

# FREQUENT QUESTIONS



**NOAA Pacific Services Center**  
**NOAA Coastal Services Center**

## Hawaii Edition – Digital Coast Sea Level Rise and Coastal Flooding Impacts Viewer

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### Introduction

The purpose of this document is to provide the Hawaii user community 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 the State of Hawaii. This document complements the [Frequently Asked Questions](#) sheet 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 does not 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?

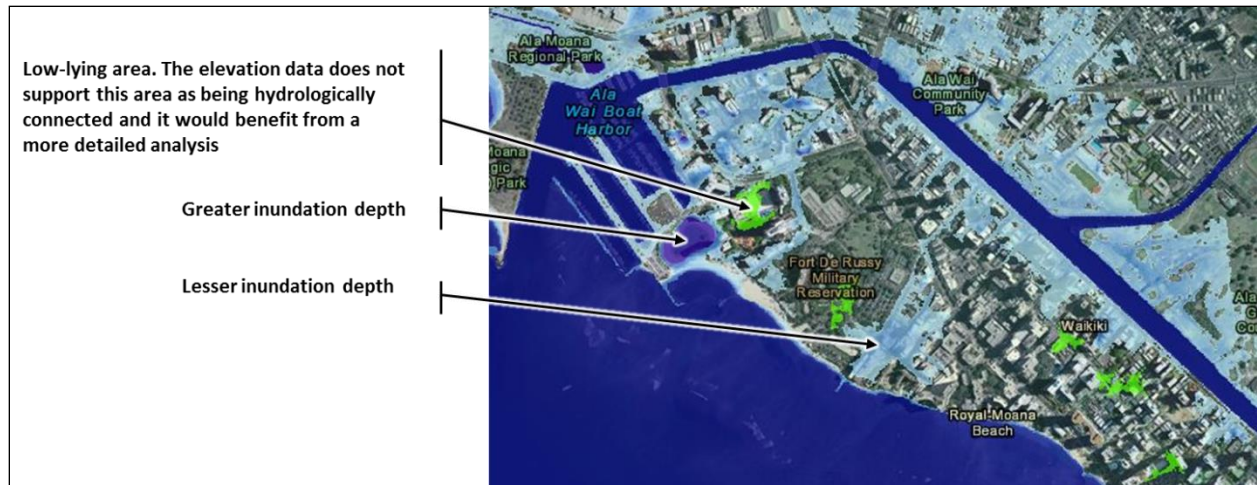
Here is a short list of resources:

- Sea Level Rise 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](http://www.csc.noaa.gov/digitalcoast/_/video/SLV_first_time_tips/story.html)
- SLR Viewer overview and demo (Ecosystem-Based Management Tools network):  
[www.ebmttools.org/mapping-and-visualizing-sea-level-rise-and-coastal-flooding-impacts-doug-marcy-noaa-coastal-services](http://www.ebmttools.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*

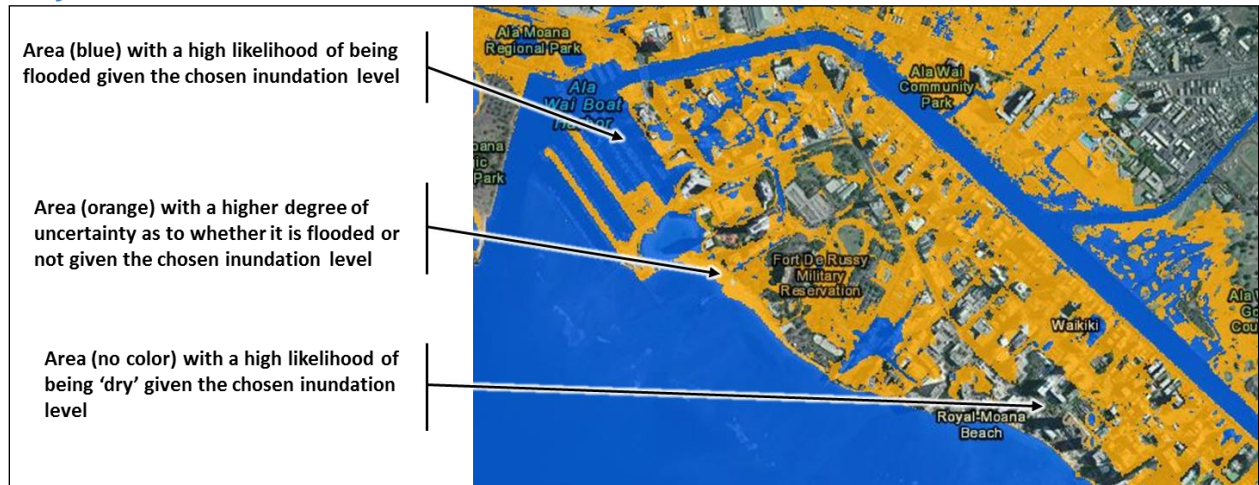


The maps in this tab show sea level rise inundation from 0 to 6 feet above MHHW. Areas that are hydrologically connected to the ocean (according to the digital elevation model used) are shown in shades of blue. Low-lying areas on land that are not directly linked to the ocean are shown in green. Based 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 the State of Hawaii. Expected availability is winter 2013.

