

NOAA OFFICE FOR COASTAL MANAGEMENT

Tools and Data for Evaluating Change at Minnesota Point

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AUGUST 24, 2023

Introduction



Physical Scientist / Regional Geospatial Coordinator
BS Geography Bemidji State University
MS University of Montana
Remote Sensing, Geomorphology, Artificial Intelligence




Presentation Overview

Tools / Data / Use Cases



Lake Level Viewer



LAKE LEVEL VIEWER

United States Great Lakes

Choose a Lake to Explore

Lake Superior Lake Michigan Lake Huron Lake St. Clair Lake Erie Lake Ontario

NOTE: Panning between lakes without changing location in the lake drop-down menu will result in incorrect lake levels displayed. Water level elevations values shown in the water level selector are specific to each Lake.

Disclaimer

The data and maps in this tool illustrate the scale of potential flooding or land exposure at a given water level, not the exact location. They do not account for erosion, subsidence, or future construction. Water levels are shown as they would appear during calm conditions (excludes wind-driven changes in water levels). The data, maps, and information provided should be used only as a screening-level tool for management decisions. As with all remotely sensed data, all features should be verified with a site visit. The data and maps in this tool are provided "as is" without warranty to their performance, merchantable status, or fitness for any particular purpose. The entire risk associated with the results and performance of these data is assumed by the user. This tool should be used strictly as a planning reference tool and not for navigation, permitting, or other legal purposes.



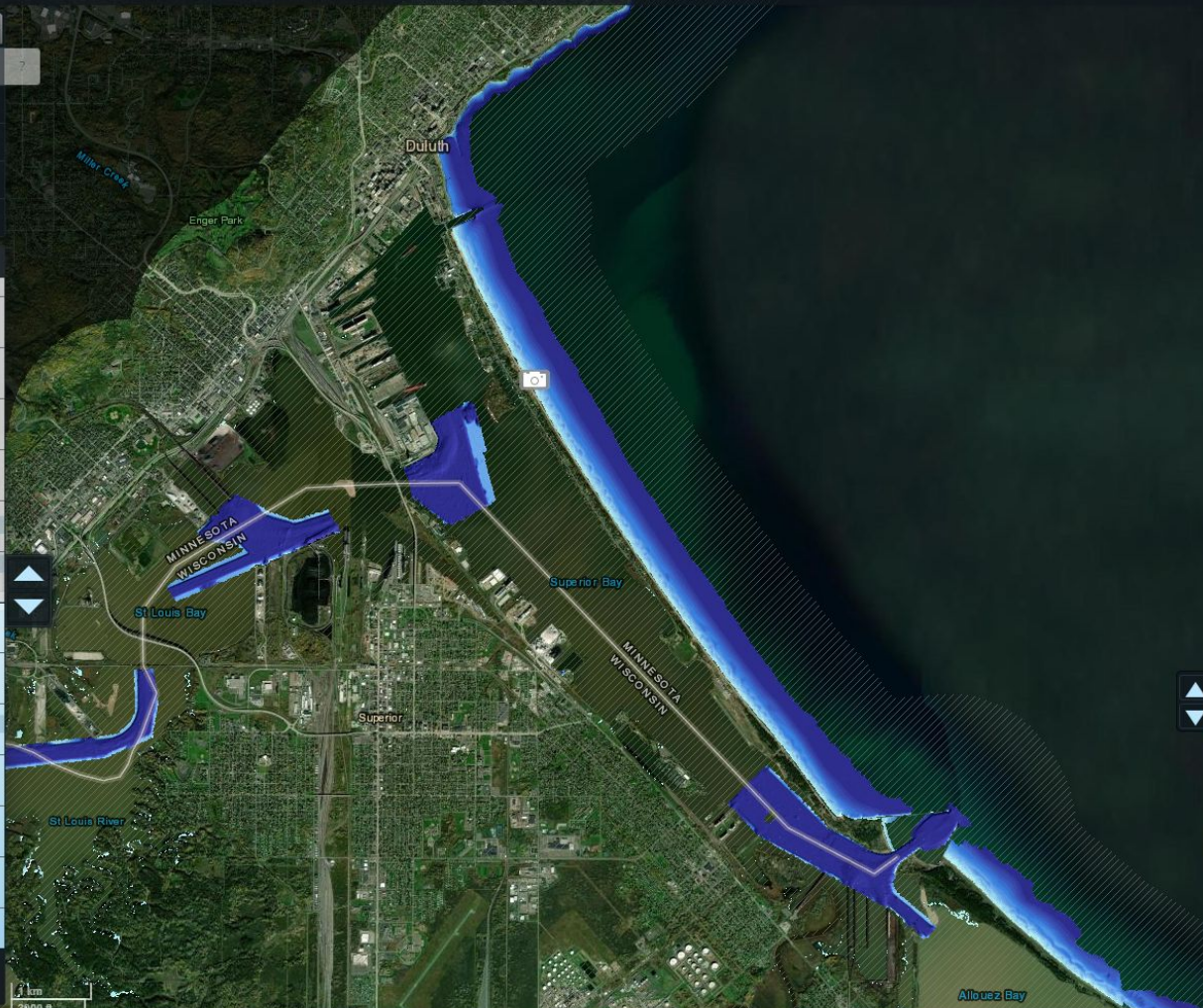


- Lake Superior
- Lake Level Change
- Mapping Confidence
- Society
- Business
- Download

Lake Superior Water Level

607.7ft	6.0ft
606.7ft	5.0ft
605.7ft	4.0ft
604.7ft	3.0ft
603.7ft	2.0ft
High (603.4 ft)	
602.7ft	-1.0ft
Current (602.6 ft)	
601.7ft	-2.0ft
Long Term Average	
600.7ft	-3.0ft
599.7ft	-4.0ft
Low (599.5 ft)	
598.7ft	-5.0ft
597.7ft	-6.0ft
596.7ft	
595.7ft	

Records & Avg. On
 Unit of Measure **FT**



Streets
 Topography Off
 Depth-Query Off

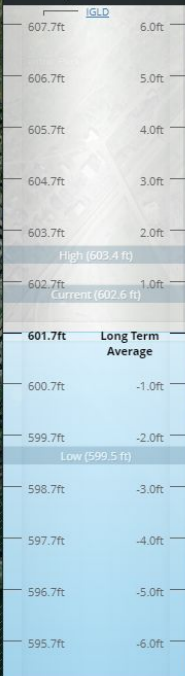
Minnesota Point

Use the water level arrows to view a simulation of lake level change at this location.



- Lake Superior
- Lake Level Change
- Mapping Confidence
- Society
- Business
- Download

Lake Superior Water Level



Records & Avg. On
 Unit of Measure FT M



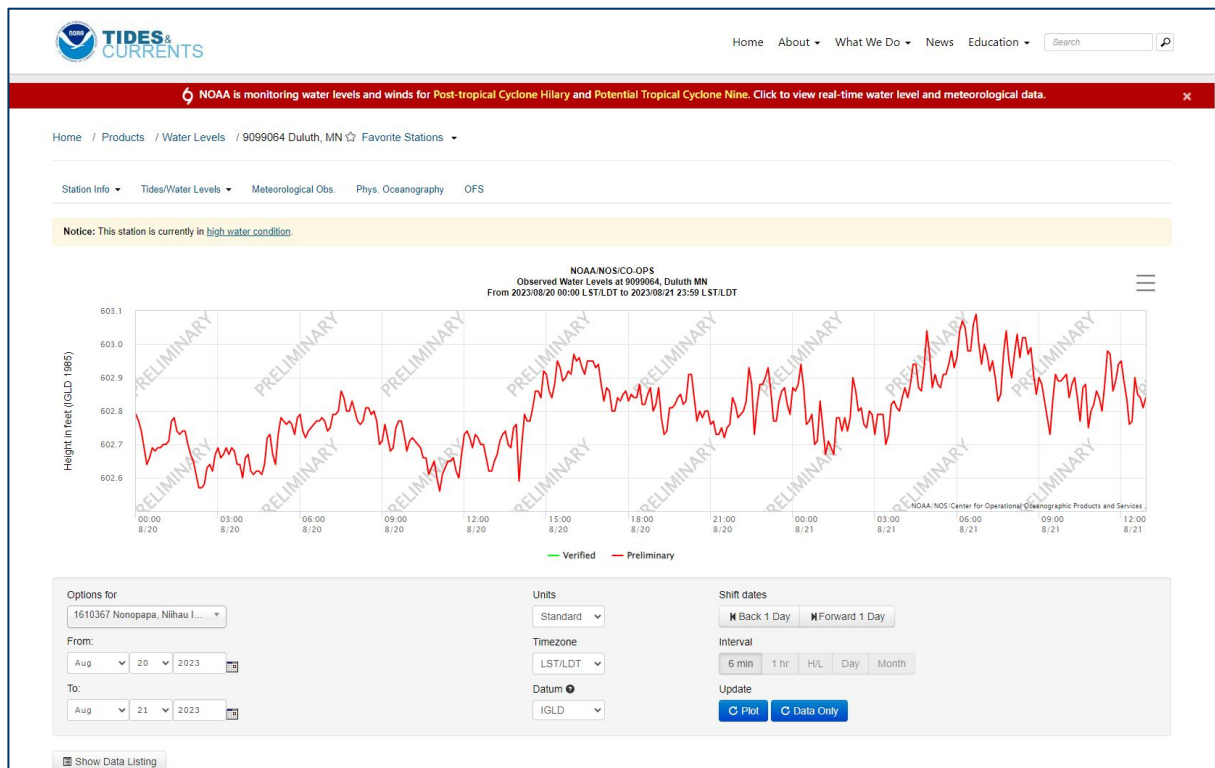
Streets 1:1 scale
 Opacity
 Topography Off
 Depth-Query Off

Minnesota Point

Use the water level arrows to view a simulation of lake level change at this location.



