Appendix A: Statement of Work

Florida Public Hurricane Loss Model Project

Model Enhancements to Estimate Losses from Storm Surge and Flooding

Year Two (2014-2015)

**Tasks due in 3 months**

1. Update the CEST model basins for the Florida Panhandle, West Florida, South Florida, and Florida Atlantic Regions using the 2011 national land cover dataset. Test the integration of the wind model with the CEST model.
2. Create wave grids over the Florida Panhandle Region. Populate the wave grids with bathymetric and topographic data. Test wave grids and test the integration of the CEST model with wave model.
3. Combine the level-6 USGS Hydrologic Unit Codes (HUC-6) to divide the State of Florida into seven large hydrologic basins: 2 basins to represent Florida east coasts, 4 for Gulf coasts, and 1 basin encompassing the central Florida.
4. Spatially disaggregate the coarse-scale flooding depths to estimate flooding depths at fine-scale (30m blocks) at any locations for the basins.
5. Establish methodologies for capacity-to-damage thresholds for components and structural elements, as well as mechanisms of interior and contents damage, due to hurricane induced freshwater inundation.
6. Prepare documentation and report.

**Tasks due in 6 months**

1. Modify Storm Track Generator (STG) to provide storms tracks of sufficient duration for storm surge and flood modeling, and include tracks of all hurricanes that may potentially have surge and flood impact on Florida in addition to wind hazard.
2. Develop a rain model that is integrated with the wind model. Compare modeled rain rates with observations of vertically free-falling and horizontally impinging rain rates (if available).
3. Examine computational time and stability of the CEST model on the Florida Panhandle Basin. Compute maximum storm surge heights and associated wind speeds, and maximum wind speeds and associated storm surges using a subset of stochastic storms, subject to the availability of the stochastic storm set generated by the FPHLM wind model.
4. Compute wave heights associated with maximum storm surges in the Florida Panhandle Region using a subset of stochastic storms, subject to the availability of the stochastic storm set generated by the FPHLM wind model.
5. Create wave grids for the West Florida Region. Populate the wave grids with bathymetric, topographic, 2011 land cover data. Test wave grids and test the integration of the CEST model with wave model.
6. Build stormwater management models (SWMM) at a relatively coarse spatial scale for 2 basins: 1 from the east coasts and 1 from the Central Florida. Calibrate and validate the two models to predict stormwater flooding depths in the basins during extreme rainfall events.
7. Define the limits between damage levels for external, interior and contents damage for the key components of the building envelope, building interior, and building contents, due to both storm surge and hurricane induced freshwater inundation

The task will be repeated for:

1. In-situ personal residential buildings
2. manufactured homes
3. low-rise commercial residential buildings
4. mid/high-rise commercial residential buildings
5. Develop relationships between physical external envelope, structure, and interior damage from storm surge and flood and repair/replacement costs. This will follow the methodology developed for the wind component of the FPHLM, whereby sources used by adjusters are adopted for consistency.

The task will be repeated for:

1. In-situ personal residential buildings
2. manufactured homes
3. low-rise commercial residential buildings
4. mid/high-rise commercial residential buildings
5. Design and implement the computer code for the wave component. Create a document describing the input and output data and its format. Create a diagram showing the processing of the input data within the component to produce the output. List the programming language, platform, and software libraries used to develop and run the software.
6. Create a document describing the input and output data of the surge component. Create a diagram showing the processing of the input data within the component to produce the output. List the programming language, platform, and software libraries used to develop and run the software.
7. Design a database schema to store data on property characteristics, insured exposure, and claim data. This task entails the design and setup of the database that will host the data.
8. Develop database procedures to clean up actuarial data in preparation for validation and calibration . These procedures will be developed in collaboration with the actuarial team.
9. Design and implement the computer code for the rain model.
10. Document and test the software implementation of the rain model.
11. Prepare documentation and report.

**Tasks due in 9 months**

1. Develop and implement the optimized system and associated methods for performing a large number of stochastic simulations using the combined wind/surge/wave models. This includes the tools and database needed to store computed storm surge data and retrieve the data feeding storm surge vulnerability functions.
2. Incorporate a roughness model to include the effect of land surface friction on off-shore wind flow near the coast.
3. Evaluate a recently published inflow model (Zang et al, MWR) for possible use in the wind model to improve the simulation of wind direction, which is important for accurate surge modeling.
4. Develop new base set of historical storm to include longer portion of storm tracks.
5. Examine computational time and stability of the CEST model on the West Florida Basin. Compute maximum storm surge heights and associated wind speeds, and maximum wind speeds and associated storm surges using a subset of stochastic storms, subject to the availability of the stochastic storm set generated by the FPHLM wind model.
6. Compute wave heights associated with maximum storm surges in the West Florida Region using a subset of stochastic storms, subject to the availability of the stochastic storm set generated by the FPHLM wind model.
7. Create wave grids for the South Florida Region. Populate the wave grids with bathymetric and topographic data. Test wave grids and test the integration of the CEST model with wave model.
8. Build storm water management models (SWMM) at a relatively coarse spatial scale for the remaining east coast basins and one Gulf Coast basin. Calibrate and validate the two models to predict storm water flooding depths in the basins during extreme rainfall events.
9. Spatially disaggregate the coarse-scale flooding depths to estimate flooding depths at fine-scale (30m blocks) at any locations for the basins.
10. Based on the results of previous tasks, develop storm surge building vulnerability functions for:
11. in-situ personal residential buildings of various construction types.
12. manufactured homes.
13. Based on the results of previous tasks, develop storm surge contents vulnerability functions for:
14. in-situ personal residential buildings of various construction types.
15. manufactured homes.
16. Based on the results of previous tasks, develop storm surge time-related-expenses vulnerability functions for:
17. in-situ personal residential buildings of various construction types.
18. manufactured homes.
19. Data Analysis of collected actuarial data in preparation for validation and calibration.
20. Document and test the code of the roughness model to include the effect of land surface friction on offshore wind flow near the coast.
21. Specify requirements for the freshwater flooding model.
22. Design, implement, and test the computer code for the freshwater flooding model.
23. Prepare documentation and report.

