FREQUENT QUESTIONS

NOAA Pacific Services Center
NOAA Coastal Services Center

Guam and Saipan Edition – Digital Coast Sea Level Rise and Coastal Flooding Impacts Viewer

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Contents

Introduction

The purpose of this document is to provide user communities with the most up-to-date information on the data and modeling approach used to develop the Sea Level Rise and Coastal Flooding Impacts Viewer for both Guam and Saipan. This document complements the Frequently Asked Questions sheet (*www.csc.noaa.gov/digitalcoast/_/pdf/SLRViewerFAQ.pdf*) available on the Digital Coast website, which gives interested users nationally relevant and more in-depth technical information.

Using the Tool

What is the purpose of the Sea Level Rise and Coastal Flooding Impacts Viewer?

The Sea Level Rise and Coastal Flooding Impacts Viewer is a helpful teaching and planning tool that enables users to visualize potential impacts from sea level rise. The viewer is a screening-level tool designed to provide interested users with a preliminary look at sea level rise and coastal flooding impacts.

Users can select different sea level rise scenarios (0-6 feet), and the maps can be viewed at several different scales to help gauge trends and prioritize actions for different scenarios. The sea level rise scenarios are mapped on or above mean higher high water (MHHW). MHHW can be defined as the average of the highest high tide of each tidal day observed over a specific 19-year period (also referred to as the National Tidal Datum Epoch). So in the context of the viewer, 0 feet of sea level rise represents the current MHHW level.

The viewer does not show specific timing of inundation depths. In other words, the viewer does not associate a particular sea level increase by a given year (e.g., 2 feet of sea level rise by 2100). Users have the flexibility to display 0-6 feet of sea level rise and choose the inundation level that meets their needs and interests. This way the tool serves many projection scenarios and time horizons.

The data and maps in the viewer illustrate the scale of potential flooding, but not the exact location of where the flooding might occur. In addition, the viewer not does account for changes such as erosion, subsidence, or future construction. The maps and data are not designed to be used for permitting or any other legal purpose.

Where can I find an instructional webinar that provides an overview and highlights the functionality of the viewer?

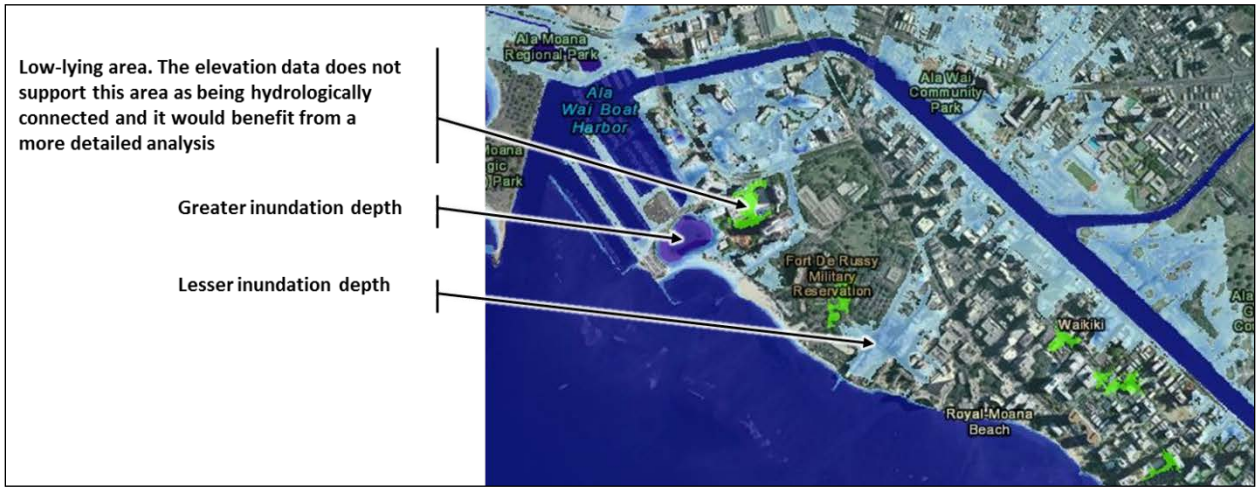
Here is a short list of resources:

- Sea Level Rise (SLR) Viewer overview and demo (Digital Coast): *http://noaacsc.adobeconnect.com/p3h5x2ubnkc/*
- SLR viewer overview and demo for West Coast (Digital Coast): *http://noaacsc.adobeconnect.com/p2hd5ve4pna/*
- SLR Viewer First Time Tips: *www.csc.noaa.gov/digitalcoast/_/video/SLV_first_time_tips/story.html*
- SLR Viewer overview and demo (Ecosystem-Based Management Tools network): *www.ebmtools.org/mapping-and-visualizing-sea-level-rise-and-coastal-flooding-impacts-doug-marcy-noaa-coastal-services*
- Q&A session, “Ask the Experts”: *http://noaacsc.adobeconnect.com/p7jwzpnpyei/*

What am I looking at in each section of the tool?

Many data layers are available in the viewer. Each functional tab displays different data. It’s important to point out that because of data gaps, some of the regularly featured components of the tool may not be available for the Pacific region.

Sea Level Rise

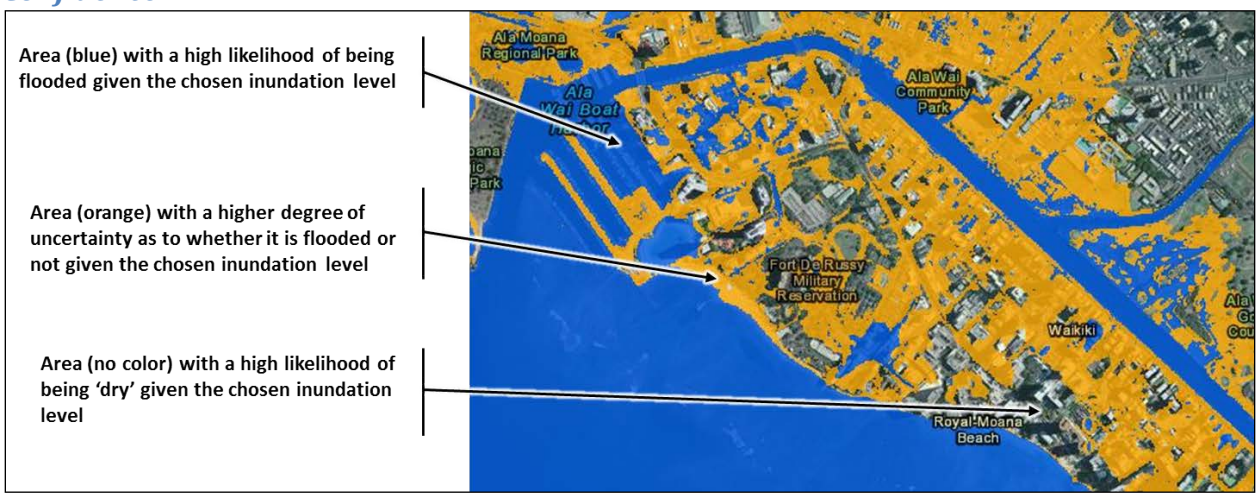


The maps in this tab show sea level rise inundation from 0 to 6 feet above MHHW. Areas that are hydrologically connected to the ocean (according to the digital elevation model used) are shown in shades of blue. Low-lying areas on land that are not directly linked to the ocean are shown in green. Based solely on elevation, it is likely the green areas will flood, but this requires a more detailed analysis to determine the true flooding susceptibility. Remember, the data in the maps do not consider natural processes such as erosion, subsidence, or future construction, and the information provided should be used only as a screening-level tool.

Visualization Locations

This feature includes clickable camera icons that are interactive, enabling users to display inundation at 0-6 feet of sea level rise at various public landmarks. At this time, this feature is not available for Guam or Saipan. Expected availability is winter 2014.