Water Level Station and Data



Water Level Station and Data

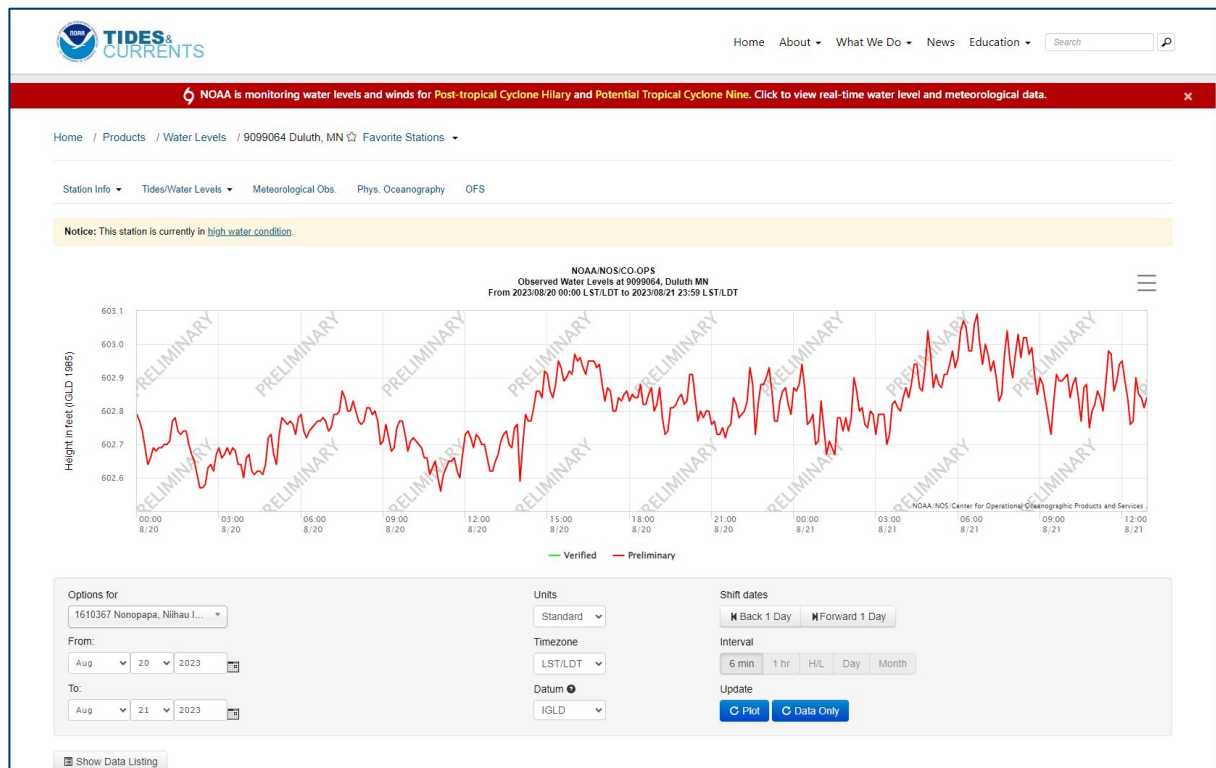
Duluth, MN

Station ID: 9099064

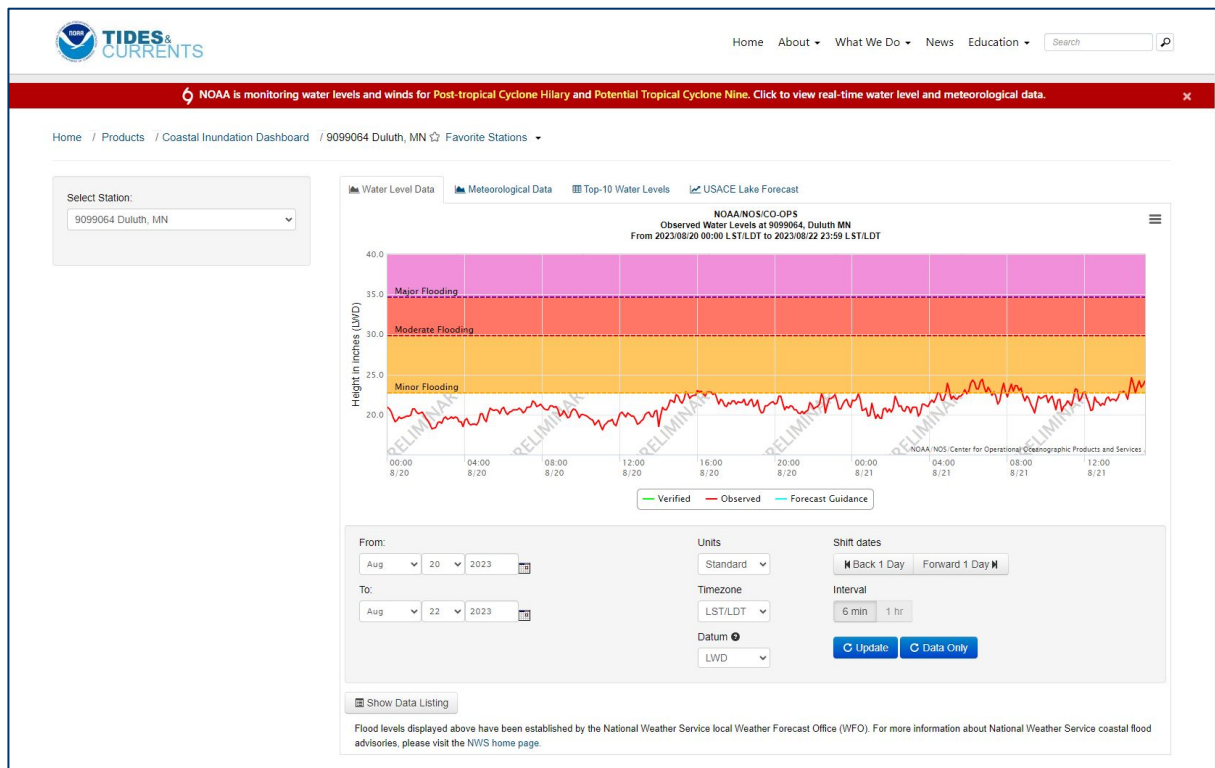
Max Record: 604.75 feet
October 21, 2019

Min Record: 598.98 feet
February 18, 2011

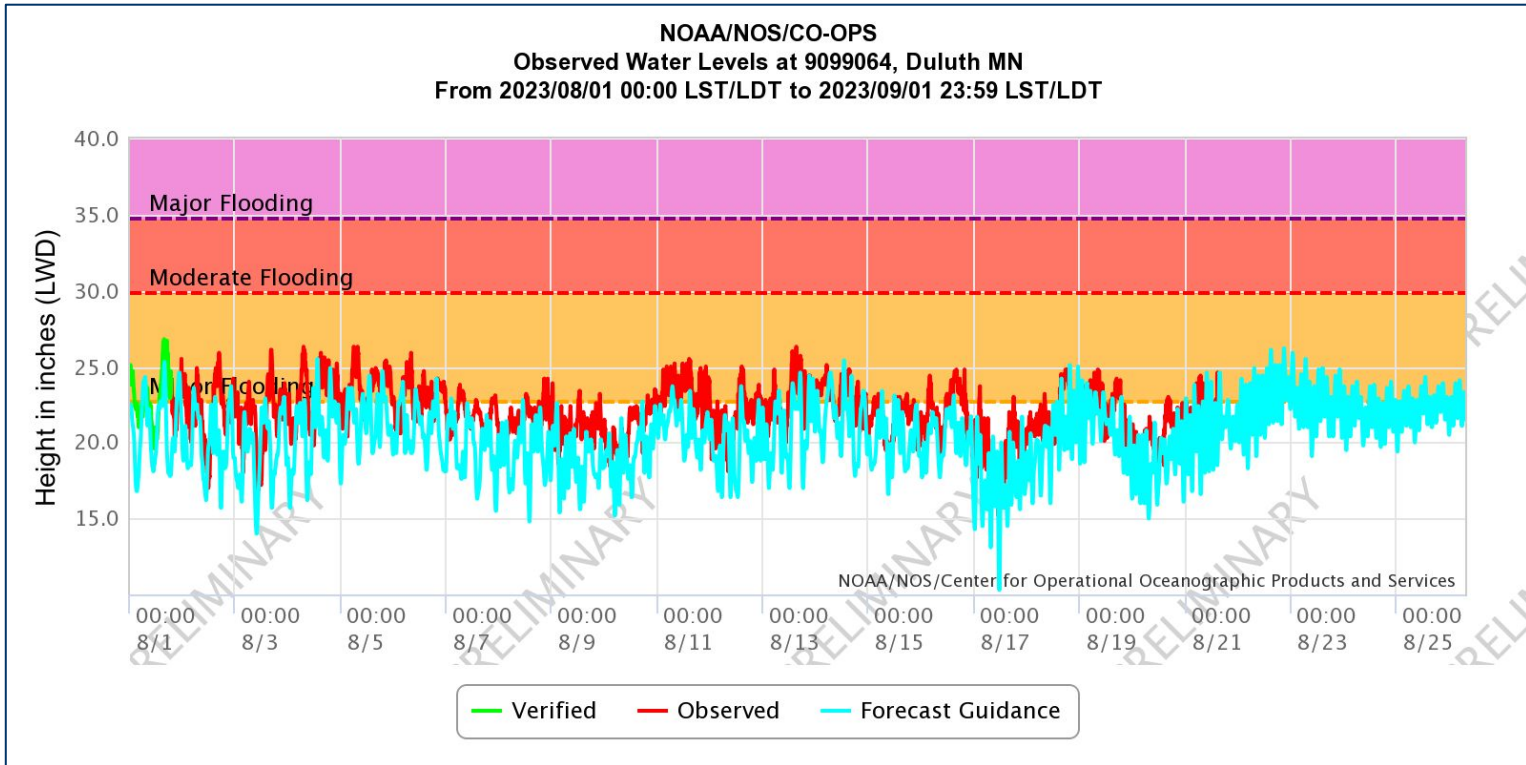
Established April 1, 1860



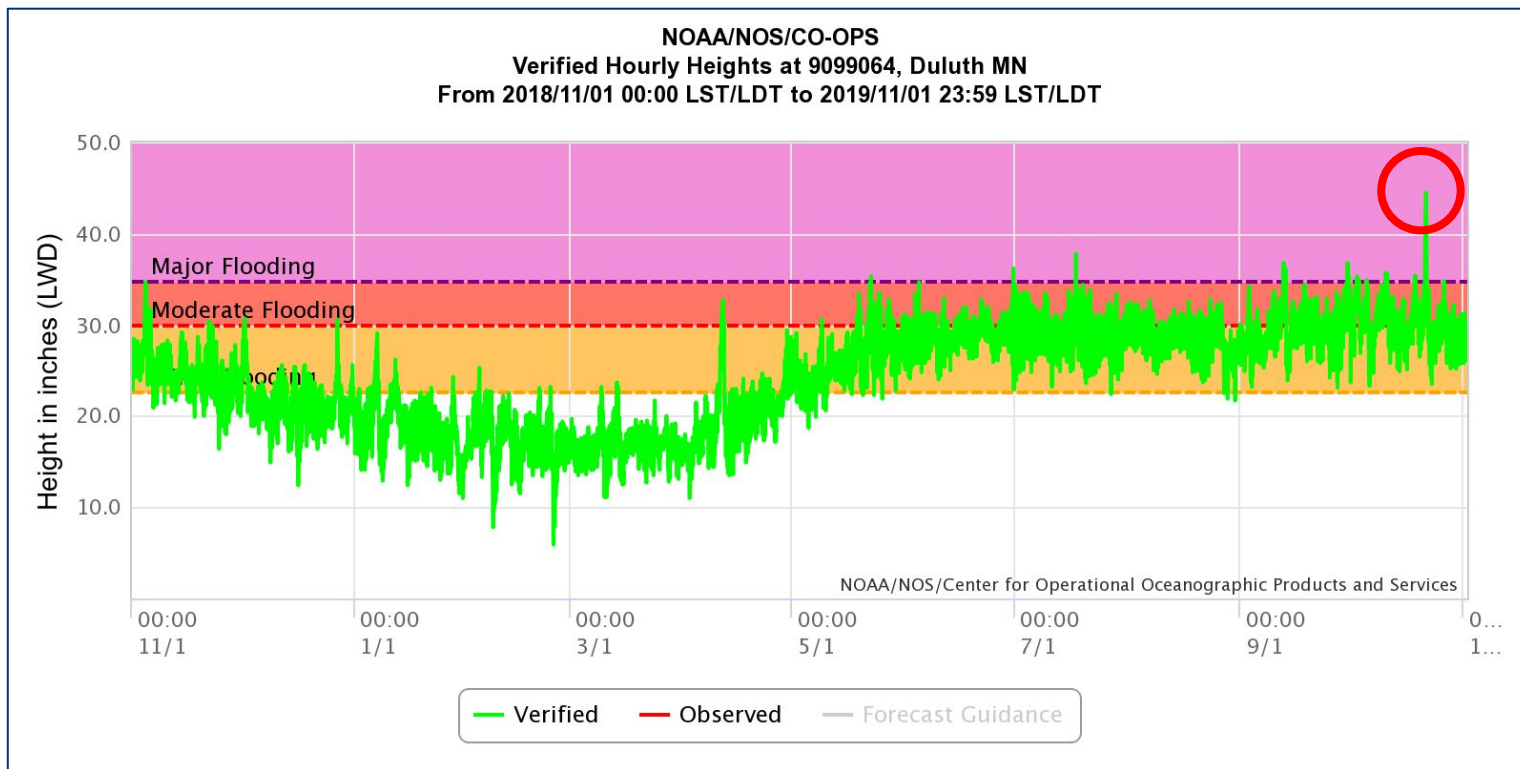
Coastal Inundation Dashboard



Coastal Inundation Dashboard



Coastal Inundation Dashboard



Use Case

Coastal Storm Impacts: 2017, 2018, and 2019



Coastal Storms: Duluth, MN 2018

AN ANGRY LAKE SUPERIOR

Today through This Evening

Highest Wind Gusts Today (mph)



GALE WARNING

• Gale-force winds and near storm-force gusts today through this evening.

IMPACTS

- Isolated tree damage and power outages near the lake.
- Flooding, erosion, and damage to shoreline.
- Difficult travel for high-profile vehicles on high bridges between Duluth and Superior.

