Integrated Assessment on Water Level Variability and Coastal Bluff Erosion in Northern Milwaukee County and Southern Ozaukee County, Wisconsin
Phase 1 Report – Interdisciplinary Synthesis of Existing Research
Draft – May 8, 2016

EXECUTIVE SUMMARY

The Lake Michigan coast from Shorewood to Port Washington in southeastern Wisconsin is characterized by coastal bluffs ranging from 70 to 140 feet in height. Lake Michigan water levels were below the long-term average from 1999 to 2013, but began to rise in March 2014. This rapid rise in Lake Michigan water levels in the past two years is causing concern among property owners and local officials about impacts to beaches and the stability of coastal bluffs. Parallel with changes in Lake Michigan shores caused by rising water levels, the state enabling legislation for shoreland zoning and comprehensive planning in Wisconsin has undergone significant changes. Shoreland zoning, enabled by state law and implemented by local governments, is a primary management tool for addressing development along both inland and Great Lakes waters in Wisconsin. The combination of these natural and legislative events has precipitated a need to synthesize existing research on coastal bluffs and engage coastal communities and riparian property owners to explore a broader range of policy options and decision tools for increasing the integrity of coastal bluffs in the face of possible increases in the variability of water levels.

In March 2015, a team of investigators representing disciplines including coastal engineering, geology, urban and regional planning, law, policy studies, ecology, landscape architecture, and social science led by the University of Wisconsin Sea Grant Institute received a planning grant from the Graham Sustainability Institute at the University of Michigan to explore the impact of changing water levels on coastal bluffs in northern Milwaukee County and southern Ozaukee County. The key activities associated with the planning grant included information gathered from interviews with 19 stakeholders, partners and investigators on their perceptions of the issues, solutions, barriers, and information needs related to changing Lake Michigan water levels and coastal bluff erosion and a workshop held in late July 2015 to connect stakeholders, partners and investigators. A discussion and vote during the last hour of the July workshop indicated there was support for continued participation in the Great Lakes Water Levels Integrated Assessment. In November 2015, Wisconsin Sea Grant received word that it was one of four teams to receive funding from the University of Michigan to collaborate in a full Integrated Assessment (IA) lasting 18 months and building on the findings of the planning grants.

The full IA consists of three phases: synthesis of existing data and information, identification and assessment of a range of policy alternatives and adaptive actions, and integration of local findings into a regional report. The first phase included a synthesis workshop on March 31, 2016 with investigators and partners in Madison, Wisconsin. The workshop leveraged a new online bibliography of over 100 studies relevant to coastal hazards in the study area and prioritized the most relevant reports, studies and data for the IA. Phase 2 will include extensive community engagement to identify and prioritize policy alternatives and adaptive actions. This engagement will be led by a pair of experienced community facilitators and the Social Science Outreach

Specialist at Wisconsin Sea Grant and will include three rounds of community conversations. The first round will consist of workshops in three locations during Summer 2016 to introduce the project; listen to hopes, wishes, concerns and issues for a healthy and vital future for coastal bluffs; and identify the widest possible range of potential policies and actions. The second round in late Summer 2016 will identify preferred policies and actions, while the third round in Fall 2016 will present the draft project report to the University of Michigan for endorsement. The final phase covers developing a final report to serve as a vehicle to integrate Wisconsin findings with those of other project teams. The desired outcome of the IA would be adoption of a select set of policy alternatives by local governments and adaptive actions by coastal property owners leading to a measurable increase in the resilience of bluffs in the study area to coastal erosion.

INTRODUCTION

The first phase of the full integrated assessment in Wisconsin involves synthesis of existing research and data to better understand the effects of increased variability of Lake Michigan water levels on the integrity of coastal bluffs. Efforts undertaken to date include: enhancement of an online annotated bibliography of studies relevant to coastal hazards in the study area; identification and summary of the most relevant reports, studies, data and resources for the integrated assessment; and initiating facilitation of community engagement for the project.

Bibliography - Water Levels and Coastal Bluffs

A bibliography of scientific studies on coastal bluffs and water levels along the Lake Michigan coast in Wisconsin was created in January 2014 using the Mendeley reference manager and academic social network (http://www.mendeley.com/). The "Integrated Assessment Library – Water Levels and Coastal Bluffs" group in Mendeley contains 104 bibliographic entries as of May 2016 (https://www.mendeley.com/groups/4020161/integrated-assessment-library-water-levels-and-coastal-bluffs/). Many of the entries in the bibliography have direct links to documents.

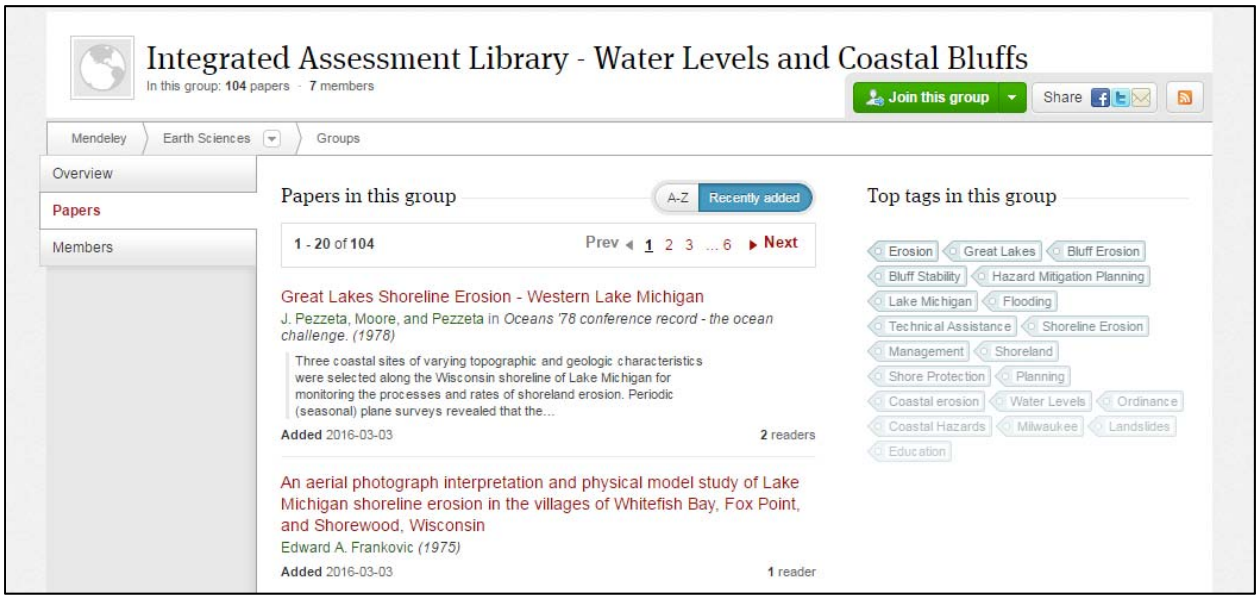

Figure 1. Mendeley Bibliography – Water Levels and Coastal Bluffs

One of the enhancements in Phase 1 of the integrated assessment is the ability to search for selected studies in the bibliography through the Open GeoPortal of the Wisconsin Coastal Atlas (http://maps.aqua.wisc.edu/opengeoportal/). The figure below shows the results of a search for "coastal processes" in "Wisconsin."

