A VULNERABILITY-ASSESSMENT TOOL THAT WILL QUANTIFY THE FUTURE RISK OF INUNDATION FOR ROAD SEGMENTS AND CRITICAL INFRASTRUCTURE

Warren Pinnacle Consulting, Inc. (WPC) with funding by the New York State Energy Research and Development Authority (NYSERDA) has added a new component to the Sea-level Affecting Marshes Model (SLAMM) that allows the assessment of infrastructure vulnerability to flooding under future sea-level rise and storm surge conditions. In particular, future frequency of inundation is evaluated for point infrastructure such as schools, fire stations, and other buildings and facilities as well as individual segments of linear infrastructure such as roads and railroads.

WPC can assist in identifying long-term responses to future inundation risk of infrastructure and roads. We produce flood vulnerability projections that enable managers to plan for solutions aiming to mitigate risk, danger, and cost of possible future flooding of coastal infrastructure. Our work includes sea-level rise estimations, storm-surge projections, and evaluation of cost-effective adaptation responses.
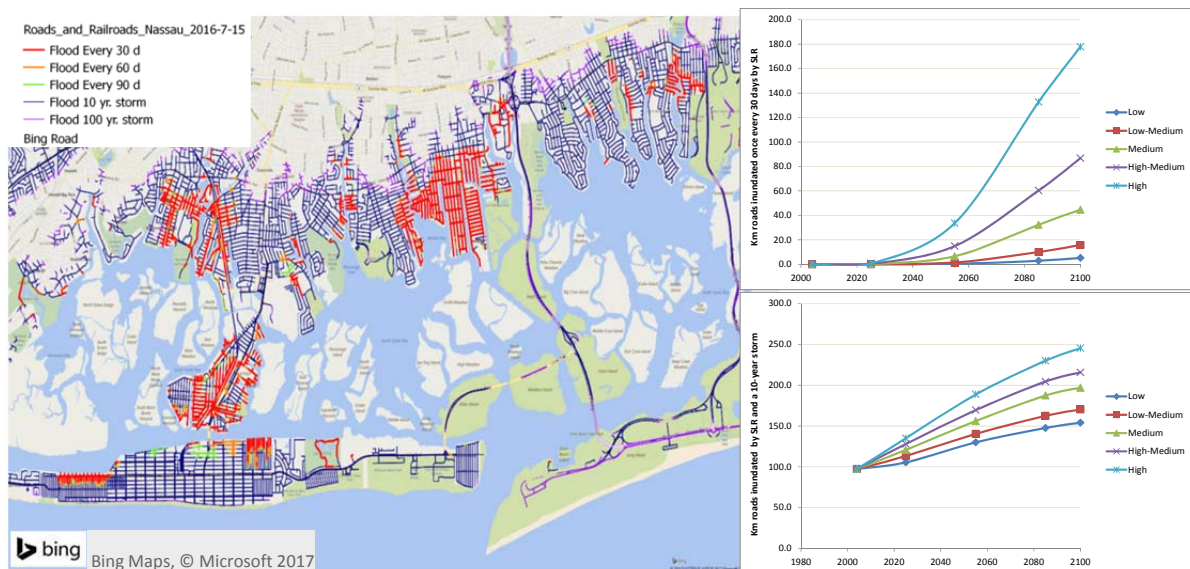

FIGURE 1. LEFT: EXAMPLE OF ROAD SECTIONS VULNERABLE TO PERIODIC FLOODING (RED, ORANGE, GREEN), 10-YEAR AND 100-YEAR STORMS (NAVY AND PURPLE), IN SOUTHERN NASSAU COUNTY (NEAR LIDO BEACH) UNDER 0.74 M (29 INCHES) OF SLR. RIGHT: TOTAL KILOMETERS OF ROADS SUBJECT TO MONTHLY FLOODING UNDER SLR ALONE (TOP) AND SUBJECT TO 10-YEAR STORMS (BOTTOM). (MICROSOFT BING MAPS SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION)
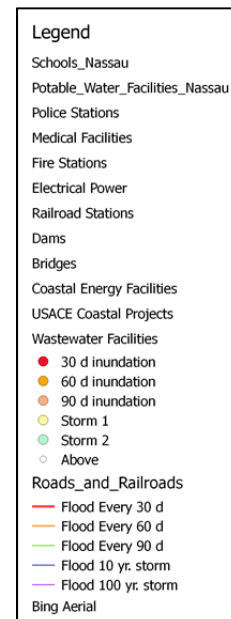
Distinctive features of the infrastructure-inundation projections are:

- Road-line and infrastructure elevation data are extracted from high resolution LiDAR data (often available elevation data have horizontal point spacing in the order of 1m or less)
- Road data do not consider the **entire** road length but are broken down in **5 meter segments**, thus providing information about the specific portions of the road that may be at risk of inundation.
- Model results are exported in the form of shapefiles that can be easily imported into GIS software for further analysis and visualization. All data are preserved from the original roads shapefiles to maximize the utility of model outputs.
- Frequency-of-inundation projections identify vulnerabilities to periodic inundations due to increased tidal water levels and also future inundation risks for 10% and 1% storm surges (10-year and 100-year storms).

- High-resolution landcover projections generated by SLAMM provide a landscape context that may assist planning and management in identifying priorities. For example if the area served by the road is projected to be flooded, then raising the road may not be critical (unless it is also serving some other dry land areas)

Effective conservation planning and management in coastal communities is often complicated by multiple competing objectives. SLAMM landscape projections can assist in considering other objectives for infrastructure adaptation such as the removal of impediments to allow coastal wetland conservation through inland migration. A related tool developed by WPC is the Dynamic Marsh Management Tool which focuses on identifying optimal adaptation strategies to increase marsh resilience.

The SLAMM roads and infrastructure tool has been applied in coastal New York and Connecticut. These projects were built on previously completed high-resolution uncertainty analysis modeling (Clough, Polaczyk, and Propato, 2016 in *Ecological Modeling*). Details about the NY and CT applications **and output data sets** may be found at the following URLS: http://warrenpinnacle.com/prof/SLAMM/NYSERDA2015 and http://www.warrenpinnacle.com/prof/SLAMM/NROC/. The original version of the SLAMM infrastructure-analysis tool was funded by U.S. Fish and Wildlife Service and applied at several refuges including Alligator River NWR.

Legend

Schools_Nassau
Potable_Water_Facilities_Nassau
Police Stations
Medical Facilities
Fire Stations
Electrical Power
Railroad Stations
Dams
Bridges
Coastal Energy Facilities
USACE Coastal Projects
Wastewater Facilities
● 30 d inundation
● 60 d inundation
● 90 d inundation
○ Storm 1
○ Storm 2
○ Above
Roads_and_Railroads
— Flood Every 30 d
— Flood Every 60 d
— Flood Every 90 d
— Flood 10 yr. storm
— Flood 100 yr. storm
Bing Aerial

FIGURE 2. ROADS AND INFRASTRUCTURE RESULTS EXAMPLE FROM SOUTHERN NASSAU COUNTY SHOWING INUNDATION FREQUENCY OF SCHOOLS, POTABLE WATER FACILITIES, MEDICAL FACILITIES, FIRE STATIONS, POLICE STATIONS, RAILROAD STATIONS, COASTAL ENERGY FACILTIES AND MORE

Existing SLAMM model applications can be utilized as the base data for the tool or new applications created with updated spatial data can be produced for a reasonable cost. To learn more about producing infrastructure inundation projections for your study area, please contact Jonathan Clough (jclough@warrenpinnacle.com) or Marco Propato (mpropato@warrenpinnacle.com) or call Jonathan at 802-496-3476.

Other Projects Warren Pinnacle Consulting has recently been involved in include:

- Development of the Dynamic Marsh Management Tool
- Modeling Effects of Deepwater Horizon on Nearshore Environments (Blancher et. al 2017; and Clough et al, 2017 accepted, URL pending)
- Creation of SLAMM version 6.7 including wave-power erosion (with ESA Associates, funding from TNC)
- Creation of AQUATOX 3.2 with EPA funding (EPA release expected in 2017)