WATER LEVELS IA – PHASE 1 REPORT

May 12, 2016

Project Title

Implementing Adaptation: Developing Land Use Regulations and Infrastructure Policies to Implement Great Lakes Shoreland Area Management Plans

Investigators
Richard K. Norton, Principal Investigator
Urban and Regional Planning Program
University of Michigan
rknorton@umich.edu / 734.936.0197

Guy A. Meadows, Co-Investigator Great
Lakes Research Center Michigan
Technological University
gmeadows@mtu.edu / 906.487.1106

Harry Burkholder, Co-Investigator
Executive Director, LIAA
Traverse City, MI
burkholder@liaa.org / 231.929.3696

Principal Investigator Contact Information
Richard K. Norton
Urban and Regional Planning Program
Taubman College of Architecture and Urban Planning
University of Michigan
2000 Bonisteel Blvd.
Ann Arbor, MI 48109-2069
rknorton@umich.edu / 734.936.0197

Supported through a grant from the Michigan Coastal Zone Management Program, Office of the Great Lakes, Department of Environmental Quality and the National Oceanic and Atmospheric Administration

EXECUTIVE SUMMARY

This project builds on previous work to incorporate information regarding Great Lakes shoreline dynamics into the community master plans of the City of Grand Haven and Grand Haven Charter Township. This step advances prior efforts by developing methods for implementing those newly adopted planning ideas into the Great Lakes coastal communities' zoning ordinances in the form of regulatory and infrastructure policy.

Given the unique challenges that Great Lakes coastal localities face in their planning efforts, this continued work with the City of Grand Haven and Grand Haven Charter Township confronts issues that arise at the water/land interface in Great Lakes shorelands settings at large. These issues include a range of environmental concerns, economic concerns, the desire to accommodate near-shore residential living, and the need to protect near-shore public and private property from coastal hazards.

There are a number of common regulatory and non-regulatory options that address managing Great Lakes coastal shorelands, but applying an abstract policy prescribed in a general plan to a particular place, and ensuring that it can yield the desired outcome, is difficult—especially considering potential political and legal implications.

The project team has been conferring with the community planners from the City of Grand Haven and Grand Haven Charter Township to better understand their perceived issues related to planning for community resiliency given fluctuating lake water levels. In doing so, we anticipate taking special note of the kinds of issues that are not clearly or strictly related to coastal area management, but that local citizens and officials believe should be addressed concurrently with coastal management concerns as part of a larger regulatory/policy reform effort (e.g., natural area protection, parking regulations, etc.).

INTRODUCTION

This research leverages work from the Planning Grant and other prior work conducted under the direction of the co-investigators. That prior work developed planning techniques to improve efforts by Great Lakes coastal localities in Michigan to analyze and incorporate information regarding Great Lakes shoreline dynamics into their local master plans and shoreland area management plans. The work addressed the topics of Great Lakes shoreline dynamics (focusing on dynamics related to lake level variation), near-shore environmental/natural resources analysis, near-shore land use and critical facilities analysis, fiscal impact analysis, and methods for visualizing shoreline dynamics. The focus of this follow-on Integrated Assessment project is to take the next step and develop methods for implementing local master plans or shoreland area management plans through regulation and infrastructure policy.

We continue our collaboration with the City of Grand Haven and Grand Haven Charter Township to assess the issues and needs related to the development and adoption of regulations and policies that are needed to implement their local plans in order to improve shoreland area management in the face of dynamic Great Lakes water levels.

STATUS AND TRENDS

Setting

In addition to its ocean coasts, the United States enjoys substantial inland freshwater seas with its five Laurentian Great Lakes. These lakes extend some 750 miles from east to west, touch some 4,500 linear miles of U.S. shoreline, and cover a combined surface area roughly the size of the United Kingdom (EPA 2014; GLERL 2014; MDEQ 2014). As with ocean coasts, the Great Lakes are large enough to generate substantial hazards to shorelands both from ongoing erosional processes and from periodic storm events.

Great Lakes coasts are different from ocean coasts, however, in several key respects physically and institutionally. Most prominently, they are geologically young features subject to background erosion rates of about 1 foot per year throughout much of the basin, while simultaneously subject to fluctuations in standing lake water levels on the order of 1 or 2 meters over the course of a single decade (Norton and Meadows 2014). Because of lake level fluctuations, Great Lakes shorelines can appear to be retreating lakeward (accreting) for extended periods while lake levels are low, only to move substantially inland as water levels again rise—sometimes from a single storm event. It is not entirely clear how climate change will affect the Great Lakes overall, but it will likely increase the frequency and intensity of storms (Gronewold et al. 2013).

One of the bigger challenges that these physical dynamics create for land and water governance on a Great Lakes shore is that both shoreland property owners and public officials are easily lured into a false sense of security during extended periods when lake water levels are low. Great Lakes shorelands experience many of the same crises and conflicts typical of ocean, inland lake, and riverine systems, including flooding and erosion hazards from short-term storm events and conflicts that arise from competing land uses. But the lull of a seemingly quiescent

Great Lake may in reality be a trap that puts private property and public infrastructure at risk in ways not typical of other land/water systems.

Institutionally, the Great Lakes are also unique because the states bordering them—including Michigan—are Northwest Territory states with civil townships (i.e., representing an added layer of local government in addition to counties and municipalities), yielding highly fragmented local governance of Great Lakes shorelands (Norton and Meadows 2014). For example, 284 units of local government (i.e., counties, townships, cities, and villages) touch Great Lakes shores in Michigan alone, and similarly large numbers of local jurisdictions manage shoreland area development in each of the remaining Great Lakes states and the province of Ontario as well. Beyond this large array of governmental actors, a large and growing array of quasi-governmental and nongovernmental actors has appeared over the past several decades to advance particular interests. In addition, all of the Great Lakes states have also applied the Public Trust Doctrine to their Great Lakes shorelands, yielding state-local legal and policy institutional arrangements that are highly diverse and complex (Norton et al., 2011, 2013).

In the U.S. in particular, there is no coherent or unified national land use planning policy, such that most planning policies are established at the state and local levels. In the State of Michigan, as with most states, both local land use planning and regulatory authorities are broadly enabled and permissive; they are neither mandated nor very constrained or prescriptive (see the Michigan Planning Enabling Act, 2008 Public Act 33, and the Michigan Zoning Enabling Act, 2006 Public Act 110, as amended). As a result, although land use and community planning in Michigan and elsewhere unfolds within a hodgepodge framework of federal and state infrastructure policies, social laws and policies (e.g., housing assistance programs), and environmental protection laws, it remains largely a local endeavor. Similarly, most public infrastructure related to land development (e.g., water, wastewater, and roads) is provided at the local level, funded substantially by local ad valorem property taxes and fees (see, e.g., Citizens Research Council (1999) for a discussion of local government services and tax authorities in Michigan).

Planning at a local level is decidedly complicated because most localities are quite small, and as such lack the financial and institutional capacities to engage in rigorous planning efforts (Burby and May, 1997; Norton, 2005a). While this particular problem is not necessarily unique to coastal localities, nor to the Great Lakes, it is magnified in coastal communities including those along the Great Lakes because local officials are often disinclined to pay attention to their coastal and other unique natural resources through their planning efforts any more than they have to, given all of the other community concerns they face. Indeed, many communities are more inclined to worry about promoting economic development and protecting private property rights, whether through their community planning or despite it, than they are inclined to use planning as a means to conserve their natural coastal resources (*id.*; Beatley, 2009; Bille, 2008; Norton, 2005b, 2005c; Beatley et al., 2002).

