

Preparing Coastal Communities and Businesses for Climate Change: Duluth, MN and Toledo, OH Focus Group Results

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In May of 2008, the Great Lakes Sea Grant Network, NOAA Great Lakes Environmental Research Laboratory, and the Cooperative Institute for Limnology and Ecosystem Research received a major grant titled: Preparing Coastal Communities for Climate Change: Translating Model Results to Prepare Ports, Harbors, and Storm-water Management Facilities in an Era of Climate Variability and Scientific Uncertainty [NOAA SARP: Coastal Resources/Water Resources Management].

Introduction

Attention to the potential effects of climate change on coastal communities and coastal infrastructure due to sea level rise, increases in storm frequency and intensity, increased variation in weather patterns, etc., have been primarily focused on the concerns of ocean communities and their ports and water access dependant industries. However, substantial changes in climate are also projected within the North American Great Lakes region, and could have profound impacts on an area containing twenty percent of the world's fresh water, home to 3,500 species of plants and animals, with thirty-six percent of both the US and Canadian population, representing three-quarters of the manufacturing capacity of the Continent, and the heart of an essential national and international trade and transportation corridor. While the probable impacts of climate change to the freshwater Great Lakes differ in some key respects from forecasts for the saltwater coasts (Great Lakes lake levels are predicted to decrease) the major obstacles to informing and motivating decision makers and managers remains the same.

Historically, we know that environmental, social and economic systems in the Great Lakes are highly sensitive to even minor changes in weather patterns, ice cover, and water levels (impacting everything from wetlands to maritime commerce). In the Great Lakes Basin, even relatively minor climatic variation can produce profound impacts on a multitude of systems and activities. In this respect, the Great Lakes sensitivity to climate variation is like the "bird in the coal mine;" serving as an early indicator of potential environmental, social and economic issues

that will become global problems in future years. There is a general consensus among scientists that understanding specific potential threats and opportunities due to climate variation, and planning adaptive strategies to these changes is essential. In addition, to create behavioral change, we need to communicate vulnerability and opportunity with a “value statement” that stakeholders understand and accept as a basis for specific action and investment. Combining research and outreach helped us to:

- 1) Involve key stakeholders in identifying climate change scenarios and potential needs;
- 2) Direct specific climate modeling to address stakeholder areas of concern;
- 3) Develop a scalable economic evaluation tool for ports and harbors to understand potential threats and opportunities facing key infrastructure elements that support commerce and marine transportation;
- 4) Help develop a strategic plan (logic models) for communicating regional climate change information;
- 5) Develop specific case studies for Toledo, Ohio, and Duluth, Minnesota, that may be used to illuminate and communicate potential economic impact information on climate change;
- 6) Develop centralized tools for climate change communication; and,
- 7) Lay the groundwork for the development of visualization products that can be used to communicate climate change information.

Economic Assessment Strategy

While a great deal of work has been done to discuss the broad impacts and general concerns related to climate variation, very little work exists evaluating the costs that could be incurred due to climate induced change on specific existing resources, structures, and systems. This is in part due to the climate modeler’s inability to supply dependable microclimate modeling information on which to make specific projections. This is coupled with the problem of describing changes within meaningful time frames to stakeholders with a degree of certainty high enough to prompt action and investment (this is especially true for private businesses, both small and large).

In this project, we examine the potential impacts of climate variation on a key element of one of the regions most important, yet poorly recognized resources: Great Lakes coastal infrastructure and aids to navigation. These man-made elements of the marine/coastal interface serve critical rolls in protecting numerous resources and aiding maritime commerce; and, they are extremely vulnerable to projected climate change scenarios. Our goal is to use the “Esperanto of dollars” to help make visible the potential impacts of climate variation on Great Lakes communities and activities by illuminating the current value of vulnerable port and marina infrastructure and intimating the potential liability faced if appropriate and timely planning and action do not occur. There are a variety of coastal infrastructure types that support and protect community investments, unique habitats, public access, recreation, a variety of major business types and utilities, as well as port terminals and maritime transportation. As noted in the USAC report: “Great Lakes Infrastructure: Critical Protection at Risk:”

[In the U.S.] Over 130 coastal cities and towns around the Great Lakes have federal navigation projects that include channels for navigation and structures like breakwaters and piers. Although [originally] authorized to safeguard navigation activities in the federal harbors from waves and ice, these navigation structures also provide critical flood and storm protection for public and private buildings, roads, and facilities that developed in their shadow along the urban waterfront. In some cases, urban waterfront development also includes critical infrastructure for power generation, water supply, and wastewater treatment... Over half of the coastal structures on the Great Lakes were built before World War I, and over 80% are older than the typical 50-year design life.” “The United States Great Lakes navigation system includes over 130 federal navigation projects with 610 miles of channels, 117 harbors, 104 miles of breakwaters, 20 dredged disposal facilities, and the locks at Sault Sainte Marie, Michigan; Chicago, Illinois; and Buffalo, New York.”

By focusing on highly valuable Great Lakes resources (coastal and port infrastructure and aids to navigation such as channels) that are particularly vulnerable to physical changes anticipated due to climate variation (storm intensity, storm frequency, storm surges, water level fluctuation, ice cover, etc.), we hope to provide a foundation for understanding the complex chain of issues that will have major economic impacts for Great lakes stakeholders. Those economic impacts can then be used to identify risk, alert potential partners, and spur new dialog to build long-term adaptive strategies and plan necessary funding. The outcome of our efforts resulted in a scalable “Infrastructure and Dredging Cost Evaluation Matrix,” to be described in its own section of this report.

Methods

With the aid of coastal community professionals, and port and maritime industry decision makers and managers we worked to effectively consider what potential economic impacts could be anticipated by coastal communities and water dependent businesses in the Great Lakes in the face of predicted climate change. Our primary goal was to identify specific port and harbor infrastructure impacts within two distinct Great Lakes Ports (Port of Duluth/Superior, and Port of Toledo). In the course of completing our work, we also considered operational, and equipment adaptations that might be necessary to protect existing coastal resources and water-dependent businesses, and enhance future opportunities, although this was not the express purpose of this effort.

Literature Search

A literature search was conducted to find out what information was available on potential climate change impacts to transportation and coastal infrastructure to support planning and development of adaptive management strategies and budgets. We sought information with a specific emphasis on Great Lakes climate change and potential impacts to man-made infrastructure associated with maritime trade and coastal community security.

Availability and Focus of Current Peer Reviewed Material

There are two major National Academy of Science reports on climate change and transportation. Both of these studies serve as thorough and unbiased literature reviews of this topic. They also go further and point out the areas where future research should be focused. These studies are currently being used to guide climate change adaptation projects managed by a number of government entities, most notably the Department of Transportation and NOAA.

