Considerations for the Town of York Comprehensive Plan
Sea Level Rise Chapter

Peter Slovinsky, Marine Geologist
Maine Geological Survey, Department of Conservation

Jonathan T. Lockman, Planning Director
Southern Maine Regional Planning Commission

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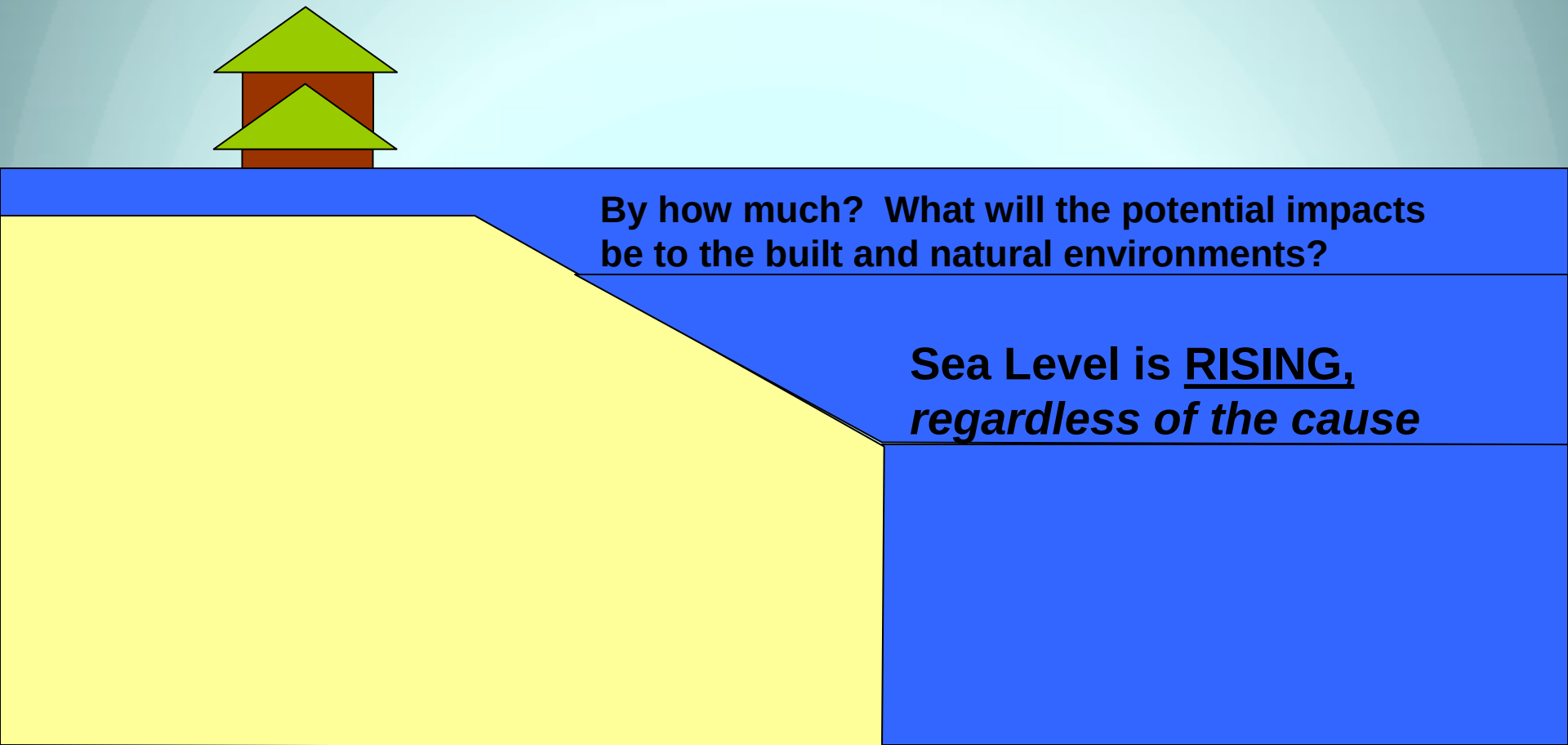
MAINE
GEOLOGICAL SURVEY

SOUTHERN MAINE REGIONAL PLANNING COMMISSION

Project Funding from:
Maine Coastal Program
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Framing the Problem

How will <u>local communities</u> respond?



By how much? What will the potential impacts be to the built and natural environments?

Sea Level is <u>RISING,</u>
regardless of the cause

Why *does* sea level change?

Global Sea Levels…

Thermal Expansion (the ocean heats up and expands as the atmosphere warms)

Volumetric Increase (volume increases with water from melting glaciers and land-based ice sheets)

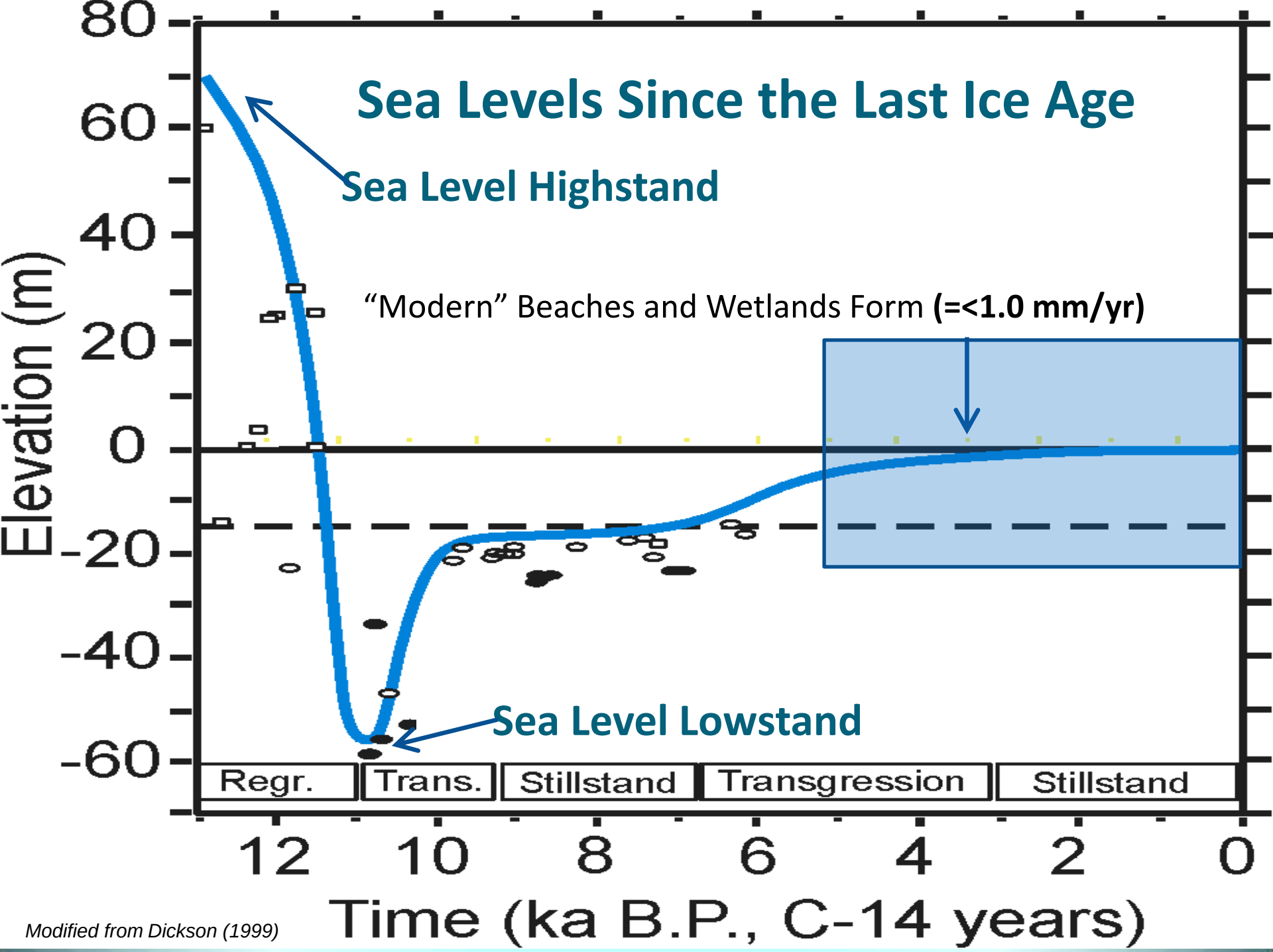
Global climate variation (impacts of ENSO, i.e., El Nino/La Niña)

Relative (or "Local") Sea levels…

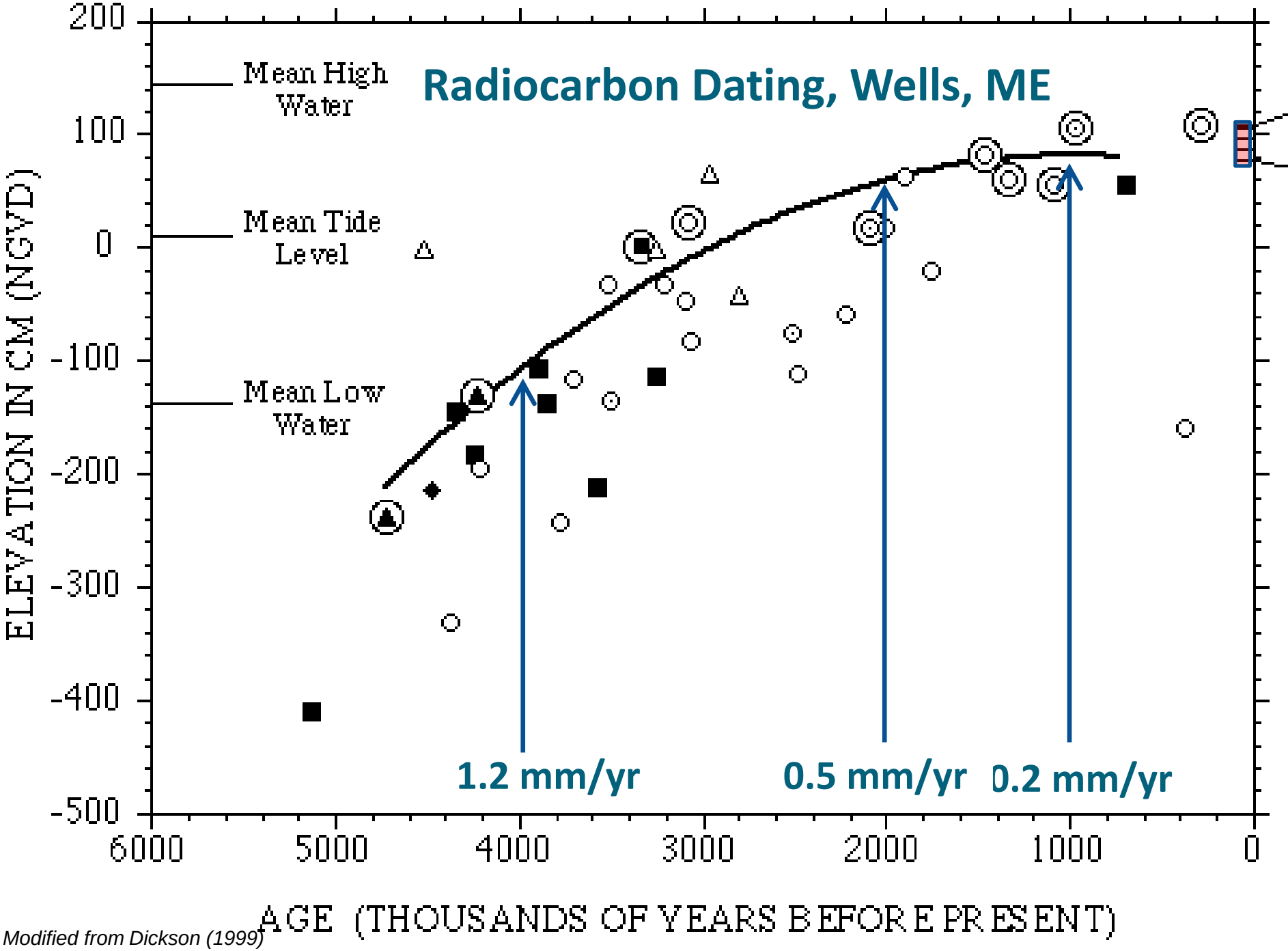
Isostatic rebound (response of the crust to glaciation)

