

Regionalized Sea Level Change & Extreme Water Level Scenarios



**Online Graphical
User Interface
(GUI) User Guide**

v3.0

October 2020

Department of Defense (DoD)

INTRODUCTION

Purpose

The Department of Defense (DoD), through its Military Services, is assessing its vulnerability and potential impacts from climate change at locations where it has permanent or enduring assets. Initial assessments began with coastal and tidally influenced DoD sites to establish a baseline of current weather and climate vulnerabilities and to look ahead to possible future conditions. This approach was later extended to inland sites.

Concurrent with these efforts, DoD's Climate Change Adaptation Working Group (CCAWG) charged an Office of Secretary of Defense-led inter-agency working group, the Coastal Assessment Regional Scenario Working Group (CARSWG), to develop *site-level* adjustments for projected future *global* sea-level rise (SLR) and extreme water level (EWL) conditions. In other words, the **task was to develop localized adjustments leading to different future SLR and EWL scenarios to support the next phase of vulnerability and impact**

assessment for DoD coastal and tidally influenced sites worldwide.

Uncertainties are inherent in projecting future climate. **Scenarios are, therefore, non-probabilistic but plausible depictions of future conditions that enable decision-makers to bound their risk based on the best available science.** The scenarios provided as part of this tool take into account physical processes, local setting, and data availability to provide a basis for the values provided. **The information is provided in terms of several future timeframes—2035, 2065 and 2100—that are relevant to management and planning horizons.**

These scenarios enable a decision-maker to add temporal and physically-based information to assess future vulnerabilities to compare against the baseline assessments. Although these scenarios are intended to be used in a “screening” context and not detailed engineering design, their development collectively represents several advancements in scenario development for coastal locations that can serve as a starting point for other applications that are concerned with assessing and responding to climate-

change related risk in the coastal environment.

Products

Two products have been developed:

- ☑ **A report** (Hall et al. 2016) that documents the methods used to develop the scenarios, accompanied by case studies and other information that illustrate their application, and
- ☑ **A database** with a Graphical User Interface (GUI) that provides users access to the scenario information for specific military sites.

This User Guide provides basic information on accessing and interpreting information in the database.

Military Sites Included

Candidate sites (as defined in DoD's real property database) were determined by using geographic information system (GIS) data to define a 20-kilometer coastal shoreline buffer and then identifying sites within that buffer. Please note that an installation may contain several “sites.” In addition, other sites that occurred outside

the buffer but were located at the head of estuaries or along the tidal portion of major rivers (i.e., potentially tidally influenced sites) were identified. Based on these filters, **1,813 sites worldwide were identified for inclusion in the database.**

Note that the database contains an additional 39 sites that were added subsequent to the analysis of the original 1, 774 sites in Hall et al. (2016). Some sites may be at elevations that may obviate scenario application. For sites whose lowest points could be determined, those sites above a 30-meter threshold were retained in the database but “flagged.” (See Hall et al. 2016 for further details, including the basis for the threshold value.)

Five Global Sea Level Change Scenarios – Basis and Characteristics

Hall et al. (2016) used the bounding scenarios (i.e., 0.2 m [0.7 ft] and 2.0 m [6.6. ft]) prepared for the Third National Climate Assessment as their initial set of *global* sea level change scenarios. The authors of that report (Parris et al. 2012) expressed a very high confidence (greater

than 9 in 10 chance) that future global mean sea levels would not fall outside that range, but did not assign specific probabilities or likelihoods to any of the individual scenarios addressed in their report. Findings since the publication of those scenarios have supported the use of these bounding conditions for vulnerability assessment and associated risk management.

For purposes of this database, Hall et al. (2016) also developed three intermediate scenarios (0.5 m, 1.0 m, and 1.5 m). In addition, they included bases and storylines for each of the scenarios.

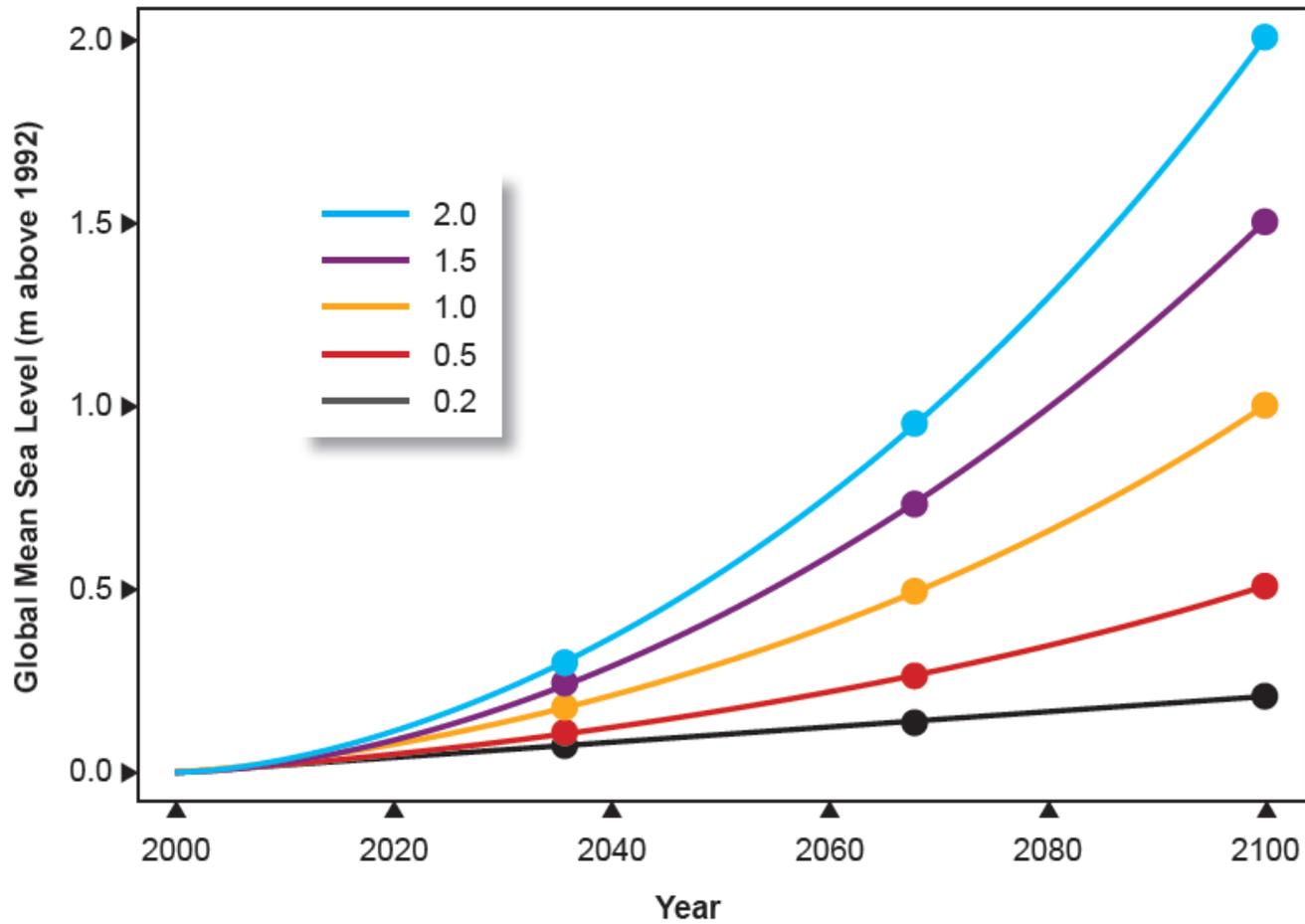
The five global scenarios have a baseline of 1992 (the last tidal epoch for which mean sea level data are available from the National Oceanic and Atmospheric Administration) and end in 2100. The figure on the following page depicts the five scenarios, as well as approximate values for each scenario at the time periods of 2035, 2065, and 2100. The 0.2-m scenario extends linearly from 1992 to 2100, whereas the other four scenarios are assumed to have a quadratic form,

