NOAA OFFICE FOR COASTAL MANAGEMENT

Tools and Data for Evaluating Change at Minnesota Point

Brandon Krumwiede

AUGUST 24, 2023

Introduction

Physical Scientist / Regional Geospatial Coordinator

BS Geography Bemidji State University

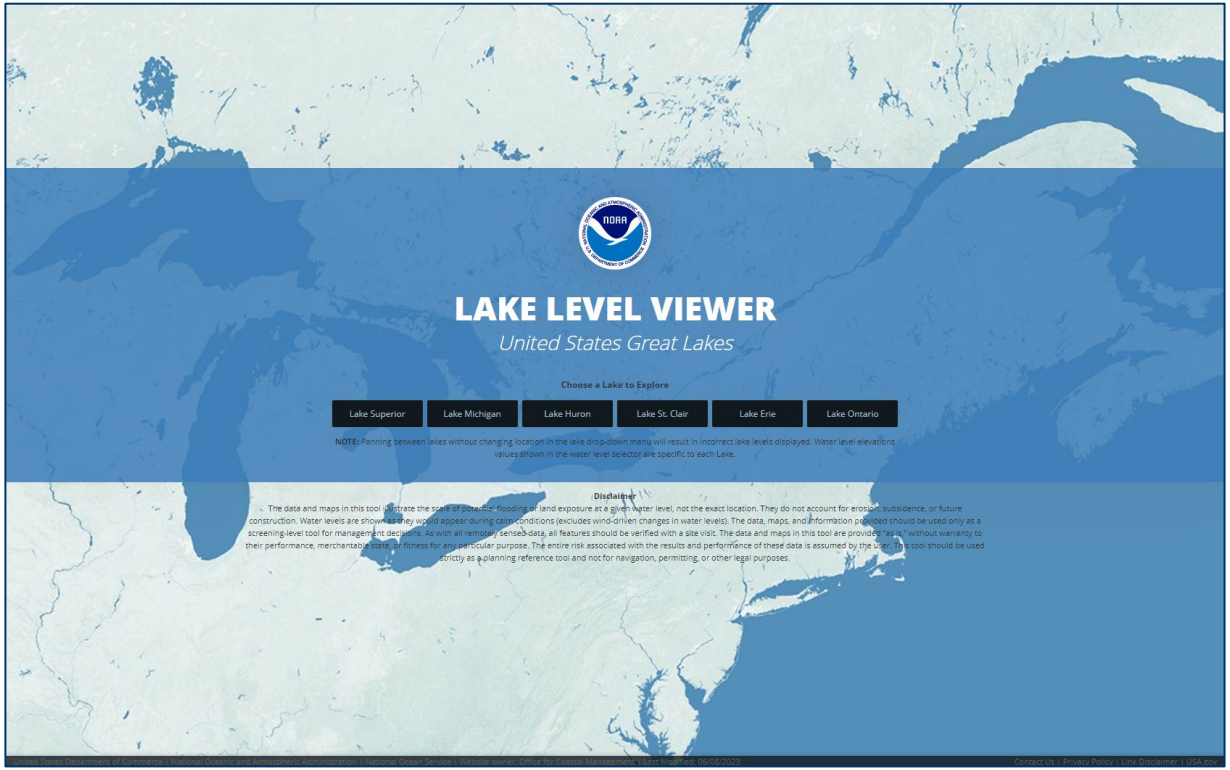
MS University of Montana

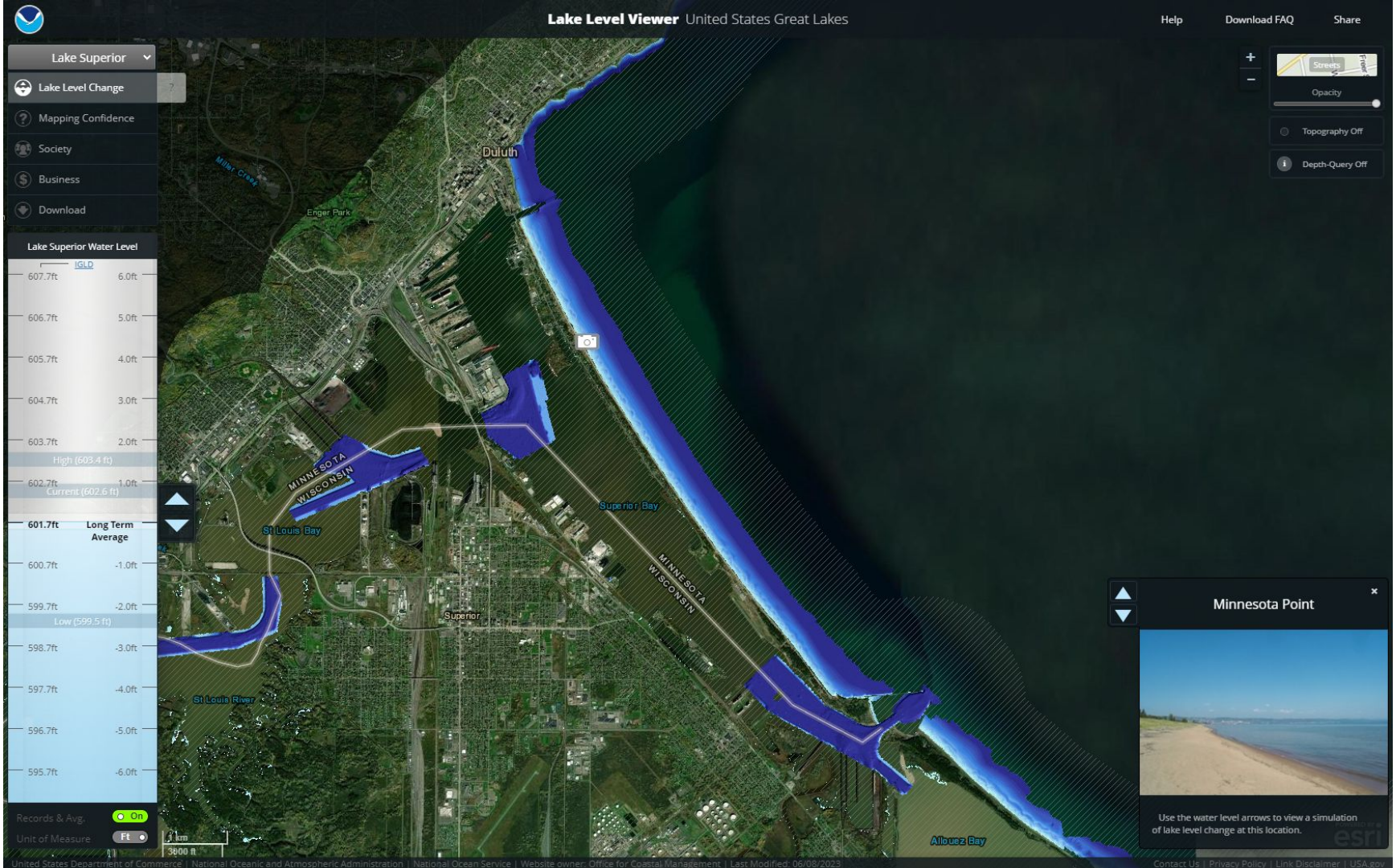
Remote Sensing, Geomorphology, Artificial Intelligence

Presentation Overview

Tools / Data / Use Cases

Lake Level Viewer




Lake Level Viewer United States Great Lakes
Help
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Lake Level Change
Mapping Confidence
Society
Business
Download
Lake Superior Water Level
IGLD
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 Long Term Average
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
Streets
Opacity
Topography Off
Depth-Query Off
Duluth
Miller Creek
Enger Park
MINNESOTA
WISCONSIN
St Louis Bay
Superior Bay
Superior
St Louis River
Allouez Bay
Minnesota Point
Use the water level arrows to view a simulation of lake level change at this location.
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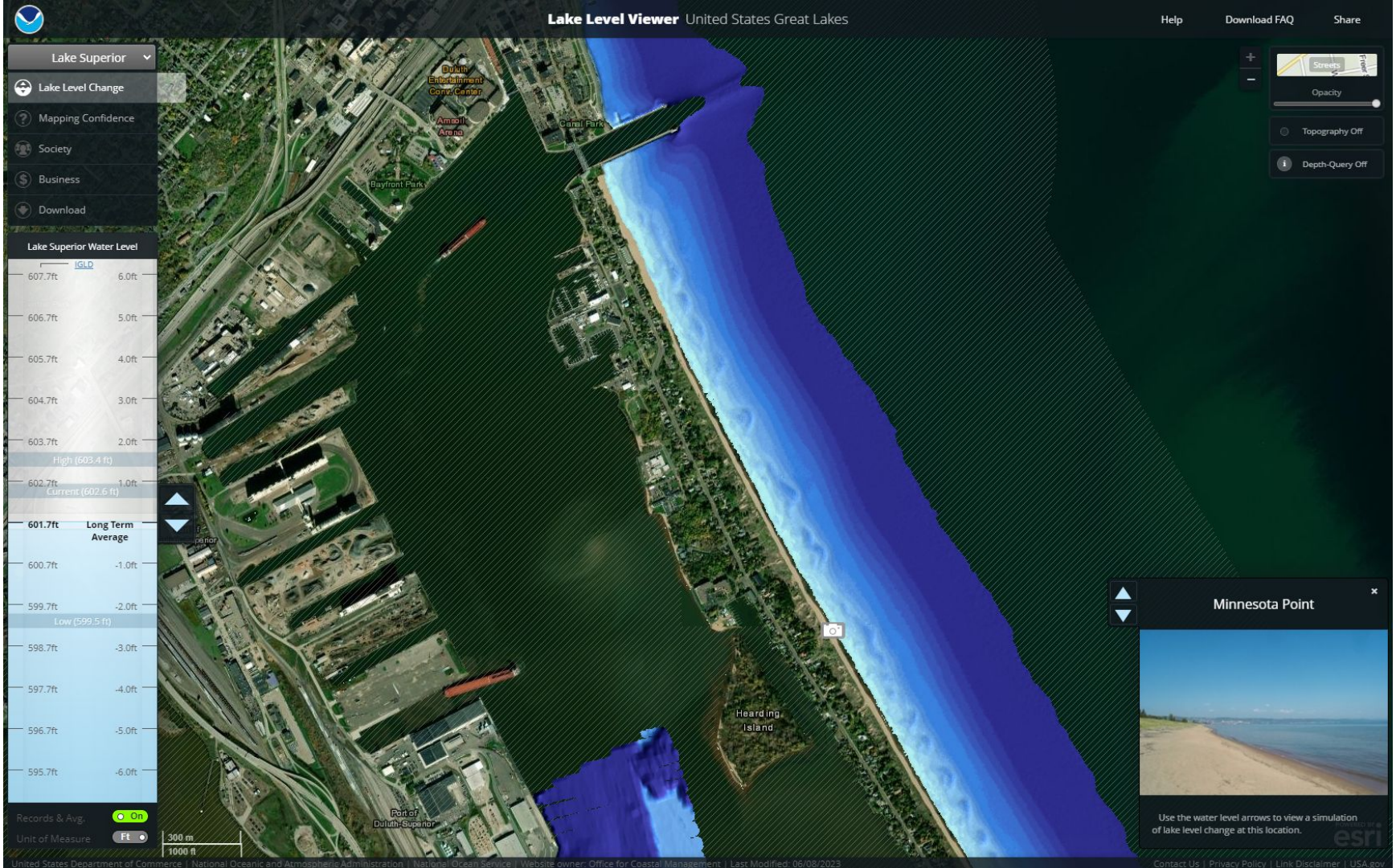
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596.7ft -5.0ft
595.7ft -6.0ft
Records & Avg.
On
Unit of Measure
Ft
300 m
1000 ft
Duluth Entertainment Conv. Center
Amsoil Arena
Canal Park
Bayfront Park
Hearding Island
Port of Duluth-Superior
Streets
Opacity
Topography Off
Depth-Query Off
Minnesota Point
Use the water level arrows to view a simulation of lake level change at this location.
esri
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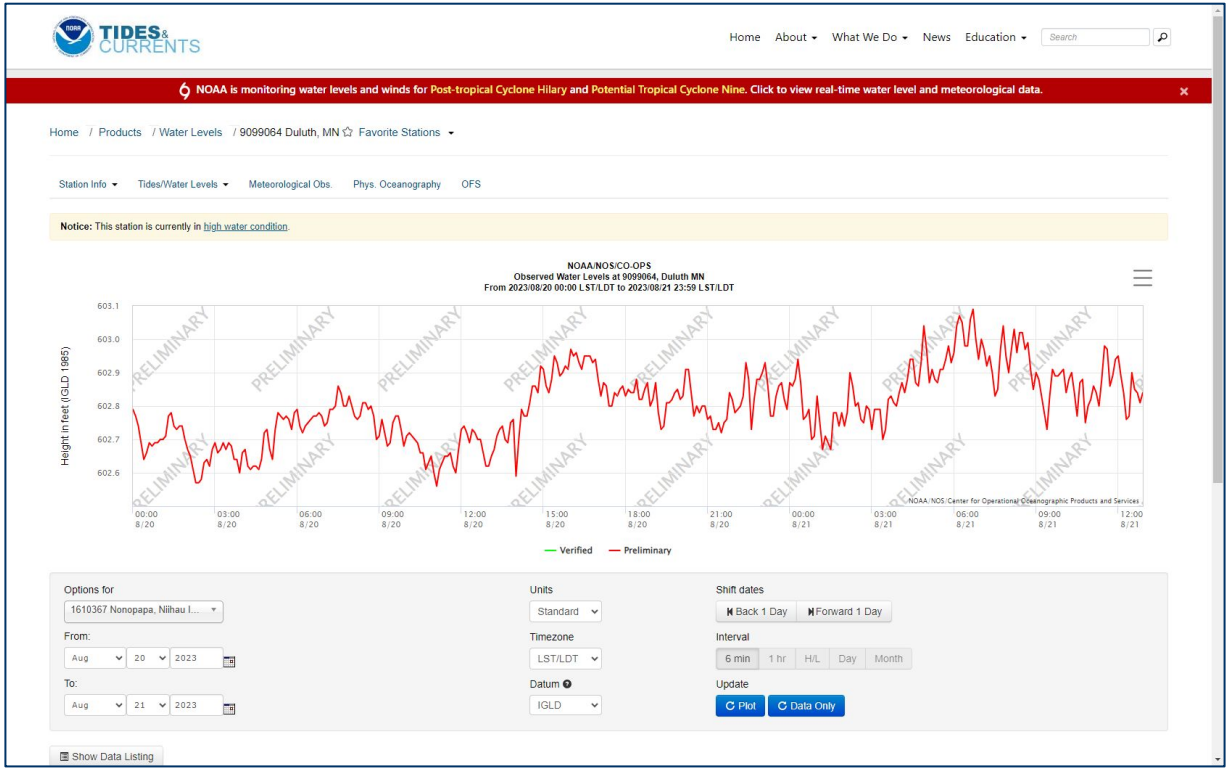
Water Level Station and Data



