Sea Level Scenario Sketch Planning Tool

Florida Department of Transportation
University of Florida GeoPlan Center

Website: sls.geoplan.ufl.edu

Tool Synopsis:

The Key West tide gauge in Florida shows a steady and gradually accelerating sea level rise (SLR) of about 9 inches since 1900. The increasing rate of rise in recent years has implications for Florida, with its long coastline, hurricane history, and low-lying coastal zones, and as a major infrastructure builder and manager, the Florida Department of Transportation (FDOT) must understand possible impacts of SLR on the state's transportation system.

The University of Florida (UF) GeoPlan Center, with funding from FDOT, developed a geographic information systems (GIS) planning tool to assist in the identification of transportation infrastructure potentially vulnerable due to inundation from sea level rise (SLR). The SLS Sketch Planning Tool provides for a preliminary assessment of when, where, and how much inundation and at-risk transportation facilities could occur under various scenarios of sea level rise. The SLS Sketch Planning Tool features an interactive map viewer, GIS data layers, and a calculator for creating GIS layers of SLR inundation. The UF GeoPlan Center is continuing to improve the tool and develop more refined data products which can be used to assess SLR impacts to the transportation system. All tool components and data are available to the public via the project website: sls.geoplan.ufl.edu.

Tool Features:

Map Viewer

Visualize areas of inundation due to sea level rise and affected infrastructure

Low technical expertise needed, no GIS software needed

GIS Data Layers

Download GIS layers of SLR inundation & affected transportation Infrastructure

GIS Software and Intermediate GIS expertise needed

SLR Inundation Surface Calculator

Create custom GIS layers of SLR inundation

GIS Software and Intermediate or advanced GIS expertise needed

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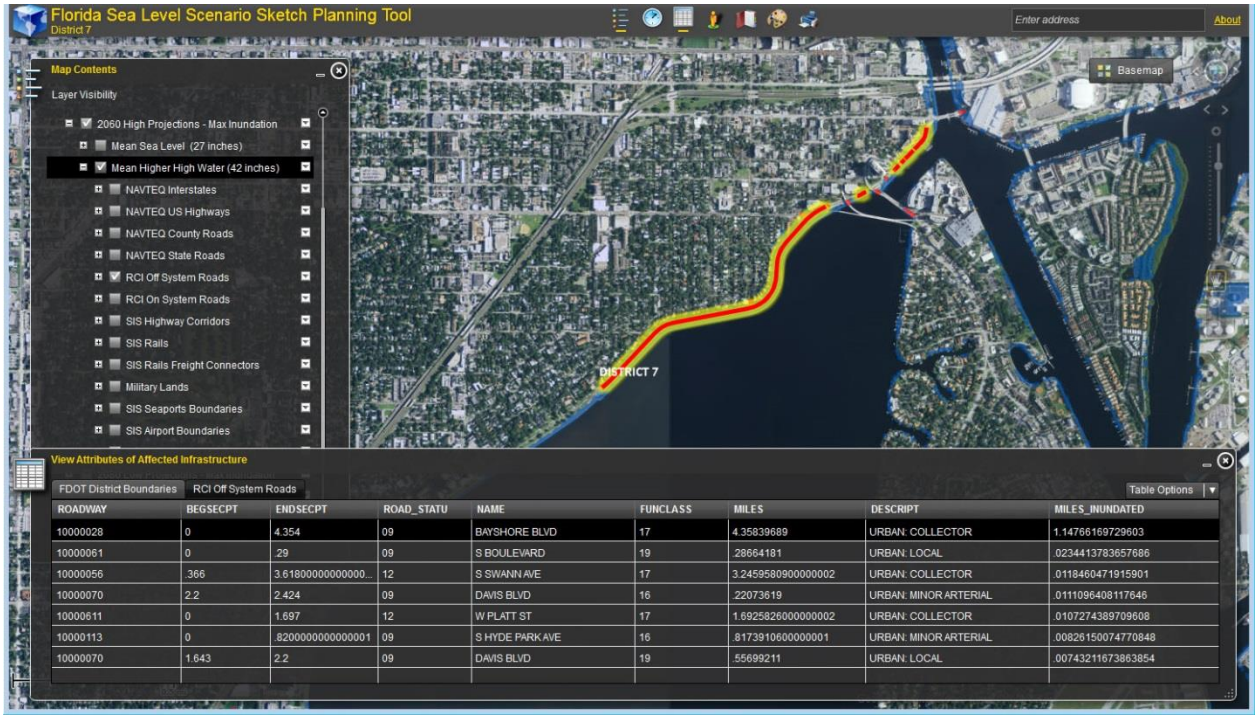
Tool Features:

Map Viewer: Interactive Maps of Sea Level Rise and Affected Infrastructure

With the map viewer, users can visualize when and where inundation is projected to occur and which transportation facilities are potentially vulnerable to inundation due to SLR. The map viewers display SLR inundation scenarios and affected transportation infrastructure for time periods (2040, 2060, 2080, 2100), three rates of SLR (Low, Intermediate, High), and two tidal datums (Mean Sea Level and Mean Higher High Water). Map Viewers are organized geographically by FDOT Districts. Other features include a "time slider" tool which visualizes SLR inundation over time, a dynamic table with information on affected infrastructure, and a Google street view tool for inspecting on the ground conditions.

Example - Map Viewer for FDOT District 7, showing Bayshore Blvd in Tampa affected at 2060 using the USACE high rate at MHHW, and table of affected infrastructure:



ROADWAY	BEGSECPT	ENDSECPT	ROAD_STATU	NAME	FUNCLASS	MILES	DESCRIPT	MILES_INUNDATED
10000028	0	4.354	09	BAYSHORE BLVD	17	4.35839689	URBAN: COLLECTOR	1.14766169729603
10000061	0	.29	09	S BOULEVARD	19	.28664181	URBAN: LOCAL	.0234413783657686
10000056	.366	3.61800000000000...	12	S SWANN AVE	17	3.2459580900000002	URBAN: COLLECTOR	.0118460471915901
10000070	2.2	2.424	09	DAVIS BLVD	16	.22073619	URBAN: MINOR ARTERIAL	.0111096408117646
10000611	0	1.697	12	W PLATT ST	17	1.6925826000000002	URBAN: COLLECTOR	.0107274389709608
10000113	0	.8200000000000001	09	S HYDE PARK AVE	16	.8173910600000001	URBAN: MINOR ARTERIAL	.0082615007477084 8
10000070	1.643	2.2	09	DAVIS BLVD	19	.55699211	URBAN: LOCAL	.0074321167386385 4