Subsidence (sinking of the land due to other factors than isostasy)

Seasonal Variations (due to local or regional weather patterns)



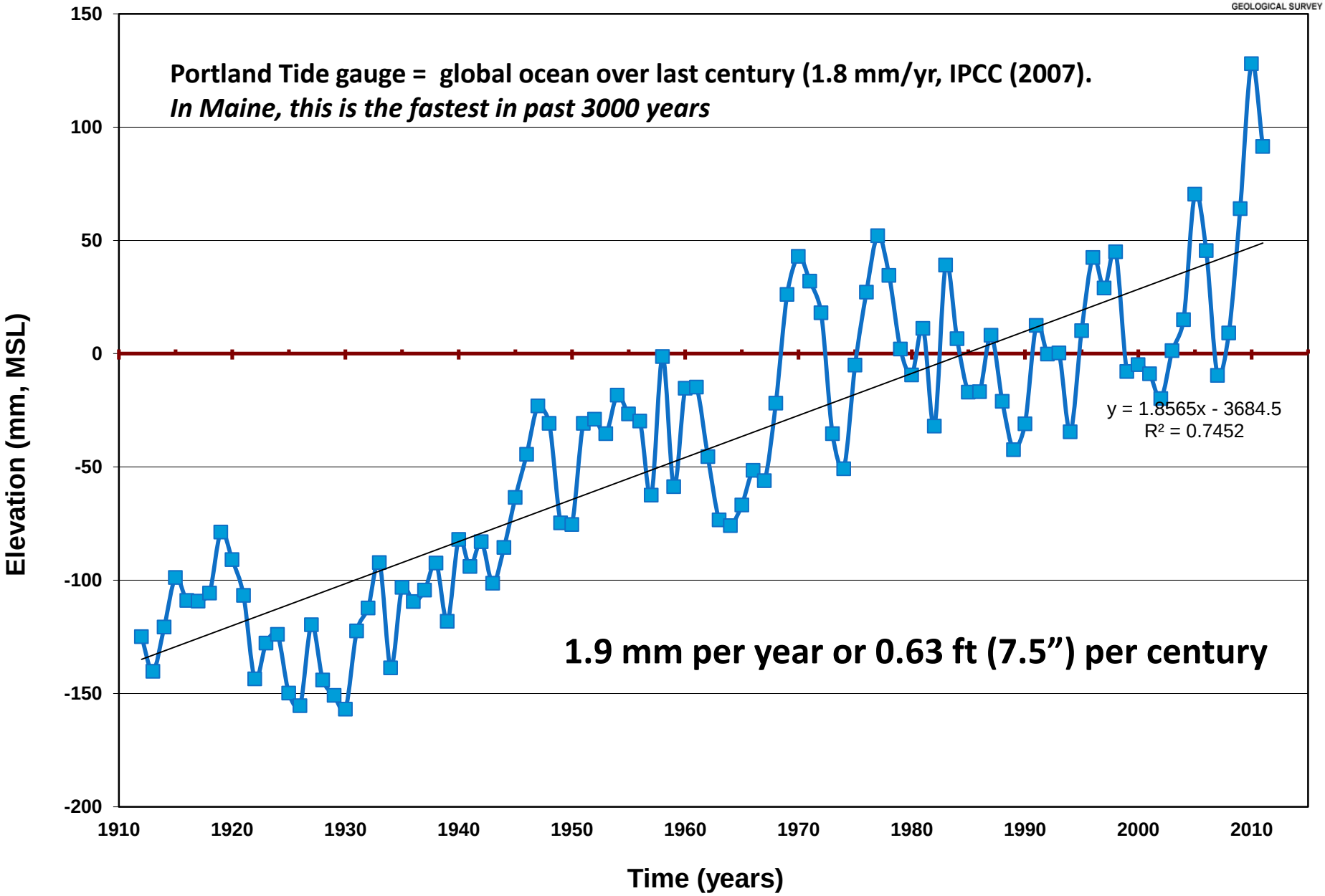
Modified from Dickson (1999)



Modified from Dickson (1999)

Sea Level, Portland, Maine

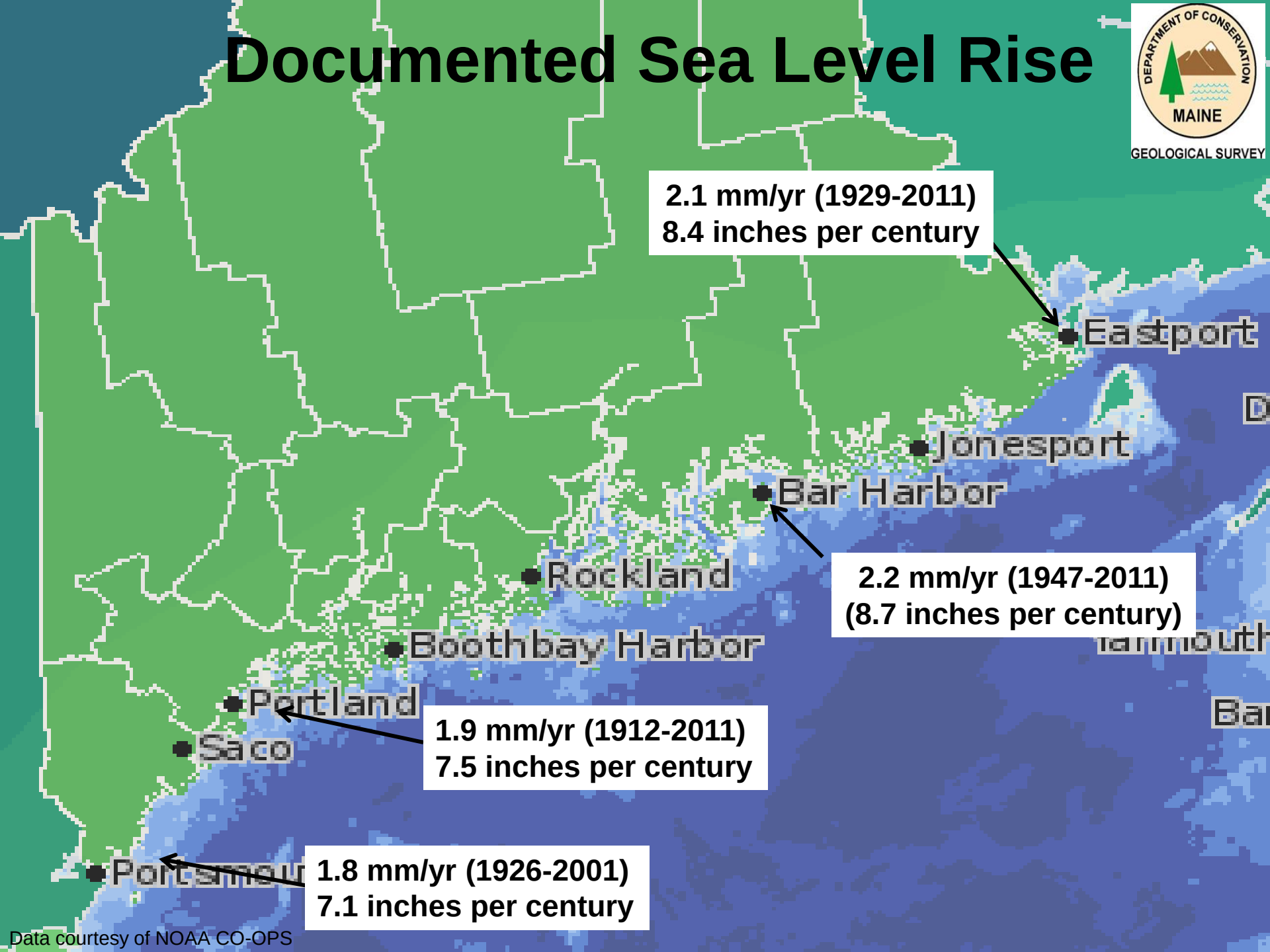
1912-2011 (through December 31, 2011)



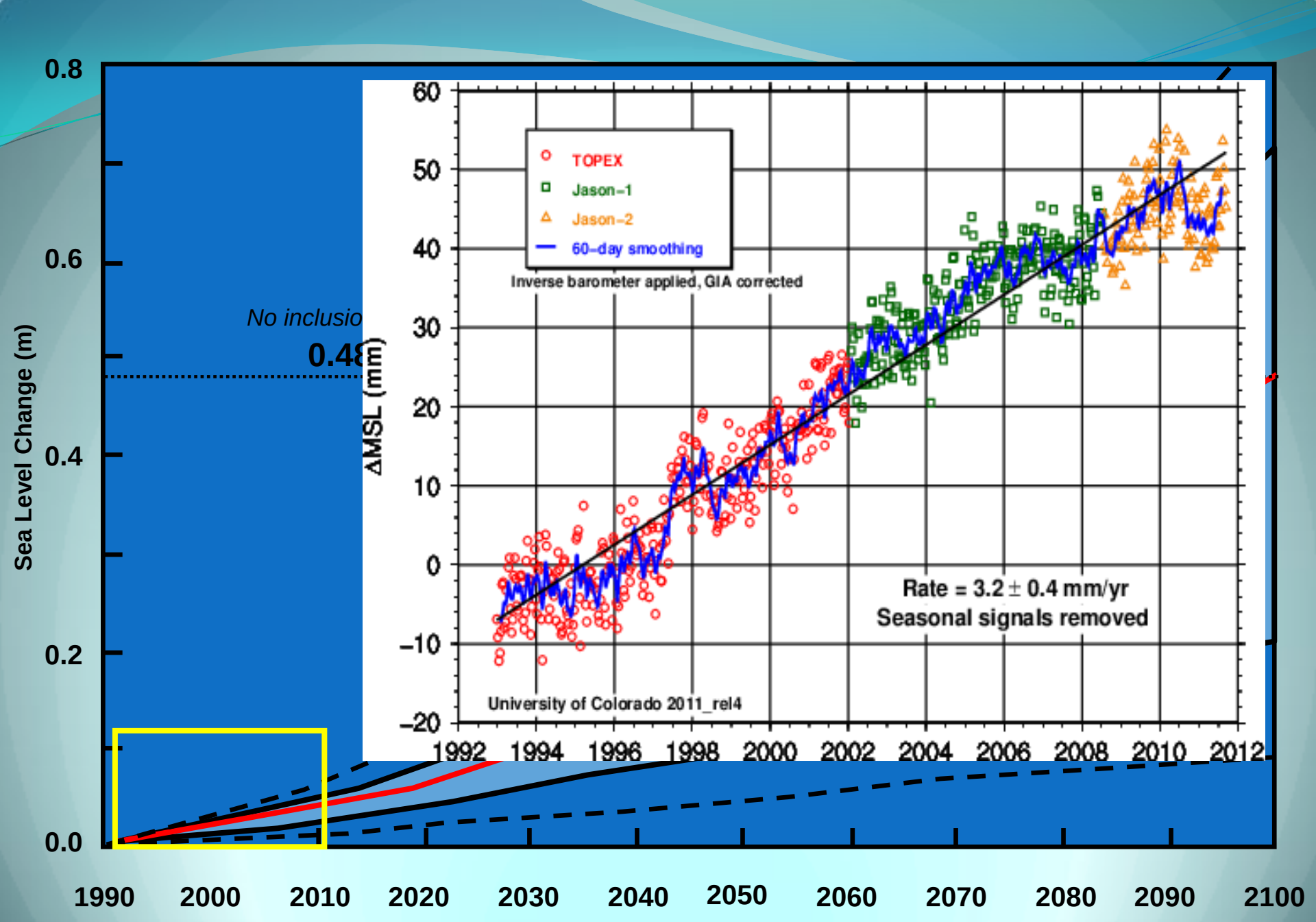
Data courtesy of NOAA CO-OPS, www.tidesandcurrents.nooa.gov