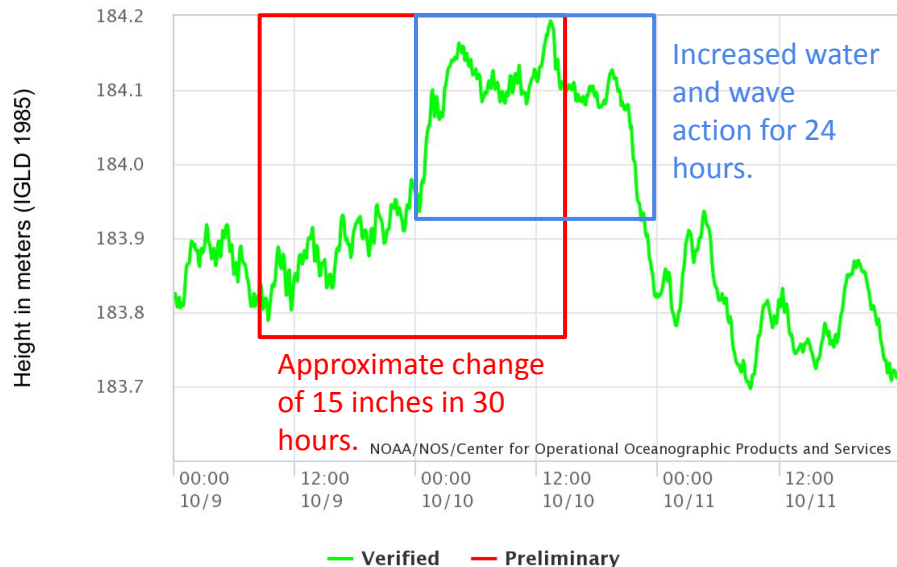
NATIONAL WEATHER SERVICE DULUTH, MN

weather.gov/duluth



Published on: 10/10/2018 at 6:58AM

NOAA/NOS/CO-OPS
Observed Water Levels at 9099064, Duluth MN
From 2018/10/09 00:00 LST/LDT to 2018/10/11 23:59 LST/LDT



Coastal Storms: Duluth, MN 2018



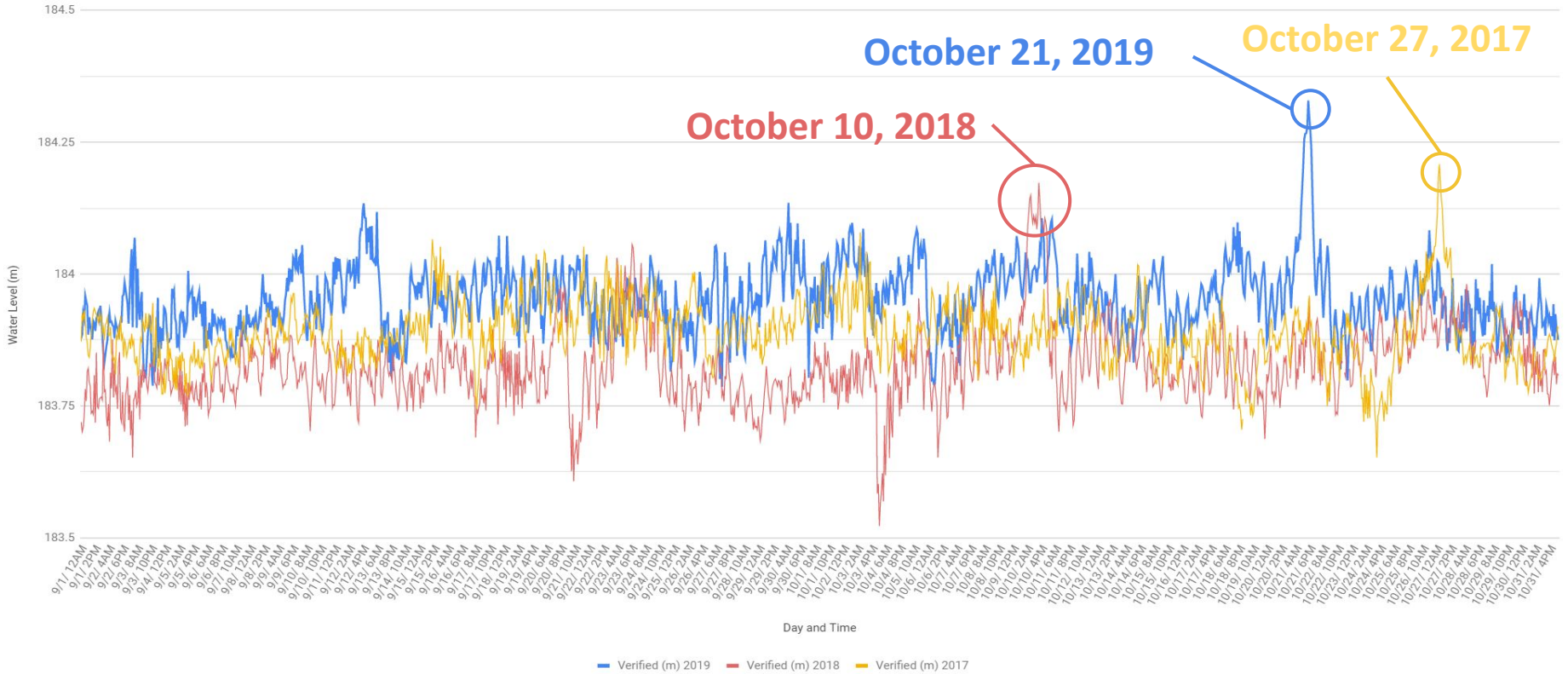
October 2018, Gale Warning. Canal Park, Duluth, MN
Source: WDIO HarborCam

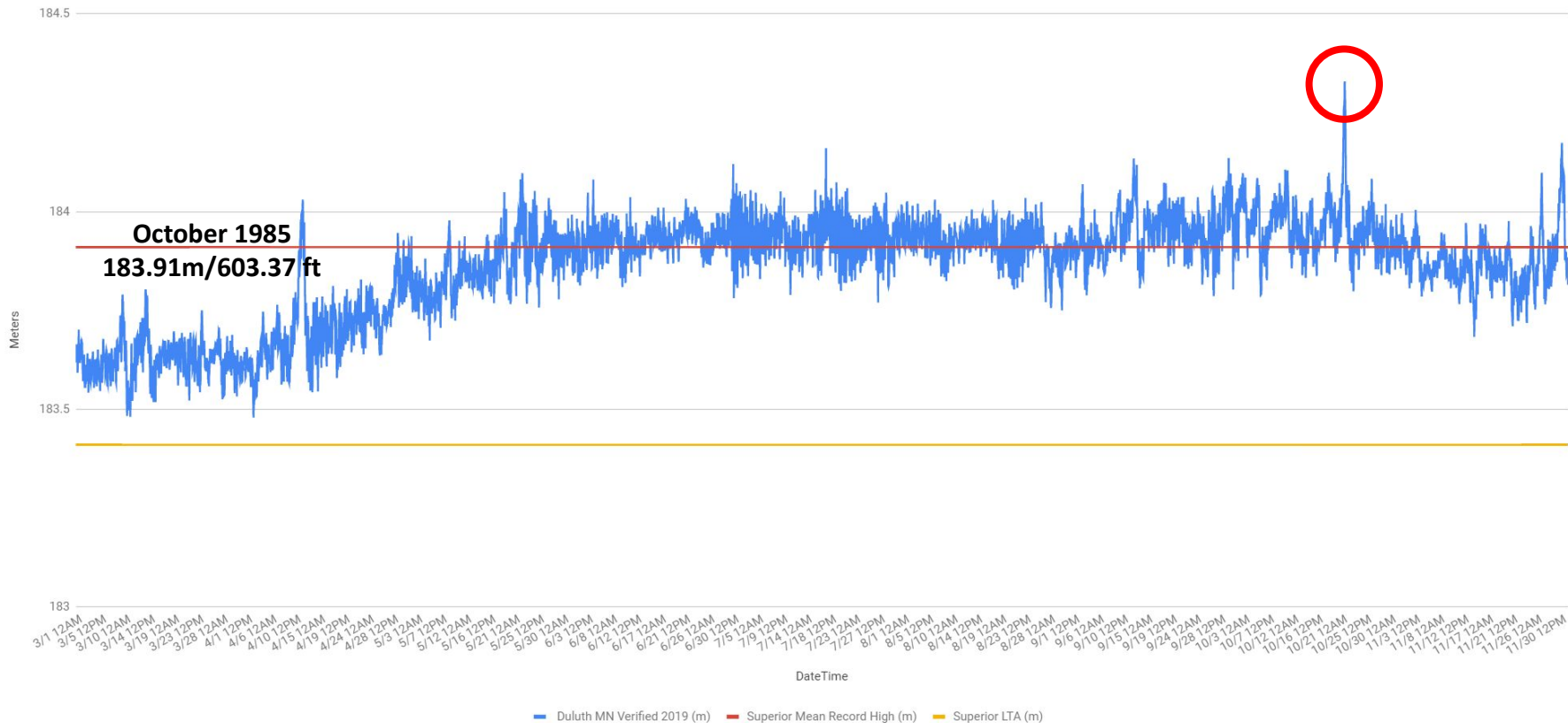


March 1975, Blizzard causes flooding. Canal Park, Duluth, MN
Source: Duluth News Tribune



Comparison of Water Levels and Storm Events - Duluth, MN 9099064





IGLD 1985





Lake Superior

- Lake Level Change
- Mapping Confidence
- Society
- Business
- Download

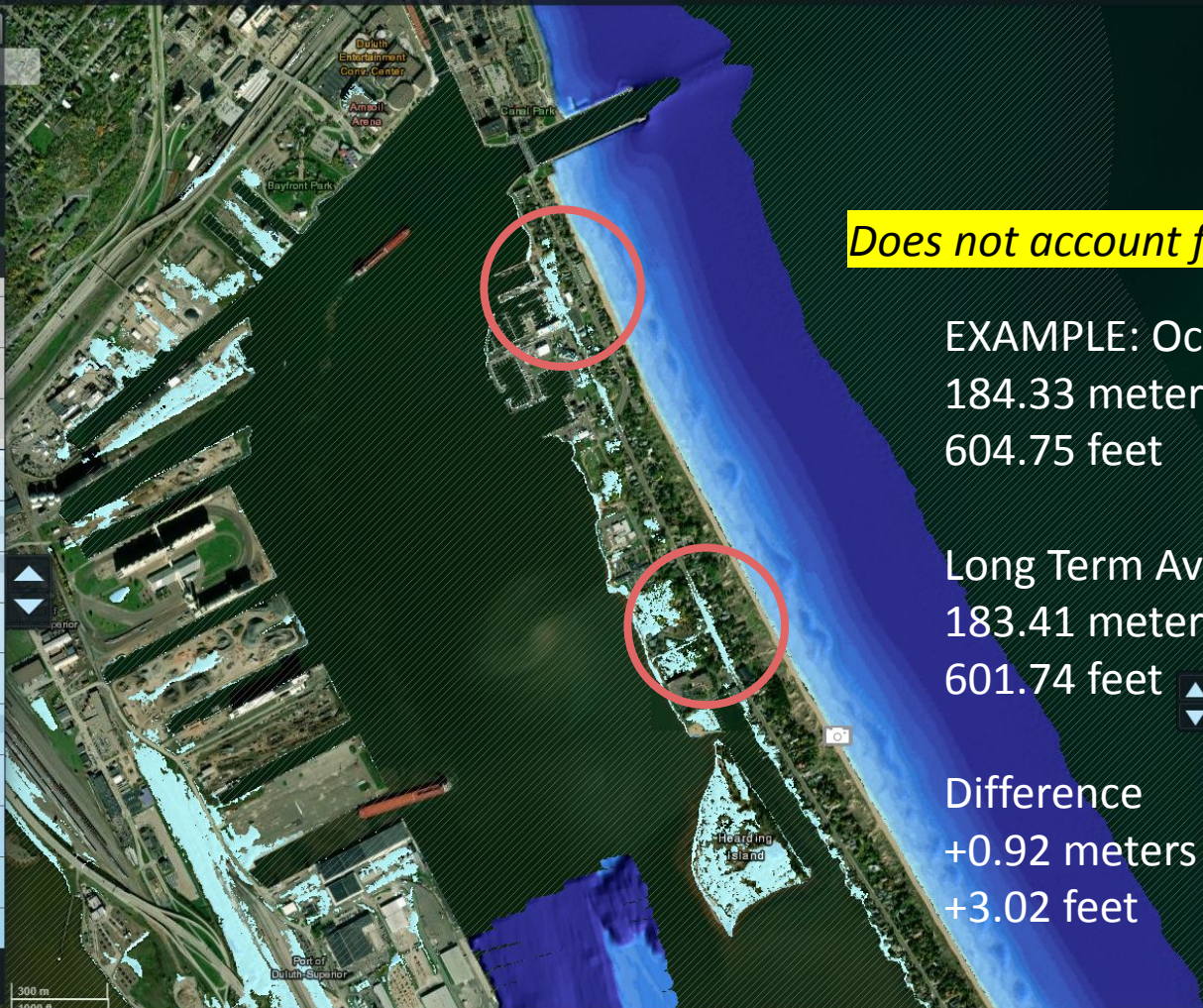
Lake Superior Water Level

607.7ft	IGLD	6.0ft
606.7ft		5.0ft
605.7ft		4.0ft
604.7ft		3.0ft
603.7ft		2.0ft
High (603.4 ft)		
602.7ft	Current (602.6 ft)	-1.0ft
601.7ft	Long Term Average	-1.0ft
600.7ft		-1.0ft
599.7ft		-2.0ft
Low (599.5 ft)		
598.7ft		-3.0ft
597.7ft		-4.0ft
596.7ft		-5.0ft
595.7ft		-6.0ft

Records & Avg. On

Unit of Measure FT

300 m
1000 ft



Does not account for wave runoff!

