) with hardiness under changing climate patterns in mind when undertaking restoration
- ☐ Protect vulnerable coastal ecosystems from wave action
- ☐ Maintain open space for ecosystem migration with changing water levels
- ☐ Develop and implement plans for controlling the spread of invasive species

Coastal ecosystems are fragile and highly valuable for the services they provide. In addition to acting as habitat and as breeding areas for many species, coastal plant populations often serve to protect vulnerable shorelines from erosion due to wave action.

Many coastal ecosystems are highly sensitive to water levels. If lake levels change significantly, these systems could be drowned or left stranded above the waters that sustain them. Under natural conditions, many plant populations are able to migrate up or down the shore as water levels vary;, however in many areas coastal development limits the area available for migration. In the case of coastal wetlands that are protected by a beach or similar formation, water level declines may reduce moisture availability effectively destroying the ecosystem.

Some plants may also suffer from rising temperatures. With rising temperatures a near-certainty, some changes in plant population makeup should be expected; these changes should be taken into account when choosing plantings for wetland restorations.

Invasive species are an additional threat to coastal ecosystems. While aquatic invasive species are nothing new to the Great Lakes, changing climatic patterns may provide new opportunities to alien species as native plant and animal communities are brought under increasing stress. Unfortunately the biological response to changing climates is quite complex and unpredictable, so the best response at this stage is vigilance.

Wastewater conveyances

- □ Eliminate combined sewers, if applicable.
- □ Minimize leaks in sanitary sewers to avoid sanitary sewer overflows during heavy rains

Combined Sewer Overflows (CSOs) and Sanitary Sewer Overflows (SSOs) are discharges of untreated sewage to surface waters. Combined sewers (those in which sanitary sewage and stormwater are purposely transported in the same system), while once common in Wisconsin, have now largely been eliminated[1], making this an isolated and well-understood problem.

SSOs, on the other hand, can be caused by sewer failure or by "infiltration/inflow" (I/I) events, wherein stormwater enters the sanitary sewer system through leaks. From 1996-2000, the state of Wisconsin reported an average of 96 overflow events per year caused by I/I. These events are generally caused by heavy rains, which are expected to increase in the future; thus it is reasonable to assume that sanitary sewer systems will come under more frequent stresses in the future.

A certain amount of I/I is inevitable and must be accounted for in the design of a sewer system; however it is important to minimize the stress on existing systems. Thus regular maintenance and monitoring of any sanitary sewer system is important.

Water efficiency

- □ Promote rainwater capture and storage
- □ Promote the use of high efficiency appliances and plumbing fixtures

The Great Lakes region is fortunate to possess abundant, high quality water resources. This resource has been critical to the development of our agricultural, industrial, and tourist economies, as well as to the high quality of life that residents have come to expect.

These supplies are not, however, inexhaustible, and it is increasingly recognized that best practices call for minimizing the impacts of human activity on the water system. The uncertainly arising from climate change increases the importance of enacting these changes, as hydrologic systems are brought under increasing stresses. In many municipalities, growth will increase water demands, and warmer air temperatures are also likely to contribute to increased water use.

Reducing water use is a "no regrets" or "low regrets" planning decision; that is, one that will cost little or nothing over the lifetime of the project, regardless of future conditions. Widespread adoption of water efficiency will allow municipalities to use smaller drinking and waste water treatment systems, in addition to providing some degree of resiliency against potential decreases in water availability.

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[1] Once common in Wisconsin, combined sewers remain only in the City of Milwaukee, The Village of Shorewood, and the City of Superior.

Urban environments

- ☐ Minimize heat island effects by planting green space and through shade plantings
- ☐ When selecting long-lived plantings such as trees, choose varieties able to tolerate increased heat stress and reduced moisture.
- ☐ Institute appropriate setbacks to protect structures in the event of water level rise
- ☐ Encourage building design standards that stress efficiency and resilience under increased climatic variability.

The development of urban environments should be carried out with an eye towards building resiliency in the face of considerable uncertainty. The potential for increased severity of storm events, heat waves, droughts, and similar climatic events may impose new stresses on urban structures and on people living in urban environments.

Potential impacts include an increase in bluff erosion rates, increased soil heave and subsidence, increased soil saturation, increased outdoor temperatures, and other stressors to both building structures and residents. Given the long design life spans and significant capital investments represented by urban development, it is important that new construction account for the range of risks likely to be encountered under future climate conditions.