The unique issues that arise at the water/land interface in Great Lakes shorelands settings make these planning issues even more difficult to tackle. Specific Great Lakes' planning issues include a range of environmental concerns, economic concerns, the desire to accommodate near-shore residential living, and the need to protect near-shore public and private property from coastal hazards. Key environmental concerns include threats to nearshore water quality and coastal habitats, while key economic concerns include primarily efforts to revitalize working waterfronts and remediate legacy industrial sites, along with efforts to promote tourism through recreational parks, rental beach homes, and vacation urban centers (see Ardizone & Wyckoff (2010) and Pure Michigan (2014) as examples of these concerns and efforts in Michigan). Not surprisingly, the fact that these concerns and imperatives are often at odds with one another makes shoreland governance in Great Lakes settings complex and sometimes contentious. Perhaps as a result, contemporary community plans in Michigan's Great Lakes coastal communities tend to focus on generic, community-wide planning issues, conveying surprisingly little attention to their coastal resources in general, let alone demonstrating efforts to coordinate land use policy making with water management planning in particular (Norton, Meadows, & Meadows, 2009, 2010).

Impact Areas and Topics

Because of the focus of our ongoing work and the settings encompassed by our study sites to date, the impact areas and topics we have been addressing—and that we will continue to address through this IA—revolve around natural system dynamics of both the lake shoreline and near-shore coastal riverine system, given combinations of longer-term lake-level fluctuations and near-term storm events. That effort translates to identifying potential zones of impact with regard to high-velocity wave action, storm-induced sheet flow, and inundation under varying lake levels and uncertain future climate conditions, and then overlaying those zones on natural and built features to determine the potential for significant impacts.

All of the issues we are addressing are typical throughout the Great Lakes. Given the settings we have studied, most of the environmental issues relate to beach erosion, ranging from shifts in sloping beaches to the undercutting of steep bluffs; potential impacts to state-designated critical dunes; and some potential for impacts to coastal wetlands and other natural habitats, although most of the wetlands in our study jurisdictions are located along inland riverine systems rather than immediately adjacent to lake shorelines.

Most of the potential social and economic impacts include potential damage to and loss of built structures, including especially private residencies, private commercial establishments, public infrastructure (roads, water, and sewer), public buildings, and public parks and beaches. Our analyses suggest that while the total numbers of such properties located within near-shore coastal zones—however defined—are relatively small compared to the entire jurisdiction, the cultural and economic values of those properties are disproportionately large. Similarly, it is not unusual for critical facilities (e.g., public facilities like hospitals) to be located in harm's way, sometimes unavoidably when those facilities are water dependent (e.g., water intake and wastewater treatment plants).

Given the nature of these potential physical impacts, we have been and will continue to grapple with a number of compelling political and legal issues. Most of these issues revolve around the identification and recommended adoption of potential policies in response to lake level variation, described in more detail below. All of these potential regulatory and policy measures raise difficult issues of political feasibility and the potential for litigation from shoreline property owners, environmental interest groups, or both.

There are a number of regulatory and non-regulatory options that are commonly put forward for managing ocean and Great Lakes coastal shorelands. These include, for example: avoidance measures (e.g., regulatory setbacks for new development, regulatory "retreat" requirements for structures, hazard area service boundaries); adaption measures (e.g., heightened building standards for new construction, "hard" and "soft" shoreline stabilization structures); and "retrofit" measures (e.g., restoration of structures following damage to elevation and other enhanced building standards, acquisition of hazard-prone properties, no-build rules and policies).

All of these and similar policies may be put forward by a locality in its master plan as a first step in improving shoreland area management. The difficulty in implementing the plan subsequently is twofold. The first challenge is in applying an abstract policy prescribed in a general plan to a particular place, ensuring that it can in fact be applied and that it will likely yield the desired outcome. The second challenge is confronting the political and legal controversy that often arises when a community moves to apply a more abstract plan policy to a concrete, on-the-ground regulation or policy action.

A focus of our work for this IA is to study systematically and contextually in what ways and how well this translation works in practice, again working collaboratively with our Grand Haven partners and community stakeholders. Two particular questions we will address are, first, how well the master plan serves both to inform and to justify the regulatory and non-regulatory policies actually adopted, and second how effective those policies will likely be in actually promoting effective shoreland area management.

CAUSES AND CONSEQUENCES

Challenges in Coastal Area Planning and Management

As noted, the work underway for this integrated assessment builds upon prior work conducted by the research team with funding provided by the University of Michigan Water Center (UMWC) and the Michigan Department of Environmental Quality Coastal Zone Management Program (MCZMP). That work was conducted from October 2013 through November 2015. Some of the key findings from that initial work substantially frame the causes and consequences of the challenges localities confront for managing their shorelands in the face of uncertainties related to fluctuating late water levels and global climate change. This report briefly summarizes highlights from that prior work.

The analytical approach we developed through our prior work and upon which we now build involved several key steps. First, we crafted an array of reasonably anticipated "climate futures," including a "lucky," "expected," and "perfect storm" future. Each climate future reflects the combination of a Great Lakes standing water elevation and level of storminess, moving from low to high along each dimension, based on historical levels and anticipated trends for each. Applying each climate future to a study community's topography through geographical information systems (GIS) analysis, we then identified areas potentially subject to coastal hazards, including inundation (shoreline to upstream riverine flooding potentially influenced by lake water levels) and high-energy wave action along lake shorelines.

Second, we documented and estimated different levels of land development that are occurring and that might occur under different arrays of shoreland area management options. These buildout levels included a baseline of current conditions ("current buildout"); potential buildout if full development occurs under current zoning regulations ("planned buildout"); and potential buildout if current zoning regulations were modified to incorporate best management practices, using spatial setbacks from shorelines and wetlands for analytical purposes ("BMP buildout").

Finally, by combining the three climate futures with the three levels of buildout, we established nine distinct scenarios for each study community (e.g., a lucky climate future with current buildout, an expected climate future with planned buildout, etc.). For each scenario, we analyzed a variety of potential impacts from coastal hazards, including land use, fiscal, and natural resource area impacts.

The precise analyses we conducted varied depending on the relevance of the analysis to a given scenario, the needs of the particular community, and the extent to which we had developed our analytical methods at a given point in the locality's planning process. For land use impacts, for example, we addressed under various scenarios land areas affected, structures potentially damaged, and critical facilities at risk. Similarly, for fiscal impacts we estimated variously aggregated taxable properties and property values at risk, revenues generated by those properties, costs of serving those properties, and potential damage recovery costs should a storm occur. For natural resource impacts we analyzed variously areas of wetlands, tree canopy, and impervious surface located within high-risk zones. In addition to these analyses, we also developed visualization techniques for presenting land areas at risk, potential buildout within those areas, selected structures at risk vis-à-vis historic lake level fluctuations, and other related concepts.

The purpose of this kind of scenario-based planning approach is to present to local officials and citizens arrays of potential outcomes from combinations of reasonable climate futures and development management responses. It is especially helpful for considering these outcomes given growing levels of uncertainty caused by lake level fluctuations and global climate change. It allows citizens and officials to decide which scenarios (or variations of a scenario) are most compelling, to modify those scenarios based on local knowledge and values, and ultimately to act upon those analyses through the adoption of appropriate master plan policies (i.e., rather than presenting a singled set of planner-derived predicted futures with corresponding planner-derived recommendations).

As noted, all of these analytical methods were developed in collaboration with Great Lakes study communities. Through that process, we presented our goals, analytical framing, proposed methods, and analytical results to different groups of local citizens and officials periodically for their consideration and feedback. The three communities we worked with most directly, all on Lake Michigan, included the larger Ludington community (including the city and two adjacent townships), the City of St. Joseph, and the larger Grand Haven community (city and township).