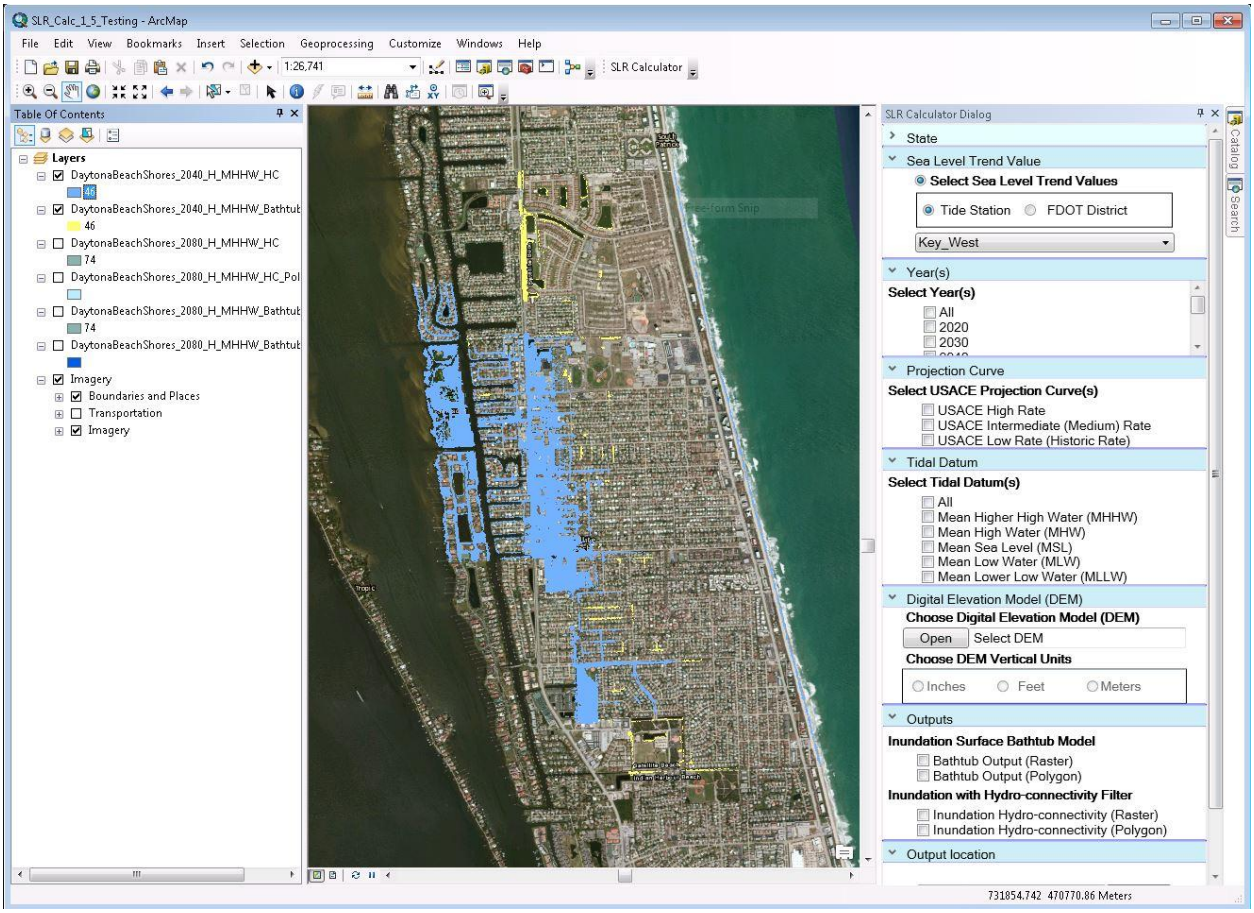
GIS Data Layers

Publicly available GIS Data for download include: Layers of SLR Inundation (every decade between 2040-2100) and Affected Transportation Infrastructure (2040, 2060, 2080, and 2100). SLR inundation layers are available in raster or vector format (ArcGIS File geodatabase). Infrastructure layers are available in vector format (ArcGIS File geodatabase). SLR inundation layers for download include a "bathtub" inundation model, and a model that accounts for hydrologic connectivity.

SLR Inundation Surface Calculator: Add-In for ArcMap

The SLR Calculator is an ArcMap add-in tool for creating custom SLR inundation layers using the USACE sea level change methodology and NOAA tide gauge data. The SLR calculator can be downloaded with or without a 5-meter cell size Digital Elevation Model (DEM) dataset. The calculator outputs include a bathtub inundation surface and a refined inundation surface assessing hydrologic connectivity. Both outputs are available in raster or vector feature class format. Intermediate GIS expertise is recommended for using the SLR calculator. Software Requirements: ESRI ArcGIS Desktop 10.1 or 10.2 with Spatial Analyst. The calculator is currently not supported with ArcGIS 10.3.

Example: SLR Inundation Surface Calculator, Version 1.5.2, docked within ArcMap (calculator window/ dialog on right)



Methods Used to Develop the Tool and Data:

The SLS Sketch Planning Tool was built using GIS-based components that incorporate standardized data inputs including U.S. Army Corps of Engineers (USACE) sea level change methods, National Oceanic and Atmospheric Administration (NOAA) tide station data, elevation data, and FDOT transportation databases. These inputs are the foundation for creating modeled results of potentially vulnerable transportation infrastructure including roadways, railways, airports, and seaports that are managed and maintained by FDOT and their local partners (counties and MPOs) or identified as critical infrastructure. The UF GeoPlan Center generated statewide and regional scenarios of sea level change at three rates of SLR (low, intermediate, and high) in 10-year increments (2040 – 2100) following the USACE methods. The projections were mapped using a 5-meter Digital Elevation Model (DEM). The mapped inundation projections were then intersected with transportation GIS layers to identify vulnerable infrastructure.

Data Inputs:

Sea Level Rise (SLR) Projections

SLR projections are based on formulas specified in the U.S. Army Corps of Engineers (USACE) Engineer Circular (EC) 1165-2-212 “Sea-level Change Considerations for Civil Works Programs” and the National Research Council’s (NRC) report *Responding to Changes in Sea Level: Engineering Implications*. Projections were calculated using the USACE Sea-Level Change Curve Calculator with three rates of SLR: historic or “low” (linear); intermediate (modified NRC Curve I) and high (modified NRC Curve III).

Low Rate (USACE Low Curve): the historic rate of sea-level change, based on NOAA observations.

Intermediate Rate (USACE Intermediate Curve): computed from the modified NRC Curve I considering both the most recent Intergovernmental Panel on Climate Change (IPCC) projections and modified NRC projections with the local rate of vertical land movement added.

High Rate (USACE High Curve): computed from the modified NRC Curve III considering both the most recent IPCC projections and modified NRC projections with the local rate of vertical land movement added.