The first of these reports is TRB Special Report 290: The Potential Impact of Climate Change on U.S. Transportation. This report “explores the consequences of climate change for U.S. transportation infrastructure and operations. The report provides an overview of the scientific consensus on the current and future climate changes of particular relevance to U.S. transportation, including the limits of present scientific understanding as to their precise timing, magnitude, and geographic location; identifies potential impacts on U.S. transportation and adaptation options; and offers recommendations for both research and actions that can be taken to prepare for climate change.”

The second of these reports is Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I. The introduction of this study is a thorough review of all the current literature on climate change and transportation infrastructure. The chapter includes a table titled: “Impacts of climate change identified in the literature, 1987-2006”, which is very comprehensive. It includes, peer-reviewed articles as well as gray literature. The concluding paragraph of this chapter highlights the current state of this field and is worth repeating here:

“In summary, research on the potential impacts of climate change on transportation is an emerging field and one that has shown a remarkable upturn in interest and activity over the past few years. This has coincided with greater interest in the subject of adaptation in general, as recognition has grown that some degree of climate change is inevitable in the coming decades, even as steps are taken to reduce future emissions. Considerable work remains to be done in bringing this field to a greater level of maturity, including investigations of impacts not yet thoroughly examined and developing strategies, methodologies, and tools that decision makers at all levels can use to both assess the importance of climate impacts and identify ways to respond.”

The NOAA project (that this article is part of) is aimed at developing the type of decision-making tool mentioned in this excerpt.

One oft-cited peer-reviewed paper that focuses on marine transportation is Planning for Impacts of Climate Change at U.S. Ports (Gallivan, Bailey and O'Rourke, 2008). This report points out that ports do not have specific information about the types of climate change impacts they may encounter. They conclude that more data is needed to help ports assess their risk as well as better planning tools and methods. While there are many articles that are tangential to our area

of interest, there were relatively few directly relevant peer reviewed articles (see SARP master References table).

Availability and Focus of “Gray Literature”

In our world of instant internet publishing and information sharing, there is a significant amount of “Gray Literature” on the subject of climate change impacts on transportation infrastructure. The quality of this material is highly variable due to the many sources posting information. However, a large amount of this “Gray Literature” can be accessed through U.S. government web-portals:

- Transportation and Climate Change Clearing House, managed by the U.S. Department of Transportation;
- The U.S. Global Change Research Program website which houses a collection of scientific reports on climate change impacts on transportation. The U.S. Global Change Research Program (USGCRP) coordinates and integrates federal research on changes in the global environment and their implications for society.

Because these web-portals are managed by the federal government, it is therefore much more likely that the information is credible and well sourced. Other sources of non-peer reviewed information must be carefully considered as to origin and purpose. The issue of climate change and adaptive management has been highly contentious and politically volatile and potential bias needs to be carefully considered (and identified) when using any “Gray Literature” source.

The general synthesis from all of these information sources is that we are now at a point where we know what we do not know. This is actually a good place to be, because now, we can focus on filling specific knowledge gaps instead of continuing to evaluate the general state of affairs. In terms of developing specific tools for making decisions and investments, one of the biggest obstacles is the fact that the timeframes used for Federal transportation infrastructure planning are 20-30 years (with even shorter budgeting cycles). This planning and budgeting strategy is out of scale, compared to the 50- to 100- year timeframes over which clearly visible climate change is projected to occur. Due to economic constraints, local communities and private businesses have even shorter planning windows, often only between 2-5 years, with 10 year consideration the exception. Exacerbating this problem is the fact that information supplied by current climate modelers has a high degree of uncertainty; and business abhors high levels of uncertainty when major investments are required.

There are also discrepancies between the geographic scales used to predict impacts vs. the scales used to plan for adaptation. This has led to the realization that there is need for cost estimates for the potential impact of climate change on specific communities or facilities such as ports, as opposed to regions; one of the goals of this NOAA project, and the specific aim of the cost-matrix that we have developed.

National Research Council (U.S.). Committee on Climate Change and U.S. Transportation: Potential impacts of climate change on U.S. transportation / Committee on Climate Change and U.S. Transportation, Transportation Research Board and Division on Earth and Life Studies, National Research Council of the National Academies. p. cm. – (Transportation Research Board special report; 290) Hyman, R.C., J.R. Potter, M.J. Savonis, V.R. Burkett, and J.E. Tump, 2008: 1.0 Why Study Climate Change Impacts on Transportation” In: Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Savonis, M. J., V.R. Burkett, and J.R. Potter (eds.)]. Department of Transportation, Washington, DC, USA

<http://www.climiite.dot.gov/impacts-adaptations/index.html>

<http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/transportation>

Great Lakes Coastal Community and Maritime Industry Survey & Focus-Group Evaluations

Climate change, often referred to as “Global Warming,” has become heavily politicized for a variety of reasons. In order to avoid polarization within the working groups, we chose not to get bogged down with the discussion of whether or not global climate change is caused by anthropogenic activities, is part of a cyclical natural process, or is some permutation of the two (although all these opinions were voiced by various participants). In initial discussions with stakeholders, it was immediately clear that to optimize group participation and productivity, we needed to focus on adaptive management questions dealing with specific observed and predicted climate changes and trends. While “mitigation” strategies were voiced, it was always in the context of competitive or adaptive advantage.

Seeking to engage key stakeholders in a thoughtful discussion on what impacts were likely to be of greatest interest to them as climate variation continues to move us towards life on a warmer planet, we introduced our project to the Duluth-Superior Harbor Technical Advisory Committee (HTAC), part of the Duluth-Superior Metropolitan Interstate Council. We then requested the assistance of a smaller, but broadly representative group of port professionals from the HTAC to form our “Climate Change Working Group.” [NOTE: The 30 voting members of the HTAC represent a wide range of harbor stakeholders including business owners, environmental groups and local, state and federal officials who are directly concerned with the planning, programming and implementation of issues pertaining to the harbors of Duluth and Superior. In addition, non-voting technical advisors from any member agency, organization or local government are encouraged to attend and participate in HTAC meetings.]

To understand our Stakeholders initial awareness of both climate change, and potential climate change impacts, we used a targeted, anonymous, attitudinal survey and discussion in facilitated focus groups. The target audience was port, carriers/shipping, wastewater, and storm-water management, and natural resources and pollution control experts within the Duluth/Superior Harbor. We also received input from key maritime transportation personnel with a broader Great Lakes, or system wide view, at the NOAA Great Lakes Shipping Stakeholders Meeting (2/24/09). A total of 43 respondents submitted initial surveys in the MN/WI effort. We had our smaller Climate Change Working Group repeat the survey at the end of the project to assess changes in attitude or focus after more intensive study and exposure to new information.

