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

1. **Project Title**.

   Experimental and Numerical Study to Improve Damage and Loss Estimation due to Overland Wave and Surge Hazards on Near-Coast Structures

2. **Principal Investigator**.

   Dr. Daniel Cox, (PI) Professor, Oregon State University
   Dr. John van de Lindt (Co-PI), Professor, Colorado State University

3. **Other Research Participants/Partners**.

   FEMA, DHS

4. **Short Project Description**.

   This project will apply the wave-surge fragility method developed in years 1-3 of the project to determine damage to several additional building types. A HAZUS analysis over a region of the New Jersey shoreline will be conducted using (1) the existing HAZUS methodology, and (2) the new fragilities developed herein. This will require utilizing the ADCIRC work of others within the Center of Excellence as input. The investigators will work with DHS FEMA HAZUS developers to lay out the steps needed to implement the new fragility types in HAZUS, including any additional validation steps needed.

5. **Abstract**.

   This project focuses on Theme 1 – Coastal Infrastructure Resilience; Topic 1a – Coastal Infrastructure Planning and Design. As building stakeholders seek to mitigate damage, risk to property and structure loss it is becoming apparent that existing design methodologies such as those outlined in the FEMA Coastal Construction Manual are inadequate to incorporate the range of building types, storm conditions, and potential for resulting damage. More effective decision support tools such as FEMA's HAZUS-MH rely on a framework of multi- hazard fragility curves to relate the hazard and affected buildings to compute/predict an expected level of damage and subsequent losses. HAZUS-MH is a software package that allows the user to determine the damage and financial losses over a region of interest using embedded databases and fragility functions. The fragility functions are based on past work and expert elicitation during the software development phase. HAZUS-MH will be updated over the next decade, so the project described herein is occurring at an ideal time to contribute to its body of knowledge through technology transfer of the science created over the first three years. Although there have been significant advances in this correlation for wind and earthquake loading and some preliminary work for tsunamis, the coastal surge and wave response of structures remains poorly defined, primarily due to a lack of large-scale data and the complexity of the fluid/structure interaction modeling. This data was generated in the first three years of this project and served to validate a new fragility type for combined surge and waves. The investigators will work with HAZUS management to lay out the steps needed to implement the new fragilities, as well as determine what additional fragilities are needed. The overall goal of this project is to develop accurate fragilities for near-coastal structures against overland surge and wave forces for input to HAZUS-MH to improve damage and loss estimation.

We outline these specific objectives to be completed in two years in order to provide (1) improved accuracy for wave and surge analysis in HAZUS-MH; and (2) innovative advances in risk-informed design methodologies to enhance coastal infrastructure resilience:

- ***Objective 1:*** Develop additional fragilities based on input from HAZUS-MH management, i.e. based on most needed, such that a basic loss analysis can be performed.
- ***Objective 2:*** Demonstrate HAZUS-MH loss analysis for a portion of the New Jersey shoreline, including working to procure FEMA data to validate the loss modeling, documenting gaps that likely result as a function of the current approach.
- ***Objective 3:*** Demonstrate the surge and wave fragilities for the same location as in Objective 2, showing improved accuracy to actual loss values.

This project will have a direct impact on estimating probable damage and loss of existing coastal infrastructure by providing improved load-response relationships to HAZUS-MH for surge and wave and develop a risk-informed framework for estimating loss avoidance and benefit analysis for mitigation. While beyond the scope of this study, the results could also help improve the potential designs associated with the retrofit of existing structures funded through FEMA hazard mitigation grant programs and the implementation of improved coastal building codes.