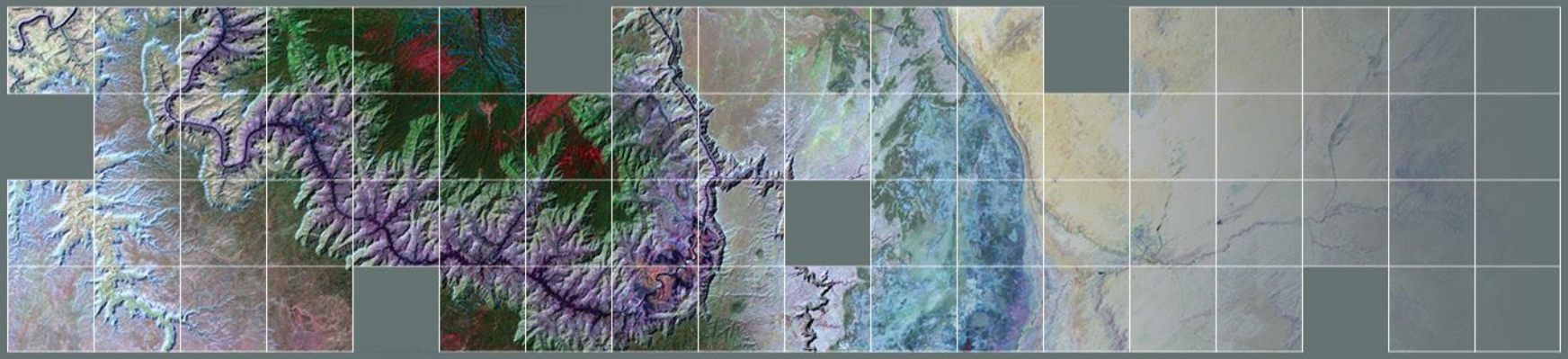
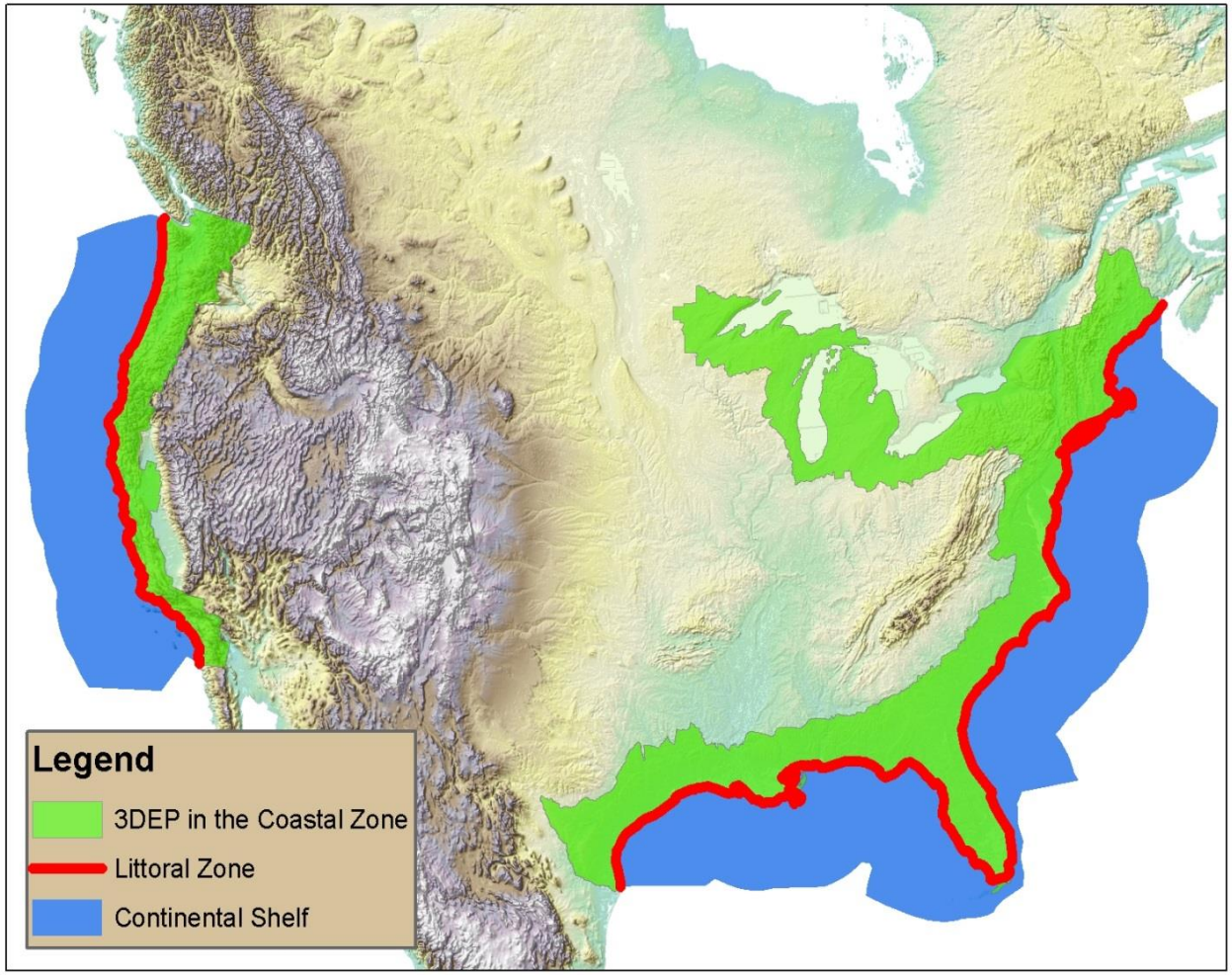
Climate and Land Use Change

Earth Resources Observation and Science (EROS) Center

Annual Update on USGS Coastal Zone Elevation Mapping (3DEP in the Coastal Zone and More….)



Coastal National Elevation Database (CoNED) Applications Project – 3DEP in the Coastal Zone (and More…)



- A USGS (CMGP, NGP) – NOAA (NGDC, NGS, OCS) – USACE (JALBTCX) collaboration.
- Geographic scope extends inland from the Fall Line offshore to the edge of the Continental Shelf.
- The CoNED Applications Project is:

1) Based at EROS.
2) Working with USGS NGP to build 3DEP in the ‘landside” coastal zone.
3) Working with USACE and the NOAA to assimilate littoral zone and continental shelf bathymetry.
4) Constructing seamless topobathymetric elevation models for a sequence of US regions.
5) Conducting “algorithm research”.

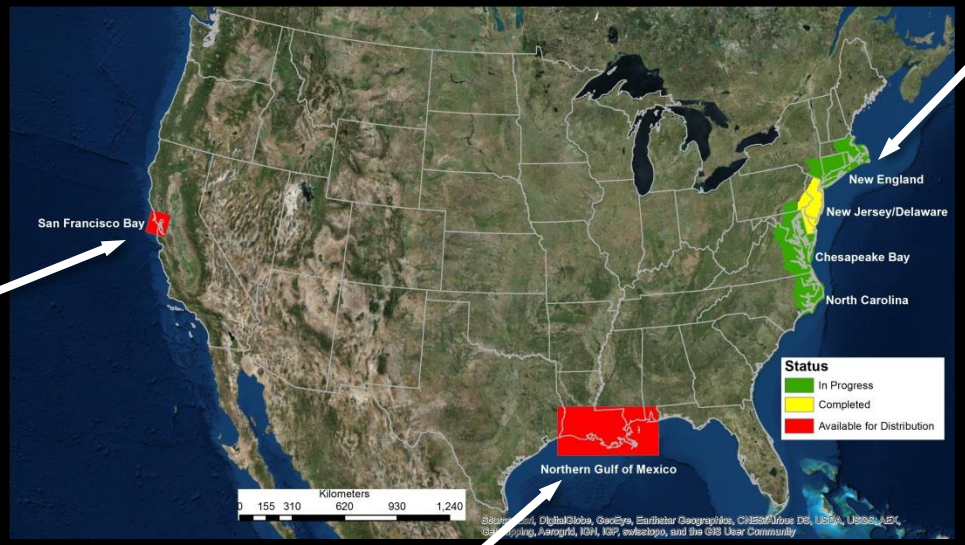
USGS

Focus Regions for the CoNED Applications Project - FY15 Deliverables:

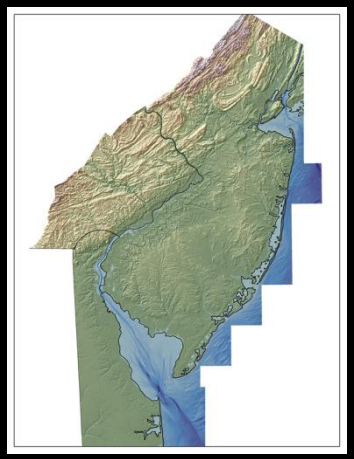
An Elevation Data Foundation for Understanding Coastal Vulnerability and Change

Alaska North Slope

Key Applications:
Navigation
Coastal erosion
Sea Level Rise



Sandy Region

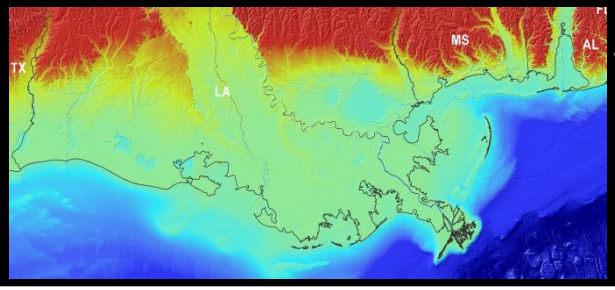


Key Applications:
Storm Surge
Water Quality
Sea Level Rise
Shorebird Habitat
Barrier Island Change

San Francisco Bay

Key Applications:
Tsunamis
Earthquakes
Sea Level Rise
Habitat Quality
Cliff failure