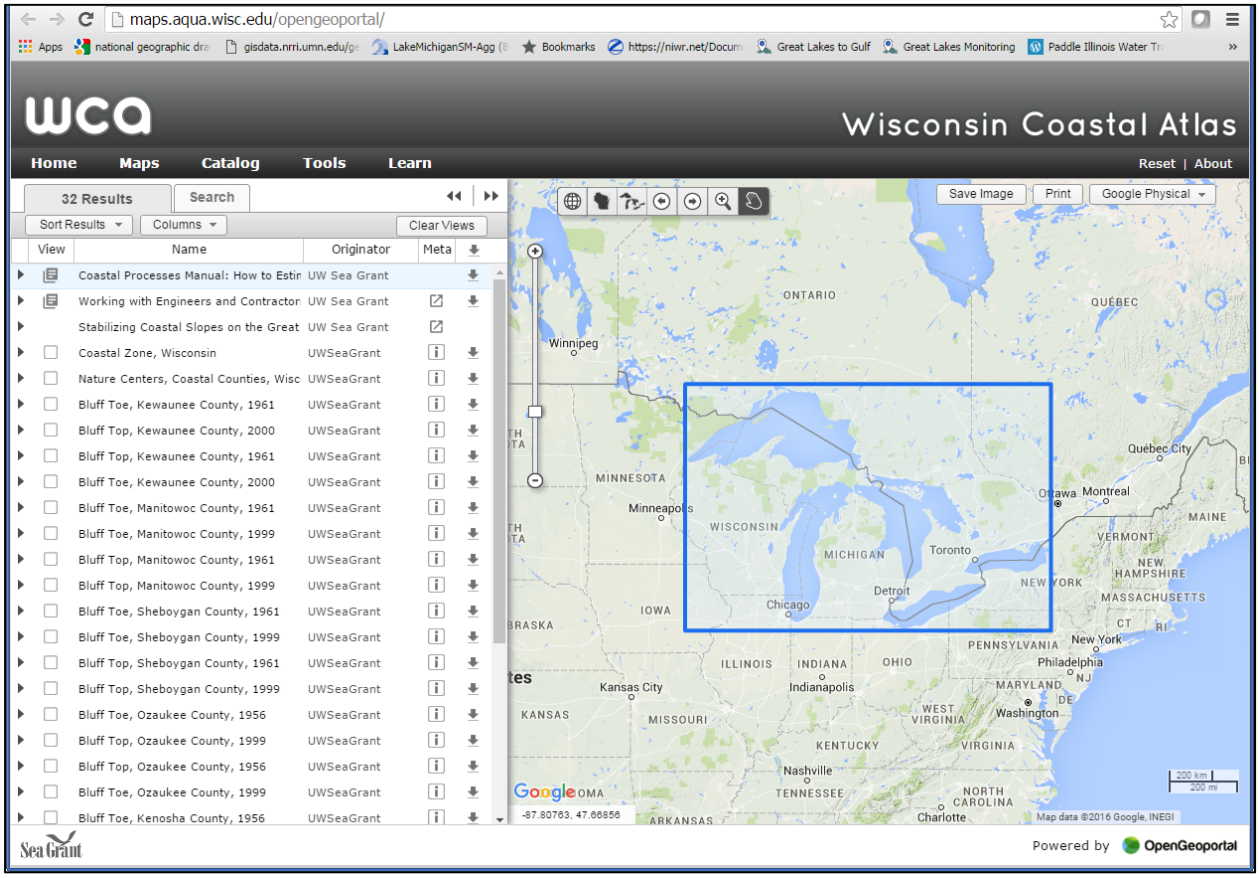

Figure 2. Wisconsin Coastal Atlas – Open GeoPortal

Synthesis Workshop

A workshop attended by 15 investigators and project partners was held on March 31, 2016 at the University of Wisconsin Aquatic Sciences Center (see Appendix A). The purpose of the workshop was to identify and prioritize the most relevant reports, studies, data and resources to support the integrated assessment. The workshop was facilitated by Bert and Linda Stitt of Stitt Facilitations and resulted in a categorized list of 26 studies, 11 resources and 15 geospatial data sets ranked for relevance by votes received.

Miscellaneous Analyses

A student hired by the UW Aquatic Sciences Center has been developing geospatial data and conducting technical analyses to support the assessment. Examples include mapping bluff and shore recession rates for the study area from a regional planning commission report (SEWRPC 1997) and developing bluff stability summaries for the study area from new data generated by investigator David Mickelson.

Community Engagement
The next phase of the integrated assessment will include extensive community engagement to identify and prioritize policy alternatives and adaptive actions. This engagement will be led by Bert and Linda Stitt of Stitt Facilitations (http://www.bertstitt.com/). Stitt Facilitations has played a key role in many community planning efforts, including a waterfront planning effort in the neighboring Lake Michigan coastal community of Sheboygan (http://bertstitt.com/archives/sheboygan.html). Community facilitation will be undertaken in collaboration with Social Science Outreach Specialist at Wisconsin Sea Grant, Deidre Peroff.

The initial stage of facilitation services, currently underway, involves setting the context for community engagement. This includes: 1) an extensive tour of the study area to establish facilitator's personal experience of the coastal environment, thus providing the context for more meaningful conversations with affected parties; and 2) conducting preliminary individual and small group conversations to establish advance personal and individual acquaintances and better understand perspectives on policy options and management actions that property owners, residents, businesses and governments may consider in adapting to current and future variability in Lake Michigan water levels and relevant bluff dynamics.

The second stage of facilitation includes three rounds of community conversations. The first round will consist of workshops in three locations (Port Washington/Grafton, Mequon, and the northern Milwaukee County villages) during Summer 2016 to introduce the project; listen to hopes, wishes, concerns and issues for a healthy and vital future for coastal bluffs; and identify the widest possible range of potential policies and actions. The second round in late Summer 2016 will identify preferred policies and actions, while the third round in Fall 2016 will present the draft project report to submitted the University of Michigan for community endorsement.

