

Milwaukee County Coastal Resources Inventory Case Study

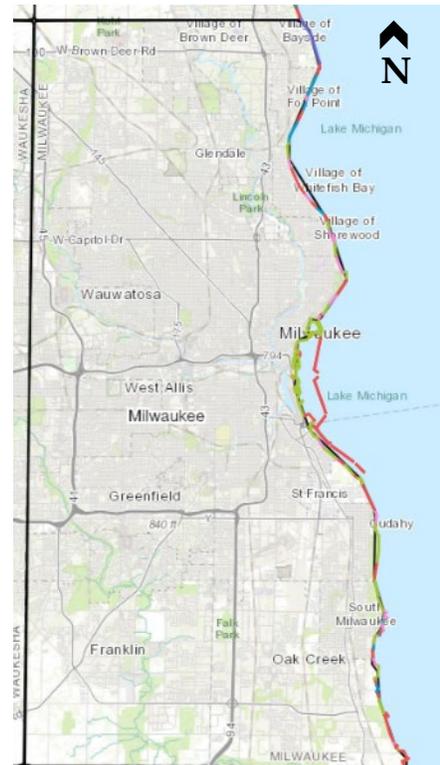
Title of Project: Milwaukee County Coastal Resources Inventory

Organization applying: Milwaukee County

Total project cost: \$70,760

Grant award: \$41,800

Summary: Milwaukee County inventoried their Lake Michigan coastal resources, summarized their current status, assigned economic values to those resources, and prioritized them according to vulnerability and value. This inventory was an important first step in a larger effort by Milwaukee County to improve preparedness for extreme weather and will be a useful tool during future planning of Milwaukee County's capital improvements. This case study describes how the project was formulated, the process county staff developed to conduct this inventory, and the results of this analysis.



Source: By Kayla Wandsnider, ArcGIS
Map Online

Coastal Resilience Self-Assessment Summary

Milwaukee County completed the Coastal Resilience Self-Assessment, a tool intended to help communities weigh the effects of various coastal hazards (Part 1) and consider planning and mitigation actions which may increase their coastal resilience (Part 2). Below are some highlights from Milwaukee County's self-assessment that guided the development of their project.

Part 1: Identifying Coastal Hazard Risks

The top hazard of concern identified in the matrix tool was a tie between Shoreline Recession/Bluff Failure and Beach Impairment.

Part 2: Resilient Practices Questionnaire

The following questions led Milwaukee County to consider some actions to enhance their resilience to coastal hazards.

→ *Question 2: Do updated maps or spatial data exist that identify areas at risk to coastal hazards?*

The only updated spatial data that existed to identify areas at risk to coastal hazards in Milwaukee County was floodplain mapping by FEMA. A top priority emerged to assess the Milwaukee County Lake Michigan shoreline for existing damage and likelihood for future coastal hazard damage.

→ Question 24: *Is the condition and expected effectiveness of shore protection structures documented?*

Milwaukee County indicated that the condition of some shore protection structures was known but not for every structure they owned. A priority emerged to inventory and assess ~~of~~ shoreline conditions and shore protection measures, including location, condition and effectiveness.

→ Question 25: *Is inspection and maintenance of shore protection structures performed routinely?*

Currently there is no formal inspection or maintenance program for shore protection structures. A priority emerged to explore what an inspection program might entail for Milwaukee County owned shore protection structures.

The Coastal Resilience Issue

Milwaukee County owns property along the Lake Michigan shoreline, primarily as part of the Milwaukee County Park System. Natural and recreational features located on the lakefront have been continuously damaged by extreme weather events. It is anticipated that damaging events will continue to occur in the future, with the possibility that the severity will be greater due to the effects of climate change.

Milwaukee County owns about 9 miles of lakefront along the Lake Michigan shoreline, primarily as part of the Milwaukee County Park System. The lake is a popular attraction, and Milwaukee County Park lands are maintained to accommodate a variety of recreational pursuits that are enjoyed along the shoreline. Natural and recreational lakefront features include sand beaches, cobble shorelines, vegetated bluffs, environmental corridors, nature trails, picnic areas, boat launches, marinas, and waterfront parks. Various types of infrastructure support those activities such as paved walks, park roads, stormwater management features, and shore protection structures.