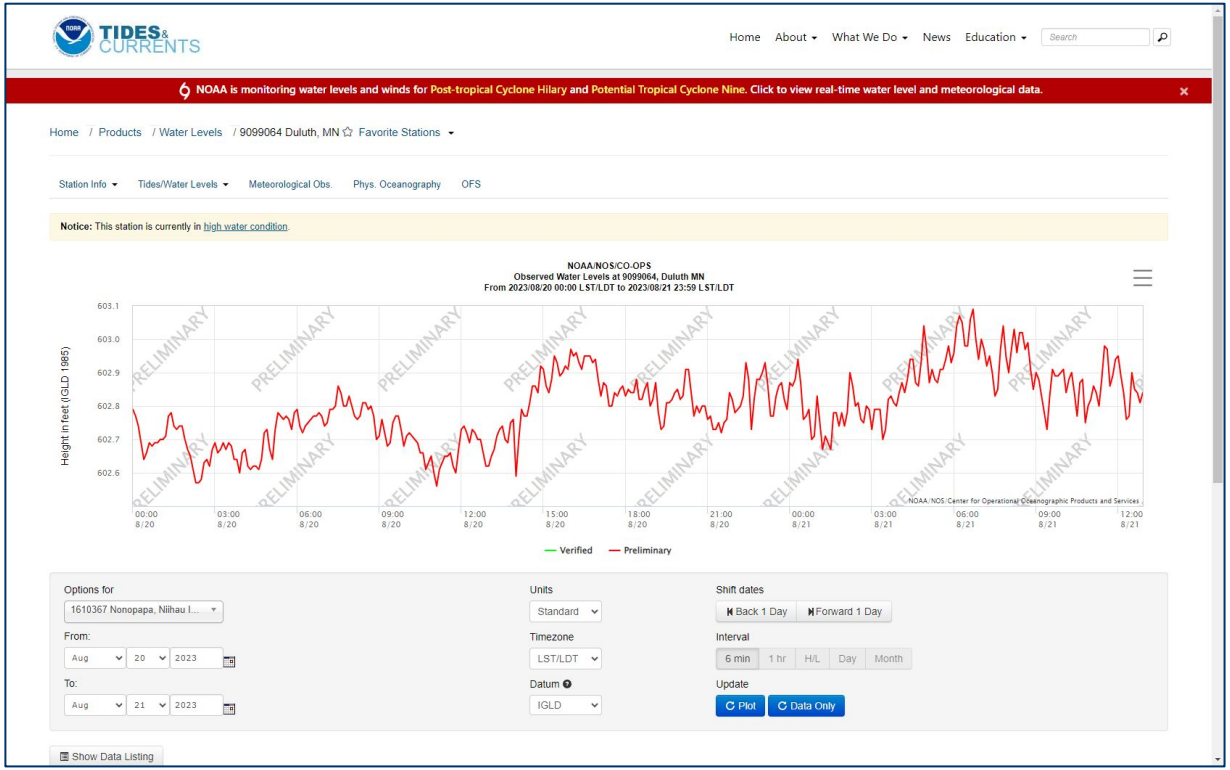
Water Level Station and Data

Duluth, MN
Station ID: 9099064

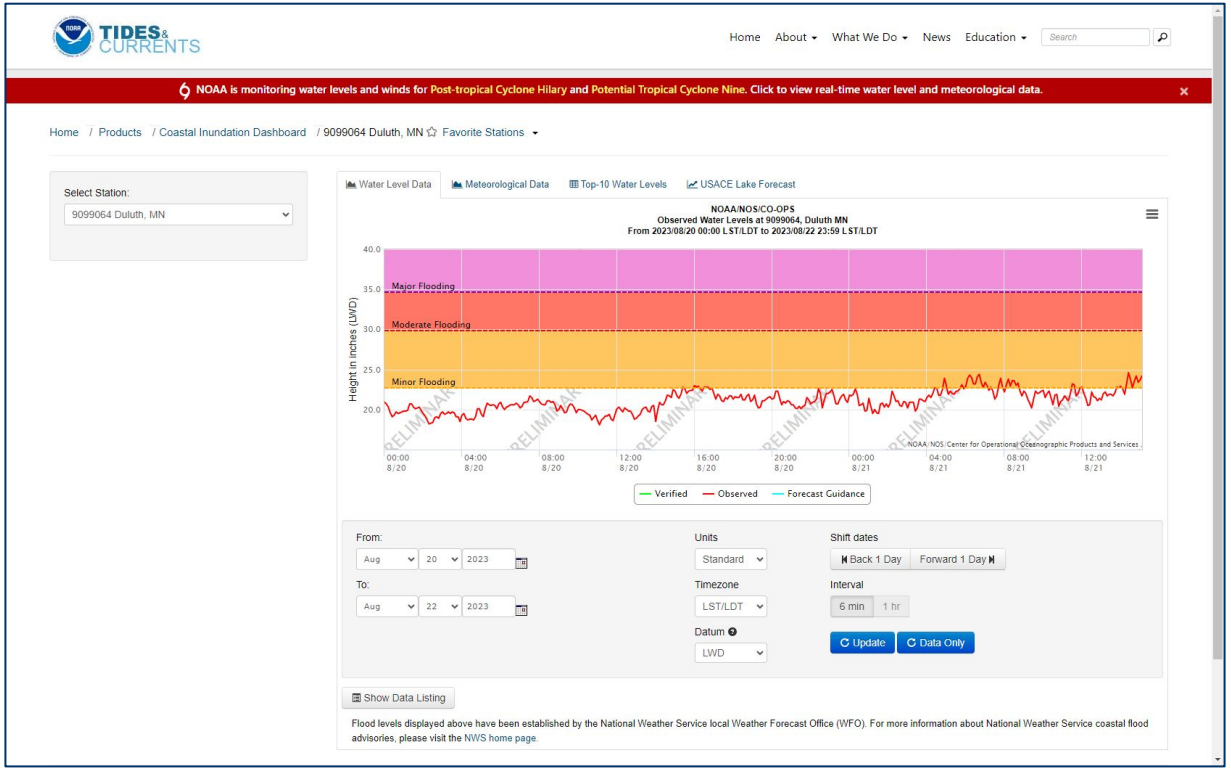
Max Record: 604.75 feet
October 21, 2019

