Final Report:

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

Project #: P0091032

Submitted to:

Florida Department of Business and Professional Regulation
Mo Madani, Program Manager
Building Codes and Standards
1940 North Monroe Street
Tallahassee, Florida 32399

Prepared by:

David O. Prevatt, Ph.D., PE (MA)
Principal Investigator
Associate Professor (Structures)

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David B. Roueche, Ph.D.
Assistant Professor (Auburn University)

Research Assistants:
Alina Gautam Acharya, Rodrigo Castillo, Xinyang Wu, Oscar Lafontaine
(University of Florida)
Brandon Rittelmeyer, Charner Blue, Brett Davis, Meredith Goergen, Kevin Ambrose
(Auburn University)

Engineering School of Sustainable Infrastructure and Environment
Department of Civil and Coastal Engineering
University of Florida
365 Weil Hall
P.O. Box 116580
Gainesville, FL 32611-6580

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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, 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, vehicle-mounted panoramic cameras, 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.

Structural damage was predominately experience by older (pre-2002) structures, while newer structures generally experienced no more than roof cover and wall cladding loss. 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.

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1 Hurricane Michael

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.

2 OVERVIEW AND SCOPE OF WORK

The University of Florida conducted two damage surveys immediately following the landfall of the hurricane and that data was presented to the Florida Building Commission in December 2018. It revealed widely variable structural performance of buildings. The surveys also suggested that the age of buildings might 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 destroyed. However, additional analysis is required to be able to establish conclusive trends. We propose this follow-up study to tie back to meta-data on structures obtainable from the relevant State Building Appraisers' websites to link the construction materials, building code and other parameters to wind loading, storm surge and damage observed.

2.1 Task A: 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.

2.2 Task B: Augment Data using County Appraiser Database

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.

2.3 Task C: 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.

3 TASKS FOR INTERIM REPORT:

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.

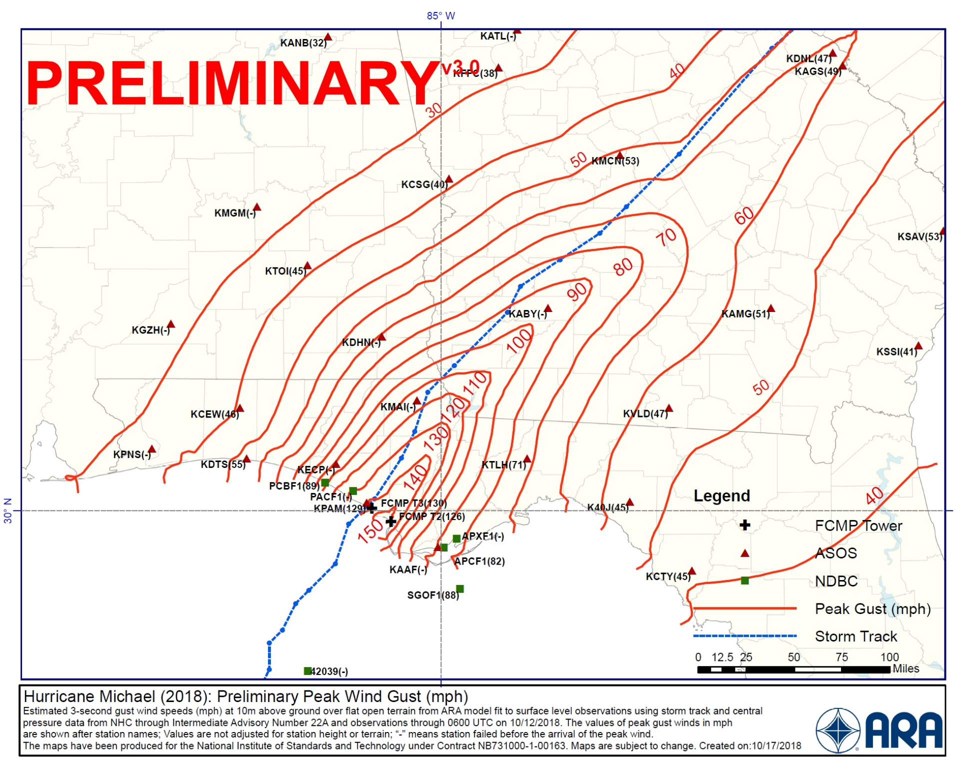


Figure 1. Estimated 3s peak wind gust by ARA (assumes open terrain and 10 meter height) (Prevatt et al. 2018)

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.

Currently we are proceeding with the data enrichment and quality control process. 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%), while 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.

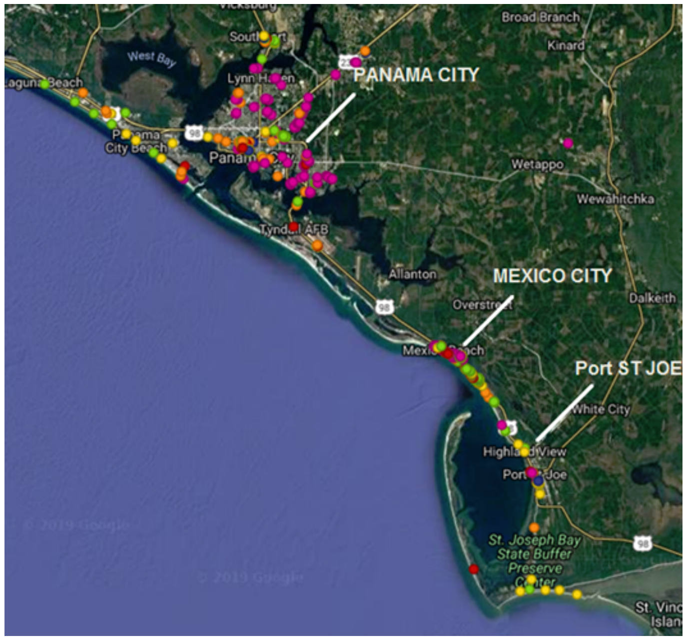


Figure 2. Data Points Distribution

In order to verify our data sets, the research team did 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://web.fulcrumapp.com/communities/nsf-rapid.

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

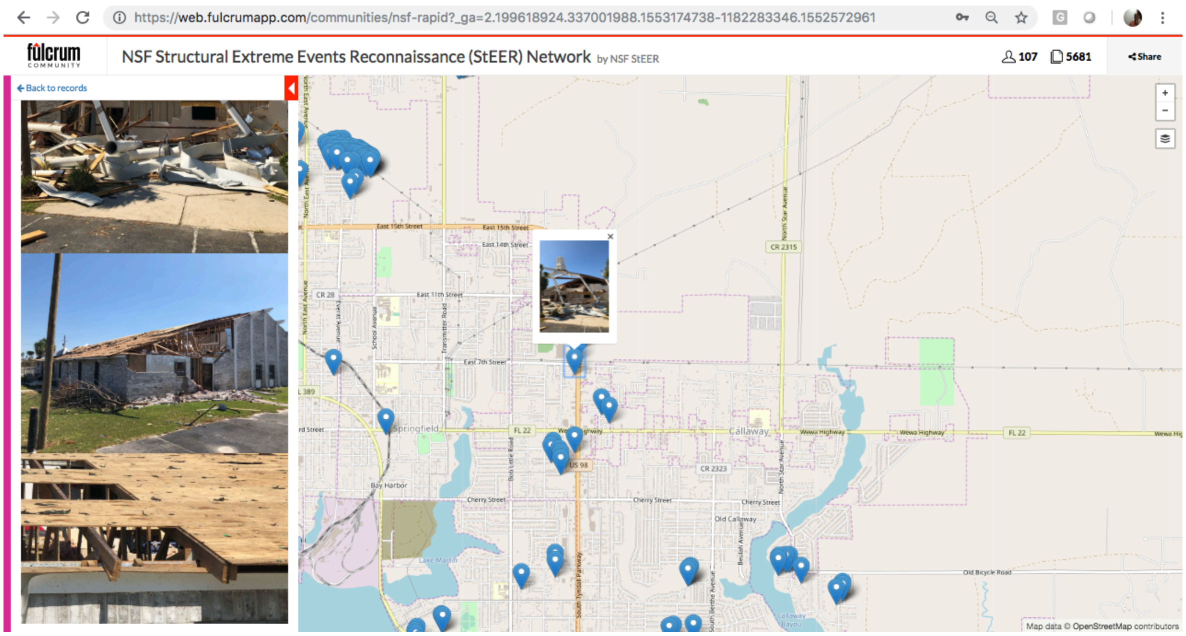


Figure 3**:** Map Showing the damaged structure

After addressing the quality control issues, the dataset created from the damage survey combined with information 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

4 RESOURCES FOR DAMAGE ASSESMENT

Detailed information of the methodology and resources used for performing damage assessment can be found in Roueche et al. (2018). The following summarizes the major tools and their uses deployed during the field reconnaissance efforts. Figure 4 illustrates the synthesis of the various reconnaissance tools for a given area. The overlapping assessment methodologies improve the quality and depth of the datasets generated from post-hurricane deployments.

Figure 4. Overview of the structural data capture strategy following Hurricane Michael.

4.1 Door-to-Door Assessments

Door-to-door assessments were conducted using the Fulcrum app through a Fulcrum Community account provided to the team by Spatial Networks, Inc. The Fulcrum app enabled the deployment of a customized, geo located assessment form created by the co-PI that focused on documenting key attributes of the building including number of stories, roof shape and slope, first floor elevation, structural load path, roof and wall construction materials, opening types and sizes, and damage experienced during the hurricane. The Fulcrum app was used in tandem with the associated web platform, enabling reconnaissance teams to move quickly and efficiently in the field, while data librarians ingested the raw field data synced to the web platform, and enriched it using data aggregation and extraction techniques described later in this document. Following the field deployments, each Fulcrum record (associated with a single building) typically contained multiple photographs of the target building, a precise geolocation of the building, field notes of key performance or damage factors observed by the investigator, and an overall assessment of wind and (if present) surge damage.

4.2 Aerial Imagery

Aerial imagery provided information from before and after the hurricane event which helped to identify building locations and damage extents. Aerial imagery from the following sources were primarily used in the study:

- National Oceanic and Atmospheric Administration post-Michael imagery acquired by the Remote Sensing Division. Much of the imagery was captured within two days of landfall, providing a rich dataset of the post-hurricane damage state prior to cleanup. The approximate ground sample distance for each pixel in the imagery is ~25 cm.
- Pictometry Eagleview was contracted to provide access to pre- and post-hurricane imagery, including both oblique and nadir viewing angles, for nearly the entire affected areas. Using the Eagleview ConnectExplorer web platform, homes could be viewed using the oblique views from the north, south, east, and west. A nadir (perpendicular to the ground) vantage point was also available.
- Midwest Aerials graciously provided access to a dataset of high-resolution images captured from a low-flying aircraft in the Mexico Beach, FL region. The imagery was stitched into a continuous orthomosaics and used to document damage in Mexico Beach, FL.

4.3 UAV Data

A variety of UAVs were used in the assessments, including a DJI Mavic Pro, DJI Phantom 4, and DJI Matrice. The DJI Phantom 4 and DJI Matrice UAVs were loaned to the research team by the University of Washington Natural Hazards Engineering Research Infrastructure RAPID Experimental Facility. The UAVs were primarily used to capture a dense grid of overlapping photographs in the same neighborhoods where D2D assessments were conducted. Photographs overlapped between 75% and 80%, and were captured at camera angles between 60° and 80° to ensure both top and side surfaces of buildings were visible in the imagery. The commercial software PIX4Dmapper was then used to construct orthomosaics and a 3D densified point cloud from the UAV imagery utilizing advanced photogrammetry techniques. Processing was done in the cloud, which allowed for rapid sharing of the final datasets, as well as access to the raw imagery from which the 3D models were built.

The densified 3D point clouds were used to corroborate damage observations from the field, extend assessments to views of the building not visible in the D2D assessments (e.g., roof, back walls), and measure key building parameters such as roof slope, as shown in Figure 5.

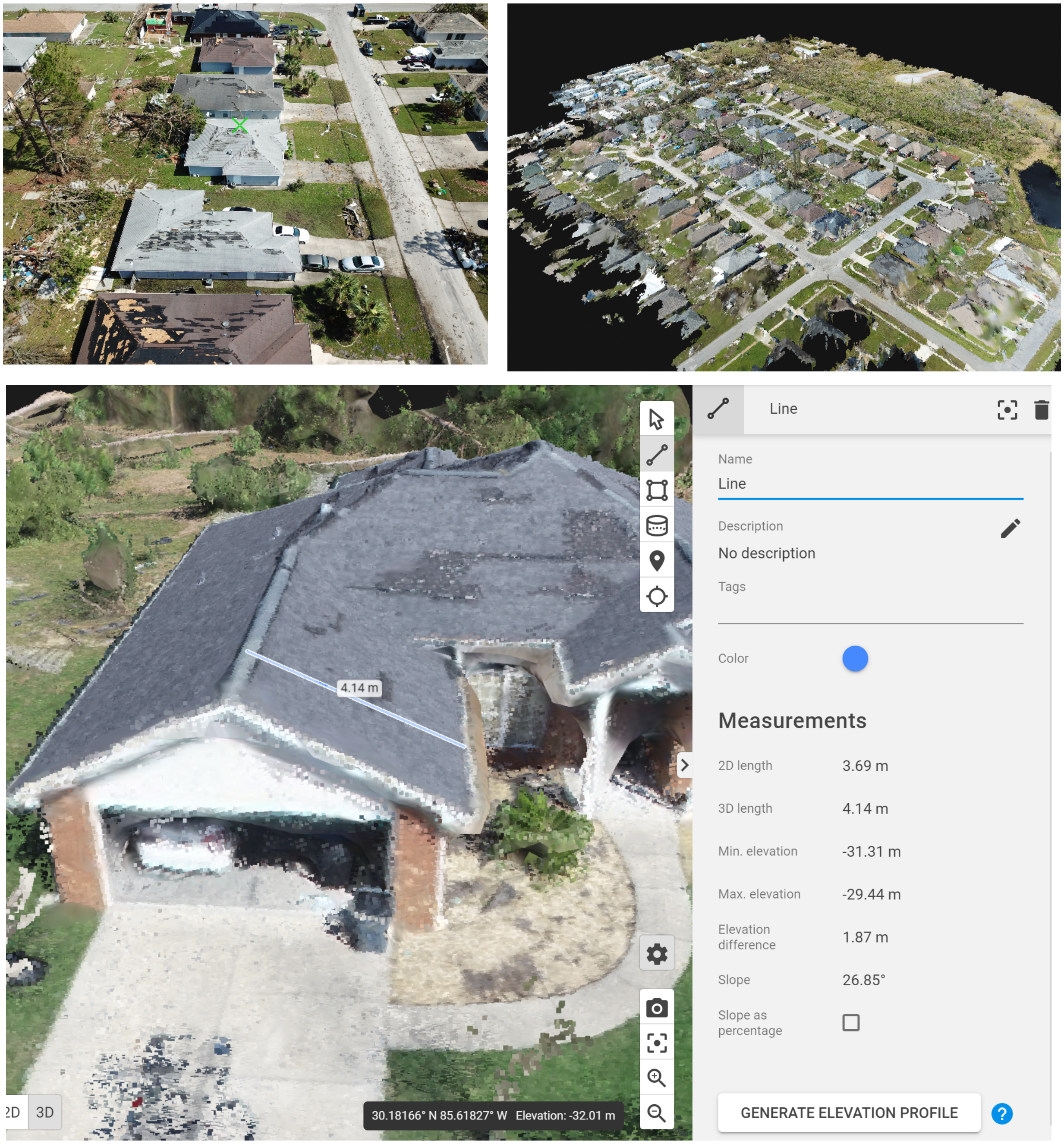


Figure 5. (Top Left) Single UAV photograph from the Cedar's Crossing dataset; (Top Right) Densified 3D point cloud of half of the Cedar's Crossing dataset, constructed from 392 photographs, resulting in a 2.5 cm (1 inch) ground sample distance; (Bottom) Roof slope measured using the 3D densified point cloud of Cedar's Crossing.