Extreme weather has damaged Milwaukee County's coastal resources and it is anticipated that damaging events will continue to occur in the future, with the possibility that the severity will be greater due to the effects of climate change. Extremely high lake levels in 2019 and 2020 had a significant impact on shoreline erosion and beach sand movement. For example, in a January 2020 storm, damages to park property were expected to require about \$8 million in repairs.

Vision for the Community

Milwaukee County wants to be strategic in planning how to protect priority shoreline and coastal resources from ongoing erosion and flooding damage so the public can enjoy recreational pursuits along the lake and throughout the County lakeshore parks.

The Need

There was a need to develop a comprehensive asset analysis and inventory of Milwaukee County's coastal resources to assess and address their vulnerability to coastal hazard damage.

Milwaukee County needed to determine what infrastructure and assets existed, what condition they were in, and what needed to be done to maintain these assets ahead of their impairment due to age and/or weather damage. The ultimate goal is to form a plan that is preventative instead of reactive to changing lake conditions.

Collaborators

- Milwaukee County
 - o Environmental Services Unit
 - o Parks Department
 - o Land Information Office
- Wisconsin Sea Grant Institute
- Southeastern Wisconsin Regional Planning Commission

What was accomplished

The project inventoried coastal resources along Milwaukee County's Lake Michigan coast, summarized their current status, assigned economic values to those resources, and prioritized them according to vulnerability and value.

This project inventoried the resilience of Milwaukee County's coastal resources in five stages: asset inventory, condition assessment, vulnerability assessment, asset valuation, and risk score. This process was developed and performed primarily by county staff with some assistance from a consultant (GZA Environmental, Inc.). Data to support this effort was obtained from the Milwaukee County Land Information Office (e.g. asset spatial data, LiDAR topography) and the Wisconsin Shoreline Inventory and Oblique Photo Viewer (e.g. bluff condition; bluff recession rates, shoreline condition)

Step 1: Asset Inventory

Before developing an inventory of coastal assets, an area of interest needed to be determined based on the coastal area that was likely to experience hazard impacts. Since most of the county's shoreline is high bluff, this area was determined based on a stable slope distance, which is the horizontal distance a bluff top edge would be expected to recede to a stable slope condition (see Figure 1). A stable slope was estimated to be 22 degrees (or a 2.5-to-1 slope) based on many past bluff stability studies in Southeastern Wisconsin. A buffer of 100 feet was added to the stable slope distance as a factor of safety.

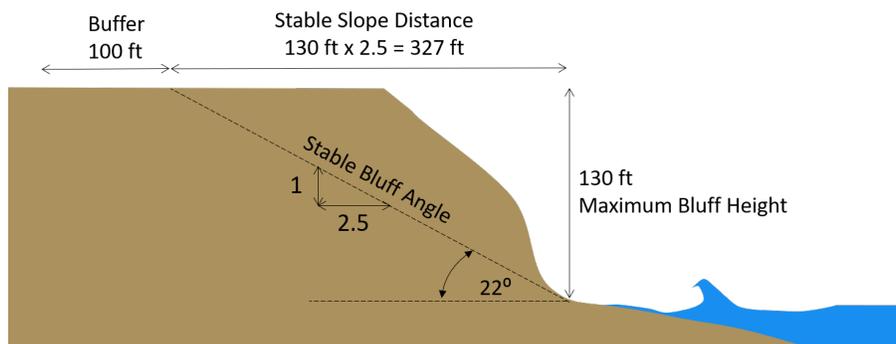


Figure 1: Diagram depicting stable slope distance calculation to determine area of interest

Based on the highest bluff in Milwaukee County (130 feet high), a horizontal stable slope distance was found to be 327 feet using the following calculation:

$$\text{Stable Slope Distance} = \text{Slope Rise} \times \text{Bluff Height} = 2.5 \times 130 \text{ feet} = 327 \text{ feet}$$

Adding a 100 foot safety buffer, the maximum setback was found to be 427 feet. From this calculation, ***the area of interest for the inventory was the area from the lakebed to a distance 427 feet landward of the shoreline.***

A total of 477 assets were found to be within the 427 foot setback distance. These assets were classified into 16 categories for further analysis. Categories included athletic courts, athletic fields, aquatic features, beaches, bluffs, bridges, buildings, golf courses, marina components, non-paved trails, open vegetated space, paved areas, playgrounds, shore protection devices, storage tanks, and stormwater management features.