STATUS AND TRENDS

Description of the Project Locality
The location covered by this integrated assessment covers approximately 26 miles of the Lake Michigan coast from the City of Port Washington on the north to the Village of Shorewood on the south (see Figure 1). This stretch of coast is characterized by bluffs ranging from 70 to 140 feet in height that are prone to episodic erosion – red areas along the shore indicate unstable bluff conditions in 2007-08, while green areas indicate more stable bluff conditions. Local governments include two cities (Port Washington and Mequon) and one township (Grafton) in southern Ozaukee County and four villages (Bayside, Fox Point, Whitefish Bay, and Shorewood) in northern Milwaukee County.

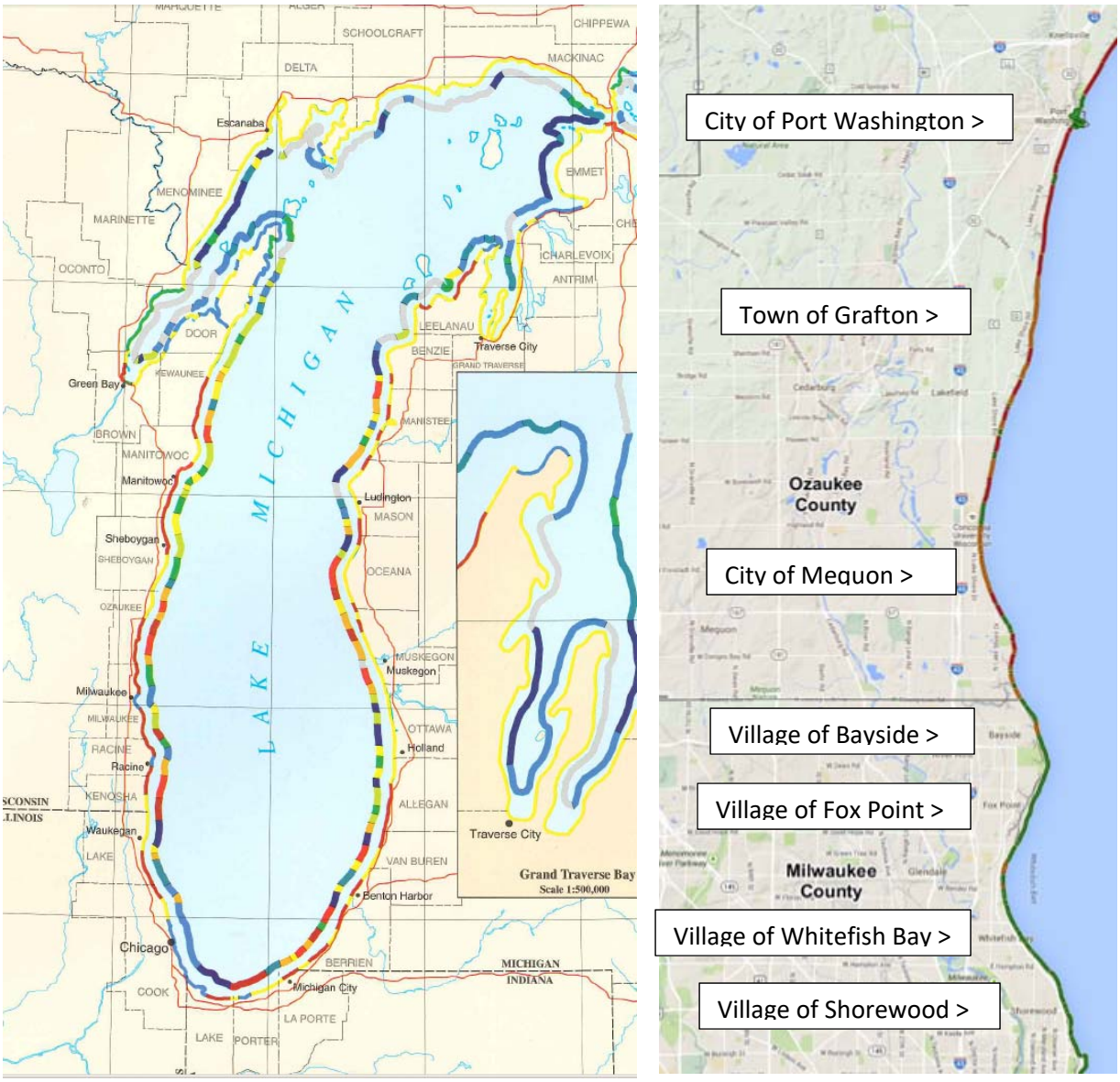

Figure 3. Project Study Area

The population of the seven local government units in the study area was 76,797 according to the 2010 Census. Population estimates for 2015 by the Wisconsin Department of Administration show growth of 1,066 people, or 1.4 percent for the five years since the last Census. The City of Mequon is the most populous local government unit at 23,793 people in 2015, while the Town of Grafton is the least populous at 4,124. The percent of population that is white ranges from 85.8 percent in the Village of Shorewood to 95.9 percent in Town of Grafton. The median age of the population ranges from 38.1 in the City of Port Washington to 49.5 in the Town of Grafton. Figure 2 shows Per Capita Income for 2008-12 from the American Community Survey by Census Block Groups and shows a higher concentration of wealth in the communities that make up the study area. Per Capita Income ranges from $30,803 in the City of Port Washington to $63,990 in the City of Mequon. Median Household Income ranges from $61,191 for the City of Port Washington to $106,733 for the City of Mequon. Demographic information is summarized in Table 1.