based on differing assumptions of sea-level rise acceleration in the future. Note: sea levels will exhibit natural variability at any point in time, so the specific scenario value at a particular point in time will have additional uncertainty associated with it due to this natural variability.

Hall, J.A., S. Gill, J. Obeysekera, W. Sweet, K. Knuuti, and J. Marburger. 2016. *Regional Sea Level Scenarios for Coastal Risk Management: Managing the Uncertainty of Future Sea Level Change and Extreme Water Levels for Department of Defense Coastal Sites Worldwide*. U.S. Department of Defense, Strategic Environmental Research and Development Program. 228 pp.

Parris, A.P., P. Bromirski, V. Burkett, D. Canyan, M. Culvert, J. Hall, R. Horton, K. Knuuti, R. Moss, J. Obeysekera, A. Sallenger, and J. Weiss. 2012. *Global Sea Level Rise Scenarios for the US National Climate Assessment*. NOAA Technical Memorandum OAR CPO-1. 37 pp.

DoD GLOBAL SEA LEVEL RISE SCENARIOS



Five Global Sea-Level Rise Scenarios Advanced in Support of this Database

ACCESSING THE SITE

Getting Started

- Visit the web application homepage via an internet browser @ <https://drsl.serdp-estcp.org>
- Select **Get Started** to begin

The screenshot shows the homepage of the web application. The background is a dark blue image of water. At the top center, the title "DoD Regionalized Sea Level Change & Extreme Water Level Scenarios" is displayed in white. Below the title, a subtitle in yellow reads "Scenarios for screening-level vulnerability assessments for Department of Defense coastal & tidally influenced sites". A prominent green button with the text "Get Started" is centered below the subtitle. A horizontal line separates this section from the three columns below. Each column has a heading in white: "WHAT" with a question mark icon, "WHY" with a question mark icon, and "HOW" with a question mark icon. Each heading is followed by a short paragraph of text in white.

DoD Regionalized Sea Level Change & Extreme Water Level Scenarios
Scenarios for screening-level vulnerability assessments for Department of Defense coastal & tidally influenced sites

Get Started

WHAT ?
The tool provides a range of site-specific scenarios of future sea level change for three time horizons in the 21st century.

WHY ?
Department of Defense (DoD) sites worldwide are potentially exposed to impacts from sea level change and extreme water levels. Given the uncertainties in future sea level change magnitude and timing, scenarios can assist in bounding and managing risks.

HOW ?
Global scenarios adjusted for local conditions enable planners and managers to understand and assess future sea level change and storm surge at a location.

Homepage

- Select **View Report** to view the full report
- Select **Site Lookup** to search sites listed in a text-based format with filters
- Select **Map View** to view a world map of sites (enables various levels of zoom and direct selection of sites)
- Select **Services Dashboard** to view highest scenarios by military service

The screenshot shows the homepage of the DRSL (Department of Defense Regional Sea Level Scenarios) website. The navigation bar at the top includes links for SITE LOOKUP, MAP VIEW, SERVICES, CONTACT US, and USER GUIDE, along with an ADMIN button and a database (DB) dropdown. The main content area features the title "Regional Sea Level Scenarios for Coastal Risk Management" and a sub-header "Managing the uncertainty of future sea level change extreme water levels for Department of Defense coastal sites worldwide". A prominent blue button labeled "VIEW REPORT" with a PDF icon is highlighted by a red arrow. A callout box points to this button, providing the following information:

Downloading the Hall et al. (2016) report:
Clicking here will allow you to directly download the entire report in PDF format.

Hall, J.A., S. Gill, J. Obeysekera, W. Sweet, K. Khuuti, and J. Marburger. 2016. Regional Sea Level Scenarios for Coastal Risk Management: Managing the Uncertainty of Future Sea Level Change and Extreme Water Levels for Department of Defense Coastal Sites Worldwide. U.S. Department of Defense, Strategic Environmental Research and Development Program. 224 pp.

Below the main content, there are three circular icons representing different features: "Site Lookup" (Search for specific sites), "Map View" (View all sites via world map), and "Service Dashboard" (View highest scenarios by military service).

Site Lookup

- Lookup sites by RPSU Id, Site Name, Primary Installation, City, State, and Country
- Select column names to **sort** sites and render up to 60 sites at a time (e.g., showing **10 entries** per page, as seen below)
- *Note: remaining screenshots come from multiple sites*

DRSL SITE LOOKUP MAP VIEW SERVICES CONTACT US USER GUIDE ADMIN DB

Regionalized Sea Level Change & Extreme Water Level Scenarios

★ MY SITES ?
Favorite sites will appear here for easy access after you have searched, found a site, and clicked the yellow star in the search results table below. To remove a site, click the X next to the site name.

SEARCH RESULTS Results are limited to 60 sites ?
Type here to filter by keyword or RPSUID

Show 10 entries

RPSUID	SITE	PRIMARY INSTALLATION	CITY	STATE	COUNTRY	
1	MCAS Cherry Point	MCAS CHERRY POINT NC	Cherry Point	North Carolina	United States	★
2	Area 5A	MCAS CHERRY POINT NC	Cherry Point	North Carolina	United States	★
4	Ft Macon Housing	MCAS CHERRY POINT NC	Cherry Point	North Carolina	United States	★
9	Hancock Island 1	MCAS CHERRY POINT NC	Cherry Point	North Carolina	United States	★
10	Hancock Island 2	MCAS CHERRY POINT NC	Cherry Point	North Carolina	United States	★
17	ALF Bogue	MCAS CHERRY POINT NC	Bogue	North Carolina	United States	★
18	OLF Atlantic	MCAS CHERRY POINT NC	Bogue	North Carolina	United States	★
19	MAW Point Target	MCAS CHERRY POINT NC	Bayboro	North Carolina	United States	★
20	Pamlico Point Target	MCAS CHERRY POINT NC	Bayboro	North Carolina	United States	★
21	MCRD San Diego Former NTC	MARCORPRCUTDEP SAN DIEGO CA	San Diego	California	United States	★

Showing 1 to 10 of 1,852 entries

Previous 1 2 3 4 5 ... 186 Next

Site Lookup – Search Results

- Type keywords into the search field to **filter** search results (field begins displaying results as partial matches made)
- Select a Site name to view **site-specific data**

The screenshot shows the DRSL (Data Reference System) interface. The top navigation bar includes links for DRSL, SITE LOOKUP, MAP VIEW, SERVICES, CONTACT US, and USER GUIDE. On the right, there are icons for ADMIN and a dropdown menu labeled DB.