P.A. Slovinsky, Maine Geological Survey, March 9, 2012

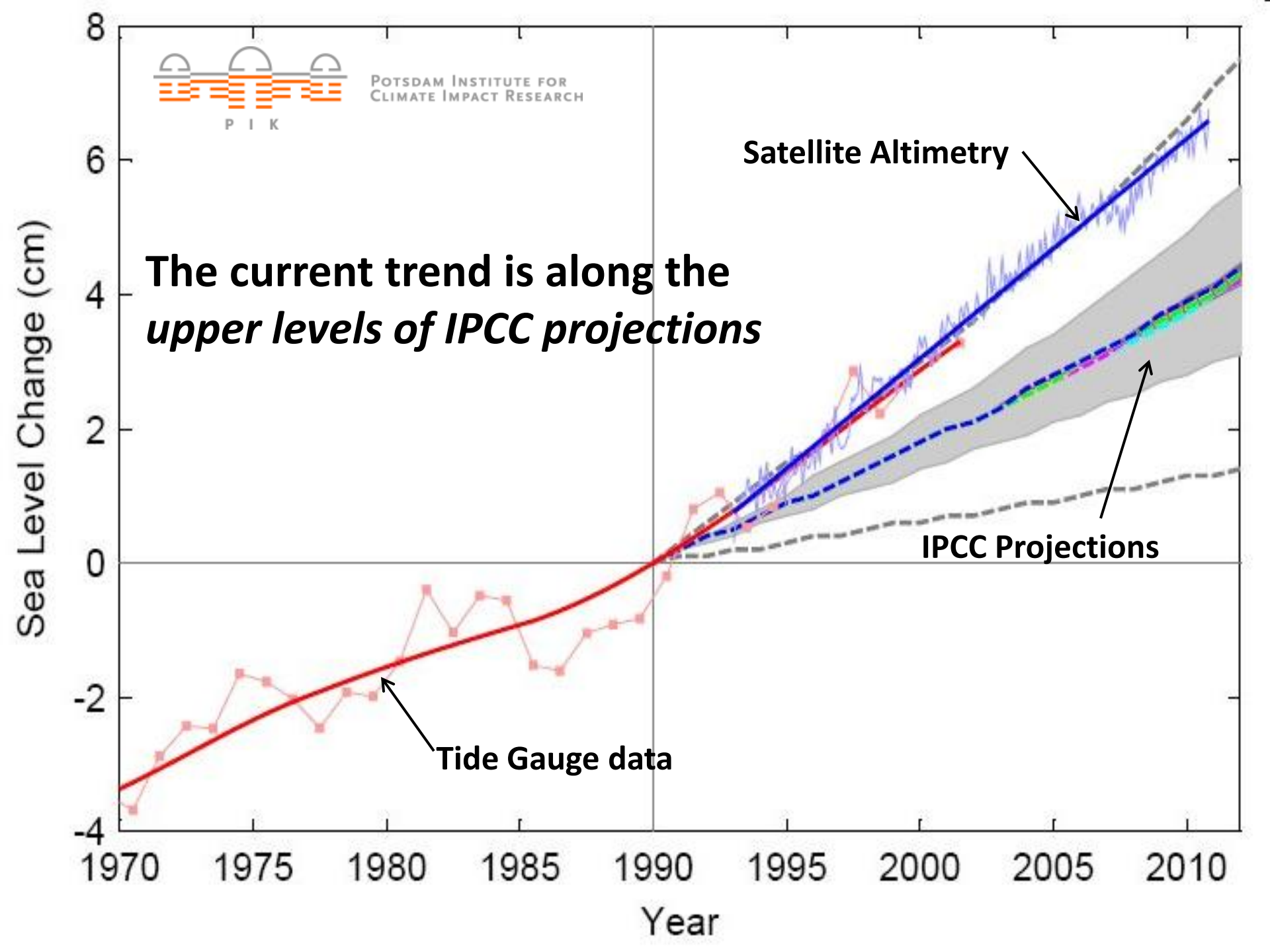
Documented Sea Level Rise

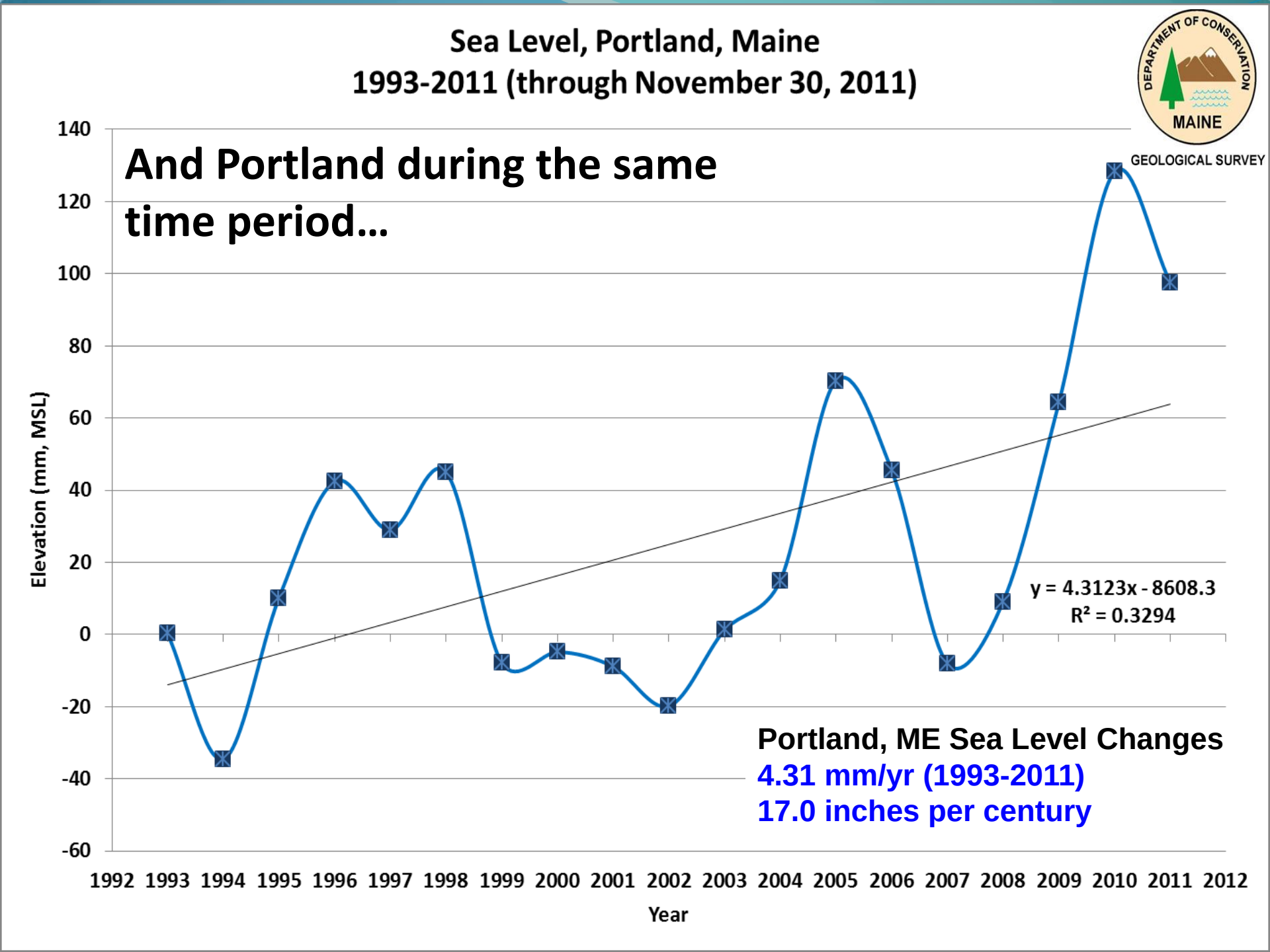


Data courtesy of NOAA CO-OPS



Adapted from the IPCC 3rd Assessment (Tech. Summary of Working Group I Report, Fig. 24, p. 74., 2001)


Potsdam Institute for Climate Impact Research
P I K
The current trend is along the
upper levels of IPCC projections
Satellite Altimetry
IPCC Projections
Tide Gauge data
Sea Level Change (cm)
Year
8
6
4
2
0
-2
-4
1970
1975
1980
1985
1990
1995
2000
2005
2010


Sea Level, Portland, Maine
1993-2011 (through November 30, 2011)
And Portland during the same time period…
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Elevation (mm, MSL)
140
120
100
80
60
40
20
0
-20
-40
-60
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Year
y = 4.3123x - 8608.3
R² = 0.3294
Portland, ME Sea Level Changes
4.31 mm/yr (1993-2011)
17.0 inches per century