We worked with Ludington initially to frame the analytical methods just described, and we were able to present preliminary analyses to local officials for the three localities, but all three completed their planning updates before we were able to fully develop those methods. The City of St. Joseph had already conducted initial shoreline analyses through a coastal engineering study prior to our work. The analyses we conducted under this program augmented the city's initial findings from that earlier work, providing additional analyses that were presented to the city through a stand-alone report. Most of our work to fine-tune methods was conducted in collaboration with the City of Grand Haven and Grand Haven Township, each of which folded analyses conducted by the UM/MTU/LIAA technical teams into its proposed master plan update.

Drawing from our planning methods development work, we identified four key findings that can inform ongoing efforts to enhance local shoreland management in the State of Michigan, including the following: 1) local governments are vitally important for advancing effective shoreland area management, but they are currently doing little toward that end; 2) the data and analytical tools currently available to those localities for shoreland area management are either underdeveloped or poorly tailored to local planning needs; 3) local capacity to act for improved shoreland area management (via new data and analytical tools) is necessary but not sufficient—local commitment to act is equally important if not more so; and 4) scenario-based planning appears to provide a good first step toward improved planning analysis for coastal resilience, but even with that progress local commitment to advancing shoreland area management for resilience to coastal hazards remains elusive and highly varied.

Local governments matter for effective Great Lakes shoreland management, but localities on Michigan's Great Lakes are doing relatively little to manage their shorelands. A total of 317 Michigan jurisdictions (counties, townships, cities, and villages) touch Great Lakes waters or connecting waterways and rivers (Houghton, St. Marys, St. Clair, and Detroit). Of those, 284 touch one or more Great Lake directly (41 counties, 177 townships, 42 cities, and 24 villages), and of those, the 243 townships, cities, and villages have the primary state-enabled legal authority to plan for and regulate shoreland areas (CRC, 1999).[1] Michigan state laws and state-level programs manage portions of Great Lakes coastal shorelines primarily through regulations addressing submerged lands, high-risk erosion areas, and designated coastal dune areas (see generally Ardizone & Wyckoff, 2010). Similarly, development in coastal and riverine flood areas is managed to a limited extent by Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) mapping and insurance regulations (*id.*). Nonetheless, outside of those narrowly defined areas, local governments enjoy primary land management authorities. Moreover, while we did not calculate precise land areas, visual inspection for our analyses to date suggests that shoreland areas in harm's way, based on the GIS mapping described above, can be substantially greater than the areas directly addressed by the State of Michigan or FEMA, with some variation across jurisdictions given variation in topography.

Based on research conducted prior to the effort described here, a systematic analysis of the planning and zoning efforts for 60 selected Michigan coastal localities from 2006 through 2014 suggests that something less than half of Michigan's coastal localities are actively engaged in planning and zoning (Norton et al., 2015).[2] Of the coastal localities that are planning, only about 60% are addressing coastal area management issues through their local master plans to any extent (or conversely, about 40% are not addressing their Great Lakes shorelands at all). Moreover, almost 75% of the plans evaluated fail to incorporate any meaningful coastal area management policies. Finally, we found no evidence that localities addressing coastal area management in their plans were clearly working to implement water management policies through their zoning codes.

These findings are consistent with our experiences in recruiting and working with coastal communities for the research program described here, only one of which—St. Joseph—had done any substantial planning-related analysis or work to address hazards in Great Lakes shoreland

---

[1] Counties both overlap these jurisdictions and have more limited land management authorities.

[2] More precisely, we were unable to obtain from the web or through direct requests local plans and zoning codes for about half of the jurisdictions we studied.

areas prior to our collaborations with them. Furthermore, all of the shoreland area management analyses and policymaking work conducted in conjunction with this research program go well beyond the planning efforts we encountered through our prior state-wide assessment of local plans and zoning codes. In sum, our work to date confirms that local governments in Michigan continue to play a vitally important role in managing Great Lakes near-shore areas at risk from coastal hazards. Absent substantial input of technical and financial support, however, few if any currently appear to be doing much to address those areas through their community planning and zoning efforts.

Currently, data and tools needed for effective Great Lakes shoreland area management are limited. A key attribute of our work has been to look for readily available data and analytical tools—and to develop new planning methods using those data and tools—that a typical Michigan coastal locality could obtain and conduct with its own professional planning staff (in-house or consulting), without having to spend substantial funds on specialized coastal engineering studies or to train existing staff. We have dedicated much of the time and effort for this research program to date on investigating and evaluating ongoing coastal research efforts, published studies and reports, and on-line guidebooks or tools that might be adapted toward that end. We have found only limited resources that provide any tailored support for use by Great Lakes coastal communities for master planning or plan implementation purposes.[3] The limitations of these resources can be grouped into three categories.

First, much of the research being conducted to help coastal localities improve shoreland area planning is being conducted in ocean coastal settings. That work does not address a key attribute that makes the Great Lakes unique and that greatly complicates Great Lakes shoreland area management—the fact that the lakes themselves fluctuate substantially in terms of standing water levels over the course of years and decades. Those fluctuations complicate the analysis of shoreline dynamics over time, and they make the salience of coastal hazards to local citizens and officials at any given time fluctuate substantially over the course of years and decades as well (see, e.g., Norton & Meadows, 2013). While general approaches for improved planning given long-term *sea level* rise are increasingly prolific, we found that none of these existing research reports, guidebooks, or tools are especially well adapted to coastal area planning in a Great Lakes setting, especially given the unique attributes of the Great Lakes.

Second, a number of widely available tools and guidebooks that have been developed specifically for Great Lakes settings provide useful educational information but do not provide sufficiently detailed guidance to support local planning efforts. During the initial period of our work, for example, NOAA released a version of its Digital Coast on-line lake-level viewing tool for general use.[4] That on-line tool allows the user to see how the intersection of land and lake varies as standing lake water levels rise and fall. It provides a useful resource that helps inform users about lake level dynamics generally. It does not differentiate between inundation and erosion, however, or provide robust analysis of areas that might be at risk to coastal hazards under different lake levels and storm conditions—key information necessary for planning for

[3] The most notable example of a resource that has been tailored for coastal communities on the Great Lakes is the *Great Lakes Coastal Resilience Planning Guide* (http://www.greatlakesresilience.org/), produced through collaboration of NOAA, the Association of State Floodplain Managers, and other partners. While this site provides some guidance on selected planning methods, it is geared toward a more general audience and does not provide extensive or in depth methodological guidance that local planning staff and other public officials might use to advance coastal area planning or plan implementation efforts.
[4] https://coast.noaa.gov/digitalcoast/tools/llv

shoreland area management and for justifying shoreland management policies. Similarly, a guidebook published several years ago with support of MDEQ, the *Filling the Gaps* guidebook (Ardizone & Wyckoff, 2010), provides a thorough review of Great Lakes-related environmental management issues, planning and zoning authorities, and other institutional topics, as well as general recommendations for improving coastal management. It does not provide, however, detailed instructions for community planners on how to evaluate site-specific conditions or how to conduct and apply its recommendations for a given locality. Moreover, because conditions and regulations change, such guidebooks can become too dated if not regularly updated.

Third, more sophisticated data and analytical tools dedicated to Great Lakes settings are being developed, but to date they may not be sufficiently well adapted or robust, if available at all, for local planning and development management purposes. Current climate models, for example, including those developed for the Great Lakes region, have yet to be sufficiently downscaled for application to local planning efforts. In terms of Great Lakes shoreline dynamics in particular, we explored thoroughly the potential use of a FEMA analytical program designed to estimate potential damage and recovery costs from storms—the HAZUS program. We ultimately determined, however, that while the HAZUS program may be used appropriately at a more regional scale, it cannot be downscaled with sufficient reliability and accuracy to inform local planning analyses. Similarly, we incorporated for several localities findings from an ongoing “wave run-up” study being conducted by FEMA (the Great Lakes Coastal Flood Study) to identify coastal areas at risk from high-energy waves during storm events, comparable to “VE Zones” in ocean coastal settings. We determined that while this study may be useful when available and reasonably robust for a given locality (e.g., Grand Haven), it is not yet available widely throughout the Great Lakes, and at least in some instances—as was the case with St. Joseph—it does not appear to be sufficiently well developed to be relied upon.