4.4 Applied StreetView Imaging

APPLIED StreetView Imaging is a vehicle-mounted panoramic camera capable of capturing the entire external view of a scene in high-resolution every five meters from a moving vehicle. The research team used StreetView imaging to rapidly capture post-hurricane conditions over large areas, filling in gaps between D2D assessments. In general, at least three sides of a given building were visible in the StreetView imagery if the vehicle it was mounted on pass by the building. The resulting dataset significantly expanded the breadth of the survey effort.

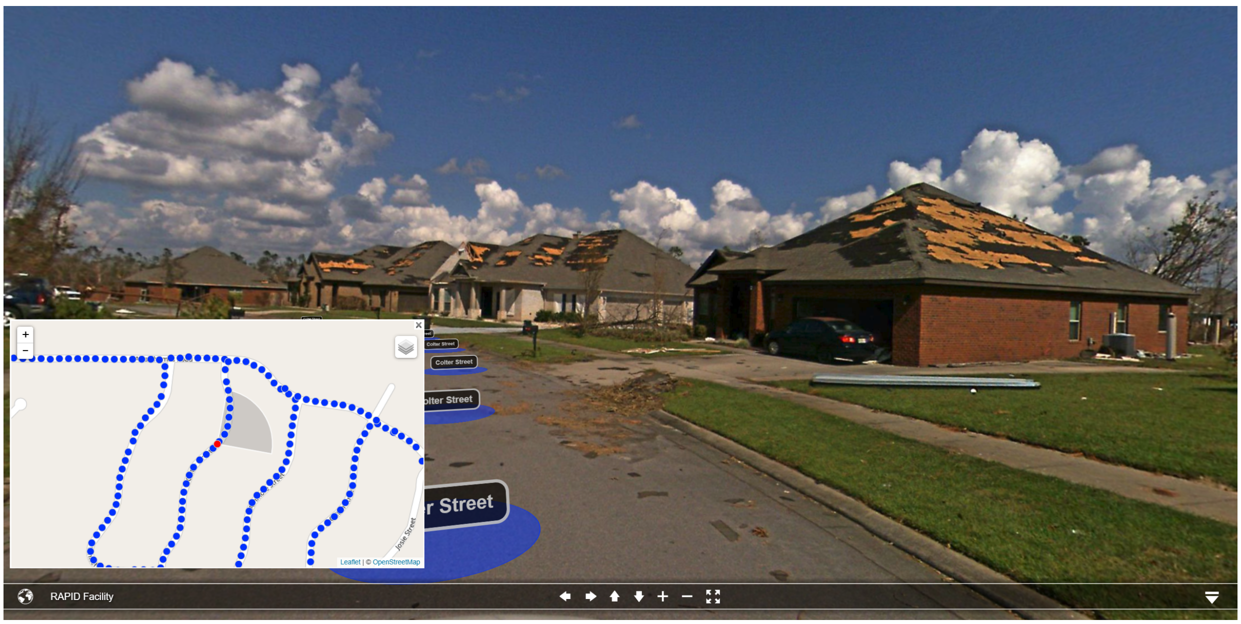


Figure 6. StreetView imagery of homes damaged by Hurricane Michael in Panama City, FL.

5 Data Enrichment and Quality Control Process

The raw data collected by the reconnaissance teams primarily consisted of the photographs and basic damage ratings. This raw database was built out using a robust data enrichment and quality control (DEQC) process that aggregated the various data sources together to extract key information from the raw data and associate it with public records to ensure a complete, quality-controlled database is available for further data analysis. Each record in the final database will have up to 99 fields associated with, described in the sections below. The quality assessment and quality control stages are composed of five stages shown in Table 1 . These quality control stages are completed by following the described methodology in the next sections.

Table 1. Data enrichment and quality control process for building out post-hurricane datasets

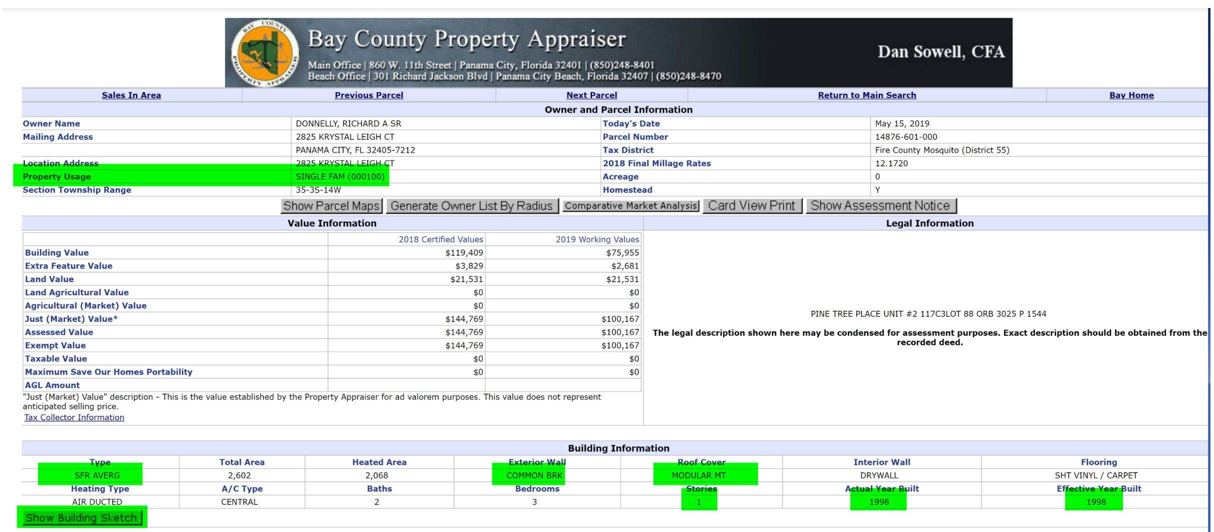
DEQC Stage	Tasks
1	Verify the location of the record.
2	Validate or fill out the minimum fields that can be considered a complete record in accordance with the StEER data standards. These fields are marked as QC Stage 1 in Table 1.
3	Verify, update, or add missing information in the app for parameters that should be available through photographs, or supplementary data sources for the majority of records, e.g., damage ratios, building attributes.
4	Verify, update or add information that was not captured in the field and may not be available or applicable for all buildings, e.g., roof sheathing fastener type, roof-to-wall connection type. Typically these fields are noted as Field Priorities, and can generally be evaluated more readily in damaged buildings than undamaged buildings. Trained investigators are often needed to identify these fields in undamaged buildings while on-site.
5	Final QC validation and checks in preparation for curation on DesignSafe. Check for blank fields, inconsistencies (e.g., Gulf vs GULF County), etc.

5.1 Aerial Imagery for Accurate Geo-Location

Fulcrum provides geo-tagged locations for each record point, set as the user's location when the record was created by default. To confirm these locations, aerial imagery taken before and after Hurricane Michael was used for completing the first quality control stage by confirming the exact location of the record observed. Aerial imagery allows to see roof shape or the surroundings of a record which helps to identify the precise location. Google Street view pre-hurricane imagery was also used to verify the location.

5.2 Property Appraisal Website

Once the location of the record is confirmed, county property appraisal websites are used to obtain available information for most buildings. These websites can provide information regarding building type, exterior wall constituents, roof cover type, construction year, main wind force resisting system type, etc. Building sketches provides plan view dimensions and porch locations in residential homes which are useful for estimating fenestrations areas.



Bay County Property Appraiser

Main Office | 860 W. 11th Street | Panama City, Florida 32401 | (850)248-8401
Beach Office | 301 Richard Jackson Blvd | Panama City Beach, Florida 32407 | (850)248-8470

Dan Sowell, CFA

Sales In Area | Previous Parcel | Next Parcel | Return to Main Search | Bay Home

Owner and Parcel Information

Owner Name	DONNELLY, RICHARD A SR	Today's Date	May 15, 2019
Mailing Address	2825 KRYSTAL LEIGH CT	Parcel Number	14876-601-000
	PANAMA CITY, FL 32405-7212	Tax District	Fire County Mosquito (District 55)
Location Address	2825 KRYSTAL LEIGH CT	2018 Final Millage Rates	12.1720
Property Usage	SINGLE FAM (000100)	Acreage	0
Section Township Range	35-3S-14W	Homestead	Y

Show Parcel Maps | Generate Owner List By Radius | Comparative Market Analysis | Card View Print | Show Assessment Notice

Value Information

	2018 Certified Values	2019 Working Values
Building Value	$119,409	$75,955
Extra Feature Value	$3,829	$2,681
Land Value	$21,531	$21,531
Land Agricultural Value	$0	$0
Agricultural (Market) Value	$0	$0
Just (Market) Value*	$144,769	$100,167
Assessed Value	$144,769	$100,167
Exempt Value	$144,769	$100,167
Taxable Value	$0	$0
Maximum Save Our Homes Portability	$0	$0
AGL Amount		

"Just (Market) Value" description - This is the value established by the Property Appraiser for ad valorem purposes. This value does not represent anticipated selling price.

Tax Collector Information

Legal Information

PINE TREE PLACE UNIT #2 117C3LOT 88 ORB 3025 P 1544

The legal description shown here may be condensed for assessment purposes. Exact description should be obtained from the recorded deed.

Building Information

Type	Total Area	Heated Area	Exterior Wall	Roof Cover	Interior Wall	Flooring
SFR AVERG	2,602	2,068	COMMON BRK	MODULAR MT	DRYWALL	SHT VINYL / CARPET
Heating Type	**A/C Type**	**Baths**	**Bedrooms**	**Stories**	**Actual Year Built**	**Effective Year Built**
AIR DUCTED	CENTRAL	2	3	1	1998	1998

Show Building Sketch

Figure 7. Typical damage assessment useful information from property appraisal website

To facilitate the matching process, a statewide Florida parcel database provided through the Florida Geographic Database Library was spatially joined with the post-hurricane database using spatial join techniques in Matlab. Attributes pulled from the statewide parcel database included the year built, effective year built, property use code, and physical address. The property use code and physical address were used to validate the location and address of the post-hurricane database. Once validated, the year built and effective year built were automatically matched to the corresponding homes in the post-hurricane database.

5.3 Damage Assessment Information

Building locations and characteristics are already known at this stage which complete most of the fields for quality control 1 and 2. Damage information fields are now completed by using the pictures collected during the field surveys. These pictures generally include all the elevation views for the observed building as well as close-up pictures of observed exterior or interior damage. Aerial imagery is also used to observe roof damage. CoNNECT Explorer Pictometry has images from before and after Hurricane Michael. The densified 3D point clouds processed in PIX4Dmapper Cloud and associated high-resolution imagery was also used to complete any missing information of a record. The fields that are completed for damage assessment include the following:

- Walls
    - Identify foundation and connection roof to wall connection types information (for most homes this is not visible)
    - Identify wall structure type
    - Identify wall substrate
    - Identify wall cladding
    - Identify soffit type
    - Calculate fenestration areas in each wall (described in next section)
    - Identify the presence of garage doors
    - Estimate damage percentages for each wall component, including soffit and fascia

- Roof
    - Measure roof slope
    - Identify roof shape
    - Identify roof structure system
    - Identify roof substrate
    - Identify roof cover
    - Identify if there has been damage to the roof structure, substrate or cladding

- Identify if there is any perceivable secondary water barrier
- Measure overhang length
- Estimate damage percentages for each roof component

5.4 Fenestration Area Calculation

Openings through the building envelope can enhance wind loads acting on the building significantly. Recognizing the importance of fenestration to the wind resistance of the building, the research team included detailed assessments of the fenestration types, sizes, protection and damage as best as possible within the constraints of the available data. This included detailing the percentage of each wall elevation (front, back, left, right) that was comprised of fenestration, whether any wind protection measures were installed or present for each wall elevation, and what proportion of the fenestration in a given wall was breached. The area of fenestration was estimated visually for most buildings, but initial visual estimates were confirmed using CONNECTExplorer, the 3D point clouds, and relative area techniques in order to calibrate the visual estimations and improve the overall accuracy of the estimates.

In addition to the fenestration ratios and protection fields, a separate set of fields within the assessment form focused on large openings such as garage doors and roll-up doors. The research team documented the type and location of each large opening of this type on the building.

5.5 Estimation of Damage Percentages

Damage ratios for walls, roof, fascia, fenestration, and foundation damage area are estimated based on the observed damage in record pictures or other images resources. Damage ratios are established by estimating the area of the observed damage in a house component or cladding and relating these to their total area. Figure 8 shows an example of an estimation of roof cover damage using CONNECTExplorer. For the case of walls, damage is related to their direction; front, back, left, right. Front wall direction is established by measuring a clockwise angle from the north up to the principal entrance of the building as illustrated in Figure 9.

Figure 8. Example of estimated area of roof cover damage

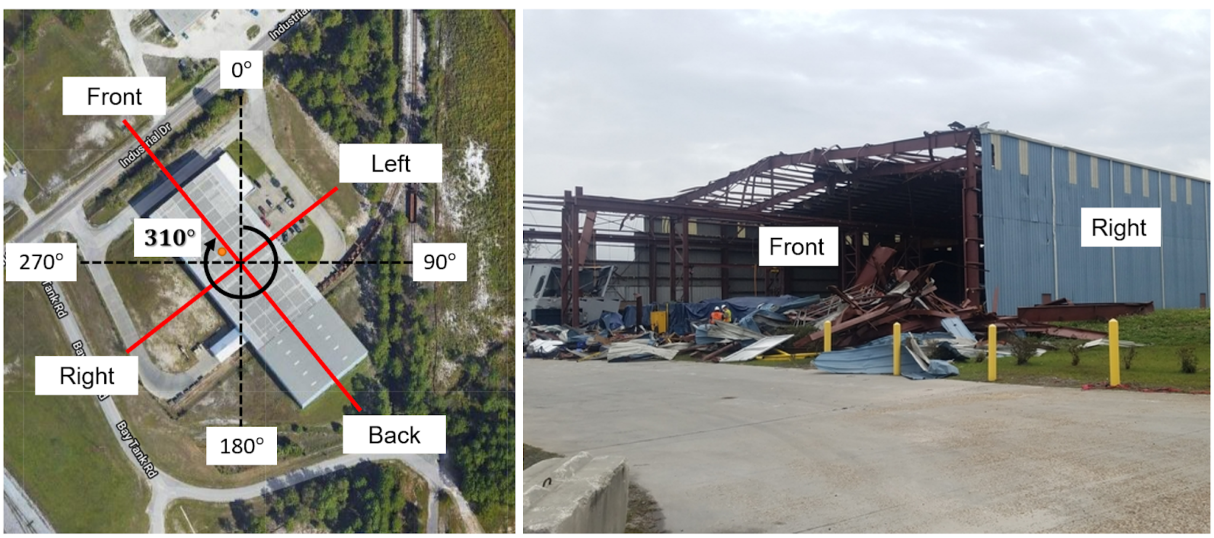


Figure 9. Definition of the convention used in defining the front, back, left and right of each structure. An arbitrary front wall was designated by the investigator, and its orientation measured clockwise from north. The remaining wall surfaces were defined based on an observer facing the front wall.

5.6 Damage Rating

Once the damage percentages are assigned to each building fields, an overall damage rating is assigned to that record. For residential houses, the damage rating is based on Vickery et al. (2006) goes from 0 to 4 and depends on observed damage to roof, walls, windows, roof substrate, roof structure and wall structure.

Table 2. Quantitative guidelines for assigning overall wind damage rating

Damage State	**Damage Description**	**Roof/Wall cover failure**	**Window/ door failures**	**Roof substrate**	**Roof structure failure**	**Wall structure failure[1]**
0	No visible damage	0%	No	No	No	No
1	Minor damage	> 2% and ≤ 15%	1	No	No	No
2	Moderate damage	> 15% and < 50%	> 1 and ≤ the larger of 3 and 20%	1 to 3 panels	No	No
3	Severe Damage	> 50%	> the larger of 3 and 20% and ≤ 50%	> 3 and ≤ 25%	≤ 15%	No
4	Destruction	> 50%	> 50%	> 25%	> 15%	Yes

Notes:
[1] Wall structure refers to walls in living area only. The ground floor of elevated structures often have breakaway walls that can be easily damaged by storm surge. This damage should be ignored in assigning the overall damage rating.
[2] A building is considered to be in the damage state if any of the shaded damage indicators in the corresponding row occurs

For storm surge, the damage states are mostly qualitative, based on Friedland (2007), and are defined as follows:

Table 3. Qualitative guidelines for assigning overall surge damage rating.