For more information on the USACE methods: http://www.corpsclimate.us/ccaceslcurves.cfm

NOAA Tide Gauge Data, Sea Level Trends, and Tidal Datums

Fourteen Florida tide stations each have a calculated sea level trend value, which indicates the local relative sea level trend (as opposed to global sea level trends). These trend values were used in the SLR projections to represent relative SLR around Florida and to create regional SLR projections by FDOT district. Regional SLR projections were created using an area weighted mean method to summarize data from one or more tide stations adjacent or closest to the shoreline of the district boundaries. For more information on tides and sea level trends: http://tidesandcurrents.noaa.gov/sltrends/sltrends.html

SLR projections were mapped with five tidal datums: Mean Higher High Water (MHHW), Mean High Water (MHW), Mean Sea Level (MSL), Mean Low Water (MLW), and Mean Lower Low Water (MLLW). SLR inundation is often mapped using MHHW as the base elevation to represent the normal daily extent of high tide. For more information on tidal datums, see NOAA's website: http://tidesandcurrents.noaa.gov/datum_options.html

Digital Elevation Model

The SLR projections were translated from LMSL to NAVD88 using correction values from each tide gauge. SLR inundation was then mapped using a 5-meter Digital Elevation Model (DEM) compiled from various sources. High-resolution Lidar-derived DEMs from NOAA were used for most coastal areas.

Frequently Asked Questions

Who is this tool intended for?

The tool is intended for use by planners and decision makers looking for a preliminary assessment of SLR impacts to the transportation system.

What should the tool not be used for?

The tool is a screening level tool and should not be used for: determining site-specific vulnerabilities, identifying exact locations of flooding areas, permitting purposes, or legal purposes. The tool does not account for groundwater effects and does not include analysis of SLR on storm water systems.

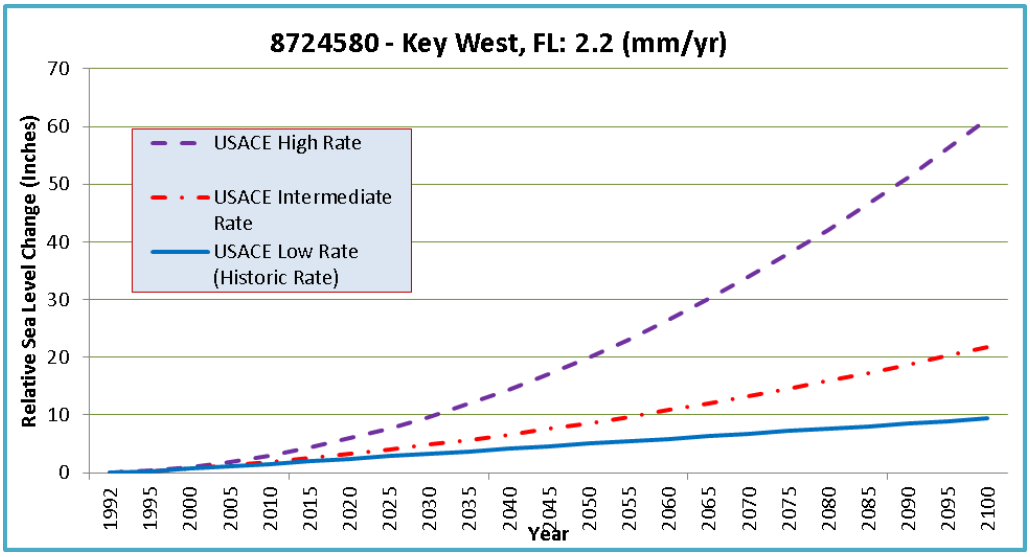
What is the difference between SLR and inundation due to SLR?

Sea level rise (SLR) refers to the increase in the mean level of the ocean. Inundation refers to land area which is normally dry, but under certain conditions becomes covered with water. SLR and inundation values are typically different because of the way in which each is measured and referenced. SLR values are typically referenced relative to mean sea level or local mean sea level (LMSL). Land elevation values are typically referenced to a vertical mapping datum, like NAVD88. In order to map inundation, the SLR values must be translated from LMSL to NAVD88, which can result in a higher or lower value depending on local conditions.