Given these limitations, the balance of the work conducted through this research program to date has focused on developing low-data-input, GIS-based analytical methods for identifying high risk coastal zones and analyzing potential impacts within those zones, factoring in uncertainties related to Great Lakes water level fluctuations and climate change and using data sources and analytical techniques that are currently widely available. The methods and guidance materials we have developed, and that we will continue to develop through this Integrated Assessment, are being made publically available through web posting, and they represent a substantial output from our research program to date. Even so, the extent to which this work has been field-tested and refined across broad arrays of Great Lakes settings and particular community needs is limited given the limited number of communities and settings through which it was developed.

Local capacity to manage Great Lakes shorelands is necessary, but not sufficient. A notable finding from our work has been that even though substantial resources are made available to localities to help them better plan for and manage coastal hazards within their shorelands, those communities might yet lack the commitment to undertake such a task. This became clear early on as LIAA staff struggled to find coastal communities willing to undertake a master planning or plan update effort that would incorporate focused attention on shorelands, despite the substantial resources and technical assistance made available to them through the grant funding provided through this research program and other sources. It became further evident over the course of the project work as communities, or subgroups of stakeholders within communities, expressed skepticism about the accuracy and usefulness of the analyses presented or struggled with how best to convey those analyses through planning documents.

Our work suggests a number of hypotheses for why communities may lack such commitment, as well as potential strategies for response. It appears that who at the local level is engaged is critically important. For example, local planning or city officials who are not used to addressing issues beyond conventional concerns, or who worry about the political backlash from engaging issues like climate change, may stifle meaningful analysis and action. Similarly, how the issues are framed and how analyses are conducted—and especially the extent to which both are tailored to the particulars of the place—appears to substantially influence local commitment to act. Likewise, the need to address coastal management through multi-jurisdictional efforts, given the multi-jurisdictional reach of the issues, may be sufficient to dissuade local officials from proceeding. More importantly, our work to date strongly suggests that while better data and techniques are needed to enable improved local shoreland management efforts, merely providing those data and tools in-and-of itself will not necessarily prompt coastal localities to act. If the goal is to enhance local shoreland area management efforts, then enhancing local capacity toward that end will be necessary but not sufficient; finding strategies to promote local commitment to act as well will be key.

Scenario-based planning looks promising, but more work is needed. Finally, our work on developing a collaborative, scenario-based planning approach to incorporating shoreland management assessments and policies into local master plans shows promise, but it also highlights challenges and the need for additional work as well. For example, an inherent attribute of this approach is that planning analysts first develop and present to local stakeholders an array of potential high-hazard areas and buildout patterns, along with the key assumptions behind those analyses. They then retreat to allow stakeholders to question and deliberate on the analyses and their implications. On several occasions we observed local officials at first express skepticism over the findings being presented and then, through their deliberations, conclude that they were indeed plausible if not conservative. We also routinely heard that local participants appreciated the framing of results in terms of arrays of conceivable potential futures, rather than predicted future certainties. These attributes appear to have made the analyses more palatable, acceptable, and useful to participants. At the same time, scenario planning highlights the probabilistic nature of risk and reward—in this case the uncertain risk of a catastrophic storm set against the very certain benefits of allowing development in high-risk areas (i.e., increased property tax revenues), which clearly gave local officials pause.

Similarly, the extent to which localities actually accepted and used the outcomes of the work we conducted varied. While participants from Ludington expressed interest in the preliminary analyses presented through our work, for example, none requested that final analyses be conducted or shared with them after they completed their plan updates. The remaining study localities accepted and incorporated into their planning efforts the analyses we conducted, but they did so to different extents and in different ways. St. Joseph, for example, questioned the validity of the data we used initially to assess wetlands areas, and they remained skeptical of the hazard-zone analyses we conducted, at least in part because of concerns about clear inaccuracies in FEMA's Coastal Flood Study preliminary analyses encompassing the St. Joseph area. As a result, LIAA produced a final stand-alone report for St. Joseph presenting our technical analyses, but those analyses were not incorporated into the city's master plan update.

Likewise, while we conducted quite similar analyses for the two Grand Haven localities, each employed the results in different ways. The city ultimately requested that the analyses and findings be incorporated as an integral component of the main text of their draft master plan. In contrast, the township incorporated key findings in an executive summary of the plan, but it presented the analyses and findings in technical appendices rather than in the body of the plan itself. The township planner recommended this change to keep the document a manageable size; to minimize the likelihood that readers would skim through the more dense analyses and thereby miss the important results; and to reduce the use of controversial language without reducing the controversial findings, which implicate the need for additional action and implementation strategies. Her goal was to increase the chance that the analyses would remain in the final document as that document proceeds through the review and adoption process. These different responses were prompted not so much out of fear of political backlash, but rather as locality-appropriate strategies designed to enhance the ultimate success of the planning initiative, and perhaps to avoid having politically conservative officials dismantle the analyses presented by the plan.

These research findings taken altogether, particularly those related to local commitment and scenario-based planning, are informative. They imply that coastal localities engage new planning methods in different ways given the particulars of their physical settings. It also appears to be the case, however, that outcomes vary as much or more because of the different approaches that might be taken to collecting data, to working with local stakeholders as they vet data and incorporate analyses, and to presenting planning assessments to officials and the larger public. These research findings also suggest the benefit of continuing to work on developing new and innovative local planning methods, to continuing to explore more thoroughly and systematically how those methods are actually used by coastal localities moving forward, and especially to explore how localities who have incorporated meaningful coastal area management planning analyses and policies into their master plans might take the next step to implement those policies through their zoning codes and by other means.

Challenges in Implementing Adaptation

Because of our success in working with the City of Grand Haven and Grand Haven Charter Township, and because of their commitment to continuing to work on and advance meaningful coastal area management, we have continued to engage with these two communities for this Integrated Assessment. The findings we describe above more broadly regarding the causes and consequences of coastal area management challenges were not drawn exclusively from our experiences with these two communities alone, but they reflect what we have learned through our work especially with these communities nonetheless. The remainder of this section provides a brief overview of these two localities, along with an overview of initial observations from our owning work with them to implement adaptation through this Integrated Assessment.

The City of Grand Haven and Grand Haven Township are located on the Western coast the State of Michigan, on the shores of Lake Michigan. Given its location, the Grand Haven community is home to a number of sensitive natural resources, including critical sand dunes areas and coastal wetlands. The city has some 600 acres of Critical Dunes Areas, and the township is home to a little over 1,000 acres of critical dunes.[5] The township contains almost

[5] Grand Haven Township Master Plan, 2016.
http://www.resilientmichigan.org/downloads/2016_resilient_grand_haven_master_plan_compressed.pdf and
City of Grand Haven Master Plan, 2016.
http://www.resilientmichigan.org/downloads/city_of_grand_haven_master_plan_compressed.pdf

3,300 acres of wetlands, and the city contains 270 acres.[6] Sand dunes provide unique habitats for rare and endangered species, hold enormous environmental and recreational value, and also provide an important coastal flood buffer for littoral communities.[7] Similarly, wetlands are critical flood-management resources that regulate the movement of water within watersheds. Their habitats are also home to a number of Michigan's sensitive wildlife population. These important features shape the Grand Haven community's identity and economy. This incentivizes the community's desire to both protect and capitalize on their coastal setting, which often pits competing interests against each other. As such, better understanding of the many impacts of dynamic water levels can help the local officials in Grand Haven make more-informed planning and coastal area management decisions. Figures 1 and 2, below, show the distribution of coastal dunes and wetlands, respectively, within the Grand Haven community.