## Confidence



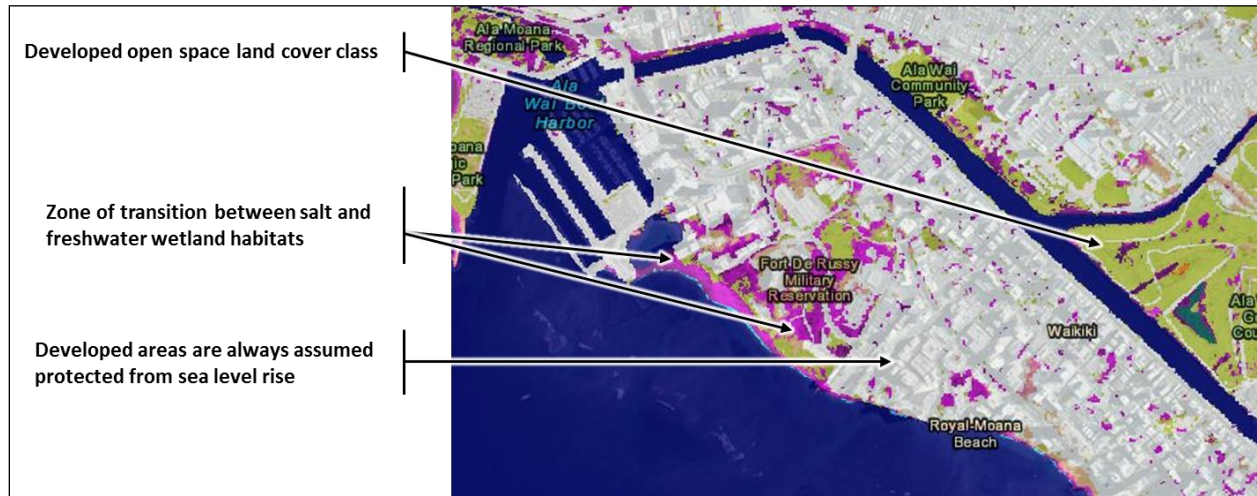
There are many unknowns associated with mapping future conditions. This is true for both the data used in the modeling to predict future changes, as well as the natural evolution of coastal land forms. The purpose of this particular tab is to depict the known error associated with the elevation and tidal 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 SLR 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](http://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:

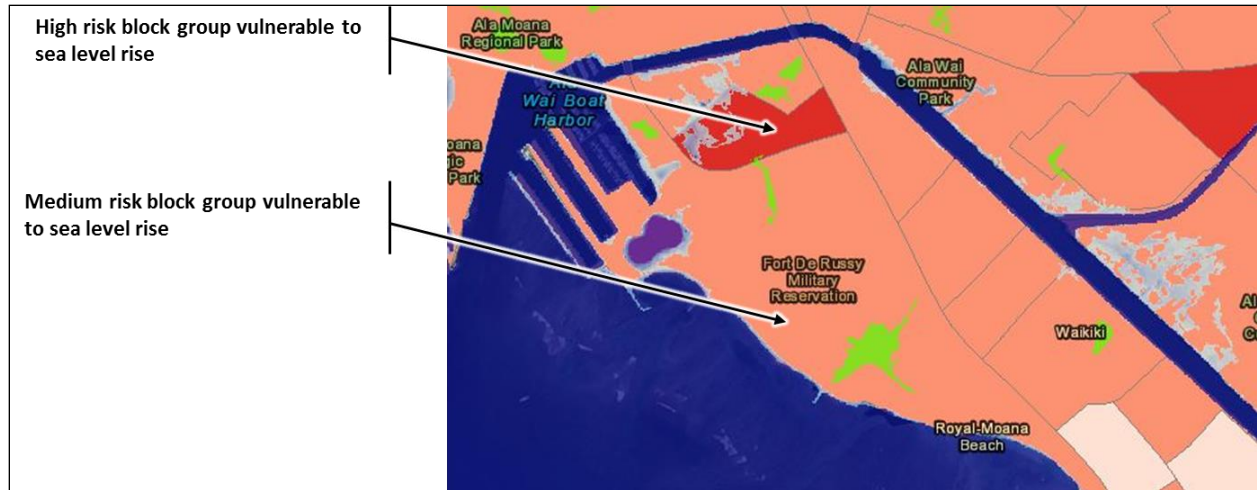
$$[\text{current sea level elevation} + \text{amount sea level rise} - \text{accretion} = \text{net marsh impact}]$$

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](http://www.csc.noaa.gov/digitalcoast/data/ccapregional)) land cover data. High- and medium-intensity development classes are treated as barriers to marsh migration. For Hawaii, 2005 high-resolution C-CAP data were used. An updated C-CAP product, derived from 2011 Worldview 2 imagery, will be available later this year. The viewer will include the updated product when it becomes available.