Damage State	**Damage Level**	**Damage Description**
0	None or Very Minor Damage	No floodwater impacts.
1	Minor Damage	Breakaway walls or appurtenant structures damaged or removed WITHOUT physical damage to remaining structure. No flood impacts the building
2	Moderate Damage	Some wall cladding damage from flood-borne debris. Breakaway walls or appurtenant structures damaged or removed WITH physical damaged to remaining structures.
3	Severe Damage	Removal of cladding from "wash through" of surge without wall structural damage.
4	Very Severe Damage	Failure of wall frame, repairable structural damage to any portion of building, or < 25% of building plan area unrepairable.
5	Partial Collapse	Building shifted off foundation, overall structure racking, > 25% of structure unrepairable.
6	Collapse	Total structural failure (no intact structure).

6 SUMMARY OF HURRICANE MICHAEL DATASET

The following summarize the dataset of buildings assessed by the research team following Hurricane Michael as it currently stands. The level of detail built into the database exceeds what was considered in the original scope of work, and has therefore taken more time than initially thought. At the time of this report, 30% of the swarth of building damage data enrichment process was completed.

6.1 General Overview with Respect to Wind Hazards

The current dataset consists of a variety of building types, summarized in Table 4, with a total of 749 buildings. Basic information, including the precise location, the year built, building type, wind damage rating, and surge damage rating (if present) are defined for all buildings in the dataset.

Table 4. Summary of buildings by type/use in the Hurricane Michael dataset.

Building Type	**Count**	**% Post-FBC**
Single Family Residence	585	38%
Multi-Family Residence	24	13%
Condominium	3	33%
Mobile/Manufactured Home	5	20%
Other (e.g. church, warehouse, motel, shopping center)	232	6%
Total	**749**	**33%**

The full post-Michael dataset spans a range of wind speeds, as shown in Figure 11. Wind speed estimates shown in are taken from the ARA wind field (Vickery et al. 2018), which was derived by conditioning a numerical hurricane wind field model to the available surface observations. Wind speeds are standardized to represent 3-second gust averaging time, open terrain, and 10 m above ground level. No adjustments have been made as yet in the current study to adjust the wind speeds for height or terrain. Assuming the ARA wind speeds provide a reasonably accurate estimate of the true wind speeds, a significant portion of the impacted region experienced wind speeds that exceeded the ultimate ASCE 7-10 design wind speeds (for a Category II building with return period of 700 years), as shown in Figure 10. This is reflected in the dataset of the current study, as approximately 50% of the assessed structures are estimated to have experienced peak wind speeds exceeding design levels, as shown in Figure 11.

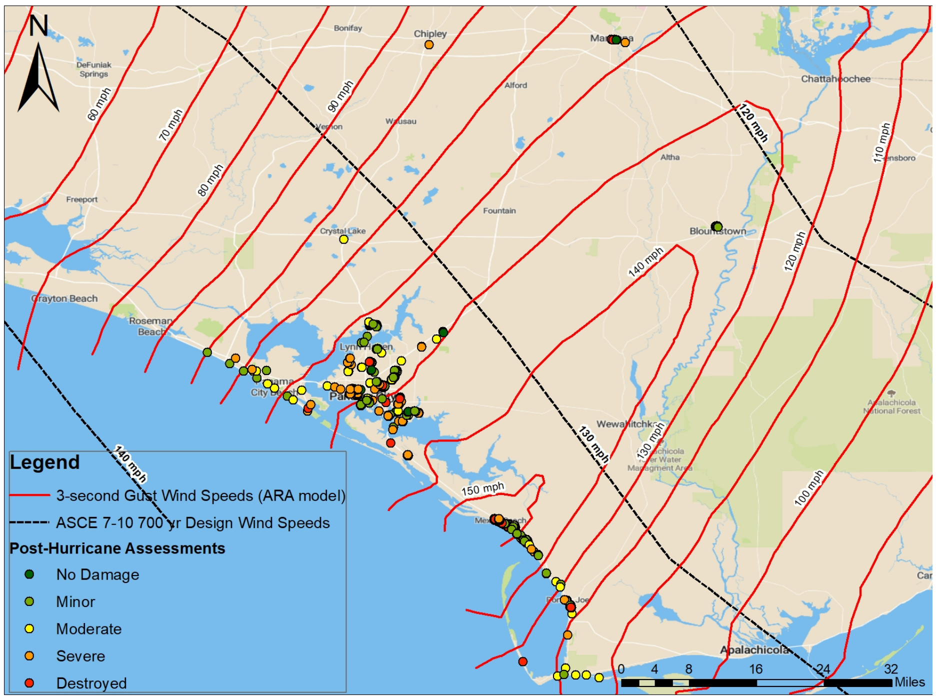


Figure 10. Map of all assessment locations in regions affected by Hurricane Michael with respect to the 700 year design wind speeds (ASCE 7-10) and the estimated peak 3-second gusts (open terrain, 10 m height) from the ARA windfield model (Vickery et al. 2018).

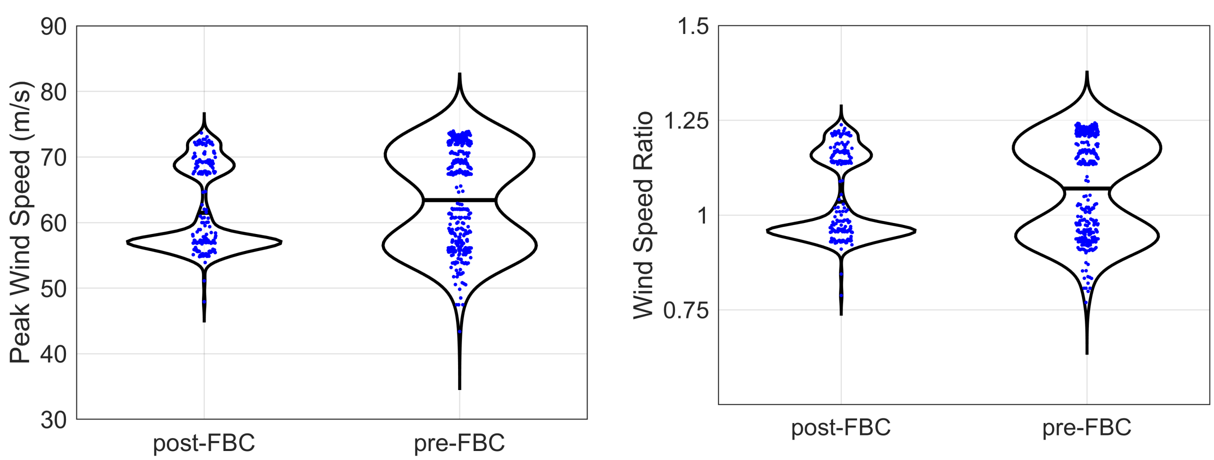


Figure 11. Violin plots depicting the distribution of (left) peak estimated wind speeds and (right) ratio of peak estimated wind speeds to ASCE 7-10 design wind speeds

(Category II structures) experienced by buildings in the dataset. Blue dots represent individual buildings. The shapes around the plots illustrate the distribution of the data using kernel density functions. The black horizontal lines depict the mean.

6.2 Detailed Assessments in Wind-Only Regions

A total of 171 buildings out of the complete dataset, all residential buildings, have so far undergone the full Data Enrichment and Quality Control protocol described in Section 5. These 171 buildings are strategically located primarily in five neighborhoods - Magnolia Hills, Brentwoods, Cedar's Crossing Gulf Aire, and Beacon Hill.

Table 5. Summary of neighborhoods in the Hurricane Michael dataset for which the full DEQC protocol has been completed.

Neighborhood	Number of Homes	% Post-FBC	Estimated Peak Gust Wind Speed	ASCE 7-10 (700 yr) Design Wind Speed
Magnolia Hills	21	100%	57 m/s	59 m/s
Brentwoods	15	100%	57 m/s	59 m/s
Cedar's Crossing	47	72%	57 m/s	60 m/s
Gulf Aire	58	12%	68 m/s	59 m/s
Beacon Hill	14	100%	68 m/s	59 m/s

Figure 12 and Figure 13 provide the distribution of wall cladding and roof cover materials in the detailed dataset by construction era. Brick and brick in combination with vinyl are the most common wall cladding materials in post-FBC homes, while fiber cement boards are also popular. In pre-FBC homes, full vinyl cladding was common along with stucco finishes.

For roofs, laminate shingles dominate the covering material for both pre- and post-FBC homes in the dataset, with 3-tab shingles and metal roofs capturing much of the remaining market share. Tile roof systems were rarely encountered throughout the study region.

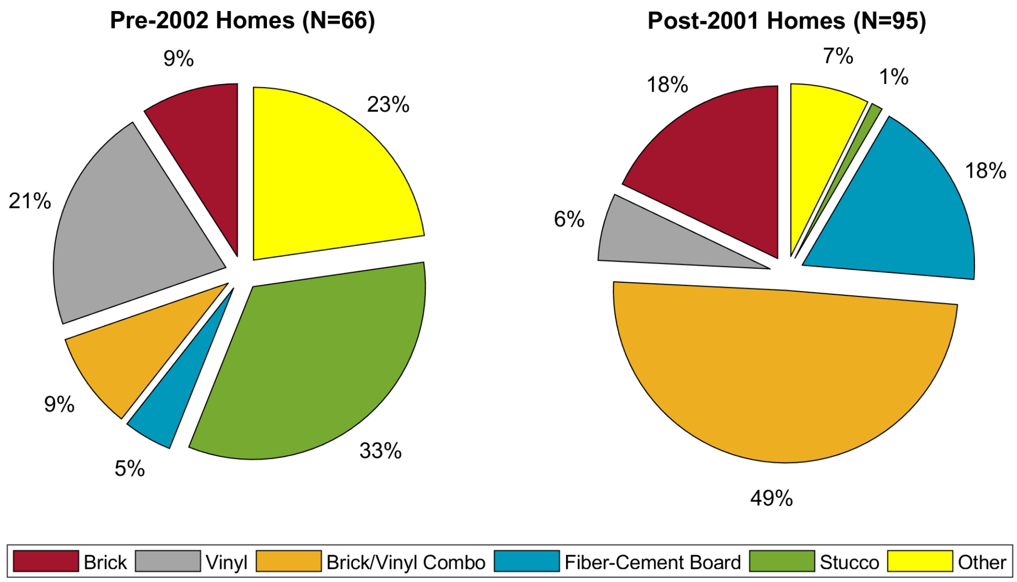


Figure 12. Distribution of wall cladding materials in the detailed assessments that have been completed to date (N = 171).

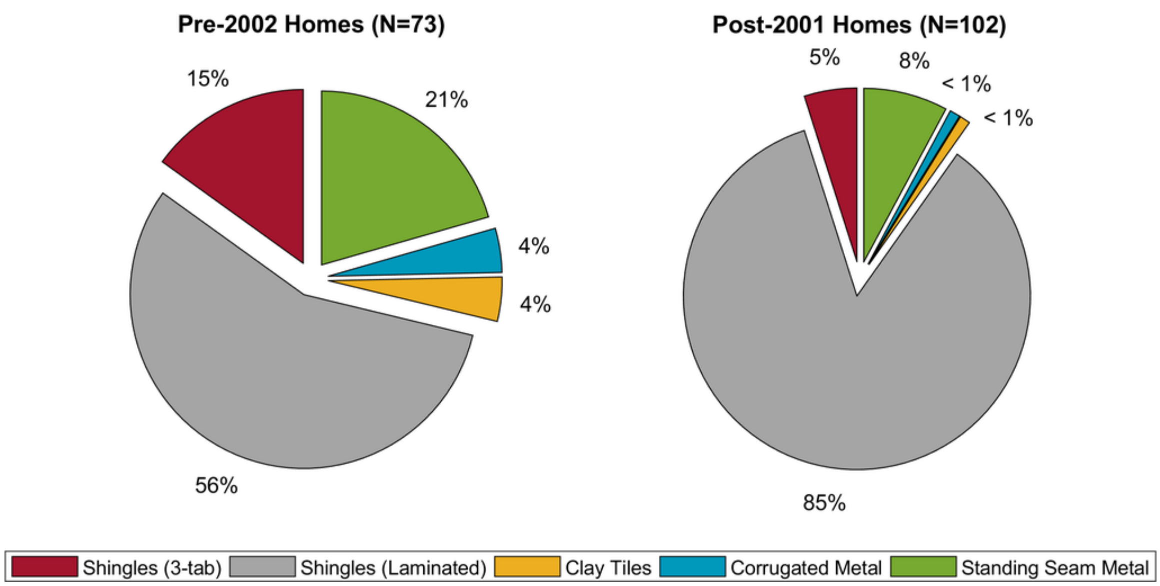


Figure 13. Distribution of roof cover materials in the detailed assessments that have been completed to date (N = 171).

6.3 General Overview with Respect to Storm Surge Hazard

The Hurricane Michael dataset contains 225 buildings that experienced non-zero storm surge inundation (Figure 14) according to estimates by the Coastal Emergency Risks Assessment (CERA) tool (Dietrich et al. 2013). Only 80 of the 225 buildings were seaward of the Coastal Construction Control Line (CCCL). The effect of the CCCL can be clearly seen in a map of the first floor elevations estimated by the research team shown in Figure 16. The first floor elevations are estimated as the height of the first floor of living space from ground level, and have an approximate uncertainty of +/- 0.2 m. Many of the estimates were obtained using the Pictometry CONNECTExplorer platform with pre-Michael imagery due to the homes being completely washed away by Hurricane Michael.

Many homes impacted by storm surge in Mexico Beach were inland of the CCCL and were constructed on slab-on-grade foundations. Some pre-FBC homes seaward of the CCCL were also constructed on slab-on-grade foundations. Post-FBC homes seaward of the CCCL were generally elevated 2.5 – 3.7 m (8-12 ft) above ground level.

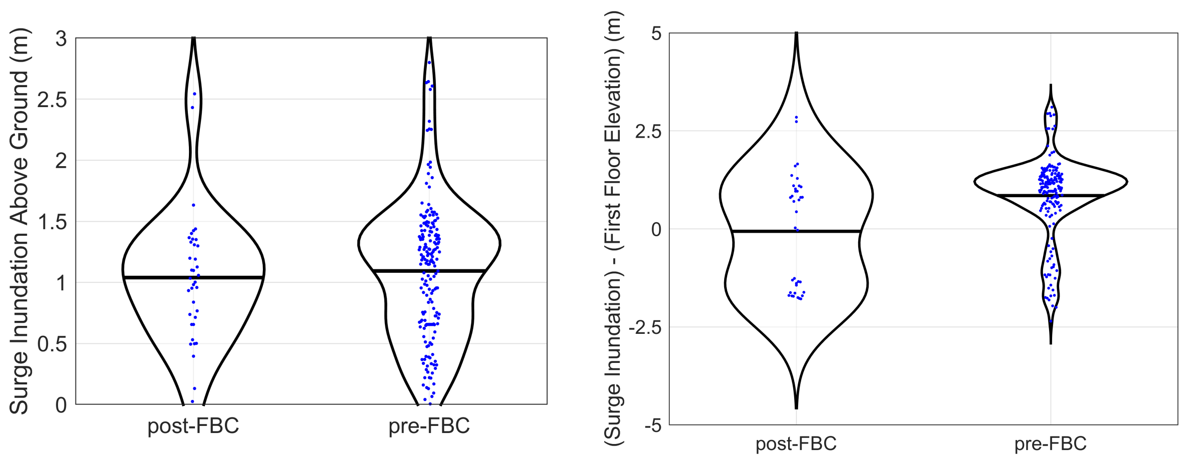


Figure 14. Violin plots depicting the distribution of (left) storm surge inundation above ground level as estimated by the CERA tool; and (right) storm surge inundation height minus the first floor elevation height. Blue dots represent individual buildings in the dataset. The shapes around the plots illustrate the distribution of the data using kernel density functions. The black horizontal lines depict the mean.