EXAMPLE: October 21, 2019
184.33 meters
604.75 feet

Long Term Average
183.41 meters
601.74 feet

Difference
+0.92 meters
+3.02 feet

Streets

Opacity

Topography Off

Depth-Query Off

Minnesota Point

Use the water level arrows to view a simulation of lake level change at this location.

esri

Data Access Viewer





DATA ACCESS VIEWER

Discover, customize, and download authoritative land cover, imagery, and lidar data.

Powered by **DIGITAL COAST**

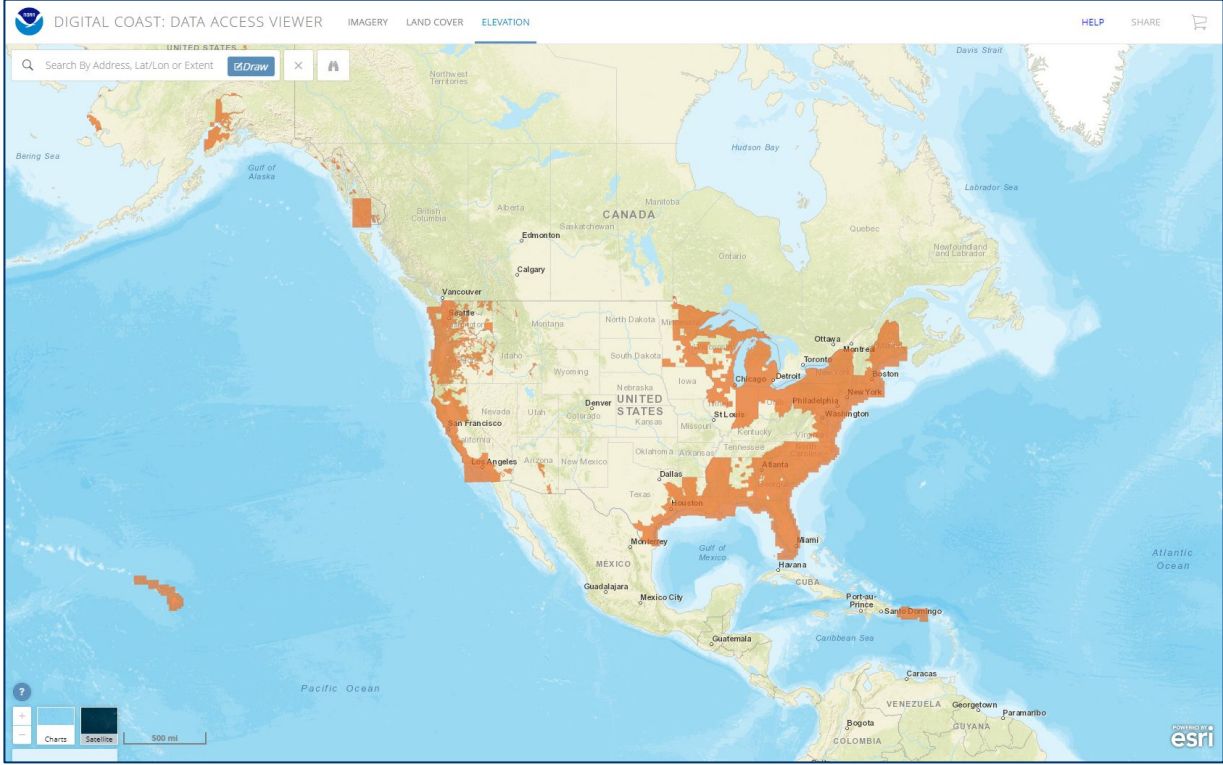
Choose a Data Type to Explore

[Imagery](#) [Land Cover](#) [Elevation/Lidar](#)

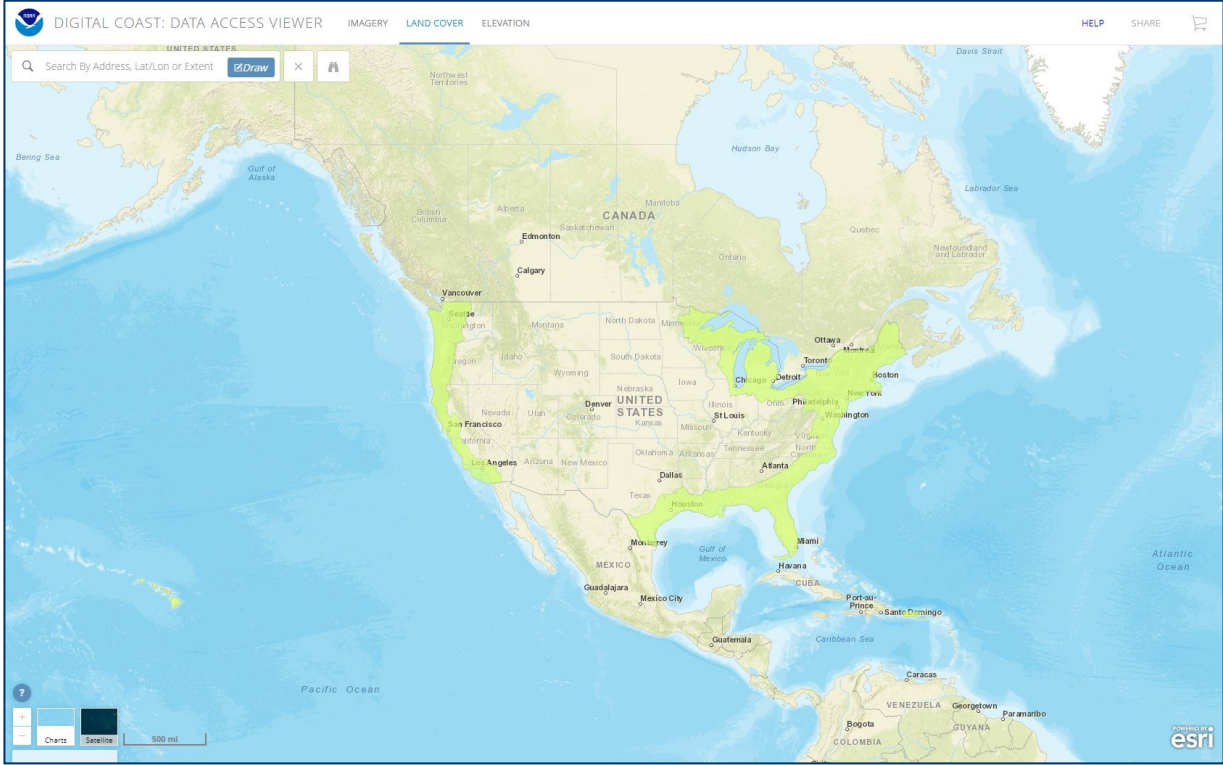
[ABOUT THIS TOOL](#)

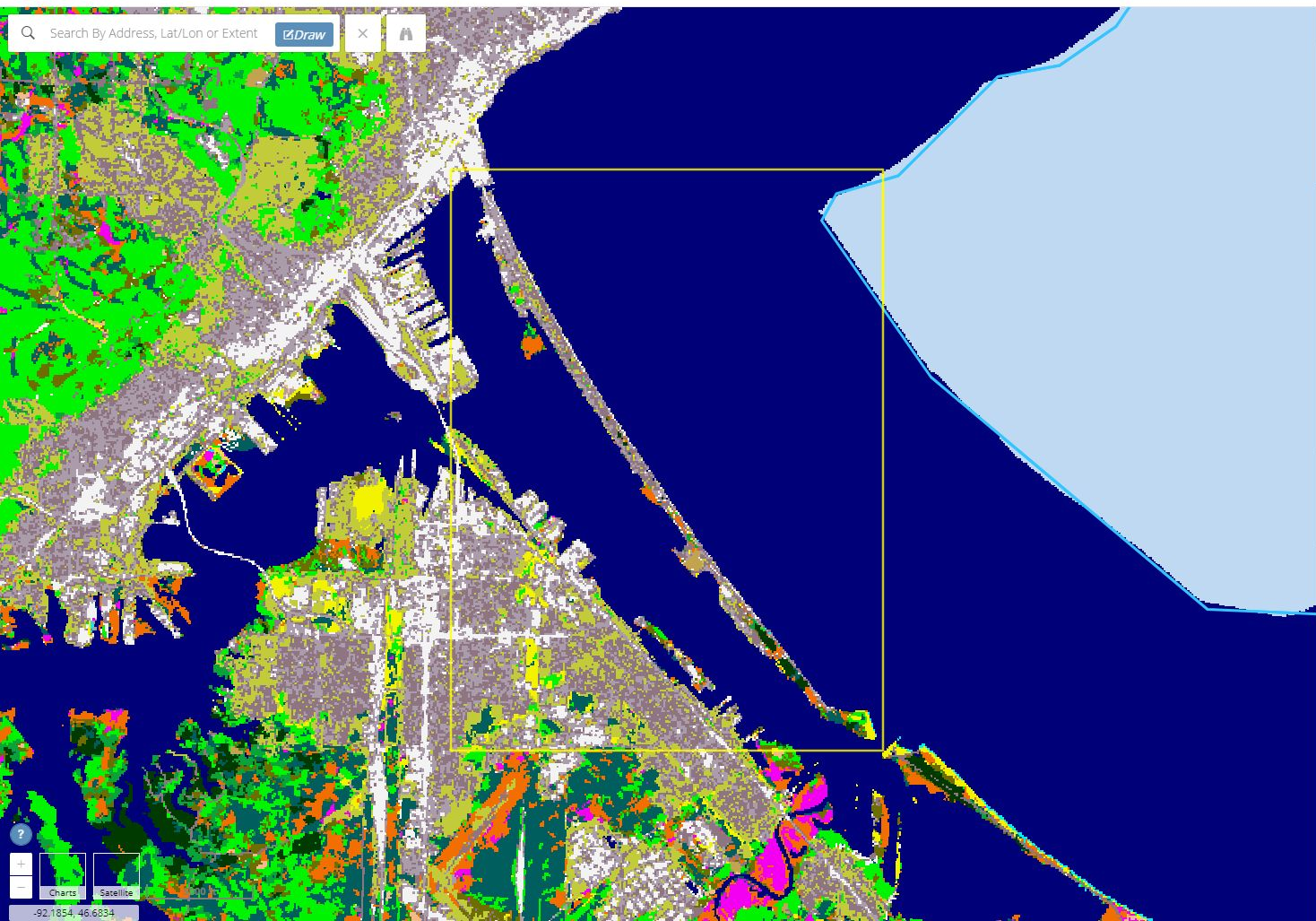


Elevation Data



Landcover Data





← Return to Results

2016 NOAA C-CAP Regional Land Cover

NOAA Office for Coastal Management
122.88 KB

Add to Cart

0 in cart

The Coastal Change Analysis Program (C-CAP) produces nationally standardized land cover data from remotely sensed imagery. C-CAP products provide inventories of coastal intertidal areas, wetlands, and adjacent uplands.