A standardized Great Lakes Sea Grant Network “Climate Change Awareness Survey,” was distributed to the Duluth/Superior Harbor Technical Advisory Committee, HTAC. After the group had been introduced to the Great Lakes SARP grant goals at a previous meeting, but prior to sharing specific details and information about regional climate change predictions. The survey was designed to assess general awareness about climate related terms and general knowledge, to introduce more complex consideration of the impacts of multiple integrated environmental factors, and to intimate the relative positive or negative impacts (or both) that come with individual stakeholder “value propositions.”

A total of 43 respondents in the Duluth/Superior area submitted surveys. The attitudinal survey was distributed to the Toledo, Ohio focus groups on February 10 and 17, 2009 (a total of 17 people completed the survey in Ohio).

Once the survey data was analyzed, it was used to draft an outline for further discussion by a select HTAC “Climate Change Taskforce.” The taskforce represented specific interests relative to port activities, procedures, maintenance, infrastructure, access, planning and development. There were port, shipping, zoning, environmental, and water management representatives involved with the focus group. The meeting dialog was transcribed (however, we allowed participants to remain anonymous in the transcript to encourage candid discussion).

Initial Climate Change Survey Implications

The vast majority of respondents, 91% in MN/WI and 76% in OH, felt they understood the terms “climate change” and “global warming.” These terms have been widely used in the media for many years and have become part of the common lexicon. However, while a full 97% of respondents in MN/WI and 94% in OH felt they were aware of specific “global” climate change issues, only 48% in MN/WI and 47% in OH felt they were aware of “Great Lakes or local” climate change issues.

Implications:

- 1) There is a clear need for further data on regional and local climate change impact.
- 2) There is a need to broaden understanding of the terminology used in describing climate change, and relating it to specific impacts.

Many respondents were unsure of the relative importance of climate change for their organization, area, or commercial interest. However, 78% in MN/WI and 100% in OH indicated they were concerned by potential climate change impacts within the Great Lakes. While 33% in MN/WI and 29% in OH indicated climate change impacts were a priority for their organizations, 48% in MN/WI and 71% in OH indicated it was not a priority, with an additional 18% in MN/WI and 6% in OH unsure of the relative importance of climate change to their organization. In other words, 66% in MN/WI and 77% in OH were either unsure or did not see climate change as a priority for their organizations. Respondents again reflected similar percentages when asked if they currently include climate change impacts in their long-term planning: 30% in MN/WI and 24% in OH indicated they did, and 66% of MN/WI respondents and 77% of OH respondents indicated they did not. When asked if their organization had a specific person assigned to deal with the long-term implications of climate change, only 9% in MN/WI and 18% in OH indicated they had an assigned individual, 31% in MN/WI and 18% in OH did not know, and more than half, 59% in MN/WI and 65% in OH, indicated no one was assigned this task.

Implications:

- 1) More than half of all respondents did not feel climate change was a priority for their area of interest.
- 2) Climate change may only be seen as a Global (or Polar) issue.
- 3) The issue of Climate Change may be viewed as “outside” the purview of local business and community planners.
- 4) Only a small percentage of business and community leaders have actually made an investment/commitment to addressing climate change issues.

The vast majority, approximately 60% of MN/WI respondents and 65% of OH respondents rated changes in global weather patterns and the concomitant physical manifestations of those changes as negative. Approximately 20% in MN/WI and 26% in OH felt there would be both positive and negative impacts, 5% in MN/WI felt there would be positive impacts, less than 10% in MN/WI felt there would be no impacts, and 8% in MN/WI and 8% in OH indicated they did not know what value statement to make about potential global climate change impacts.

Implications:

- 1) The initial response towards climate change impacts is negative.
- 2) Although forecasters and planners have indicated for some time that there will be both “winners and losers” in relation to global climate change impacts, this awareness is not widespread.

When asked to rate specific effects of climate change currently anticipated by scientists in the Great Lakes regionally, the two impacts seen as most negative by the MN/WI group were lower lake levels and extreme drought throughout the system (95%). In OH the two impacts seen as most negative were extreme drought (94%) and lower lake levels (100%) throughout the

system. Increased wind speed, and extreme precipitation were also seen as negative, by approximately 77% in MN/WI and 76% and 88% respectively in OH. Surprisingly, diminished ice cover was also seen as a negative by 60% of respondents in MN/WI and 88% of respondents in OH, while 27% in MN/WI and 11% in OH saw it as a positive. The regional impacts viewed as most positive were longer summers (66% MN/WI and 41% OH), and warmer winters (48% MN/WI and 29% OH).

Implications:

- 1) Great Lakes maritime commerce, both at sea and in port are dependent on water levels, any climate impacts that might limit or impinge on channel depths or port access will limit loading, seasonal capacity, and ultimately profitability.
- 2) Climate change reducing water levels (drought) or increasing harbor sedimentation and silting (storm intensity) will potentially increase costs for dredging to maintain channel depths.
- 3) There is a general awareness in the Great Lakes maritime industry that although diminished ice cover could allow for an extended shipping season, reduced ice cover means more evaporation resulting in lower seasonal water levels, which is the number one issue impacting maritime trade in the Great lakes.
- 4) “Longer summers,” and “warmer winters,” were considered to be more positive than negative by respondents. However, because ambient air temperatures and seasonal length themselves do not substantially impact or inhibit general maritime operations in the Great Lakes, these “impacts: were seen as negative in contributing to water level declines.
- 5) No substantial differences in facilities management or operational management were seen as being impacted directly by temperatures, or storm events. Although, a longer, or continuous (year-round) season of shipping in the Great Lakes would alter strategies and timing for vessel maintenance and repair. Currently the entire U.S. Great Lakes fleet spends approximately 75-85 days in lay-up each year. Port facilities are intermodal, and currently remain active year-round.

When asked to evaluate possible local climate change impacts on the economics of the Duluth/Superior and the Toledo port communities respondents viewed all potential impacts as largely negative. Water levels were the major concern; 84% of respondents in MN/WI felt there would be negative impacts to both stormwater conveyance structures and shore-land erosion. In the Ohio survey 94% and 86% felt there would be negative impacts to both stormwater conveyance structures and shore-land erosion respectively. Negative impacts were anticipated almost uniformly (between 70-78% in MN/WI and 63% -73% for OH) for dredging, inland river water levels, general maritime infrastructure, the integrity of breakwaters and docks, port operations and equipment, and fisheries.

In addition, negative impacts on human health, agriculture, and maritime trade were anticipated. Only tourism in MN/WI was seen as being potentially positively impacted by future local climate changes. In OH less than 18% said climate change would positively impact tourism. Significant percentages of OH respondents (up to 29%) said they did not know how climate change would

affect the local port community in human health, tourism, port operations, maritime markets, fisheries, agriculture, and river levels.