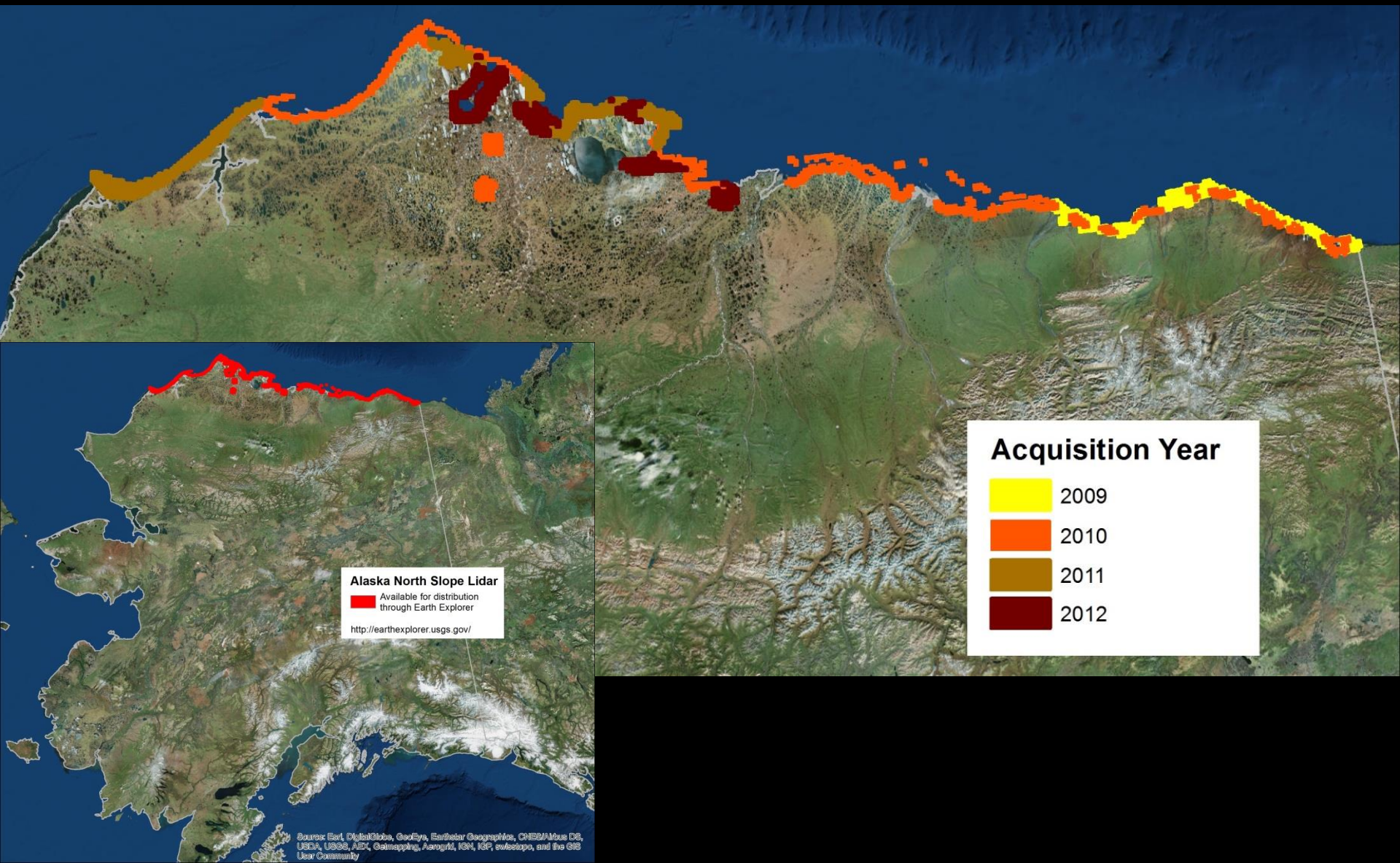
Northern Gulf of Mexico

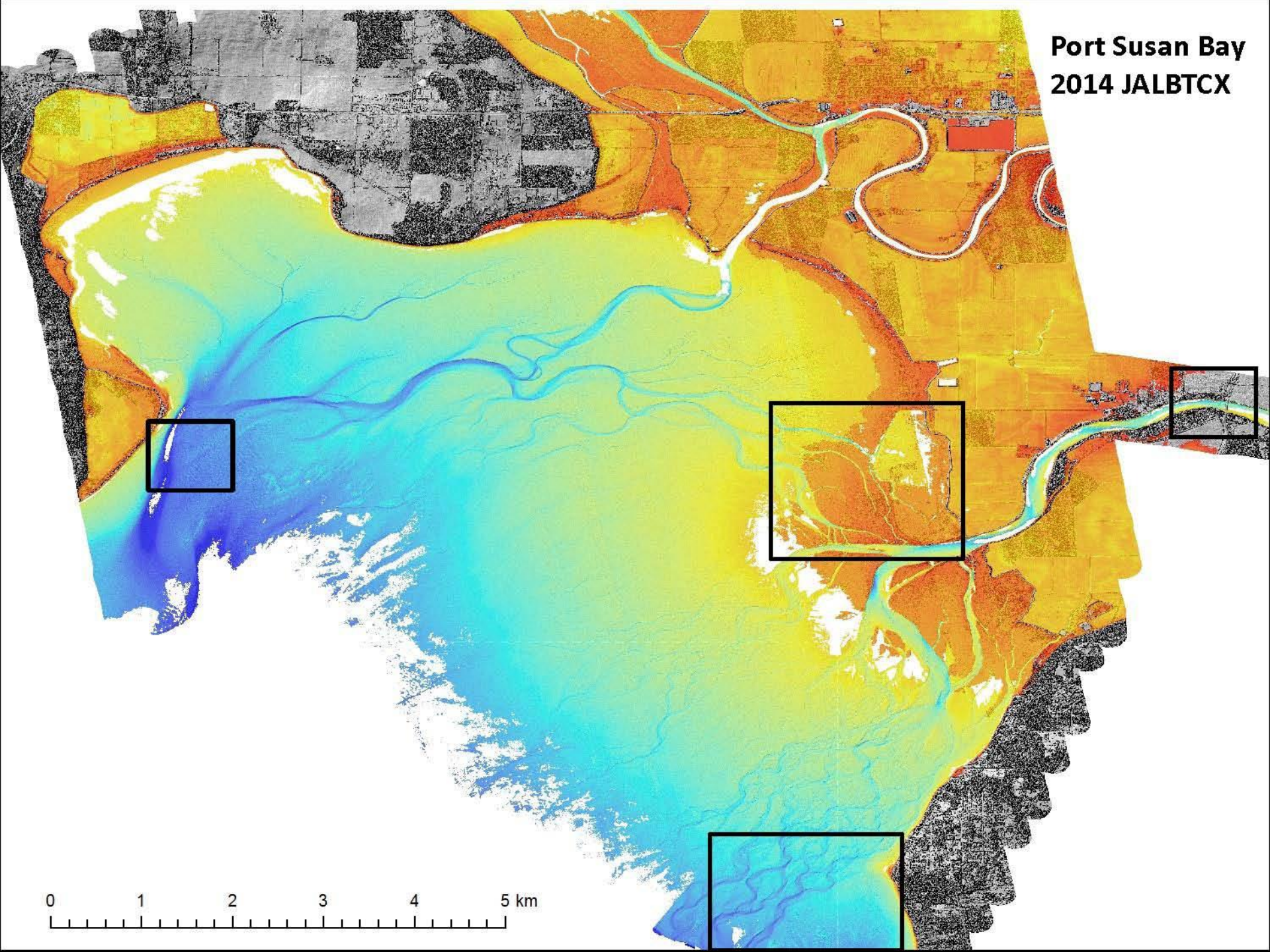


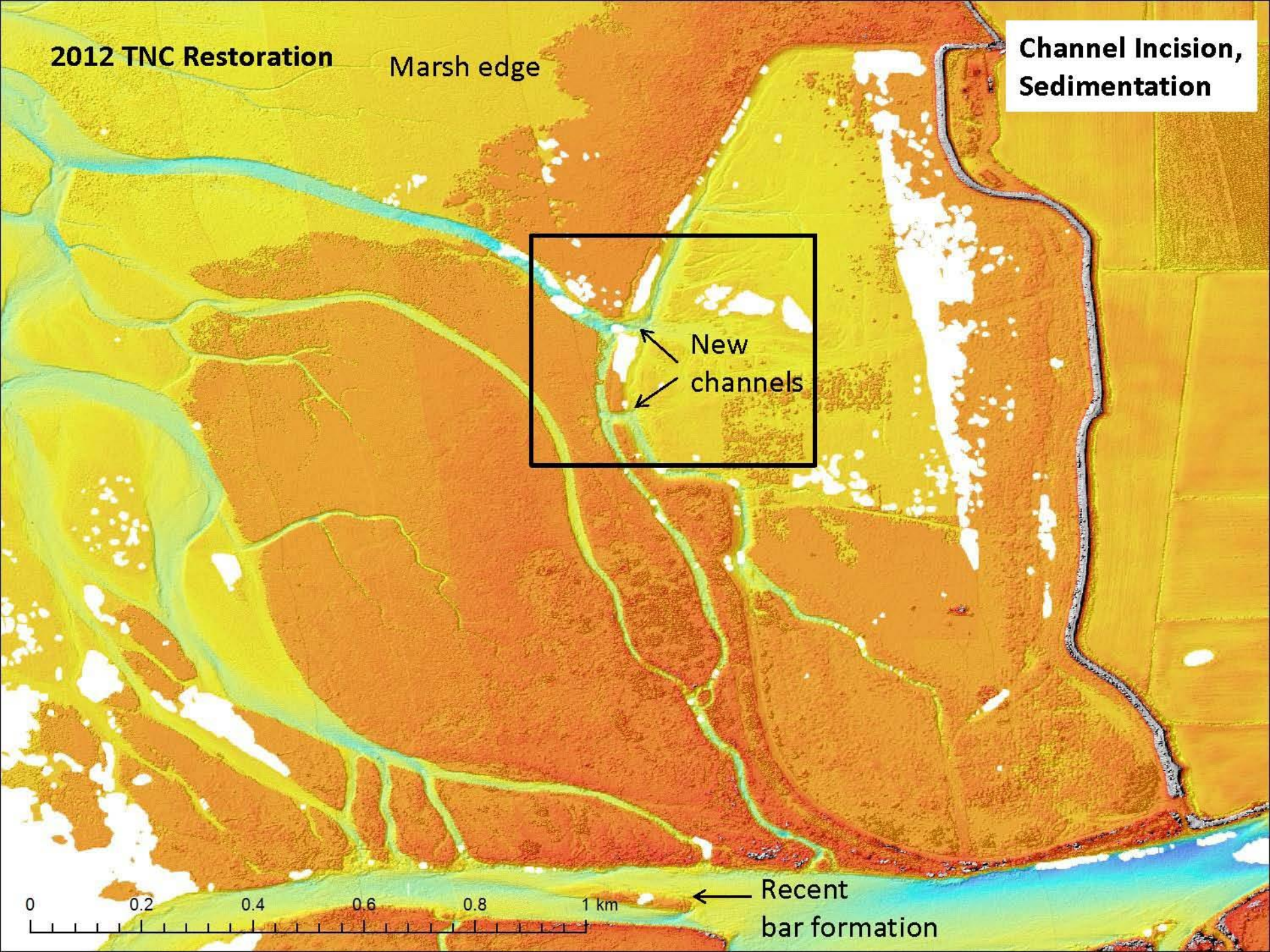
Key Applications:
Wetland Loss
Sea Level Rise
Storm Surge

