FREQUENT QUESTIONS

Guam and Saipan Edition – Digital Coast Sea Level Rise Viewer

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Contents

Introduction **1**
Using the Tool **2**
What is the purpose of the Sea Level Rise Viewer? 2
Where can I find an instructional webinar that provides an overview and highlights the functionality of the viewer? 2
What am I looking at in each section of the tool? 2
Data and Modeling Approach **5**
Where can I go to download the data in the viewer? 5
Is this viewer based on a “bathtub” modeling approach? 6
What can you tell me about the digital elevation model (DEM) that was used to generate the inundation layers? 6
Does this viewer show timing of inundation levels (e.g., 3 feet by 2100)? 7
What is the accuracy of the mapping used in this tool? 7
Sea Level Rise Viewer Applied Examples **8**
How has the Sea Level Rise and Coastal Flooding Impacts Viewer been used in other areas of the country? 8

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 Viewer for both Guam and Saipan. This document complements the Frequently Asked Questions sheet (*coast.noaa.gov/data/digitalcoast/pdf/slr-faq.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 Viewer?

The Sea Level Rise 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 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?

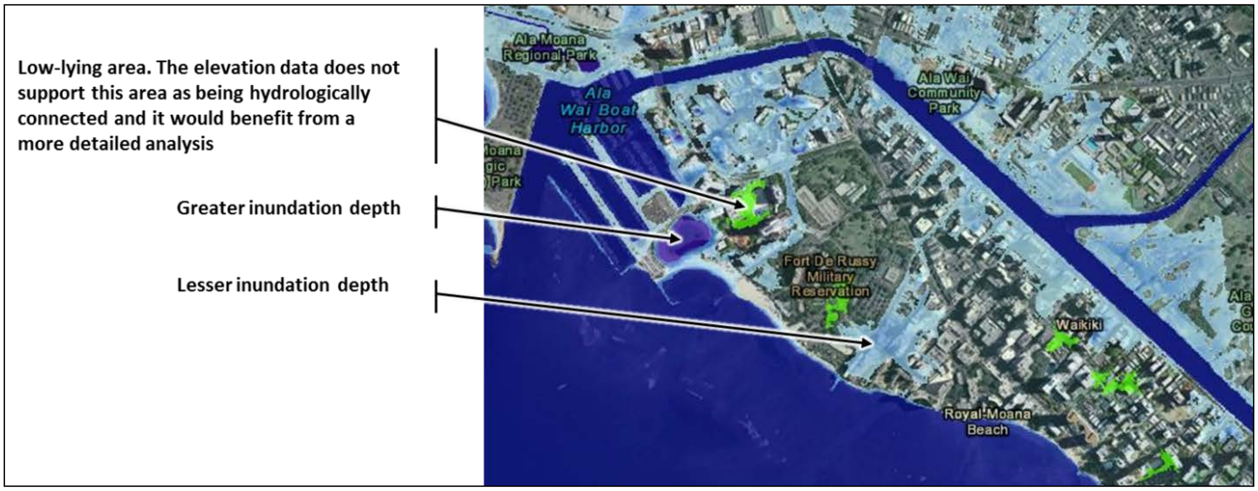
Here is a short list of resources:

- 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: *climate.gov/news-features/videos/explaining-noaa-sea-level-rise-viewer*
- 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.