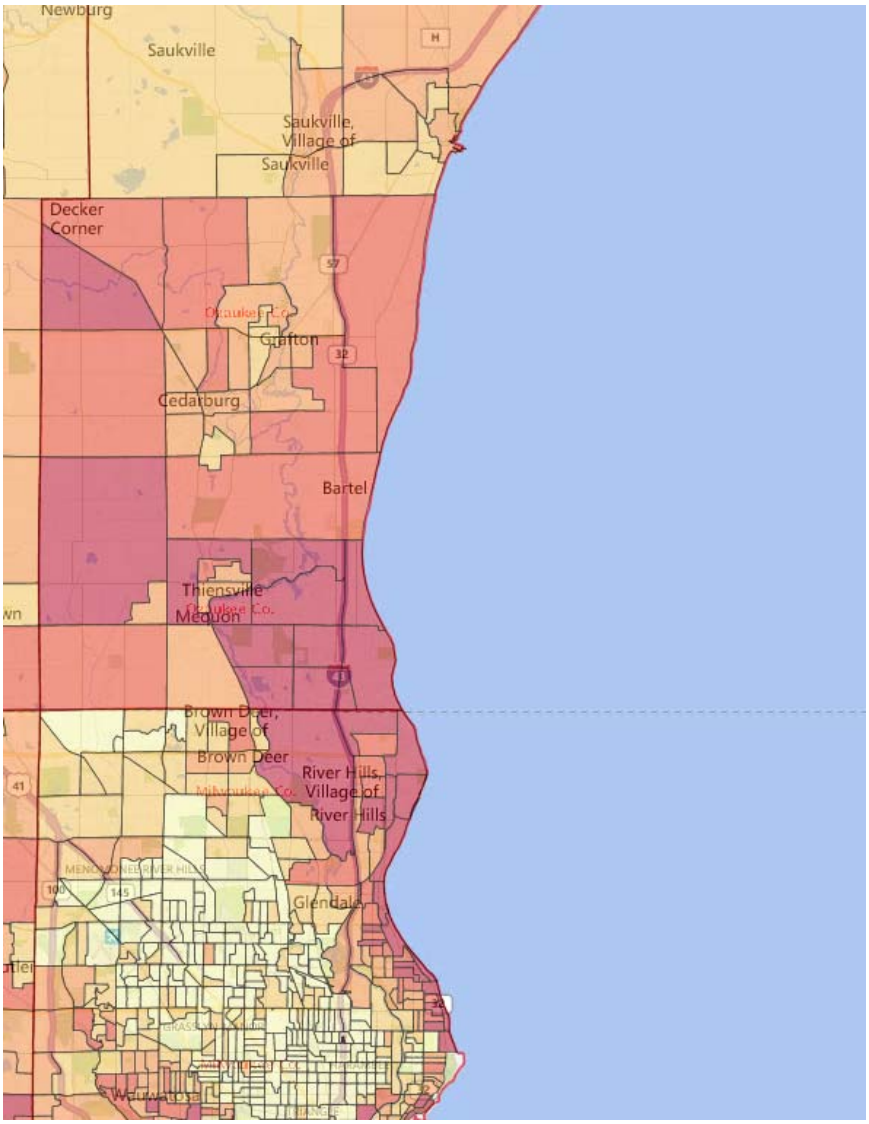

Figure 4. Per Capita Income from 2008-12. Yellow areas are under $20,000, while red areas are over $50,000. Source: Get Facts, Applied Population Lab, UW-Madison.

Table 1. Demographics for Study Area

Place Name	Split	County Name	Population Estimate, 2015 WIDOA	Population 2010, Census	Numeric Change	Percent Change	Percent White 2010, Census	Median Age, ACS 2008-12	Median Household Income, ACS 2008-12	Per Capita Income, ACS 2008-12
C Port Washington		Ozaukee	11,459	11,250	209	1.9%	92.9	38.1	61,191	30,803
T Grafton		Ozaukee	4,124	4,053	71	1.8%	95.9	49.5	83,191	43,665
C Mequon		Ozaukee	23,793	23,132	661	2.9%	90.4	46.7	106,733	63,990
V Bayside	*	Ozaukee	90	89	1	1.1%	95.5	61.6	101,667	105,852
V Bayside	*	Milw aukee	4,286	4,300	- 14	- 0.3%	88.4	45.7	90,500	51,794
V Fox Point		Milw aukee	6,690	6,701	- 11	- 0.2%	89.6	44.4	102,552	57,284
V Whitefish Bay		Milw aukee	14,243	14,110	133	0.9%	89.7	39.9	106,699	52,360
V Shorew ood		Milw aukee	13,178	13,162	16	0.1%	85.8	38.9	61,740	40,929

Key Impacts

The primary impact area that would be addressed by the integrated assessment is the influence of changing Lake Michigan water levels on coastal bluff erosion. Impact areas discussed in this report include: 1) changes to beach and bluff toes due to higher water levels; 2) impacts of shore protection structures; and, 3) changes to the lake bed, bluff face and bluff top.

Changes to Beach and Bluff Toes Due to Higher Water Levels

Changes to Great Lakes water levels have a direct impact to beaches and bluffs. With wide beach areas, higher water levels merely allow the waves to reach closer to shore. This impact could allow sediment that was once stable beach to erode and enter the nearshore coastal littoral transport system moving sediment in the direction of the dominate wave action. Any existing stable beach dunes and vegetation could be eroded as well.

Narrow beach areas would also erode due to the higher water levels and could allow waves to reach shoreline structures or bluff toes. Once the waves reach the bluff toes, erosion of the toes can cause the loss of bluff stability due to this removal of material. Bluff material above the toe cut falls into the void created by the wave erosion and the process continues up the slope.

For our study area, Lake Michigan had a 13-14 year period of low water levels from approximately 1998 to 2013. From 2013 to the beginning of May 2016, Lake Michigan rose a total of approximately 3½ feet from a record low level established in January 2013 (see Figures 5 and 6). This rapid rise in water levels have caused new beach and bluff toe erosion not seen for many years. As will be explained further below, this rise in water levels is expected to cause a change from many relatively stable slopes within the study area to being unstable.

