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

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Executive Summary

In this project, researchers from the University of Florida developed a sketch planning tool that can be used to conduct statewide and regional assessments of transportation facilities potentially vulnerable to climate trends. The project focused on the potential vulnerability of transportation infrastructure to the effects of possible future rates of sea level change (SLC) and increasing tidal datums (Mean Lower Low Water (MLLW), Mean Low Water (MWL), Mean Sea Lea Level (MSL), Mean High Water (MHW), and Mean Higher High Water (MHHW). This work builds upon the research completed under Florida Department of Transportation (FDOT) contract BDK79 977-01, *Development of a Methodology for the Assessment of Sea Level Rise Impacts on Florida's Transportation Modes and Infrastructure* (Florida Atlantic University, 2012).

The Florida Sea Level Scenario Sketch Planning Tool was constructed using an interactive framework of GIS-based components that incorporate standardized spatial data input layers including, but not limited to, scale-appropriate topographic data, U.S. Army Corps of Engineers (USACE) sea level change projections, National Oceanic and Atmospheric Administration (NOAA) tide station data, and FDOT-derived data from the Roadway Characteristics Inventory (RCI), Strategic Intermodal System (SIS) and the Unified Basemap Repository (UBR). These input layers are the foundation for creating modeled results of potentially vulnerable transportation infrastructure including roadways, railways, airports, and seaports that are managed and maintained by the FDOT and their local partners (counties and MPOs) or identified as critical infrastructure.

The sketch planning tool consists of a set of three tools, which can be used independently or together, to assist transportation planners in assessing and prioritizing transportation facilities potentially at risk due to SLC. Each tool is designed to address varying levels of technical expertise and data analysis needs. The tools were developed using ESRI ArcGIS, FDOT-supported and industry standard GIS software. The tools allow for visualization of potentially inundated areas due to SLC, identification of transportation facilities potentially at risk from sea level rise inundation, report creation to summarize and prioritize affected infrastructure, and the ability to create custom

inundation surfaces. The tools are currently designed for use at the statewide and regional scale. The regional analysis of potential infrastructure vulnerability was based on FDOT district boundaries. The mechanism for delineation of potentially vulnerable infrastructure is a spatial selection of infrastructure that intersects a given inundation surface. This means that any roadway segment or portion of a roadway segment that intersects the inundation layer was identified as potentially vulnerable. The output infrastructure layers include an attribute field indicating the portion (miles or area) of the facility that is affected due to inundation.

The Florida Sea Level Scenario Sketch Planning Tool includes (1) a map viewer, (2) the output modeled data layers (inundation surfaces and affected infrastructure), and (3) an ArcGIS calculator for creating custom inundation surfaces.

The map viewer allows for visualization and identification of potentially inundated areas and affected transportation infrastructure due to sea level rise. The map viewer requires no technical expertise, and the only user requirements are an internet connection and a web browser. It was developed using ESRI's Flex Viewer for ArcGIS Server. The map viewer displays areas of potential inundation and affected infrastructure at three rates of sea level rise (USACE historic/low, intermediate, and high curves), for two tidal datums (MSL and MHHW), and for the time periods 2040, 2060, 2080, 2100. The infrastructure data layers include FDOT-derived data from the RCI, SIS, and the UBR. The map viewer allows the user to choose from a variety of base maps, including high resolution imagery, streets, and terrain. The viewer features a "time slider" widget, which allows for visualization of consecutive inundation over multiple decades. It also features a report generation function, which summarizes the potentially affected infrastructure, miles or area inundated, and other key attributes about that infrastructure, based on the user's geographic area of interest.

The next tool is the collection of output modeled data layers, which include the inundation surfaces and corresponding affected infrastructure layers. These output data layers are displayed in the map viewer, but due to the high number of total data layers created, only a subset are displayed in the viewer. In addition to the data layers visualized in the map viewer, data layers for more time periods and tidal datums are available for download. All data layers are available for download on the project website (http://sls.geoplan.ufl.edu). Inundation surfaces are available at decadal intervals from 2040 – 2100, for three USACE curves (low/ historic, intermediate, high), and using five Tidal Datums: MLLW, MLW, MSL, MHW, MHHW. Two geographic extents are available for download: FDOT District or the entire state. The analyses of affected infrastructure are available at the FDOT District scale for four planning horizons (2040, 2060, 2080, and 2100), the three USACE curves, and the five tidal datums listed above.

The inundation surfaces are available for download as shapefiles or rasters, and the infrastructure layers are available as shapefiles. All data layers require GIS software to view and moderate knowledge of GIS and mapping. Data layers can be overlaid with local infrastructure data and other data layers of local interest. These output data layers are designed to be integrated into existing FDOT decision support systems and assist state and regional transportation planning and programming activities (e.g. Efficient Transportation Decision Making, Long Range Transportation Plan).

The final tool is the Sea Level Change Inundation Surface Calculator, which is an ArcGIS tool for creating custom inundation surfaces. The calculator allows users to choose one of the three USACE projective curves (low/ intermediate/ high), a decade (2040-2100), a tide station, and a Digital Elevation Model (DEM) layer. ArcGIS software and intermediate/ advanced technical and/or GIS expertise is needed to use this tool. With this tool, it is possible for a user to create a more refined inundation surface using a DEM with a higher horizontal resolution (than the 5-meter DEM used).

It is important to note that this version of the Florida Sea Level Scenario Sketch Planning Tool was designed for use at the statewide and regional scale. The 5-meter horizontal resolution of the statewide and regional DEMs limits the granularity of the analysis. This level of resolution does not provide local and site-specific features such as roadway and bridge elevations, gullies, ditches, dikes, and levees. Also, the selection procedure and the small scale of analysis may in some cases overestimate the affected infrastructure. Applied at the appropriate scale, the errors discussed above, while potentially significant, do not diminish from the utility of the toolkit as a useful statewide and regional indicator of potentially vulnerable infrastructure under various SLC and tidal scenarios.

Future versions and enhancements of this tool could address local level planning and analyses, such as a County or Metropolitan Planning Organization (MPO). The design of this toolset supports the addition of higher resolution data inputs and facilitates reproduction of the data outputs (inundation surfaces and affected transportation infrastructure layers). As higher resolution data inputs (DEM data, tide station zones of influence, and local transportation infrastructure) become available, the analysis can change from statewide and regional to MPO in scale. The range of geographic scale and variety of sea level change projections supports the need for a standardized method to identify those areas that may be adversely affected and vulnerable to future sea level and tidal changes. As sea level projections and tidal datums are modified over time, horizon year, and place, the ability to have a framework of tools that are customizable (based on latest data inputs and projections) will facilitate the revision and reassessment of potentially impacted areas and related infrastructure.