**Tasks due or ongoing in 12 months**

1. Examine computational time and stability of the CEST model on the South Florida and Florida Atlantic Basins. Compute maximum storm surge heights and associated wind speeds, and maximum wind speeds and associated storm surges using a subset of stochastic storms, subject to the availability of the stochastic storm set generated by the FPHLM wind model.
2. Create wave grids for the Florida Atlantic Region. Populate the wave grids with bathymetric, topographic, 2011 land cover data. Test wave grids and test the integration of the CEST model with wave model.
3. Compute wave heights associated with maximum storm surges in the South Florida and Florida Atlantic Regions using a subset of stochastic storms, subject to the availability of the stochastic storm set generated by the FPHLM wind model.
4. Build storm water management models (SWMM) at a relatively coarse spatial scale for the remaining Gulf coasts basins. Calibrate and validate the two models to predict storm water flooding depths in the basins during extreme rainfall events.
5. Spatially disaggregate the coarse-scale flooding depths to estimate flooding depths at fine-scale (30m blocks) at any locations for the basins.
6. Based on the results of previous tasks, develop storm surge building vulnerability functions for:
7. low-rise commercial residential buildings of various construction types.
8. units of mid/high -rise commercial residential buildings.
9. Based on the results of previous tasks, develop storm surge contents vulnerability functions for:
10. low-rise commercial residential buildings of various construction types.
11. units of mid/high -rise commercial residential buildings.
12. Based on the results of previous tasks, develop storm surge time-related-expenses vulnerability functions for:
13. low-rise commercial residential buildings of various construction types.
14. units of mid/high -rise commercial residential buildings.
15. Examine the surge and wave compatibility at the overlap area between two basins.
16. Develop new input-output libraries and interfaces for the SWMM model to (i) read rainfall data provided by the WIND team; (ii) run the SWMM model automatically for thousands of simulation; and (iii) generate numeric (spatially explicit, hourly time-series) and graphical outputs (on GIS maps of the study basins).
17. Run the built SWMM models for the 7 large basins to generate the required number of simulations that provide spatially explicit freshwater flooding depth under different rainfall events.
18. Based on the results of previous tasks develop fresh water inundation building vulnerability functions for:
19. in-situ personal residential buildings of various construction types.
20. manufactured homes.
21. low-rise commercial residential buildings of various construction types.
22. units of mid/high -rise commercial residential buildings.
23. Based on the results of previous tasks develop fresh water inundation contents vulnerability functions for:
24. in-situ personal residential buildings of various construction types.
25. manufactured homes.
26. low-rise commercial residential buildings of various construction types.
27. units of mid/high -rise commercial residential buildings.
28. Based on the results of previous tasks develop fresh water inundation time-related-expenses vulnerability functions for:
29. in-situ personal residential buildings of various construction types.
30. manufactured homes.
31. low-rise commercial residential buildings of various construction types.
32. units of mid/high -rise commercial residential buildings.
33. Develop actuarial model for estimating losses from storm surge and rain flood.

*Ongoing. Interim report.*

1. Actuarial modifications for policy characteristics. Make appropriate actuarial modifications for deductibles, policy limits, replacement cost etc. Model deductibles.

*Ongoing. Interim report.*

1. Develop and test storage and retrieval of the wind, storm surge, and wave data for the damage function.

*Timeline: ongoing to year 3.*

1. Document the codes and utility programs developed in 2014-2015.

*Ongoing to year 3.*

1. Design, implement, and test the computer code and database schemas for the optimized system for conducting a large number of stochastic simulations using the combined wind/surge/wave models.
2. Adapt as needed the rain intrusion vulnerability model for low-rise and mid/high-rise commercial residential models to use the output of the new rain model.

 *Ongoing to year 3.*

1. Design, implement, and test the computer code of the coupling of the rain model and rain intrusion vulnerability models for the mid/high-rise commercial residential model.

 *Ongoing to year 3.*

1. Assess distributional fits as needed for the development of the model components..

*Timeline: Ongoing.*

1. Statistical analysis as needed to assist the meteorology, surge and hydrology and the actuarial teams in developing statistical models for various parameters as needed.

*Timeline: Ongoing.*

1. Prepare documentation and report.