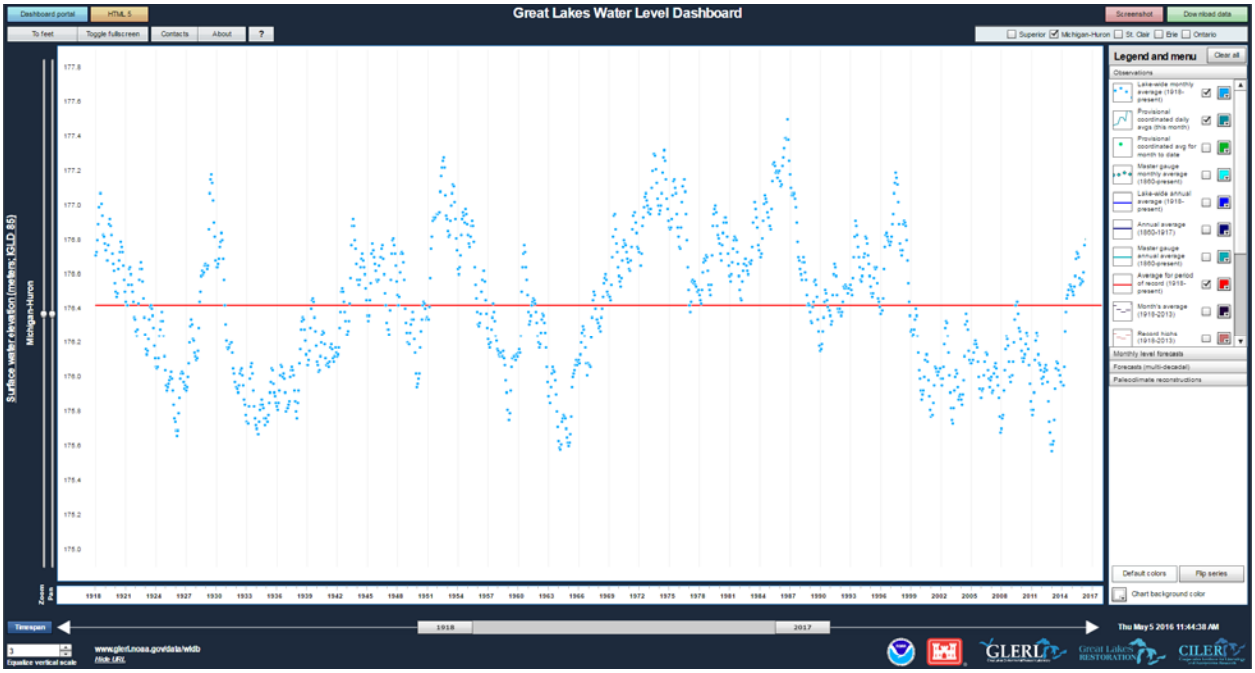

Figure 5. Lake Michigan-Huron Water Levels from 1918 to 2016.. Source: NOAA Great Lakes Water Level Dashboard.

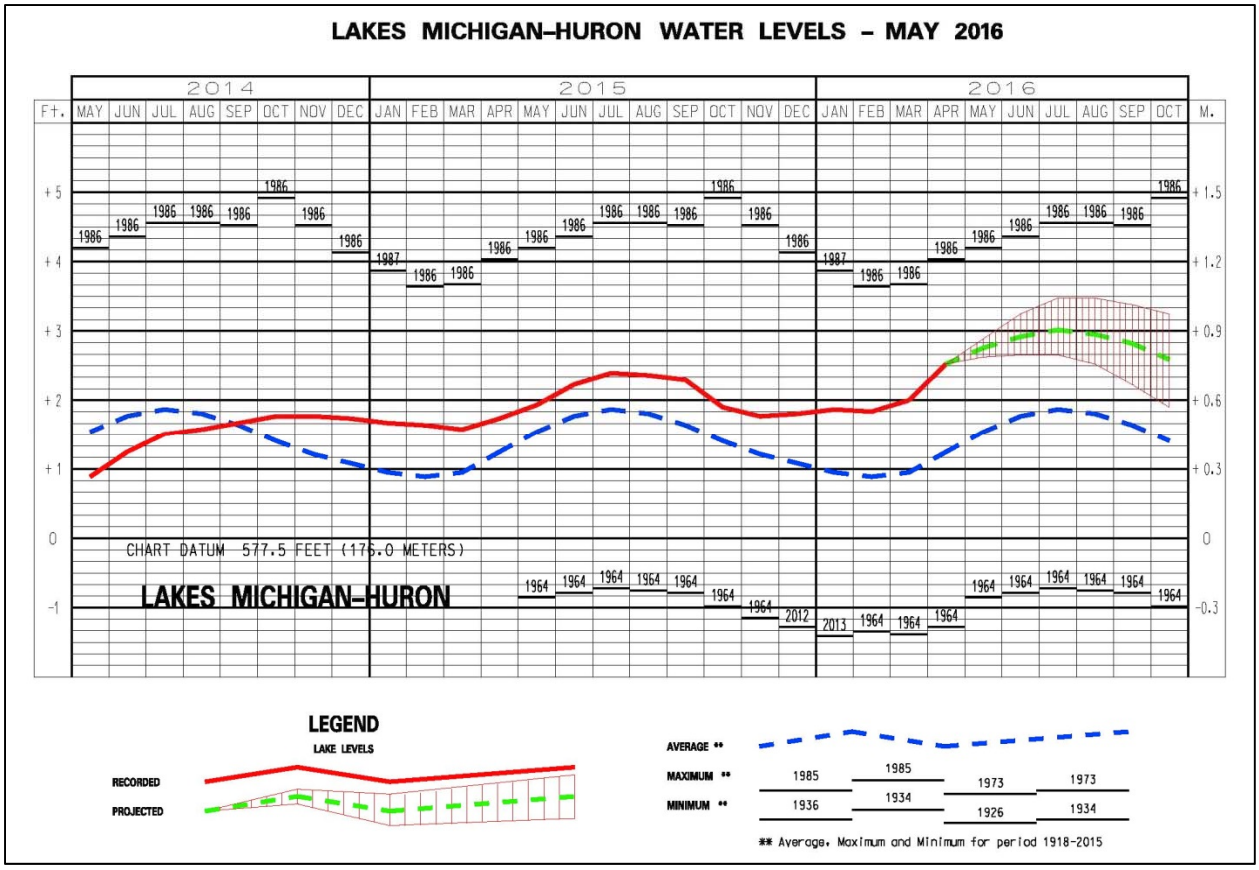

Figure 6. Monthly Bulletin of Great Lakes Water Levels for Lakes Michigan-Huron in May 2016. Source: U.S Army Corps of Engineers.

Impacts of Shore Protection Structures

Many Great Lakes private and public shorelines have been protected from damage (erosion) by storms, waves, ice and high water levels by a variety of engineered coastal and offshore shore and bluff protection structures. Just as there are many types of Great Lakes shorelines and coastal bluffs, there are many shore and bluff protection alternatives. The potential effects caused by those structures (both negative and positive) can often be observed not only directly at the immediate structure site but also farther away along the shoreline. Each structure site and structure type combination has different potential effects. The impact of bluff toe protection structures in the project area will be discussed in the changes to bluff face/top section below. Changes along the shoreline can be influenced by several key factors: the wave climate, the geology of the region, the weather (temperature, storms, freeze/thaw cycles, etc.) and human-induced shoreline changes such as the placement of coastal structures.

The most common shore and bluff toe protection structures installed along the study reach include shoreline parallel rock revetments, seawalls and shoreline perpendicular groins. High water levels can allow greater wave energy impacts to these structures causing them to fail, greater scour of beach material at their base which also can cause structural failure as well as the removal of beach material which may have been trapped by the structures (especially in the case of groins).

The presence of shoreline and bluff toe protection structures in the project region has greatly increased during the period of 1976-2007. The table below details that for Milwaukee County the percent of armored shoreline has increased from 44.6% to 62.6% and the percent of armored shoreline for Ozaukee County has increased from 9.6% to 27.3%.

