# Testing and Enhancement of the Florida Sea Level Scenario Sketch Planning Tool

## FDOT Contract BDV31-932-1
## October 2015

## Executive Summary

This project continued the work completed under FDOT Research Contract BDK75-977-63 entitled "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". In the prior work ("Phase 1"), researchers from the University of Florida (UF) GeoPlan Center developed the Florida Sea Level Scenario Sketch Planning Tool (SLS Sketch Planning Tool) to facilitate the identification of transportation infrastructure potentially at risk from projected sea level changes. The purpose of the tool is to visualize various sea level scenarios at future time periods in an effort to inform transportation planners and highlight infrastructure for potential avoidance, minimization, or mitigation. Continuing this work in "Phase 2", the UF GeoPlan Center tested and made enhancements to the SLS Sketch Planning Tool to increase its efficacy as a decision support tool.

In Phase 1, the tools and data were developed at the state and regional scale. In Phase 2, the data and tools were evaluated at the local or Metropolitan Planning Organization (MPO) scale. Partnerships with the Hillsborough MPO and Broward MPO (serving as the lead agency for the southeast Florida four-county region of Broward, Miami-Dade, Palm Beach, and Monroe Counties) offered testing opportunities through pilot projects. Both MPOs were awarded grants through the Federal Highway Administration (FHWA) Climate Change Resilience Pilot Program, which has funded partners to assess infrastructure vulnerability to the impacts of sea level changes and extreme weather events, determine adaptation options, and improve resiliency of infrastructure. This unique opportunity allowed the GeoPlan team to test the use of the SLS Sketch Planning Tool in a real-world context, while learning about data gaps and technical issues encountered when assessing vulnerability. The pilot projects utilized FHWA's Climate Change and Extreme Weather Vulnerability Assessment Framework for assessing transportation infrastructure vulnerable to the effects of climate change and extreme weather events and for developing recommendations on how to integrate this information into the decision-making process. In addition, other testing partnerships arose with the City of Satellite Beach and Monroe County, who were engaged in community resiliency and adaptation planning efforts.

During the work with the pilots, issues of data accuracy and resolution were examined. First, a known data issue involving areas around bridge approaches being incorrectly identified as inundated under sea level rise (SLR) scenarios was addressed. Methods to accurately represent bridge elevations were developed and tested in five counties (MPO pilot areas) and future work should include application of these methods to correct false positive inundation areas statewide. Next, the resolution of digital elevation models (DEMs) was evaluated to determine the difference in inundated areas derived from varying resolution DEMs. DEMs with higher horizontal resolution (less than 5.4 meter) were used to create GIS layers of inundation under various SLR scenarios. The

results indicated that the horizontal resolution of 5.4-meter used in the SLS Sketch Planning Tool is appropriate for use at the regional and state planning scale and achieves a balance of file size and processing time, while not grossly over or under estimating the areas inundated. If adequate resources exist, then higher resolution elevation data can be used for analysis, but will take considerably more computing resources, time, and storage space to compute and store data outputs. The Sea Level Rise (SLR) Inundation Surface Calculator supports the input a DEM of any resolution from which inundation layers can be created.

Working with the FHWA pilots also offered an opportunity to learn about how other communities are assessing storm surge and inland flooding impacts to the transportation system. Currently, the SLS Sketch Planning Tool only includes information on potential impacts due to inundation from SLR. A more comprehensive approach to planning for transportation resiliency would include assessment of multiple inundation risks (SLR, storm surge, and inland flooding). Rising sea levels are estimated increase storm surge flood depths and the frequency of coastal flooding due to the higher “launch point” or water level for the surge to push onto the land (Kirshen, 2008a, Neumann, et al. 2015, Sweet and Park, 2014, Tebaldi et al. 2012). Storm surge models, methods, and current literature were researched to determine whether best practices are emerging for modeling storm surge in the context of SLR. Modeling approaches vary widely from simple additive models to complex hydrodynamic models typically used for engineering scale applications, and depend on factors of analysis scale, geographic extent, and resources available (financial, temporal, and expertise).