Implications:

- 1) We again see a predominately negative view of climate change impacts on the local port community, but responses are likely oversimplified. Upon further examination and interrelation of impacts and specific outcomes, it is likely that these responses will become more varied.
- 2) The general makeup of the respondents towards maritime interests is likely to skew the responses. Fisheries impacts are such an example: while warmer waters might reduce some populations, other populations (and new species) could create a more robust and active fishery (it is important to understand what species of fish the community desires, or values).
- 3) Water levels and the integrity of marine infrastructure are again seen as being in jeopardy due to climate change impacts.
- 4) The number of respondents that did not anticipate any effects, or indicated that they “did not know,” was high when considering issues outside of their areas of expertise.

Based on the categories used to discuss local climate change impacts above, respondents noted how well or poorly the Duluth/Superior maritime and Ohio communities are prepared to deal with climate change. It was clear that the MN/WI community did not feel well prepared to deal with stormwater capacity and shore-land erosion issues. In OH 35% of respondents thought their community was moderately well prepared to deal with stormwater and 29% thought their community was moderately well prepared to deal with marine infrastructure and breakwaters & docks. Respondents in both MN/WI and OH generally felt only moderately prepared to deal with the majority of issues considered in the survey. “Very well prepared” was not a description used by more than one respondent concerning any issue except for “Dredging” (12%). “Very well prepared,” was not a description used by any respondent in OH for any item they considered. A large number of respondents (between 35-60% in MN/WI and 24-71% in OH) indicated they simply did not know about local preparedness for most of these issues.

Implications:

- 1) Storm-water issues are already a problem for the Duluth/Superior harbor communities, and would likely be exacerbated by future climate change scenarios.
- 2) There is a lack of general knowledge as to the current condition and future impact of climate change on port infrastructure.
- 3) There may be a misunderstanding between the concepts “very well prepared,” and “very well understood,” by some port experts in narrow areas of expertise.

The final survey question, asking if respondents were interested in knowing more about potential impacts of long-term climate change on their organization or work, was overwhelmingly

positive, with 81% of MN/WI respondents agreeing or strongly agreeing and 94% of OH respondents agreeing or strongly agreeing. Only 6% of MN/WI respondents disagreed with the statement, and 12% were undecided. In the OH survey 6% were undecided.

Implications:

- 1) There is a need for more local climate change predictive modeling, and better local long-term forecasting.
- 2) There is a need for additional information on the individual and cumulative effects of climate change variables.
- 3) There is a need for specific information on how a wide range of climate variables (individually or linked) might impact current and future business, equipment, operational, and infrastructure issues, in addition, to a host of social and environmental concerns.

Final Climate Change Survey Summary

(Only the Climate Working Group was used in the final survey)

There was no change in the percentage of respondents (90%) who felt they understood “Climate Change” and “Global Warming.” Half felt they were aware of specific “Great Lakes or local” climate change issues, with 40% undecided if specific changes were occurring.

Implications:

- 1) There is a clear need for more specific science-based information at the regional and local levels. Current technology and the inherent uncertainty in climate modeling projections may not be able to support this demand. Without clearer timelines indicating specific climate change impacts, interest and action will continue to be limited (businesses and organizations must plan and live within budget cycles, a high degree of uncertainty or a distant time frame is not conducive to current action or investment).

Only 20% of respondents felt climate change was a priority to their specific organization, area, or commercial interest. However, as individuals, 80% were concerned by potential climate change impacts within the Great Lakes. More than twice as many organizations as previously (20%) had assigned a person to deal with the long-term implications of climate change, only 20% did not know (down 10%), and 60% indicated no one was assigned this task.

Implications:

- 1) Clearly, respondents are better informed about their companies (organizations) focus on climate change issues (whether positive or negative).
- 2) Due to numerous business realities (economic planning windows and short-term budgets likely chief among them) businesses are not particularly focused on, or concerned about, climate change issues.
- 3) Even though companies are not focused on Climate Change, individual respondent's interests remain high.

The majority, again approximately 60% of respondents, rated weather changes and the associated physical manifestations of those changes as negative. However an additional 7% felt there would be both positive and negative impacts (now up to 27%).

Implications:

- 1) The initial response towards climate change continues to be negative.
- 2) The realization that climate change is complex, and that impacts may create both winners and losers is increasing.

When asked to rate specific effects of climate change currently anticipated regionally by scientists in the Great Lakes, the two impacts seen as most negative were lower lake levels and extreme drought throughout the system (100%). Increased wind speed, and extreme precipitation were also seen as negative (80%). Diminished ice cover is seen as a negative, by 100% of respondents, none saw it as a positive (a change of 27%). The regional impacts viewed as most positive were longer summers (50%) and warmer winters (40%).

Implications:

- 1) More awareness that Great Lakes maritime commerce, both in transit and in port, are dependent on water levels and any climate impacts that might limit or impinge on channel depths or port access will limit loading, seasonal capacity, and ultimately profitability.
- 2) Climate change reducing water levels (drought) or increasing harbor sedimentation (storm intensity) will potentially increase costs for dredging to maintain channel depths.
- 3) There is a greater understanding that diminished ice cover means more evaporation resulting in lower seasonal water levels, which is the number one issue for maritime trade in the Great Lakes. It could also mean shipping year-round but with lower productivity per transit due to lower volumes carried (i.e., seasonal gross tonnage might remain the same, but require more vessel transits). In addition, general maintenance would require new rotations, since seasonal lay-up would not occur (see #5 below)
- 4) "Longer summers," and "warmer winters," were considered to be more positive than negative by respondents. However, because ambient air temperatures and seasonal length themselves do not substantially impact general maritime operations in the Great Lakes, these "impacts" were only seen as negative in contributing to water level declines.

- 5) No substantial differences in facilities management or operational management were seen as being impacted by temperatures, or storm events. Although, a longer, or continuous (year-round) season of shipping in the Great Lakes would alter strategies and timing for vessel maintenance and repair. Currently the entire U.S. Great Lakes fleet spends approximately 75-85 days in lay-up each year. Port facilities are intermodal, and remain active year-round. Key locks and related aids to commerce and navigation would also have to “rethink” their maintenance and building schedules to avoid negatively impacting maritime activity (new lock redundancy might be required to maintain logistical security).

Final survey respondents were again largely negative about climate change impacts on the local economics of the Duluth/Superior port community. A full 90% felt that storm water systems, shore land erosion, port operations, and maritime infrastructure would all be negatively impacted. NOTE: There were almost no positives indicated by the group, largely because it was composed of experts specifically focused on maritime, port, and wastewater issues. [Potential positive impacts on some elements of tourism for example were not considered by this group. Other studies indicate that while the golf industry might be enhanced by a longer season, snowmobiling might be hurt. Facilities that can “make snow” like down hill ski areas could have extended seasons and better access (if debilitating cold periods decline), while cross-country skiing and snowmobiling could be limited by natural snow cover.]