Min Record: 598.98 feet
February 18, 2011

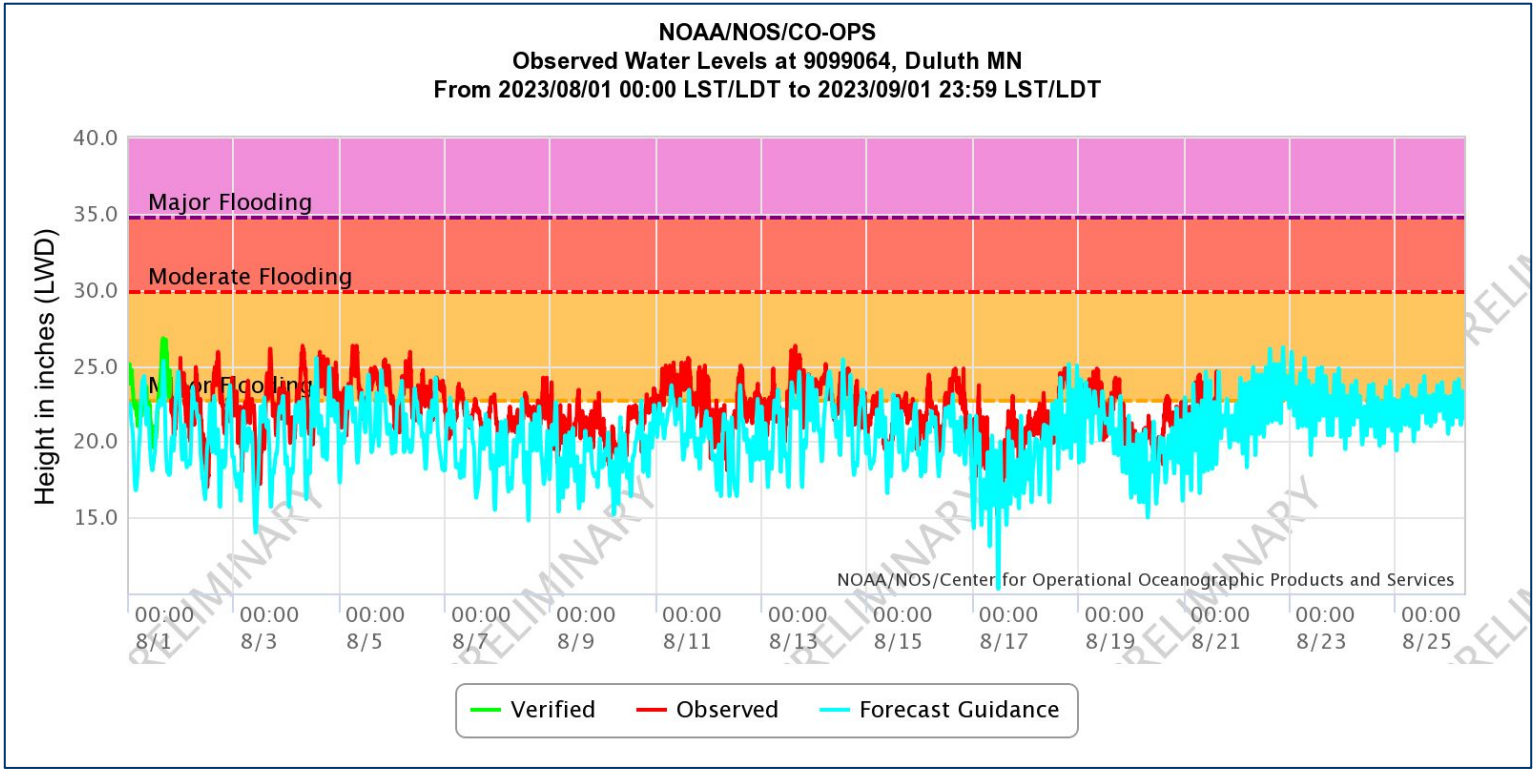
Established April 1, 1860



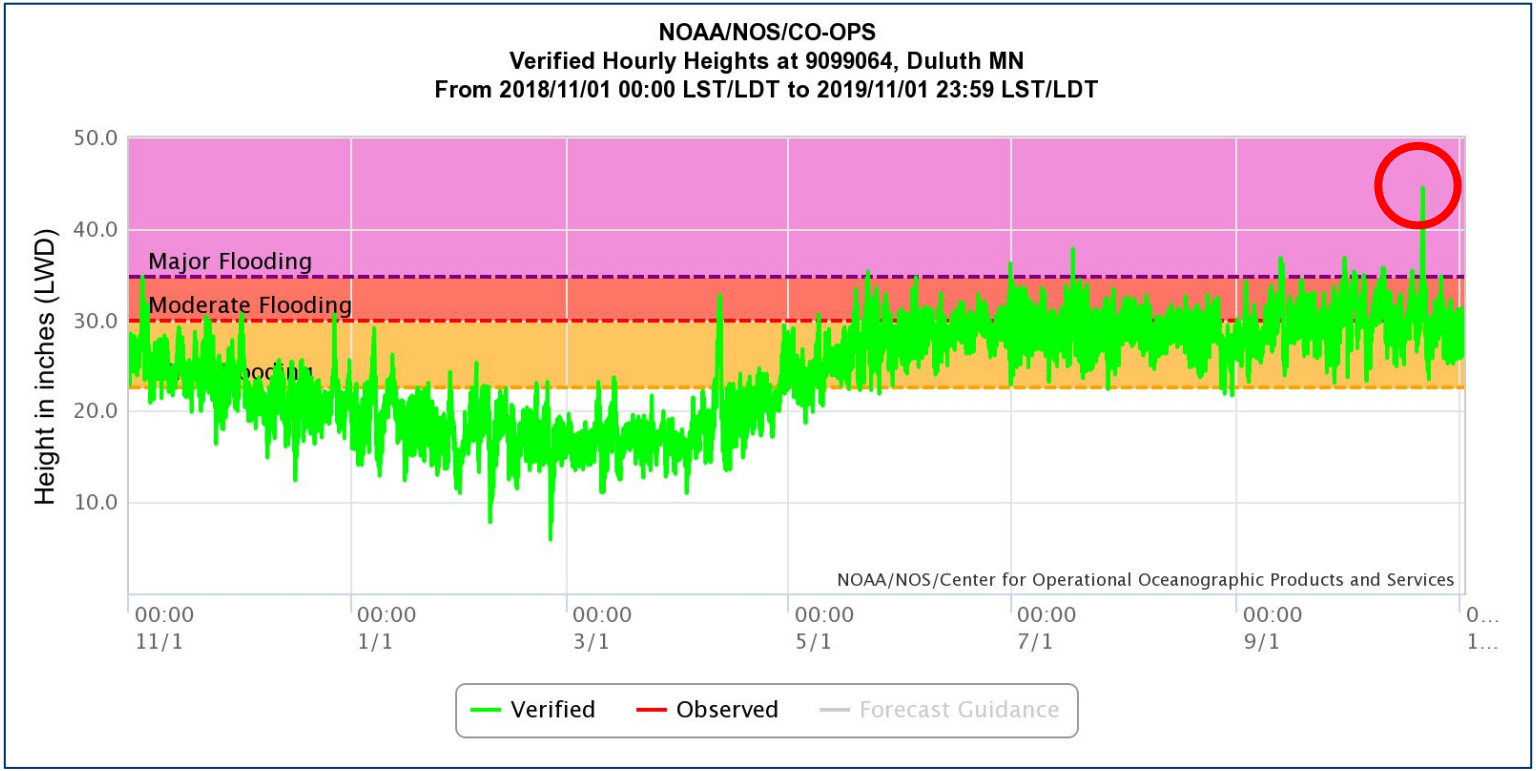
Coastal Inundation Dashboard



Coastal Inundation Dashboard



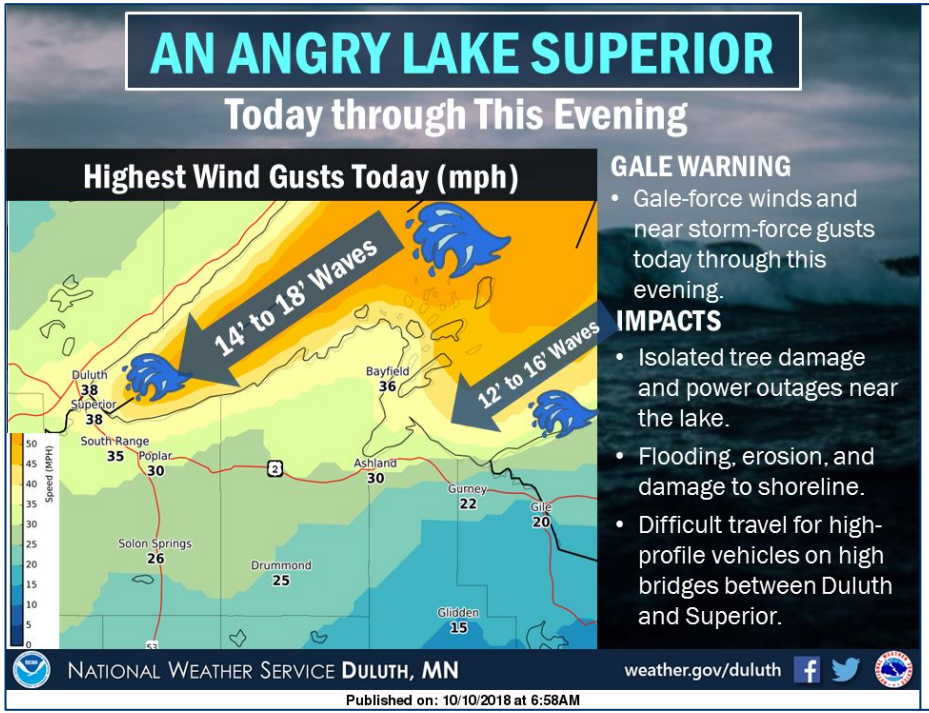
Coastal Inundation Dashboard

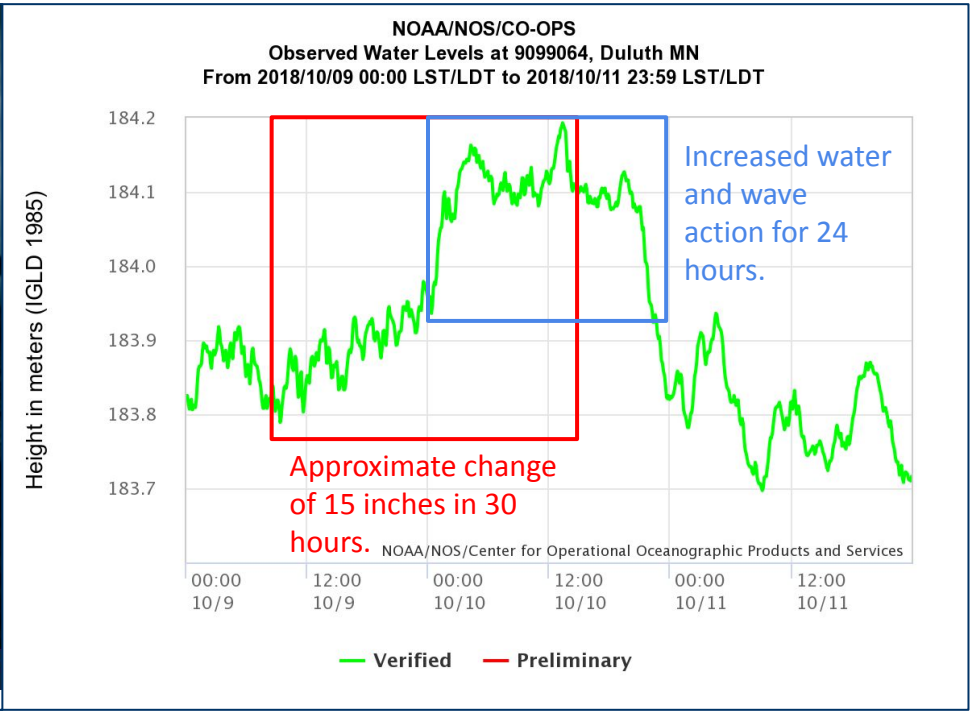


Use Case

Coastal Storm Impacts: 2017, 2018, and 2019

Coastal Storms: Duluth, MN 2018



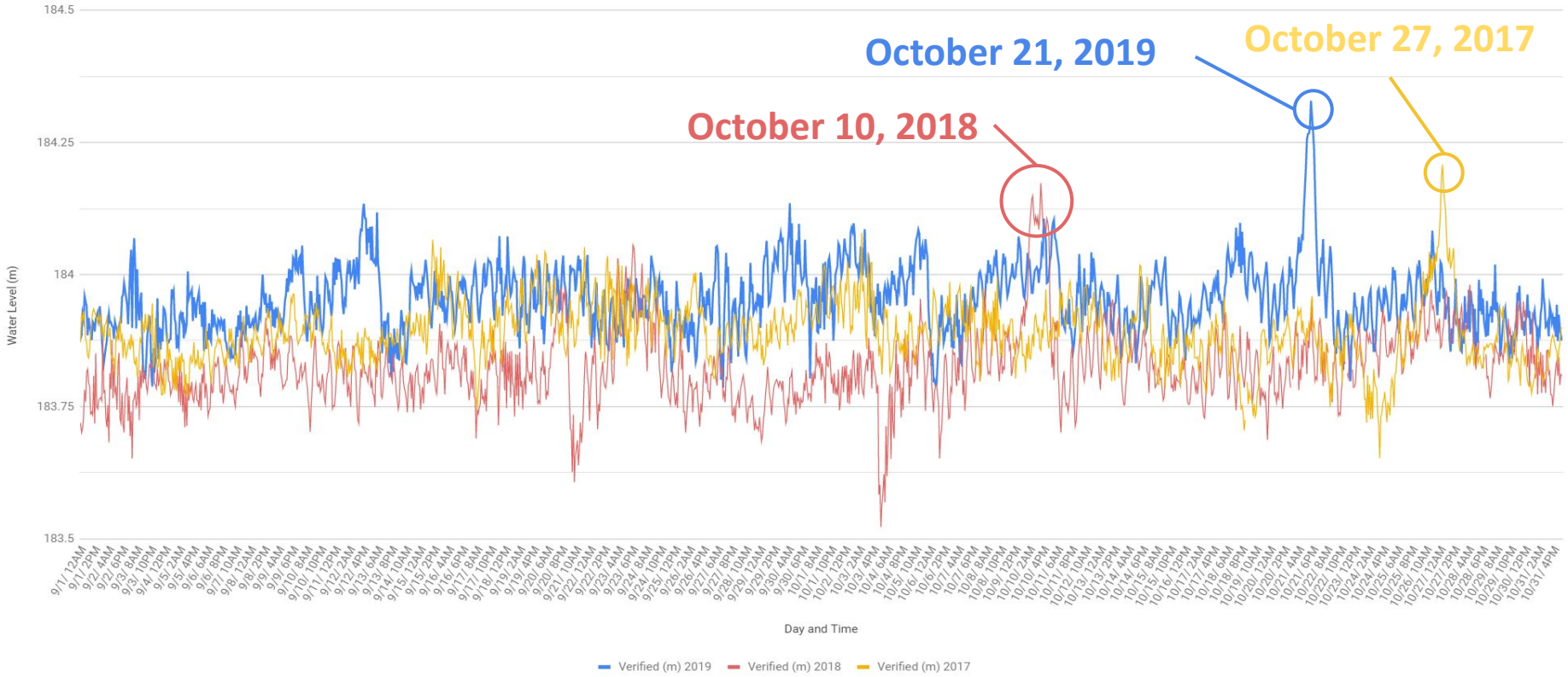


Coastal Storms: Duluth, MN 2018

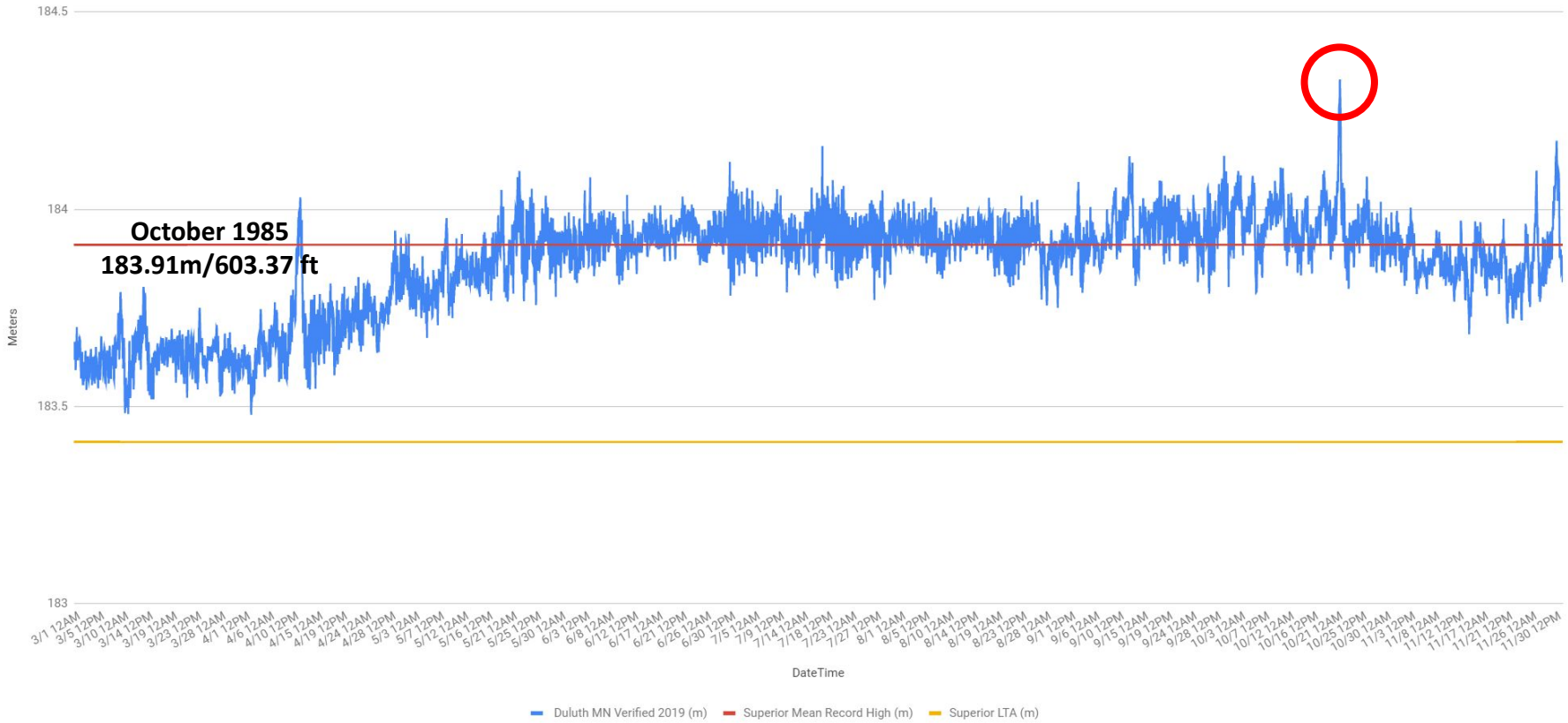
October 2018, Gale Warning. Canal Park, Duluth, MN
Source: WDIO HarborCam