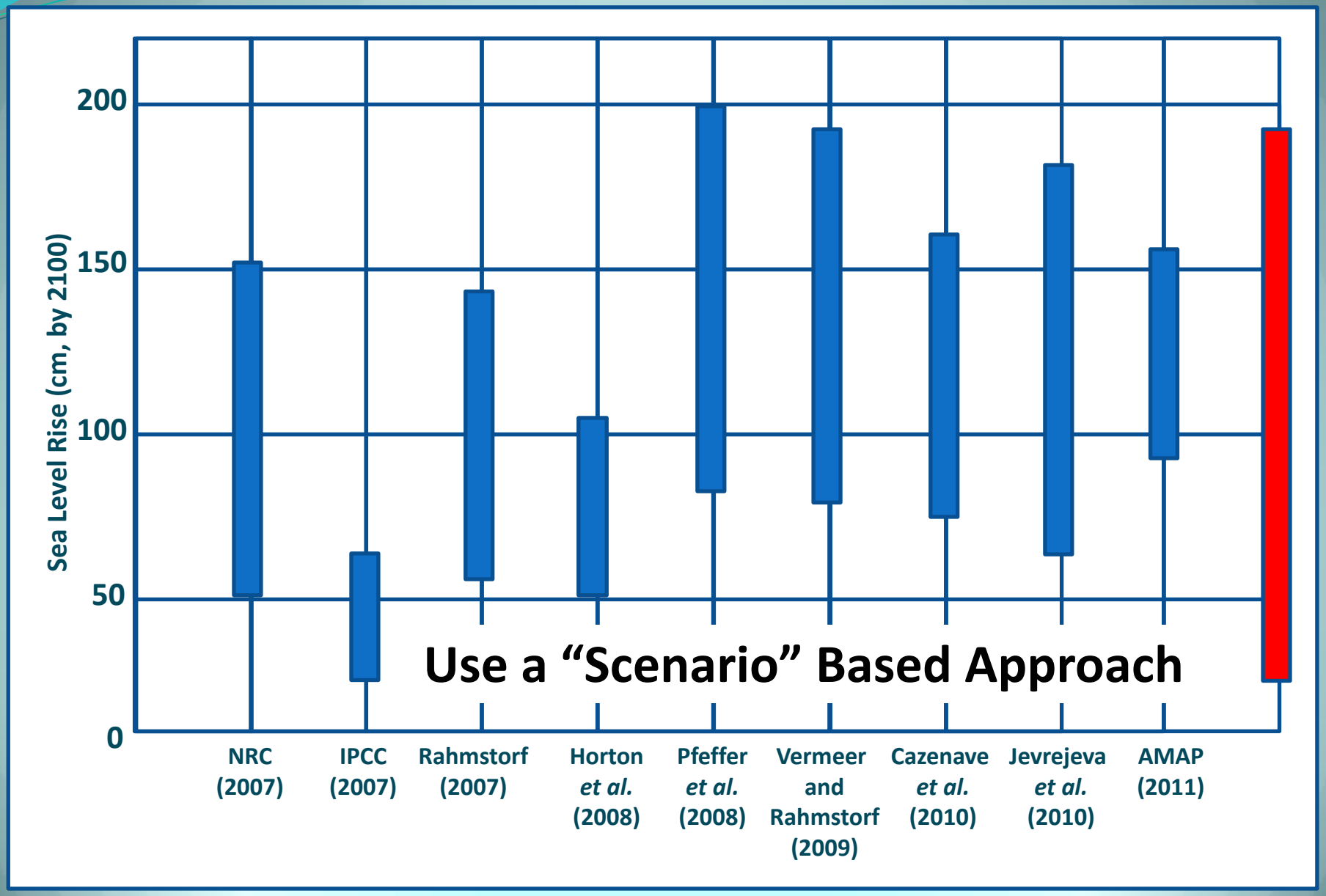
…if current [Antarctic and Greenland] ice sheet melting rates continue for the next four decades, their cumulative loss could raise sea level by 15 centimeters (5.9 inches) by 2050. When this is added to the predicted sea level contribution of 8 centimeters (3.1 inches) from glacial ice caps and 9 centimeters (3.5 inches) from ocean thermal expansion, total sea level rise could reach 32 centimeters **(12.6 inches) by the year 2050**.

Rignot and others, March 2011 (AGU, in press)

http://www.agu.org/news/press/pr_archives/2011/2011-09.shtml

Image from www.swisseduc.ch

For a Range of Scenarios…



Adapted from Rahmstorf (2010); and Williams (2012)

Vulnerability Assessment

- Sea level rise scenarios (by 2100, or a "phased" approach):
  - **0.3 meters (1 foot)**
  - **0.6 meters (2 feet)**
  - **1.0 meters (3.28 feet)**
  - **1.8 meters (5.95 feet)**

"Scenario-based" Approach

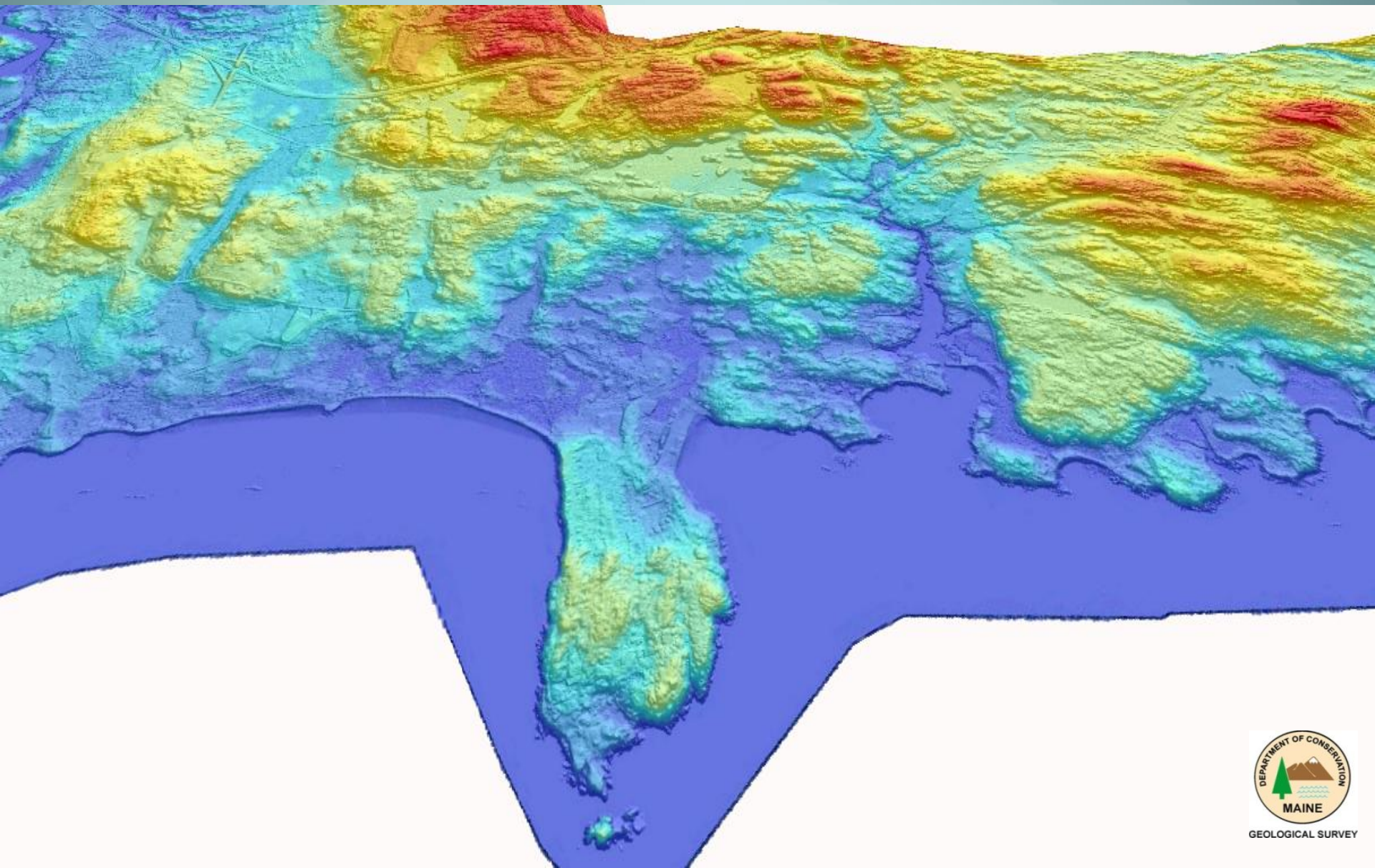
- Scenarios **assume static topography** ('bathtub model').
- Scenarios **do not include** the effects of **freshwater runoff from rain events or waves.**
- The **Highest Annual Tide (HAT)** and the **1978 storm** stillwater elevation were used as a basis for simulating impacts to infrastructure.
- For assessing impacts to buildings, it was assumed that the **entire building was impacted** if inundation intersected the building footprint.
- For assessing impacts to roads, it was assumed that inundation of a road made it **impassable** but did not assume the road would be damaged.
- For assessing impacts to wetlands, tidal elevations were used as proxies for different marsh surfaces.

Using the Sea Level Rise Simulation Tool

Steps:

1) Groundtruth **LiDAR** data for representing ground conditions using RTK – GPS *(very accurate).*
2) Determine Tidal Elevations as proxies for existing marsh surfaces using nearby tide gauge data
3) Demonstrate accuracy in simulating **existing conditions** using **tidal elevations** to define marsh habitats and inundation
4) Simulate **potential** **impacts of sea level** rise on:
   a) Marsh Habitat
   b) Existing Buildings and Road Infrastructure
5) Identify areas potentially suitable for marsh migration and at-risk built infrastructure

Couldn’t do it without LIDAR!



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Coastal wetlands

"Coastal wetlands" means all tidal and subtidal lands; all areas with vegetation present that is tolerant of salt water and occurs primarily in salt water or estuarine habitat; and any swamp, marsh, bog, beach, flat or other contiguous lowland that is subject to tidal action during the ***highest tide level for each year*** in which an activity is proposed as identified in tide tables published by the National Ocean Service. Coastal wetlands may include portions of coastal sand dunes.

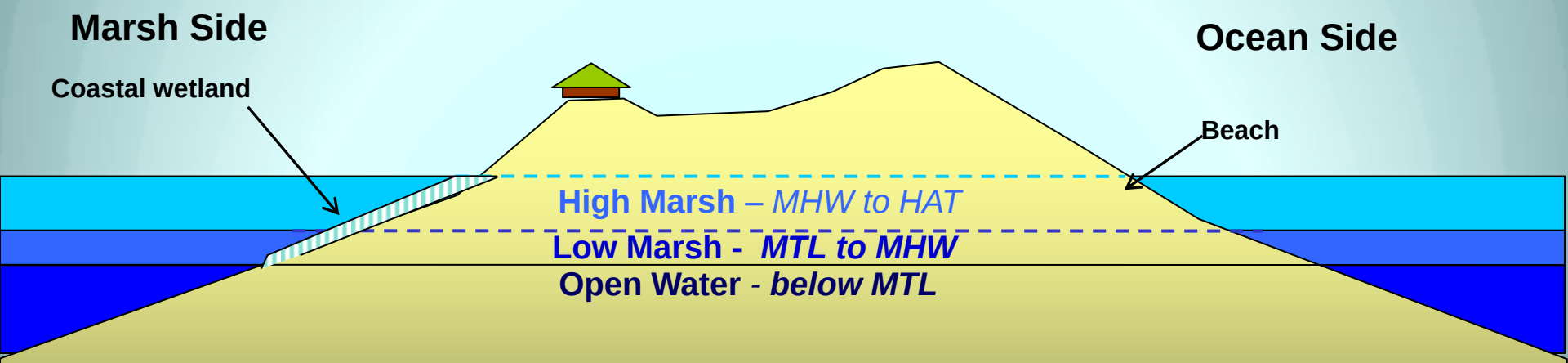
Required in Maine's Municipal Shoreland Zoning

Setting the Stage with Tidal Elevations

Highest Annual Tide (HAT) - "spring" tide, the highest predicted water level for any given year but is reached within several inches numerous tides a year

Mean High Water (MHW) - the average normal high water level.

Mean Tide Level (MTL) = average height of the ocean's surface (between mean high and mean low tide).