Table 2. Percent of Classified Shore that is Armored with Shore Parallel, On-shore Structures

	Percent armored 1976	Percent armored 2007-08	1976-2007 change in percent armored
Marinette	na	20.1	na
Oconto	na	30.0	na
Brown	na	32.2	na
Door	na	24.0	na
Kewaunee	5.9	14.9	9.1
Manitowoc	22.4	26.6	4.2
Sheboygan	31.1	32.3	1.2
Ozaukee	9.6	27.3	17.7
Milwaukee	44.6	62.7	18.1
Racine	56.5	67.0	10.6
Kenosha	58.9	85.7	26.8
Total L. Michigan	**16.6**	**29.8**	**13.2**

The significance of this increase in percentage of shoreline armored, not only in just the study area, but also in the Wisconsin Lake Michigan shoreline region-wide is that there are significant changes in the historical availability of littoral sediment supply. That change being a regional starvation of previously available sediment now taken out of what would have been natural littoral drift. The result of this starvation would mean greater regional erosion potential such that the impacts of individual shoreline structures should be considered in regional sediment analysis.

Changes to Lake Bed (Lakebed Downcutting), Bluff Face and Bluff Top

Erosion of the lakebed is called lakebed downcutting and is common along cohesive shorelines and bluffs of glacial till and clay. In such locations, the rates at which visible erosion and recession of cohesive coastal slopes take place are ultimately controlled by the rates of invisible underwater downcutting of the lakebed. Some of the bluff or bank slope recession takes place as a result or wave erosion at the toe of the slope. Where lakebed downcutting occurs, it allows ever-larger waves to reach the toe of the slope (given the same water levels). Lakebed downcutting and slope recession proceed in unison. Lakebed downcutting is an irreversible process.

The project study reach has nearshore sediment characteristics which make lakebed downcutting a possible issue. Lin & Wu (2014) conducted a lakebed downcutting measurement project along a 1.6 km shoreline in Ozaukee County. The study area has a 1k revetment-like shoreline structure along with a reshaped bluff face (milder slope) at its center. The six year study (2007-2012) collected annual transects of ground penetrating radar (GPR) and sub-bottom profiler (SBP) data to observe the changes in the upper sand layer and most importantly, underlying glacial till composed of fine lacustrine deposits (susceptible to lakebed downcutting).

The study results showed that lakebed downcutting was occurring with mean lakebed downcutting rates measured at 1.0, 2.1 and 2.6 cm/year for the north, middle and south regions. The study concluded that "for future coastal development and management in the Great Lakes, the local geomorphologic and hydrodynamic conditions have to be taken into consideration in the planning and designing stages to provide a more thorough picture on the consequences of coastal structures."

Bluff face and bluff top failures are caused when stable slopes become unstable. Many factors can cause unstable slopes. Example factors include bluff toe erosion (discussed above as water levels increase), layers of bluff material that allow for groundwater seeps to occur, intense rainfall or rapid snowmelt on top of the slope, excess weight added to the top of the slope (buildings, mound septic systems, pools) the removal of bluff strengthening vegetation, the lessening of longshore transport (such as when adjacent properties install bluff protection structures which reduce the littoral drift contribution from their bluff), lakebed downcutting allows greater wave energy to reach the bluff toe, an increase in bluff top storm water runoff caused by impervious surfaces, etc.

Mickelson and Stone (2014) analyzed regional bluff recession by investigating changes observed between 1976 and 2007 oblique air photos. The results were clear that in general, the bluffs were considerably more stable in 2007 than in 1976. The study region was experiencing high water levels in 1976 while in 2008 the region had been in a long period of low water levels. Clearly, the water levels had an impact on the bluff slope stabilities. The study looked at the impact of the existence or lack of seeps in the bluffs and found no discernable relationship between the presence or absence of seeps on the bluff's factor of safety.

The study also showed no clear relationship between nearshore bathymetry depth distances to the bluff, shoreline orientation to the bluffs, or differences in bluff heights to the bluffs factor of safety. However, the study revealed that the presence of a structure at the toe of the bluff showed a large increase to the bluffs factor of safety when compared to bluffs with no type of shoreline protection. It is important to note that this result looks only at the bluff immediately behind the shoreline protection and not adjacent bluffs which may be impacted by the neighboring structure (regional sediment management).

Interdisciplinary Topics

Topics covered by the integrated assessment in Wisconsin include environmental, social, political, and economic drivers that must be studied to form a holistic course of action to increase the resilience of coastal bluffs to increased variability of water levels (see Figure 7). Environmental drivers include the increasing reliance on shore protection and its influence on coastal processes; and, potential climate impacts on water levels, waves, temperature and precipitation; changes in bluff vegetation. Social drivers include the nature of interactions between property owners stemming from choices for shore management; and, the degree that riparian property owners and local officials are receptive to education, outreach and resilience planning efforts. Political drivers include increased support for private property rights; changes to enabling legislation for planning and zoning legislation at the state level; and, implementation of local comprehensive and hazard mitigation plans and regional environmental plans. Economic drivers include damage to coastal property and infrastructure; the costs and benefits of shore protection and corresponding changes in property values.