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

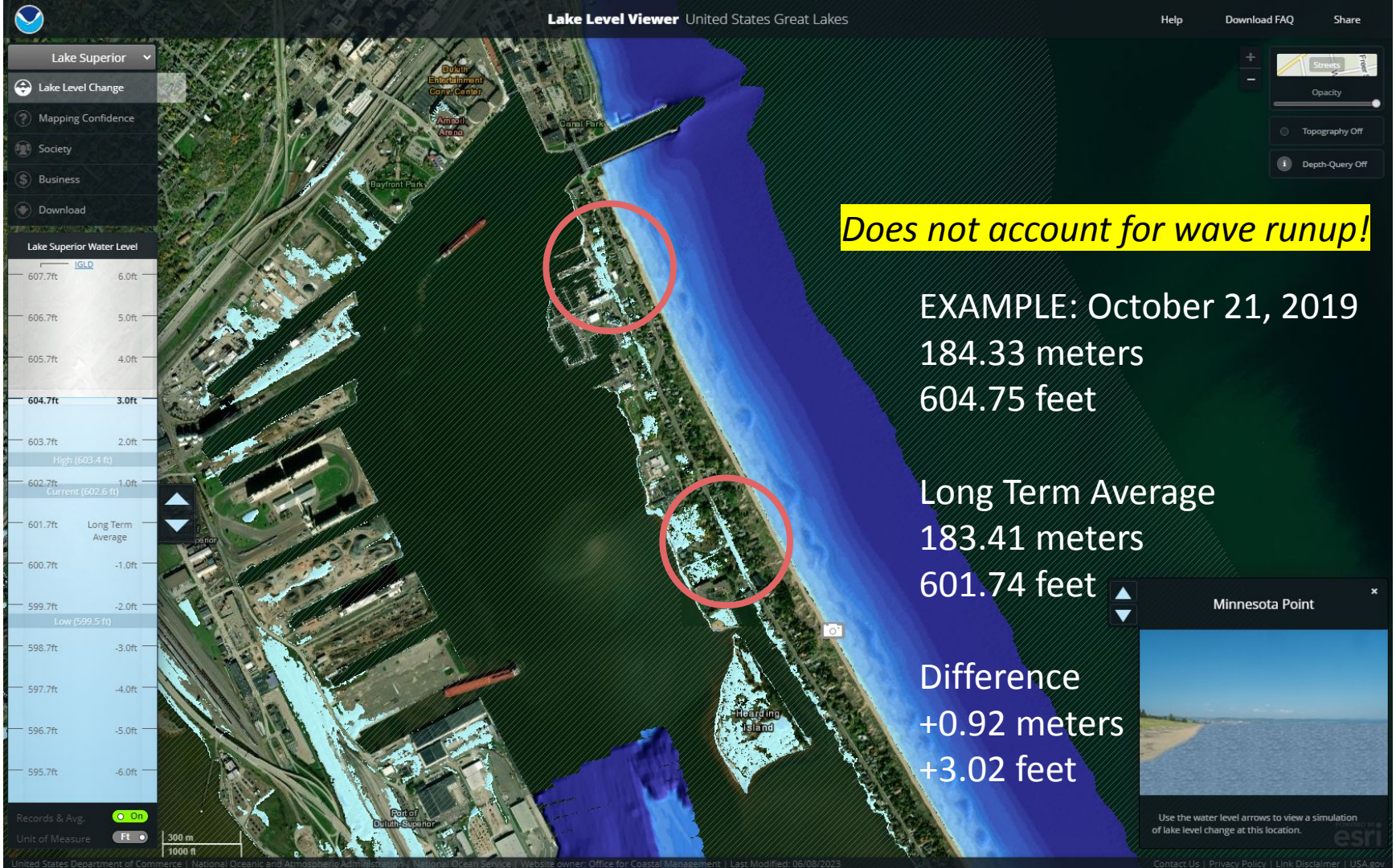
Comparison of Water Levels and Storm Events - Duluth, MN 9099064



NOAA CO-OPS Water Level Data



IGLD 1985



Does not account for wave runup!

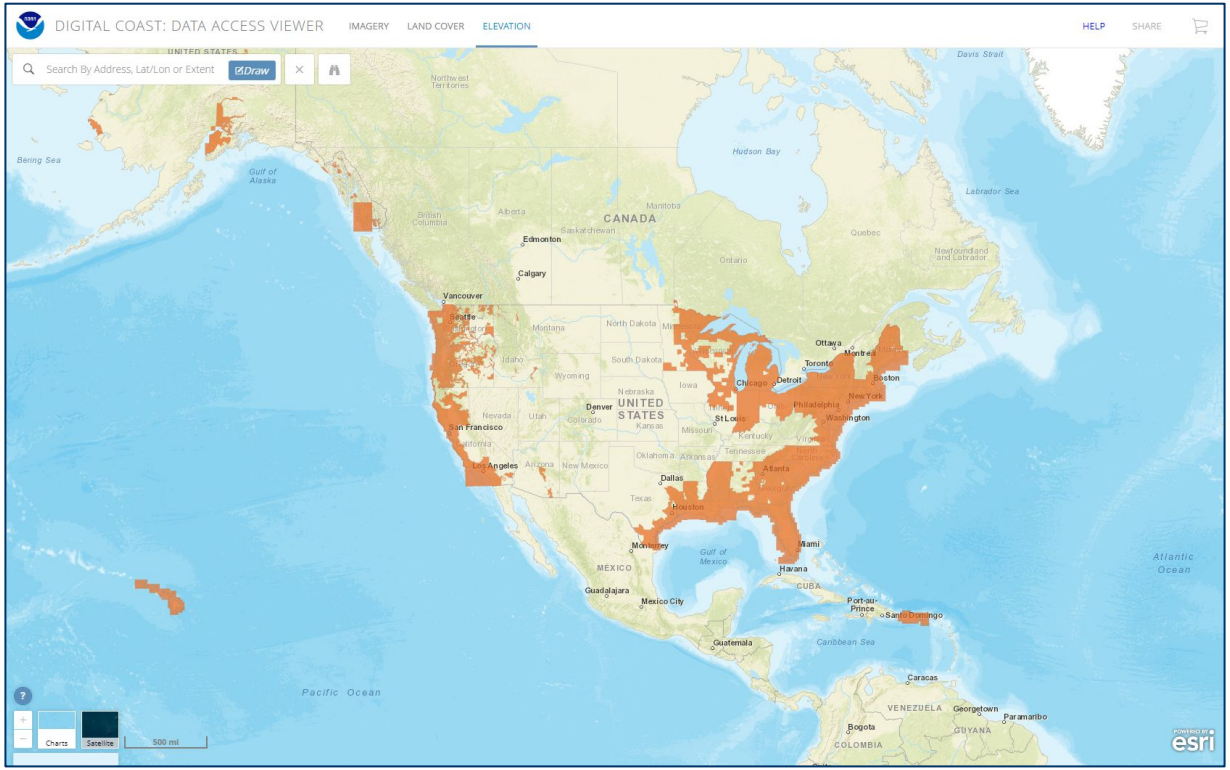
EXAMPLE: October 21, 2019
184.33 meters
604.75 feet