Confidence



There are many unknowns associated with mapping future conditions. This is true for both the data used in the modeling to predict future changes, as well as the natural evolution of coastal

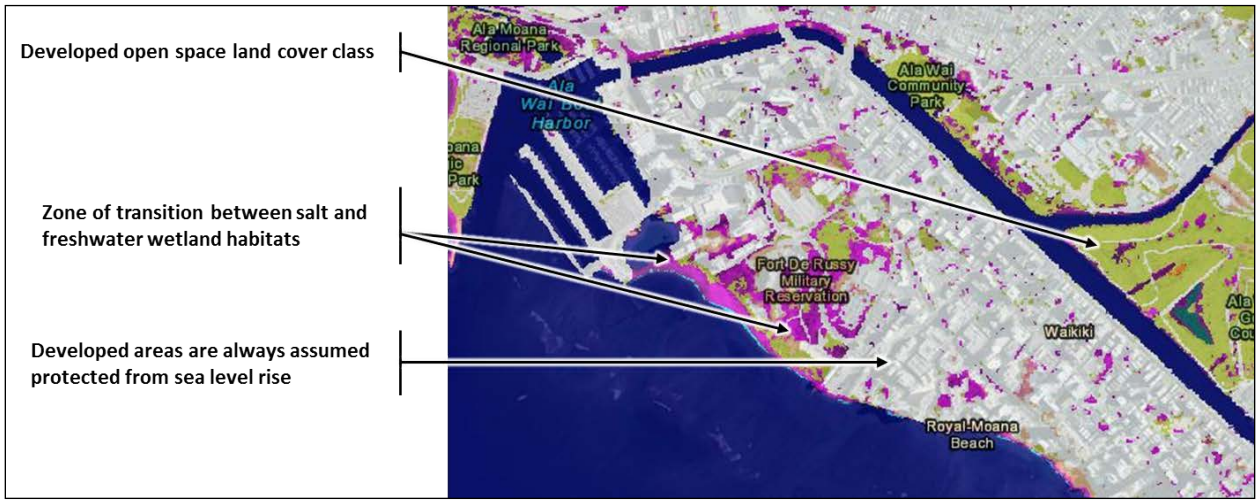
land forms. The purpose of this particular tab is to depict the known error associated with the elevation and tidal data used to produce the inundation maps, and make this aspect apparent to users. *Note: Data in this tab do not depict uncertainties associated with climate change models and sea level rise in any way.*

Levels of confidence are depicted as follows:

- Blue areas denote a high confidence of inundation.
- Orange areas denote a low confidence of inundation.
- Unshaded areas denote a high confidence that these areas will be dry given the chosen water level.

Confidence mapping is a fairly complicated procedure that is explained in detail in the *Mapping Inundation Uncertainty* document available at *www.csc.noaa.gov/slr/viewer/assets/pdfs/Elevation_Mapping_Confidence_Methods.pdf*.

Marsh



The map on this tab represents the potential distribution of several marsh and wetland types based on their ecological (tidal) niche and the resulting elevation under several scenarios of sea level rise and sediment accretion. As sea levels increase, each tidal niche raises in relation to this amount, as well as any offsetting accretion values (selected by the user). This can be thought of as a bathtub style model where there is a separate layer or surface for the threshold between each wetland type. As a result, some marshes may migrate into neighboring low-lying areas, while other sections of marsh will be lost to open water. A simple explanation of the mapping assumptions is as follows:

[current sea level elevation + amount sea level rise - accretion = net marsh impact]

The initial starting condition (0 feet of sea level rise) is derived from NOAA's Coastal Change Analysis Program (C-CAP) (*www.csc.noaa.gov/digitalcoast/data/ccapregional*) land cover data. Development classes (e.g., impervious surfaces and developed open space) are treated as

barriers to marsh migration. For Guam and Saipan, 2005 high-resolution C-CAP data were used. An updated C-CAP product for Guam, derived from 2011 Worldview imagery, was recently released. The viewer will be updated to include this new data set in the near future.