Also available as a Bulk Download.

Attributes

Cell size (m): 30

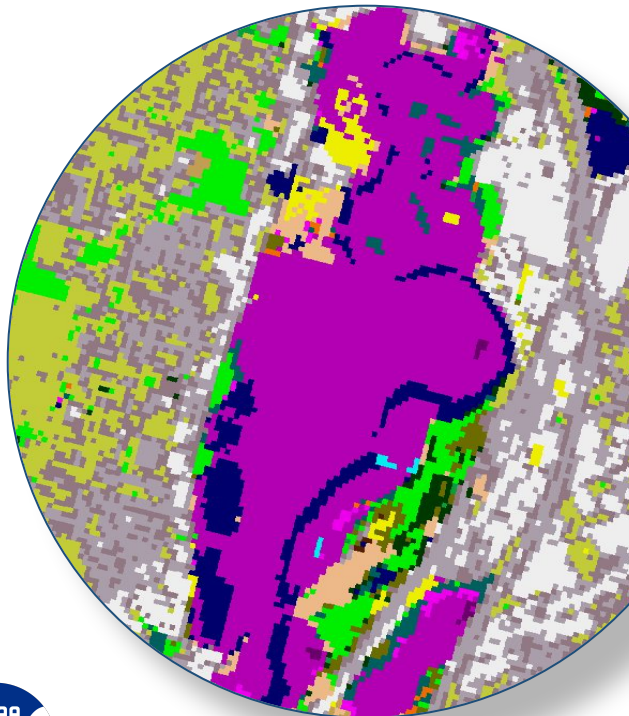
Related Links

- Metadata
- Image Service

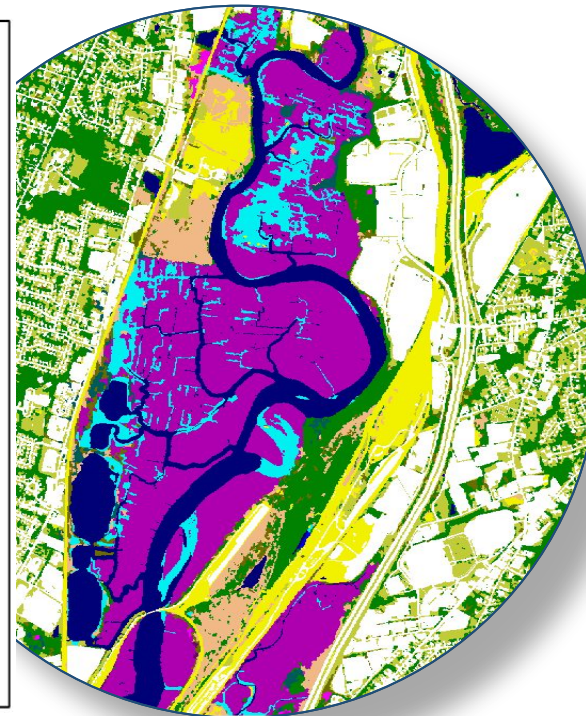
Imagery Opacity 100%

Comparison of Resolutions

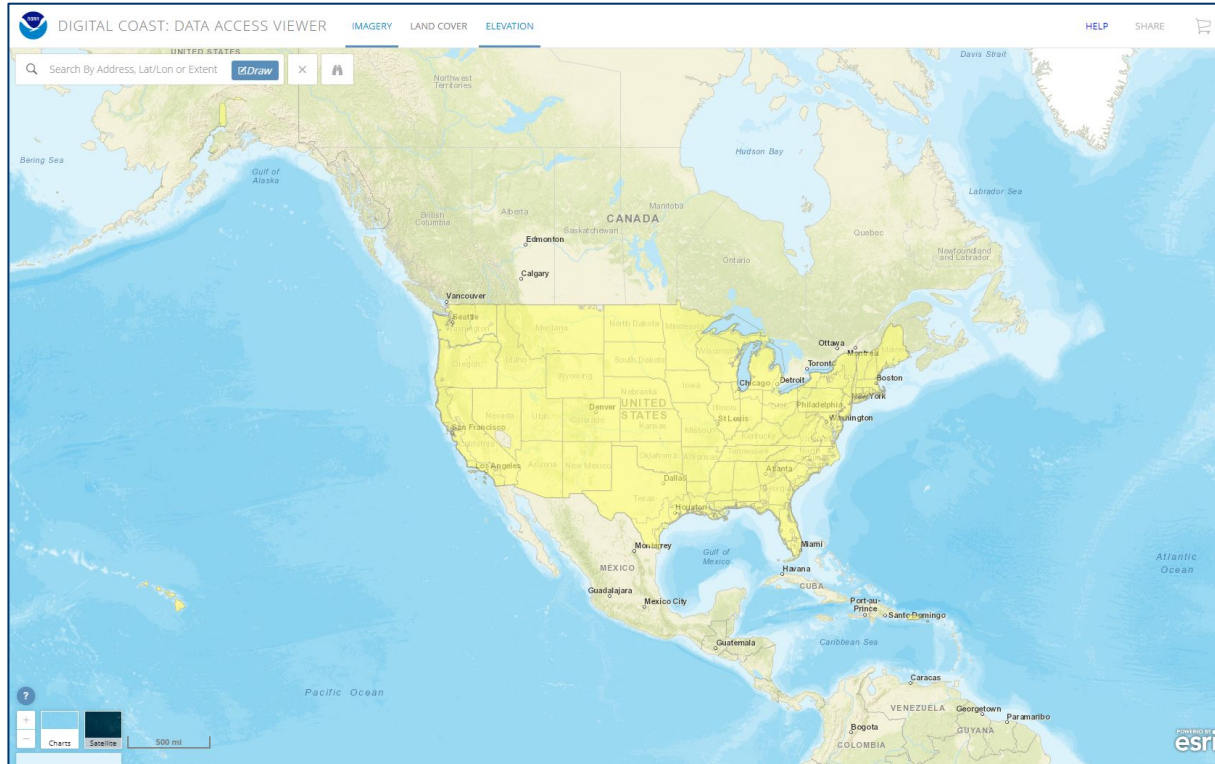
REGIONAL (30 METER)



LOCAL (1 METER)



Imagery Data



Search By Address, Lat/Lon or Extent



Filter by Provider

- 2022 NOAA NGS DSS 4-Band 8 Bit Imagery: Two Harbors, WI NOAA NGS
5.23 GB · BULK DOWNLOAD
- 2021 USDA NAIP 4-Band 8 Bit Imagery: Minnesota USDA
1.18 GB · BULK DOWNLOAD
- 2020 USDA NAIP 4-Band 8 Bit Imagery: Wisconsin USDA
755.07 MB · BULK DOWNLOAD
- 2019 NOAA NGS DSS Natural Color 8 Bit Imagery: Duluth, MN NOAA NGS
1018.51 MB · BULK DOWNLOAD
- 2019 NOAA NGS DSS Infrared 8 Bit Imagery: Duluth, MN NOAA NGS
338.04 MB · BULK DOWNLOAD
- 2018 USDA NAIP 4-Band 8 Bit Imagery: Wisconsin USDA
752.05 MB · BULK DOWNLOAD
- 2015 USDA NAIP 4-Band 8 Bit Imagery: Lake Superior NERR USDA
435.08 MB · BULK DOWNLOAD
- 2010 GLRI Natural Color 8 Bit Imagery: Lake Superior, WI EPA
204.61 MB · BULK DOWNLOAD

Showing 10 results

5000 ft
 -92.1854, 46.6831

Use Case

Evaluating Change at Minnesota Point



Evaluating Change at Minnesota Point

1. Want to look at elevation and shoreline changes.
2. Want to look at which areas are potential for coastal flooding.
3. Want to look at nearshore bathymetry change.
4. Want to be open and transparent about my methodology.
 - Use QGIS, Python, and SAGA for geospatial data selection and processing. (Open source software solution)



Evaluating Change at Minnesota Point

Useful Numbers to Remember:

Low Water Datum: 601.1 feet / 183.215 meters

Ordinary High Water Mark (OHWM): 603.1 feet / 183.825 meters

Lakewide Long Term Average: 601.75 feet / 183.41 meters

2009 Lakewide Average: 601.25 feet / 183.26 meters

2019 Lakewide Average: 602.85 feet / 183.75 meters

All referenced to International Great Lakes Datum 1985 (IGLD85)



Evaluating Change at Minnesota Point

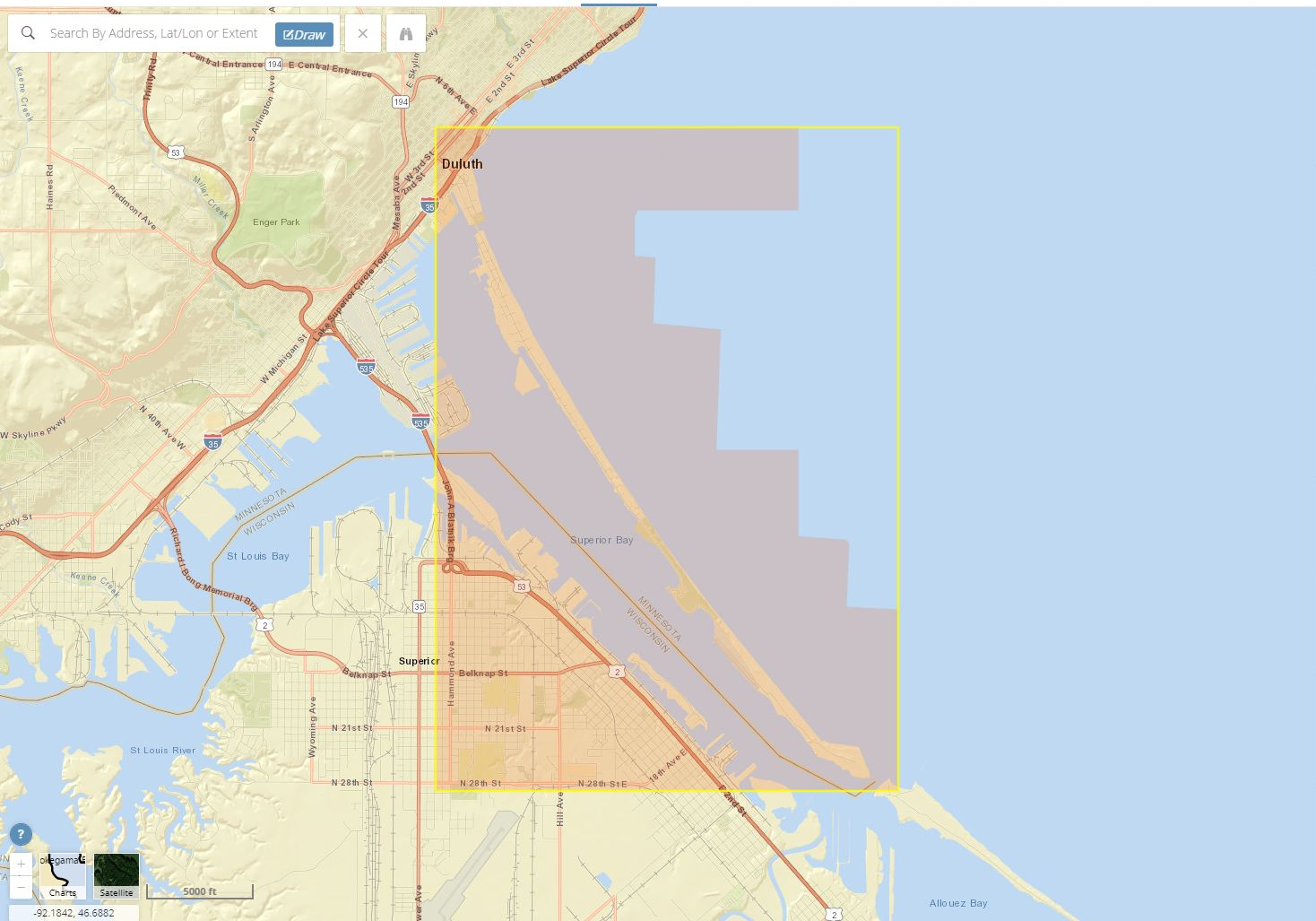
Grab elevation data from Data Access Viewer