The city-township relationship is a common governance structure found within the state, especially in its coastal settings, as described more generally above. This structure often puts two or more different types of communities in similar natural environments. This is especially true of Grand Haven. While the City of Grand Haven and Grand Haven Township share many of the same benefits and potential burdens of the natural resources that accompany their location, they look and operate differently from a management perspective. The City of Grand Haven is much smaller and more urban than Grand Haven Township, and as a result is almost fully developed (or built out). This influences the potential management options that the city can employ to protect and grow around their natural features—for example, wetland restoration instead of wetland protection (reactive vs. proactive). Grand Haven Township, on the other hand, is still rapidly growing and evolving from its roots as an agriculture community. The township gained an additional 1,200 housing units between 2000 and 2014, and its population is projected to grow by 46% over a 20-year period.[8] Large portions of the township are not yet developed, and so they have an opportunity to employ more protective and proactive management options than the city through initiatives such as, for example, clustering residential development to conserve open space, wetlands, or tree canopy.

Despite the clear differences between the City of Grand Haven and Grand Haven Township from a structural and management perspective, their collaboration in the resilient master planning process, and now the Integrated Assessment, affords the Grand Haven community a cohesive future plan for its shared natural features.

As described more generally above, using a scenario-based planning framework and off-the-shelf GIS technology, we crafted three "climate futures" for the Grand Haven community to assess where they were most at risk for flooding events. We labeled these climate futures "Lucky," "Expected," and "Perfect Storm," reflecting increasing levels in flood severity based on higher water levels and higher precipitation storm events. The map attached to this report presents these high hazard zones cumulatively for the city and township (showing jurisdiction lines, with the city situated in the northwest and bordered by the township to the south and east). The following attributes characterize the three climate futures as presented on this map:

- *Lucky Climate Future*: Great Lakes water levels will continue to stay relatively low. Although there will be wave and wind action, major storm events and wave impacts will not encroach on properties landward of current beaches.

---

[6] Ibid.

[7] Michigan Conservation Districts, 2010. Michigan's Critical Dunes. http://macd.org/critical-dunes.html

[8] Grand Haven Township Master Plan, 2016.
http://www.resilientmichigan.org/downloads/2016_resilient_grand_haven_master_plan_compressed.pdf

- *Expected Climate Future*: Great Lakes water levels will continue to fluctuate according to long-term decadal patterns, including recent extreme storm events incorporated into FEMA's ongoing Great Lakes Coastal Flood Study. There will be periods of high water levels similar to the long-term highs recorded in 1986, with Great Lakes still-water elevation closer to that of long-term average (580 feet). There will also be more frequent large storm events than in the past with the potential to create damaging, high velocity wave action along the coast.
- *Perfect Storm Climate Future*: Great Lakes water levels will continue to fluctuate according to decadal patterns, consistent with assumptions made for the Expected future. However, still-water elevation will be higher than the long-term average and closer to the long-term high (583 feet). The Perfect Storm Climate Future also accounts for additional riverine flooding that comes from higher precipitation events.

Figure 3 illustrates these high hazard zones cumulatively for the city and township. Figure 4 provides some results from our analysis of potential impacts to land and structures within these zones under the various scenarios.

Finally, since undertaking the formal Integrated Assessment, the project team has been conferring with the community planners from the City of Grand Haven and Grand Haven Charter Township to better understand their perceived issues related to planning resiliently for fluctuating water levels moving forward. Generally, we have determined so far that:

1. The issues facing and/or of greatest interest to the city and the township are very different. These differences, however, are representative of the State of Michigan's local government fragmentation; cities and townships near similar ecological environments confront and maintain very different interests and issues for various reasons (political climate, state of current build out and infrastructure, and hierarchy of goals).
2. Issues that originate due to land use or policy further inland (like parking requirements or fences) may hold greater implications for the shorelands (like water quality impacts or restricting viewsheds) than in other settings.
3. Obtaining accurate local data will be an obstacle to appropriately addressing several of the issues. For example, wetland data in the region has not been updated since 1983.
4. This project will likely require assistance from other departments, most especially public works and building standards.

In addition to these general observations, staff from the township and city having been collaborating with the project team to work scope out the kinds of analyses they believe would be most helpful to their communities, such as analyses that would help the locality join the FEMA Community Rating System (a township interest) or revise existing sensitive overlay districts (a city interest). These issues are summarized in more detail below (See Appendices for links).

ADDITIONAL CONSIDERATIONS

None.

FIGURES

FIGURES 1A and 1B (labeled Figs 16 and 17): Buildout assessments in Grand Haven City and Township showing potential development within critical dune areas, without and with the use of BMPs.

Figure 16 Critical Dunes and the Final Build-outs:

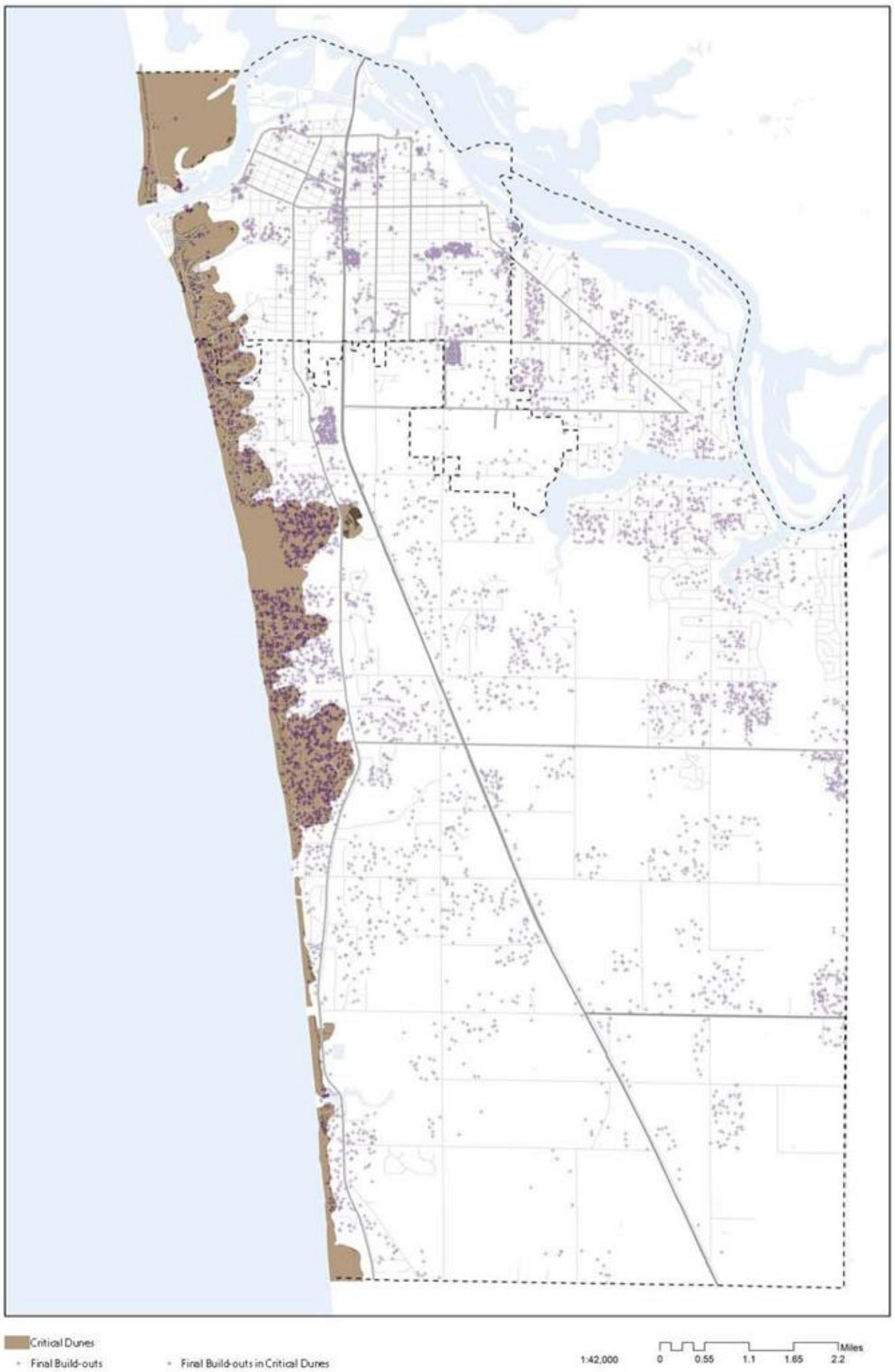

Figure 17 Critical Dunes and the BMP Build-outs:

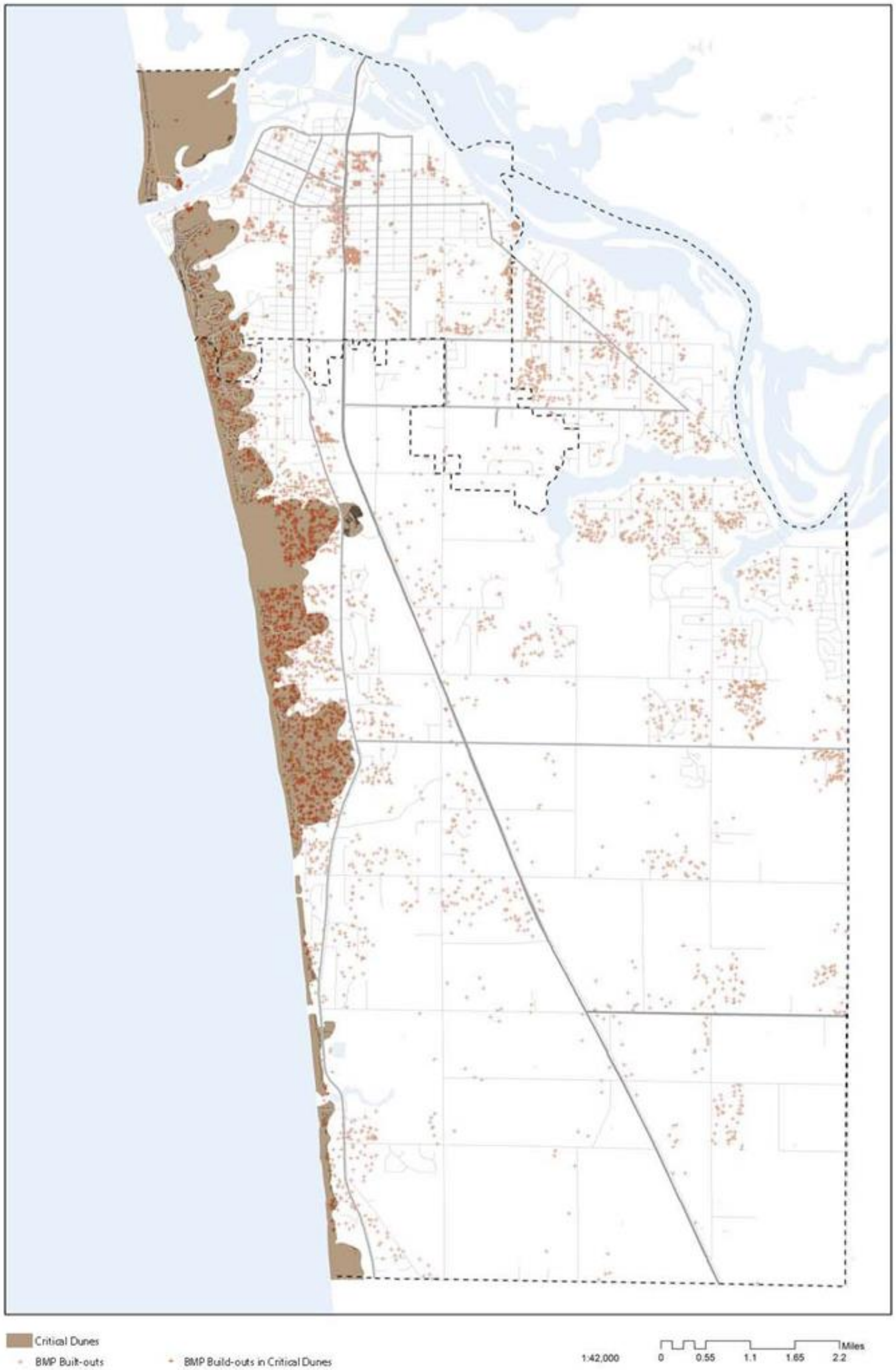

FIGURE 2: Buildout assessments in Grand Haven City and Township showing potential development within existing wetlands, without and with the use of BMPs.