Regionalized Sea Level Change & Extreme Water Level Scenarios

MY SITES ⓘ
Favorite sites will appear here for easy access after you have searched, found a site, and clicked the yellow star in the search results table below. To remove a site, click the X next to the site name.

SEARCH RESULTS ⓘ *Results are limited to 60 sites*

Search: Show 10 entries

RPSUID	SITE	PRIMARY INSTALLATION	CITY	STATE	COUNTRY	?
640	NS Newport Naval Hospital	NAVAL STATION NEWPORT RI	Newport	Rhode Island	United States	☆
961	Naval Hospital Key West	NAS KEY WEST FL	Key West	Florida	United States	☆
170042	Naval Hospital	NAVBASE GUAM	Agana	Guam	Guam	☆

Showing 1 to 3 of 3 entries (filtered from 1,852 total entries) Previous 1 Next

Map View

- Use mouse scrolling or the +/- buttons at the bottom right-hand corner of the screen to **zoom in (+)** and **zoom out (-)** on the map
- To **drag** the screen, first click anywhere on the map and hold down the mouse button, then move the mouse as desired

The screenshot shows the DRSL Map View interface. At the top, there is a navigation bar with links for DRSL, SITE LOOKUP, MAP VIEW, SERVICES, CONTACT US, and USER GUIDE. The main header area contains the title 'Map View' and instructions: 'Hover over a marker to view the site name. Click a marker to view site details.' Below this is a legend box with a cyan border, containing icons and labels for Army, Air Force, Marines, WHS, Army Guard, and Air Force Guard. The map itself shows the United States with various markers: orange circles with numbers (107, 100, 140, 347, 110) and blue circles with numbers (71, 94, 89). A cyan circle highlights the '140' marker in California. A cyan arrow points from the legend box to the map. Another cyan arrow points from the '140' marker to a text box on the left. A third cyan arrow points from the legend box to a text box on the right. The bottom right corner of the map shows zoom controls (+, -) and a 'Muted' button.

Site Grouping

At a given zoom level, when too many sites are present to show all of them clearly, a circle indicating the number in that area is displayed. Clicking on these circles will zoom in to that area to see individual sites. Orange circles indicate over 100 sites in the area, whereas blue circles have less than 100.

Service Selection

By default, all sites are displayed, regardless of Service. If a user wishes to delimit those displayed to specific services, however, clicking on these Service buttons will remove them from the display. This action is confirmed by the respective Service button lettering changing from yellow to gray.

Map View – Accessing Site Data

- When hovering the mouse over a site the site name will display, and clicking on a site will open a **Detail** popup
- *Note: this page can also be viewed in “Map” or “Hybrid” formats, and that terrain and labels can be added or removed*

The screenshot shows the DRSL website's Map View interface. At the top, there is a navigation bar with links for SITE LOOKUP, MAP VIEW, SERVICES, CONTACT US, and USER GUIDE. The main header area includes the title 'Map View' and instructions: 'Hover over a marker to view the site name. Click a marker to view site details.' A legend on the right lists service types with corresponding icons: Army (red star), Air Force (red shield), Marines (red shield with 'M'), WHS (red shield with 'W'), Army Guard (blue star), Air Force Guard (blue shield), and Navy (red anchor). Below the legend is a map of the United States with several markers. A red circle highlights a red shield icon (Air Force) on the West Coast. A detail popup is open for this site, showing: 'Navy Active', 'Coos Head OR', 'Site Rpsuld 502', 'Site Code N00620-CH', 'Installation Name NAS WHIDBEY ISLAND WA', and 'Installation Code N00620'. A red 'VIEW SITE' button is at the bottom of the popup. A red circle highlights this button. A red arrow points from the button to a text box on the right. Another red arrow points from the 'Map View' title to a text box on the left. A third red arrow points from the 'Map', 'Hybrid', and 'Muted' map style buttons to the top navigation bar.

Service Icon

For each site, a Service icon is shown that corresponds to those in the Legend, above. For example, Air Force.

Viewing Site Data

Limited identification information is displayed about a given site in map view mode. To see the associated SLR/EWL database information, click the **VIEW SITE** link. This will bring you to the respective site-specific data page.

Service Dashboard

- **Select a service** to view the top 10 highest combines sea level change & extreme water level scenarios for a 1% annual chance event.
- **Hover on a cell** to view location info. **Click a cell** to view site data.
- Use the map to view sites limited to the currently selected service.

The screenshot shows the DRSL Service Dashboard for the Navy. The top navigation bar includes links for SITE LOOKUP, MAP VIEW, SERVICES, CONTACT US, and USER GUIDE. The main content area is titled 'Service Dashboard' and features a 'Select a service' dropdown menu with icons for Army, Air Force, Navy, Army Guard, Air Force Guard, and Marines. The Navy service is selected, and the dashboard displays 683 sites (457 CONUS, 226 OCONUS) and 160 sources (TIDE GAUGE STATIONS). A table titled 'Highest Service Scenarios' shows the highest combined sea level change and extreme water level scenarios for a 1% annual chance event for the years 2035, 2065, and 2100. The table lists 10 sites with their respective sea level change ranges in meters.

	2035	2065	2100
	5.9m - 6.1m NOSC Portland	5.9m - 6.6m NOSC Portland	5.8m - 7.8m NOSC Portland
	5.6m - 5.9m NOSC West Trenton NJ	5.7m - 6.5m NOSC West Trenton NJ	5.7m - 7.8m NOSC West Trenton NJ
	4.5m - 4.7m Bremerton RR	4.4m - 5.3m Sample Site	4.6m - 6.6m Bremerton RR
	4.4m - 4.7m Sample Site	4.5m - 5.2m Bremerton RR	4.5m - 6.6m Sample Site
	4.2m - 4.4m NOSC Fort Schuyler	4.2m - 5.0m NOSC Fort Schuyler	4.3m - 6.4m NOSC Fort Schuyler
	4.1m - 4.3m Fort Lewis	4.2m - 4.9m Fort Lewis	4.2m - 6.2m Fort Lewis
	4.0m - 4.2m Camp McKean	4.1m - 4.8m Camp McKean	4.2m - 6.2m Marysville WA
	4.0m - 4.2m Camp Wesley Harris	4.1m - 4.8m Camp Wesley Harris	4.1m - 6.1m Camp McKean
	4.0m - 4.2m Jackson Park Hsg	4.1m - 4.8m Jackson Park Hsg	4.1m - 6.1m Camp Wesley Harris

REVIEWING SITE DATA

Sea Level Change

- A site's **Sea Level Change** Scenarios are displayed on the initial site data page (see example interpretation in the box below)
- You may still **Favorite** a site you are currently viewing by using the Star button (top-right)

Interpreting Site Data
For example, applying the **Highest** global SLR scenario (2.0-meter rise by 2100), regional adjustments for this site would result in a total rise of **2.7 meters** by 2100, compared to the 1992 baseline.