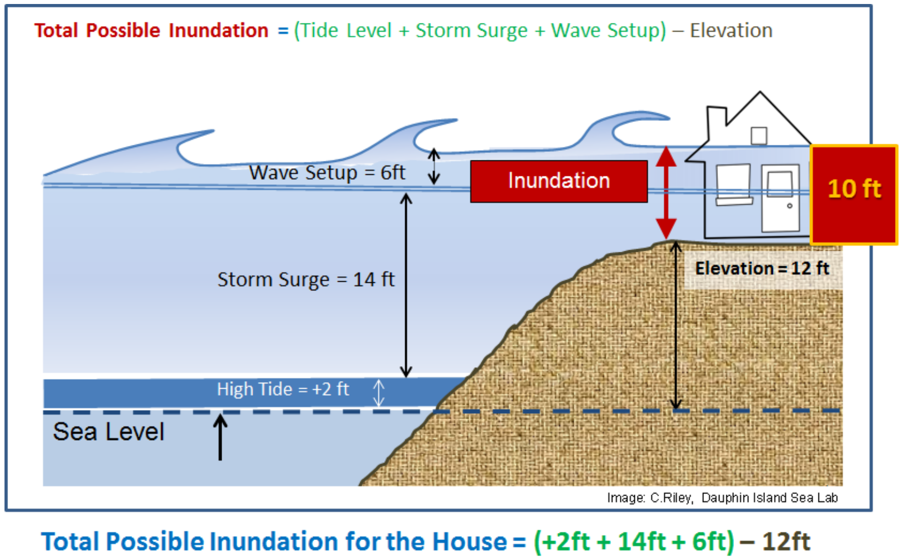


Figure 15. Definition of the storm surge inundation above ground level provided through CERA (Dietrich et al. 2013).

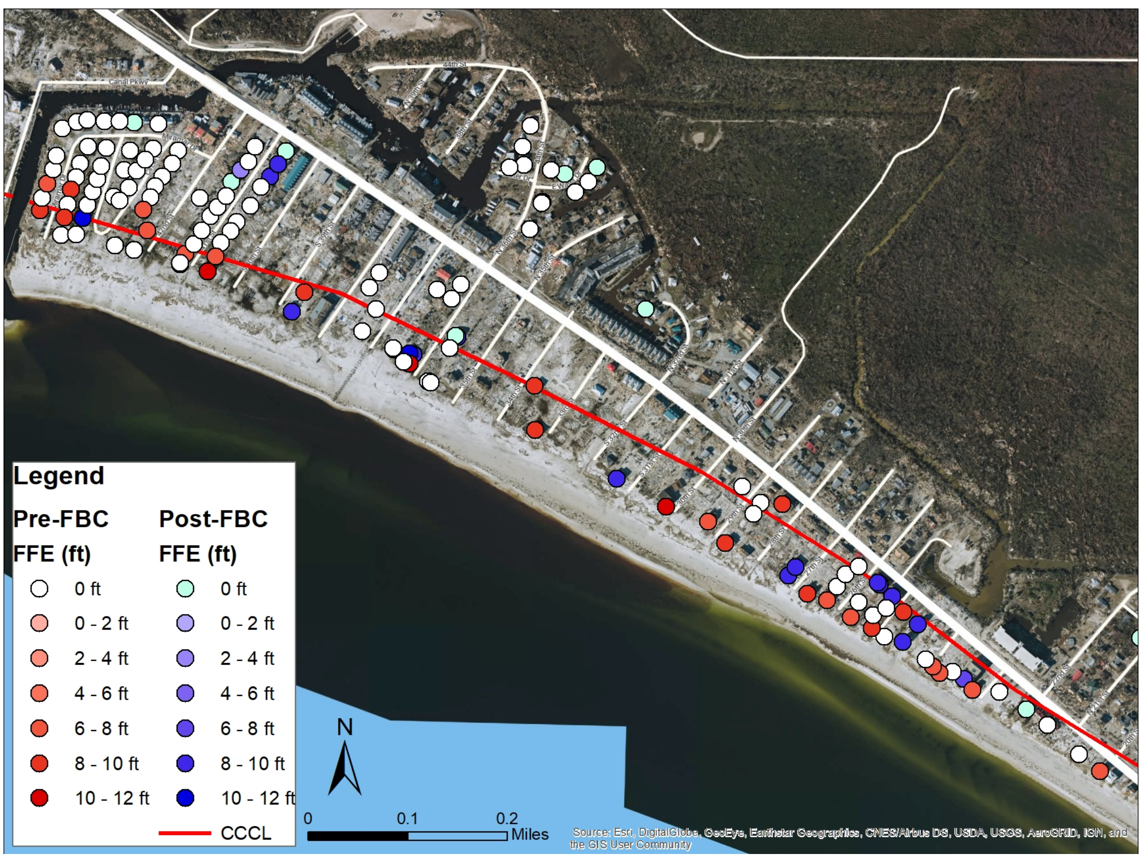


Figure 16. Assessment locations and first floor elevations in Mexico Beach, FL for pre- and post-FBC buildings with respect to the Coastal Construction Control Line.

7 ANALYSIS OF BUILDING PERFORMANCE

The analysis of the post-Michael building performance database is organized in the following way. First, a broad overview of building performance is presented for buildings experiencing primarily wind hazards, and separately for buildings experiencing wind and storm surge. Performance is assessed with respect to year built, specifically with respect to whether the buildings were constructed before or after the statewide Florida Building Code was adopted in 2002. Second, following the broad overview, the current dataset of 171 homes for which the full DEQC protocol has been performed are analyzed, with performance again delimited by year built, whether pre-Florida Building Code (pre-FBC, i.e., pre-2002) or post-Florida Building Code (post-FBC, i.e., post-2001).

7.1 Broad Overview of Wind Performance

The following figures (Figure 17, Figure 18, and Figure 19) provide an overview of pre- and post-FBC wind performance stratified by peak gust wind speed for all buildings combined, single-family residences, and non-single-family residences respectively. Regardless of building type and peak wind speed, post-FBC buildings perform better or, in one case (single-family residences that experienced < 55 m/s gust wind speeds), nominally the same as pre-FBC buildings. However, an interesting trend demonstrated in the data is the non-progressive nature of the wind speed to damage relationship. Generally, it is expected that wind damage increases with wind speed, all else being equal. In this case, design wind speeds for the majority of the study region are nearly the same, negating that possible factor. It is unexpected then to see the average wind damage rating actually decrease for homes that experienced the highest wind speeds, relative to those that experienced the lowest or middle tier wind speed range. Further research into this trend is warranted, potentially with detailed review of permit records where available. It is possible that newer homes in the coastal areas that experienced higher wind speeds were more likely to invest in code-plus construction. The famous Sand Palace home is one example (Pino 2019), as well as the Habitat for Humanity homes in Mexico Beach, FL that performed well[1]. These homes may be representative of a general trend of code-plus construction in certain areas.

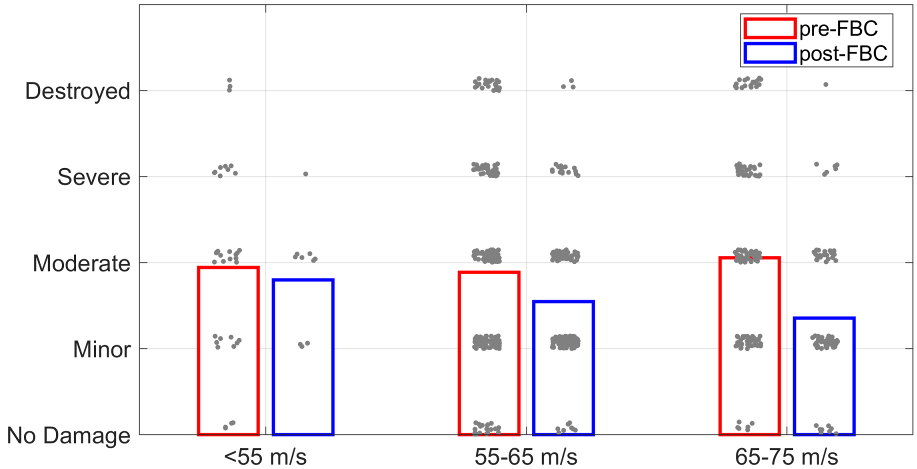


Figure 17. Distribution of wind damage ratings for all buildings, stratified by peak gust wind speed. Within each wind speed bin, the left bar is pre-FBC and the right bar is post-FBC, and indicates average damage rating. Grey circle markers represent the wind damage rating of each individual building in the dataset.

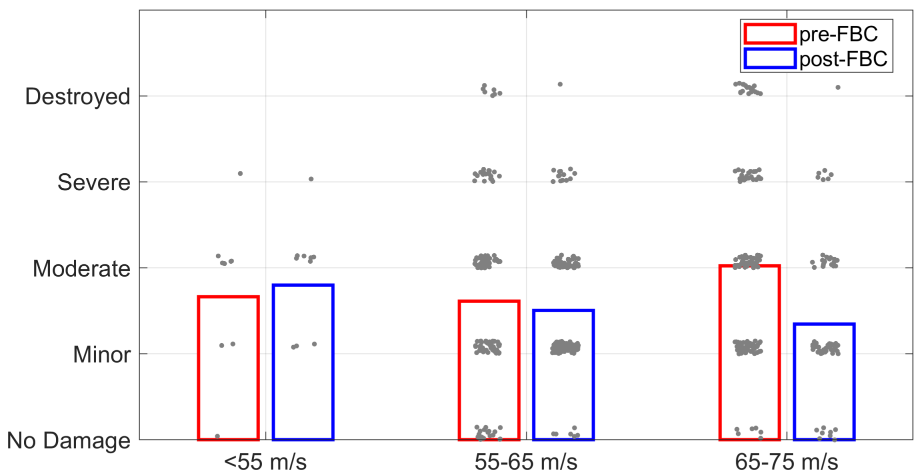


Figure 18. Distribution of wind damage ratings for single-family residences, stratified by peak gust wind speed. Within each wind speed bin, the left bar is pre-FBC and the right bar is post-FBC, and indicates average damage rating. Grey circle markers represent the wind damage rating of each individual building in the dataset.

[1] https://www.washingtonpost.com/politics/panhandle-houses-intact-after-michael-were-often-saved-by-low-cost-reinforcements/2018/10/17/d3ca97c0-d152-11e8-b2d2-f397227b43f0_story.html?utm_term=.200aa16d45af

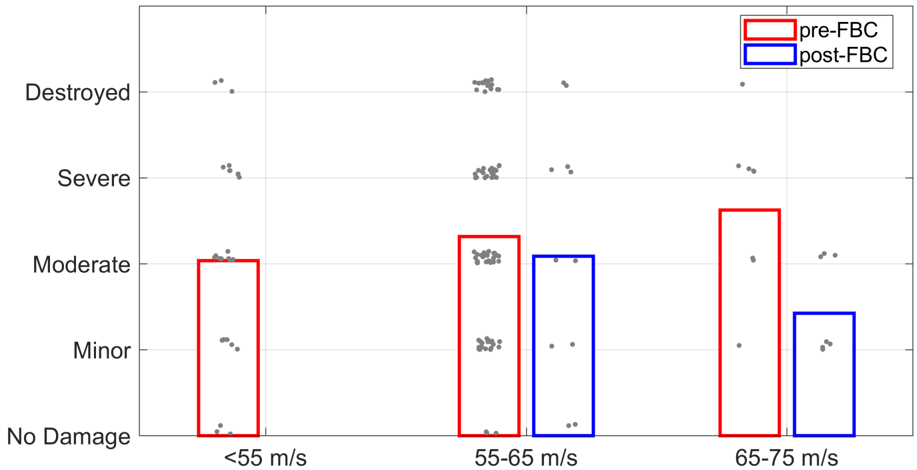


Figure 19. Distribution of wind damage ratings for non-single-family residences, stratified by peak gust wind speed. Within each wind speed bin, the left bar is pre-FBC and the right bar is post-FBC, and indicates average damage rating. Grey circle markers represent the wind damage rating of each individual building in the dataset.

7.2 Detailed Assessment of Wind Performance

The following summarizes the performance of the pre- and post-FBC homes in the dataset of 171 homes for which the full DEQC protocol has been completed. Figure 20 and Figure 21 provide the relative distribution of roof and wall failures in pre- and post-FBC buildings. Roof cover damage occurred to the majority of pre- and post-FBC homes. If no secondary water barrier was present, this data also indicates that interior damage due to rainwater ingress was likely a significant driver of economic losses, as has been the case in past hurricane events. The research team did not directly observe any secondary water barriers in the inland study regions, so we do not expect that was commonly installed.

Roof sheathing and roof structure failures were rare in post-FBC homes, even though wind speeds were close to or exceeded design for many of the homes. Such failures occurred in about 1 in 5 pre-FBC homes.

The same trends observed in roof damage mostly hold true in wall damage as well. Cladding damage was frequently observed in both pre- and post-FBC homes. Sheathing and structural wall failures were rare in post-FBC homes but occurred in about 1 in 5 pre-FBC homes. Overall, the analysis confirms that structural failures are no longer a major concern in homes built to modern building codes. However, much improvement is still needed in cladding systems. Damage to these systems and the ensuing rainwater ingress will continue to drive economic losses and inhibit recovery without renewed research, policies, and industry buy-in aimed at improving the rate of failures.

The lone structural roof failure in a post-FBC home occurred to a home built in 2016 located in the Magnolia Hills subdivision. As shown in Figure 22, the home experienced the collapse inward of the garage door, collapse of approximately 5-10% of the roof structure, removal of ~15% wood roof decking, and ~45% of the roof cover. Nearly 70% of the brick and vinyl wall cladding was lost. The research team was unable to access the roof structure to determine specifics of the load path, but building permit records can be pursued for further analysis.

Figure 23 and Figure 24 provide more detailed assessments of wall cladding material by material type. The assessments are separated by wind speed, since the Gulf Aire and Beacon Hill subdivisions experienced significantly higher wind speeds than the inland neighborhoods in Panama City. In the Panama City neighborhoods, vinyl siding was the most frequently observed and damaged cladding system in post-FBC homes. Even considering only homes constructed in the past three years (N = 18), on average 30% of the vinyl siding cladding failed, with failure rates as high as 60% in four of the eighteen homes, and no visible failures in five of the eighteen homes. In the coastal neighborhoods in the detailed dataset, damage was on average the highest in pre-FBC vinyl siding systems, with minor failures observed in most other cladding systems. Post-FBC vinyl cladding systems performed well, albeit over a small sample size (N=3).

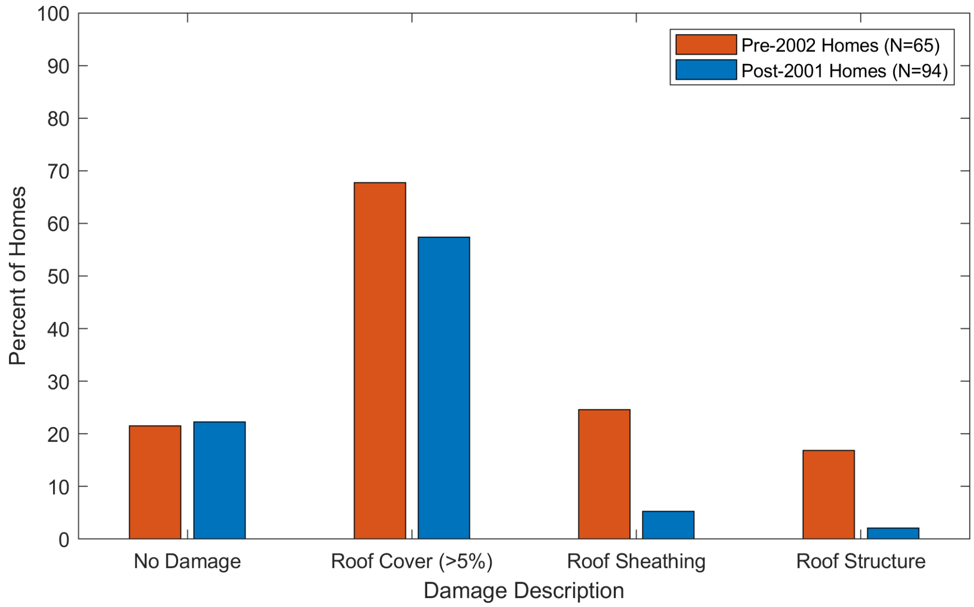


Figure 20. Percent of pre- and post-FBC homes experiencing no or very minor roof damage, roof cover damage, roof sheathing damage, or roof structure damage.