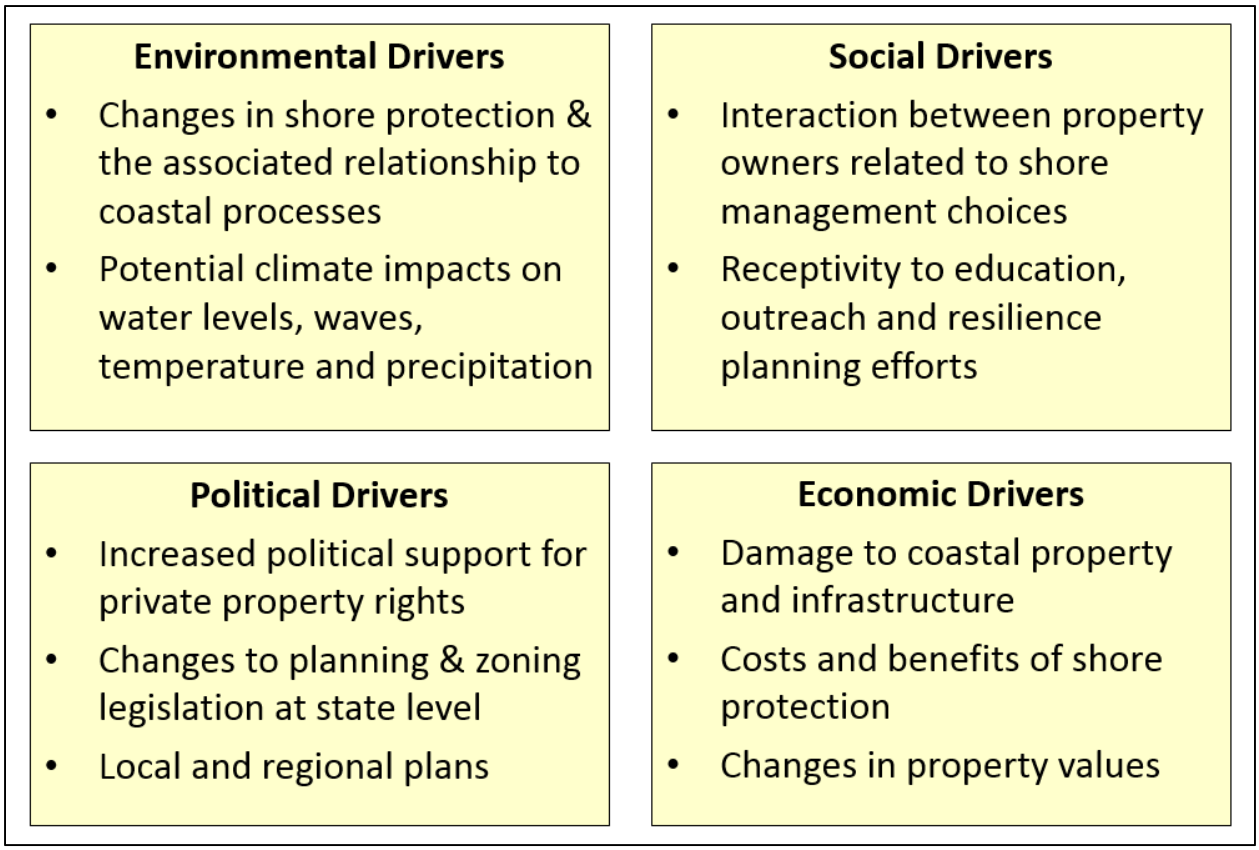

Figure 7. Interdisciplinary drivers of the Wisconsin Integrated Assessment on Water Level Variation and Coastal Bluff Erosion.

CAUSES AND CONSEQUENCES

This section presents a brief summary of the status and trends concerning changing water levels and coastal bluff erosion between Shorewood and Port Washington, Wisconsin and the corresponding consequences of those trends.

Summary of status and trends:

- Waters levels have been increasing during the last three years. Lake Michigan water levels were below the long-term average from 1999 to 2013 and have quickly jumped above that average during the past twelve months.
- From 1976 to 2012, there was a trend towards more stable coastal bluffs in the study area. Despite the general trend, new bluff failures continue to appear in the study area.
- There has been an increase in shoreline structures in the study area built since high water levels in 1976. Specifically, from 1976 to 2007/08, armoring of the Lake Michigan shore increased from 9.6% to 27.3% in Ozaukee County and from 44.6% to 62.7% in Milwaukee County.
- In recent years, waves are causing new bluff toe failures influenced by decreased beach widths.
- Lakebed downcutting has been observed at one location within the study region.
- In recent years, there have been legislative changes in Wisconsin that favor an increase in private property rights.
- The rapid rise in Lake Michigan water levels since March 2014 is causing concern among property owners and local officials.

Consequences of these trends:

- New single-property shoreline protection structures are designed and constructed with little planning for potential regional impacts.
- Properties with shoreline structures had bluffs with higher factors of safety than those with no structures.
- Water levels will remain high in the near term. Waters levels will probably fluctuate in the longer term, but not likely go down and stay down.
- New bluffs are failing which were initially stable, especially those adjacent to newly built shoreline/bluff protection structures.
- Lakebed downcutting is expected to continue due to the prolonged low water level period.
- Beaches are likely to continue to lessen in width and/or disappear. It is anticipated that the current higher water levels above long-term averages in Lake Michigan coming after the extended period of low levels could have an impact on nearshore bathymetry and beaches and correspondingly affect the stability of coastal bluffs.
- Waves will continue to cause bluff toe erosion if no shore protection present.
- The increase in shoreline structures will occur on piecemeal basis.
- The increase in shoreline armoring will decrease the amounts of regional littoral material in reach with the structures. The significance of this increase in percentage of shoreline armored not only in just the study area but also in the Wisconsin Lake Michigan shoreline region-wide is that there are significant changes in the historical availability of

littoral sediment supply. That change being a regional starvation of previously available sediment now taken out of what would have been natural littoral drift. The result of this starvation would mean greater regional erosion potential such that the impacts of individual shoreline structures should be considered within a regional sediment analysis.

- The presence of a structure at the toe of the bluff showed a large increase to the bluffs factor of safety when compared to bluffs with no type of shoreline protection. It is important to note that this result looks only at the bluff immediately behind the shoreline protection and not adjacent bluffs which may be impacted by the neighboring structure (regional sediment management).
- Lakebed downcutting will continue to occur and influence wave energy at bluff toe as well as changes to regional sediment budgets. The lakebed study concluded that "for future coastal development and management in the Great Lakes, the local geomorphologic and hydrodynamic conditions have to be taken into consideration in the planning and designing stages to provide a more thorough picture on the consequences of coastal structures".

ADDITIONAL CONSIDERATIONS

Additional knowledge needs include:

- Current analysis of bluff recession rates.
- More extensive lakebed downcutting study cover within project area.
- Identification of areas most prone to structural impacts on regional sediment management regions.
- Educational model runs showing potential coastal structure impacts on adjacent unprotected shorelines.
- Communication of changes in shoreland zoning legislation.
- Story maps to visualize and communicate issues.
- An interactive map for the study area integrating different environmental, social, political and economic issues.