Step 2: Condition assessment

A unique set of metrics was developed for each asset category to rate the condition of the asset itself as either poor, fair, or good. For example (Figure 2), paved surfaces like athletic courts and roads were assessed using existing Pavement Asphalt Surface Evaluation and Rating (PASER) scores while bluff condition was rated based on weighted measures of slope steepness, presence of vegetated cover, and presence of failures and modifications (as indicated on the Wisconsin Shoreline Inventory and Oblique Viewer). The County worked with a consultant to conduct field assessments of beaches and shore protection.

Asset Type	SubAsset Type	Condition				Weight
		Metric	Poor	Fair	Good	
Athletic Courts	Volleyball Courts					
	Tennis Courts	PASER Scoring ³	< 40	41-69	> 70	100%
	Track					
Athletic Fields	Soccer					
	Multi-Use					
	Archery					
Aquatic Features	Lagoon	BMP Maintenance Assessment [1]	1	2	3	100%
Beach	Cobble/Gravel	Soil type, nourishment needs, and amount of beach unusable [2]	D, F	C	A, B	100%
	Formal Sand	Soil type, nourishment needs, and amount of beach unusable [2]	D, F	C	A, B	100%
Bluffs		Slope steeper than 22 degrees ²	> 6%	3 - 6%	< 3%	40%
		Vegetative Cover ⁴	Mostly Bare Slope	Partly Vegetated	Thick Cover	25%
		Bluff Failure ⁴	Deep seated slumps	Shallow slides, Creep	Mostly Vegetated	20%
		Bluff Modification ⁴	Fill	Regraded	No modification	15%

Figure 2: Condition assessment example chart

Step 3: Vulnerability Assessment

For each asset category, a set of weighted metrics was developed to rate vulnerability to coastal hazards as high, medium, or low. For example, athletic court vulnerability (Figure 3) was based on distance from the shore (25% weight), whether it is located in a flood plain (25%), presence of shoreline protection (25%), and whether it is located on a bluff (25%). To quantify these ratings, “Low” vulnerability is worth 3 points since low vulnerability is desirable, each “medium” is worth 2 points, and each “high” vulnerability is worth 1 point. Then the vulnerability score for each metric was multiplied by the weight and summed to get a total vulnerability score. **If the total score was less than 1, the asset was deemed to have a “high” vulnerability to coastal hazards, between 1 and 2 was considered “medium” vulnerability and greater than 2 was considered “low” vulnerability.** Approximately 22% of assets were deemed to have high vulnerability to coastal hazards.

Asset Type	Metric	Vulnerability			Weight	Score	Weighted
		High	Medium	Low			
Athletic Courts	Distance from Shore	<100 ft	100-350 ft	>350 ft	25%	1	0.25
	In 100 Year flood plain (Elevation at 587.5ft)	Yes	-	No	25%	1	0.25
	Shoreline Protection	Rated Poor or None	Rated Fair	Rated Good	25%	3	0.75
	Located on a bluff?	Yes	-	No	25%	3	0.75
	Total						

Figure 3: Example vulnerability scoring chart

Step 4: Asset Valuation

To help compare vulnerable assets in economic terms, each asset was assigned a repair or replacement value. For example, athletic courts are most likely to be replaced in the event of substantial damage whereas existing shore protection structures are often rehabilitated rather than fully replaced. One unique category was bluff lands, which cannot necessarily be replaced. The value of bluff lands was assigned the costs of preventative measures to postpone erosion (stabilization, shore protection, etc). This valuation method did not attempt to include social value of any assets. Measuring the economic value of an asset not only helps compare high risk assets but also helps plan for their eventual repair and replacement.