Test model runs were conducted in an effort to create a proof of concept for modeling future storm surge with SLR. The Multi-Hazard Loss Estimation Methodology (Hazus-MH) and the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) models were utilized for modeling future coastal flood risk areas. Created by the Federal Emergency Management Administration (FEMA), Hazus-MH is a standardized methodology used to estimate potential losses from earthquakes, hurricane winds, and floods. The Hazus-MH Flood Model was used to analyze future coastal flood hazard areas by adding increments of SLR to the Stillwater elevation of the base 100-year storm surge. This flood model follows FEMA’s methodology for developing the Flood Insurance Rate Maps (FIRMs), where flood frequency and flood magnitude (or depth) are used to define flood hazard. Additionally, SLOSH model runs were conducted within the Hazus-MH Coastal Surge Model using a historic storm for the Tampa Bay area.

Estimating the effects of SLR on storm surge and inland flooding is a complex issue; with no one size fits all solution for modeling these effects. FHWA’s 2014 Hydraulic Engineering Circular No. 25 - Volume 2, *Highways in the Coastal Environment: Assessing Extreme Events* outlines a framework for modeling storm surge and coastal flooding in the context of SLR. The framework is a tiered, level of effort approach that offers a gradient of modeling methods based on the geographic region, scale of analysis, technical expertise, and available resources. The subsequent levels of effort can be leveraged as the need for more refined analyses arises. From the research and testing completed in this phase of work, a tiered approach is recommended for assessing transportation vulnerability to storm surge and coastal flooding. First, transportation infrastructure at risk to current flood hazard areas should be incorporated into the SLS Sketch Planning Tool using the best available 100-year floodplain data from FEMA. Next, future coastal flood risk areas should be evaluated using the 500-

year floodplain as a simple proxy to estimate future flood hazard areas (and in accordance with FEMA's updated Federal Flood Risk Management Standard). A more detailed approach for assessing future coastal flood risk would involve further evaluation of the Hazus-MH Coastal Flood Model. Incorporation of future storm surge risk (accounting for the effects of SLR) is a more complex topic that needs further investigation. While hydrodynamic models offer the most robust analyses, they are too time and computationally intensive for planning level analyses. One suggested approach for planning level analyses is the utilization of the Hazus-MH Coastal Surge Model with SLOSH to run historic storms, which could represent a more realistic surge risk than the Maximum of Maximums (MOMs) outputs which are typically used for hurricane evacuation studies. If the historic storms can be validated, then SLR can be added and modeled.

Working with the FHWA pilot projects also offered an opportunity to learn about the broader adaptation planning process outlined by FHWA for promoting resiliency in the Nation's transportation systems. While quality data is essential for successful vulnerability assessments, building public support for these assessments through community outreach and public education are also critical components to the planning process. Equally important is the integration of vulnerability and risk information into the transportation planning process as another variable to consider when making infrastructure investment decisions. An iterative process for evaluating risks and prioritizing investments based on vulnerability and risk will be crucial for increasing the resiliency of transportation systems.

Feedback and suggestions from the FHWA pilots and other communities regarding the SLS Sketch Planning Tool were utilized to make improvements and prioritize future enhancements to the map viewer and calculator components of the tool. Suggestions for the map viewer included a simplified table of contents for ease of use and summary generation tools to facilitate analysis of transportation facilities. In response, development of a new map viewer based on a different software platform was begun in order to achieve better functionality and a more modern software framework. In addition, improvements have been made to the SLR Inundation Surface Calculator based on feedback and an updated version of the calculator is available on the project website.

The involvement with the FHWA pilots and other communities demonstrated the demand and need for planning level tools to assess inundation risks and incorporate risk information into the planning process to ensure resilient infrastructure and protect public investments. While the available functionality in the SLS Sketch Planning Tool has proved useful, additional work remains to maintain its relevancy and increase its utility. First, the GIS layers of inundation should be modified to reflect the corrected bridge elevations and the analysis of at-risk infrastructure should be re-analyzed with the most current GIS infrastructure layers. Next, the map viewer interface should continue to be redesigned for ease of use and reporting. Finally, current and future coastal flood hazard areas should be incorporated per recommendations and findings in this report. Moving forward with these changes would address the feedback received from users and improve the applicability of the tool for planning-level infrastructure assessments.