The screenshot displays the Digital Coast Data Access Viewer interface. The main map shows a topographic view of Duluth, Minnesota, with a yellow rectangular selection box highlighting a specific area near the waterfront. The interface includes a search bar at the top left, navigation controls, and a list of data products on the right side. The data products list includes:









- 2021 USGS Lidar: Lake Superior, MN (2,243,162,364 Pts - BULK DOWNLOAD)
- 2019 USACE NCMP Topobathy Lidar DEM: Lake Superior (M, MN, WI) (98.00 MB - BULK DOWNLOAD)
- 2019 USACE NCMP Topobathy Lidar: Lake Superior (M, MN, WI) (68,019,770 Pts - BULK DOWNLOAD)
- 2016 3DEP Lidar: Douglas County, WI (583,849,459 Pts - BULK DOWNLOAD)
- 2012 MN DNR Lidar: Duluth Post-Flood (240,997,266 Pts - BULK DOWNLOAD)
- 2011 MN DNR Lidar: Arrowhead, MN (96,868,658 Pts - BULK DOWNLOAD)
- 2010 GLRI Bathymetric Lidar: Lake Superior Coastline (M, MN, WI) (692,241 Pts - BULK DOWNLOAD)
- 2009 USACE NCMP Topobathy Lidar: Duluth, MN & Superior, WI (5,355,690 Pts - BULK DOWNLOAD)

The interface also shows a search bar, navigation controls, and a list of data products on the right side. The data products list includes:





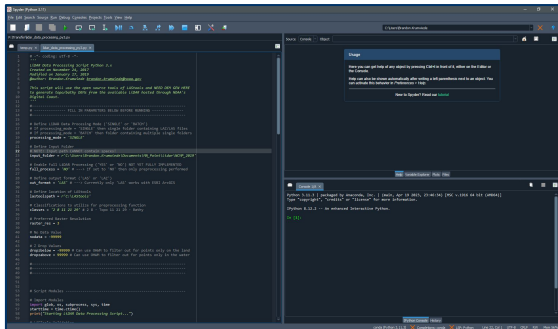
Filter by Provider Sort Results

- 
2021 USGS Lidar: Lake Superior, MN
 USGS
 2,243,162,364 Pts · BULK DOWNLOAD
- 
2019 USACE NCMP Topobathy Lidar DEM: Lake Superior (MI, MN, WI)
 USACE, USACE NCMP
 98.00 MB · BULK DOWNLOAD
- 
2019 USACE NCMP Topobathy Lidar: Lake Superior (MI, MN, WI)
 USACE
 68,019,770 Pts · BULK DOWNLOAD
- 
2016 3DEP Lidar: Douglas County, WI
 USGS
 583,849,459 Pts · BULK DOWNLOAD
- 
2012 MN DNR Lidar: Duluth Post-Flood
 MN DNR
 240,997,266 Pts · BULK DOWNLOAD
- 
2011 MN DNR Lidar: Arrowhead, MN
 MN DNR
 86,868,658 Pts · BULK DOWNLOAD
- 
2010 GLRI Bathymetric Lidar: Lake Superior Coastline (MI,MN,WI)
 NOAA, EPA
 692,241 Pts · BULK DOWNLOAD
- 
2009 USACE NCMP Topobathy Lidar: Duluth, MN & Superior, WI
 USACE, USACE NCMP
 5,355,690 Pts · BULK DOWNLOAD

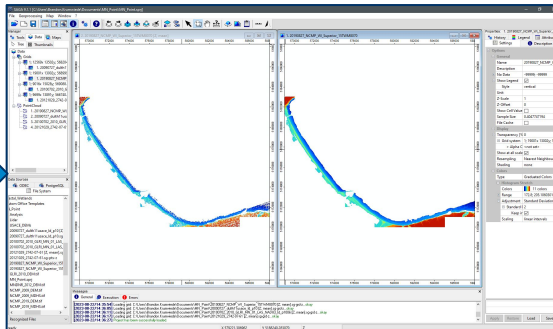
Showing 11 results

Evaluating Change at Minnesota Point

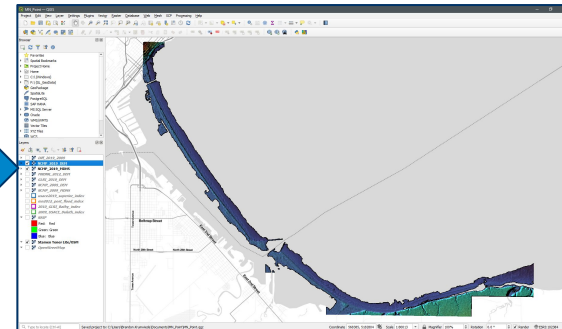
Extract lidar elevation data points and convert into Digital Elevation Models (DEMs)



Scripting in Python



Conversion to Raster in SAGA

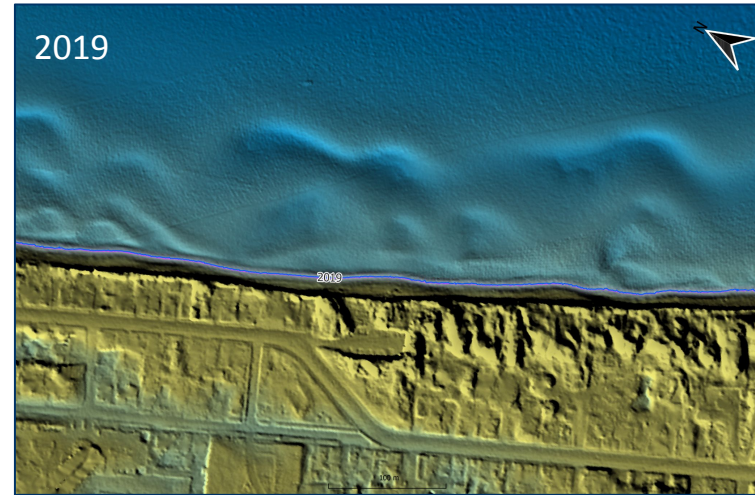
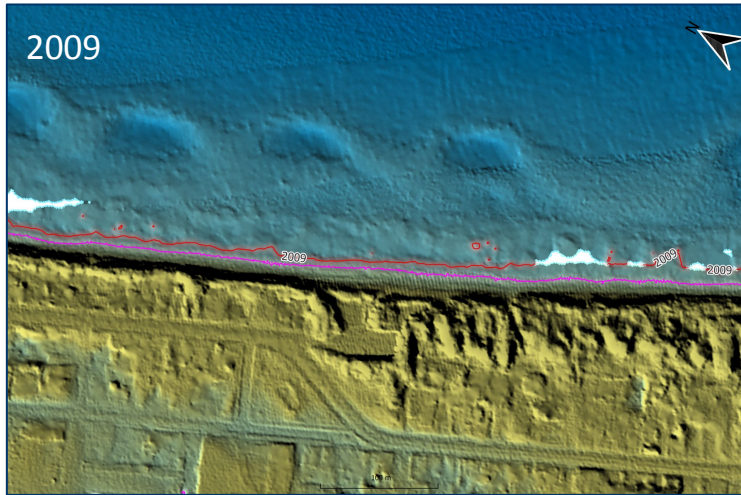


DEM Development in QGIS

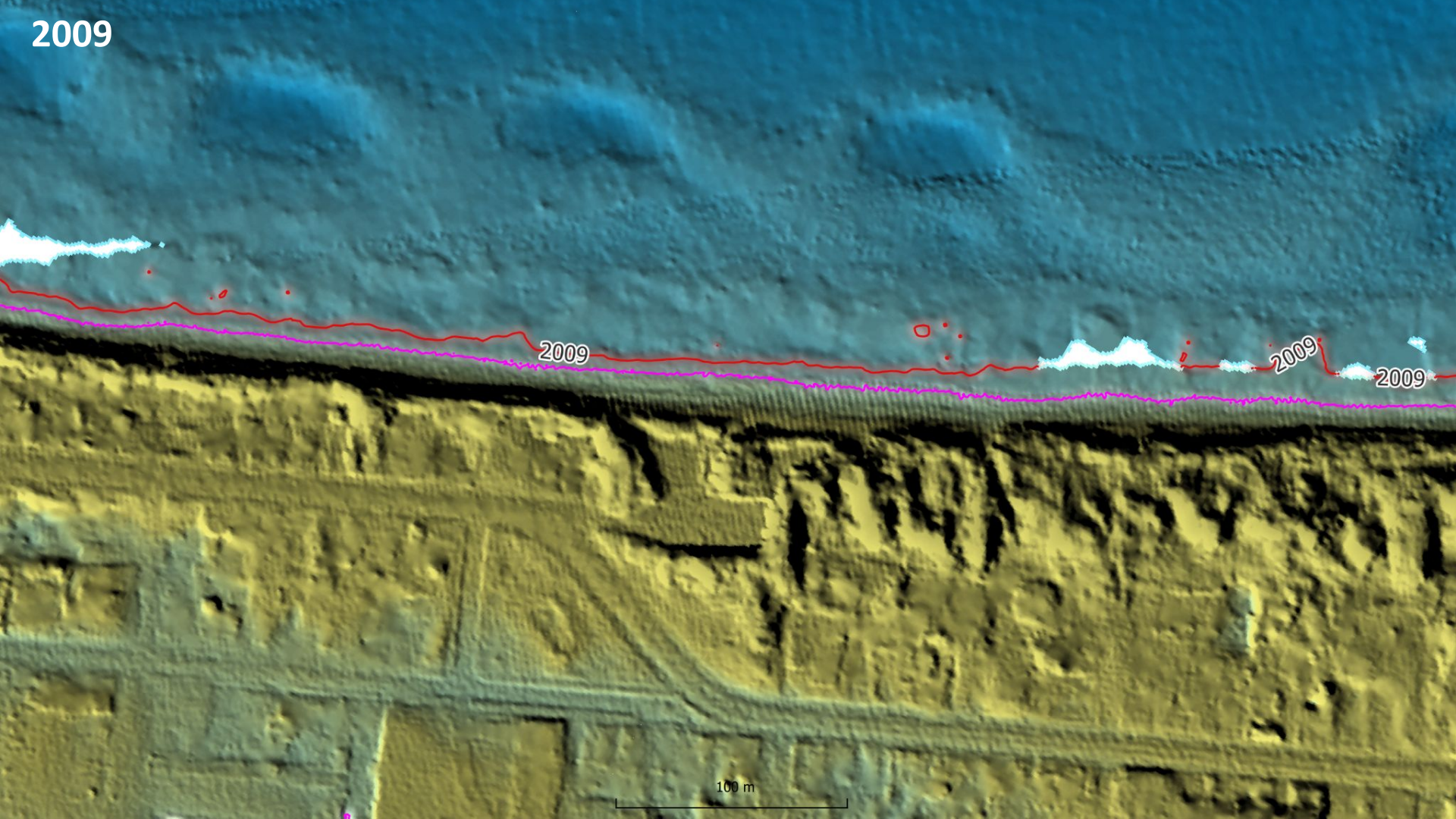


Evaluating Change at Minnesota Point

Extract contours for shoreline at the time of data collection and also Ordinary High Water Mark (OHWM) for reference