Asset Type	Sub Asset Type	Number of Assets	Value Type	Value Cost	Value Source	Sub Asset Valuation Total	
Athletic Courts	Stand-alone volleyball courts	1	Replacement	\$5,000/each	Capital Planning	\$5,000	
	Tennis Courts	1	Replacement	\$115k/each	Capital Planning	\$115,000	
	Track	1	Replacement	\$100k/each	Capital Planning	\$100,000	
Athletic Fields	Soccer	4	Replacement	\$1,800/each	Capital Planning	\$7,200	
	Multi-Use	2	Replacement	\$1,800/each	Capital Planning	\$3,600	
	Archery	1	Replacement	\$1,800/each	Capital Planning	\$1,800	
Aquatic Features	Lagoon	2	Repair	\$80/LF	Milwaukee County Lagoon Maintenance Projects	\$592,954	
	Beach	Cobble/Gravel	3	Replacement	\$0.24M / acre	2018 South Shore Cost Estimates	\$3,997,505
		Formal Sand	6	Replacement	\$0.24M / acre	2018 South Shore Cost Estimates	\$8,676,735
Bluffs		45,505 LF	Preventative	\$3,000/LF	Shoreline Erosion Study for Warnimont Park, 2001 with inflation	\$1,486,059,488	

Figure 4: Asset valuation example chart

Step 5: Risk Score

A risk score index was developed to summarize the condition and vulnerability ratings assigned to each asset. This was done to have a general understanding of the risk and potential loss/cost for each asset as determined from the asset valuation (Step 4). **The risk score was calculated by multiplying the condition score (from Step 2) by the vulnerability score (from Step 3).**

$$\text{Risk Score} = \text{Condition Score} \times \text{Vulnerability Score}$$

This risk score was used to group assets into three levels of priority based on the following criteria:

- High Priority: Risk score below 4.5
- Medium Priority: Risk score between 4.5 and 6.74
- Lower Priority: Risk score 6.75 and above.

The total number of assets falling into each priority category was

- High Priority: 90
- Medium Priority: 143
- Low Priority: 244

	Type	Location	Condition	Vulnerability	Risk Score	2020 Cost
1	Beach	Big Bay	1	1	1	\$1,121,285
2	Groin	Warnimont Park	1	1	1	\$454,883
3	Groin	Warnimont Park	1	1	1	\$343,651
4	Rip Rap	McKinley Marina	1	1	1	\$175,375
5	Parking Lot	Bradford Beach	1	1.25	1.25	\$6,185,435
6	Breakwater	South Shore Park	1	1.5	1.5	\$2,990,000
7-18	Groin	Sheridan Park	1	1.5	1.5	\$55,000
19	Rip Rap	War Memorial and Art Center	1	1.5	1.5	\$83,000
20	Rip Rap	War Memorial and Art Center	1	1.5	1.5	\$83,700

Figure 5: Example of the top 20 priority assets

Results

Milwaukee County inventoried all of their coastal assets that may be impacted by coastal hazards. A set of metrics was developed to evaluate the condition, vulnerability, risk and value of each asset. From a total of 477 assets, Milwaukee County identified 90 assets with a high risk to harm from coastal hazards like storms, high water levels and erosion. The results of this analysis provides Milwaukee County with starting point of priorities to manage coastal risk throughout its nearly 9 miles of county-owned Lake Michigan shoreline.

This assessment was documented in Geographic Information System and the resulting data was compiled into a geodatabase and an interactive map (Figure 6) that highlights risk areas, ratings, and background data.

Links to this publicly available data are available at:
[Geodatabase link](#)
[Interactive map link](#)