Implications:

- 1) We again see a predominately negative view of climate change impacts on the local port community.
- 2) Water levels and the integrity of marine infrastructure are seen as being in jeopardy due to climate change impacts.
- 3) The number of respondents that did not anticipate any effects, or indicated that they “did not know,” was high when considering issues outside of their areas of expertise.

The final survey group was split on its ability to deal with climate change. It was clear that the community did not feel well prepared to deal with storm-water capacity and shore-land erosion issues. Respondents generally felt only moderately prepared to deal with the majority of issues considered. “Very well prepared,” was not a description used by more than one respondent concerning any issue. A large number of respondents again indicated they did not know about local preparedness in areas outside their fields.

Implications:

- 1) Storm-water issues are already a problem for the Duluth/Superior harbor communities, and would likely be exacerbated by future climate change scenarios.
- 2) Port experts were evenly split between “moderately prepared,” and “not well prepared,” as to their ability to deal with future impacts of climate change on port infrastructure. In follow-up discussions, it was apparent that participants felt they

would be able to adapt, if they knew what adaptations were required. However, there was a clear lack of comfort with the degree of uncertainty connected to specific climate projections and their impacts.

- 3) There may be a misunderstanding between the concepts “very well prepared” and “very well understood,” by some port experts in narrow areas of expertise.

Comparing and contrasting questions 2 and 5, with questions 11 and 12 of the survey respondents indicated that personally 80% were concerned with climate change issues and 20% were not. However, 100% indicated that they were interested in knowing more about climate changes that could have a direct impact on their company or organization. In addition, 40% indicated that their companies currently include climate change issues in their long term planning (a dramatic increase from the initial survey).

Implications:

- 1) There is a clear interest and concern related to local climate change modeling and impacts. There is a clear desire for better local long-term forecasting (in contrast to the initial assessment, no one disagreed (formerly 6%) and none were undecided (formerly 12%).
- 2) There is a need for specific information on how a wide range of climate variables (individually or linked) might impact current and future business, equipment, operations and infrastructure issues; in addition to, a host of social and environmental concerns.

Focus Group Comments and Discussions (Port of Duluth/Superior)

The goals of the Climate Change Working Group were to:

- I) Engage specialists and experts within the broader port and harbor community to share information on the kinds of “climate drivers” (discrete measurements of gas content, radiation, evaporative index, etc., not well understood by the general public) and “weather or climate indicators” (composite results of the impacts of climate drivers) used to discuss climate change.
- II) Receive feedback from the group on which climate indicators or climate change trends were most important for them to understand in order to continue efficient and safe port and harbor activities in the face of climate variation; and relate that information back to climate modelers.
- III) Identify which specific port facilities, operations, or infrastructure types were most susceptible to interruption or degradation due to specific weather occurrences or climate trends.

- IV) Identify the “tipping points” where weather occurrences (storm frequency, storm intensity, precipitation, etc.) or physical changes in the lake environment (water temperature, water levels, ice coverage, etc.), would negatively or positively impact current port facilities, operations, or infrastructure types.

- V) Identify the planning and budgeting windows currently used by port and harbor businesses and support organizations, both private and public, and the degree of “certainty” necessary for these entities to begin to engage and invest in climate change adaptation or specific harm mitigation.

Climate Change Working Group Comments

Evaluating the potential economic impacts of Great Lakes climate variation on ports and harbor communities was our goal for the working group. We expressly stated during our group introductions that we would not be debating “why” global warming or climate change was occurring. This was necessary to avoid being side tracked by the polarization that climate change attribution can generate. For our purposes, we simply acknowledged that extreme climate variation has occurred in the past (as observed in Paleoclimatic records) and, that current scientific observations indicate that we are again in a climactic warming period that will likely continue for generations. We acknowledged that differing climate models predict a variety of outcomes for different parts of the Great Lakes Basin. Because currently available localized climate models are not necessarily in agreement, and at times in opposition, we asked the group to consider various specific weather occurrences, and then predict at what “tipping points” (high and low-outside the range of historical averages) those changes would impact their operations, facilities, or essential infrastructure.

Weather Drivers and Impacts of Highest Concern

- 1) Water levels (at datum)
- 2) Compound impacts, with Seiches (absolute water level highs and lows)
- 3) Ice coverage (increased evaporation impacts, times for ice-in & ice-out, maximum thickness of ice cover)
- 4) Storm frequency
- 5) Storm Intensity (winds)
- 6) Precipitation (volume, intensity, and phase- as rain, snow, sleet, etc.)
- 7) Air and Water temperature (standard highs and lows, seasonal shift, ice impacts, etc.)

Operations and Facilities

Somewhat to the surprise of the group was the initial general agreement that extreme weather events themselves, were not likely to heavily impact operations or general facilities at the ports; primarily because current Great Lakes practices are already designed to deal with extreme

weather variation and handling of multiple vessel and cargo types. However, an increase in the frequency of extreme weather events, and the compound impacts of thinning ice cover, and longer growing seasons, could all alter the timing of current operations (grain shipments; rotational fleet and facility maintenance, etc.; and, due to year-round shipping opportunities, the possible implementation of new services such as container or break-bulk liner service). These events were not viewed as being beyond the adaptive capacity of the organizations and businesses involved, and all changes presented both obstacles and opportunities (note: as discussions continued, it became clear that initial conclusions might have been overly simplistic and optimistic).

Coastal security, urban waterfront, and maritime in-water infrastructure and aids to navigation (such as channels and turning basins) were seen as much more vulnerable to climatic variables and extreme weather than operations and shore-side facilities. These structures are very important and costly investments to build and maintain, and as mentioned previously, they protect and support a variety of secondary and tertiary structures and investments within port communities. We examined specific types of infrastructure found within the harbor, their functions and their economic value. It is important to note that many of these structures were designed with 50-100 year life spans and have already exceeded their useful-life design parameters (making them more vulnerable to the weather impacts anticipated by climate change). In addition, the complex issue of dredging and storage of dredge materials was reviewed, as well as its critical role in maintaining a viable port and harbor, especially in the face of changing water levels.

Points of Interest from Climate Working Group Discussions:

- Engineers design and build based on “historical” 100-year averages, it is when projected impact ranges exceed historical ranges that real concern is created. To adapt to climate variation, engineers will need to design for uncertain future scenarios. How will these be modeled, and what degree of certainty must we have before action and investment will take place?
- Commercial maritime Port and Harbor structures regularly use more robust design standards than private water dependent businesses and community access structures. This implies non-commercial transportation structures will be impacted by smaller ranges of climactic change, these include: community access points, recreational marinas, water treatment or wastewater facilities, or any non-commercial transportation related facilities).
- The most dramatic threats come from compound climate variables that impact water levels (Seiches throughout the Great Lakes can quickly alter water levels by 3-12 ft., and compound wave heights to well over 20Ft.). While a dock face may be able to withstand a 3ft change in water level in relation to current chart datum, the addition of a seiche event may push water levels (up or down) beyond infrastructure capacity when driven by more frequent and/or more severe storms. This will also impact water

treatment and sewer facilities that are at or below the current water table, creating or exacerbating infiltration and inflow problems.