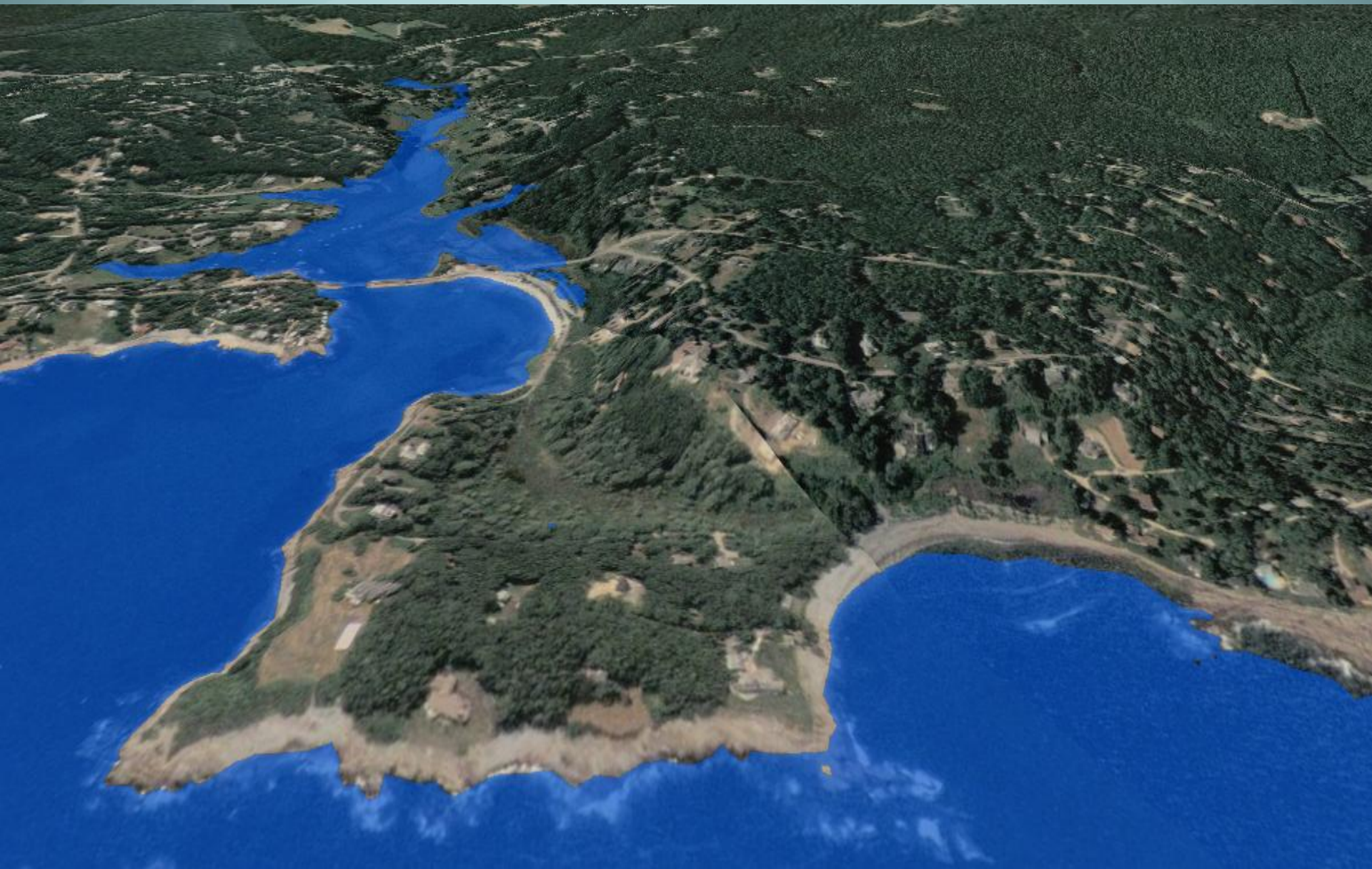


Tidal elevations determined from nearby applicable NOS tide stations

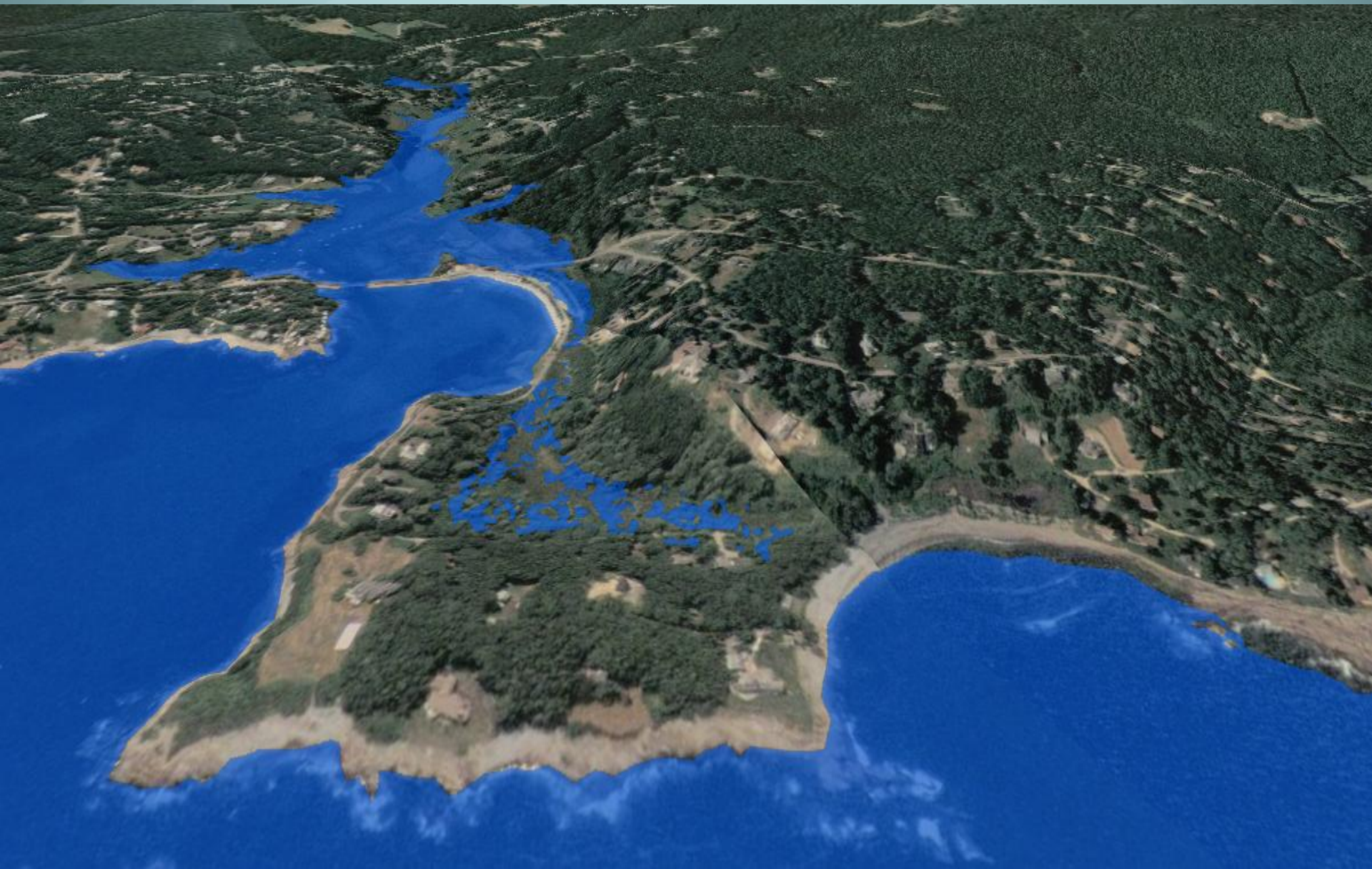
P.A. Slovinsky, MGS

Examine Marsh Transgression

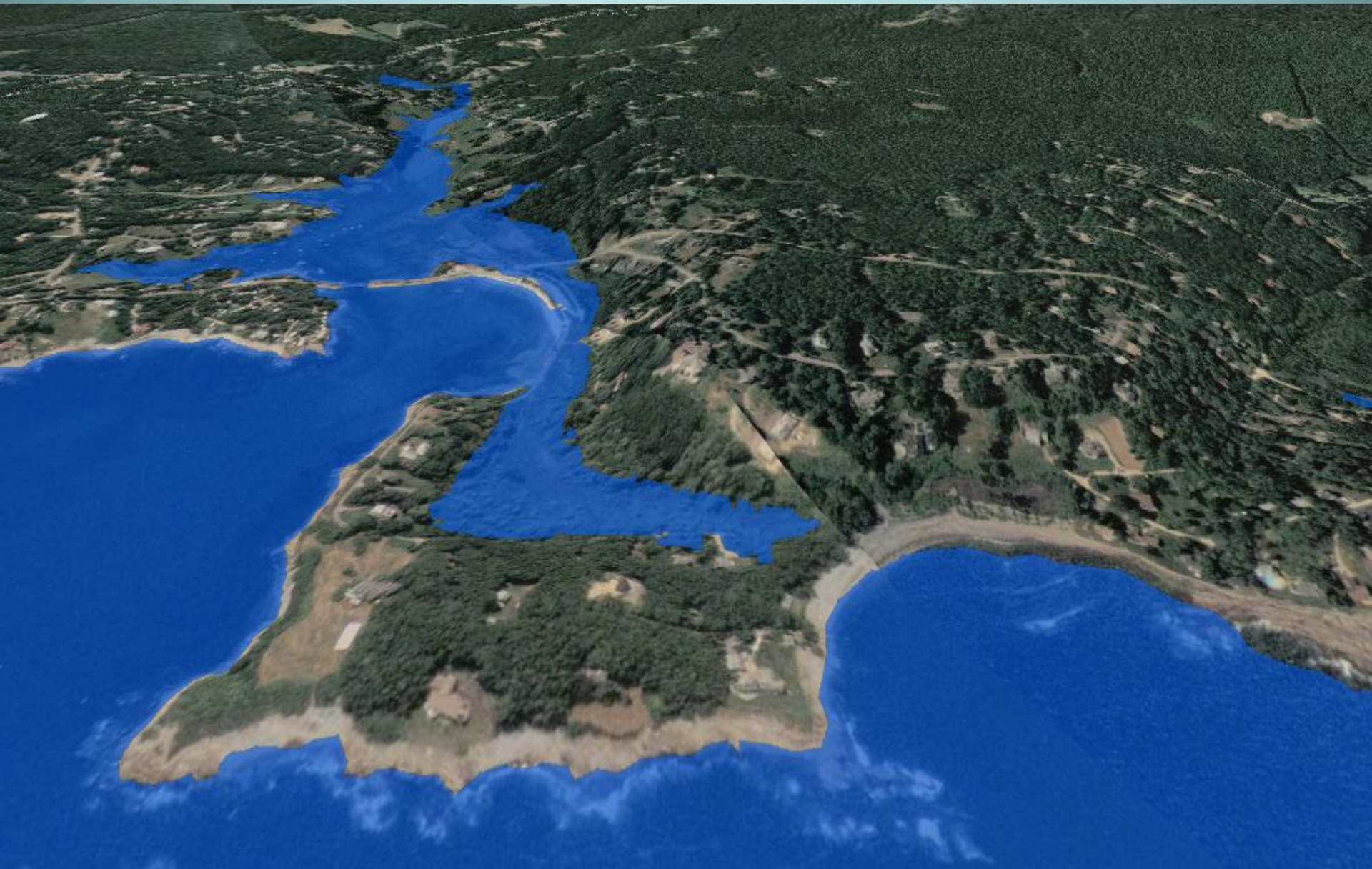
Existing Conditions (HAT)