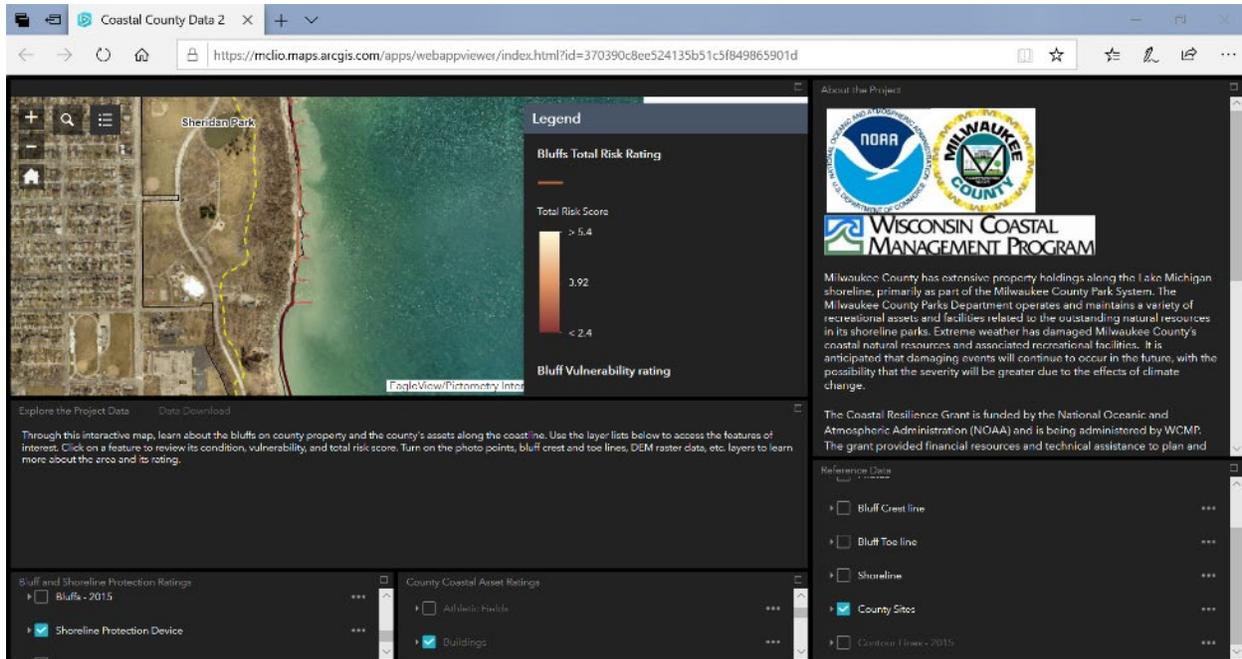


Figure 6: Screenshot of Milwaukee County Coastal Resources Inventory Interactive Map

Partnerships Reinforced or Made

This project strengthened relationships with experts and organizations in the field of coastal hazards. For example, the project team worked with Adam Bechle of Wisconsin Sea Grant and David Mickelson, GeoProfessional Consultants LLC, to utilize the Wisconsin Shoreline Inventory and Oblique Photo Viewer to assess bluff recession rates and shoreline changes since 1956 as well as information regarding County-owned structures captured in GIS work. The team also used a cost estimating tool (Small Harbor and Marina Infrastructure and Dredging Cost Evaluation Matrix) developed by UW Sea Grant, to help assign values to port and harbor assets.

Going Forward

The inventory is an important first step in a larger effort by Milwaukee County to improve preparedness for extreme weather. The completed inventory identifies the County's coastal resources and the assets' vulnerability to weather driven damage, and it prioritizes investments in coastal resiliency. Following completion of the project, meetings were scheduled with the Parks Department staff to determine how the GIS data can be used as an internal planning tool. The information generated by the study will also be a useful tool during future planning of Milwaukee County's capital improvements budgets as it will help ensure that limited local funds are used in the most cost-effective manner possible. Documenting the extent to which the County's coastal resources are vulnerable to extreme weather will also help in the pursuit of construction grants, and potentially help stimulate greater investments in funding coastal protections by the state and federal governments.

The Milwaukee County Parks Department is also developing a Coastline Management Policy in a separate but related project funded through the Coastal Resiliency Grant Program. This work will lay out practices for managing County-owned lands to assist with preventing or reducing shoreline recession, bluff failure, or erosion. Together, the asset inventory and management policy will provide direction for future decisions and proactive actions by the County.

Lessons Learned

- The asset inventory has provided a systematic understanding of Milwaukee County's coastal assets and what potential future projects need to be done to preserve their use and enjoyment.
- There is not a standard of practice available regarding how to assess vulnerability to coastal hazards. County staff developed their own process to do this.
- Outside expert knowledge was gained by hiring a consultant engineer for specialized tasks like inspecting the condition of coastal structures.