A more in-depth method for mapping marsh migration can be found here:
www.csc.noaa.gov/slr/viewer/assets/pdfs/Marsh_Migration_Methods.pdf

Social Vulnerability

By overlaying social and economic data on a map that depicts sea level rise, a community can see the potential impact that sea level rise can have on vulnerable people and businesses.

Social and Economic
The NOAA Coastal Services Center is currently working to compile the relevant data that will be used to generate both the social and economic components in this feature of the tool. It is undetermined when the data for this portion of the viewer will be available for Guam and Saipan because of data inconsistencies with U.S. Census data.

Flood Frequency

Typically, for other areas of the country, this layer is based on predicted water levels that exceed a specific tidal height. For states and territories in the Pacific, this layer needs to incorporate flooding resulting from big wave events. The NOAA Coastal Services Center is currently working with regional experts to develop a method for mapping this layer to include locally relevant factors. Estimated availability is fall 2014.

Data and Modeling Approach

Where can I go to download the data in the viewer?

Here are the links for the Saipan data currently featured in the viewer. Metadata for each layer are included in the zip file.

- Sea level rise (SLR) inundation layers:
  www.csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/CNMI_slr_data_dist.zip
- SLR mapping confidence layers:
  www.csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/CNMI_conf_data.zip
- Saipan final digital elevation model used in mapping:
  www.csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/CNMI_dems.zip
- Coastal Change Analysis Program (C-CAP) high-resolution land cover:
  www.csc.noaa.gov/digitalcoast/data/ccaphighres

Here are the links for the Guam data featured in the viewer.

- SLR inundation layers:

www.csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/Guam_slr_data_dist.zip

- SLR mapping confidence layers:
  www.csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/Guam_conf_data.zip
- Guam final digital elevation model used in mapping:
  www.csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/Guam_dems.zip
- Coastal Change Analysis Program (C-CAP) high-resolution land cover:
  www.csc.noaa.gov/digitalcoast/data/ccaphighres

Is this viewer based on a "bathtub" modeling approach?

Generally, the process used to map sea level inundation in this viewer can be described as a modified bathtub approach or linear superposition method. Unlike the bathtub approach, the maps in this tool take into account local tidal variability and hydrologic connectivity. For Guam and Saipan, historical data from the available tide stations in the territory were used to generate the tidal surface for the inundation maps. The tidal surfaces were developed using the mean higher high water (MHHW) datum value from the respective tide stations as reported by NOAA's Center for Operational Oceanographic Products and Services. Since the lidar data for both geographies are referenced to local mean sea level (LMSL), the difference between the MHHW elevation and the LMSL elevation became the value used for the starting tidal surface value (i.e., SLR = 0). The single-value approach using an adjusted tide station MHHW datum value seemed acceptable given the minimal amount of tidal variability and the lack of a hydrodynamic solution (e.g., VDatum) for both areas.

In addition, the maps take into account the hydroconnectivity of inundated areas, which distinguishes them from a simple bathtub approach. However, the maps also show low-lying areas, which are considered hydrologically "unconnected" areas that may flood. Both hydrologically connected and unconnected areas are determined solely by how well the elevation data capture the area's hydraulics.

What can you tell me about the digital elevation model (DEM) that was used to generate the inundation layers?

The NOAA Coastal Services Center developed the high-resolution DEMs with assistance from Dewberry and the University of Hawai'i Coastal Geology Group. These DEMs serve as the source data sets used to derive the inundation maps that can be viewed on the Sea Level Rise tab of the viewer. The resolution of the DEMs is 3 meters, and they were derived from 2007 United States Army Corps of Engineers lidar, which were the best available lidar data sets known to exist at the time of DEM creation.

Hydrographic breaklines were generated to more accurately capture coastal features and maintain hydrologic connectivity between the ocean and inland water bodies. The DEMs are

referenced vertically to the local mean sea level (LMSL) tidal datum, with vertical units of meters, and horizontally to the North American Datum of 1983 (NAD83).