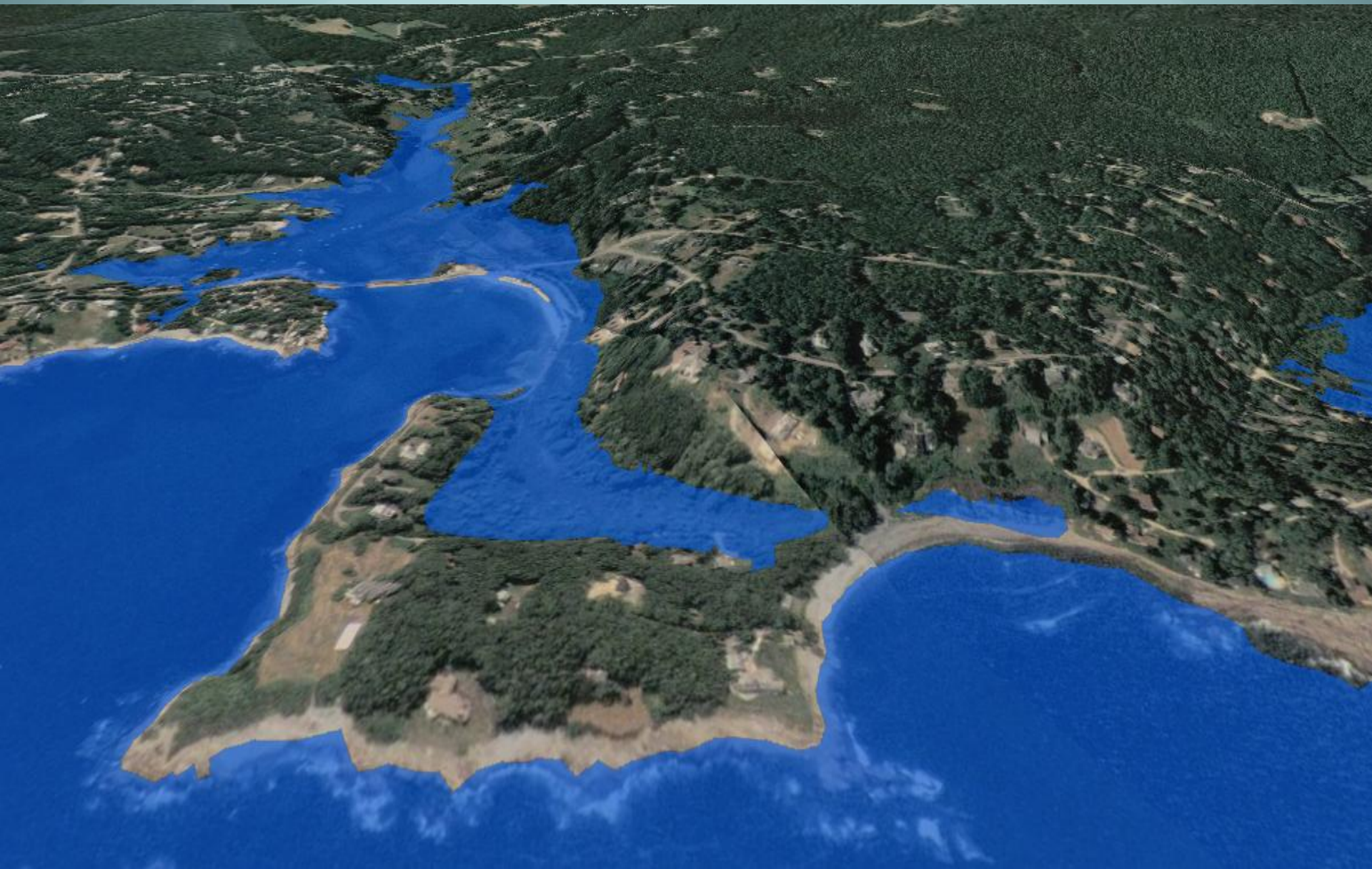
Future Conditions (HAT+0.3m)



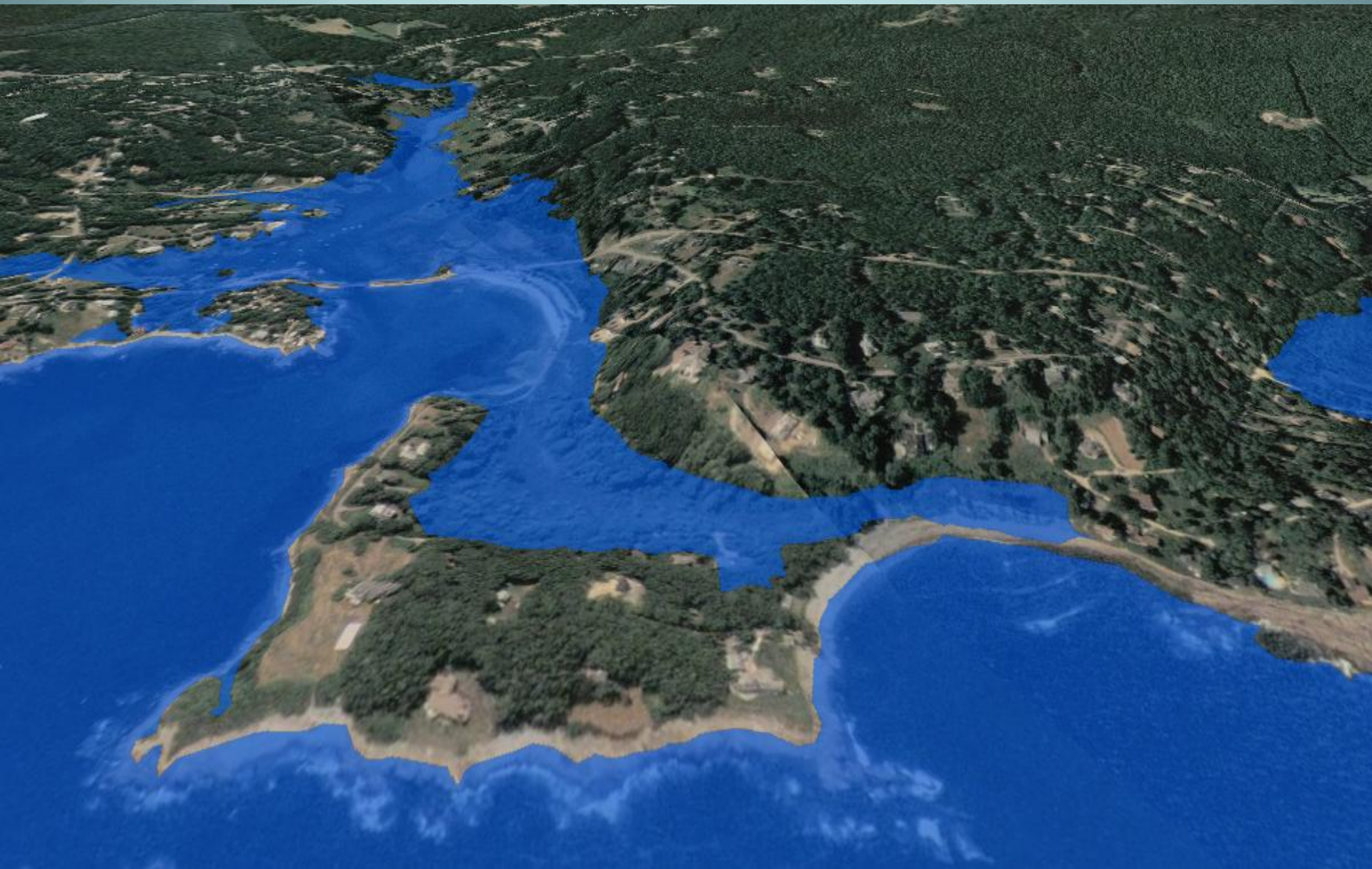
Future Conditions (HAT+0.6m)



Future Conditions (HAT+1.0m)



Future Conditions (HAT+1.8m)



Implications

Use Tidal Elevations to simulate existing wetlands, and potential future coastal wetland migration in response to SLR.

This will help identify low-lying, undeveloped uplands where marshes may migrate unimpeded, and areas where development (roads, buildings, etc.) may be inundated.

Infrastructure Vulnerability Assessment

Highest Annual Tide (HAT), is the highest predicted water level for any given year. For 2012, the predicted HAT was 6.4 ft NAVD88 (11.6 ft MLLW).

1978 Storm is the highest recorded water level at the Portland Tide Gauge which occurred on the February 7, 1978 Noreaster' Storm (~3.0 feet of surge). The "100-year" storm, 8.9 ft NAVD88, (14.1 ft MLLW). *Does not include wave impacts!*

Scenario	Highest Annual Tide	1978 Storm
Existing	6.4 feet	8.9 feet
+0.3 m (1 ft) SLR	7.4 feet	9.9 feet
+0.6 m (2 ft) SLR	8.4 feet	10.9 feet
+1.0 m (3.3 ft) SLR	9.7 feet	12.2 feet
+1.8 m (6.0 ft) SLR	12.2 feet	14.9 feet

All elevations referenced to NAVD88; 0 ft NAVD88 approximately 5.2 ft above MLLW.

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Infrastructure Vulnerability Assessment

** Plan for **"Today's Storms and Tomorrow's Tides"** **

Surge Amount	Frequency	Last Occurred
3.0 feet or more*	1 in 7 years	Oct 30, 1991
3.5 feet or more*	1 in 14 years	Oct 30, 1991
4.0 feet or more*	1 in 47 years	Mar 3, 1947

**at time of high tide only; surges of these levels are much more frequent (i.e., February 26, 2010 had a surge of 4.4 feet but at mid-falling tide)*

Source: John Cannon, NWS, Gray, Maine. May include storms through 2008.