- Many loading facilities, grain elevators, commercial buildings, roads, and railroad tracks are only 2.5 feet above low water datum on Lake Superior. There has been flooding in the past, and a persistent water level increase in this range would threaten many port facilities. This would increase the need for rip-rap and stone facings, increasing port costs to address erosion concerns.
- Potentially, a permanently lowered water level of a smaller range would impact Great Lakes water-dependant businesses and industry more than a permanently higher water level. NOTE: Loosing vessel draft reduces cargo capacity (for a 1000-foot vessel in the Great Lakes capacity is impacted by 260 short-tons per inch of draft, for a Seaway size vessel it is approximately 135 short-tons, and over a season, for a large volume dock, this can translate into two vessel loads left behind [approx. 118,000 short tons], resulting in lower productivity and higher costs).
- Low water can limit vessel speed and cause “squatting” and loss of maneuverability. It will also change the impacts of wave actions and erosion/deposition within harbors (this can impact both commercial infrastructure security and stability, as well as general public access and safety). It is likely that as water levels change, the safety of various sections of a harbor may be affected (for example turning basins and mooring areas, due to changing currents and/or prevailing winds, reflected wave patterns, and the direction of major storm events could become unsafe at times).
- Ice-in and ice-out times can be extremely important to seasonal productivity. This can also be impacted by maximum ice thickness. Ultimately, we could see year-round maritime transportation with ice breaking assistance. This would alter the scope of the ice-breaking mission by the USCG in the Great Lakes and the budget (this, in addition to lock opening and closing dates would require the intervention of Congress to address). It could alter the paradigm of Great Lakes shipping, creating new markets and cargo opportunities. It would also change inventory and stockpiling strategies for numerous companies, especially the iron ore and steel industries. It could impact winter trucking, limiting the movement of heavy lift efforts and reducing the time allowable for movement of forest products (they typically carry 10% overweight in winter). Year-round shipping would require stronger docks to withstand the stresses of vessels pushing ice into these structures for longer periods, and this problem could be exacerbated by water level changes that would reposition ice in relation to dock cross-beams and support structures, bumpers, etc., potentially impacting dock strength and security. However, a longer ice-free season would have benefits for recreational marinas creating a longer season and perhaps greater activity and interest in Great

lakes boating and fishing. Over all, an increase in the freeze and thaw cycles were seen as being both destructive and costly to a wide variety of infrastructure types including staging and loading areas, port buildings, access tracks and roadways, etc. If overall seasonal temperature range increased, this could impact engineering design standards related to thermal expansion, affecting bridges and other highly engineered structures.

- Increased storm severity, number, and precipitation amounts are viewed as likely to adversely impact the entire drainage system of a community by increasing culvert and pipe loads and increasing the number of system blockages due to sand and gravel. The current placement of drainage systems could be problematic as weather activities impact access to existing infrastructure. In extreme cases, storm surge could threaten or breach areas that have been artificially created by beach nourishment or inundate buildings or facilities lying at or near the water table (such as the sand bar protecting the Duluth/Superior Harbor). These events could also “re-suspend” settled or capped contaminants in the harbor. In addition, there was concern that existing storm water and waste water systems were barely adequate and even minor increases in precipitation events would cripple the current system.
- Most frequent extreme storm events would also impact port operations, commodity handling, energy and maintenance costs, and even create navigation and safety issues. These events add moisture to stockpiles, slow or inhibit loading and unloading operations, and can create hazards to navigation like strong currents, freezing spray, or waterborne debris such as logs. Heavy storms also create erosion problems and channel silting. Most of the vessels in the harbor will cease moving with constant winds of about 25-30 mph because their thrusters are not designed to hold them in place beyond that range. Increased wind can also slow or halt the use of port cranes and ship unloaders (they typically shut down when winds reach 45 mph). In addition, high winds can slow or halt inspection crews, service vessel access, and create mooring problems. All of these delays reduce productivity and increase shipping costs. For private marinas, frequent major storms with high winds and waves on the Great Lakes could raise significant safety issues for boat owners and cause a decrease in recreational activity, even with longer seasons.
- Precipitation as snow has not traditionally been a major issue for the ports, occurring primarily during non-operating periods (very little snow clearing occurs and some storage areas sit unattended until spring thaw). Year-round shipping could demand a dramatic increase in the need for snow removal at and around port facilities. Larger snowfalls could also impact building design standards and port configurations. Snowfall could also impact commodity stockpiles (such as coal and taconite) by creating an insulating effect and keeping piles frozen and/or wet, well into the spring. Overall, with increased snowfall and year-round shipping, port operation costs could increase substantially.

- While increased temperature was generally not viewed as a major health or work concern, group members pointed out the potential for increased biological activity due to warmer waters (increasing microbial induced corrosion, algal blooms, habitat change and species migration impacting aquatic nuisance species distribution, etc.). Waste-water facilities could see a situation where both lower water levels in the harbor, and warmer water temperatures could create a need for revised waste-water treatment handling strategies and methods. Intermodal transportation connections and logistics could be negatively impacted by a reduced winter season, with more numerous cycles of freeze and thaw, limiting road access for heavy or overweight loads. Higher humidity could accompany increased summer temperatures and impact the handling and movement of commodities like grain, cement, and coal that can hold substantial moisture. It could also create more episodes of heavy fog impacting both cargo handling and vessel movements (anything that slows down cargo movement impacts overall productivity of both the carriers and the ports).

Focus Group Comments and Discussions (Port of Toledo, OH)

Two focus groups were conducted at the University of Toledo's Lake Erie Center by the Ohio Sea Grant Program: one on February 10, 2009 for representatives of commercial ports and marina interests and a second on February 17, 2009 for stormwater managers and community planners. Seventeen people participated. The 2009 shipping and marinas focus group included the Toledo Port Authority, Toledo Beach Marina, the Lake Carriers Association, Pier 75 Marina, the U.S. Army Corps of Engineers, The Andersons, Inc., Trident Marine and a Great Lakes freighter captain. The stormwater managers and community planners' focus group included the Toledo Metropolitan Area Council of Governments, Ohio EPA, the Natural Resources Conservation Service, Maumee Remedial Action Plan, Ohio Division of Water, Toledo Dept. of Utility Engineering, Heidelberg College Water Quality Lab, and American Rivers.