The screenshot shows the DRSL website interface for site 'NG Norfolk'. The top navigation bar includes 'DRSL', 'SITE LOOKUP', 'MAP VIEW', 'SERVICES', 'CONTACT US', and 'USER GUIDE'. The site information includes RPSUId 6551, Installation VIRGINIA NATIONAL GUARD, and various coordinates and elevations. A star icon in the top right corner is highlighted with a hand cursor, indicating the 'Favorite' function.

The 'Sea Level Change' section is active, showing regionalized scenarios. A table below the text provides site-specific adjustments for the years 2035, 2065, and 2100. The 'Highest' scenario for 2100 is circled in red, showing a value of 2.7 meters. A line graph to the right shows the 'Lowest' and 'Highest' scenarios over time, with the 'Highest' scenario showing a significant rise by 2100.

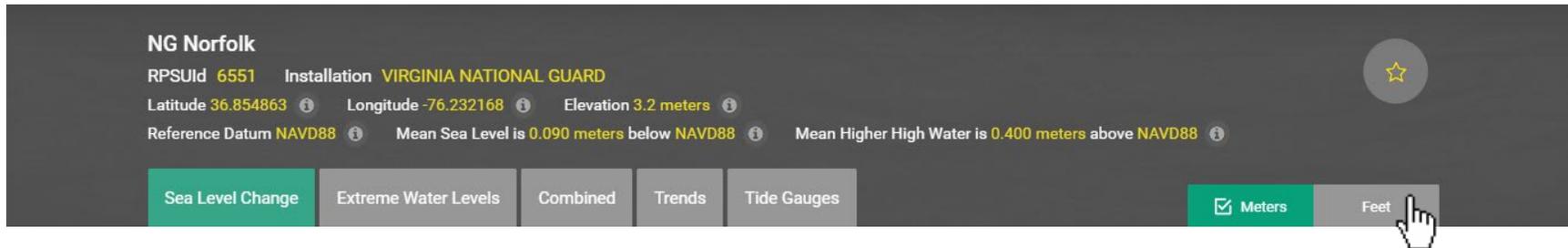
Global Scenario	2035	2065	2100
Lowest	0.2	0.3	0.5
Highest	0.5	1.2	2.7

Base Unit → Meters

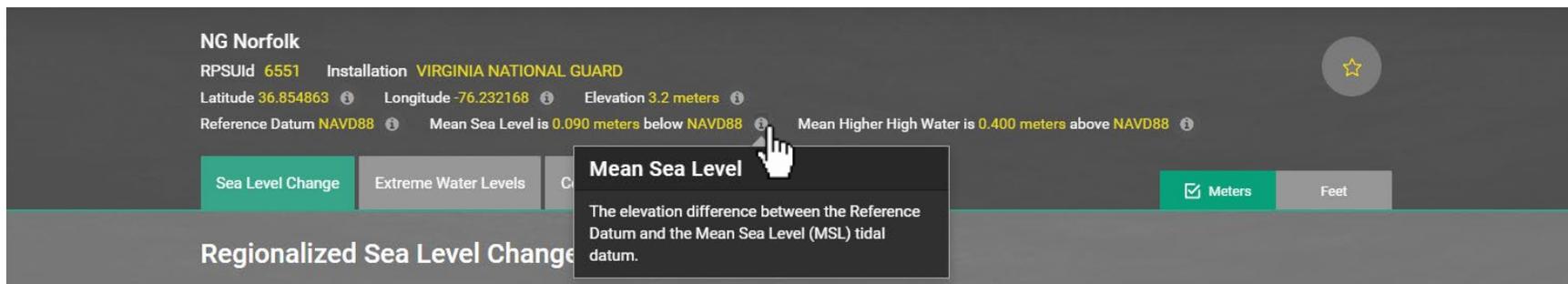
Global Scenario	Global SLR	Site-Specific Adjustments			Total Site-Specific Adjustments	Site-Specific Sea Level Change Projections
		Vertical Land Movement	Ocean Circulation	Ice Melt Effects		
Lowest (0.2)	0.1	0.1	0.0	0.0	0.1	0.2
Low (0.5)	0.1	0.1	0.0	0.0	0.1	0.2
High (1.0)	0.1	0.1	0.0	0.0	0.1	0.2

Sea Level Change – Site Header

- In the Site header, site specific information is displayed
- This header remains the same across the application
- Below the site-specific information, there are Tabs with the Sea Level Change (highlighted in green)
 - Some sites do NOT have Extreme Water Level data and in those cases, the Extreme Water Levels and Combined tabs will NOT be displayed
 - On the far-right side, you can change units from meters (default) to feet and ALL the data in the application will convert including site header data

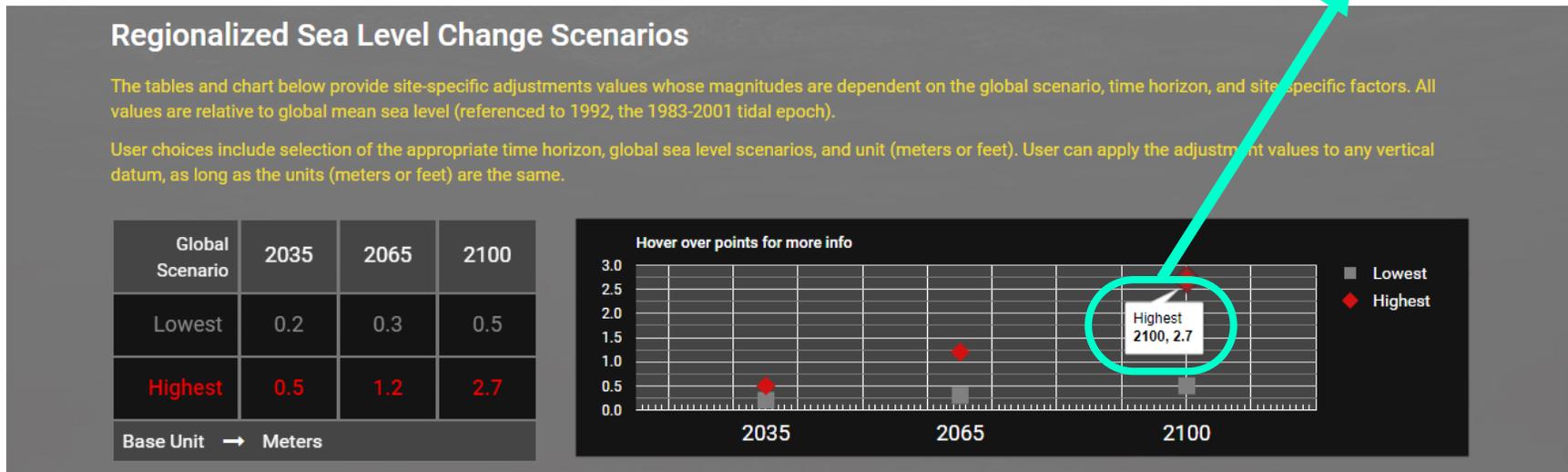


- Throughout the application, you can move your mouse cursor over information icons to learn more about data fields



