Interim Report:

Survey and Investigation of Buildings Damaged by Category III, IV and V Hurricanes in FY 2018-2019- Hurricane Michael

Project #: P0091032

Submitted to:

Florida Department of Business and Professional Regulation

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Report No. 03-19
21 March 2019

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Executive Summary

On October, 10 2018, Hurricane Michael made landfall just south of Panama City, FL with the National Hurricane Center reporting a minimum pressure 919 MB and maximum sustained winds of 150 mph. Surface observations near the eyewall measured peak wind gusts of at least 130 mph at 10 m height, but gusts may have been higher as several observation stations were damaged and stopped reporting. Regardless of its place in history, Hurricane Michael caused catastrophic damage from high winds over a wide swath that stretched across much of the FL panhandle and inland into southeastern GA and beyond. Best estimates of the hurricane wind field indicate that design wind speeds for many structures were exceeded for a sizable region near Mexico Beach and further inland. Heavy storm surge inundated regions from Tyndall Air Force base down through Mexico Beach (8-12 ft storm surge inundation reported), Port St. Joe, Apalachicola, and the barrier islands.

The University of Florida in coordination with several other groups mounted a coordinated response to identify the major damage caused and assess the intensity of the wind speeds and storm surge that created the damage. The effort involved field assessment by door-to-door inspections of structures, use of unmanned aerial vehicles and comparing with existing geolocated photographs of conditions before the event. The extent of the assessments included Panama City Beach, Panama City and surrounding communities, Mexico Beach, Port St. Joe, Apalachicola, a few routes out to barrier islands in the region, and the inland communities of Blountstown and Marianna.

In general, FAT-1 observed widespread wind- and surge-induced damage from Panama City Beach down to Apalachicola, with extensive joint wind- and surge-induced damage in Mexico Beach.

- **Structural Wind Damage:** Structural wind damage was widely observed in Panama City but highly variable, with adjacent buildings often exhibiting highly disparate levels of damage. In Panama City Beach, and inland areas such as Marianna and Blountstown, structural damage was more isolated but roof cover and wall cladding damage was still frequently observed. In coastal regions, including Mexico Beach and Port St. Joe, multiple buildings were destroyed by the high winds but destruction was still not uniform.

- **Storm Surge Damage:** Storm surge was most prevalent from Mexico Beach down into to the Big Bend, including Apalachicola. Structural surge-induced damage was mostly confined to an approximately 1-mile stretch of Mexico Beach and portions of Port St. Joe. Washout of roads and coastal features was documented in multiple areas.

- Anecdotally, the most extreme levels of damage were observed in older (pre-2002) structures, while newer structures generally performed much better. However, roof cover and wall cladding damage was still commonly observed even in newer structures. Failures were frequently observed in both engineered and non-engineered buildings.

Introduction

Hurricane Michael was a design level event for storm surge and damaging extreme wind speeds in the Florida Panhandle. The hurricane particularly affected Mexico Beach and Panama City and nearby coastal towns as well as interior areas, such as Blountstown and Marianna FL located north of the I-10 Interstate highway. Many hundreds of houses, businesses were damaged or destroyed, some swept away by up to 19 ft. storm surge, others by inland flooding and yet others were broken apart by as building components of structures failed in high winds. The peak wind speeds exceeded the design wind speed for many areas of the Panhandle which ranged from 130 to 145 mph.

The Florida Building Commission *voted unanimously to:*

Accept UF's Presentation/Report Regarding Hurricane Michael Initial Triage Damage Assessment Effort; and, to approve using existing funds to expand the scope of work to conduct Phase II activities to include interim additional damage investigations/data collection, site visits to investigate the performance of building envelope products, and data processing and information extraction with the scope of work to be negotiated and administered by DBPR staff. The scope of the work is as follows:

Data Processing and Information Extraction

- Detailed post-processing, quality assurance and quality control (QA/QC) of the collected data, currently stored in the Fulcrum.com database. Information on specific houses will be augmented with data extracted from UAV imagery (collected by UF) and other available sources.
- Where feasible we will utilize remote data collection sources, such as the NOAA and NICB aerial imagery in combination with StreetView imagery (collected by StEER and others) to expand the damage assessment database.
- The database will be formatted to query the damage down to the building component level of damage (i.e., percentage of roof cover damage %, percentage of sheathing damage etc.)
- During our data collection, we will identify the relative popularity and performance of various exterior building roofing and siding systems used on residential construction, including vinyl siding and vinyl soffits.
- We anticipate collecting large enough sample sets of each material or system to enable statistically robust analysis to be conducted (e.g., > 10 - 20 samples of a given product type within a local area and similar wind speed and terrain conditions) as well as a few individual case studies where appropriate.

Augment Data Using House Appraisers' Website Metadata

- We will augment the database with building attribute data from the county attribute and permitting data and local terrain classifications to parse out the influence of building code changes on observed damage, and failure rates in code-compliant buildings.

Interior Damage Data Collection:

- Where appropriate, the Contractor will set up and interview homeowners' resident in the specific areas of our surveys to estimate the extent of interior damage suffered and the costs for repairing them. Our experience from the previous Hurricane Irma and Hurricane Matthew leads us to expect a low response rate to this solicitation yet UF feels this is an important aspect of hurricane damage that ought to be quantified.
- We will contact homeowners by mailings (postcards and flyers), and by in-person in one or two site visits to the areas, if necessary. We will query homeowners regarding mitigation actions they took ahead of the storm, evacuation actions, and the interior and exterior damage to their houses.

Tasks To Date:

Following our Preliminary Damage Survey, in which the University of Florida conducted two damage surveys immediately following the landfall of the hurricane, we presented that information to the Florida Building Commission in December 2018. As seen in **Figure 1**, projected maximum wind gusts along the Florida coastline varied from 40 mph to 140 mph, although the National Hurricane Center reported wind speeds as high as 155 mph. At any given point however, the maximum wind speed and direction from which it occurs is a function of the distance to the hurricane eyewall, the local terrain surrounding the point, and the presence of any convective features within the hurricane wind field. The hurricane gradually weakened as it traveled across land, but was still a Category 3 as the eye passed from Florida to Georgia, with measured sustained wind speeds reaching 115 mph. Although it quickly deteriorated in a matter of hours, tropical storm-level winds were experienced by the Carolinas, as well as in Northern Georgia.

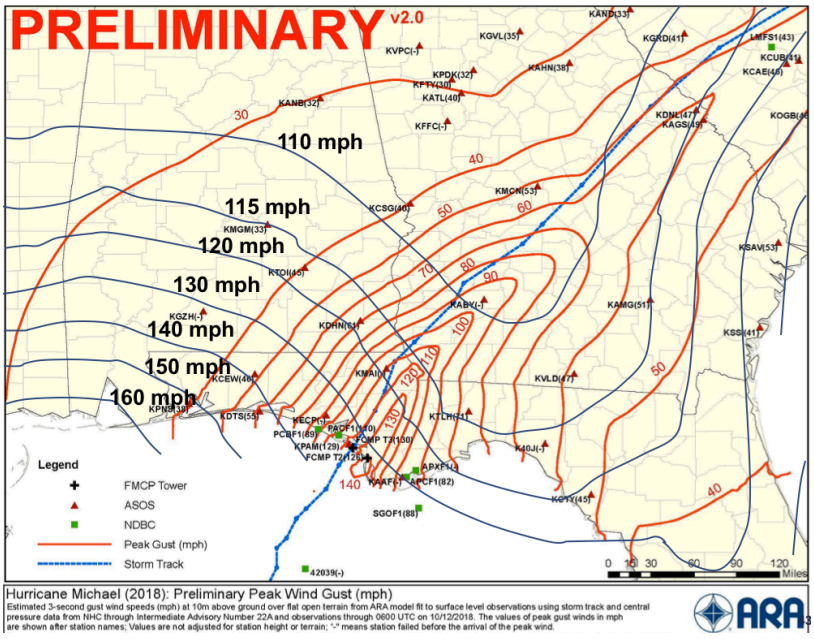

Figure 1: Estimated 3s peak wind gust by ARA (assumes open terrain and 10 meter height) (Courtesy of NIST) Superimposed on the map are the Design Wind Speeds for the area (blue lines)