Roadways

- ☐ Ensure alternatives exist for roads at risk from water-level rise, bluff recession, or groundwater flooding
- ☐ Assess bridges, culverts, and other road crossings for potential larger storm events
- ☐ Develop a flood response plan identifying vulnerable areas

Transportation infrastructure is, of course, vitally important to maintaining the economic vitality of a community, as well as playing a critical role in emergency management. Researchers predict an increase in maintenance costs and frequency with rising air temperatures. Indeed, the city of Chicago predicts a doubling of road maintenance costs under a high emissions scenario. In addition, the potential for increasing flood peaks and/or rising lake levels could increase flood damages. In addition, more extreme climate events could leave roads inaccessible during emergency response activities, potentially exacerbating damages.

Adapting physical transportation infrastructure to for climate change will likely happen over time as existing structures are replaced and upgraded. The need to upsize or change infrastructure such as culverts and bridges will have to be evaluated on a case-by-case basis, depending on the estimated cost of failure. Analysis should examine backwater effects, and the potential to lose road access to critical infrastructure in the case of a failure.

General adaptation and risk assessment

- □ Identify site-specific risks or vulnerabilities
- □ Identify goals and objectives for your community
- □ Organize and prioritize objectives into first, second, and third-tier categories.
- □ Engage community members and stakeholders in decision-making and priority-setting processes

A certain amount of any adaptation strategy will be entirely specific to a particular community. Certain risks will be greater or less for particular communities, as will the willingness to bear particular costs, either for implementing adaptation strategies or losses from future climate events.

Setting clear goals for your community will allow planners to balance different costs and identify priorities. Many planners use the "SMART" framework to help identify goals that are "**S**pecific, **M**easureable, **A**chievable, **R**esults-oriented, and **T**ime-bound".

Prioritizing objectives will help simplify the daunting task of choosing which items can be tackled immediately, and which should be put off for the future. First-tier items are those which can be undertaken in the current planning session, which require no additional research or information to undertake, and which do not require a drastic reordering of a maintenance schedule. Second-tier items are those which cannot be tackled immediately, either due to information or funding constraints, in addition to items which can be included in a regular maintenance or upgrade schedule. Third-tier items are those which are probably out of reach within your planning window.

Finally, engaging the community and local stakeholders is a critical part of the planning process.

Additional Resources
Climate Change, Wisconsin Sea Grant
http://www.seagrant.wisc.edu/home/Topics/ClimateChange.aspx

Climate Change in Minnesota and the Lake Superior Basin, Minnesota Sea Grant
http://www.seagrant.umn.edu/climate/

Changing Climate, The Ohio State University
http://changingclimate.osu.edu/
Includes an archive of webinars on Great Lakes climate topics.

Wisconsin Initiative on Climate Change Impacts (WICCI)
http://www.wicci.wisc.edu/
In February 2011, WICCI released its first comprehensive report titled "Wisconsin's Changing Climate: Impacts and Adaptation." The Coastal Community Working Group report provides useful information for Great Lakes coastal communities (http://www.wicci.wisc.edu/report/Coastal-Communities.pdf).

Climate Wisconsin: Stories from a State of Change
http://climatewisconsin.org/
Wisconsin's Educational Communications Board received a regional Emmy for this series of 12 videos and accompanying resources that highlight expected climate change impacts on a variety of industries and pastimes in Wisconsin.

Climate Ready Great Lakes, NOAA
http://www.regions.noaa.gov/great_lakes/climate_ready.html
The Climate Ready Great Lakes training modules are 3 presentations designed to help Great Lakes coastal managers learn what they are adapting to, how to plan for adaptation, and what tools are available to help in the process.

Adapting to Climate Change: A Planning Guide for State Coastal Managers, NOAA Office of Ocean and Coastal Resource Management
http://coastalmanagement.noaa.gov/climate/adaptation.html
This report helps coastal managers develop and implement adaptation plans to reduce the risks associated with climate change impacts affecting their coasts. A Great Lakes Supplement (http://coastalmanagement.noaa.gov/climate/docs/adaptationgreatlakes.pdf) provides more specificity on regional climate trends and impacts.

Hazards and Climate Adaptation, NOAA Coastal Services Center
http://www.csc.noaa.gov/climate/

CAKE: Climate Adaptation Knowledge Exchange
http://www.cakex.org/

Collabatory for Adaptation to Climate Change, University of Notre Dame
http://adapt.nd.edu/