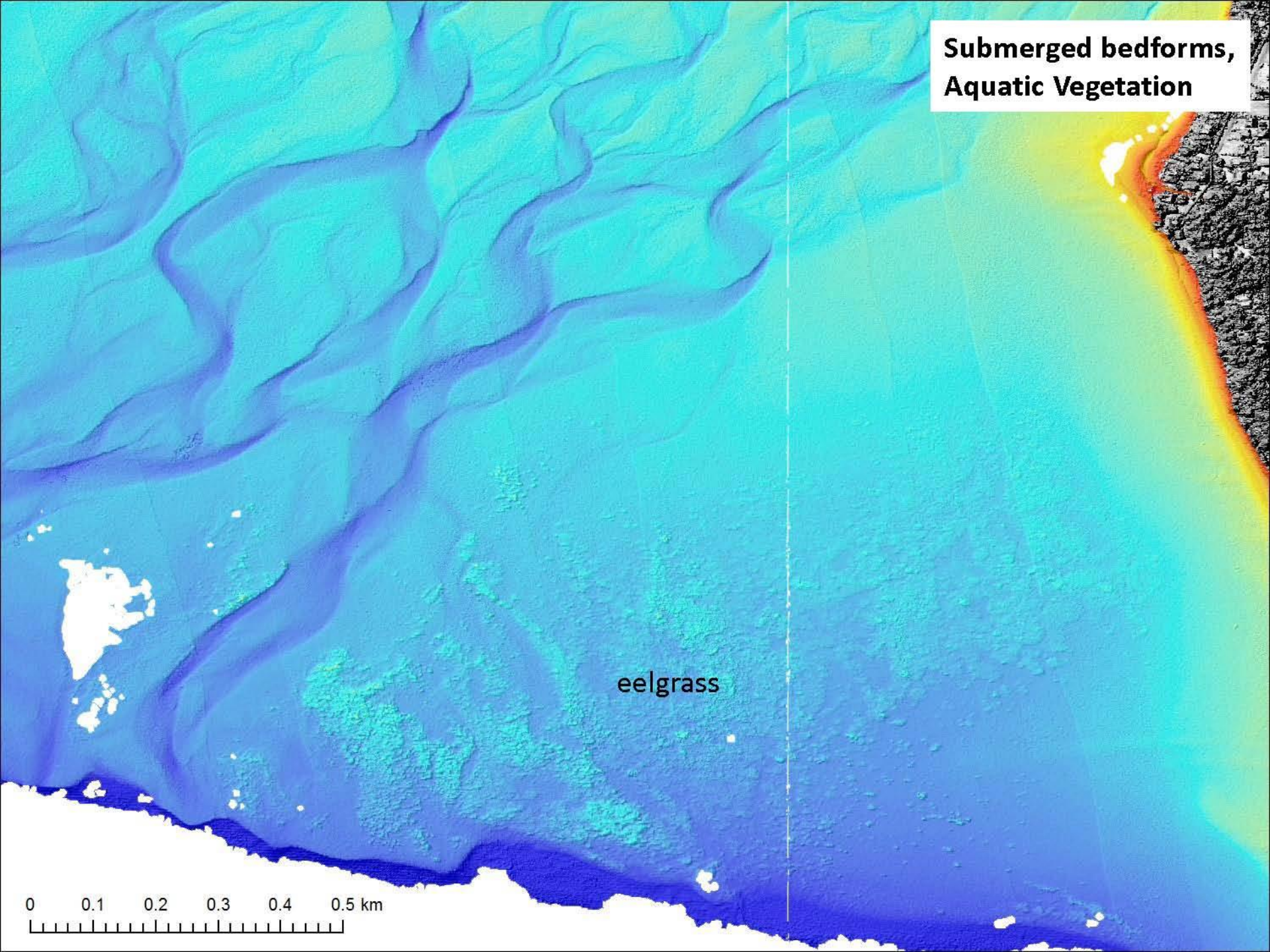
USGS

Lidar Topography Data is Now Available for the Alaskan North Slope Coastline




Port Susan Bay
2014 JALBTCX
0
1
2
3
4
5 km


2012 TNC Restoration
Marsh edge
Channel Incision, Sedimentation
New channels
0
0.2
0.4
0.6
0.8
1 km
Recent bar formation


Submerged bedforms,
Aquatic Vegetation
eelgrass
0
0.1
0.2
0.3
0.4
0.5 km

Enabling Science and Decision-Making: USGS Coastal Storm Modeling System (CoSMoS)

San Francisco Bay Region – 2m Topobathy Model (2012)

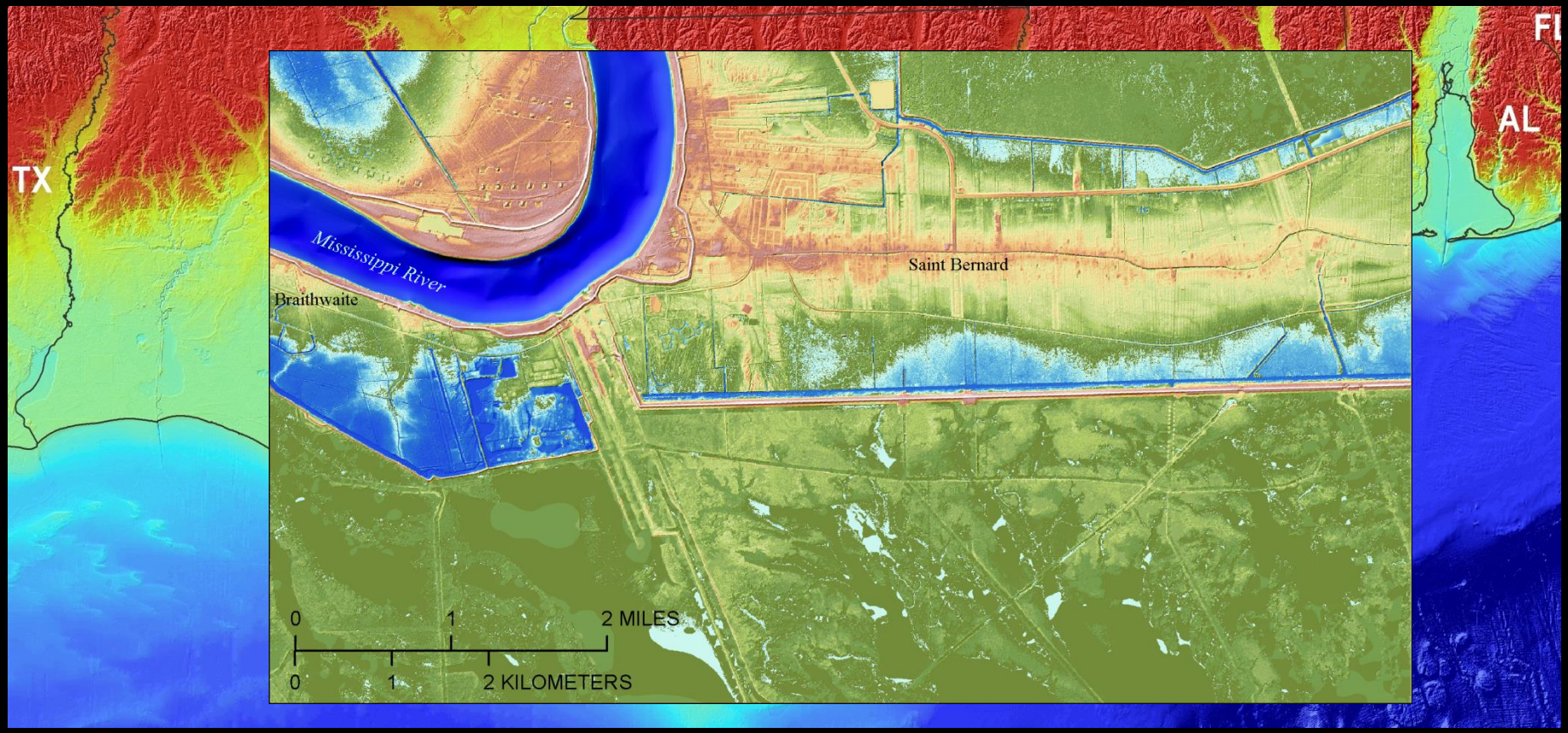
What is CoSMoS?
Coastal Storm Modeling System

- Physics-based numerical modeling system for assessing coastal hazards on West Coast
- Predicts coastal hazards for the full range of sea level rise and storm possibilities using the most sophisticated global climate and ocean modeling tools
- Developing coastal vulnerability tools with guidance from federal (e.g., NOAA, NPS), state (e.g., California State Parks), and city governments (City of San Diego, L.A., and San Francisco) to meet their planning and adaptation needs

USGS

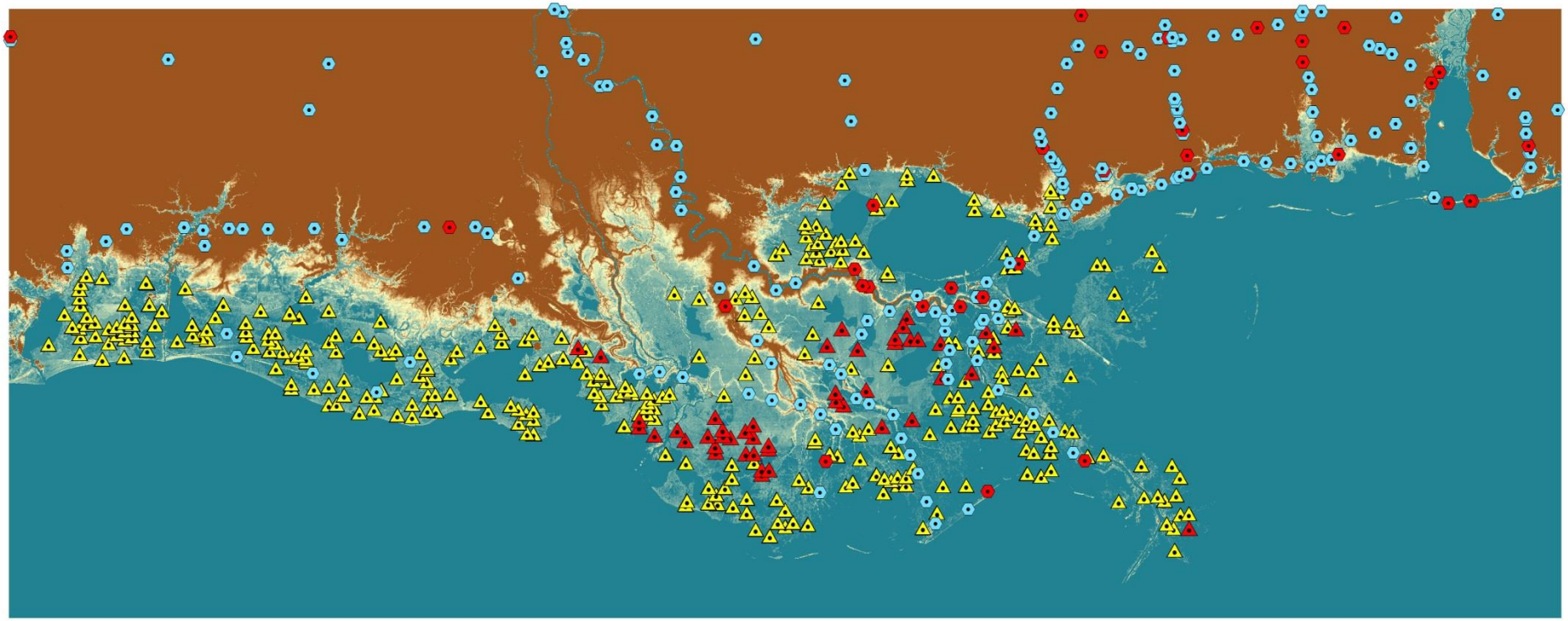
USGS

The Northern Gulf of Mexico (NGOM) Topobathymetric Elevation Model is Now Available:



USGS

Reference data sets for the topography validation:



Explanation

NGS GPSonBM Geoid12a control

- Excluded (35)
- Included (183)

CRMS Monitoring Station Mean Marsh Surface Elevation (MMSE) control

- CRMS MMSE excluded control stations representing floatant (floating) marsh or water (46)
- CRMS MMSE control stations (3,432)

Northern Gulf of Mexico Topobathy DEM

Value

- High : 3 m
- Low : 0 m

Validation Results:

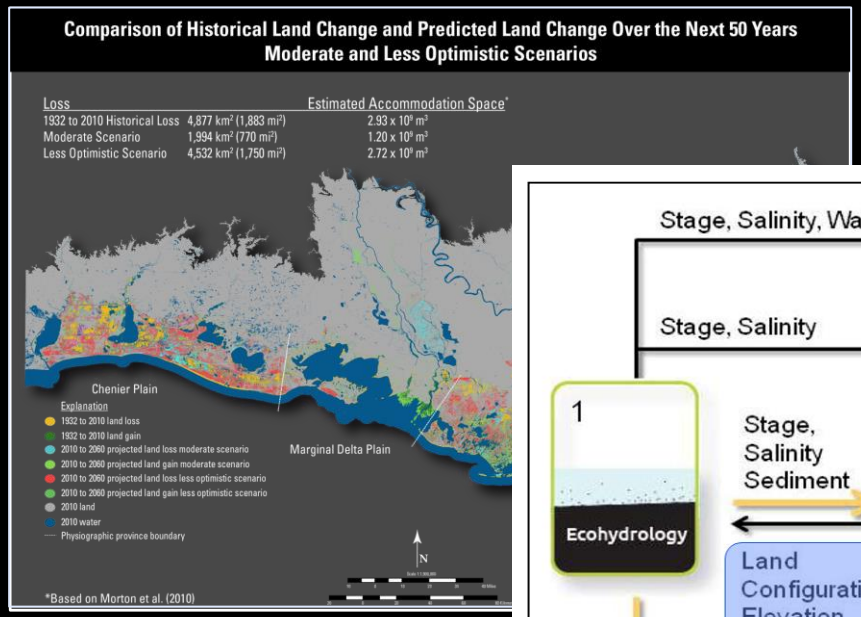
$RMSE_z$ of 0.259 m (~ 0.85 ft) for the non-wetland topography

$RMSE_z$ of 0.326 m (~ 1.1 ft) for the wetland topography

Scale 1:2,494,512

20 0 20 40 60 km

Construction of the NGOM Region TBDEM Responds to the Needs of System Level Models that was Described in the LA CPRA 2012 State Master Plan



Modified from CPRA (2012)
http://www.lacpra.org/assets/docs/2012%20Master%20Plan/Final%20Plan/appendices/Appendix%20D-Decision%20Support%20Tools-ModelsFINAL_wTpg.pdf

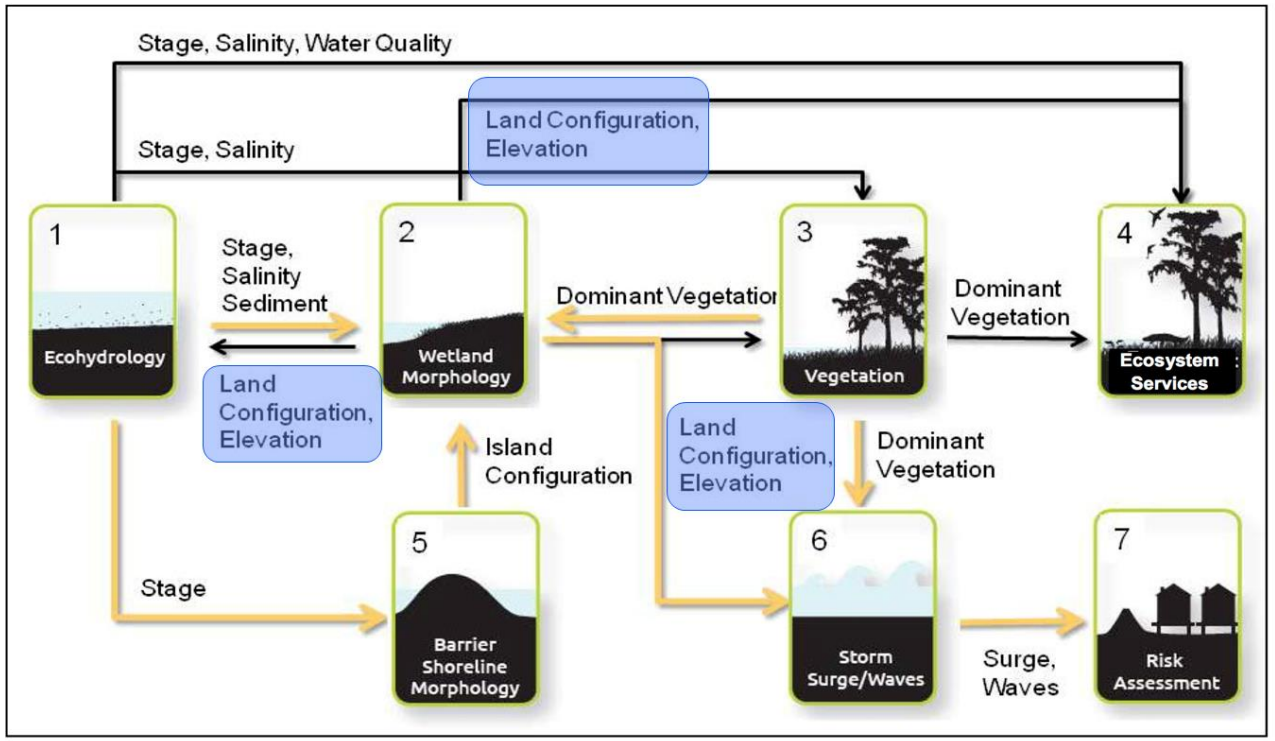


Figure 1. Systems Level Predictive Models Used to Inform the 2012 Coastal Master Plan

New linkages are indicated in yellow.

USGS

Northern Gulf of Mexico (NGOM) Topobathymetric Model

- **Available in USGS Earth Explorer (EE) -- http://earthexplorer.usgs.gov/**
- **TBDEM Products Page -- https://lta.cr.usgs.gov/coned_tbdem**

https://lta.cr.usgs.gov/coned_tbdem

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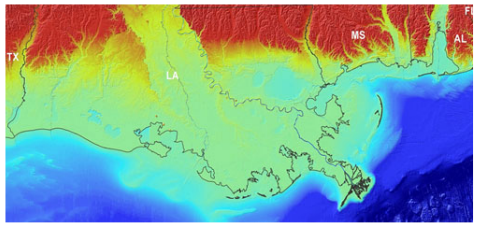
Coastal National Elevation Database (CoNED) Project - Topobathymetric Digital Elevation Model (TBDEM)



Northern Gulf of Mexico (NGOM) Topobathymetric Digital Elevation Model (2014)

Physical processes in the coastal environments are controlled by the geomorphology of both "over-the-land" topography and "underwater" bathymetry; therefore, many applications of geospatial data in coastal environments require detailed knowledge of near-shore topography and bathymetry (topobathymetry). The Coastal National Elevation Database (CoNED) Project is a collaboration between the U.S. Geological Survey (USGS) Coastal and Marine Geology Program (CMGP), the National Geospatial Program (NGP), and the National Oceanic and Atmospheric Administration (NOAA) National Geophysical Data Center (NGDC). This coastal elevation database integrates disparate light detection and ranging (lidar) and bathymetric data sources into common databases aligned both vertically and horizontally to common reference systems. CoNED Project - topobathymetric digital elevation models (TBDEMs) provide a required seamless elevation product for science application studies such as shoreline delineation, coastal inundation mapping, sediment-transport, sea-level rise, storm surge models, tsunami impact assessment, and analysis of the impact of various climate change scenarios on coastal regions.

CoNED Project elevation model development is focused in select regions along the U.S. coast, such as in the Northern Gulf of Mexico (NGOM), the Hurricane Sandy region, San Francisco Bay, the Pacific Northwest, and the North Slope of Alaska. The models vary in spatial resolution from 1 to 3 meters. The temporal range of the input bathymetry and topography data varies for most CoNED Project TBDEMs from the mid- to late-1900s to the present. The raster topobathymetric elevation product, the Federal Geographic Data Committee (FGDC) metadata, and a spatial referenced ESRI shapefile are contained in the downloadable bundle.

CoNED Topobathymetric Digital Elevation Model Data Products

This collection of high-resolution coastal elevation data is available in a user-friendly Georeferenced Tagged Image File Format (GeoTIFF). The elevation model has floating point numeric values. Areas where data is incomplete due to lack of full image coverage or No Data are represented with the numeric value of -3.40282346639e+038.

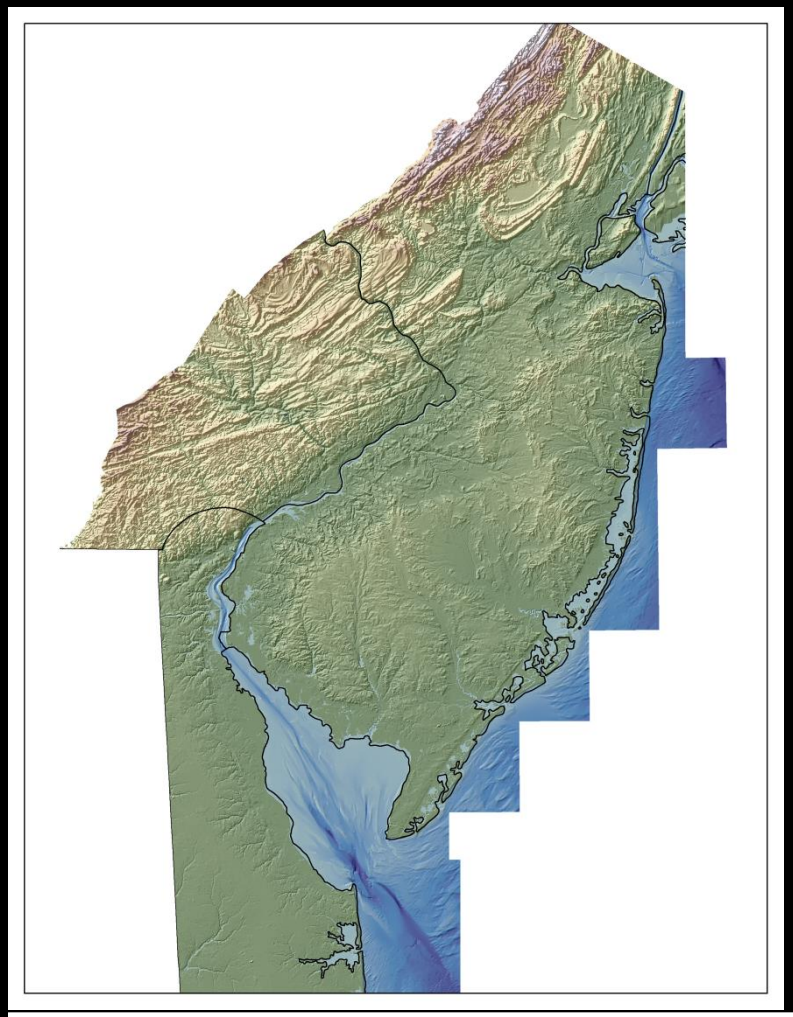
CoNED topobathymetric elevation data are intended for scientific use within a Geographic Information System (GIS) or other special application software.