The link to this 12 December 2018 presentation can be accessed here: https://www.dropbox.com/s/ynthr5o2tsch1df/FBC_Hurricane_Michael_Prevatt%20Prelim-12-11-2018.pptx?dl=0

Our surveys revealed widely variable structural performance of buildings. The surveys also suggested that the age of buildings may play a part in the extent of the damage to individual structures. In some cases, it appeared that the age of the structures appears to have greatest influence on whether it was just damage or completely destroyed. However, additional analysis is required to be able to establish conclusive trends. This report summarizes the progress in the proposed follow-up study which ties back to meta-data on structures obtainable from the relevant State Building Appraisers' websites and links the construction materials, building code and other parameters to wind loading, storm surge and damage observed.

We surveyed approximately 800 locations that exhibited some damage levels from Hurricane Michael extending from Panama City through the Big Bend Area to the east, including Apalachicola. The data set contains the majority of locations from Panama City (45%) and 40% are located in Mexico Beach. About 4% of the remaining locations are in outlying areas of Port St. Joe, Blountstown and Mariana, Figure 2.

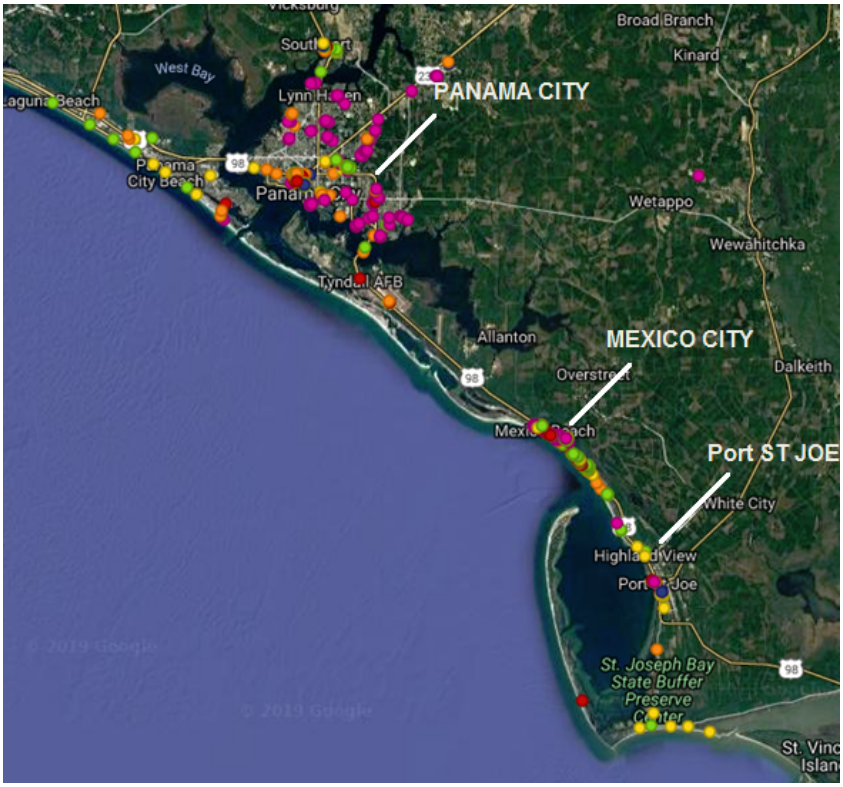

Figure 2: Data Points Distribution

In order to verify our data sets, the research team is currently doing quality control on the data sets using the existing server data Fulcrum app (https://www.fulcrumapp.com). (note that this data has been publicly available since immediately after the event at: https://www.fulcrumapp.com/community/hurricane/.

Each available record includes meta data on the location surveyed (i.e. address, GPS coordinates, etc.), as well as photographs of the damage to the structure that we observed. Following our field work in some of the records we added the Before-Storm condition photographs taken from publicly available sources, such as Google Maps, Figure 3.