Does this viewer show timing of inundation levels (e.g., 3 feet by 2100)?

This viewer does not show specific timing of inundation depths. This is by design. One-foot depth increments are mapped above MHHW up to 6 feet. This range covers most of the sea level rise projections found in recent scientific literature, which range from extrapolation of the existing sea level trends to >2 meters by 2100. We leave it up to the use to select which inundation level to use at a particular planning horizon. This way the tool serves many projection scenarios and time horizons, similar to the many state and local sea level rise and adaptation strategies.

The only component of the tool that uses any timing is the "advanced options" in the Marsh tab. This feature enables the user to select both a high, medium, or low sediment accretion rate, and time horizon in intervals of 25 years. For this section, the tool uses an algorithm based on the acceleration of sea level rise from the Intergovernmental Panel on Climate Change (IPCC) 2007 A1B climate scenario, now considered a conservative estimate.

What is the accuracy of the mapping used in this tool?

The maps in the viewer are derived from source elevation data that meet or exceed the Federal Emergency Management Agency (FEMA) mapping specifications for the National Flood Insurance Program.

- 0.6 feet (18.5 centimeters) root mean square error (RMSE) for low relief terrain
- 1.2 feet (37.0 centimeters) RMSE for high relief terrain

Areas that do not have elevation data that meet this criteria are shown as "Areas not mapped" in the viewer.

Sea Level Rise Viewer Applied Examples

How has the Sea Level Rise and Coastal Flooding Impacts Viewer been used in other areas of the country?

Here are a few examples; for the full description of these efforts, visit the In Action section of the viewer's webpage: *www.csc.noaa.gov/slr*.

Florida: *Understanding Vulnerability to Sea Level Rise in Southeast Florida*
GIS practitioners representing the Southeast Florida Regional Climate Change Compact counties (Monroe, Miami-Dade, Broward, and Palm Beach), as well as the South Florida Water Management District, local universities, and federal agencies, worked with NOAA Coastal Services Center experts to understand inundation mapping methods, define the local challenges, review available topographic source data, and create a consensual set of methods and criteria for inundation mapping. Inundation and confidence mapping layers used in the Sea Level Rise and Coastal Flooding Impacts Viewer were supplied for Martin, St. Lucie, and Indian River counties. GIS staff members for each county received digital elevation maps for 1-, 2-, and 3-foot sea level rise scenarios created by the South Florida Water Management District using recent Florida Division of Emergency Management lidar elevation data and the NOAA VDatum surface. Each county performed the vulnerability assessment for specified infrastructure using regionally consistent methods and created a report outlining impacts that may occur under each of the three scenarios.

Mississippi: *Visualizing Flood Hazards with Residents and Floodplain Managers*
The Coastal Hazards Outreach Strategy Team, in collaboration with Mississippi-Alabama Sea Grant, set up a hazards exhibit at the Edgewater Mall in Biloxi, Mississippi, to help local residents and floodplain managers get a sense of what their town and neighborhoods could experience at various sea level rise scenarios. Potential flooding impacts were demonstrated using the Sea Level Rise and Coastal Flooding Impacts Viewer on a large screen at the exhibit. Using the Web-based tool, people were able to visualize the extent of flooding and zoom in to local landmarks to see a simulation of flooding under various degrees of sea level rise. The ability to see the potential impacts from sea level rise proved to be a powerful tool for those attending the exhibit.

Georgia: *Identifying Areas Vulnerable to Sea Level Rise*
The NOAA Sea Grant Community Climate Adaptation Initiative worked with the City of Tybee Island to identify the areas of the island most vulnerable to sea level rise using the Sea Level Rise and Coastal Flooding Impacts Viewer. Once these areas were identified, a plan was developed for dealing with the current problems of flooding and frequent high tides, as well as future sea level rise. City staff members also used the visuals provided by the viewer at public meetings to display vulnerable areas and increase awareness of the impacts that future sea level rise could have on the community.