Long Term Average
183.41 meters
601.74 feet

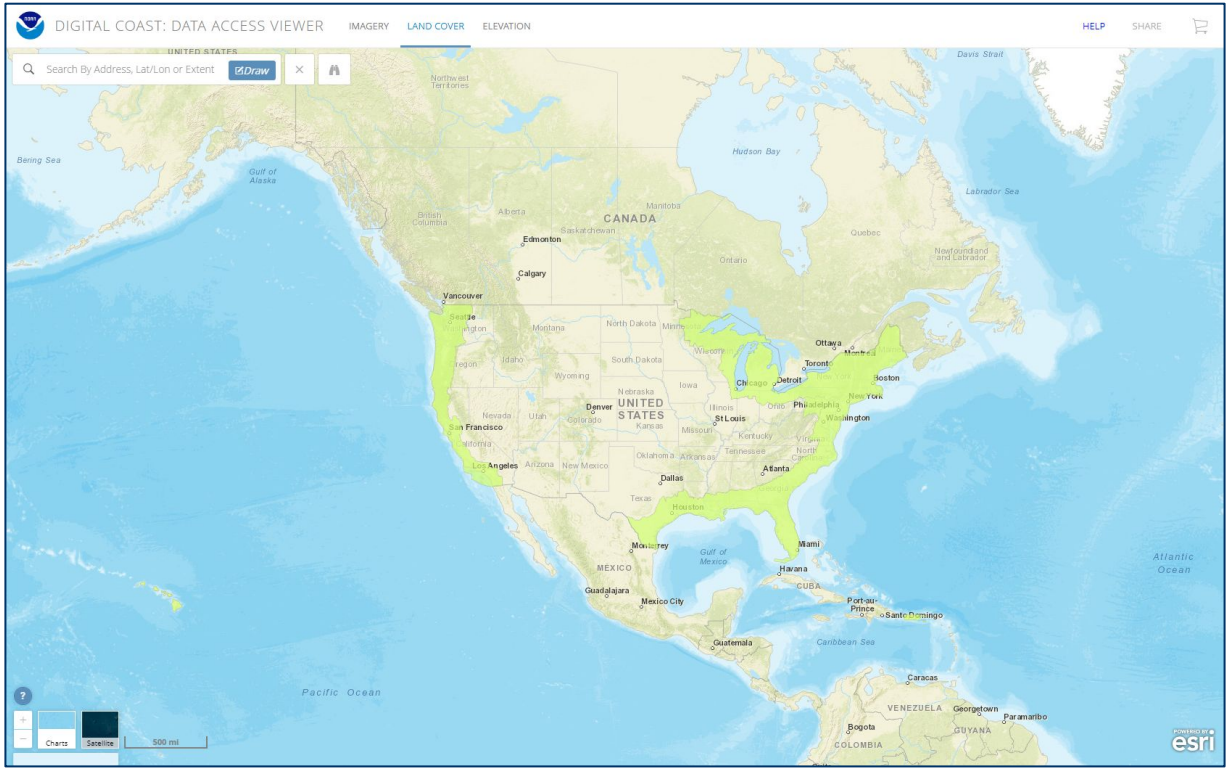
Difference
+0.92 meters
+3.02 feet

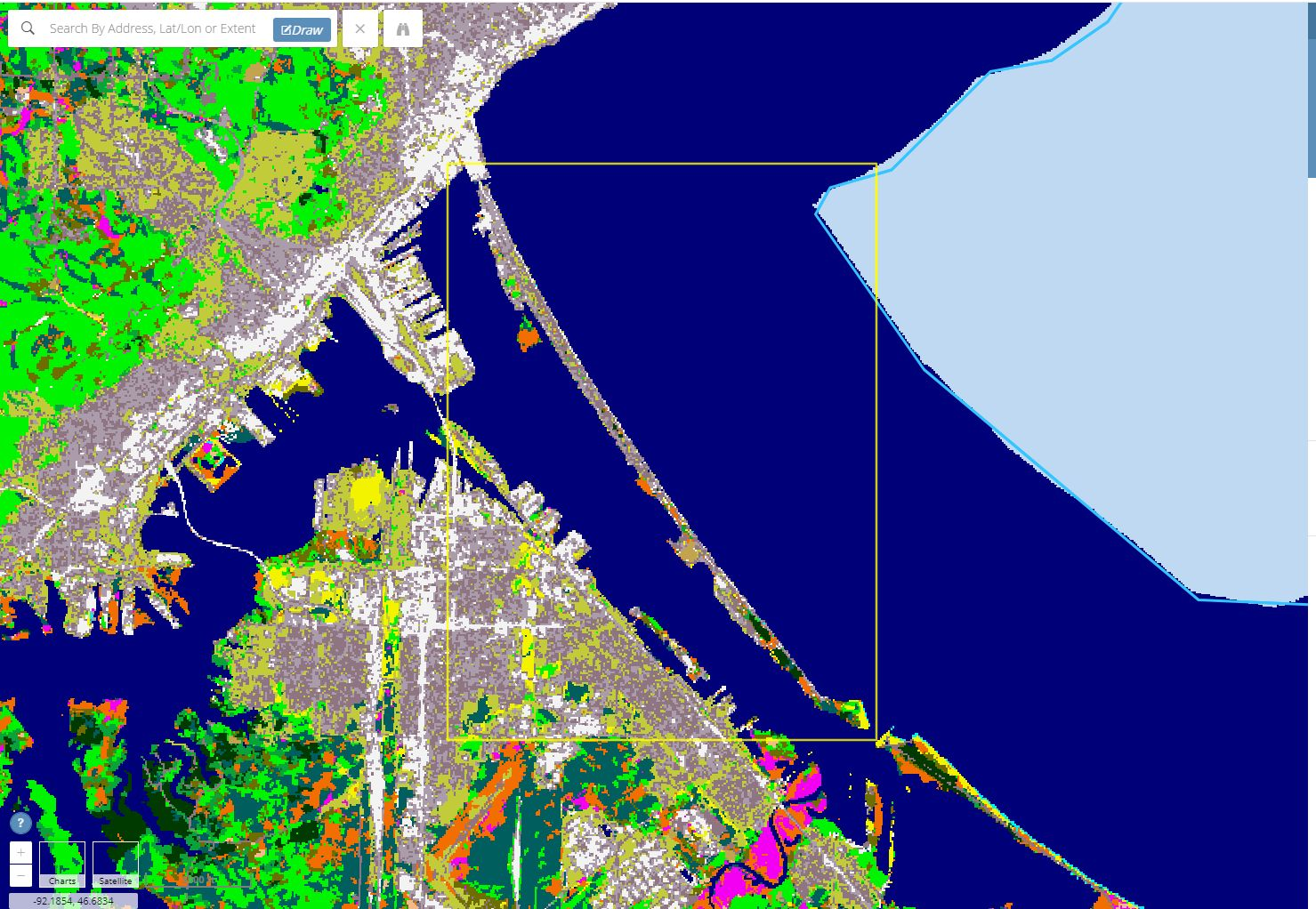
Data Access Viewer

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

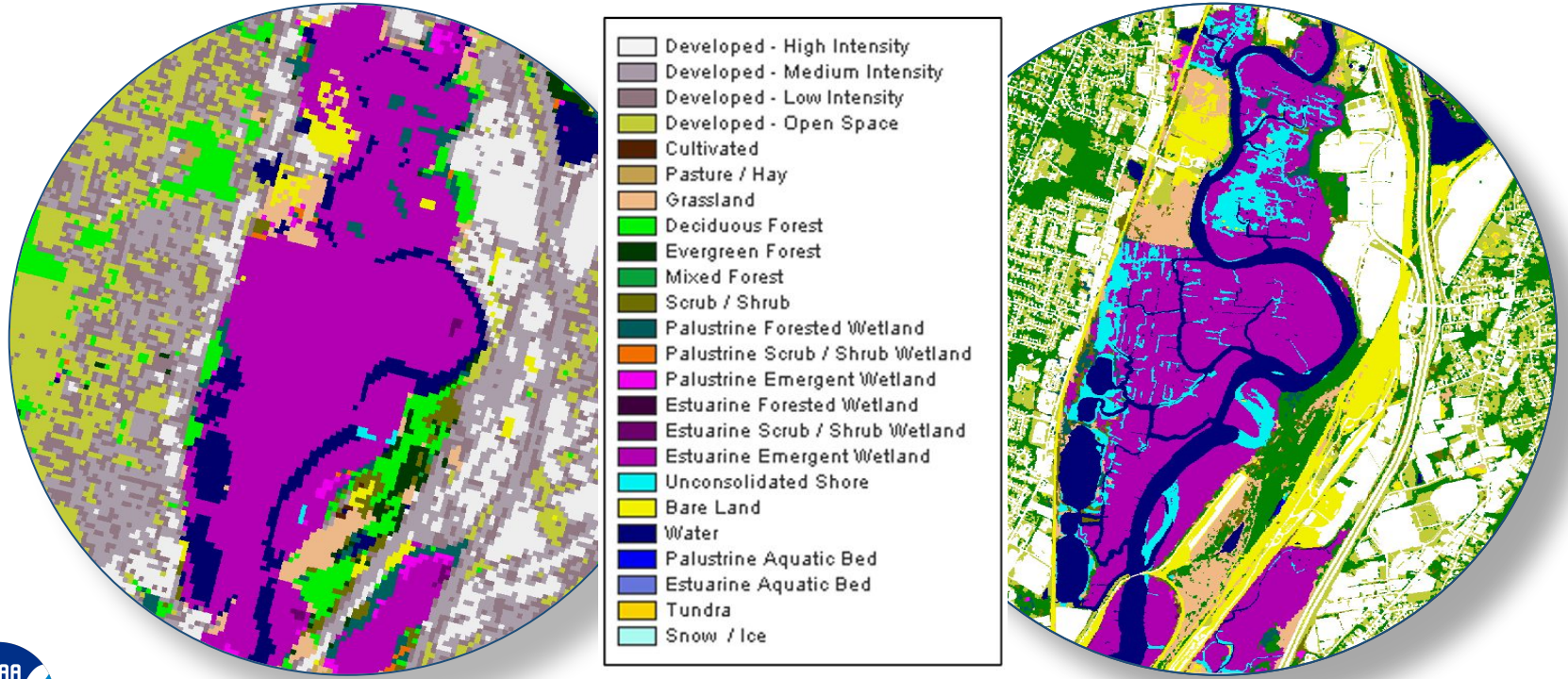
Metadata
Image Service

Imagery Opacity 100%

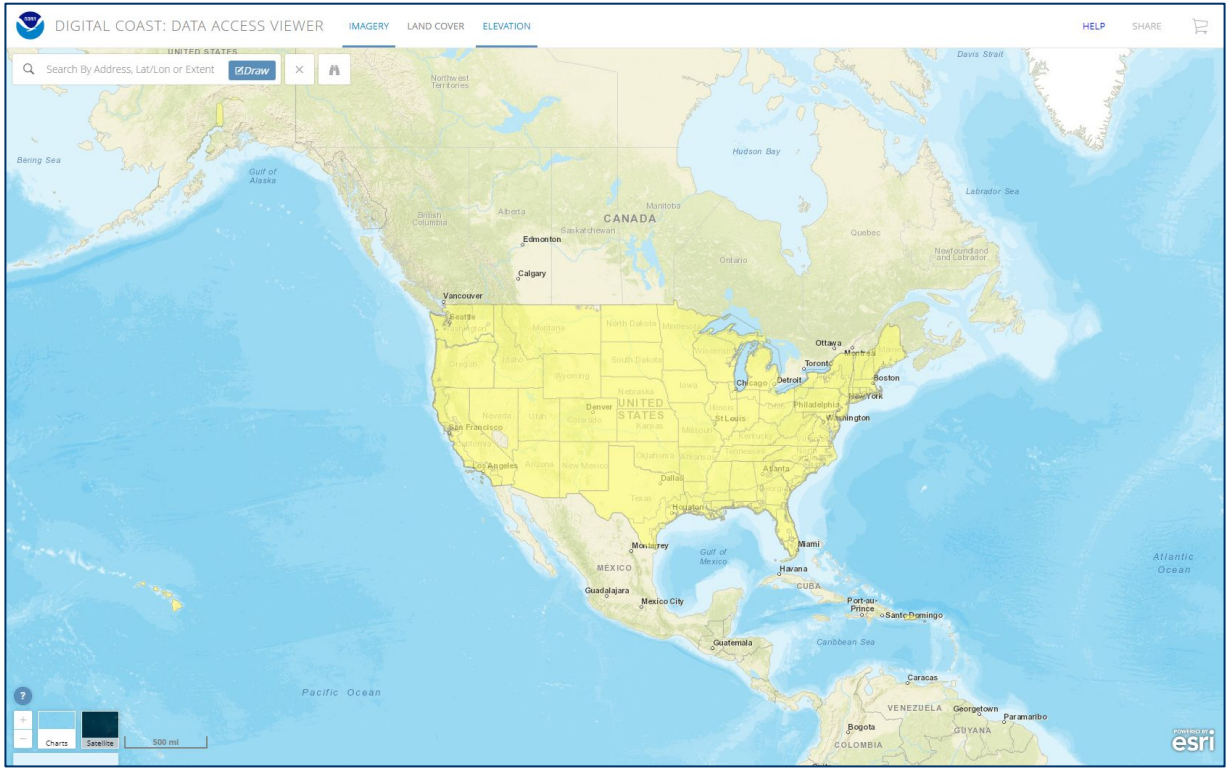
Comparison of Resolutions

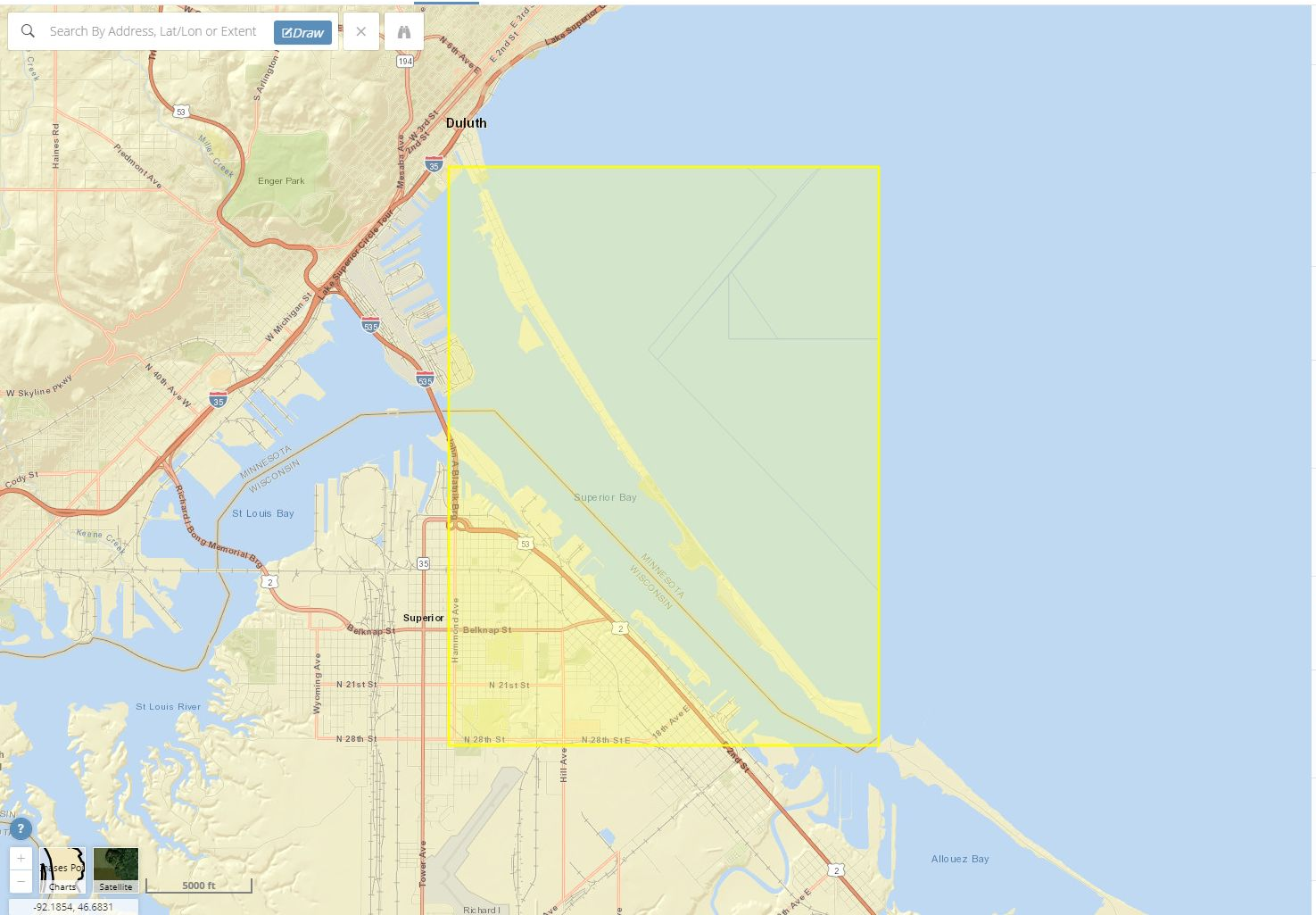
REGIONAL (30 METER)

LOCAL (1 METER)



Imagery Data





Filter by Provider | Sort Results

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

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

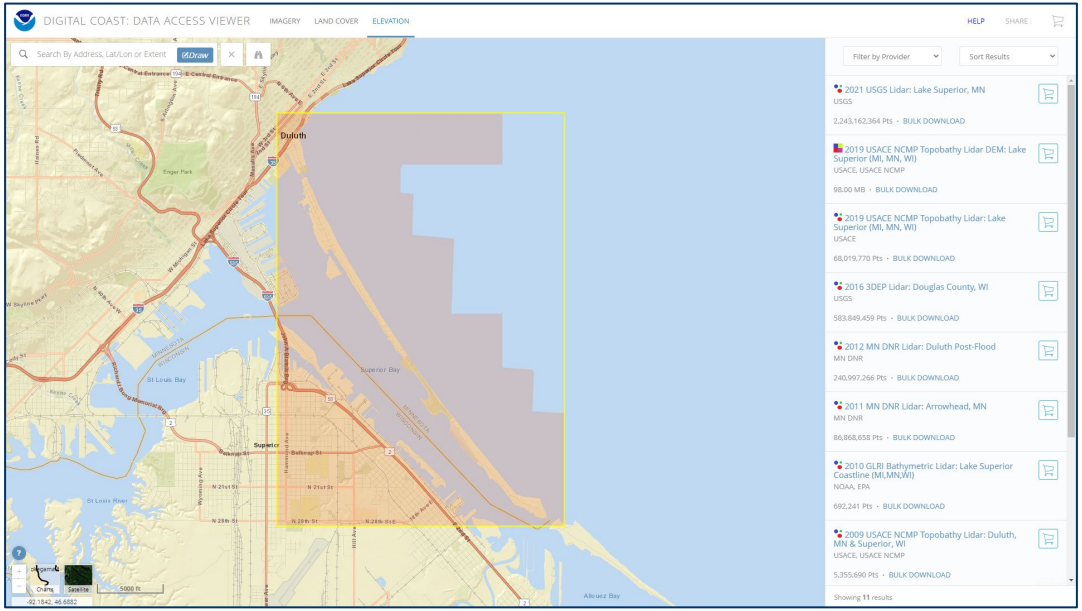
Useful Numbers to Remember:

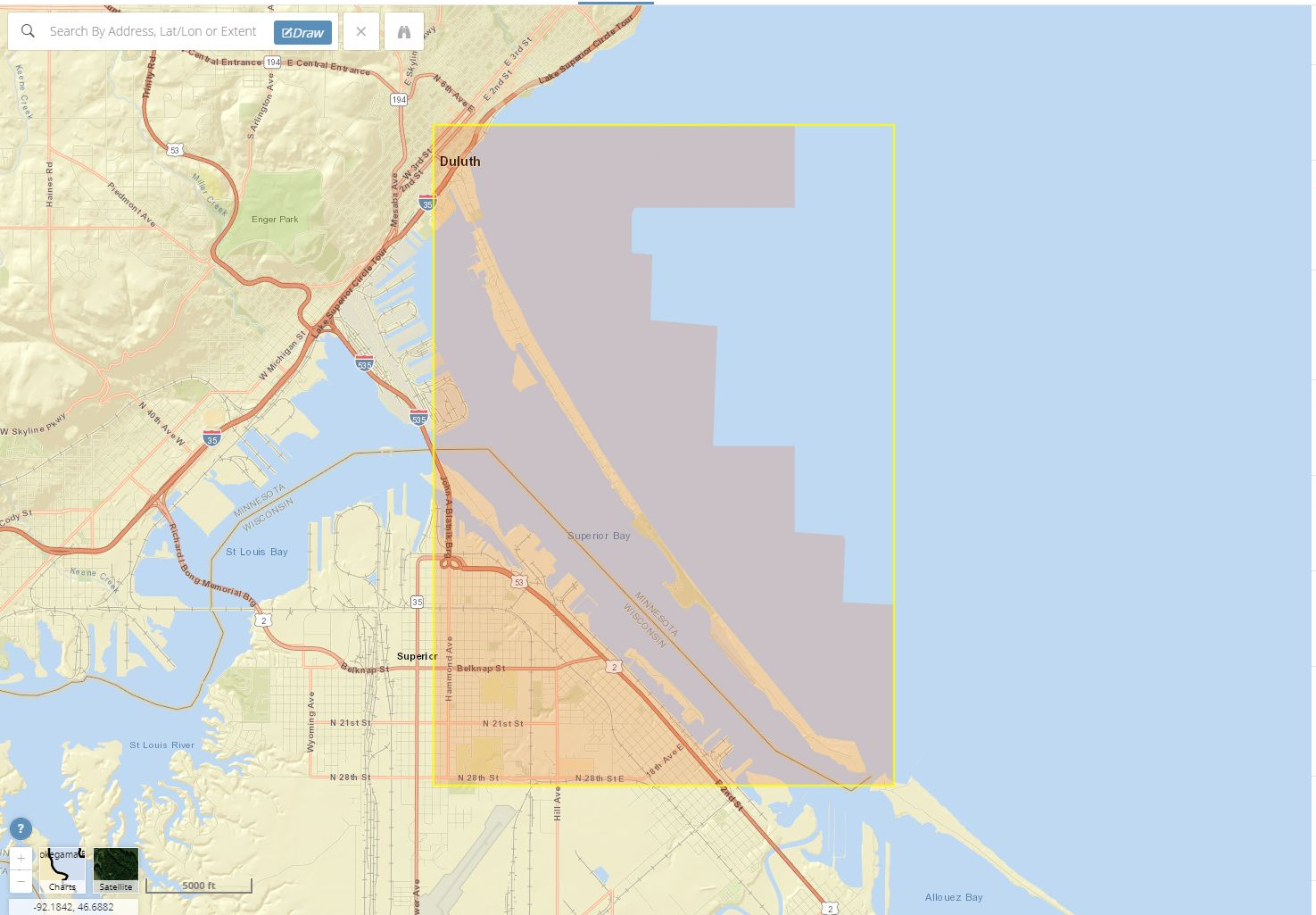
Low Water Datum: 601.1 feet / 183.215 meters
Ordinary High Water Mark (OHWM): 603.1 feet / 183.825 meters
Lakewide Long Term Average: 601.75 feet / 183.41 meters
2009 Lakewide Average: 601.25 feet / 183.26 meters
2019 Lakewide Average: 602.85 feet / 183.75 meters

All referenced to International Great Lakes Datum 1985 (IGLD85)

Evaluating Change at Minnesota Point

Grab elevation data from Data Access Viewer





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

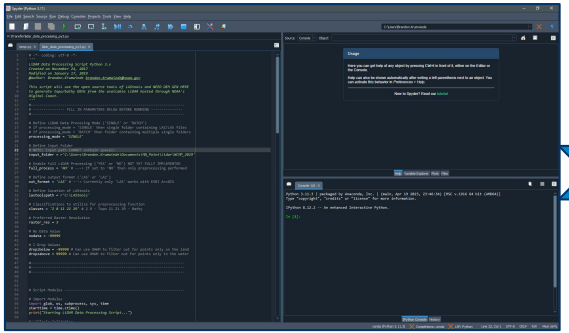
2010 GLRI Bathymetric Lidar: Lake Superior Coastline (MI,MN,WI)
NOAA, EPA
692,241 Pts · BULK DOWNLOAD

2009 USACE NCMP Topobathy Lidar: Duluth, MN & Superior, WI
USACE, USACE NCMP
5,355,690 Pts · BULK DOWNLOAD

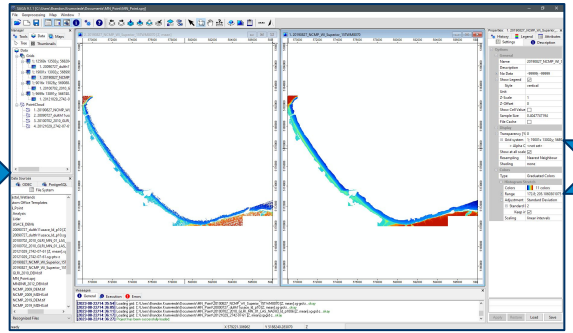
Showing **11** results

Evaluating Change at Minnesota Point

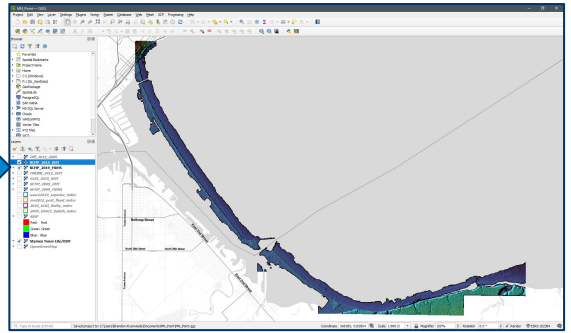
Extract lidar elevation data points and convert into Digital Elevation Models (DEMs)