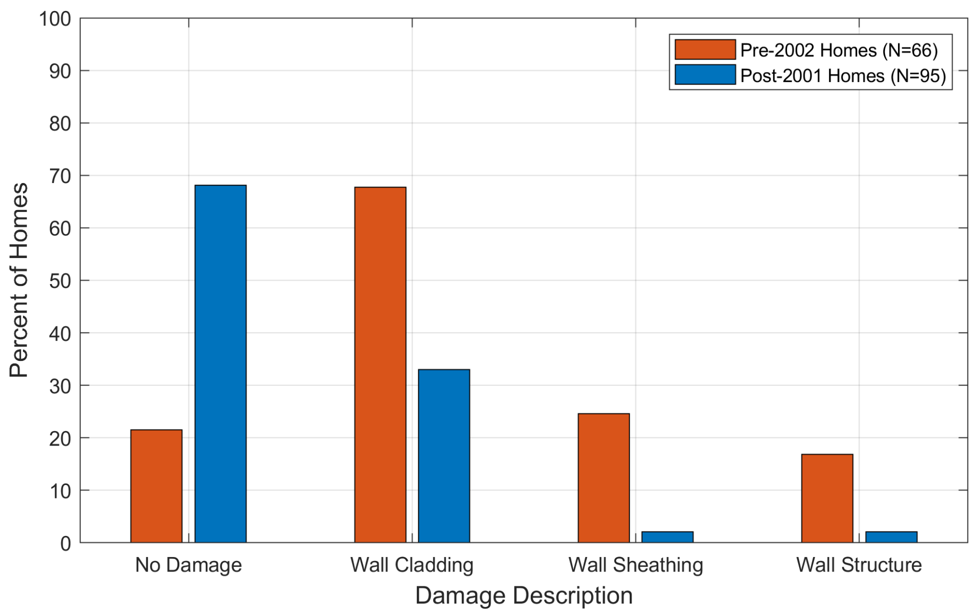


Figure 21. Percent of pre- and post-FBC homes experiencing no wall damage, wall cladding damage, wall sheathing damage, or wall structure damage.

Figure 22. Damage to a 2016 home in the Magnolia Hills subdivision in Panama City, FL. The estimated peak gust wind speed here was 57 m/s, with an ASCE 7-10 design wind speed of 59 m/s.

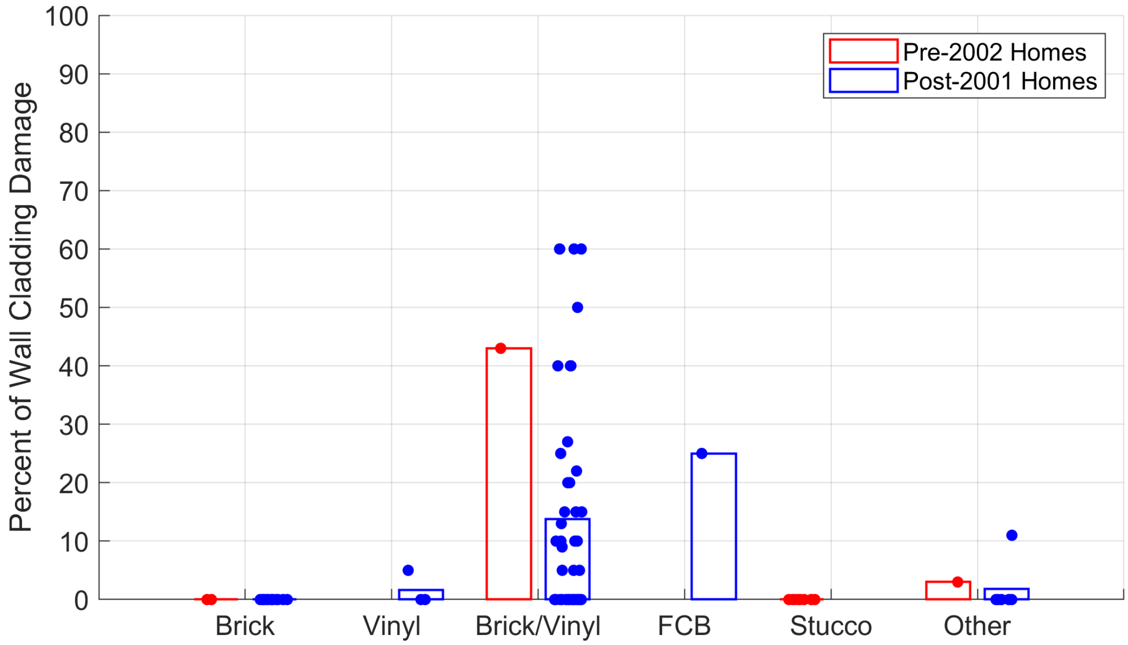


Figure 23. Wall cladding damage percentage by material type for homes experiencing peak gusts of approximately 57 m/s (Magnolia Hills, Brendwoods, and Cedar's Crossing Neighborhoods). Bars depict the mean percentage. FCB = fiber cement board.

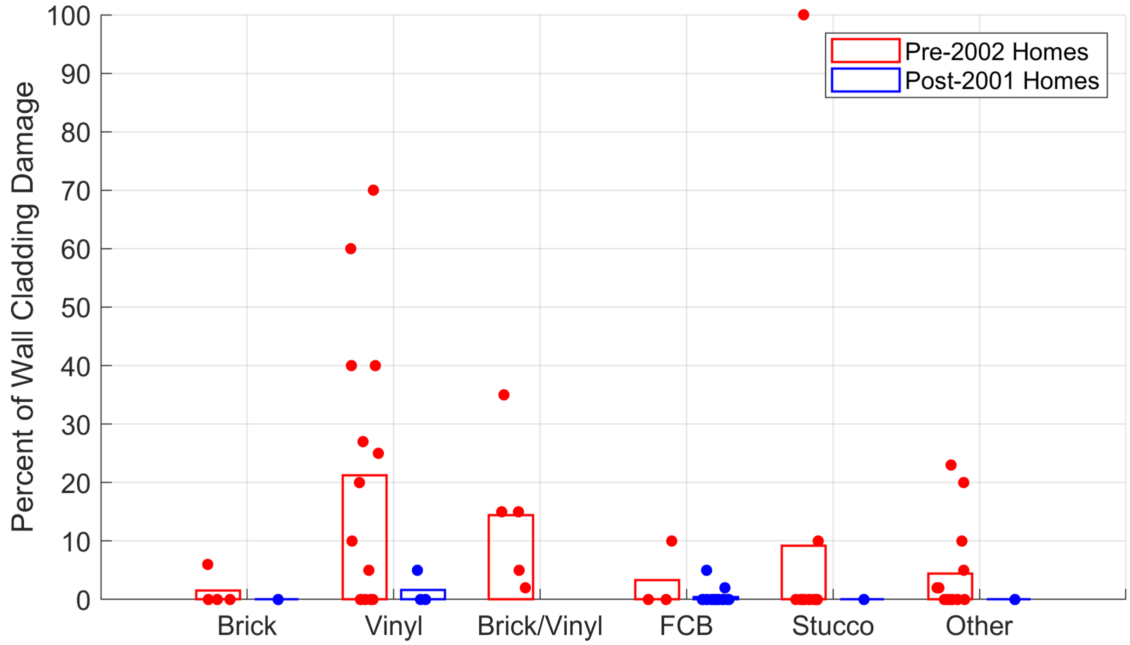


Figure 24. Wall cladding damage percentage by material type for homes experiencing peak gusts of approximately 68 m/s (Gulf Aire and Beacon Hill neighborhoods). Bars depict the mean percentage. FCB = fiber cement board.

Fenestration damage was observed in about 1 in 5 homes. Thirty homes were observed with failed garage doors out of the 136 homes in the detailed dataset in which a garage door was observed (22%). We observed that forty homes in the dataset of 171 homes (23%) experienced some degree of fenestration damage, whether to windows or doors. Soffit damage was observed in approximately 30% of the homes, and fascia damage in approximately 45% of the homes.

7.3 Surge Performance

Surge performance was driven by the first floor elevation of the structure relative to the surge inundation height. Figure 16 showed the first floor elevation of the homes in the assessment database, while Figure 25 shows the storm surge rating assigned to these homes by the team in Mexico Beach. A key factor in explaining the reported surge damage was the CCCL. For a portion of the Bay and Gulf County coastlines, the CCCL follows US-98. However, as shown in Figure 25, the CCCL follows the contour of the coastline and there are a large number of buildings inland of the CCCL that were built slab on grade, particularly for pre-FBC homes, but were exposed to significant storm surge inundation. Nearly all of these homes failed due to storm surge impacts, particularly the further west along the coastline. It is important to note however, as Figure 25 shows, the entire coastline was not completely gone as has often been reported. There were examples of pre- and post-FBC homes on the coast that avoided complete collapse due to storm surge, although the overall structural performance was often compromised by the wind impacts. An example is shown in Figure 26 for a pre-2002 building built in 1997. The research team documented several examples of this nature, both in pre- and post-FBC homes. Additional research should implement more accurate or precise surge estimates into the damage analysis, as well as extract permitting data to fully explore the factors responsible for the building performance.

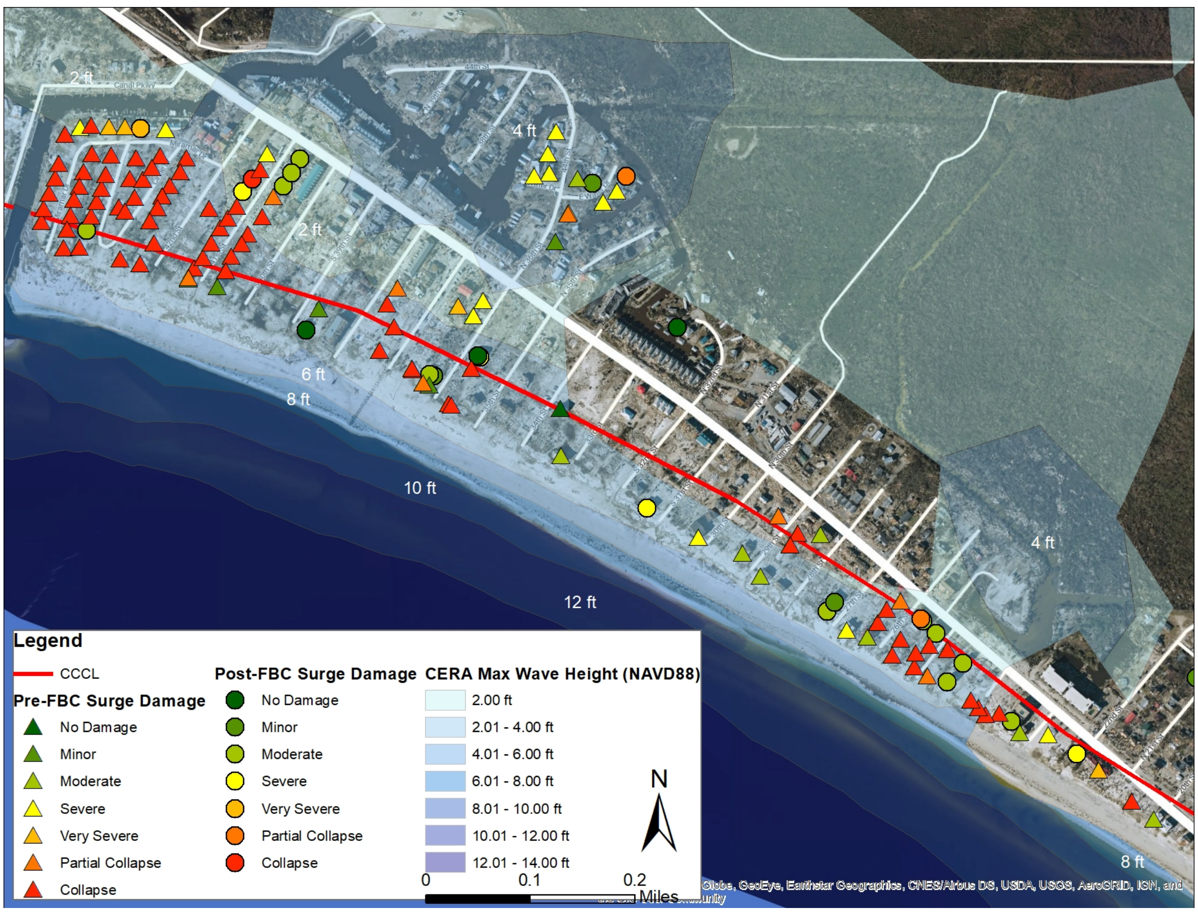


Figure 25. Surge damage assessments in Mexico Beach for pre- and post-FBC homes relative to the CCCL, and the estimated maximum wave heights relative to NAVD88. Triangles indicate pre-FBC buildings, and circles post-FBC.

Figure 26. Performance of a pre-FBC home (Year Built = 1997) on Mexico Beach (Latitude: 29.950607, Longitude: -85.426983). CERA estimated the maximum surge inundation above ground level was 1.27 m (4.2 ft) while the first floor elevation was estimated at 3.5 m. The bottom image shows the home surrounded by other homes with slabs swept clean. Green rectangles indicate the outlines of where homes used to be.

Figure 27 plots the distribution of surge damage by first floor elevation. The surge damage is not conditioned on the surge inundation in this plot. Overall, post-FBC buildings still performed better even for nominally equivalent first floor elevations. The exception was the highest first floor elevation bin (3-3.5 m), but the number of data points there is small (N = 6). Permit data should be explored to more precisely examine the details of the structural load paths in these homes as customized construction (i.e., code plus construction), is potentially more likely in such coastal areas and year built may not be as accurate of a delineator between design and construction quality.

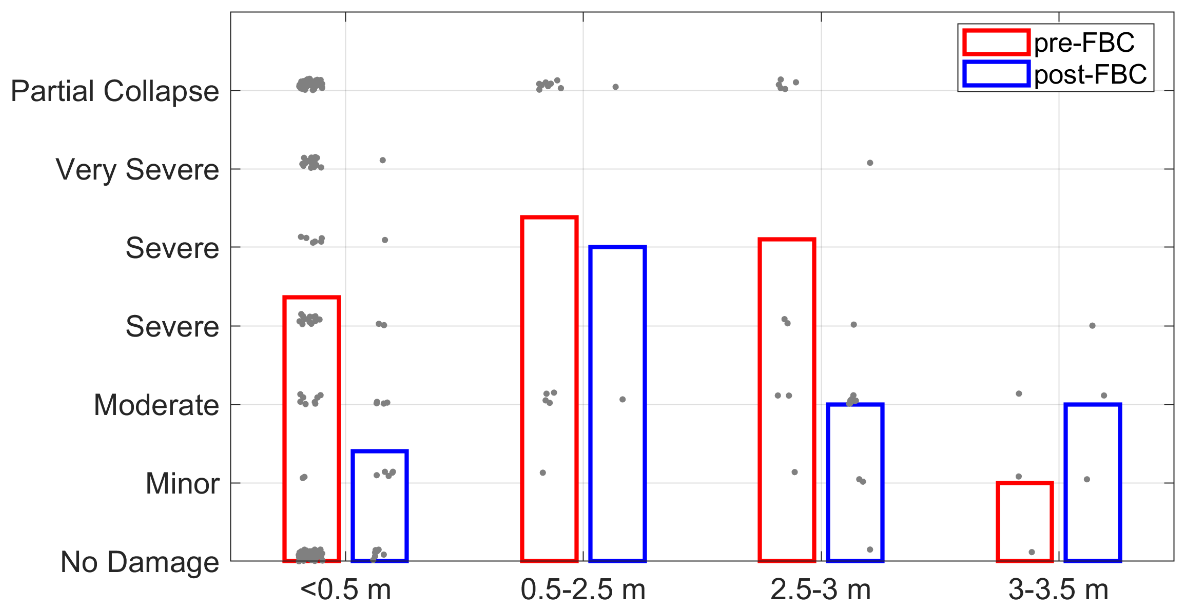


Figure 27. Surge damage ratings by first floor elevation (m) for pre- and post-FBC buildings. Note that surge inundation varied significantly between the buildings represented here.