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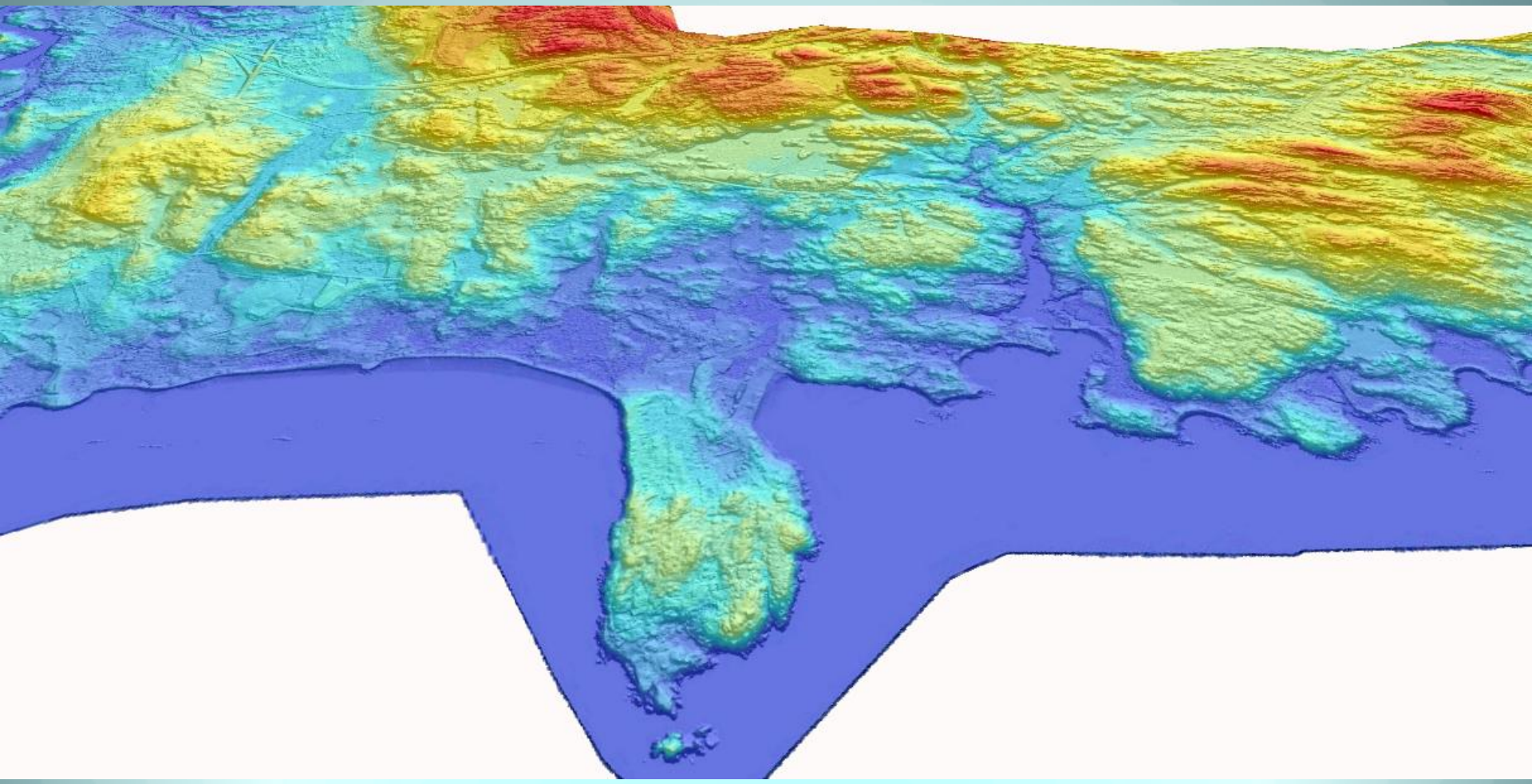
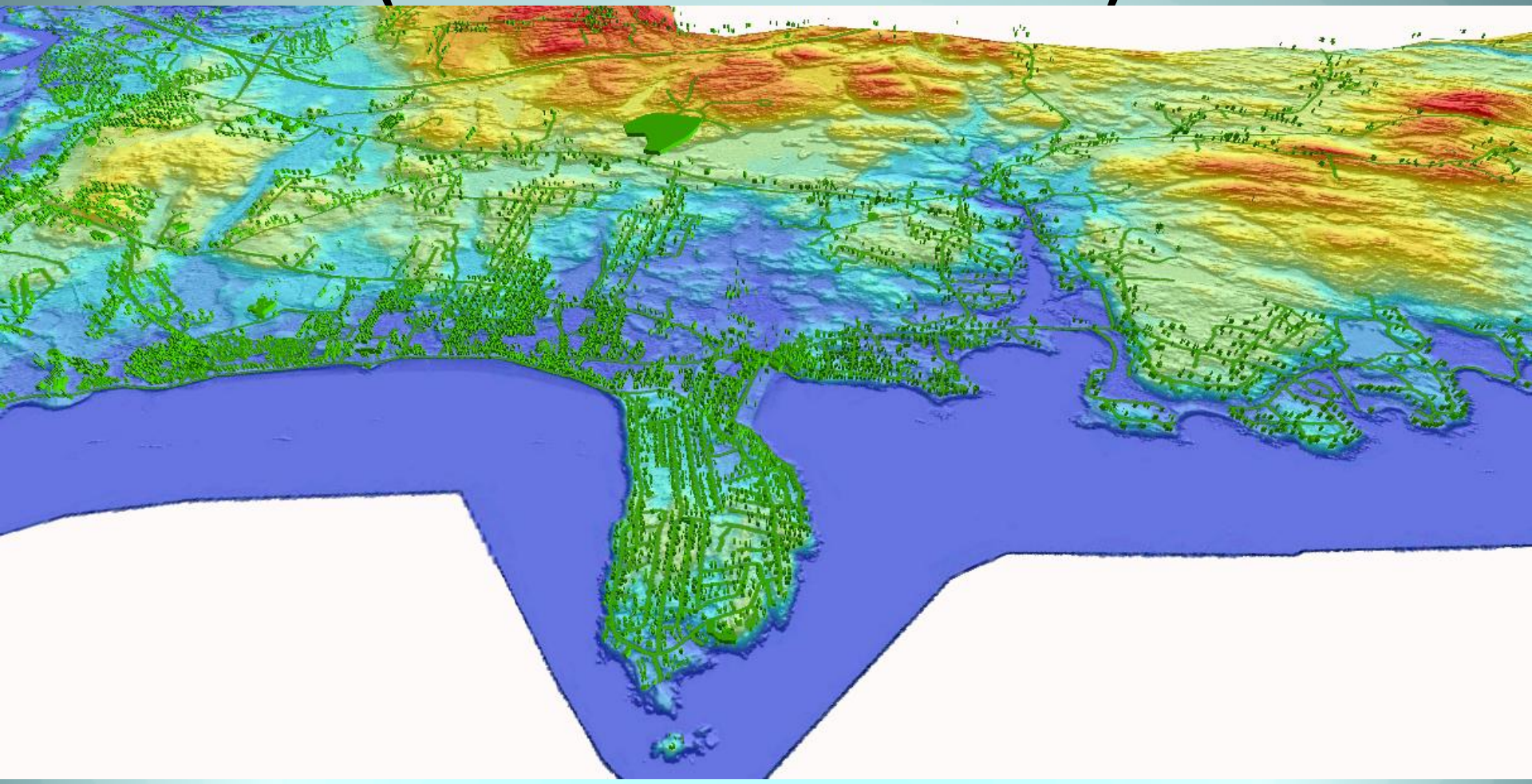
Base LiDAR Data



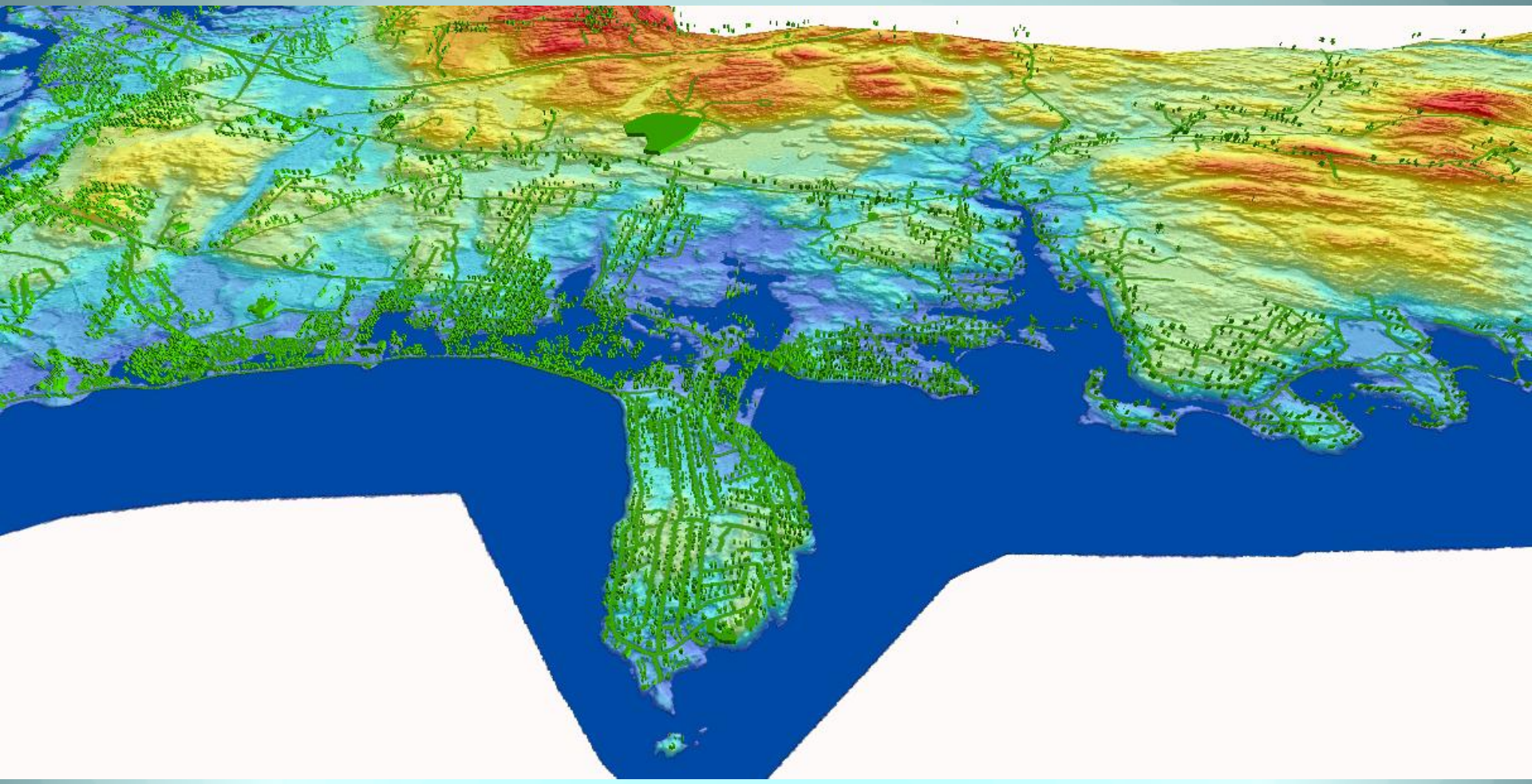
2006 LiDAR tiles (18 cm RMSE)
Mosaic and clip to municipal boundaries

Buildings and Transportation Infrastructure (overlain onto Base LiDAR)



Add Polygon layers for buildings and roads (municipal)