2009



2009

2009

2009

100 m

2019



2019

100 m

Imagery 2022



2009

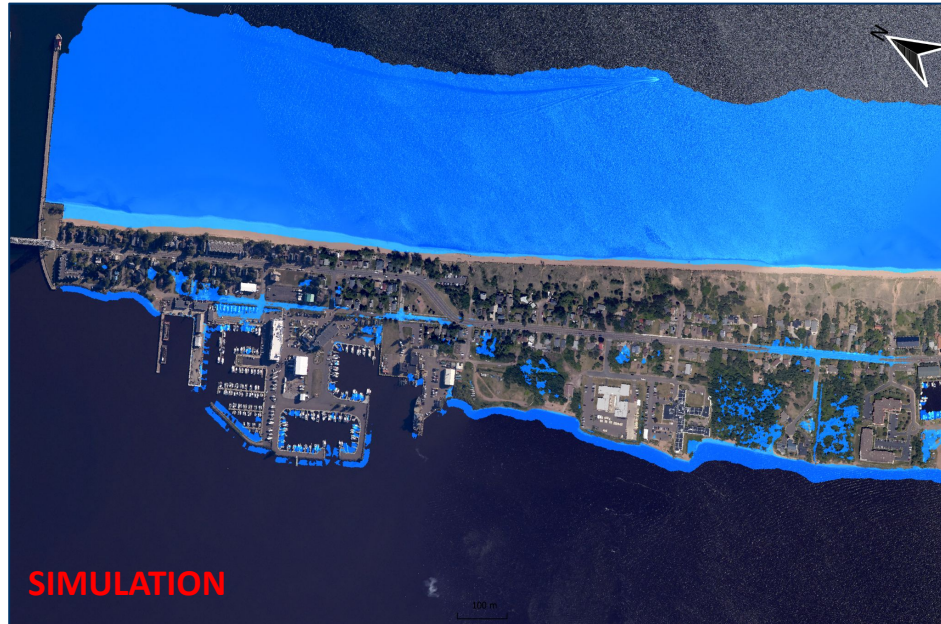
2019

2009

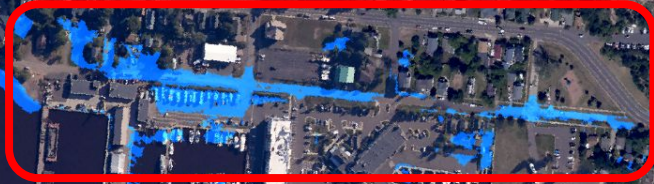
2009

Evaluating Change at Minnesota Point

Determine potential inundation area extent by creating a mask



Evaluating Change at Minnesota Point



Determine potential inundation
EXAMPLE: October 21, 2019
184.33 meters
604.75 feet

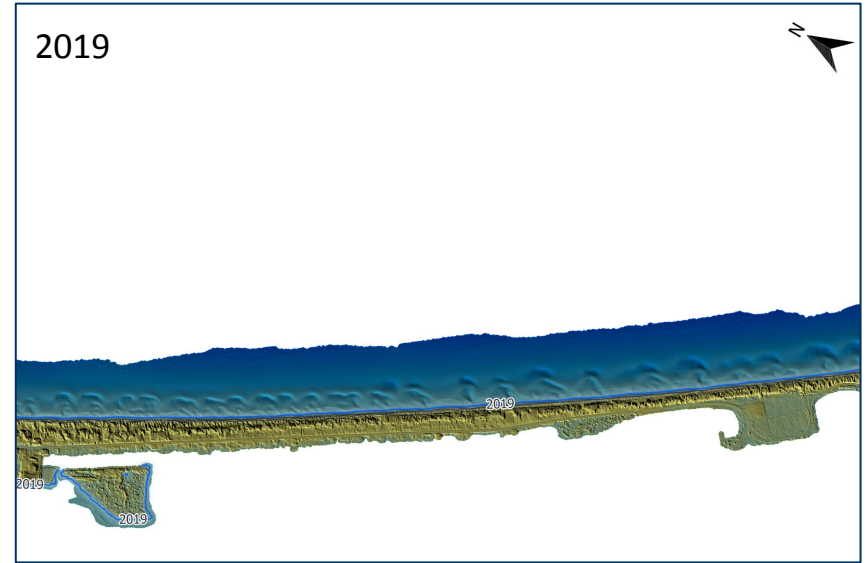
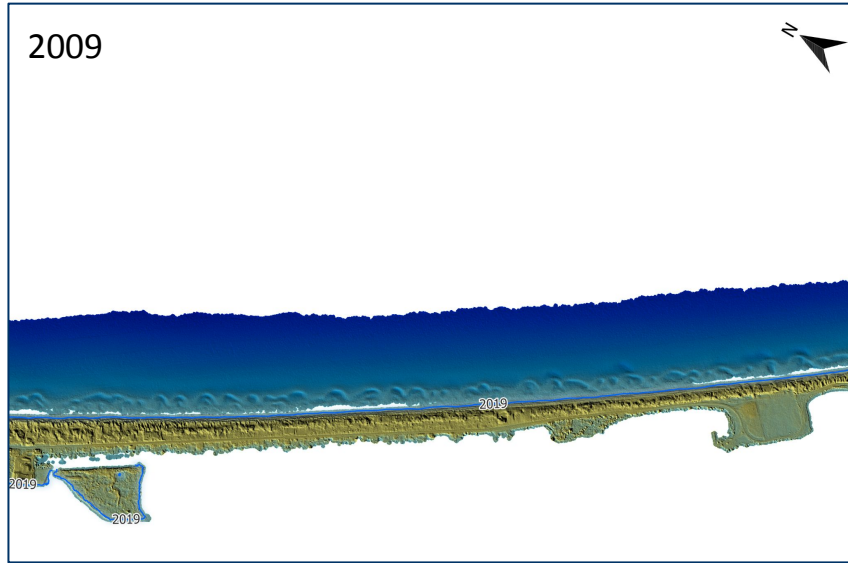
SIMULATION