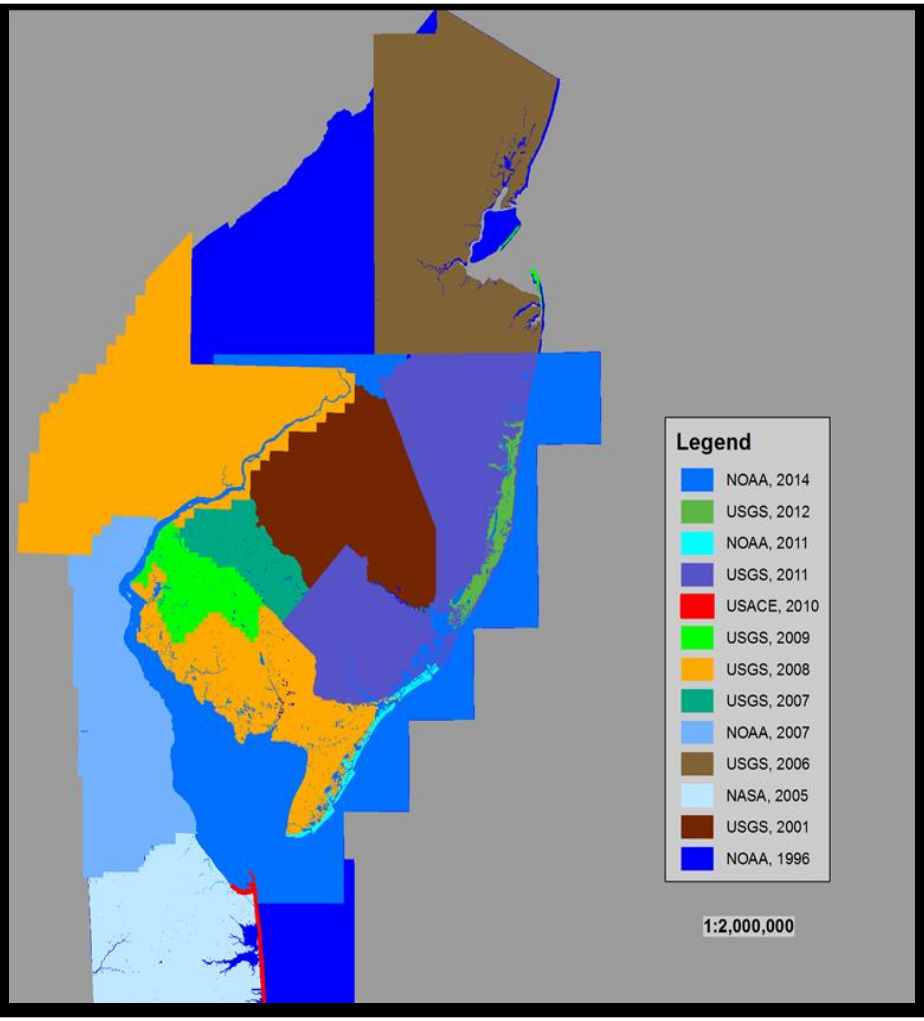
Product Specifications	
Projection	Geographic or UTM*
Horizontal Datum	NAD83 (North American Datum of 1983)
Vertical Datum	NAVD88 (North American Vertical Datum of 1988)
Vertical Units	Meters
Spatial Resolution	3 meter, 2 meter, or 1 meter*

*Projection and resolution will vary by region.

Product Info | Get Data | Policies | Help

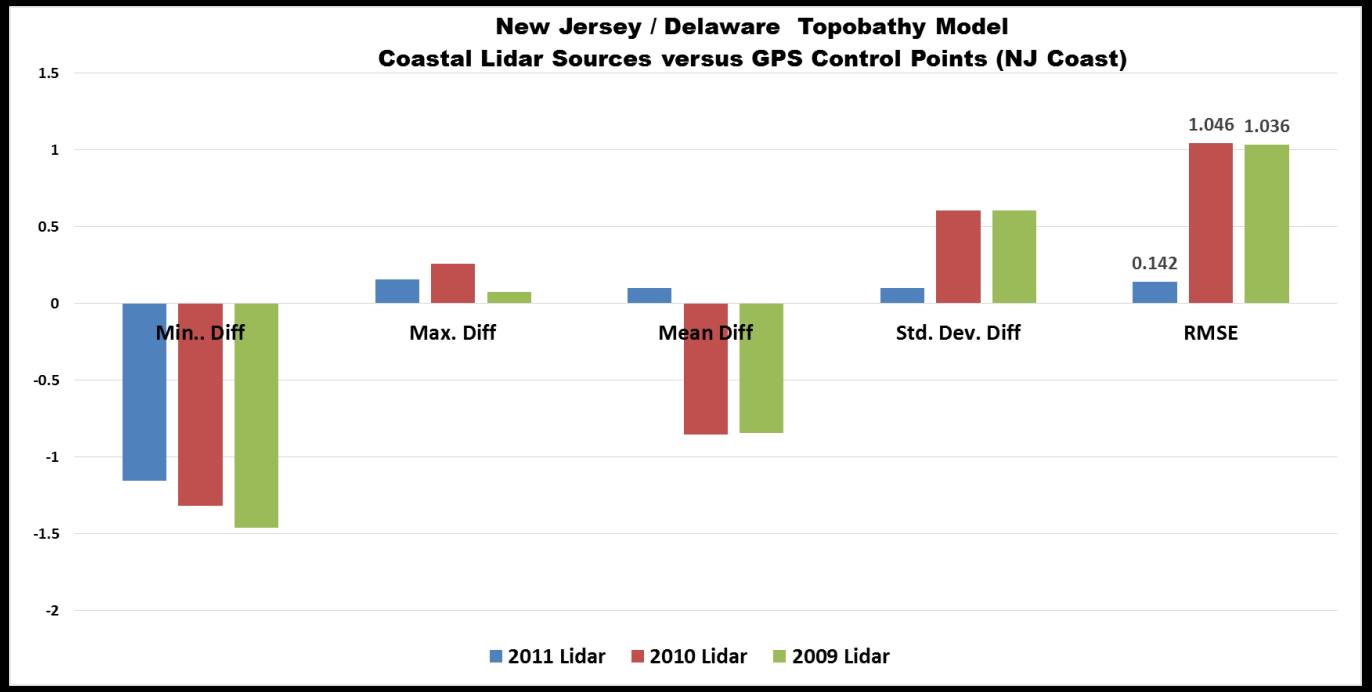
Sandy Region: Completion of the New Jersey - Delaware Subregion Topobathymetric Elevation Model:





Anticipated July 15 Completion and September 1 Earth Explorer Release

Assessing Individual Lidar Collections Used to Create the NJ-DE Topobathymetric Elevation Model:



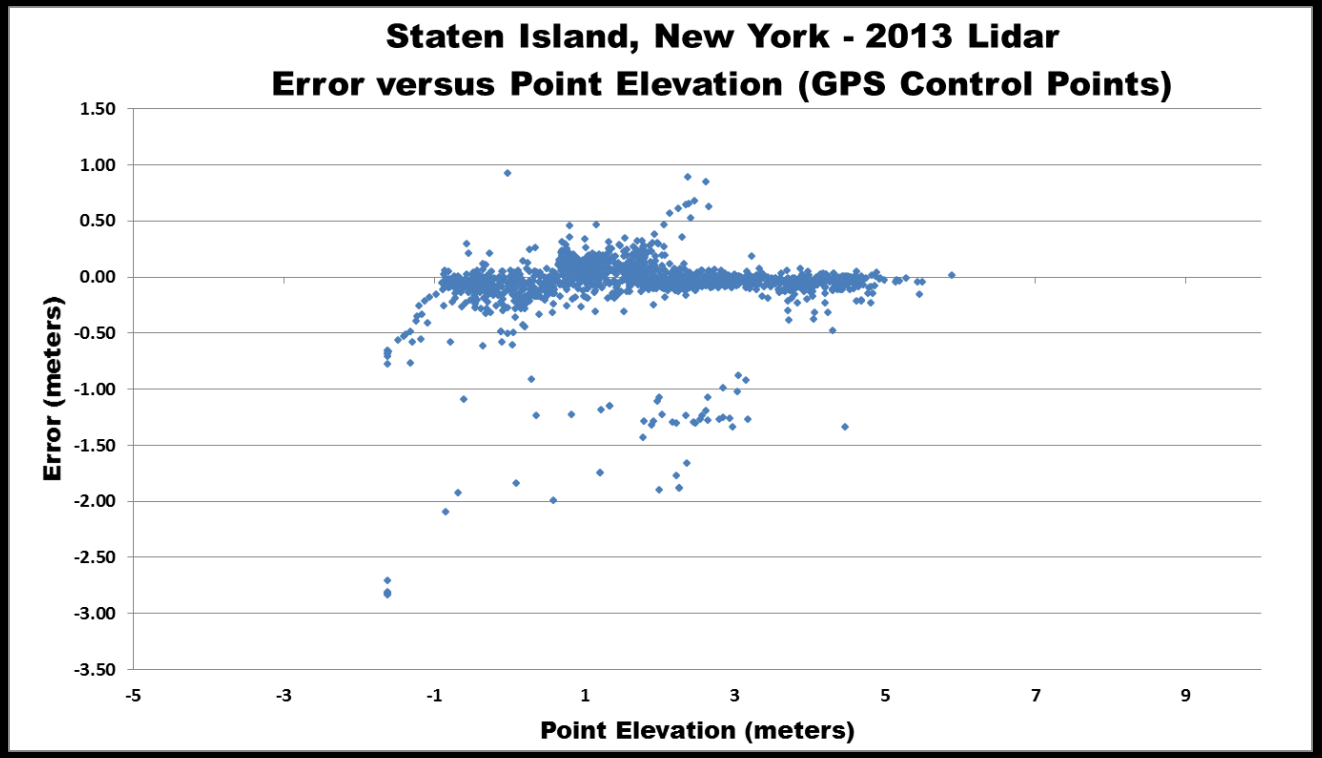
Sources	Min.. Diff	Max. Diff	Mean Diff	Std. Dev. Diff	RMSE
2011 Lidar	-1.152	0.155	0.102	0.099	0.142
2010 Lidar	-1.318	0.258	-0.855	0.603	1.046
2009 Lidar	-1.461	0.076	-0.843	0.604	1.036