8 HOMEOWNER INTERVIEWS

We conducted the online surveys in the area of Cedar’s crossing, located in Panama City. This method allows us to know the damage to the interior of the home, and also the economic losses due to the water leaks, storm surge, and wind. The perception and behavior of Florida residents towards Hurricane Michael was also learned.

8.1 Methodology

8.1.1 Recruitment

Participants were selected from the Cedar’s crossing, Panama City which were identified with visible damage from onsite survey assessment. A personalized letter was sent to each of the residents of the Cedar’s Crossing area to about 180 houses on May 28, 2019. Follow-up postcards were sent out to all the participants on June 3, 2019 resulting in a total of 10 completed surveys until now. The information about the study and also the sign-up instructions along with the link of the survey were provided to the participants. See Appendix A for a copy of the letter, sign-up instruction and postcard.

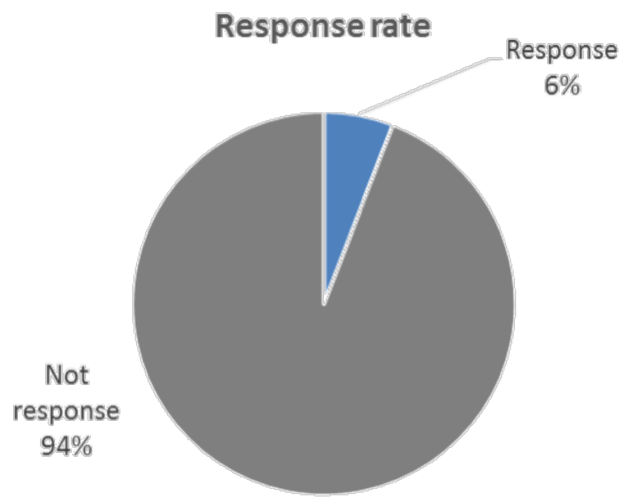


Figure 28. The percentage of people who participate this survey

8.1.2 Institutional Review Board

Before conducting any survey related to human subject, the Institutional Review Board (IRB) at the Investigator's institution must approve the Research and all the survey questions. The IRB protects the welfare and rights of each participant by reviews these type of research. The description of the research project, survey protocol, and the recruitment materials were submitted to the University of Florida IRB on May 8, 2019 and the approval was granted on May 24, 2019. See Appendix B for a copy of the approval letter.

8.1.3 Survey Protocol

Following a brief description of the study and obtaining informed consent form, participants were able to enter their unique participant ID. They were asked the questions regarding the evacuation behavior which includes whether they evacuated or not and also why didn't they evacuate. This is followed by the questions related to Risk perception, Preparation and Interior home damage. Participants were also asked about the exterior home damage which includes whether they faced the damage to soffit, vinyl siding and fascia. They were also asked about the structural retrofits and some demographics questions. The participants were able to enter their email address for the compensation purposes by clicking the link given at the end of the survey. The survey for compensation purposes is linked with the main survey as per IRB requirement. See Appendix C for a copy of survey.

8.2 Results

8.2.1 Participants

The participants reported their age between 24 and 72. Among the total participants until now, 30% are female whereas 70% are male. Participant reported having household income of below \$50k (20%), \$50k-\$100k (50%) followed by \$100-\$150 (10%) and prefer not to answer (20%). The participants moved to their house ranging from the year 2002-2018. They reported that their houses were built ranging from 1986-2009. All the participants reported living in their own house. All participants reported that there are no adults over 65 in their house. Most of the participants don't have a child under age 5 in their house. They reported having 4 year degree (40%), 2 year degree (20%) and followed by high school diploma(10%), some college(10%), doctorate degree(10%) and prefer not to answer by (10%) each. Finally, most of the participants have full time (70%) employment status, followed by retired (20%) and part-time (10%).

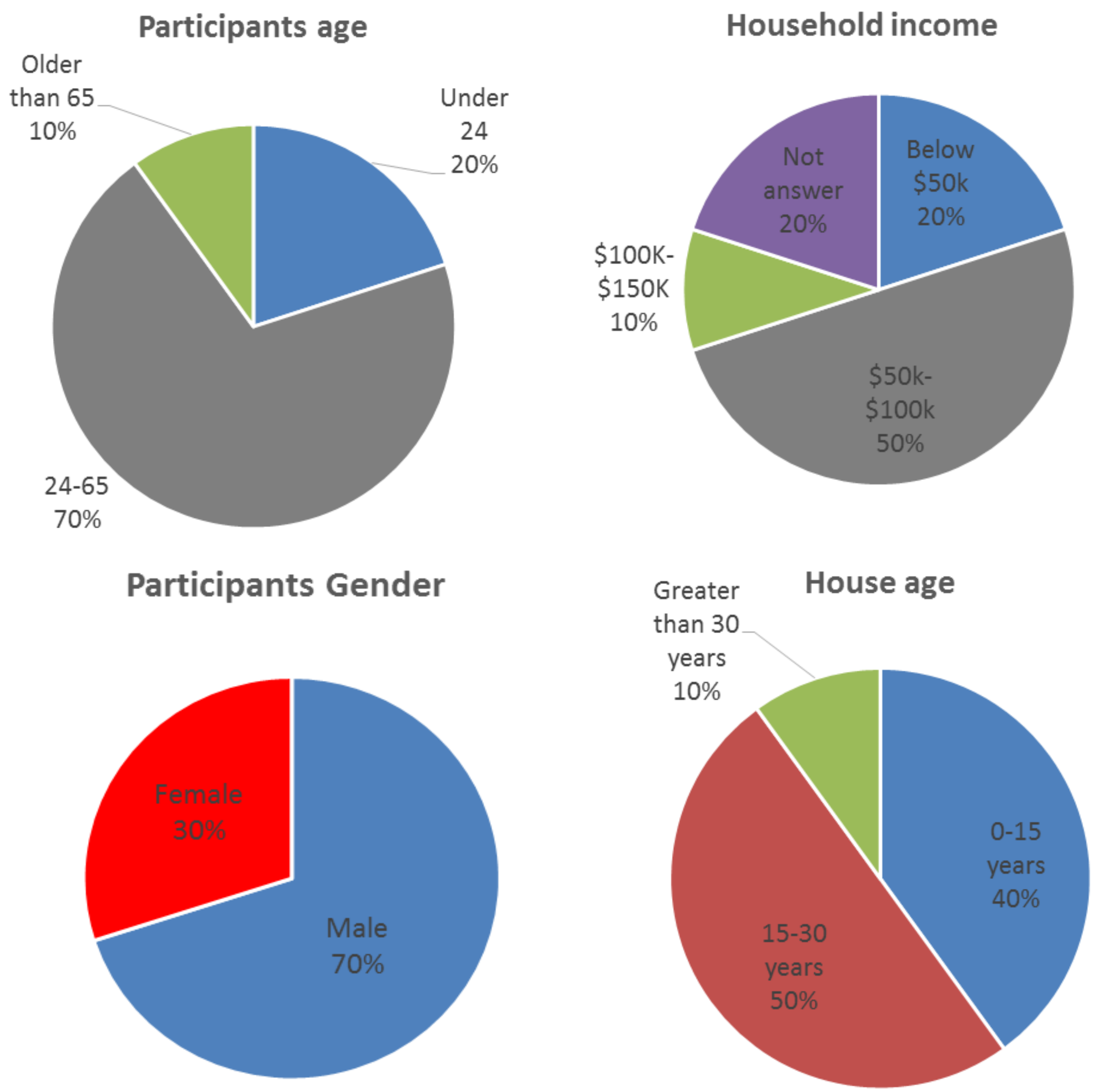


Figure 29. Participants information

8.2.2 Evacuation Behavior

As shown in table below, most of the people did not evacuate during the Hurricane Michael (60%) and (40%) did evacuate. The reasons for evacuating includes: living in evacuation zone (22%), taking care of pets (22%), feeling risks (22%), could afford evacuating expense (22%). Other evacuation reasons involve: military instruction, taking care of his handicap daughter. The main reasons for people who wasn't evacuating were not living evacuation zone (50%), taking care of their house (50%).

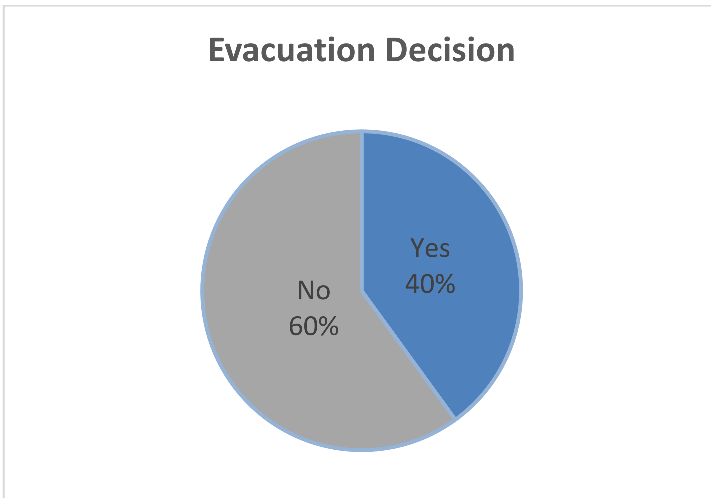


Figure 30**.** Participants evacuation decision before or during Hurricane Michael

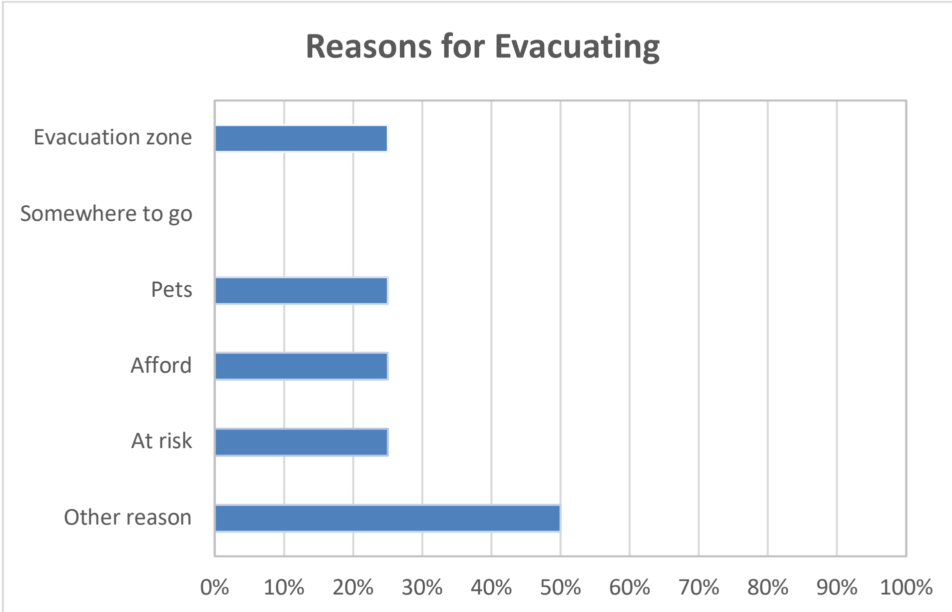


Figure 31. Reasons for evacuating among those who evacuated before or during Hurricane Michael

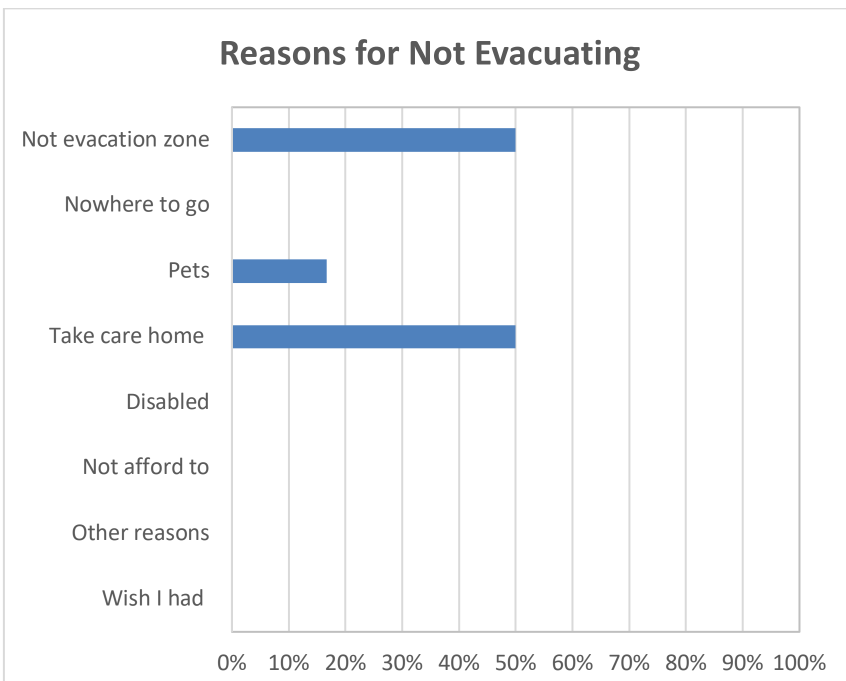


Figure 32. Reasons for not evacuating among those who did not evacuate before or during Hurricane Michael

8.2.3 Risk Perceptions

The participants thought that their home would be severely damaged or destroyed because of hurricane or its aftermath (Mean=35% (M), Standard Deviation=28 (SD)). They also reported that the damage would be covered by insurance (M=83%, SD= 15%). They thought that they would never be able to return to their current home as a result of hurricane or aftermath (M=24%, SD=26%). They thought that the chances that they would be injured by the hurricane or aftermath (M=16%, SD=30%). They believed that the chances someone close to them would be injured by the hurricane or its aftermath (M=19%, SD= 27%).

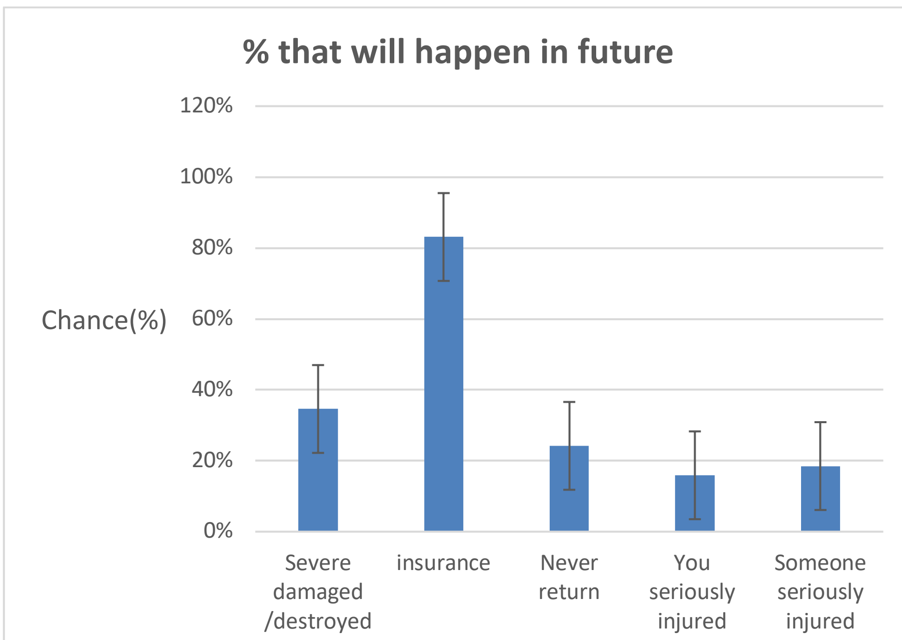


Figure 33. Reported perceived risk as a result of Hurricane Michael

*Note: The next questions ask you to give the percent chance that something will happen. Use a '0' to indicate the event will not happen and a '100' to indicate it will be certain to happen. Before Hurricane Michael hit, what did you think was the percent chance

8.2.4 Preparation

The participants reported that the they will learn about the risks from hurricanes and how to prepare for them (60%), move vehicle to a new location (60%), put together an emergency kit (80%), identify shelter location (30%), copy important documents (30%), make my home more hurricane proof (30%), have flood insurance (30%) and (20%) specify other preparation as Generator/Gas.