Scripting in Python



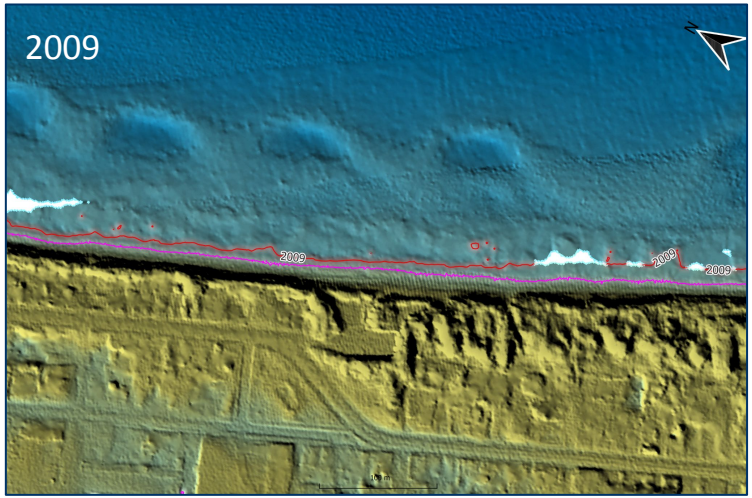
Conversion to Raster in SAGA

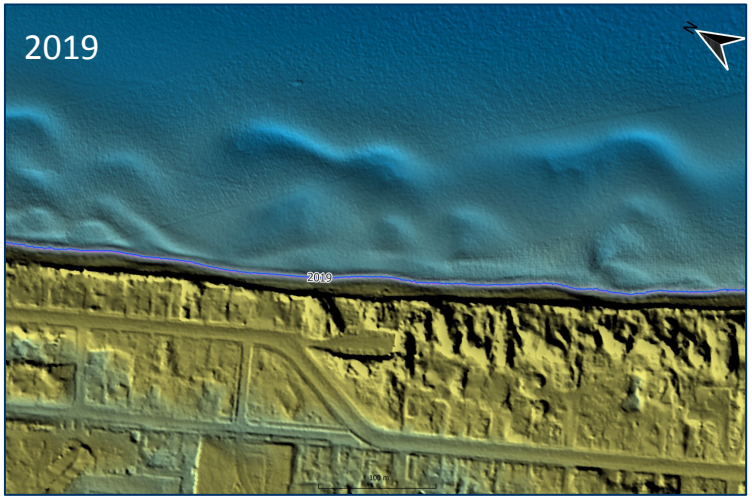


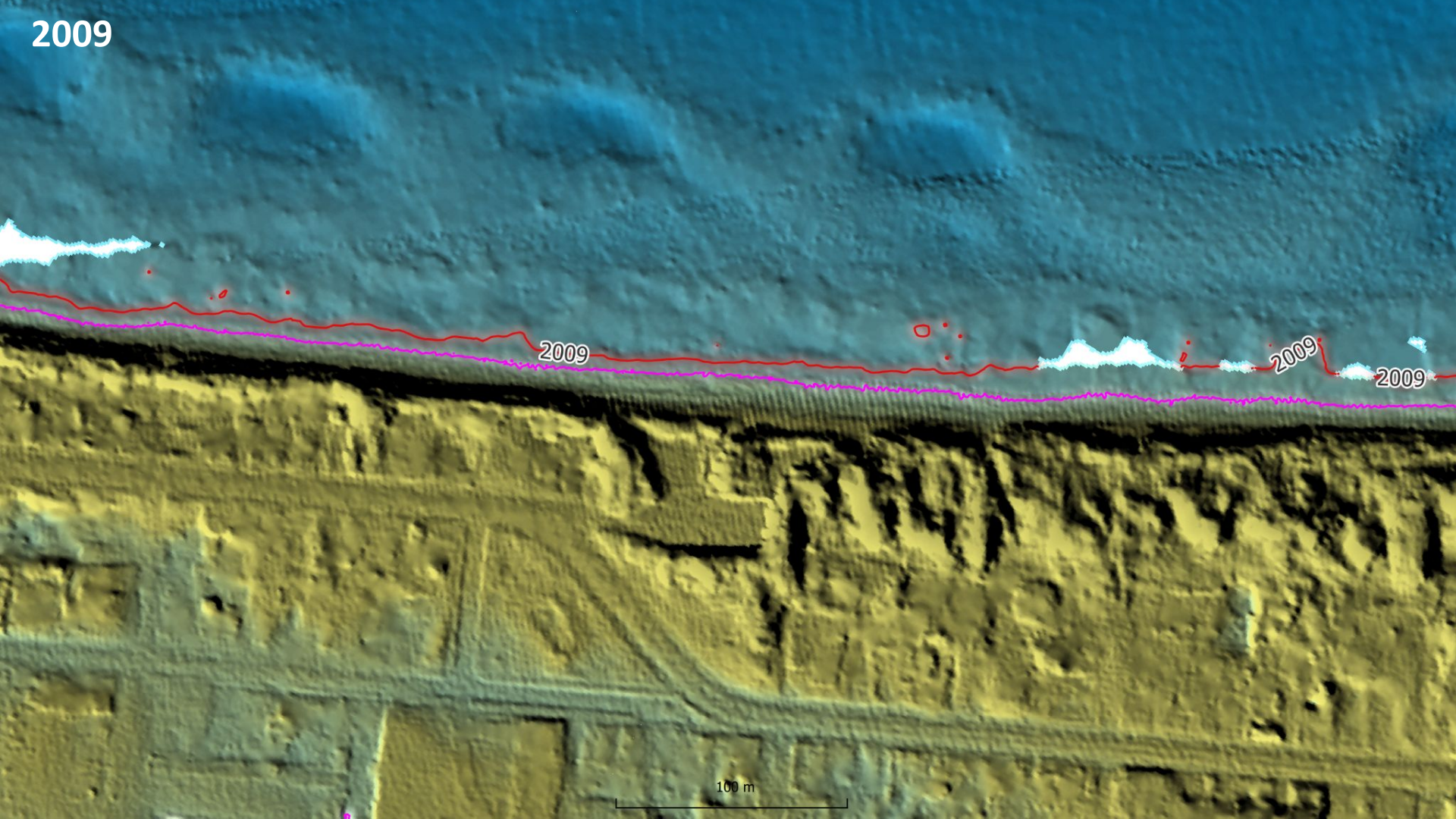
DEM Development in QGIS

Evaluating Change at Minnesota Point

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





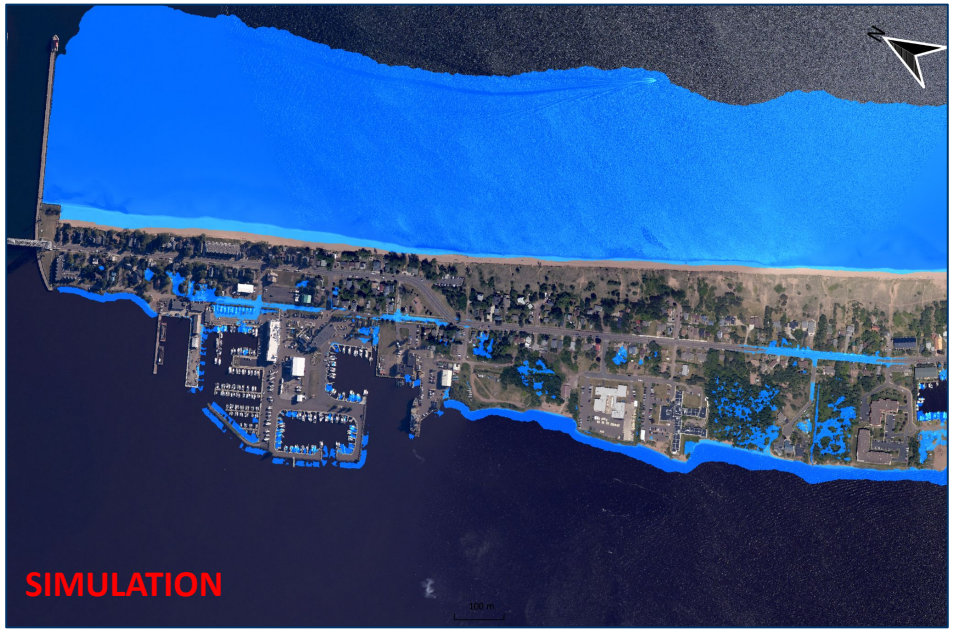

2009
2009
2009
2009
100 m


2019
2019
100 m

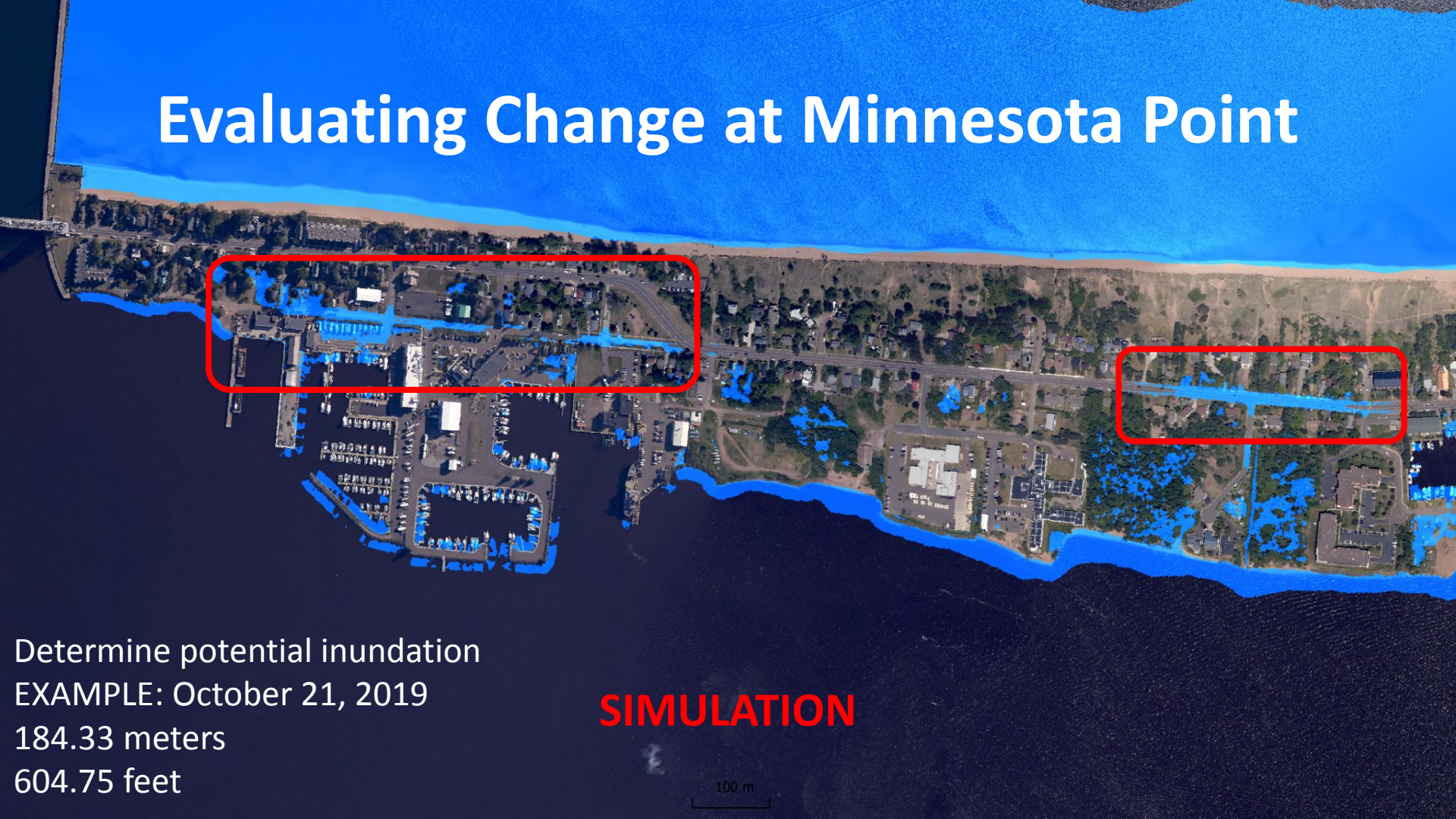

Imagery 2022
2009
2019
2009
2009

Evaluating Change at Minnesota Point

Determine potential inundation area extent by creating a mask



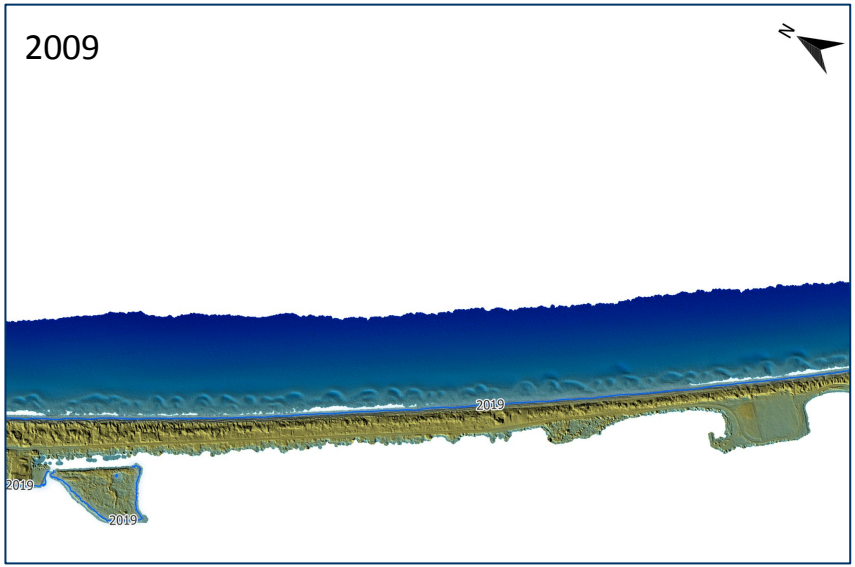
Evaluating Change at Minnesota Point

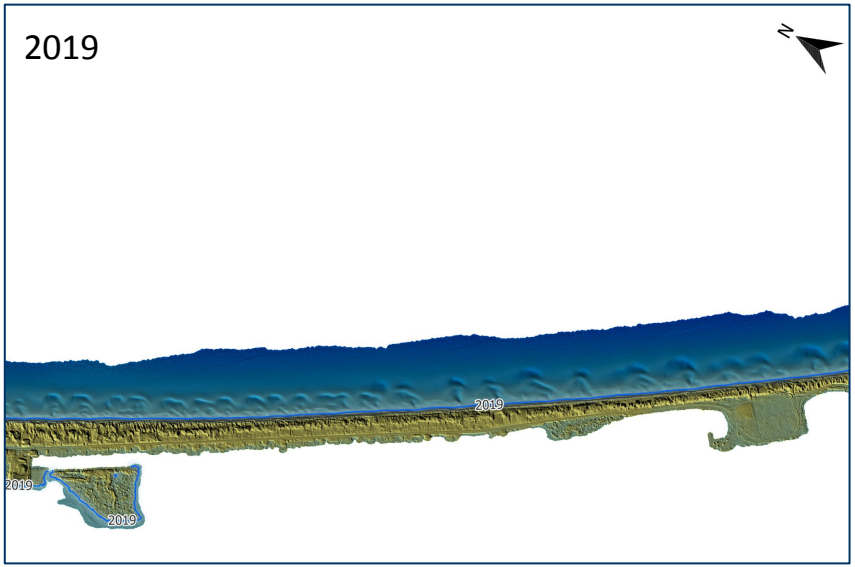


Determine potential inundation
EXAMPLE: October 21, 2019
184.33 meters
604.75 feet

