

Table 2. Data sources for evaluating biophysical vulnerability in Great Lakes coastal states. (<http://resilientgreatlakescoast.org/>) (As of 01/2021)

Hazard	Dataset	Data Source	Data Format	Description	Advantages	Disadvantages
Shoreline Type	U.S. Great Lakes Hardened Shorelines Classification 2019 ¹	NOAA Office for Coastal Management	GIS layer	This dataset is a GIS polyline layer that identifies the shoreline classification. The data were created by digitizing the shoreline using the National Agriculture Imagery Program imagery from 2014 through 2017 and comparing it with oblique imagery. The dataset provides updated shoreline classifications.	Free dataset. Shoreline segments can be selected based on attributes like which state the shoreline belongs to. This makes it easier to quickly map shoreline armoring locations, as well as calculate the percentage of the shoreline that is armored. Additionally, the dataset includes structural condition ratings for artificial shoreline segments. This allows for a better understanding of how to rate vulnerability for artificial shoreline segments. Prior indices rated the vulnerability of all artificial shorelines the same—whether the artificial shoreline would last 1-5 years or 20+ years.	The dataset is not updated frequently. The previous version was developed in 2012 for 1990s data. Bluff height information is not detailed.
	Humphry's Shoretypes ²	Superior Watershed Partnership Great Lakes Shoreviewer	Online data viewer	MSU Extension partnered with various agencies to map Humphry's shoretypes for select critical dune areas and develop updated maps. Humphry's shoretypes are more detailed than those tracked by NOAA and focus on the bluff composition in vulnerability ranking, even where shoreline armoring is located.	Free dataset. Very detailed analysis of shoreline composition that includes many variables other classification schemes do not account for.	The GIS layer is not downloadable. Also, the detailed information is only available for select sites, and shoretypes are provided at the county-level.
Coastal Slope	Digital Elevation Model Products (3DEP) ³	USGS	GIS layer	Digital elevation models can be downloaded from the USGS and used to calculate the regional coastal slope.	Free dataset.	The coastal slope must be calculated in GIS using the digital elevation model raster.
	U.S. Coastal Lidar Elevation Data - Including the Great Lakes and Territories, 1996 - present ⁴	NOAA National Centers for Information	Lidar data	This dataset shows the elevation profile for the U.S. shoreline, including the Great Lakes. Coastal slope can be calculated using this data.	Free dataset.	The coastal slope must be calculated in GIS using the lidar data. More complicated than working with raster data.

¹ <https://coast.noaa.gov/digitalcoast/data/hardened-shorelines.html>

² <https://superiorwatersheds.org/projects/great-lakes-shoreviewers>

³ <https://viewer.nationalmap.gov/basic/#/>

⁴ <https://catalog.data.gov/dataset/u-s-coastal-lidar-elevation-data-including-the-great-lakes-and-territories-1996-present>

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Water Level Variability	NOAA National Data Buoy Center ⁵	NOAA	GIS layer and table	This dataset includes water level measurements. Data are recorded every 6 minutes and can be compiled seasonally and annually.	Free dataset. GIS point layer and data summaries are available on the Great Lakes Aquatic Habitat Framework webpage. ⁶	None.
Water Level Variability (Continued)	Great Lakes Water Level Dashboard ⁷	NOAA-GLERL	Graph on online dashboard	The Great Lakes water level dashboard provides historic water level data for each of the Great Lakes. The graphs show observed values, as well as the long-term average.	Simple, easy to use.	Aggregates lake levels by lake. NOAA buoy data are higher resolution.
Coastal Flooding	National Flood Hazard Layer (NFHL) ⁸	FEMA	pdf maps, GIS layers	The national flood hazard layer includes pdf maps and GIS layers that show FEMA's flood insurance rating maps (FIRMs). These depict the various flood zones, X, A, AE, AO, V, VE, and so on.	Free dataset. Already compiled in a GIS layer that can be clipped and manipulated to identify areas at risk.	Out-of-date and inaccurate compared to flood factor. Static view of flood risk; does not project future risk. Does not capture Great Lakes coastal flooding. Requires additional elevation and lake level/storm surge data to estimate VE zones where not established by FEMA (see e.g., Norton and colleagues).
	Risk Rating 2.0 ⁹	FEMA	pdf maps, GIS layers	This dataset is expected to be released in October 2021. The maps are intended to be more accurate than current FEMA FIRMs. Rating characteristics will be based on distance to coast, different types of flood risk, and cost to rebuild home.	Free dataset.	Unsure of the accuracy compared to Flood Factor. Limited information available about the dataset. Also, determining risk based on cost to rebuild home may result in inequitable resource allocation.
	Coastal Wetlands Explorer ¹⁰	Great Lakes Aquatic Habitat Framework	Online data viewer, GIS layer	This dataset shows coastal inundation scenarios based on high lake levels and wave run-up.	Pre-compiled dataset showing projected coastal inundation.	Data do not allow for evaluation of different flooding scenarios; static depiction of risk.