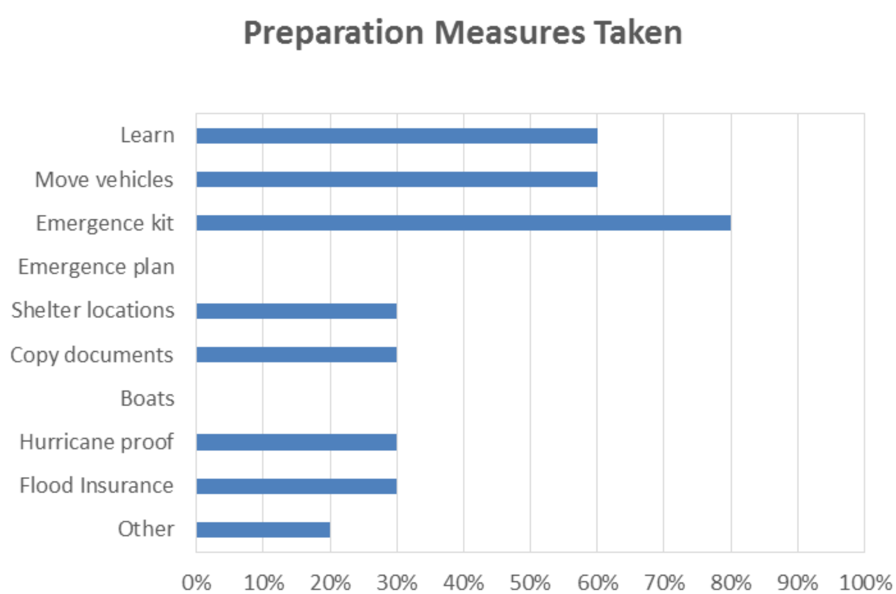


Figure 34. Preparation measures taken before Hurricane Michael

8.2.5 Interior Home Damage

Most of the participants faced the water leakage damage (90%). They reported that they had storm surge damage (10%), wind damage (50%) following with other interior damage (10%). The highest estimated costs is for water leakage repair (n=9,M=$32,000), for storm surge (N=1 , M=$32000) and for Wind (N=1 ,M=$32000)

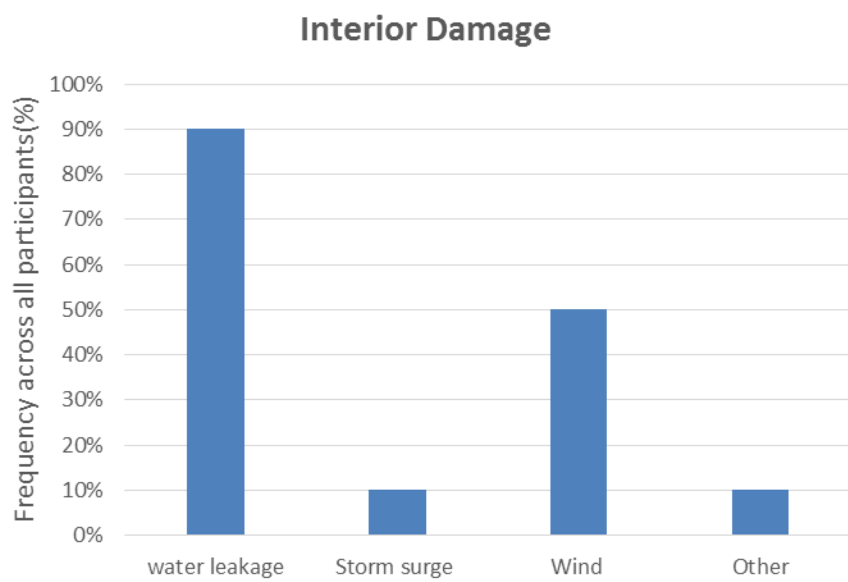


Figure 35. Frequency of reported interior damage across all participants

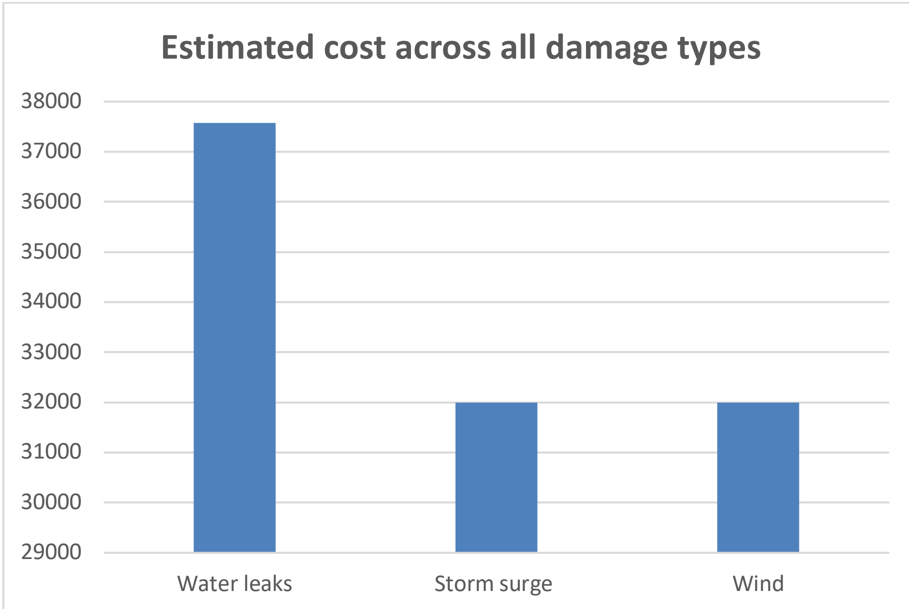


Figure 36. Reported estimated repair cost across all damage types

8.2.5.1 Water Leaks

The participants reported that the water leakage occurred in the various areas of the room. Most of the participants had the damage to their roof, windows and damage to their belongings. They thought that the water leakage occurred due to the wind, rain, debris etc.

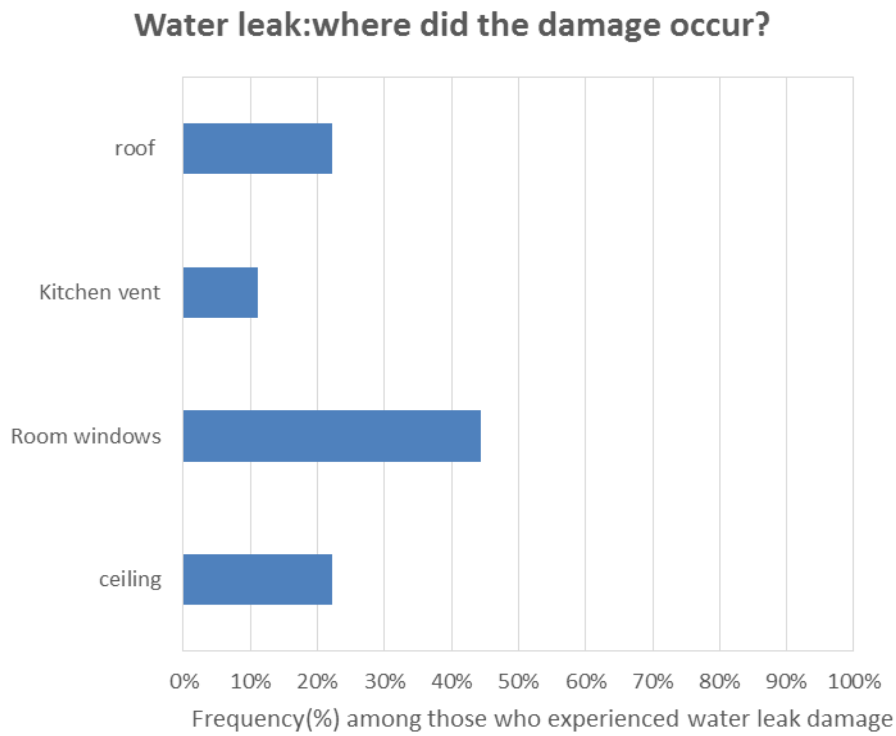


Figure 37. Where the water came in as a result of Hurricane Michael for those reporting water leak damage.

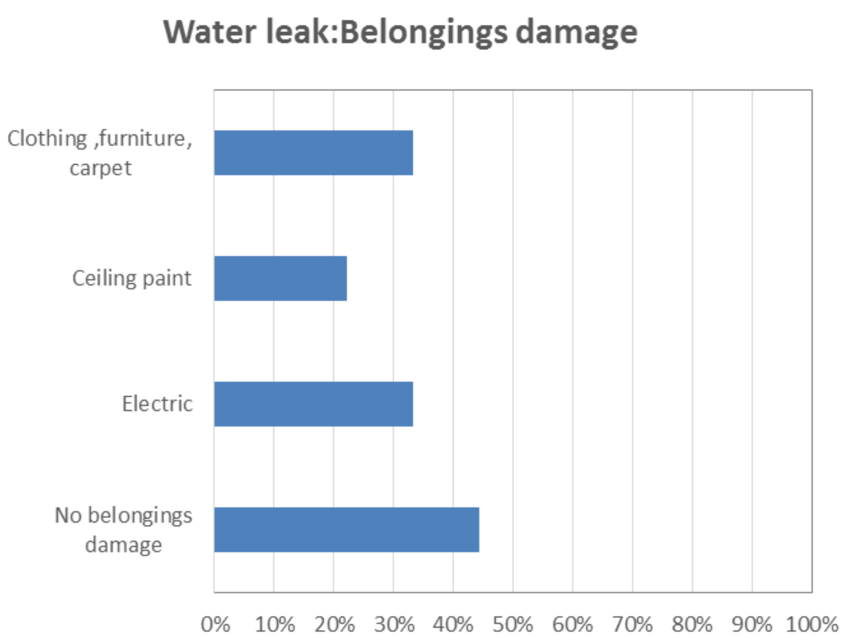


Figure 38. What the belongings damage in as a result of Hurricane Michael for those reporting water leak damage.

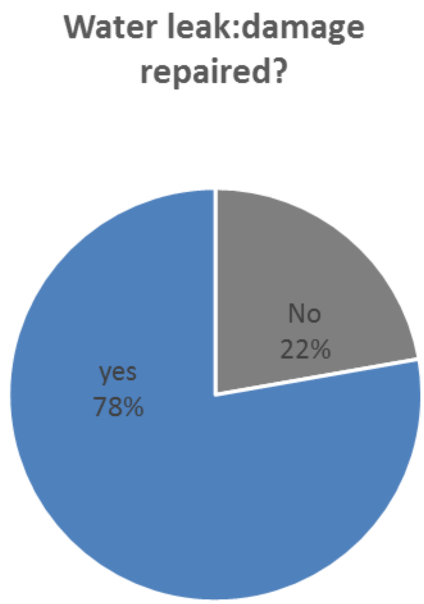


Figure 39. Whether the water leak damage has been repaired

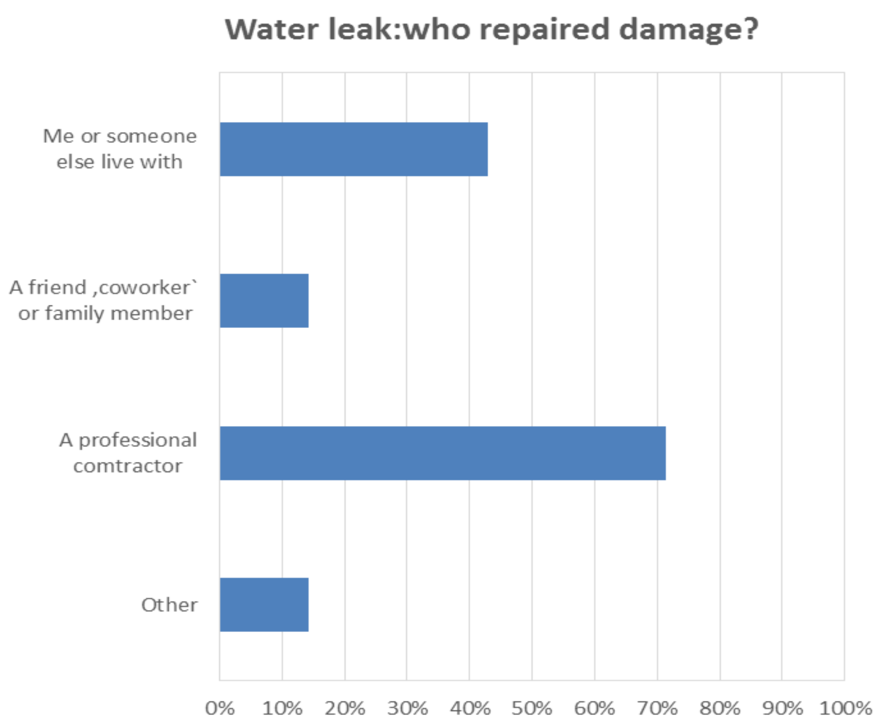


Figure 40. Among those who repaired the water leak damage, who did the repairs

8.2.5.2 Storm Surge

Among the 7 participants until now, only 1 participant had storm surge damage. The participant reported that the height of the water reach in his/her main living area is 3ft. He/she reported that the water damage occurred in the living room, bedrooms, bathrooms and kitchen. He/she reported that only minor items needed replacements. He/she repaired the damage costs for about $32000.

8.2.5.3 *Wind*

About (71.2%) participants had faced the damage due to the wind. The location of the wind damage, extent of the damage, damage to the belongings and the reasons for the wind damage were responded by the participants which is shown in the following table 11 and table 12.