Sea Level Change – Data Summary

- Below the Site header, a data summary is displayed including a table and corresponding graph
- The table includes three time horizons and the lowest and highest scenarios
- The graph reflects the table data
 - You can also move your mouse cursor over each data point to display the scenario, time horizon, and corresponding value



Sea Level Change – Data breakdown

- Click on any of the time horizons (blue boxes) to view detailed data
- Under each time horizon, data are broken down into multiple scenarios (one on each row)
- For more information about each column, move your mouse cursor to the info icons in the column headers

Global Scenario	Global SLR	Site-Specific Adjustments			Total Site-Specific Adjustments	Site-Specific Sea Level Change Projections
		Vertical Land Movement	Ocean Circulation	Ice Melt Effects		
Lowest (0.2)	0.1	0.1	0.0	0.0	0.1	0.2
Low (0.5)	0.1	0.1	0.0	0.0	0.1	0.2
Medium (1.0)	0.2	0.1	0.0	0.0	0.1	0.3
High (1.5)	0.2	0.1	0.1	0.0	0.2	0.4
Highest (2.0)	0.3	0.1	0.1	0.0	0.2	0.5

Base Unit → Meters

Regionalized Sea Level Change Scenario Formula:
Site-Specific Sea Level Change Scenario = Global SLR (t) + Total Site-Specific Adjustments (t)

For example, for the **0.5-meter (Low)** Global SLR scenario:
Vertical Land Movement adds an additional 0.1 m, Ocean Circulation adds 0.0 m,
and Ice Melt Effects adds 0.0 m to the 0.5-meter Global SLR scenario, for a total of
0.2 m SLR at this site in 2035, compared to the 1992 baseline.

Sea Level Change – Ice Melt Effects Breakdown I

- View the component-level **breakdown** of Ice Melt Effects by hovering over an ice cube icon (if available)
- This breakdown is **always presented in meters** (whereas all other GUI values can be displayed in Meters or Feet – this limitation for ice melt components prevents rounding errors associated with unit conversions at the component level)
- the individual component values are first added, for a total of **0.10 m**, which is then rounded to 0.1 m total for the Ice Melt Effects contribution [2.0-meter (Highest) scenario , 2065; in this case, contribution magnitudes are fairly similar for all three components]

2035 Scenarios		2065 Scenarios			2100 Scenarios	
Global Scenario	Global SLR	Site-Specific Adjustments			Total Site-Specific Adjustments	Site-Specific Sea Level Change Projections
		Vertical Land Movement	Ocean Circulation	Ice Melt Effects		
Lowest (0.2)	0.1	0.2	0.0	0.2	0.3	
Low (0.5)	0.2	0.2	0.1	0.3	0.5	
Medium (1.0)	0.4	0.2	0.1	0.3	0.7	
High (1.5)	0.6	0.2	0.1	0.3	0.9	
Highest (2.0)	0.8	0.2	0.1	0.4	1.2	

Ice Melt Effects Breakdown (2065, Highest Scenario)	
Antarctica	0.08
Glacier	0.07
Greenland	-0.05
Total	0.10

Base Unit → Meters

Sea Level Change – Ice Melt Effects Breakdown II

2035 Scenarios		2065 Scenarios		2100 Scenarios		
Global Scenario	Global SLR	Site-Specific Adjustments			Total Site-Specific Adjustments	Site-Specific Sea Level Change Projections
		Vertical Land Movement	Ocean Circulation	Ice Melt Effects		
Lowest (0.2)	0.2	0.3	0.0	Antarctica	0.20	0.5
Low (0.5)	0.5	0.3	0.1	Glacier	0.11	0.9
Medium (1.0)	1.0	0.3	0.2	Greenland	-0.19	1.5
High (1.5)	1.5	0.3	0.2	Base Unit → Meters		2.0
Highest (2.0)	2.0	0.3	0.3		0.7	2.7

In contrast, for the same **2.0-meter (Highest)** scenario but in the later 2100 timeframe, the magnitude of the component adjustment for Antarctica is significantly greater than for Glaciers and Greenland.

Sea Level Change – Vertical Land Movement Editing

- Users who have *more site-specific information* about Vertical Land Movement (VLM) may wish to substitute that data. Please note that edits made to VLM data will be reset after exiting the GUI. **Edit** VLM values by first **clicking any cell in the VLM adjustment data column**.
- Adjust the values up or down using the mouse, keyboard, or manually typing in a value
- Results of editing the value are then reflected throughout the page

2035 Scenarios
 2065 Scenarios
 2100 Scenarios

Global Scenario <small>(i)</small>	Global SLR <small>(i)</small>	Site-Specific Adjustments			Total Site-Specific Adjustments <small>(i)</small>	Site-Specific Sea Level Change Projections <small>(i)</small>
		Vertical Land Movement <small>(i)</small>	Ocean Circulation <small>(i)</small>	Ice Melt Effects <small>(i)</small>		
Lowest (0.2)	0.2	0.2 <small>(i)</small>	0.0	0.0	0.2	0.4
Low (0.5)	0.5	0.3	0.1	0.0	0.4	0.9
Medium (1.0)	1.0	0.3	0.2	0.0	0.5	1.5
High (1.5)	1.5	0.3	0.2	0.0	0.5	2.0
Highest (2.0)	2.0	0.3	0.3	0.1	0.7	2.7

Base Unit → Meters

Regionalized Sea Level Change Scenario Formula:
 Site-Specific Sea Level Change Scenario = Global SLR (t) + Total Site-Specific Adjustments (t)

Extreme Water Levels

- Clicking on the green Extreme Water Levels tab will display a site's Extreme Water Level Statistics reported as heights above mean higher high water (the higher of two high tides experienced per tidal day)

Regionalized Extreme Water Level Statistics

Values in the table(s) below are heights above mean higher high water

Note: these water levels do not include the effects of waves. User choices include multiple gauges vs single gauge, % annual chance event, and unit (meters or feet). User must convert value to appropriate reference datum as these values are relative to mean higher high water.

Extreme Water Levels include the effects of the astronomical tide and storm surge. Given that both of these are time varying, their combined effect can be expressed in terms of annual exceedance probability. The probabilities chosen here reflect different return periods for combined storm and tide elevations of different magnitudes of interest to planners and managers. Tide gauge information is a common method to estimate extreme water level statistics. The length of records, dictate the category to which a site belongs and the type of analyses that may be conducted - since these values are heights above mean higher high water. Note: these water levels do not include the effects of waves.

This site belongs to **Category 2** - Site has a local tide gauge within 50 km but with less than 30 years of record.