Evaluating Change at Minnesota Point

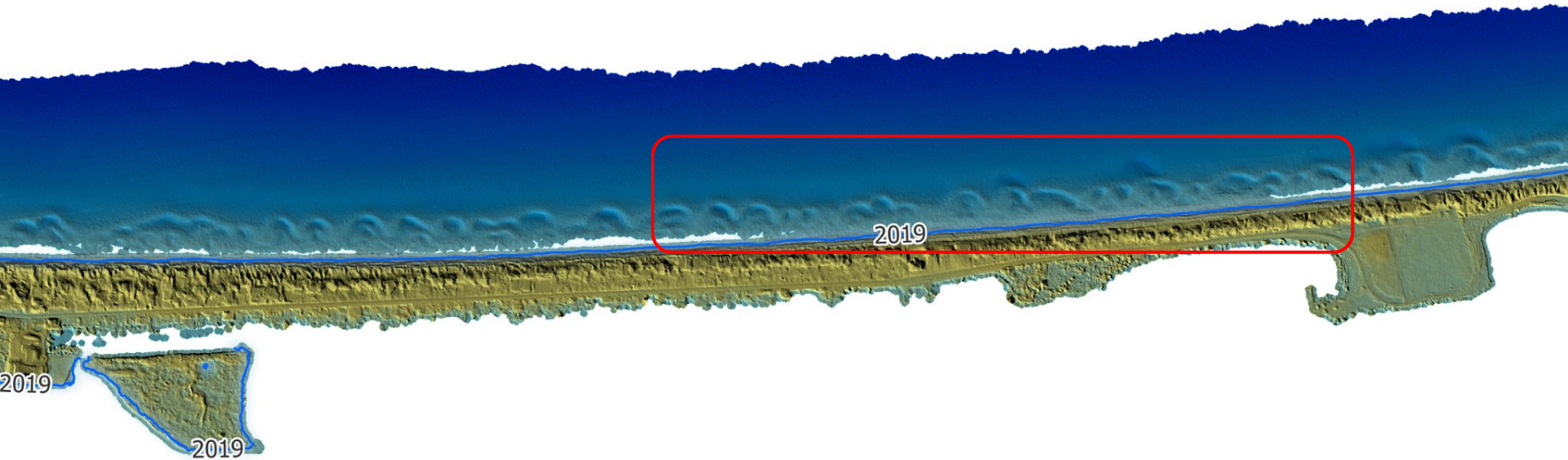
Change in nearshore bathymetry





Evaluating Change at Minnesota Point

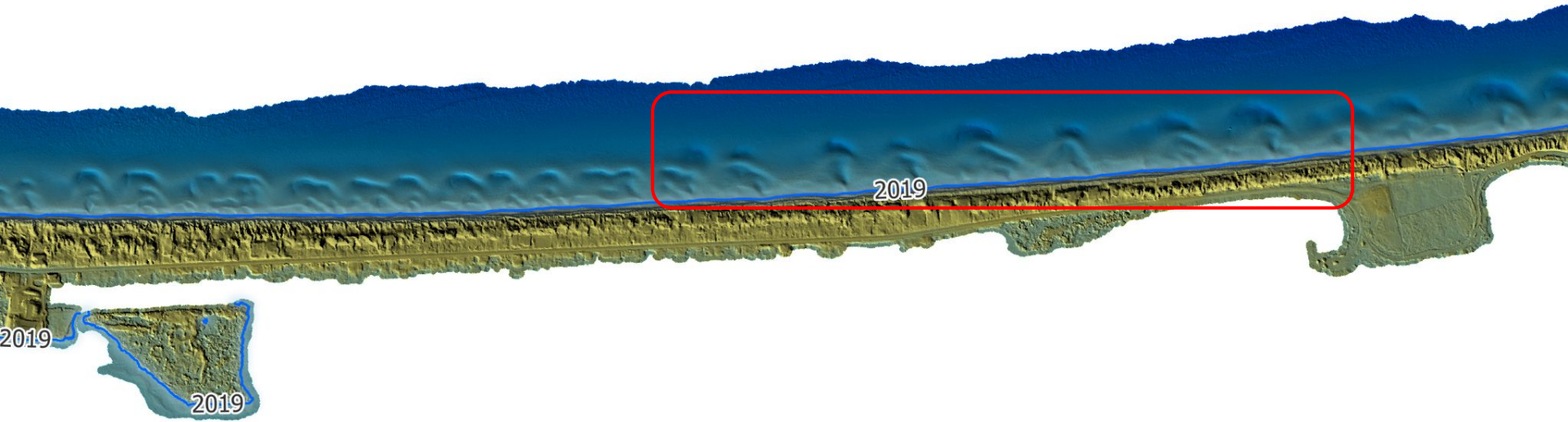
Change in nearshore bathymetry



2009

Evaluating Change at Minnesota Point

Change in nearshore bathymetry



2019

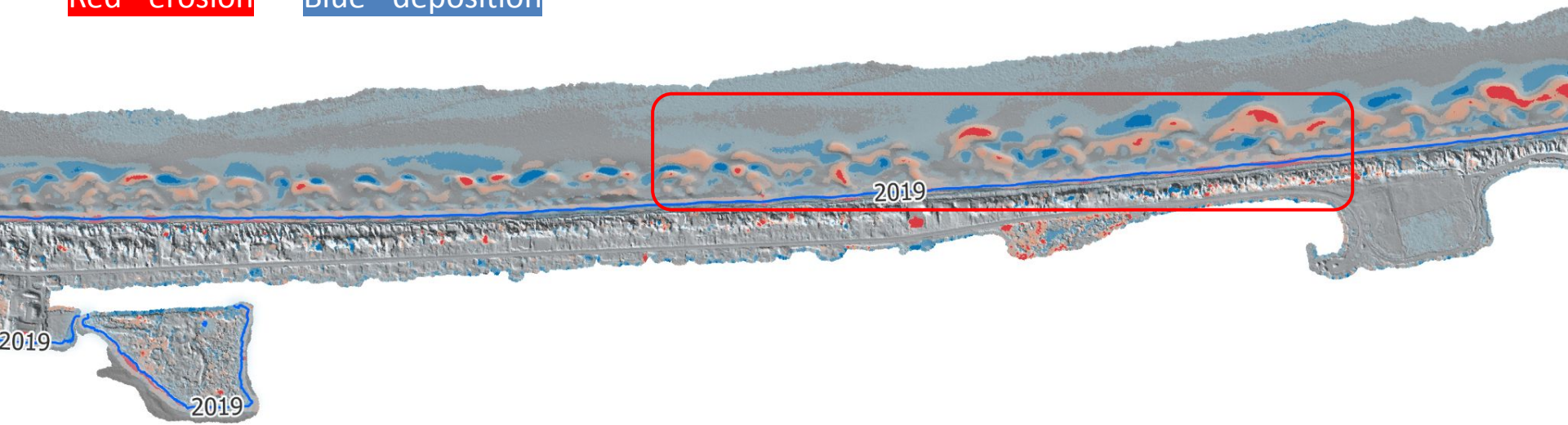
Evaluating Change at Minnesota Point

Change in nearshore bathymetry

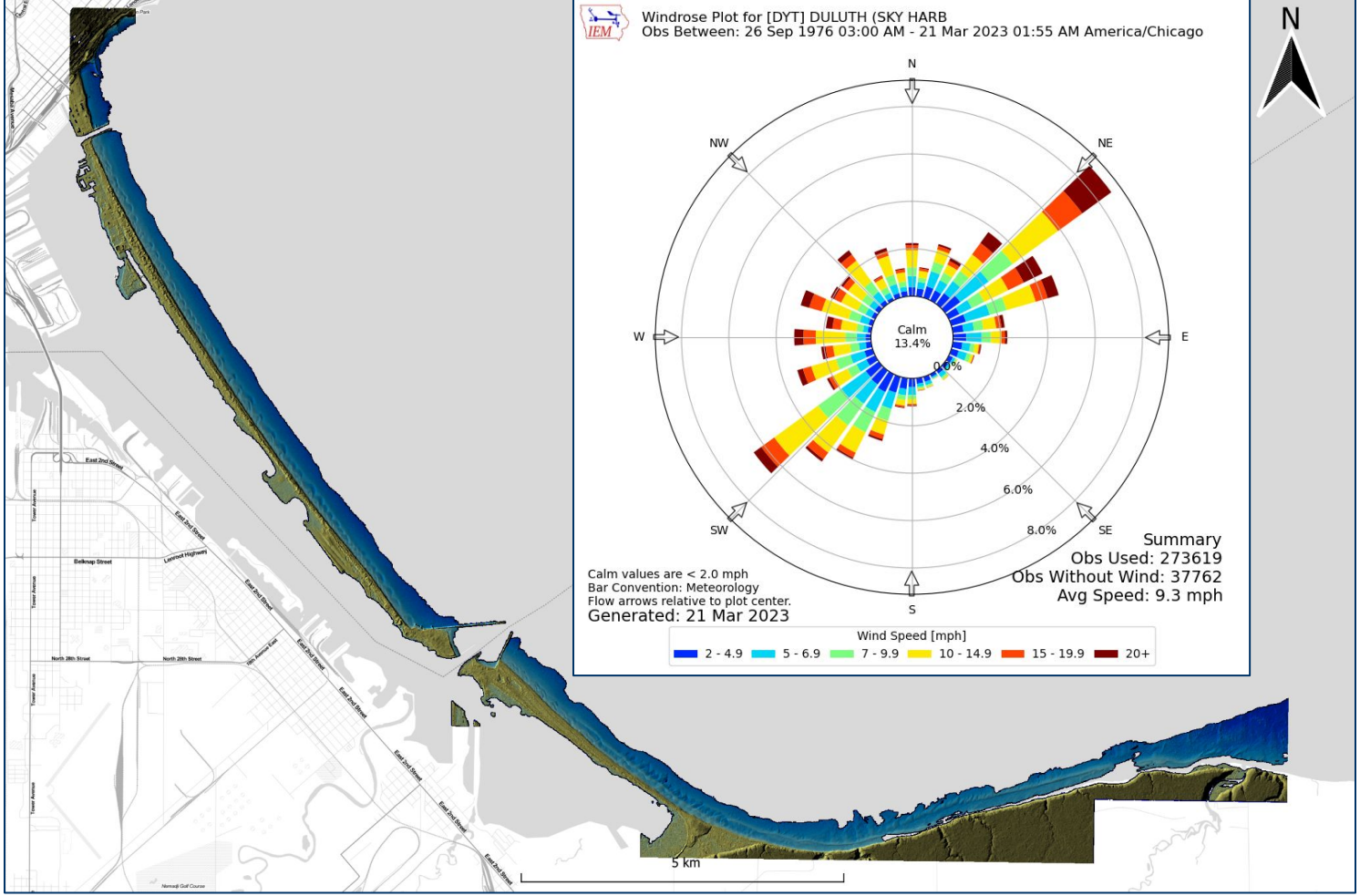
Littoral sediment transport

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
N
NE
E
SE
S
SW
W
NW
Calm
13.4%
0.0%
2.0%
4.0%
6.0%
8.0%
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
Wind Speed [mph]
2 - 4.9
5 - 6.9
7 - 9.9
10 - 14.9
15 - 19.9
20+
5 km

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

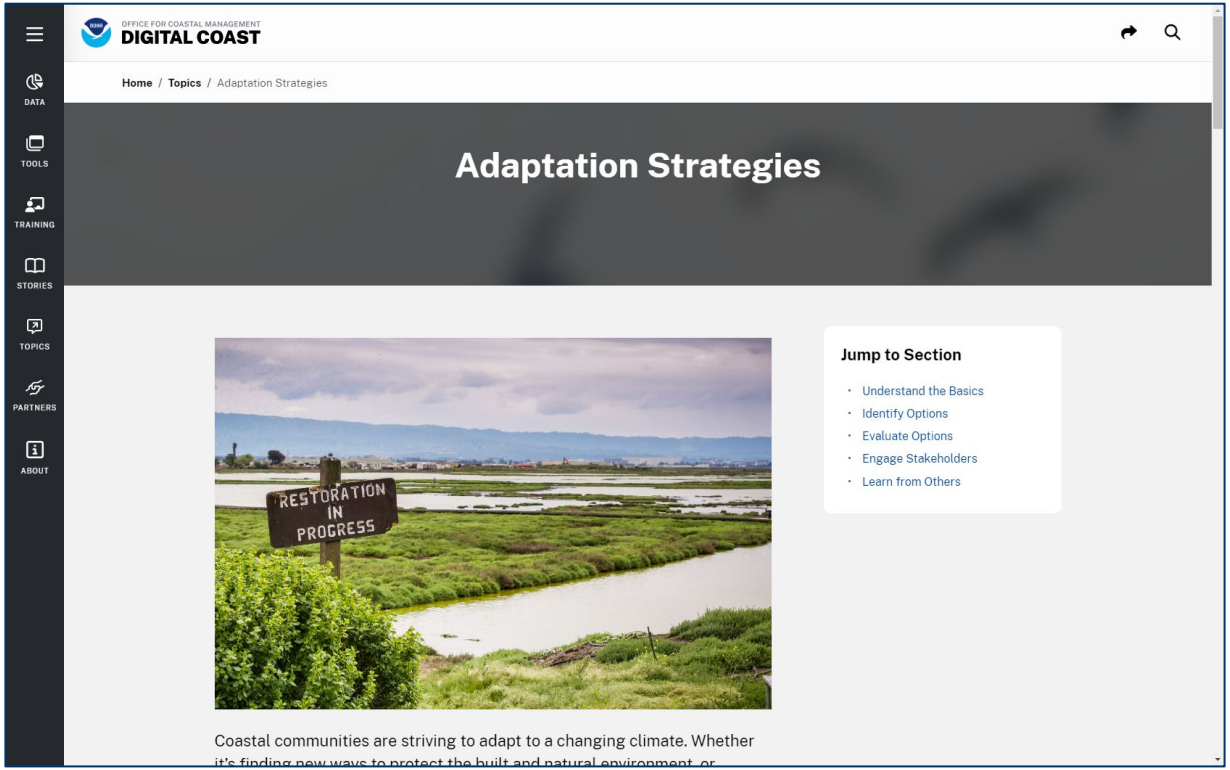
Wind: Increased Storm Severity = Increased wave action and aeolian transport

Ice: Increased Freeze Thaw Cycling = Increased physical weathering

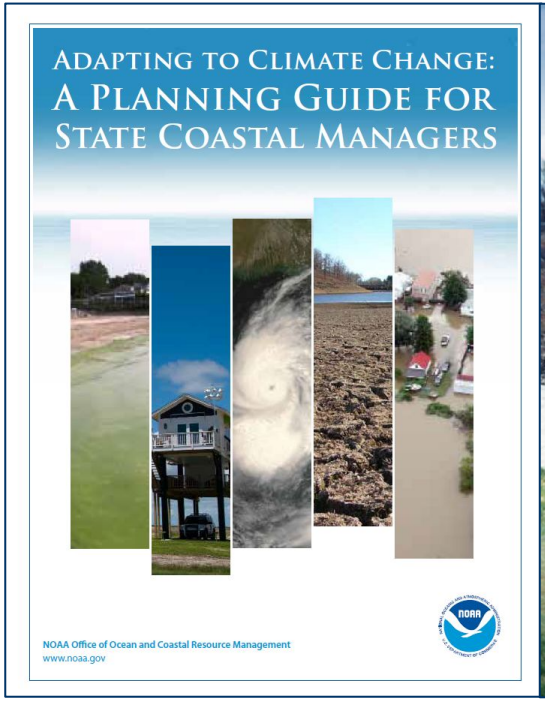
Ice: Loss of Shorefast Ice = Increased exposure to winter storms

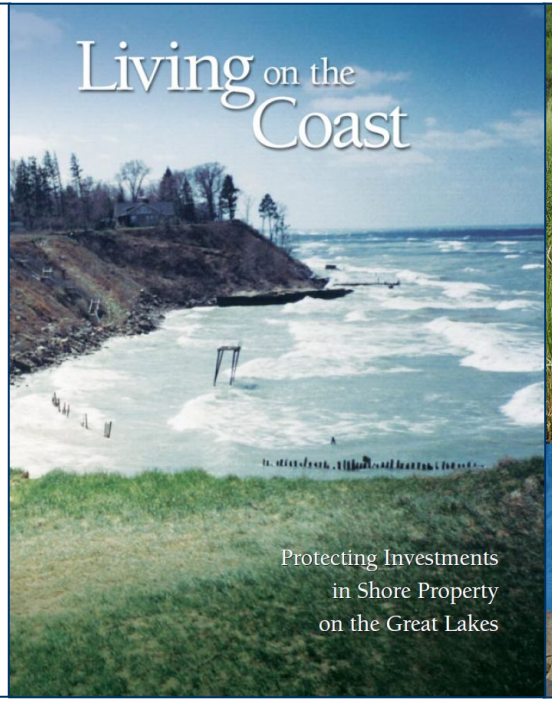
Wrap Up

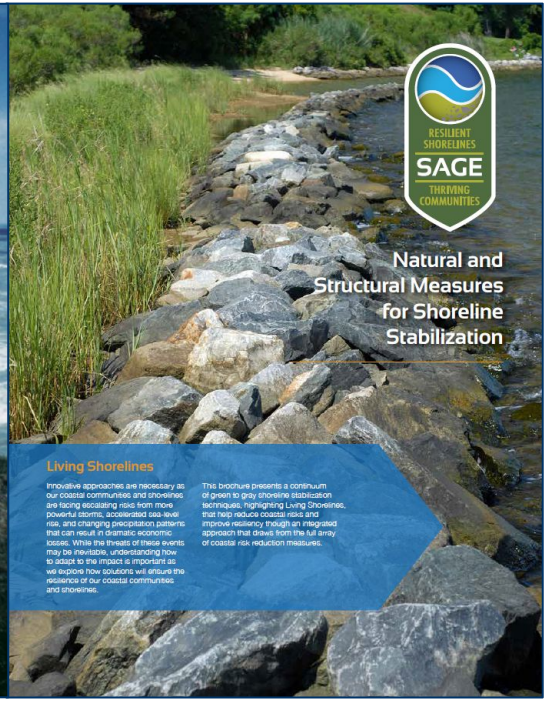
Adaptation Strategies



Adaptation Strategies



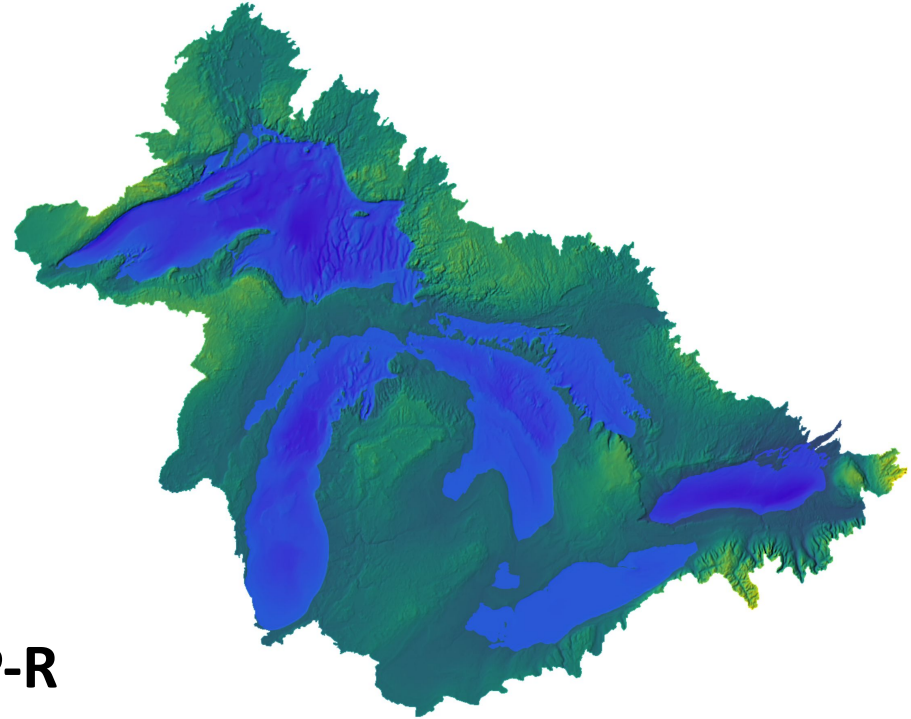




Key Takeaway Messages

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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Physical Scientist/Regional Geospatial Coordinator
brandon.krumwiede@noaa.gov