About 16 months after the initial interviews two smaller focus groups were conducted at the University of Toledo's Lake Erie Center by the Ohio Sea Grant Program on June 8, 2010 representing commercial ports, community planning, environmental and stormwater interests. Marina interests were not represented as it was in the middle of their busy summer season and we were not successful in recruiting participants from this sector. The focus groups represented a mix of previous 2009 SARP focus group participants and new participants. In 2010, the focus groups assembled represented the Toledo Port Authority, Toledo Metropolitan Area Council of Governments, American Rivers (a national environmental organization), stormwater planners, Trident Marine, and a Great Lakes freighter captain. In 2010 the focus group questions were modified somewhat to reflect what was learned from the 2009 focus groups.

Participants in the 2010 focus groups were shown a short PowerPoint presentation on the development of a port and harbor structure matrix, which included economic costs of repairing or replacing the dozen or so different kinds of port and harbor structures necessary to support commercial transportation on the Great Lakes. Data on repair and replacement of structures at

three different water depths were presented. This data set is a model tool for the estimation of repair/replacement costs for port infrastructure at any port in the Great Lakes.

Additionally, Sea Grant outreach educators involved with sustainable coastal community development (SCCD) efforts participated in a focus group as part of their SCCD conference in Zion, IL in June 2010.

All of the focus group sessions were recorded with the informed consent of those participating. The small focus group numbers in 2010 somewhat limited the discussion compared to 2009. The SCCD educator focus group was added to see what Sea Grant professionals might have to say on the climate issue. Here are some ideas, observations, and interpretations given during focus group sessions:

Q1: What are the planning windows for your organization, agency or business? (Short term – 1 to 5 years; intermediate – 6 to 15 years; long term - greater than 15 years) What percent of your yearly FTE is spent on each planning window? What percent of your yearly budget is spent on each planning window?

2009

- Most respondents looked at planning only in the short term. Only two organizations looked at planning in intermediate terms and only one respondent talked of long term planning. Personnel and budgets for planning were limited or non-existent.

2010 and in 2009

- Most respondents looked at short term planning windows. Marine operators looked at very short-term timeframes (24-48 hours or days). Depending on the projects, some port and stormwater projects were long term. Any long-term plans were broken down into shorter (5 year) segments for implementation. Stormwater plans were for five years. Respondents responded to short term issues that impacted their plans. Budgets were tight and no specific percentages of an organization's resources were allocated to long term planning.

Sea Grant SCCD group:

- Sea Grant operations have 5-year planning windows. Some Sea Grant educators work with groups that look at 20- or 30-year efforts. Land use plans typically look 20 years out.

Q2: What areas of management/operation are most vulnerable to climate change impacts?

2009

- Ports and marinas respondents were interested in and concerned about short-term lake levels, water levels, storm events and sediment dredging that might impact cargo movement. Stormwater respondents were concerned about and interested in sewer systems, storm events, land use, wetlands, and the ability to generalize data from other

geographic areas, as well as the use of historical data for planning and forecasting that may or may not apply as climate and conditions change.

2010

- Respondents focused on stormwater, lake levels, green energy, drought and erosion issues. Climate change and its impact on management activities were not discussed. The large amount of port infrastructure (7 miles in Toledo) is a concern. Work schedules were impacted by weather.

Q 3: What specific forecasting resources do you currently use in making management decisions? Where do you go for information?

2009

- Port and marina respondents were more interested in immediate dredging issues than in forecasting. They looked to a variety of possible sources for information (USACE, Sea Way Corporation, Universities, USDOT, Great Lakes Transportation, etc.). Stormwater respondents looked more to the past and not to forecasting. They also used a variety of information sources including USGS, FEMA maps, ARS, citizen complaints, NOAA NWS, etc. Both groups would have liked to have had forecast model outputs for climate change impacts.

2010

- Depending on the issue, respondents looked to the USEPA, Ohio EPA, the Lucas County auditor's office, US Census Bureau, Lucas county engineers office, the USGS and the NOAA National Weather Service for information relating to their management decision making. Much of this information was found via agency websites as well as the Ohio Revised Code for legal information relating to townships. Development trends and economic and population forecasts were important in discussion. They posed the question, when does climate change information become so specific that it begins to impact economic decisions?

Sea Grant SCCD group:

- Lake levels are a concern, especially for marine recreation infrastructure development. Green infrastructure is mentioned, as is the Chicago Wilderness NGO effort. Wetlands and fisheries are a concern. They tend to manage in discrete environmental segments and not as a whole ecosystem.

Q4: What forecasting information do you use in making management decisions? How do you want to receive your information?

2009

- Port and marina respondents looked to weather buoys, weather forecasts, personal observations and other short-term information. They used radio, cell phone, a web system, satellite data and experience as ways to receive information. Some places on the water are dead zones without cell phone service. Stormwater managers would have liked to have some forecasting, but the model output would have had to be highly

reliable. They preferred a free searchable website with local information, as national information was not much use. Economic benefit/cost analysis on a regional or local level was desired for local infrastructure planning.

2010

- Respondents liked electronic methods to receive information. Webinars targeted on specific topics of interest were well received. Monthly electronic updates on topics of interest were desirable. Electronic links to specific information were useful so as not to waste time searching an agency website. Marine weather forecasting was valuable. Economic forecasting and growth trends were also useful, as was population forecasting. Respondents would have liked to have information to determine how climate change might impact flood zone designations. Current climate forecasts were too general to be of much use and did not impact planning.

Sea Grant SCCD group:

- Watershed management is important, as well as stormwater issues. The Ohio EPA's Balanced Growth Program, which features economic incentives for regional land use planning on a watershed basis, is currently being used in Ohio.

Q5: What specific climate change forecasting needs are met with current data and modeling capacity? Separate REAL-TIME VS Intermediate/long-term FORECASTING:

- a. What data are you using that is climate related data?
- b. Where are you getting current information? (primary/secondary/tertiary level info suppliers)

[Note: This question was not used in 2010.]

2009

- Port and marina respondents were wary of using long term forecasting to make decisions. Investing in new marinas and new ships was reported as being very expensive, and port and marina organizations and businesses wanted solid reliable information for decision making. Stormwater respondents did not feel that their needs for climate change forecasting were being met. They needed local as well as regional information. Climate related information that they used included rainfall data, lake level data, stream flow data, water quality data (pollution loads), storm duration and frequency, and temperature data. They received information from rainfall stations, NOAA – NWS, USACE (lake levels), FEMA USGS, personal observations, etc.

Sea Grant SCCD group:

- The Union of Concerned Scientists website and climate change visualizations are useful.
- Sea Grant SCCD professionals desired forecast models of the hydrology of the Great Lakes at regional, state, and local watershed scales. Historical data may be useful. It would also be nice to have a Great Lakes website for everyone to go to in order to get climate information. This information must be presented in an easy to use and understandable format.