⁵ <https://www.ndbc.noaa.gov/>

⁶ <https://www.glahf.org/data/>

⁷ https://www.glerl.noaa.gov/data/dashboard/GLD_HTML5.html

⁸ <https://www.fema.gov/flood-maps/products-tools/national-flood-hazard-layer>

⁹ <https://www.fema.gov/flood-insurance/work-with-nfip/risk-rating>

¹⁰ <https://www.glahf.org/wetlandexplorer/>

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Coastal Flooding (continued)	Flood Factor ¹¹	First Street Foundation	xls	Provides updated flood maps for inland and coastal flooding. Risk ratings are based on “a location’s history and geographic information (such as elevation, climate, proximity to water, and adaptation measures).”	Comprehensive, up-to-date, and more accurate than FEMA FIRMs. Includes both FEMA FIRM data and flood score data for comparison. Includes inland and coastal flooding. Identified 14.5 million properties at risk for flooding compared to 9 million properties identified by FEMA FIRMs—nearly 70% more properties at risk. Also, identifies percent properties at risk and risk scores for 2020, 2035, and 2050.	Dataset must be purchased. Unclear how accurate coastal flood data are for the Great Lakes.
Wave Height	Wave Information Study (WIS) Station Data ¹² and Locations ¹³	U.S. Army Corps of Engineers	Space-delimited columnar ASCII files and x-y coordinate table	The wave information study (WIS) provides data on wave height. There are hundreds of stations located in the Great Lakes region, providing high resolution data.	Free dataset. Very comprehensive dataset that can provide wave data at a high resolution.	Large and intensive dataset to work with—space-delimited columnar ASCII files require extensive cleaning and converting x-y coordinates of buoys to points in GIS.
	NOAA National Data Buoy Center ¹⁴	NOAA	GIS layer and tables	This dataset includes information on min, max, and mean wave height. It can be calculated seasonally and annually.	Free dataset. GIS point layer and data summaries are available on from Great Lakes Aquatic Habitat Framework ¹⁵	Fewer stations with data compared to U.S. Army Corps of Engineers WIS.
Coastal Erosion	High Risk Erosion Areas Michigan ¹⁶	EGLE	pdf maps, GIS layer	This is a polyline layer showing the erosion rate for high erosion areas in Michigan.	Free dataset. Simple, easy to use.	Not comprehensive, not up to date, and low-resolution data.
	Coastal Change Viewer ¹⁷	MTU	Online data viewer	Allows user to view historic imagery, shorelines, and bluff lines along the Great Lakes Coast. Measures changes in shoreline position and provides access to coastal oblique imagery (limited extent).	Shows historic water levels for entire shoreline for 1938, 1980, 2009, and 2016.	Received error when trying to download GIS layers for work in ArcGIS Pro. Limited coverage of 30-bluff erosion rates.

¹¹ <https://floodfactor.com/methodology>

¹² <http://wis.usace.army.mil/hindcasts.html>

¹³ http://wis.usace.army.mil/wis_station_info_tables.html

¹⁴ <https://www.ndbc.noaa.gov/>

¹⁵ <https://www.glahf.org/data/>

¹⁶ https://www.michigan.gov/egle/0,9429,7-135-3311_4114-344443--,00.html

¹⁷ <https://portal1-geo.sabu.mtu.edu/mtuarcgis/apps/webappviewer/index.html?id=d758800bb18e460ab39aa66631051156>

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Coastal Erosion (Continued)	Humphry's Shoretypes Map Viewer ¹⁸ and MNFI Report ¹⁹	Superior Watershed Partnership Great Lakes Shoreviewer	Online data viewer	MSU Extension partnered with various agencies to map Humphry's shoretypes for select critical dune areas and develop updated maps. Provide erosion vulnerability rankings for the Michigan shoreline based on physical characteristics (sediment type and slope).	Free dataset. Very detailed analysis of shoreline composition that includes many variables other classification schemes do not account for.	The GIS layer is not downloadable. Also, the detailed information is only available for select sites, and shoretypes are provided at the county-level.
	U.S. Coastal Lidar Elevation Data - Including the Great Lakes and Territories, 1996 - present ²⁰	NOAA National Centers for Information	Lidar data	This dataset shows the elevation profile for the U.S. shoreline, including the Great Lakes. Coastal erosion rates can be calculated using this data.	Free dataset. More accurate and comprehensive than EGLE dataset.	The coastal slope must be calculated in GIS using the lidar raster data. There are only 2-3 years available for each portion of shoreline, which are insufficient for calculating 30-year erosion rates.
Ice Cover and Concentration	Great Lakes Historical Ice Cover and Concentration ²¹	NOAA-GLERL	GIS layers	NOAA-GLERL provides downloadable GIS raster layers showing ice cover (number of days) and concentration (percentage) from 1973 to 2019.	Free dataset. Comprehensive and up to date.	None.

¹⁸ <https://superiorwatersheds.org/projects/great-lakes-shoreviewers>

¹⁹ <https://mnfi.anr.msu.edu/reports/MNFI-Report-2019-07.pdf>

²⁰ <https://catalog.data.gov/dataset/u-s-coastal-lidar-elevation-data-including-the-great-lakes-and-territories-1996-present>

²¹ <https://www.glerl.noaa.gov/data/ice/#historical>