100 m



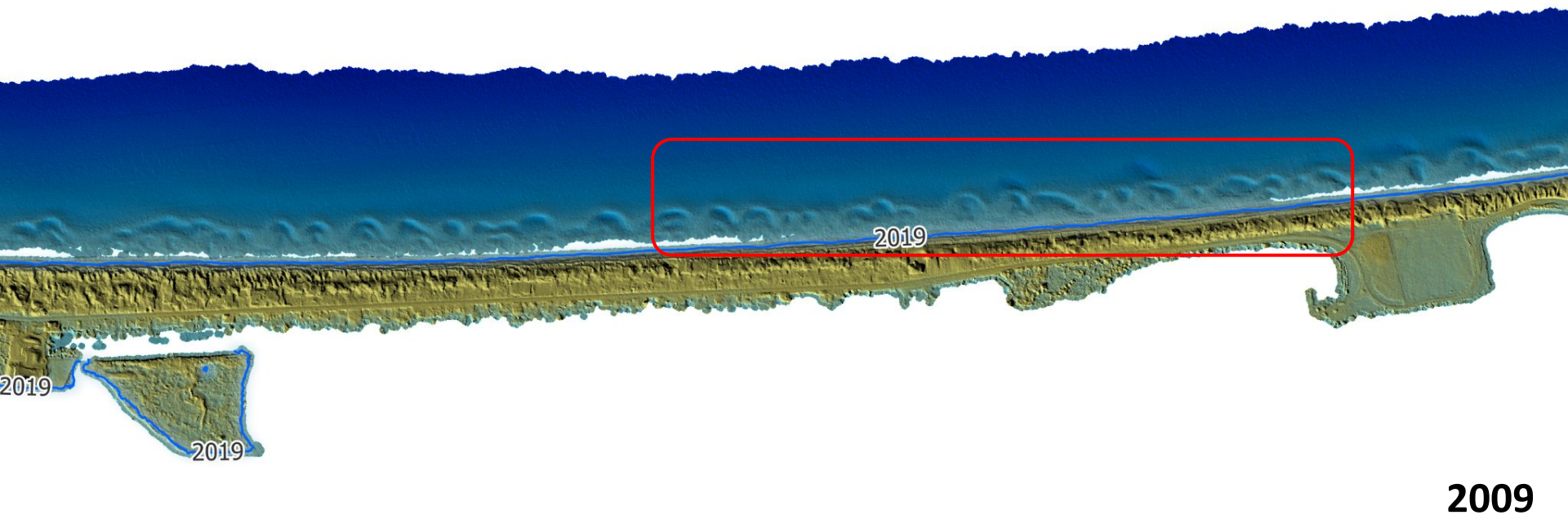
Evaluating Change at Minnesota Point

Change in nearshore bathymetry



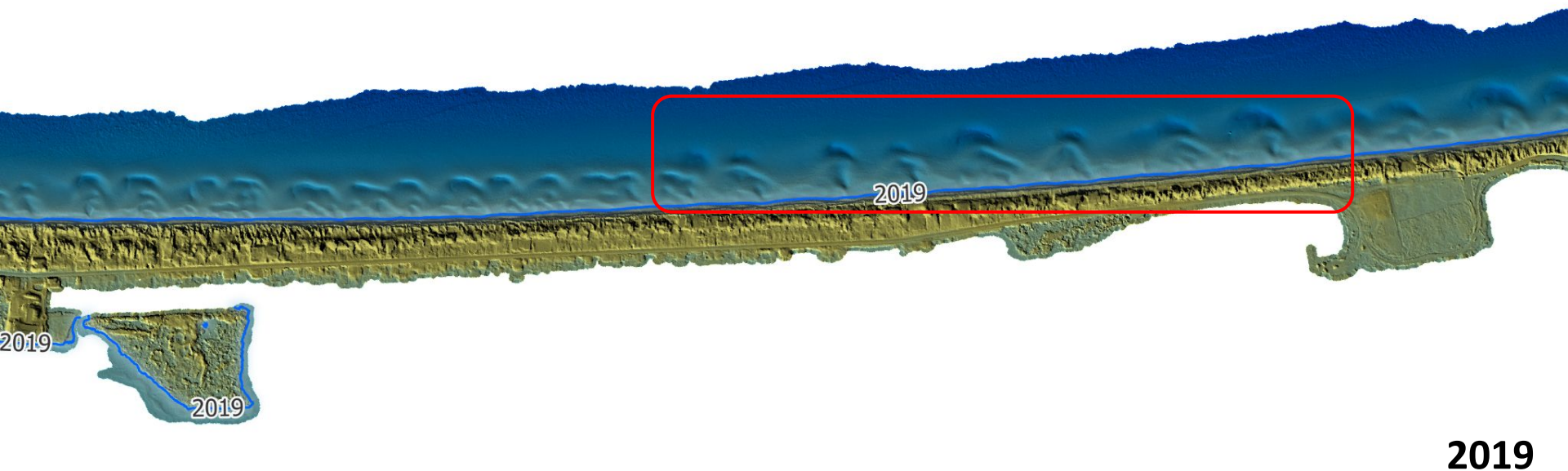
Evaluating Change at Minnesota Point

Change in nearshore bathymetry



Evaluating Change at Minnesota Point

Change in nearshore bathymetry



2019

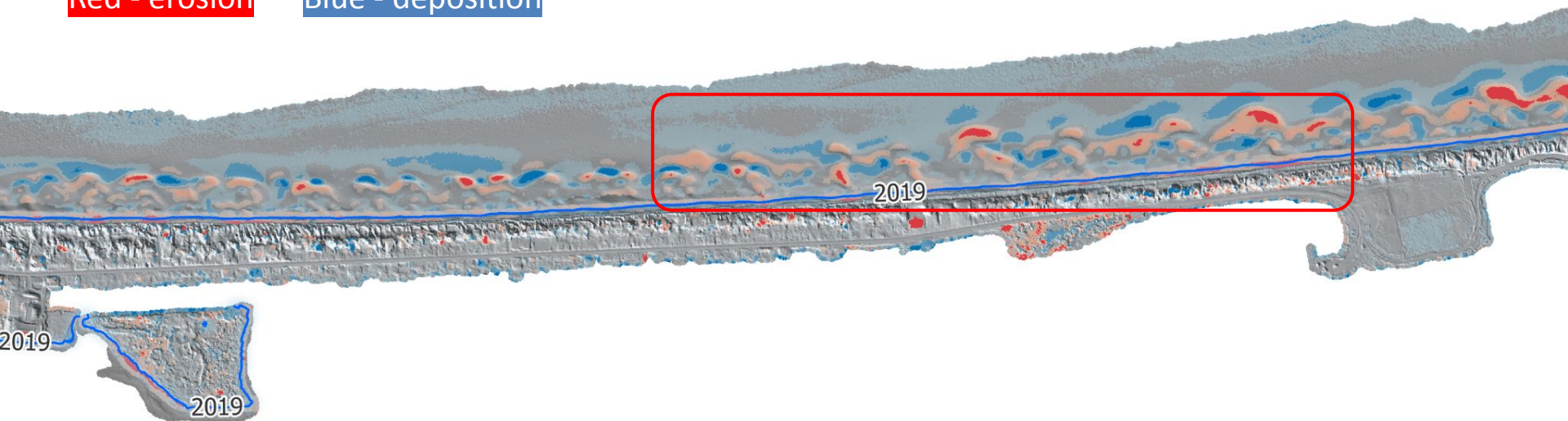
Evaluating Change at Minnesota Point

Change in nearshore bathymetry

Littoral sediment transport

Red - erosion

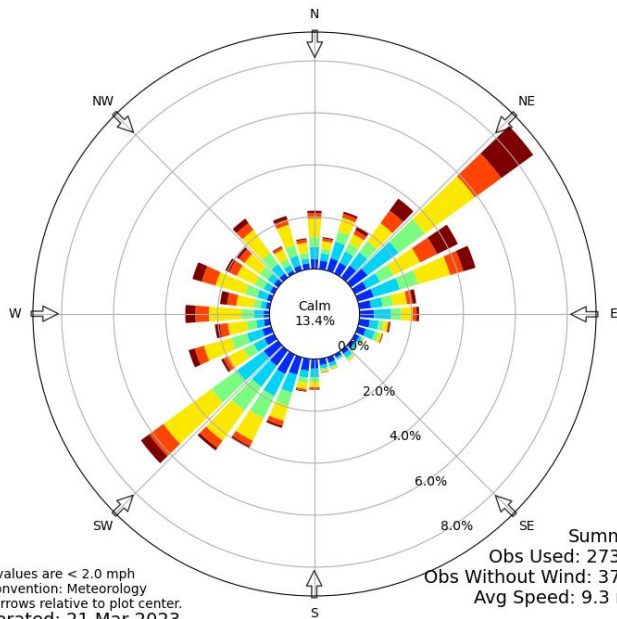
Blue - deposition



Difference between 2019 to 2009

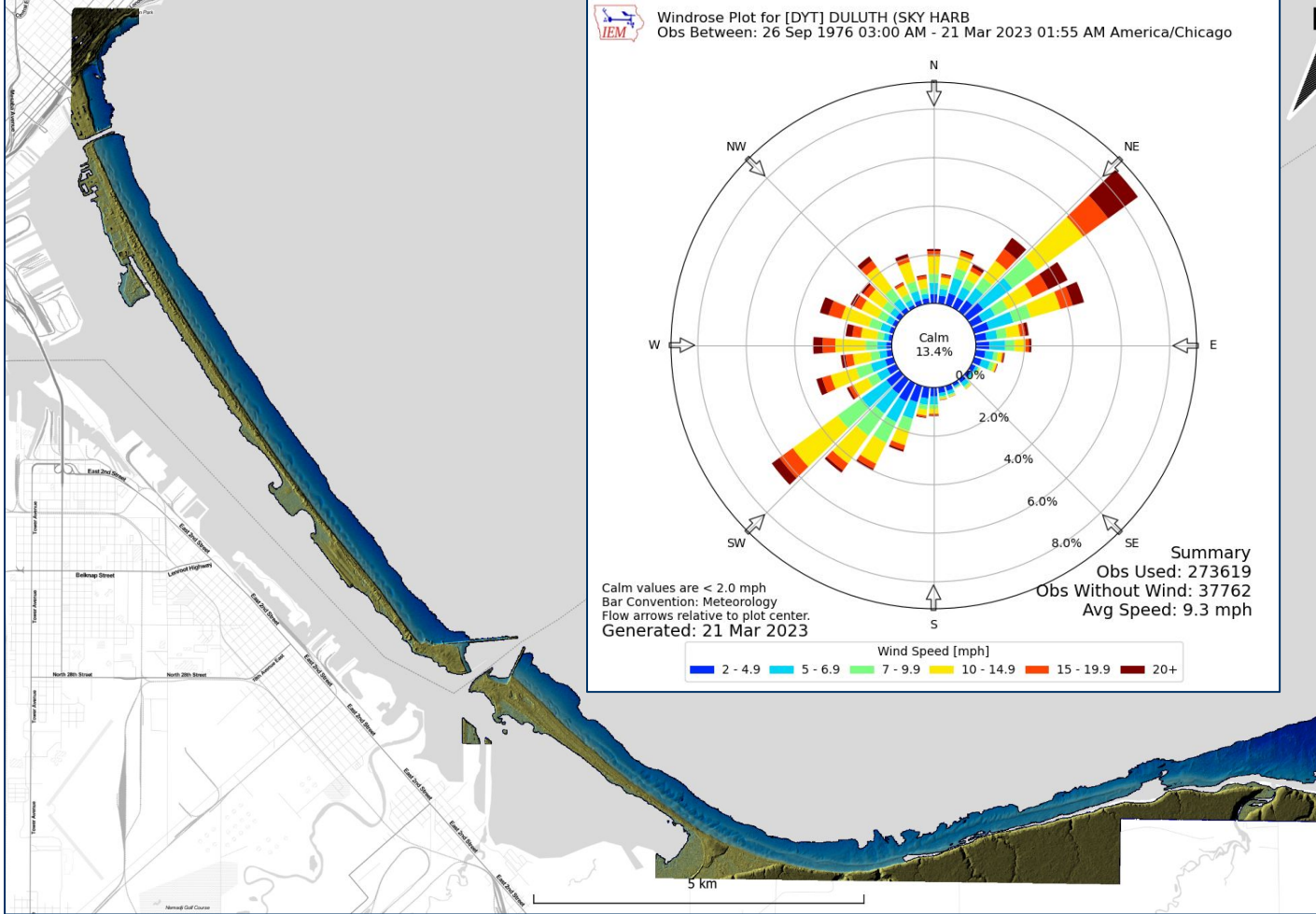
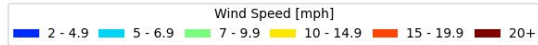


Windrose Plot for [DYT] DULUTH (SKY HARB
 Obs Between: 26 Sep 1976 03:00 AM - 21 Mar 2023 01:55 AM America/Chicago



Summary
 Obs Used: 273619
 Obs Without Wind: 37762
 Avg Speed: 9.3 mph

Calm values are < 2.0 mph
 Bar Convention: Meteorology
 Flow arrows relative to plot center.
 Generated: 21 Mar 2023



Evaluating Change at Minnesota Point

Climate Change in the Coastal Zone:

Coastal Zones are very dynamic and impacted by multiple geomorphological processes (exogenic)

Water: Increase Precipitation = Increased water levels in the lake and saturation of shoreland leading to possible mass wasting events

Wind: Increased Storm Severity = Increased wave action and aeolian transport

Ice: Increased Freeze Thaw Cycling = Increased physical weathering

Ice: Loss of Shorefast Ice = Increased exposure to winter storms



Wrap Up



Adaptation Strategies

OFFICE FOR COASTAL MANAGEMENT
DIGITAL COAST

Home / Topics / Adaptation Strategies

Adaptation Strategies

Jump to Section


- Understand the Basics
- Identify Options
- Evaluate Options
- Engage Stakeholders
- Learn from Others

Coastal communities are striving to adapt to a changing climate. Whether it's finding new ways to protect the built and natural environment, or




Adaptation Strategies

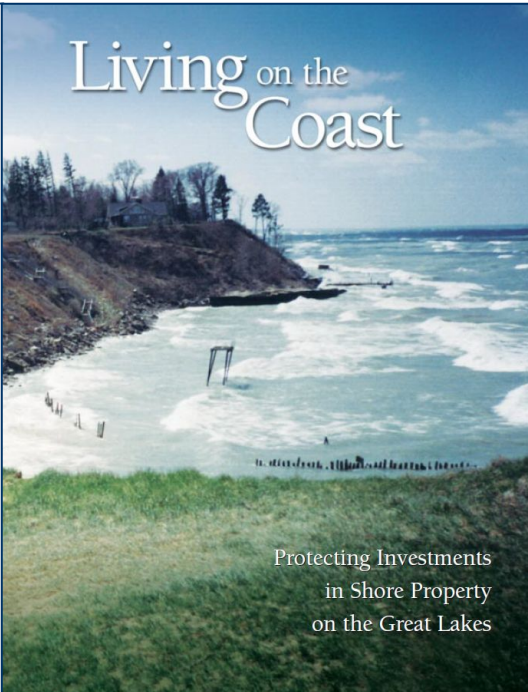
ADAPTING TO CLIMATE CHANGE:
A PLANNING GUIDE FOR
STATE COASTAL MANAGERS




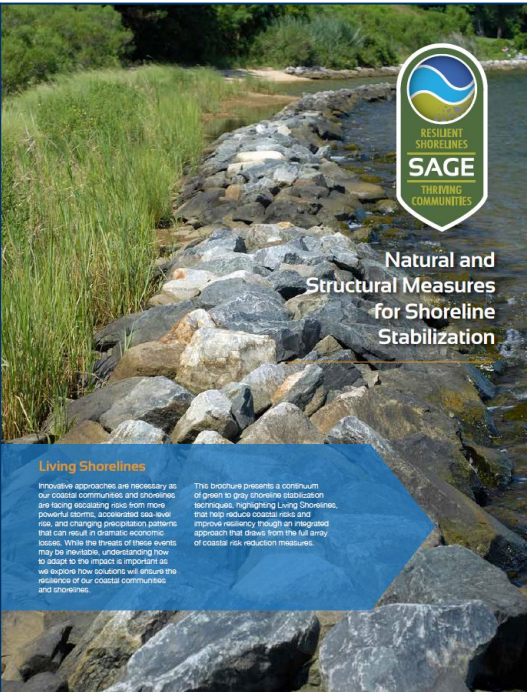
NOAA Office of Ocean and Coastal Resource Management
www.noaa.gov



Living on the Coast



Protecting Investments
in Shore Property
on the Great Lakes



Natural and Structural Measures for Shoreline Stabilization

Living Shorelines

Innovative approaches are necessary as our coastal communities and shorelines are facing escalating risks from more powerful storms, accelerated sea-level rise, and changing precipitation patterns that can result in dramatic economic losses. While the threats of these events may be revision, understanding how to adapt to the impact is important as we explore how solutions will ensure the resilience of our coastal communities and shorelines.

The brochure presents a continuum of green to gray shoreline stabilization techniques, highlighting Living Shorelines that help reduce coastal risks and improve resiliency through an integrated approach that draws from the full array of coastal risk reduction measures.

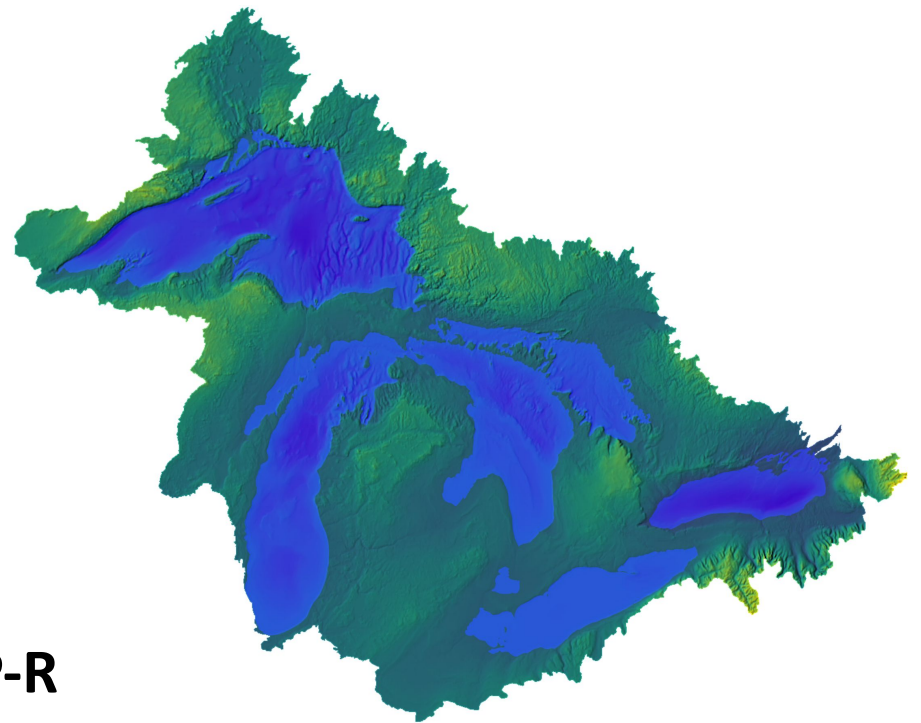


Key Takeaway Messages

1. Minnesota Point is a very complex and delicate system.
2. Great Lakes coastal areas are very dynamic and directly influenced by climate change.
3. Recent high water levels and coastal storms have led to increased rates of erosion and sediment transport.
4. Reduced ice cover over the winter allows for additional coastal erosion.
5. Data and tools are available to help with understanding the complexity of geomorphic processes, coastal impacts, and adaptation strategies.



Questions?



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