2009 Q6: How could current modeling results be used in decision making to adapt to climate change? [Note: This question was not used in 2010.]

2009

- Port and marina respondents could have used modeling results to help locate and design facilities, to help reduce uncertainty in decision making to improve long term planning and to forecast the need for commodities. The reliability of the models and politics were a concern of the port group. Stormwater respondents could have used modeling to help determine design standards, to help locate and site facilities, to predict flooding and runoff intensity, and to assess impacts on agricultural practices and more.

2009 Q7: What type and magnitude of weather/climate/water event (storm intensity/duration, high/low water, longer/shorter boating season, and ice thickness/duration) would cause major problems in your operation? What would cause changes in your management/operations practices? What would cause changes in your operational strategies?

2009

- Commercial mariners were concerned with even a one-inch drop in lake levels, as it impacts the amount of cargo vessels can carry. A two-foot drop in lake levels would be very significant to marinas in the western basin. Lower lake levels would necessitate even more expensive dredging. They posed several questions and the desire for additional information during their discussion:
- Where is the political will to fund the necessary dredging? Lower lake results in fewer beaches as beaches are eroded by intense storms.
- Better planning for intense storms is required. Respondents asked what constitutes a typical storm? What kinds of information can we expect in the future?
- Respondents desired new stormwater designs that can mitigate increased storm intensity as well as reliable modeling scenarios for decision makers.
- They also asked for reliable scientific data that can be used to make decisions regarding flood prevention plans and aid in stormwater management is highly desirable.
- Respondents expressed the need to know how a changing climate could impact existing infrastructure and the impacts of climate change on the decision making process, for example, what considerations should be considered in the location of new infrastructure?

2010

- Respondents looked to NOAA and the NWS for short-term forecasts. Economic forecasts relating to the need for shipping would have been useful. They found that work in the township level of government was not impacted by climate change. Cleaning of ditches was a concern. Flooding created short-term interest, but then it subsided and not much was done. Changes in stormwater regulations impacted operational strategies. Flooding was an issue with industrial partners. Storm duration and intensity could have impacted operations. Lake level information was important.

2010 Q7: How important do you feel climate change information is to your organization directors/supervisors/leaders?

- Respondents felt that economics may overshadow climate issues, and warmer weather and less ice may cause more winter navigation if it is economically viable. They felt that ice damage to vessels and need for raw materials must be taken into consideration. Lake carriers had information on winter navigation studies and trials, which was important. Dredging was, and continues to be, an issue of great importance. If lake levels went up, they see it as a plus for navigation, however if lake levels went down it was harmful to navigation.

Climate change and variability issues were very important to those higher up in the organizations. The vice-president of Conservation was currently working on the subject. At that point, it had not yet trickled down to people in lower positions.

I do not hear too much about climate change, it is market driven due to population changes and movement of people to warmer climates. Baby boomers moving south to warm and dry - drought. Drought is not an issue here - we have a big lake.

Q 8: What specific information do you need to begin planning and preparing for adoption to climate change in your day-to-day management responsibilities?

2009

- Port respondents were most concerned with short-term events. Long-term shipping contracts were a thing of the past. Wind, rain, and frequency of events were important to shippers. Stormwater managers were concerned about the intensity of events and getting data specific to local areas. They were also concerned about the reliability and user friendliness of their data.

2010

- Models of what other communities were doing in the Great Lake region would have been helpful. More specific information on climate change impacts was needed. General climate information was not very helpful in getting changes made, however historical data was useful. Models for riparian setbacks in new developments were needed. Storm intensity was very important. They asked the questions: What is the 25-year storm like now? Is it the same as it was decades ago? A 25-year storm could change from 2 inches to 3 inches, which could make a big difference. They also wondered if they were using the most appropriate data for planning for stormwater infrastructure. Short term winds were noted as being important to mariners and commercial shippers, as force 5 storms could impact what shippers were able to carry. Water levels in Toledo Harbor could be impacted up to 6 feet by storm events. Lake levels and ice cover impacted shipping. More certainty and timeliness in predictions and forecasts were needed for planning.

Sea Grant SCCD group:

- The USACE 6 month water level forecasts, historical records, and trend analysis are all useful. A question brought up was, what is the direction of change? It was suggested to look at the 150 year record and predict where it may be heading, as well as looking at historical highs and lows. Visualization tools may be used to help people see a 10, 25, or 100-year event. An interactive tool for event visualization is desired. Accurate bathymetry data for the Great Lakes would help modelers. Some of the coastal marine visualization tools are useful, however include the inclusion of parcel lines and property

in the visualizations would be helpful. Respondents expressed a desire to obtain this technology for the Great Lakes.

2010 Q 8: Do you think climate change impacts are going to be important to your business interests during your working career?

The response was a mix of “yes” and “no”. Climate was predicted to be important as it impacts lake levels, ice cover, storm intensity in Great Lakes and drought in other areas. They needed more facts as soon as possible. They wondered how soon climate change/variability will occur. If the rainfall intensity curve was changing, engineers needed that information to be used in infrastructure design. They needed more real time pictures and supporting data.

Q 9: How important is climate change to you?

2009

- Responses were mixed. Some thought it was important, while others did not think it would impact them in their lifetimes. Education was believed to be the key. Education was needed. Small incremental climate changes were tough to see with all the focus and attention being paid to more intense weather events. Climate change was of some importance to a few organizations, but current project implementation was of immediate concern. Maintaining green space was a concern in new developments. Air quality issues were not receiving as much attention as water issues. Compromises were expected to be needed in decision-making. Dredging and what to do with the dredged material was seen as important. It was noted that dredged sediment flow and disposal impacts Lake Erie water quality.

Sea Grant SCCD group:

- Winter tourism is impacted by a few degrees, as the Great Lakes region can get more rain instead of snow. This can hurt the ski and snowmobile industry. Lake levels are important, especially on Lake Erie. It was noted that the change impacts location of resorts and marinas. The question was asked: Can you count on the snow for ski resorts and water depth for marinas?

Q9: Is there anything else?

2009

- Professional associations could support the modeling output to get managers to use the new information.
- Managers want to be sure they are using quality data for decision-making.
- The magnitude and the timeframe of potential changes needs to be known.
- Stakeholders want information on the uncertainties in regarding climate change modeling.

2010

- Connect green infrastructures, energy and water.

- Define what people could afford to implement.
- Educate people on the use of energy and energy efficiency.
- More climate information should be presented at meetings attended by the focus group participants.

Sea Grant SCCD group:

- A highly interactive visual base tool would be useful. Good communication tools such as fact sheets, web sites, etc., are needed. They suggested that the information be presented to communities, and to give communities the opportunity to decide. They mentioned the importance of listening to and engaging clientele and communities, so communities can use Sea Grant SCCD professionals to find resources.
-