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APPENDICES

Municipalities in the study area

Village of Shorewood
Milwaukee County
2010 Population: 13,162
2000 Population: 13,763
Government Website
http://www.villageofshorewood.org/
Comprehensive Plan (2011)
http://www.villageofshorewood.org/DocumentCenter/Home/View/1077
Zoning Code Website
http://ecode360.com/7777777?#7777777

Village of Whitefish Bay
Milwaukee County
2010 Population: 14,110
2000 Population: 14,163
Government Website
http://www.wfbvillage.org/
Comprehensive Plan (2009)
http://www.wfbvillage.org/index.asp?Type=B_BASIC&SEC={76FBF35A-EB7D-4DB2-BE00-A81DE71D0666}
Municipal Code Website
http://www.wfbvillage.org/index.asp?Type=B_BASIC&SEC=%7BF850FCEB-EAB2-4F1B-A0FB-F6577617F7B4%7D

Village of Fox Point
Milwaukee County
2010 Population: 6,701
2000 Population: 7,012
Government Website
http://www.vil.fox-point.wi.us/
Comprehensive Plan (2010)
http://www.vil.fox-point.wi.us/314/Comprehensive-Plan-Information
Municipal Code Website
http://www.ecode360.com/FO2984

Village of Bayside
Milwaukee and Ozaukee County
2010 Population: 4,389
2000 Population: 4,415
Government Website
http://www.bayside-wi.gov/
Comprehensive Plan (2009)
http://www.village.bayside.wi.us/DocumentCenter/View/192

Municipal Code Website
https://www2.municode.com/library/wi/bayside/codes/code_of_ordinances?nodeid=ptiimuco_ch106zo&searchtext=

City of Mequon
Ozaukee County
2010 Population: 23,132
2000 Population: 22,643
Government Website
http://www.ci.mequon.wi.us/
Maps
http://www.ci.mequon.wi.us/index.asp?Type=B_BASIC&SEC={25962BDA-0B2D-4304-9AF1-F480EB83E7CE}&DE=
Comprehensive Plan (2009, updated 2012)
http://www.ci.mequon.wi.us/vertical/Sites/%7BEC6048ED-C06B-457B-A49D-CC38EE9D051C%7D/uploads/%7B5AE92E65-D859-4504-8FC5-43356E08A209%7D.PDF
Zoning Website
http://library.municode.com/index.aspx?clientId=13876&stateId=49&stateName=Wisconsin

Town of Grafton
Ozaukee County
2010 Population: 4053
2000 Population: 3980
Government Website
http://www.townofgrafton.org/
Comprehensive Plan (adopted: April 9, 2008; amended: March 16, 2016)
http://townofgrafton.org/comprehensive-plan
Code Website
http://townofgrafton.org/code,-resolutions,-and-ords

City of Port Washington
Ozaukee County
2010 Population: 11,250
2000 Population: 10,467
Government Website
http://cityofportwashington.com/
Comprehensive Plan (2009)
http://cityofportwashington.com/compPlan.html
Zoning Website
http://cityofportwashington.com/zoningCodes.html

Counties in the study area

Milwaukee County
2010 Population: 947,735
2000 Population: 940,166
Government Website
http://county.milwaukee.gov/
Web Mapping Site
http://county.milwaukee.gov/mclio
Hazard Mitigation Plan (June 2011)
http://county.milwaukee.gov/ImageLibrary/Groups/cntySheriff/documents/2012/2011MKECountyMitigationPlan_FE.pdf

Ozaukee County
2010 Population: 86,395
2000 Population: 82,317
Government Website
http://www.co.ozaukee.wi.us/
Web Mapping Site
https://ozaukeeco.ags.ruekert-mielke.com/
Comprehensive Plan (Adopted: April 2008; Amended May 2009)
http://www.co.ozaukee.wi.us/898/Final-County-Comprehensive-Plan---2035
Hazard Mitigation Plan (Draft: July 2013)
http://www.co.ozaukee.wi.us/emergencymanagement/PDF/HazardMitigationPlan.pdf
Comprehensive Emergency Management Plan (January 2013)
https://wi-ozaukeecounty.civicplus.com/DocumentCenter/View/126

List of events and participants

Synthesis Workshop, University of Wisconsin Aquatic Sciences Center, 3/31/16 (15 attendees)

- David Hart, Assistant Director for Extension, Wisconsin Sea Grant
- Deidre Peroff, Social Science Outreach Specialist, Wisconsin Sea Grant
- Julia Noordyk, Coastal Storms Outreach Specialist, Wisconsin Sea Grant
- Gene Clark, Coastal Engineering Outreach Specialist, Wisconsin Sea Grant
- Mike Hahn, Deputy Director, Southeastern Wisconsin Regional Planning Commission
- Kate Angel, Federal Consistency & Coastal Hazards Coordinator, Wisconsin Coastal Management Program
- Caitlin Shanahan, Mitigation Section Supervisor, Wisconsin Emergency Management
- John Janssen, Professor, School of Freshwater Sciences, UW-Milwaukee (by Webex)
- Adam Mednick, Beach Health Fellow, Wisconsin Sea Grant
- David Mickelson, Emeritus Professor and Senior Scientist, Department of Geoscience, University of Wisconsin-Madison
- Brian Ohm, Professor, Department of Urban and Regional Planning, University of Wisconsin-Madison
- Chin Wu, Professor, Department of Civil and Environmental Engineering, UW-Madison
- Ben Kranner, Student, Department of Civil and Environmental Engineering, UW-Madison
- Bert and Linda Stitt, Facilitators

Key resources

- Mendeley Bibliography (https://www.mendeley.com/groups/4020161/integrated-assessment-library-water-levels-and-coastal-bluffs/papers/) [104 entries as of May 8, 2016]
- Wisconsin Coastal Atlas, Open GeoPortal (http://maps.aqua.wisc.edu/opengeoportal/)
- Great Lakes Coastal Resilience Planning Guide – Ozaukee bluffs case study (http://greatlakesresilience.org/case-studies/land-use-zoning/communicating-long-term-bluff-erosion-prevent-unsustainable-development)

List of publications

- Hart, David. 2016. *Relevant Reports, Studies, Data and Resources - Integrated Assessment on Water Level Variability and Coastal Bluff Erosion in Northern Milwaukee County and Southern Ozaukee County, Wisconsin*. Project White Paper. April 3, 2016.
- Hart, David. 2015. *Finding and Organizing Existing Research, Data and Decision Tools Related to Water Level Variability and Coastal Bluffs in Northern Milwaukee County and Southern Ozaukee County, Wisconsin*. Project White Paper. June 26, 2015.

List of presentations

- Project Overview at Synthesis Workshop, David Hart, Wisconsin Sea Grant (30 slides)

Timeline of project activities

	2016												2017			
Activity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1. Conduct interdisciplinary overview synthesis																
2. IA Phase 1 report (synthesis)																
3. GLWLIA Meeting (Ann Arbor)																
4. Setting the context for community engagement																
5. Community conversations - Round 1 (3 meetings)																
6. Identify policy and adaptive actions																
7. Community conversation - Round 2 (prioritize options)																
8. IA Phase 2 report (policies and actions)																
9. Mid-project evaluation																
10. Communicate select policy options																
11. IA Phase 3 report (select options)																
12. Community conversation - Round 3 (endorsement)																
13. Phase 3 report peer review																
14. GLWLIA meeting (Ann Arbor)																
15. IA final report compilation																
16. Final project evaluation																

List of students involved

- Ben Kranner, Student, Department of Civil and Environmental Engineering, UW-Madison