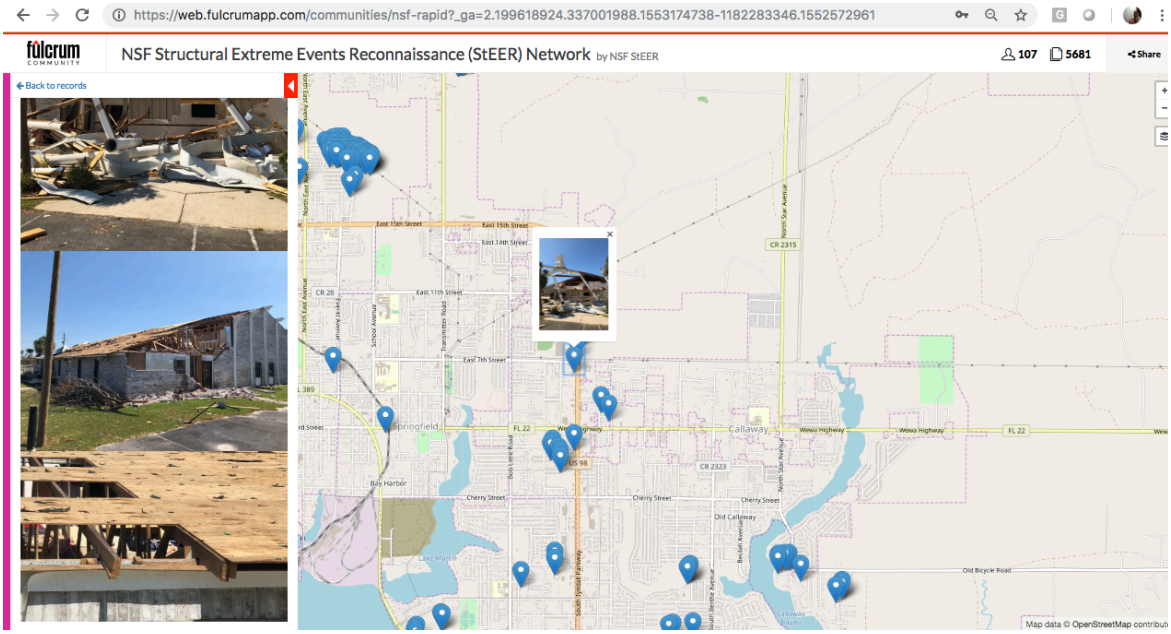

Figure 3: Location of Sample Screen from the FULCRUMM Community Server Showing Location and Photographs of Damaged Structure

Once all quality control issues are addressed, the dataset created from the damage survey will be combined with information to be extracted from the Property Appraiser's publicly available Dataset, to augment categories such as the building age, exterior building envelope materials, building permit information and other pertinent information that is available

The current status of the tasks are summarized as follows:

<u>Task A: Data processing and information extraction.</u>

- Data librarians have completed Stage 1 of the post-processing protocol, which involved verifying the correct location and address of the field-created damage records in the Fulcrum database.
- Four of the seven UAV datasets have been processed into 3D densified point clouds and integrated into the post-processing protocol for use by the data librarians in quantifying damage.
- Gridded wind speed and direction time history outputs has been requested from NIST/ARA for Hurricane Michael and Hurricane Irma and is currently being

compiled by the same for delivery to the researchers. This data will allow damage to be quantified relative to dominant wind directions.

- Once UAV imagery is fully processed, precise material and damage identification and quantification will get underway.

Task B: Augment Data using County Appraiser Database

- A protocol has been developed in Matlab for automating the definition of building attributes in the Fulcrum database using building attributes provided in the Gulf and Bay County property appraisal databases.
- The protocol allows for attributes including year built, effective year built, number of stories, living area, roof cover material, wall cladding material, and more to be automatically assigned in the Fulcrum database using spatial and relational joining techniques.
- A methodology has been developed, in the form of a Matlab script, for parsing building permit information associated with individual buildings present in the Fulcrum database. The methodology allows for the automated matching of permit data (such as permit type, year, value, etc) with individual buildings.
- The automated matching process is being completed now for Bay and Gulf Counties.