RMSE

$$\sqrt{\frac{\sum_{i=1}^{n}[\hat{Z}(s_i) - z(s_i)]^2}{n}}$$

USGS

Validation of the Topobathymetric Elevation Model for the NJ-DE Sandy Subregion (Staten Island):



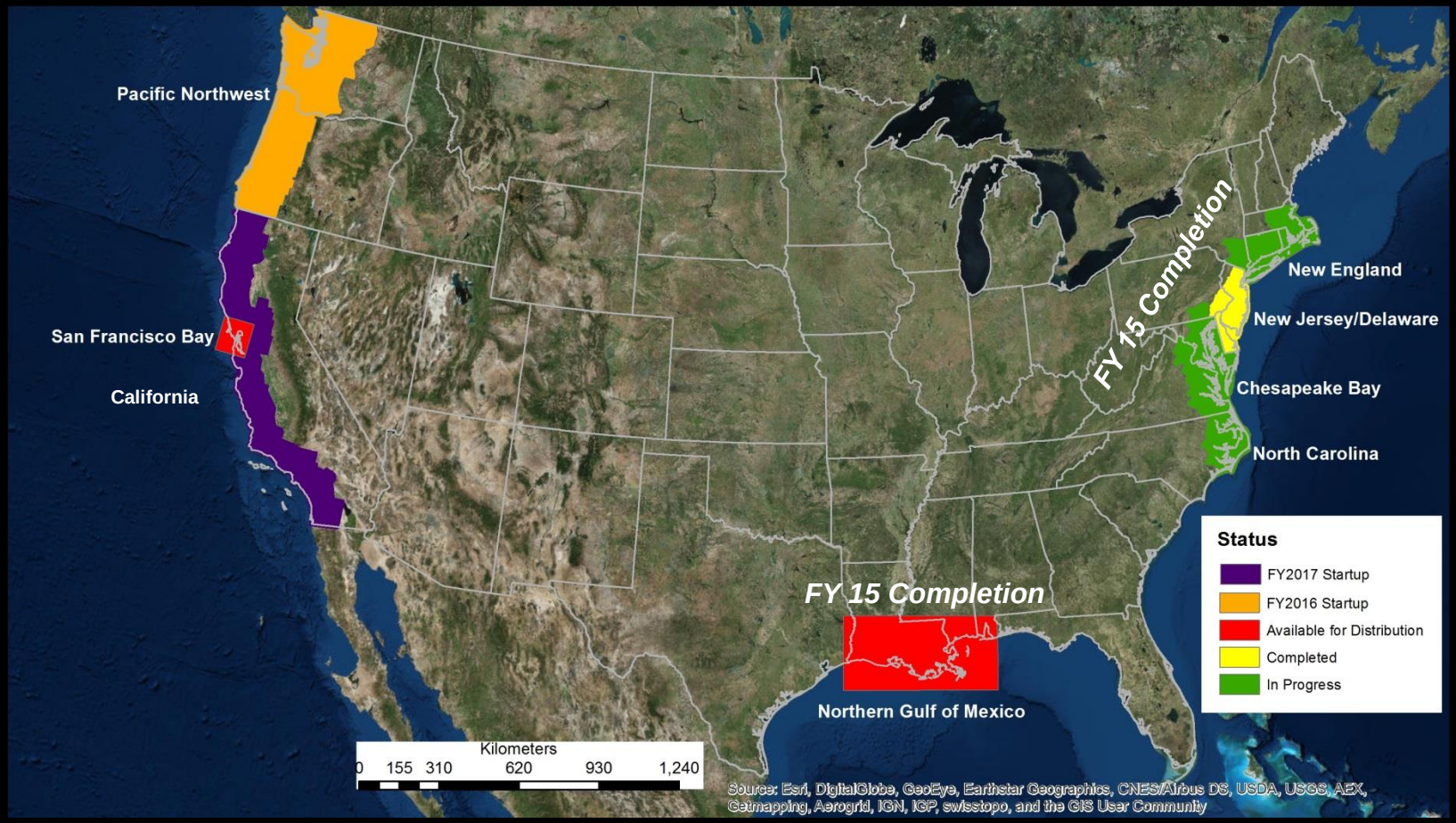
Min. Diff	-2.830 Meters
Max. Diff	0.924 Meters
Mean Diff	-0.063 Meters
Std. Dev. Diff	0.307 Meters
RMSE	**0.313 Meters**

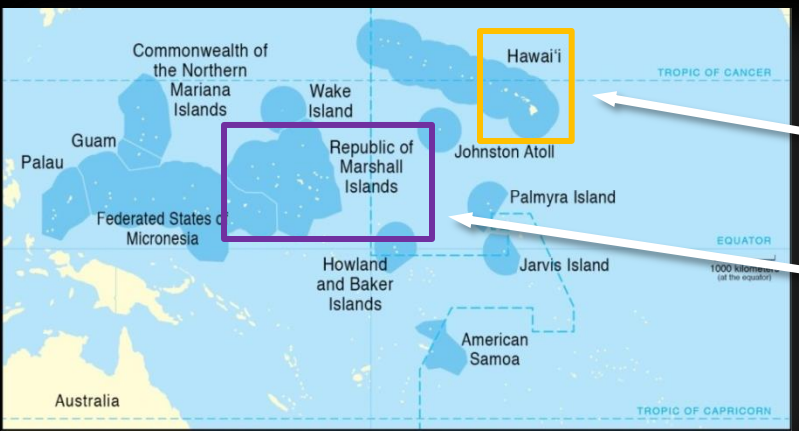
RMSE

$$\sqrt{\frac{\sum_{i=1}^{n}[\hat{Z}(s_i) - z(s_i)]^2}{n}}$$

USGS

Focus Regions for the USGS CoNED Applications Project in FY16 and FY17

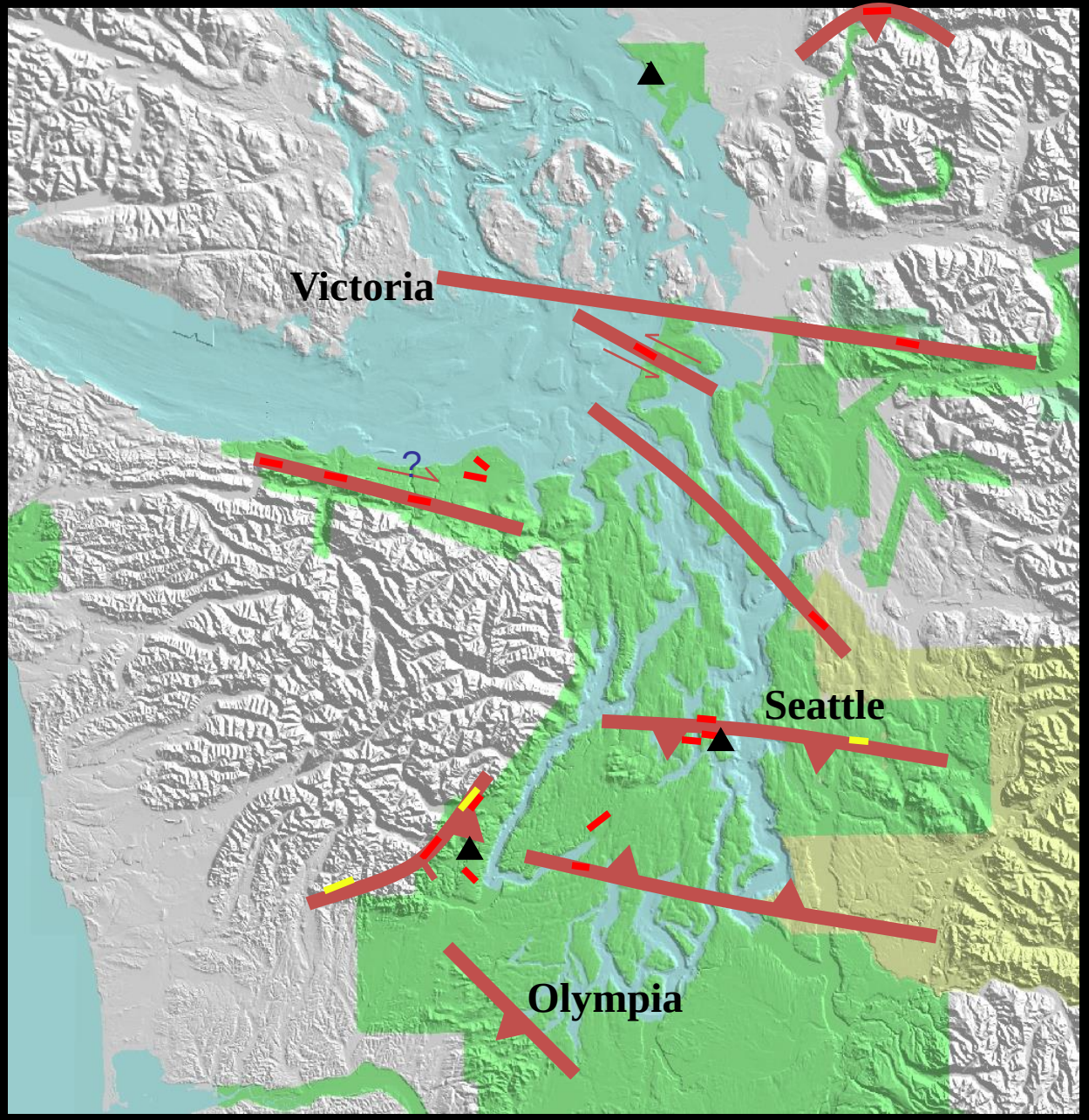




Hawaiian Islands - Construct seamless topobathymetric elevation models for Hawai'i and Maui in FY16.

US Affiliated Pacific Islands - Initiate non-traditional elevation data acquisition at the Marshall Islands in FY17.