Multiple Gauges - Regional Frequency Analysis

A Regional Frequency Analysis (RFA) is a statistical method that provides estimates for extreme event probabilities with the assumption that coastal environments with similar attributes will experience a similar flood frequency. To conduct an RFA, three to five tide gauges of sufficient length of record and proximity to the site of interest are needed. An RFA assists in placing tide gauges with short records into a regional context, enlarging the sampling for rare events both in space and time, and transferring Extreme Water Level information to un-gauged sites.

20% Annual Chance Event ["5 Year Event"]	5% Annual Chance Event ["20 Year Event"]	2% Annual Chance Event ["50 Year Event"]	1% Annual Chance Event ["100 Year Event"]
1.4	1.7	1.9	2.1

Base Unit → Meters

For example, this means that the EWL associated with the "5% Annual Chance Event" (or "20 Year Event") will reach an elevation of 1.7 meters above mean higher high water (MHHW) for this site.

Extreme Water Levels – Category and Data

- Every site belongs to a certain Category based on available Tide Gauge information – **for more details, see text below**
- The **info button** next to the site Category definition provides similar information for all Categories

Regionalized Extreme Water Level Statistics

Values in the table(s) below are heights above mean higher high water

Note: these water levels do not include the effects of waves. User choices include multiple gauges vs single gauge, % annual chance event, and unit (meters or feet). User must convert value to appropriate reference datum as these values are relative to mean higher high water.

Extreme Water Levels include the effects of the astronomical tide and storm surge. Given that both of these are time varying, their combined effect can be expressed in terms of annual exceedance probability. The probabilities chosen here reflect different return periods for combined storm and tide elevations of different magnitudes of interest to planners and managers. Tide gauge information is a common method to estimate extreme water level statistics. The proximity of gauges to a site, and their length of records, dictate the category to which a site belongs and the type of analyses that may be conducted - single gauge or multiple gauge. Values in the table(s) below are heights above mean higher high water. Note: these water levels do not include the effects of waves.

This site belongs to **Category 2** - Site has a local tide gauge within 50 km but with less than 30 years of record. 

- A site can have either one or both sources of data: Single Gauge Analysis and Regional Frequency Analysis (RFA). RFA is defined below.
- When relevant for the site, “Multiple Gauges – RFA” and/or “Single Gauge” boxes will each display unique values for the four return periods (e.g., “20 Year Event”)
- Section 4.4.4 of Hall et al. (2016) provides a comparative discussion on application of single gauge or RFA results when both are available

Multiple Gauges - Regional Frequency Analysis			
A Regional Frequency Analysis (RFA) is a statistical method that provides estimates for extreme event probabilities with the assumption that coastal environments with similar attributes will experience a similar flood frequency. To conduct an RFA, three to five tide gauges of sufficient length of record and proximity to the site of interest are needed. An RFA assists in placing tide gauges with short records into a regional context, enlarging the sampling for rare events both in space and time, and transferring Extreme Water Level information to un-gauged sites.			
20% Annual Chance Event ["5 Year Event"]	5% Annual Chance Event ["20 Year Event"]	2% Annual Chance Event ["50 Year Event"]	1% Annual Chance Event ["100 Year Event"]
1.4	1.7	1.9	2.1
Base Unit → Meters			

Combined

- Clicking the green Combined tab displays the corresponding Combined Scenario Values

NG Norfolk
RPSUID **6551** Installation **VIRGINIA NATIONAL GUARD**
Latitude **36.854863** Longitude **-76.232168** Elevation **3.2 meters**
Reference Datum **NAVD88** Mean Sea Level is **0.090 meters** below **NAVD88** Mean Higher High Water is **0.400 meters** above **NAVD88**

Sea Level Change Extreme Water Levels **Combined** Trends Tide Gauges

Meters Feet

Combined Scenario Value: Sea Level Change Scenario & Extreme Water Level Statistics

Values in the tables below represent elevations above the reference datum for the combination of sea level change scenario and the selected annual chance event.
Note: these water levels do not include the effects of waves. User choices include multiple gauges vs single gauge, annual chance event, and unit (meters or feet).

20% Annual Chance Event
["5 Year Event"]

5% Annual Chance Event
["20 Year Event"]

2% Annual Chance Event
["50 Year Event"]

1% Annual Chance Event
["100 Year Event"]

% chance in any given year that there will be an extreme water level event of at least this magnitude

Combined - Formula

- The formula used to calculate the Combined values is displayed at the **bottom** of the page
- Moving your mouse cursor over the **info icon** will display detailed information about each formula component

Combined Scenario Value: Sea Level Change Scenario & Extreme Water Level Statistics

Values in the tables below represent elevations above the reference datum for the combination of sea level change scenario and the selected annual chance event. Note: these water levels do not include the effects of waves. User choices include multiple gauges vs single gauge, annual chance event, and unit (meters or feet).

20% Annual Chance Event
["5 Year Event"]

5% Annual Chance Event
["20 Year Event"]

2% Annual Chance Event
["50 Year Event"]

1% Annual Chance Event
["100 Year Event"]

% chance in any given year that there will be an extreme water level event of at least this magnitude

Based on Multiple Gauge Analysis

Global Scenario	2035	2065	2100
Lowest (0.2)	2.0	2.1	2.3
Low (0.5)	2.0	2.3	2.7
Medium (1.0)	2.1	2.5	3.3
High (1.5)	2.2	2.7	3.8
Highest (2.0)	2.3	3.0	4.5

Base Unit → Meters

Based on Single Gauge Analysis

No Single Gauge data is available for this site

Combined Scenario Value Formula:
Combined Scenario Value = Global SLR (t) + Total Site-Specific Adjustments (t) + Mean Higher High Water Offset + Extreme Water Levels (ace)
where (t) is time and (ace) is % annual chance event

Combined - Data

- The page includes four buttons, one for each EWL return period
- Clicking any of these four buttons displays the corresponding table of combined values
- Multiple Gauge (RFA) and/or Single Gauge data will be displayed depending on availability.

The screenshot shows a web interface with four buttons at the top, each representing a different return period for an extreme water level (EWL) event:

- 20% Annual Chance Event ["5 Year Event"]
- 5% Annual Chance Event ["20 Year Event"]
- 2% Annual Chance Event ["50 Year Event"]
- 1% Annual Chance Event ["100 Year Event"]

Below the buttons, a text label reads: "% chance in any given year that there will be an extreme water level event of at least this magnitude".

The interface is split into two sections:

- Based on Multiple Gauge Analysis:** A table showing EWL values for different scenarios in the years 2035, 2065, and 2100. The value 3.8 is circled in red, with a red arrow pointing to a callout box.
- Based on Single Gauge Analysis:** A message stating "No Single Gauge data is available for this site".