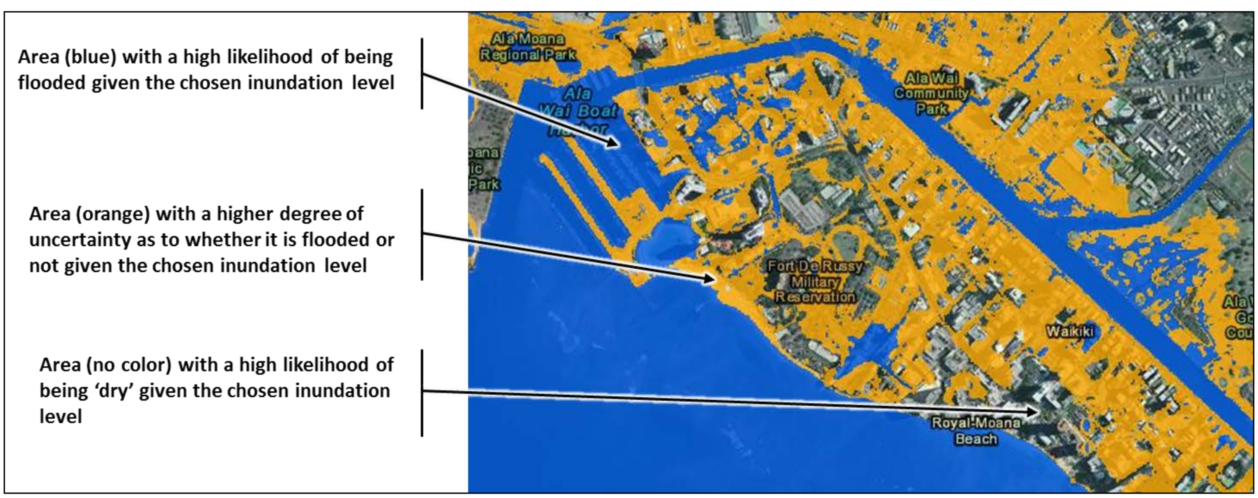
Sea Level Rise



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



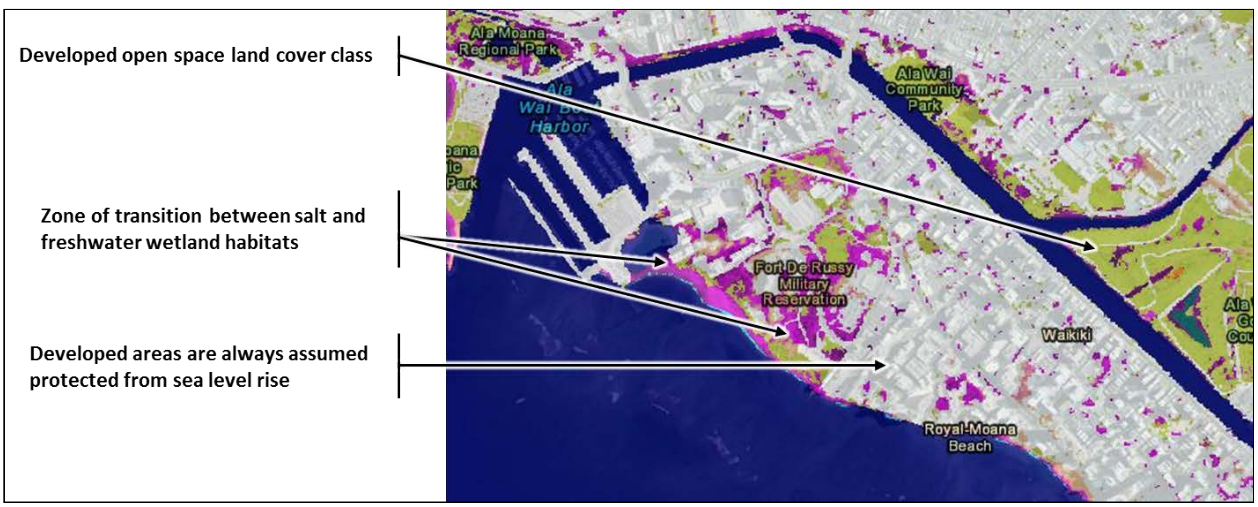
There are many unknowns associated with mapping future conditions. This is true for both the data used in the modeling to predict future changes, as well as the natural evolution of coastal land forms. The purpose of this particular tab is to depict the known error associated with the elevation and tidal 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 *coast.noaa.gov/data/digitalcoast/pdf/slr-inundation-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) (*coast.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: *coast.noaa.gov/data/digitalcoast/pdf/slr-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 Office for Coastal Management 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 Office for Coastal Management 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: *coast.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/CNMI_slr_data_dist.zip*
- SLR mapping confidence layers: *coast.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/CNMI_conf_data.zip*
- Saipan final digital elevation model used in mapping: *coast.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/CNMI_dems.zip*
- Coastal Change Analysis Program (C-CAP) high-resolution land cover: *coast.noaa.gov/digitalcoast/data/ccaphighres*

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

- SLR inundation layers: *coast.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/Guam_slr_data_dist.zip*
- SLR mapping confidence layers: *coast.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/Guam_conf_data.zip*
- Guam final digital elevation model used in mapping: *coast.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/Guam_dems.zip*
- Coastal Change Analysis Program (C-CAP) high-resolution land cover: *coast.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 Office for Coastal Management 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)?

Yes, the latest updated of this viewer includes a Local Scenarios tab that enables the direct comparison of local sea level rise scenarios with potential inundation impacts. Four sea level rise scenarios (lowest, intermediate low, intermediate high, and highest) can be customized by the user either by year or by scenario and compared with the viewers' existing 0-6 feet above MHHW inundation map layers.

The four sea level rise scenarios are from Parris and others 2012 (input to the 3rd National Climate Assessment) global scenarios and corrected to include local vertical land motion data from long-term NOAA tide gauges. Rounding to the nearest 1-foot mapping increment to view potential impacts is appropriate based on the accuracy of the elevation and tidal surface data used as mapping inputs.

Zoom to the closest NOAA tide gauge to your area of interest and click on the icon in the map view. The selected gauge will be displayed as text in the scenarios window. Choose "view by year" or "view by scenario" to customize the desired local scenario. "View by year" will display all four scenarios (lowest, intermediate low, intermediate high, highest), and the user can use the slider to select a year. "View by scenario" will display each local scenario in 25 year increments (2025, 2050, 2075, 2100), and the user can use the slider to select each of the four individual scenarios. For each option the user should use the vertical water level slider to view potential impacts for each scenario rounded to the nearest 1-foot mapping increment.

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: *coast.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.