UNF-RESIO
DHS Coastal Resilience Center
Research Project Work Plan Template
Years 4 - 5
[July 1, 2018 – June 30, 2019 / July 1, 2019 – June 30, 2020]

1. **Project Title**: Development and Validation of Efficient and Accurate Methods for Coupling ADCIRC to Hydrologic Models
2. **Principal Investigators:** Donald Resio (University of North Florida) and John Atkinson, Arcadis
3. **Other Research Participants/Partners:** None.
4. **Short Project Description**. Today, the ability of coastal communities to sustain health and prosperity is being threatened by rising sea level and increased development in areas vulnerable to flooding. Recent storms such as Isaac, Harvey, and Irma have shown that a somewhat previously overlooked threat, the combination of storm surges and hydrologic (i.e. combined rainfall, runoff, and river flow) flooding, is contributing to a serious problem of under-predicted flood risk. This project will develop methods to couple hydrologic and surge models for evaluating flood risk from predictions of potential flooding for real-time evacuation planning, supporting long-term resiliency planning, and hazard level prediction in coastal areas. Products derived from this research mission will be of immediate utility to DHS and their mission to define existing risk and proposed risk reduction activities for United States coastal communities. The project will also develop a set of metrics that include accuracy, computer resource requirements (primarily execution time) and the flexibility of the system to function effectively in a range of conditions.

5. **Abstract**. In this project, boundary conditions for linking open-source upland hydrologic models to the well-used coastal surge model ADCIRC (Advanced Circulation Model) will be investigated in terms of efficiency and accuracy of predictive capability. The extremely damaging flood scenarios witnessed during Hurricanes Matthew and Irma in the Jacksonville FL region will be used as case studies for proposed coupled modeling using the nearshore wave model STWAVE (Steady State Wave Model used for slowly varying wave fields – a validated USACE model) coupled with ADCIRC for surge generation and tide propagation coupled with up to three candidate open-source upland hydrologic models. The computational mesh used for the ADCIRC model will be the latest representation of Jacksonville as developed by FEMA with local enhancements along the St Johns River using available airborne LIDAR (Light Detection and Ranging) information . LIDAR provides the most accurate topographic information available for use in flooding models. In the case of Hurricane Irma in particular, this topological data is available to the project team and is needed to ensure that the elevation of the river bank crests are represented as accurately as possible, since much of the downtown flooding was associated with fairly shallow, localized areas of overflow. Significant data is available from many sources to define topography, bathymetry, and recent flooding dynamics along the coast and along the St Johns River. These data will provide detailed data for evaluating the performance of the coupled hydrologic-surge models used in this study. The ADCIRC grid for this area has already been used for a forensic study of coastal flooding, conducted by UNF graduate students using wind fields made available by Oceanweather, Inc. for Hurricane Matthew, which can be freely used for applications to this hurricane in this area.

This study was presented by UNF graduate students in a session devoted to their study at the National American Shore and Beach Preservation Association in Fort Lauderdale last year. For this upcoming effort, modeling decisions about placement of the boundary between the hydrologic and surge models will be tested for optimal accuracy and efficiency, including 1) allowing the ADCIRC domain to cover the entire area, with an inflow boundary at a point well upriver from Jacksonville; 2) placing the boundary of the ADCIRC domain along the high-tide line; and 3) placing the hydrologic model boundaries for inflow from tributaries and the main river channel at locations closer to the mouth of the river.

Proposed model testing will determine the effectiveness of coupling the ADCIRC surge computations with hydrologic and precipitation model to cover more comprehensive flooding of the entire coastal domain, including the river and major tributaries. This modeling effort builds upon recent model coupling and sensitivity studies performed for Virginia Beach – Hampton Roads area during years 1 – 3 of this DHS project with an emphasis shifted to testing performance metrics of ADCIRC coupled with well-tested hydrologic models from national and international sources. In cases such as the HEC-RAS system, that are not considered open-source, needed subroutines will be recoded from equations contained in manuals accompanying this software.

It is expected that these tests will help determine the effectiveness of allowing the ADCIRC model to cover the entire coastal domain, including the river and major tributaries, similar to tests already conducted for the Virginia Beach – Hampton Roads area during years 1 – 3 of this UNF effort on this work. The major difference in this case, is that a single case with a large quantity of measurements will form the basis for detailed comparisons in the areas of flooding, which will serve as the focus for a journal article on this topic. As always, the accuracy of forcing functions, such as rainfall and river discharge at the upstream boundary are key to the accuracy of these tests. However, estimated river flow information (based on validated stage-discharge relationships) and rainfall (from NCEP, the National Centers for Environmental Prediction) is available for this time period. These data are likely to be as accurate or more accurate than data used as inputs in actual applications.