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](http://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*

For this tab, the Social Vulnerability Index (SOVI), was used to depict areas of high human vulnerability to hazards. SOVI is based on population attributes (e.g., age and poverty) and the built environment. By looking at the intersection of potential sea level rise and vulnerable block groups, one can get an idea of how vulnerable populations might be affected by sea level rise.

In this map, dark red indicates block groups having a high vulnerability, and the lighter reds indicate decreasing vulnerability. The method for creating the SOVI data is available from the University of South Carolina Hazards and Vulnerability Research Institute, the creators of the data set: <http://webra.cas.sc.edu/hvri/products/sovi.aspx>

*Economic*

The NOAA Coastal Services Center is currently working to compile the relevant data that will be used to generate the economic piece. It is estimated that the data for this portion of the viewer will be available by fall 2014.

***Flood Frequency***

Typically, for other areas of the country, this layer is based on predicted water levels that exceed a specific tidal height. For Hawaii, 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 Hawaii data currently featured in the viewer. Metadata for each layer is included in the zip file.

- SLR inundation layers –
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Hawaii\\_slr\\_data\\_dist.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Hawaii_slr_data_dist.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Kauai\\_slr\\_data\\_dist.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Kauai_slr_data_dist.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Lanai\\_slr\\_data\\_dist.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Lanai_slr_data_dist.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Maui\\_slr\\_data\\_dist.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Maui_slr_data_dist.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Molokai\\_slr\\_data\\_dist.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Molokai_slr_data_dist.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Oahu\\_slr\\_data\\_dist.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Oahu_slr_data_dist.zip)
- SLR mapping confidence layers –
  - [http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI\\_Hawaii\\_conf\\_data.zip](http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI_Hawaii_conf_data.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI\\_Kauai\\_conf\\_data.zip](http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI_Kauai_conf_data.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI\\_Lanai\\_conf\\_data.zip](http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI_Lanai_conf_data.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI\\_Maui\\_conf\\_data.zip](http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI_Maui_conf_data.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI\\_Molokai\\_conf\\_data.zip](http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI_Molokai_conf_data.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI\\_Oahu\\_conf\\_data.zip](http://csc.noaa.gov/htdata/Inundation/SLR/ConfData/Distribution/Pacific/HI_Oahu_conf_data.zip)
- Hawaii Final digital elevation model used in mapping –
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Hawaii\\_dems.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Hawaii_dems.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Kauai\\_dems.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Kauai_dems.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Lanai\\_dems.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Lanai_dems.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Maui\\_dems.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Maui_dems.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Molokai\\_dems.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Molokai_dems.zip)
  - [http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI\\_Oahu\\_dems.zip](http://csc.noaa.gov/htdata/Inundation/SLR/SLRdata/Pacific/HI_Oahu_dems.zip)
- Coastal Change Analysis Program (C-CAP) high-resolution land cover:  
[www.csc.noaa.gov/digitalcoast/data/ccaphighres](http://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 Hawaii, historical data from the nine available tide stations in the state were used to generate the tidal surface for the inundation maps which begins at MHHW (i.e., 0 feet of sea level rise).

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. These DEMs serve as 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. The DEMs were derived from the best available lidar data sets known to exist at the time of DEM creation and include the following islands in Hawaii: Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii.

The DEM used in the viewer is actually derived from multiple sources:

- 2003 Oahu Coastline Lidar – acquired by NOAA
- 2005 Oahu/Maui Lidar – acquired by NOAA
- 2006 Hawaii FEMA Lidar – acquired by the Federal Emergency Management Agency (FEMA) along south shores of islands
- 2007 USACE Pacific Islands Lidar: Hawaiian Islands – acquired by U.S. Army Corps of Engineers (USACE) and Hawaii State Civil Defense along north- and windward-facing shores of islands
- 2006 DBEDT Lidar: Lanai – acquired by the State of Hawaii Office of Planning

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



## SLR 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](http://www.csc.noaa.gov/slr).

#### **Florida:** *Developing Consistent Methods for Mapping Sea Level Rise*

To assist several Southeast Florida counties in developing a unified set of methods and criteria for creating sea level inundation maps, a two-day technical workshop was held in April 2010. The NOAA Coastal Services Center and the Center for Operational Oceanographic Products and Services facilitated discussions to help workshop participants understand state-of-the-practice inundation-mapping methods, define local challenges, and ultimately agree upon a consistent set of methods and criteria. These are the same methods used to create the Digital Coast Sea Level Rise and Coastal Flood Impacts Viewer. After consistent mapping methods were developed, the counties and the South Florida Water Management District worked together, via the Southeast Florida Regional Climate Change Compact, to develop a vulnerability assessment of the Southeast Florida region for one-, two-, and three-foot sea level rise scenarios. The assessment revealed that the counties of interest are vulnerable to sea level rise and highlighted areas of particular concern where adaptation measures need to be in place.

#### **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.