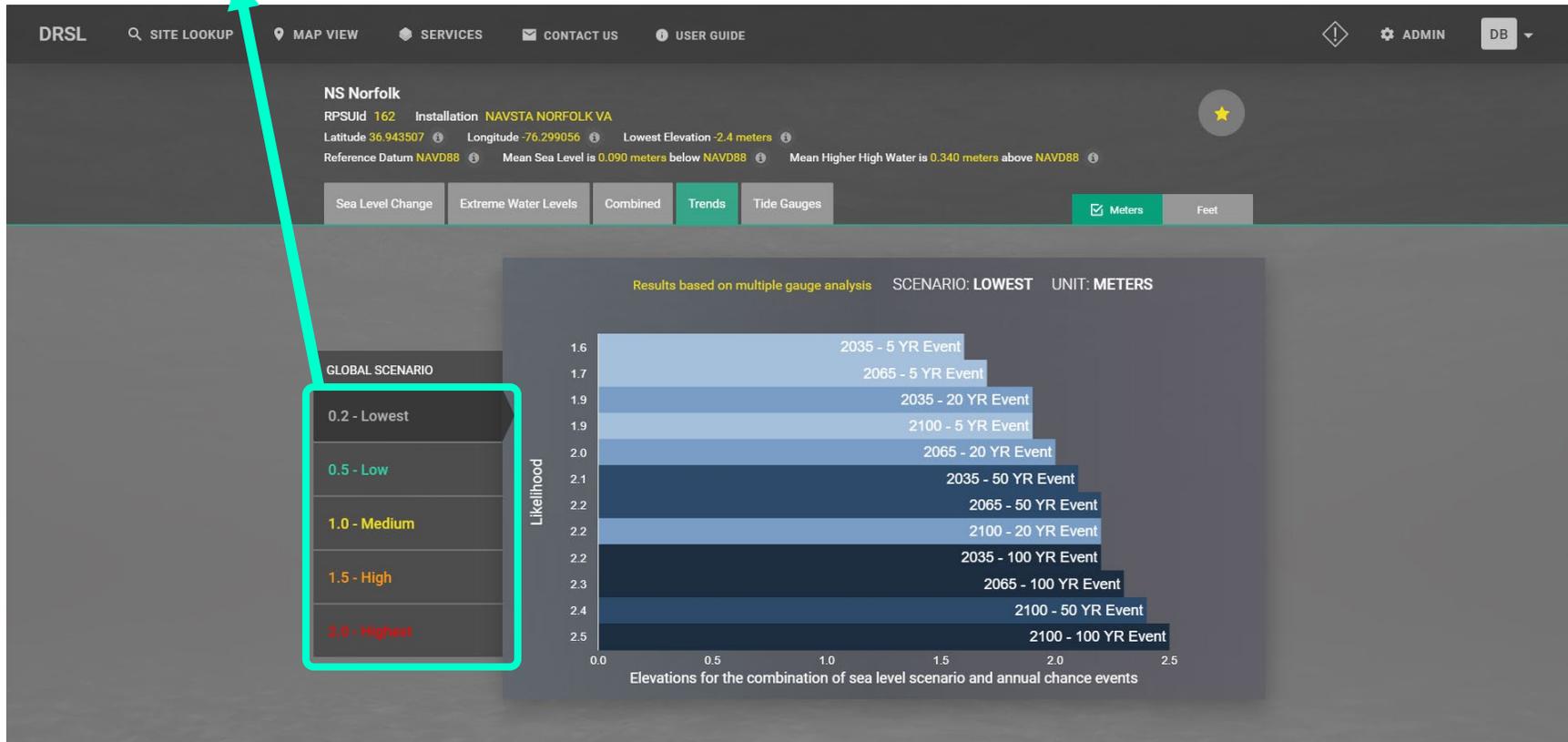
Global Scenario	2035	2065	2100
Lowest (0.2)	2.0	2.1	2.3
Low (0.5)	2.0	2.3	2.7
Medium (1.0)	2.1	2.5	3.3
High (1.5)	2.2	2.7	3.8
Highest (2.0)	2.3	3.0	4.5

Base Unit → Meters

This means that for the **1.5-meter (High)** scenario, the combination of regionally adjusted SLR and the EWL associated with the 20% annual chance event (or 5-Year Event) would reach an elevation of 3.8 meters in 2100, compared to the 1992 baseline.

Trends

- **Select a global scenario** from the left menu to view the annual chance events sorted by combined sea level scenario elevations. All results are based on multiple gauge analysis.



Tide Gauges

- View a listing of the tide gauges used in the single and multiple gauge analysis for the site.
- Select a Station Id to view more information about the tide gauge on the official NOAA website.

The screenshot displays the DRSL website interface for the NS Norfolk site. The top navigation bar includes links for SITE LOOKUP, MAP VIEW, SERVICES, CONTACT US, and USER GUIDE. The main content area shows site details for NS Norfolk, including RPSUID 162, Installation NAVSTA NORFOLK VA, and various coordinates and elevations. Below this, there are tabs for Sea Level Change, Extreme Water Levels, Combined, Trends, and Tide Gauges. The Tide Gauges tab is active, showing a list of five tide gauge stations. The first station, SEWALLS POINT, HAMPTON ROADS, has its Station Id: 8638610 highlighted with a red box. A red arrow points from the text 'Select a Station Id to view more information about the tide gauge on the official NOAA website.' to this highlighted Station Id. To the right of the list is a map of the Norfolk area with red tide gauge icons overlaid on the locations.

Station Name	Station Id	Latitude	Longitude	Years Of Records	Distance From Site
SEWALLS POINT, HAMPTON ROADS	8638610	36.93	-76.33	84	2,800 meters
CHESAPEAKE BBT	8638610	36.97	-76.11	37	17,100 meters
MONEY POINT, S. BR. ELIZABETH RIVER	8639348	36.78	-76.3	10	18,200 meters
YORKTOWN USCG TRAINING CENTER, VA	8637689	37.23	-76.48	12	35,300 meters
KIPTOPEKE, CHESAPEAKE BAY	8632200	37.17	-75.99	36	37,300 meters

Case Studies – Inundation Mapping and Tidal Surface Considerations

- The Hall et al. (2016) report accompanying this database contains guidance on incorporating considerations related to inundation mapping error and tidal surface variation when analyzing the potential impact of SLR and EWL scenarios.
- Section 4.5.3 and Section 5.2.3 contained associated discussion (See slide 7 for where to find the report)