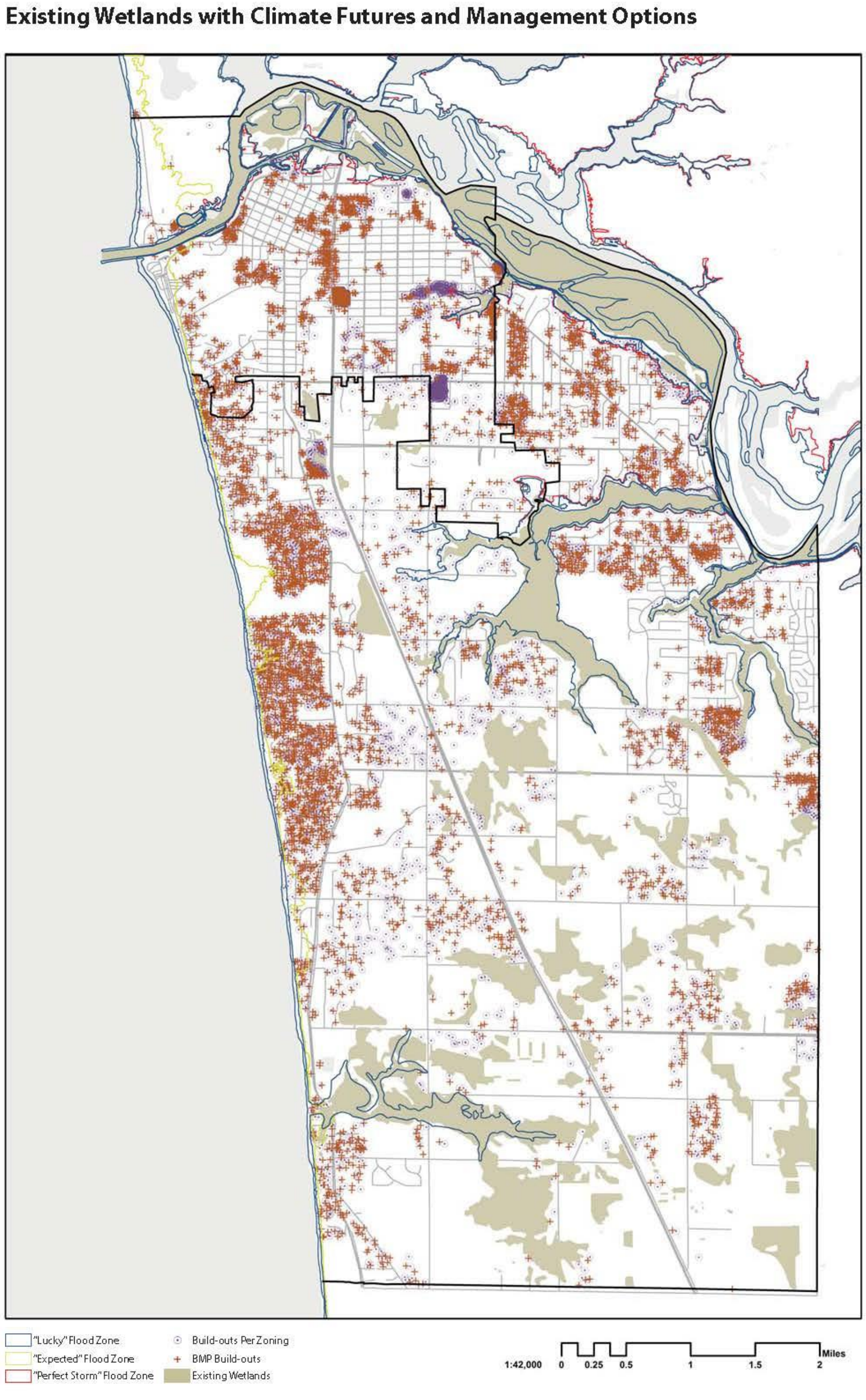

FIGURE 3: High risk flood zones in Grand Haven City and Grand Haven Township.

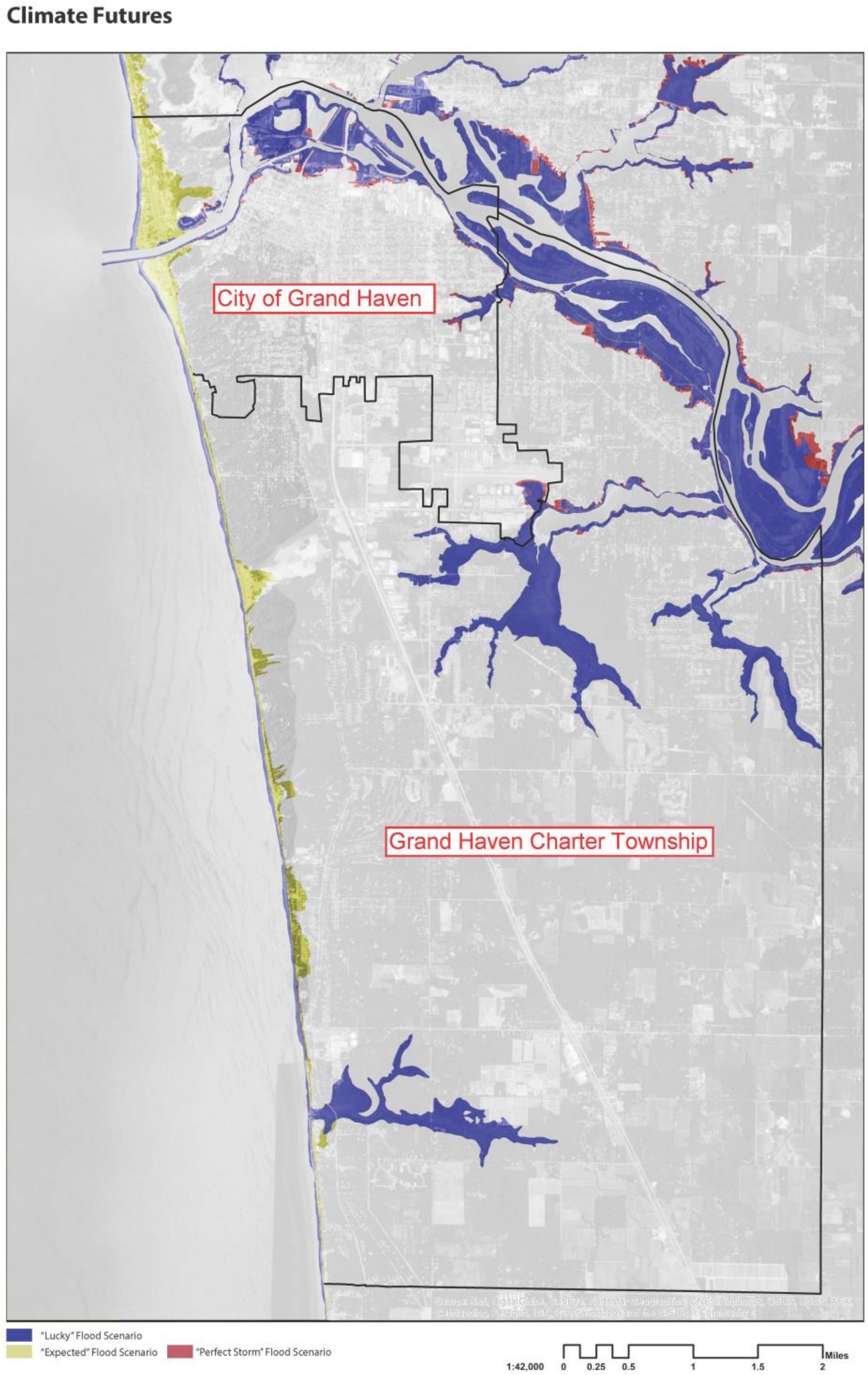

FIGURE 4: Acres and buildings potentially affected by flooding in the City of Grand Haven and Grand Haven Township under various "climate futures" ("lucky," "expected," and "perfect storm") and various development management options ("current," "build-out" under current zoning, and buildout incorporating best management practices or "BMPs")

Acres Impacted:

	Lucky	Expected	Perfect Storm
City of Grand Haven	682 total – 346 water = 336 Land	911 total – 346 water = 565 Land	953 total – 347 water = 606 Land
Grand Haven Township	1,722 total – 527 water = 1,195 Land	1,908 total – 527 water = 1,381 Land	1,946 total – 528 water = 1,418 Land

Structures Impacted:

City of Grand Haven	Current	Build-Out	BMPs
Lucky	78	+150	+2
Expected	239	+202	+48
Perfect Storm	256	+241	+49

Grand Haven Township	Current	Build-Out	BMPs
Lucky	46	+163	+6
Expected	96	+251	+49
Perfect Storm	119	+266	+52

LITERATURE CITED

Ardizone, Katherine A., and Mark A. Wyckoff. 2010. *Filling the Gaps: Environmental Protection Options for Local Governments* (2nd ed.). Lansing, MI: Michigan Department of Natural Resources and Environment.

Citizens Research Council (CRC) (1999). *A bird's eye view of Michigan local government at the end of the twentieth century*. Livonia, MI.

EPA (U.S. Environmental Protection Agency). 2014. *The Great Lakes: An Environmental Atlas and Resource Book*. http://epa.gov/greatlakes/atlas/index.html.

GLERL (U.S. Great Lakes Environmental Research Laboratory). 2014. *About Our Great Lakes: Great Lakes Basin Facts*. http://www.glerl.noaa.gov/pr/ourlakes/facts.html.

Gronewold, Andrew D., et al. 2013. Coasts, water levels, and climate change: A Great Lakes perspective. *Climatic Change* 120:697-711.

International Joint Commission. 1993. *Lake Levels Reference Study: Great Lakes---St. Lawrence River Basin, Annex 2 (Land Use and Management)*. Working Committee 2 Final Report submitted to the Levels Reference Study Board, March 31, 1993. ISBN 1---895085---46--2.

MDEQ (Michigan Department of Environmental Quality). 2014. *Shorelines of the Great Lakes.* http://www.michigan.gov/deq/0,4561,7-135-3313_3677-15959--,00.html.