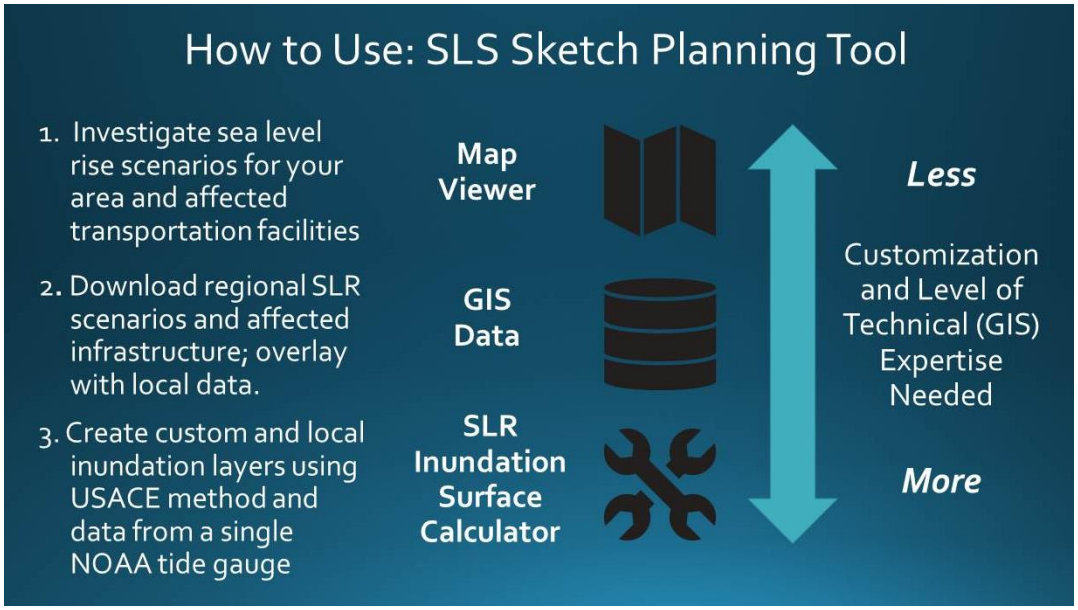
How much sea level rise is projected to occur using this tool?

Sea levels are not rising uniformly and estimates of SLR vary based on the rate of SLR used for calculation. This tool uses USACE methods and NOAA tide station data to map inundation in Florida due to relative sea level rise (as opposed to global SLR) by decade from 2040 - 2100. These methods result in a range of SLR values: approximately 4.5 - 5.3 feet by 2100 using the USACE High Rate, approximately 1.3 – 2 feet by 2100 using the USACE Intermediate Rate, and approximately 3 -12 inches by 2100 using the USACE Low/ Historic Rate. These amounts of SLR are relative to local mean sea level (LMSL). In order to map inundation, the values must be translated to NAVD88, which can result in a higher or lower value depending on local conditions.

The example graph below shows the projected SLR values (relative to LMSL) using the three USACE scenarios with data from the Key West tide gauge:



How can I use the data available in the tool?



What kind of GIS data is available in the tool?

GIS data includes layers showing areas of inundation from sea level rise ("inundation layers") and layers showing transportation infrastructure affected under various scenarios of SLR ("affected infrastructure layers"). The data is organized geographically by FDOT districts. Inundation layers can be downloaded by FDOT district or statewide. For calculation of projected SLR inundation, the statewide layers only utilize data from the Key West tide station, while the district SLR inundation layers use data from one or more tide stations adjacent or closest to the shoreline of the district. Affected infrastructure layers are only available at the district level. All data is publicly available on the "Download Data" page of the project website: http://sls.geoplan.ufl.edu/download-data/

SLR Inundation Layers

Example map: Old Tampa Bay, 2060, USACE High Rate SLR (1-meter of inundation). Blue areas are inundated and hydrologically connected to the bay. Yellow areas are additional isolated inundation areas using bathtub model.

Affected Transportation Infrastructure

Example: Tampa Bay, local roadways affected at 2060 under USACE High Rate SLR

What geographic areas does the tool cover?

The tool covers the entire State of Florida. Data is organized geographically by FDOT districts. See FAQ above.

Where can I get more information?

Technical Report - "Development of a Geographic Information System (GIS) Tool for the Preliminary Assessment of the Effects of Predicted Sea Level and Tidal Change on Transportation Infrastructure, FDOT Contract # BDK75 977-6" includes detailed methods on the development of the SLS Sketch Planning Tool and is available on the project website: http://sls.geoplan.ufl.edu/documents-links/

U.S. Army Corps of Engineers: Sea-Level Change Curve Calculator (and links to EC 1165-2-12 and updated guidance ER 1100-2-8162): http://www.corpsclimate.us/ccaceslcurves.cfm

NOAA Center for Operational Oceanographic Products and Services (CO-OPS): Tide station data, sea level trends, tidal datums: http://tidesandcurrents.noaa.gov/