US West Coast Elevation Mapping is Needed to Assess Seismic Hazards:



Scarp found with lidar

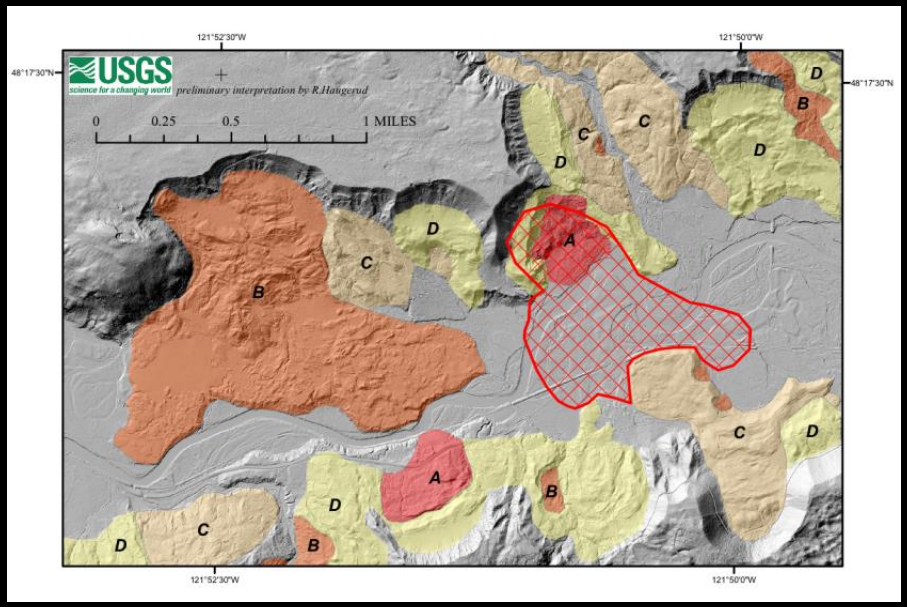
Scarp found other means

Geomorphic evidence of shoreline uplift

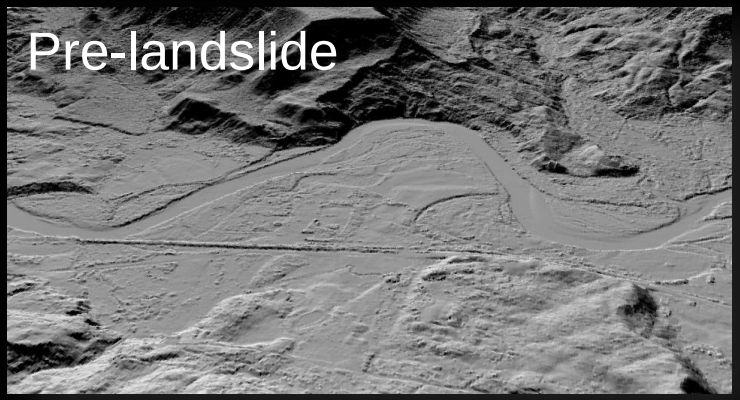
USGS science for a changing world

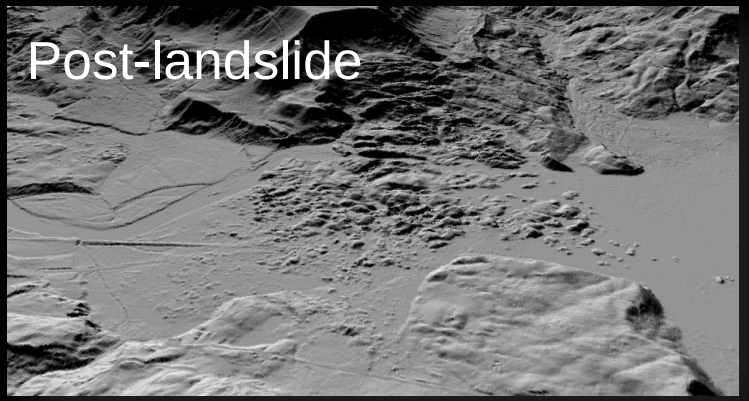
US West Coast Elevation Mapping is Needed to Assess Sea Cliff Erosion and Landslide Hazards:

Oso, WA Landslide March 22, 2014



High-resolution lidar reveals historic and potential slides





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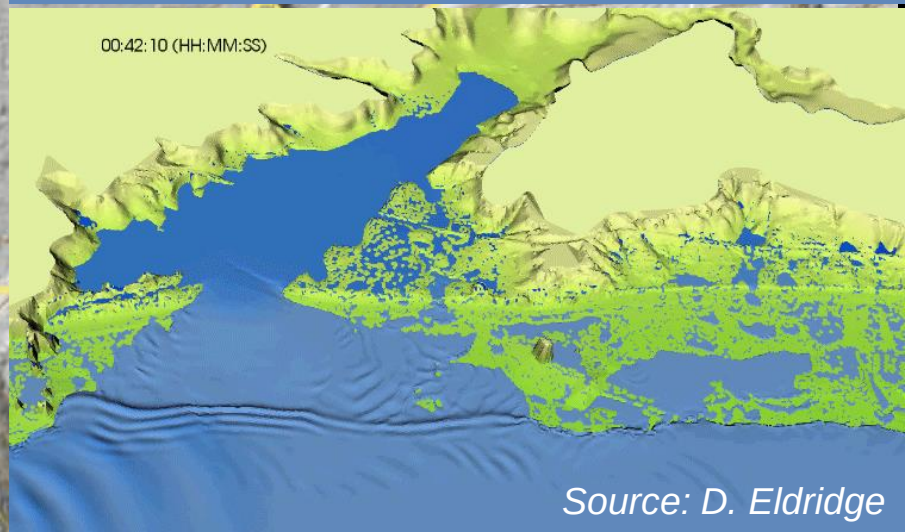
Source: D. Eldridge

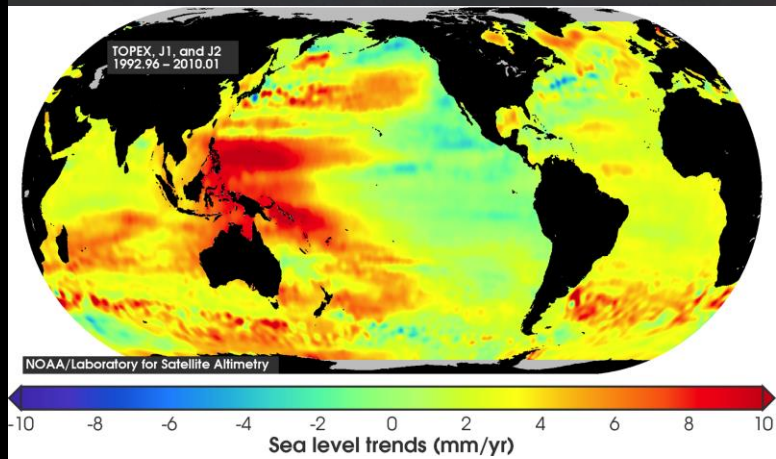
US West Coast Elevation Mapping is Needed to Predict Tsunami Inundation:

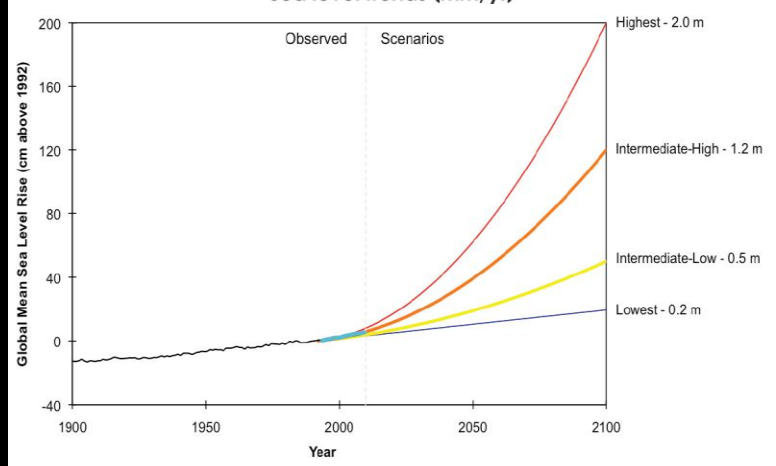


Source: D. Eldridge

“Fragmented” Accurate Topobathymetric Mapping is Needed to Enable Planning to Increase the Resilience of U.S. Pacific Islands to Sea Level Rise:

- Many U.S. Pacific islands are atolls fringed with coral reefs and have maximum elevations of 3-5 m, with mean elevations of 1-2 m.
- Sea level in the western Pacific Ocean has been increasing at a rate 2-3 times the global average, resulting in almost +0.3 m of net rise since 1990.
- The 2012 US National Climate Assessment provided global sea level rise scenarios that ranged from 0.2 to 2.0 m by 2100.





Sea level in the western Pacific Ocean has been increasing at a rate 2-3 times the global average, resulting in almost +0.3 m of net rise since 1990:

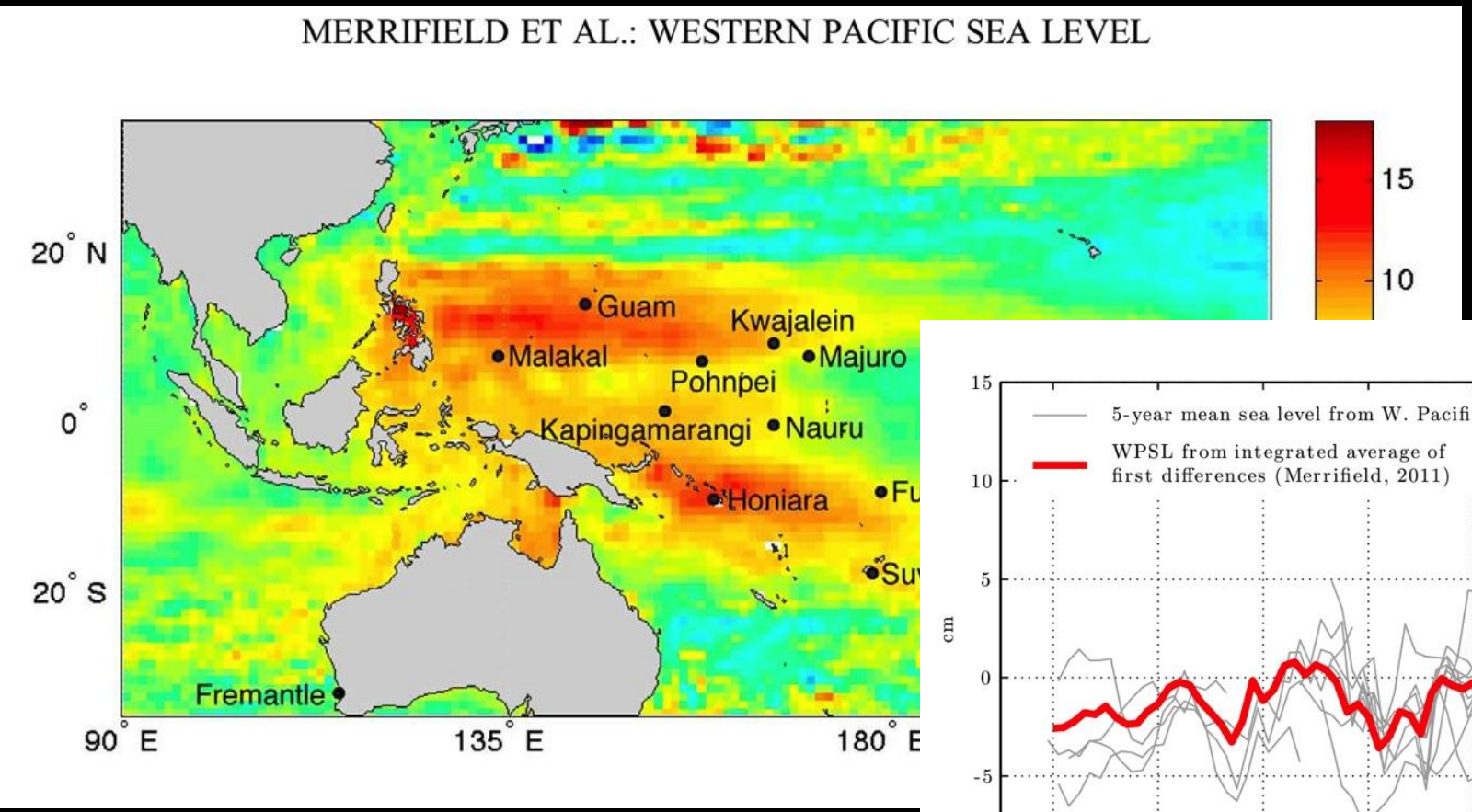
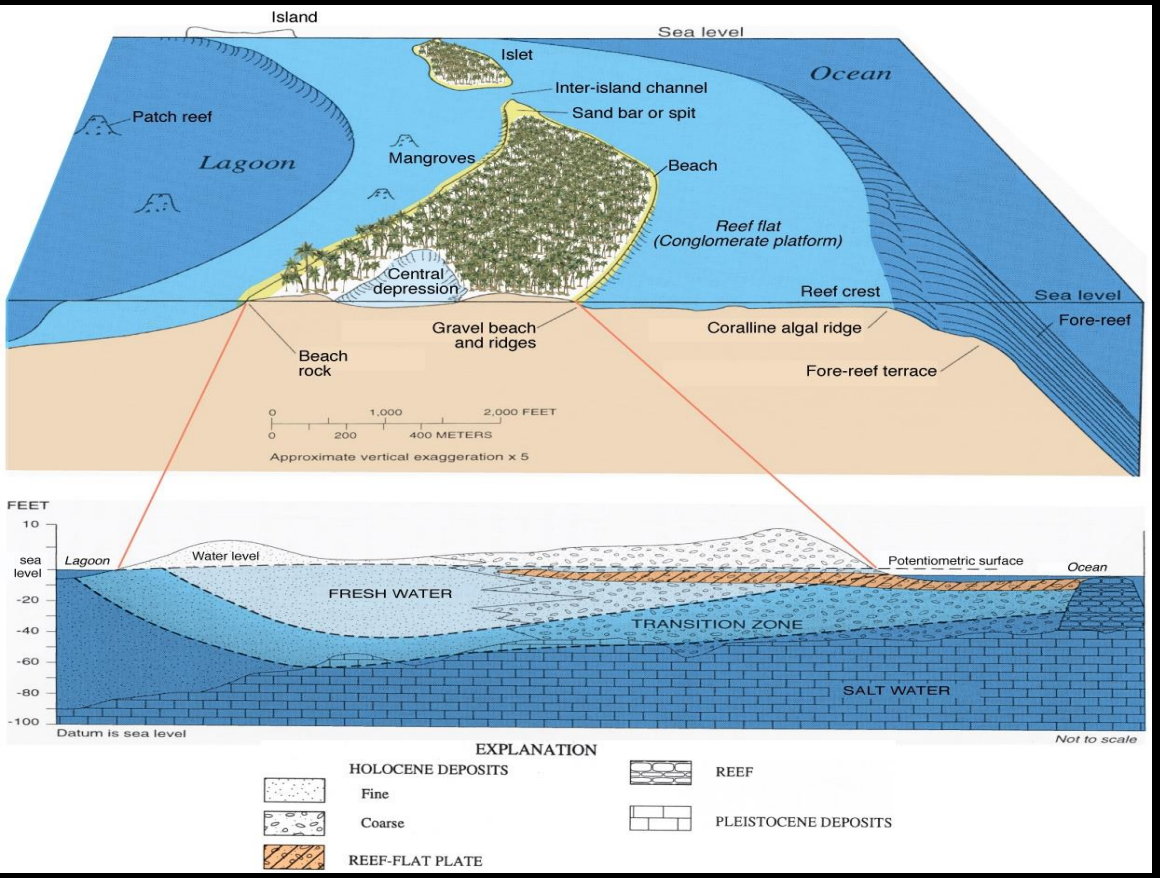


Figure 2. Five-year average sea level time series from tide gauge stations in the western tropical Pacific. The average of all stations (red curve) is referred to as western Pacific sea level (WPSL).

Source: C. Storlazzi

USGS science for a changing world

Pacific Atolls are Endangered and Poorly Mapped



1) Very low and poorly known topography.
2) Very steep and poorly mapped bathymetry.
3) Available freshwater is limited to a shallow lens.
4) A mix of unconsolidated and consolidated carbonate sediments.
5) Changing coral reef status and biogeomorphology.

There are over 2000 islands in the Pacific that are extremely vulnerable to sea-level rise, tsunamis, storm surge, coastal flooding, and climate change that could impact the sustainability of their infrastructure, groundwater, and ecosystems.

USGS science for a changing world

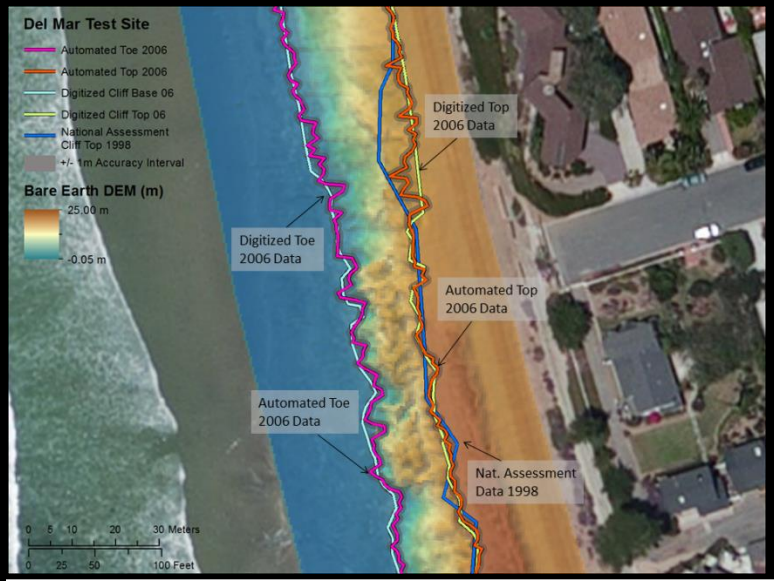
Source: C. Storlazzi

Algorithm Research and Dedicated Workshops Associated with FY16+ Focus Regions

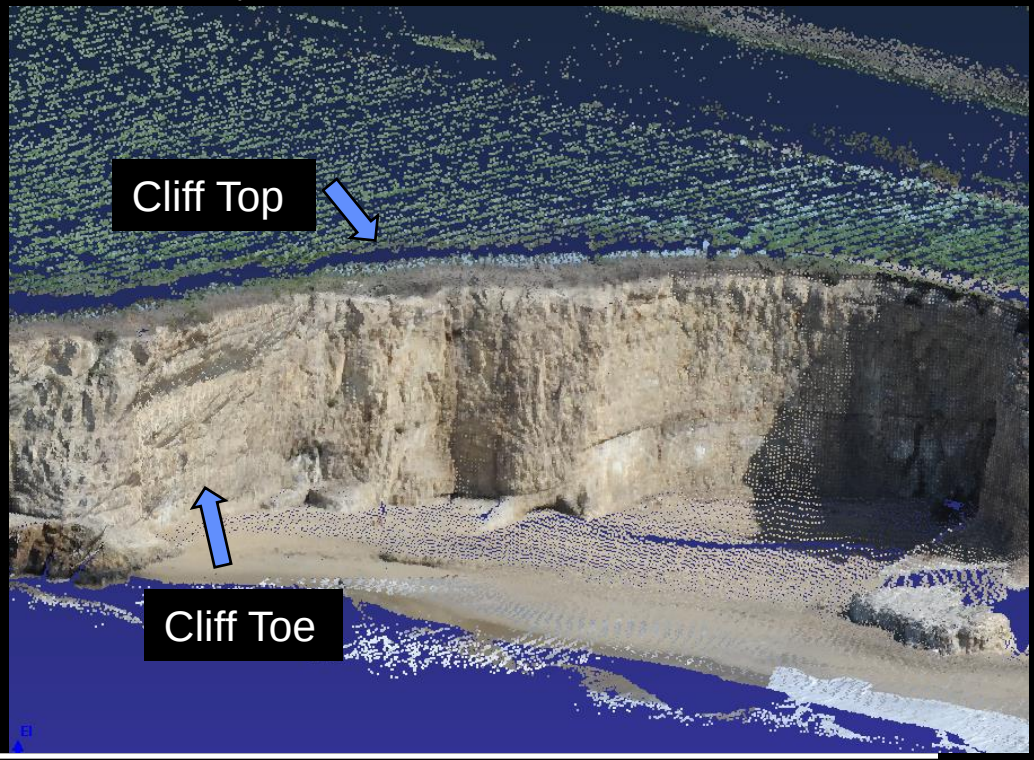
Techniques for the Use of Lidar in Mapping and Monitoring Sea Cliffs Have Been Developed By USGS

Applications:

- Efficient, accurate mapping of cliff top/toe from airborne lidar.
- Identifying erosion hotspots to reduce risk to lives/property.
- Understanding how storms (large waves, precipitation) affect cliff failure.



Ground-based lidar survey of cliffs near Santa Cruz, CA: new technology provides unprecedented detail on beaches, cliff faces.



USGS

Workshop on Needs for Topobathymetric Elevation Models and Applications in the US Pacific Northwest Coastal Zone

To Be Convened in February 2016 in Olympia (Lacey), WA

Objective: Bring users of topobathymetric elevation data together to establish requirements for high-resolution topobathymetric data for Puget Sound and the coastal zones of Oregon and Washington. Workshop participants will:

1) **Examine the current state of existing topographic and bathymetric data and potentially initiate the development of a 3DEP BAA proposal for future lidar data acquisition in the PNW coastal zone.**

2) **Review recent improvements in topobathymetric methods, techniques, and frameworks for the consistent creation of integrated elevation data for science applications.**

3) **Exchange information on science applications in the Pacific Northwest that require integrated topobathymetric elevation data.**

Please contact Jeff Danielson (daniels@usgs.gov) of EROS for additional information.

Exploration of Innovative and Practical Methods to Acquire High – Accuracy Elevation Geodata Across US Affiliated Pacific Islands for Increased Coastal Resilience

Tuesday, September 15th – Wednesday, September 16th, 2015
USGS Pacific Regional Office, Sacramento, California

Objective: The primary objective of this workshop is to define practical methods for the acquisition of accurate high-resolution topographic and bathymetric data on and around low-lying US Affiliated Pacific Islands (USAPI). Topics to be covered will include:

- **Needs within the USAPI for accurate high-resolution elevation data.**
- **Exploration of innovative surveying methods.**
- **Current state of existing US Pacific Island topographic and bathymetric data.**
- **Options for US Pacific Island topographic and bathymetric data access through a web-based portal.**
- **Methodologies for diverse topographic and bathymetric data integration.**
- **Predictive modeling of tidal, tsumani, storm surge and sea-level rise inundation.**

Questions or Comments on USGS Coastal Elevation Mapping?

USGS
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