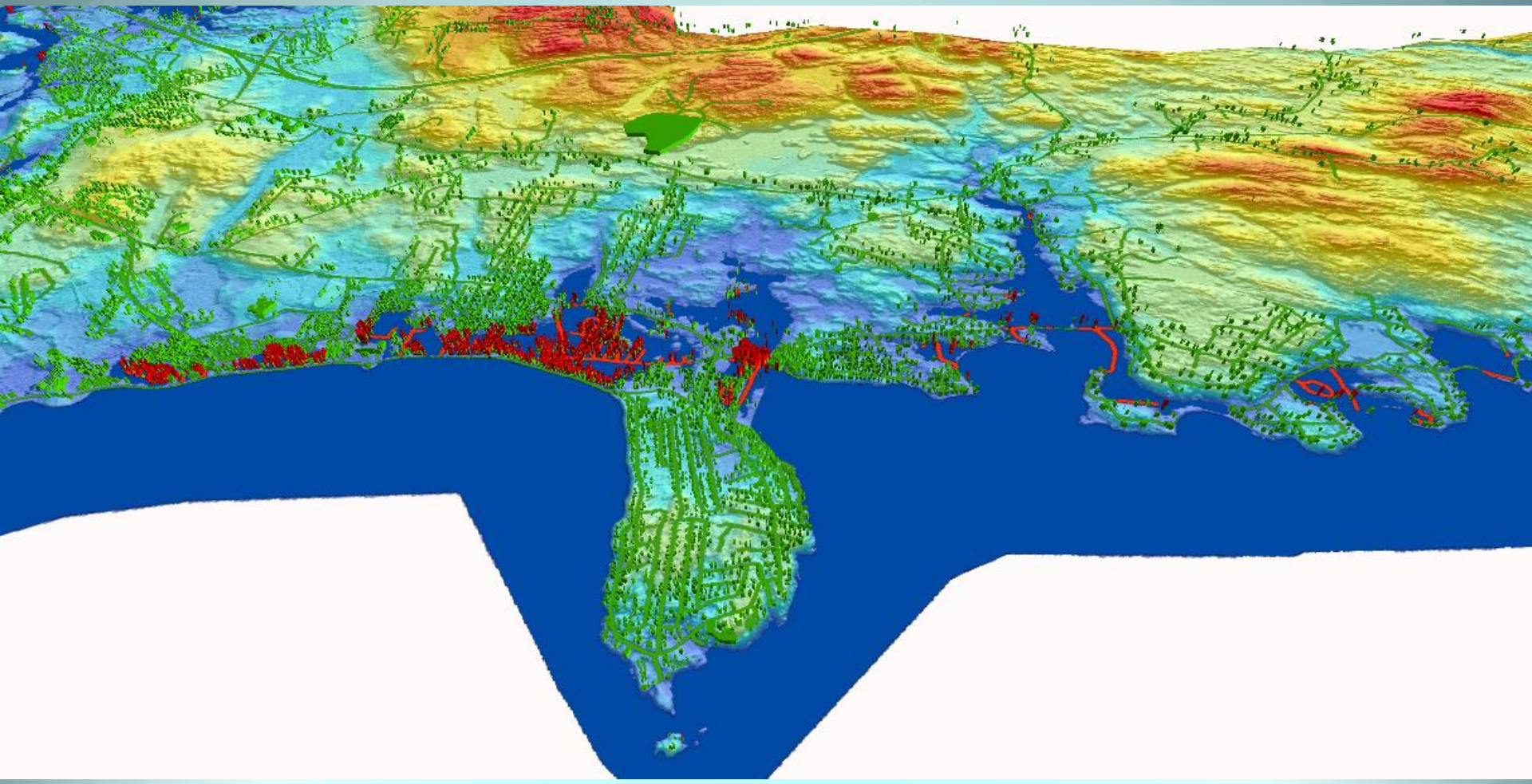
Simulate Inundation Levels



Determine future inundation levels under different scenarios

Raster queries to determine areas below certain water levels

Identify Potentially Inundated Infrastructure



Determine inundation impacts to buildings and infrastructure

Preliminary Evaluation of Impacts from Highest Annual Tide (HAT) and 1978 Storm Inundation

Buildings

Highest Annual Tide Simulations

For general planning purposes only; does not account for dynamic changes

Existing Conditions – HAT (6.4 feet)

For general planning purposes only; does not account for dynamic changes

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Potential Future Conditions (HAT+0.3 m) 2030-2050?

For general planning purposes only; does not account for dynamic changes

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Potential Future Conditions (HAT+0.6 m, 8.4 feet) 2050-2100?

For general planning purposes only; does not account for dynamic changes

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Potential Future Conditions (HAT+1.0 m, 9.7 feet) 2100?

For general planning purposes only; does not account for dynamic changes

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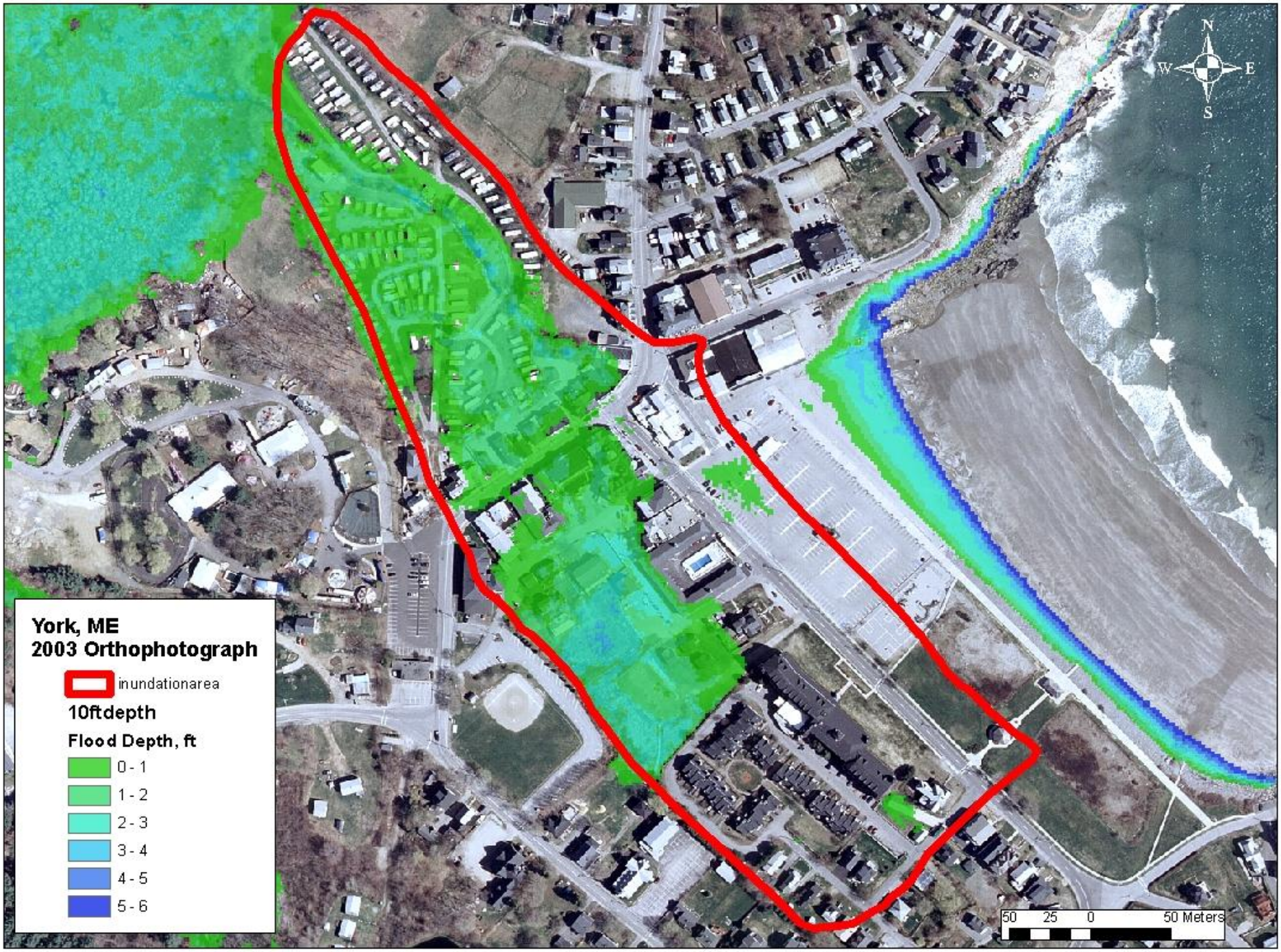
York, ME
2003 Orthophotograph
inundationarea
10ftdepth
Flood Depth, ft
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
N
W
E
S
50 25 0 50 Meters

Potential Future Conditions (HAT+1.8 m, 12.2 feet) 2100-?

For general planning purposes only; does not account for dynamic changes

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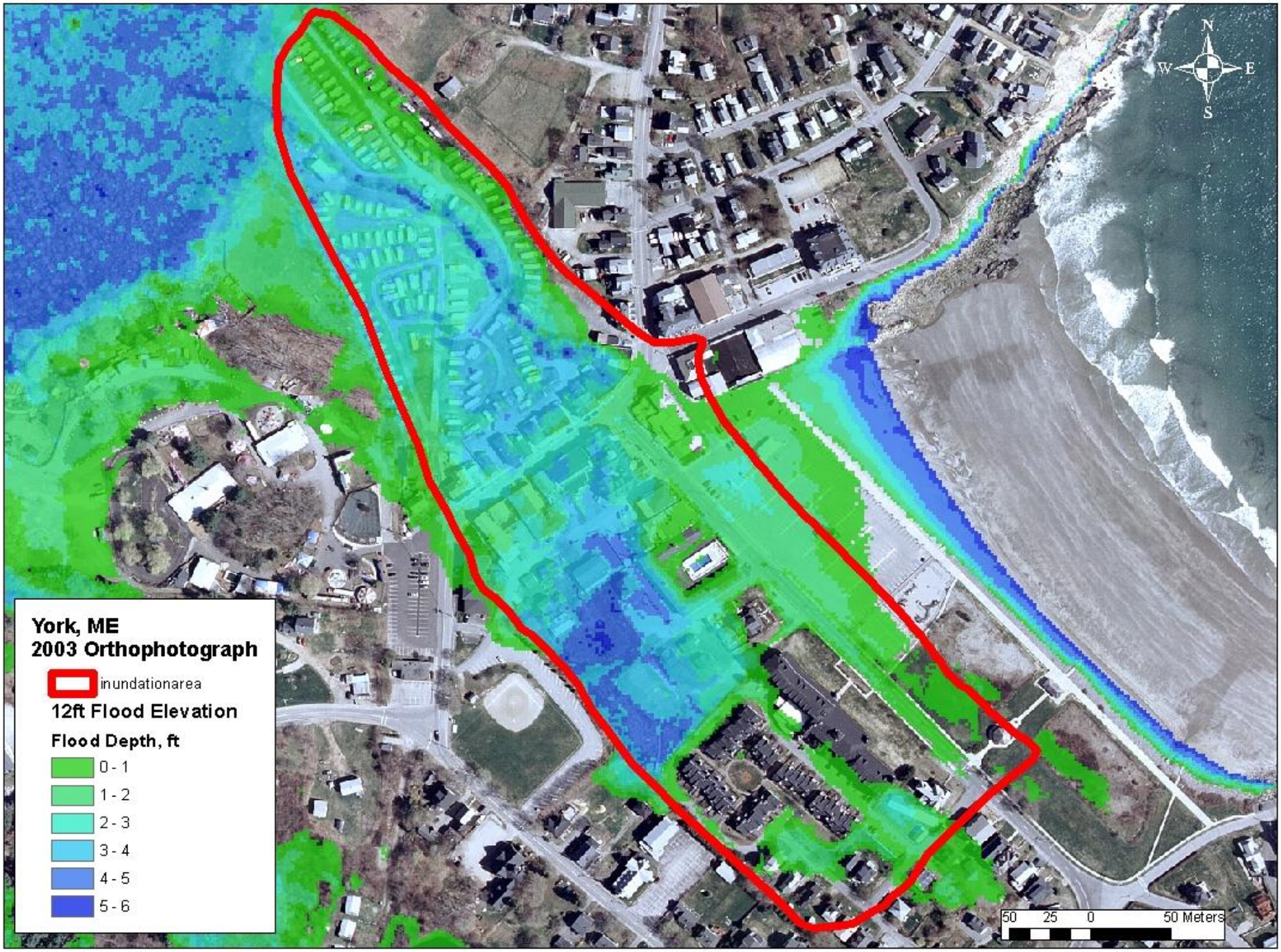
York, ME
2003 Orthophotograph
inundationarea
12ft Flood Elevation
Flood Depth, ft
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
N
W
E
S
50 25 0 50 Meters

1978 Storm ("100 year") Simulations

For general planning purposes only; does not account for dynamic changes

Historic Conditions - 1978 storm (8.9 ft NAVD)

For general planning purposes only; does not account for dynamic changes

Potential Future Conditions (1978+0.3 m) 2030-2050?

For general planning purposes only; does not account for dynamic changes

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