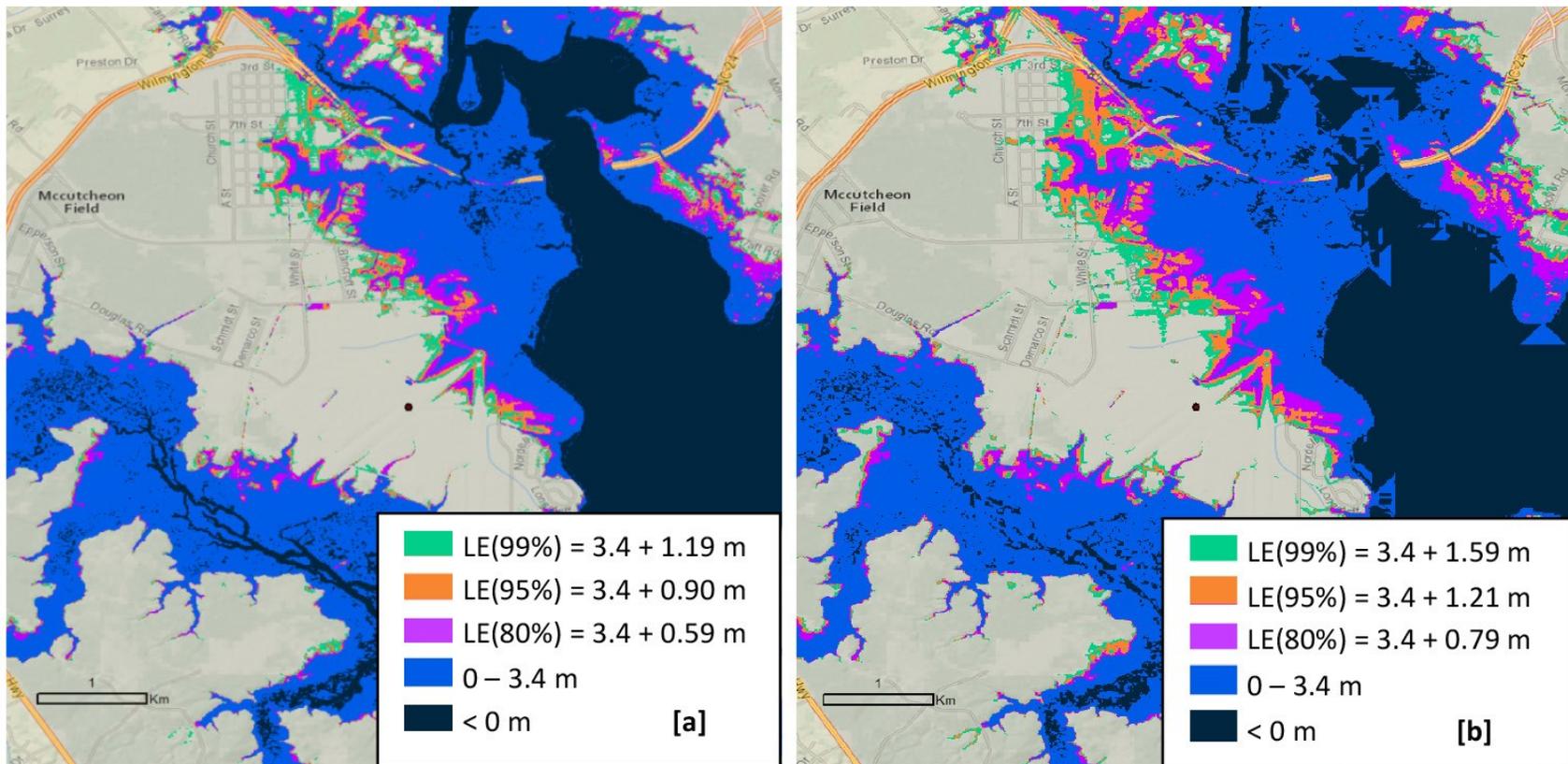
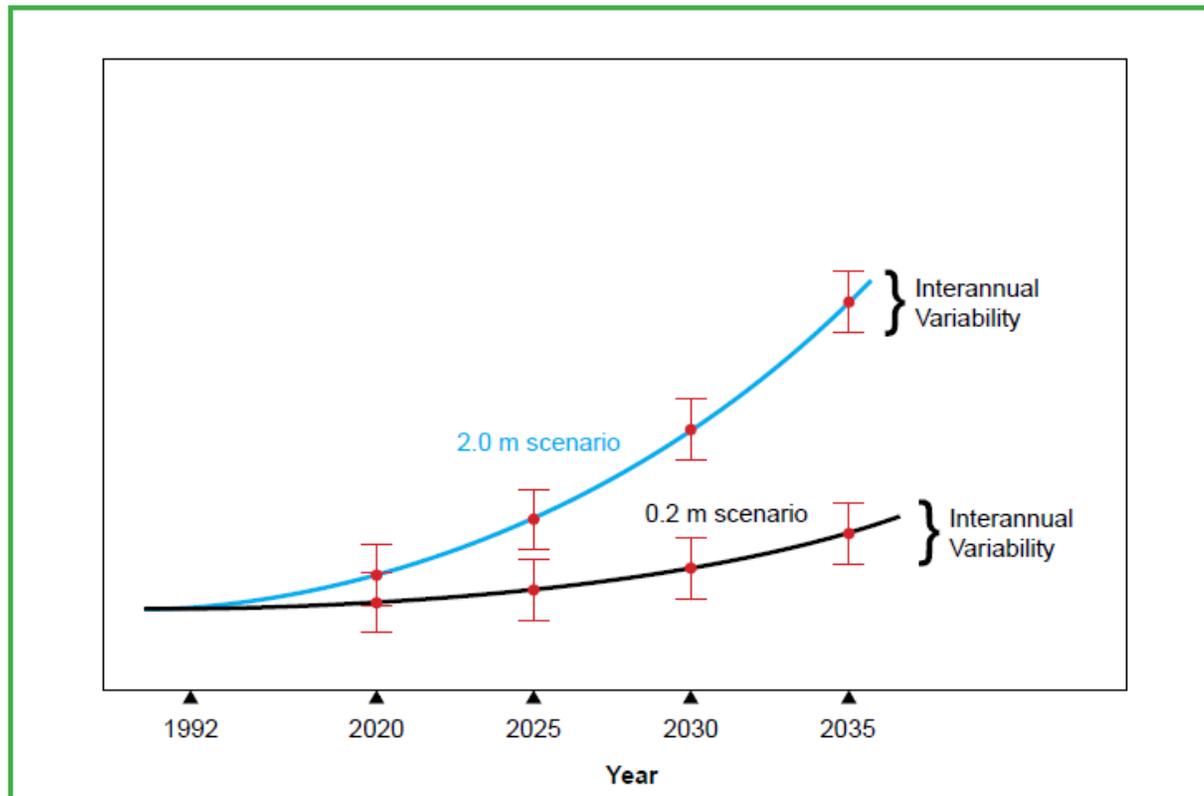


Figure 5.10 MCBCL West Site 3.4-Meter Inundation Map
([a] NED 1/9 arc-second DEM dataset; [b] NED 1/3 arc-second DEM dataset)

Case Studies – Making Decisions in the Zero- to 20-Year Timeframe

- Section 5.3.5 of Hall et al. (2016) contains guidance on making decisions with consequences limited to less than 20 years, offering decision-makers interested in more near-term SLR scenarios a simplified set of scenarios and adjustments.
- *(Note that it is incumbent on the decision-maker, however, to decide under what circumstances the consequences of his or her decision do not extend past 20 years and when it is appropriate to apply the simplified approach.)*



Conceptual Diagram to Illustrate Application of SLR Scenarios in the Zero- to 20-Year Timeframe

The depiction of interannual variability is illustrative and not to scale with the rest of the figure.

Thank You!

Regionalized Sea Level Change & Extreme Water Level Scenarios

Contact Information

If you experience difficulty accessing the website or other technical challenges, please send an e-mail to sealevelscenarios@serdp-estcp.org describing the problem. If you have access and have any other questions, you can use the **CONTACT US** link in the header.

DoD (Department of Defense)

CARSWG (Coastal Assessment Regional Scenario Working Group)