Norton, Richard K. 2011. Who decides, How and Why? Planning for the Judicial Review of Local Legislative Zoning Decisions. *Urban Lawyer* 43(4):1085-1105.

Norton, Richard K. and Guy A. Meadows. 2014. Land and water governance on the shores of the Laurentian Great Lakes. *Water International* 39(6):901-920.

Norton, Richard K., Guy A. Meadows, and Lorelle A. Meadows. 2013. The deceptively complicated 'elevation ordinary high water mark' and the problem with using it on a Great Lakes shore. *Journal of Great Lakes Research* 39(2013):527-535.

Norton, Richard K., Lorelle A. Meadows, and Guy A. Meadows. 2011. Drawing lines in law books and on sandy beaches: Marking ordinary high water on Michigan's Great Lakes shorelines under the public trust doctrine. *Coastal Management* 39(2):133-157.

US Army Corps of Engineers, Detroit District, and Great Lakes Commission. 1999. *Living with the Lakes: Understanding and Adapting to Great Lakes Water Level Change*. ISBN 0-9676123-0-6.

APPENDICES

List of Events and Participants

- January 25, 2016 – First project meeting with community planners
  - Richard Norton – University of Michigan
  - Harry Burkholder – LIAA
  - Katie Sieb – LIAA
  - Zach Rable – University of Michigan
  - Jennifer Howland – City of Grand Haven
  - Stacey Fedewa – Grand Haven Charter Township
- February 16, 2016 – Project check-in phone call
  - Katie Sieb
  - Zach Rable
- March 15, 2016 – Public Hearing for City of Grand Haven Master Plan
  - Katie Sieb
- May 10, 2016 – Introduction of IA project to City of Grand Haven Planning Commission
  - Richard Norton
  - Zach Rable
- May 16, 2016 – Scoping meeting with community planners, and photo documentation of issues
  - Katie Sieb
  - Zach Rable

Grand Haven Planning Issues

Grand Haven Charter Township identified a number of issues that have an impact on shoreline management. These include:

- Critical Dune Areas- the Township has many areas designated as CDA. In 2012, the State greatly loosened restrictions on building in these areas and prevented local governments from exceeding these restrictions. The Township is wondering to what extent they can regulate land in the Critical Dune Area for reasons unrelated to the dunes (max lot coverage, impervious surface requirements?).
- Wetlands Buffers- ensuring that this would not trigger a takings case
- Desire to develop an FQI suitability tool
  - *Background* - Floristic Quality Index (FQI): "FQI is an indication of native vegetative quality for an area: generally 1-19 indicates low vegetative quality; 20-35 indicates high vegetative quality and above 35 indicates 'Natural Area' quality. Wetlands with a FQI of 20 or greater are considered high quality aquatic resources." (LINK)
- Community Rating System- The Township is considering joining. How worthwhile is this? In what ways can this program be leveraged to increase shoreland management?
- The Township currently does not have a local floodplain ordinance/overlay
- The need for housing in the Township is greatly increasing- is the issuance of permits in accordable with demand?

- Parking regulations- the Township has received complaints that industrial parking requirements are under met in some areas and overly restrictive in others.
- Monitoring fences and dock lengths
- A concern over the need to balance administrative vs. commission decisions.
- MTA proposal to deregulate agricultural land from MDEQ and SEC

The City of Grand Haven identified the following key issues, which are related to shoreland management:

- The Sensitive Areas Overlay District review is administrative now for single-family residential projects, but remains with the PC for all other uses.
- Are the boundaries of the SA Overlay District still accurate and effective?
- Do we need to add some regulations for waterfront buffers? There has been some interest from residents of North Shore to require dune grass preservation and planting.
- Look to the draft master plan for areas to focus on for possible zoning code amendments that relate to water level variability. We are looking for recommendations on possible ways to make changes. How closely do we need to connect the issue of water level variability to the items we are looking into?

Working from this feedback, we have begun identifying and exploring a number of well-researched model ordinances to use as references to meaningfully engage the issues presented to us by the City of Grand Haven and Grand Haven Charter Township. We are meeting with the planners from the two communities on May 10, 2016 to further discuss these model ordinances, and to glean their preferences regarding regulatory options.

Model Ordinance Links

High FQI:

- http://www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/FQA_text.pdf
- http://www.sustainourgreatlakes.org/wp-content/uploads/Properties-and-Performance-of-the-Floristic-Quality-Index-in-Great-Lakes-Coastal-Wetlands.pdf
- https://www.municode.com/library/mi/spring_lake_township,_ottawa_co/codes/code_of_ordinances?nodeId=COOR_CH14EN_ARTVWEPR_S14-107FIFA
- http://quod.lib.umich.edu/cgi/p/pod/dod-idx/use-of-floristic-quality-assessment-as-a-tool-for-monitoring.pdf?c=mbot;idno=0497763.0050.402
- http://dnr.wi.gov/topic/wetlands/documents/fqamethodwithacknowledgements.pdf

Wetlands Buffer:

- http://www.aswm.org/pdf_lib/model_ordinance_1209.pdf
- http://dnr.wi.gov/topic/ShorelandZoning/documents/NR117model.pdf
- http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.319.6568&rep=rep1&type=pdf
- https://www.scdhec.gov/HomeAndEnvironment/Docs/CLBO_Manual.pdf

Riparian Buffer:

- http://www.hrwc.org/wp-content/uploads/2009/11/HRWC_riparianbuffer_model_ordinance.pdf
- http://www.epa.gov/sites/production/files/2015-12/documents/2002_09_19_nps_ordinanceuments_buffer_model_ordinance1.pdf
- http://superiorwatersheds.org/images/riparianbufferreportnew.pdf

Ag Buffers:

- http://www.dca.state.ga.us/intra_nonpub/Toolkit/ModelOrdinances/AltZ/4_3.pdf

Maximum % lot coverage (limiting impervious surfaces):

- http://www.oregon.gov/lcd/docs/publications/wqgbchapter4zon.pdf
- http://www.ncwrpc.org/county_ftp/NR115/Chapter2.pdf
- http://www.dem.ri.gov/programs/bpoladm/suswshed/pdfs/imperv.pdf
- http://www.fws.gov/southwest/es/Documents/R2ES/LitCited/4TX_Sal/Arnold_and_Gibbons_1996_Impervious_cover.pdf

Smart Growth parking schedules:

- http://contextsensitivesolutions.org/content/reading/parking_md/resources/parking_paper_md/

Fencing Regulations for Waterfront properties (viewshed protection):

- http://www.preservationnation.org/information-center/law-and-policy/legal-resources/preservation-law-101/resources/Viewshed-Protection.pdf

General Model Ordinance Information:

- http://dnr.wi.gov/topic/ShorelandZoning/documents/NR115ModelOrdinance.pdf
- http://seagrant.noaa.gov/Portals/0/Documents/what_we_do/social_science/ss_tools_reports/resilient-planning_web.pdf
- http://coastalsmartgrowth.noaa.gov/elements/design.html
- http://dnr.wi.gov/topic/ShorelandZoning/LocalGovResources/local.html
- http://www.miseagrant.umich.edu/wp-content/blogs.dir/1/files/2013/08/13-720-Best-Practices-Working-Waterfronts-Case-Study.pdf
- http://dnr.wi.gov/topic/ShorelandZoning/documents/annotatedordinance.pdf
- http://www.jstor.org/stable/3147260
- https://coast.noaa.gov/czm/enhancement/media/mi3092011.pdf
- http://coastal.ohiodnr.gov/ocmp
- http://www.semcog.org/reports/lid/index.html#
- http://landpolicy.msu.edu/resources/rural_water_quality_protection_a_planning_zoning_guidebook_for_local_offici