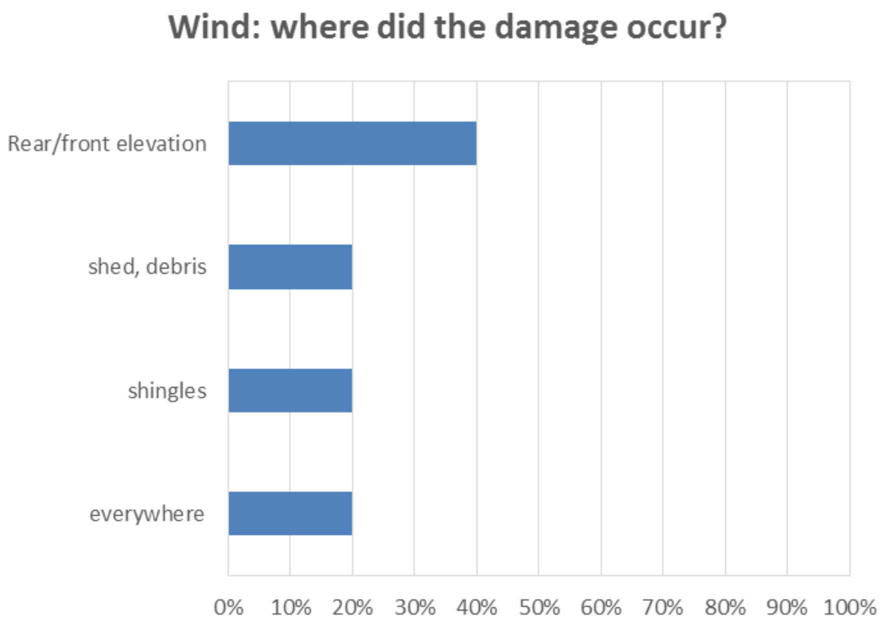


Figure 41. Location in the home where the wind damage occurred

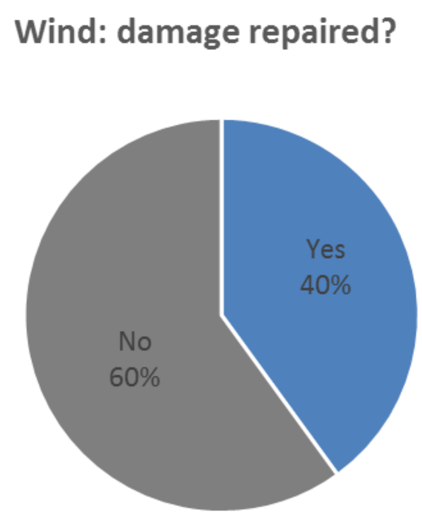


Figure 42. Whether the wind damage has been repaired

8.2.5.4 Other Reasons for Interior Damage

Among 10 participants until now, one participant had no interior damage. He/she reported damage in the garage roof, porch yard and minor damage to his/her belongings. He/she thought damage occurred by wind and tree debris. He/she reported that the repair cost is $25000.

8.2.6 Exterior Home Damage

The participants reported that they had the fascia damage (80%), soffit damage (70%) and the vinyl siding damage (20%).

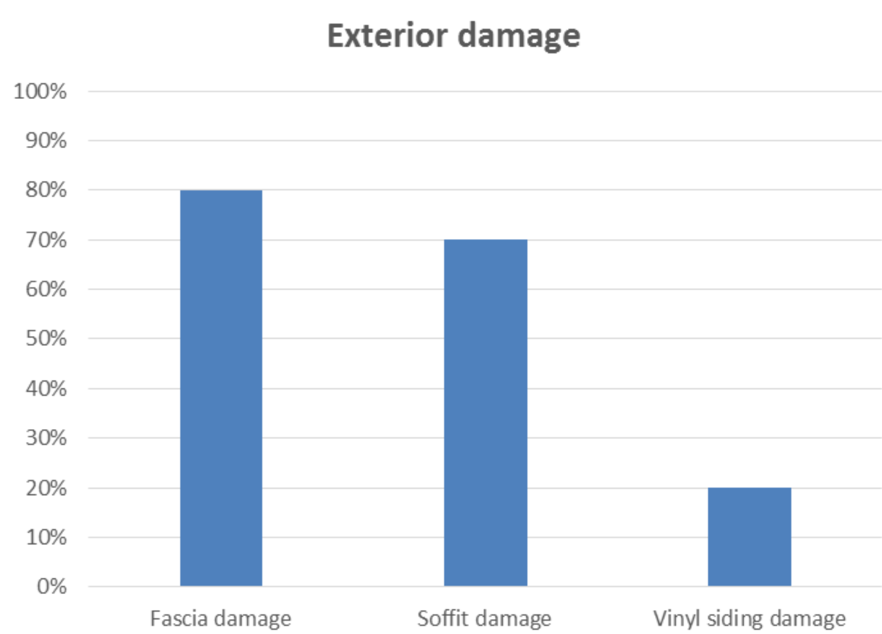


Figure 43. Frequency of reported exterior damage across all participants

8.2.7 Structural retrofits

Among 10 participants, neither of them did the hurricane retrofit after the hurricane. The participants (Mean-3.7) agree that their house performed well during the hurricane Michael, whereas the participants (Mean-3.9) neither agree nor disagreed that performed well during Hurricane Michael. All the participants agree to do structural retrofits in future.

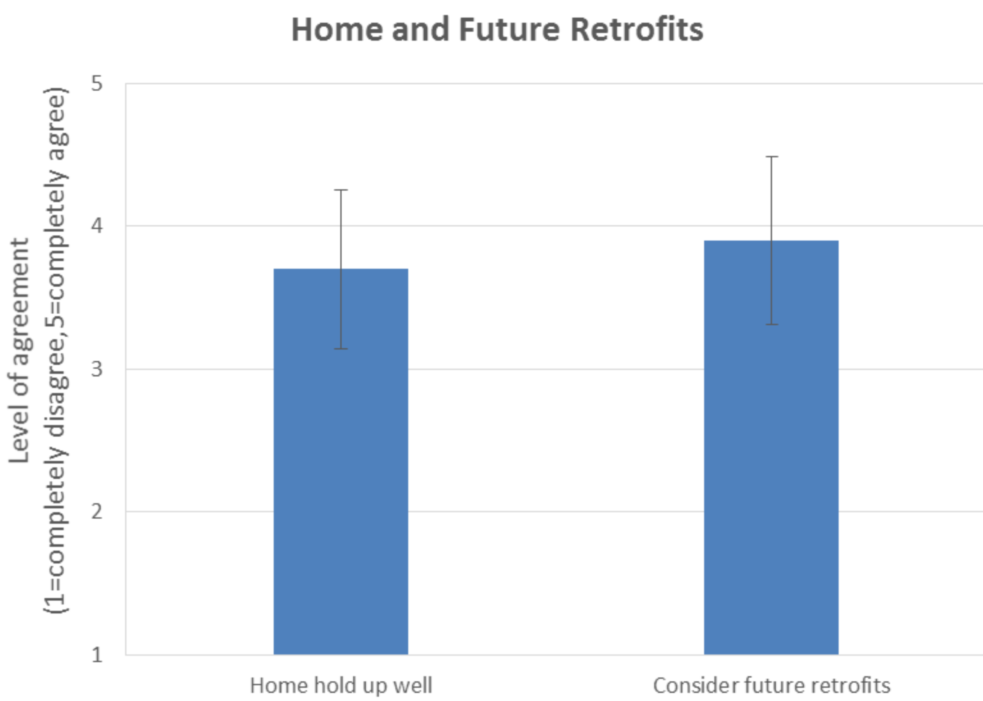


Figure 44. Views on whether the home held up well with respect to Hurricane Michael and whether participants would consider future retrofits

9 CONCLUSIONS FROM DATA ANALYSIS PORTION

1) Based on overall damage ratings, post-FBC buildings performed better than pre-FBC buildings, but the improved performance was primarily seen in areas that experienced the highest wind speeds (65-75 m/s). For wind speeds below 65 m/s, performance was nominally the same, likely due to the prevalence of cladding and roof cover damage in both pre- and post-FBC buildings.
2) In single-family homes, roof and wall structure damage was observed in less than 2% of post-FBC homes, contrasted with almost 20% of pre-FBC homes. Roof and wall sheathing damage rates were similar in post- and pre-FBC homes.
3) Wall cladding performance was mixed. Vinyl siding consistently experienced the highest damage rates, regardless of location. However, in post-FBC homes that experienced the highest wind speeds in our dataset, vinyl siding damage was minimal, albeit for a small sample size (N=3).
4) Roof cover performance was also mixed at best for both pre- and post-FBC homes, regardless of the observed wind speed magnitude. More than 60% of post-FBC, and more than 70% of pre-FBC homes experienced at least 5% roof cover loss. Metals roofs experienced at least 50% loss in 11% of homes. Asphalt shingle roofs experienced at least 50% loss in 15% of the homes in our dataset.
5) Devastation was not complete in Mexico Beach as is often reported. A number of pre- and post-FBC homes were still standing, primarily a function of the first floor elevation relative to the local storm surge and wave height. Several good case studies are likely present in these homes, but building permit records would be needed to obtain the complete perspective on the structural systems used and their relative performance.

10 RECOMMENDATION

1) Re-evaluate code requirements for roofing products and installation. Roof cover loss continues to be the most common failure, driving economic losses from ensuing rainwater ingress, and was frequently observed even in post-2016 homes experiencing below design-level winds.

2) Continue to investigate the high wind performance of permeable cladding systems, including soffit systems, relative to current product approval requirements.

3) Investigate the placement of the coastal construction control line in Mexico Beach. Poor siting and elevation in Mexico Beach led to the extent of the disaster experienced there during Hurricane Michael. The CCCL is located with consideration of the upland or landward extent of the damaging effects of a 100-year storm event. With potential impacts of climate change, the 100-year storm impacts may change, requiring subsequent changes to the CCCL.

11 REFERENCES

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Appendix A. Personalized recruitment letter and postcard

UF | UNIVERSITY of FLORIDA

Herbert Wertheim College of Engineering
Engineering School of Sustainable Infrastructure and Environment

365 Weil Hall
PO Box 116580
Gainesville, FL 32611-6580
352-294-7798 Phone
352-392-3394 Fax
www.essie.ufl.edu

May 22, 2019

Jack and Allen
2902 CEDARS XING
PANAMA CITY, FL 32405-6388

Subject: Invitation to Participate in Online Survey Evaluating Interior Damage and Water Leakage During Hurricane Michael for Cedar's Crossing Residents

Dear Scott and Courtney Frazier or Current Resident,

My name is Dr. David O. Prevatt and I am an Associate Professor of Civil Engineering at the University of Florida. As part of a follow-on study, I would like to invite you to participate in a survey seeking to determine the extent of water leaks and interior damage caused by Hurricane Michael to your home, and your experience with hurricane retrofits. As a recognized wind engineer, I have studied the effects of hurricanes winds on low-rise buildings for many years.

My research team and I spent several days following Hurricane Michael to make damage observations in Panama City, including Cedar's Crossing. The Cedar's Crossing subdivision is a major focus for us because most of the houses were built recently and so their performance helps us to understand the effectiveness of the building code. Your assistance is most valued.

a)  b)

Figure 1: Post Hurricane Michael Damage to Residential Houses in Cedar's Crossing, Panama City, FL

Our full report is available at: https://doi.org/10.17603/DS2G41M. In addition, the damage observations can be viewed here: https://web.fulcrumapp.com/communities/nsf-rapid/.

The Foundation for The Gator Nation
An Equal Opportunity Institution

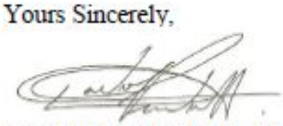
During the online survey, you will be asked about your perspectives and decisions regarding Hurricane Michael and its aftermath, specifically related to performance of your house. You will also be asked demographic questions. The survey should take no more than 20 - 30 minutes. You will be compensated $20 USD for your participation via an Amazon gift card.

To participate in the online survey, you must include your **Participant ID HM001**. **Sign-up instructions are provided in the attached document.** The study is limited to the first 180 participants, so please sign-up now. Survey data collection will end on **May 31, 2019**.

If you have any questions about this study, you should feel free to ask them by contacting me, the Principal Investigator, Dr. David O. Prevatt, Associate Professor, Civil and Coastal Engineering, dprev@ce.ufl.edu, 352- 294-7798. If you have questions later, desire additional information, or wish to withdraw your participation, please contact Dr. David O. Prevatt by mail, phone or e-mail in accordance with the contact information listed above.

If you have questions pertaining to your rights as a research participant or to report objections to this study, you should contact the Institutional Review Board at the University of Florida. Email: myirbtech-l@lists.ufl.edu. Phone: (352) 273-9600 or (352) 392-0433.

Yours Sincerely,



David O. Prevatt, Ph.D., PE, F.ASCE, F.SEI
Associate Professor of Civil and Coastal Engineering

EVALUATING INTERIOR DAMAGE AND WATER LEAKAGE DURING HURRICANE MICHAEL FOR CEDAR'S CROSSING RESIDENTS

Online survey sign-up Instructions

Step 1:

- Open your internet (web) browser (Google Chrome, Internet Explorer, Mozilla Firefox, Opera, Safari, etc.) using your computer/laptop/mobile device.

- Type the web link (https://ufl.qualtrics.com/jfe/form/SV_9ntxIoVG4qcg0MB) into the address bar of your web browser as shown below and press "Enter".

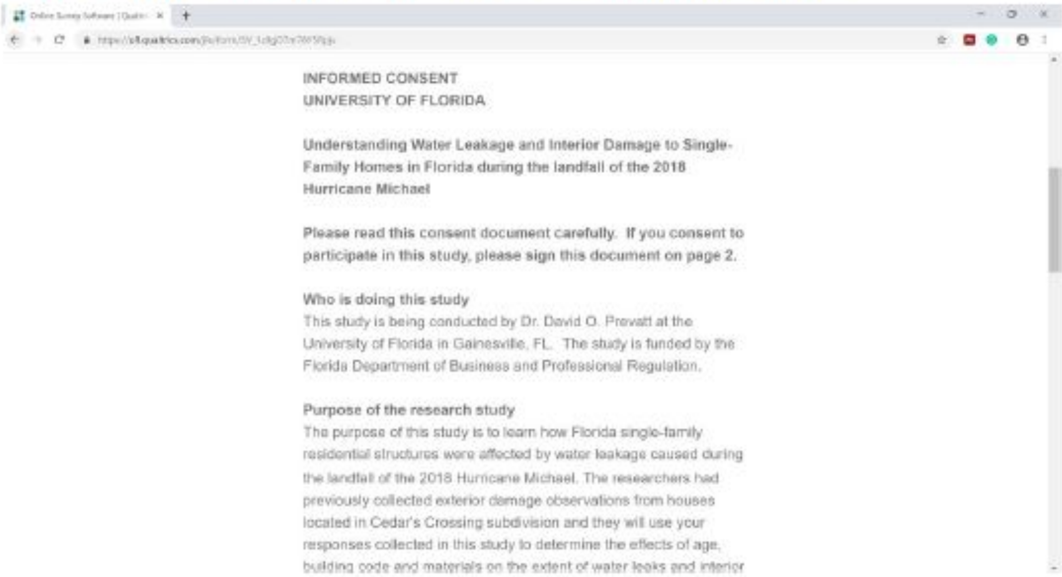
Step 2:

- After that you will see the front "welcome" page (as shown below) with provided information that you need to know in order to participate in survey:

...

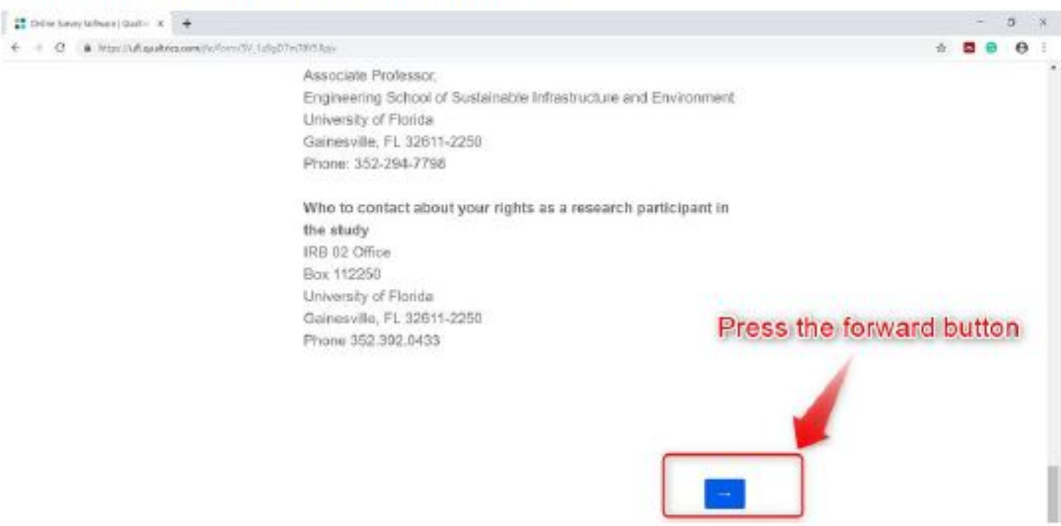
The Foundation for The Gator Nation
An Equal Opportunity Institution

- Please, read consent document provided on the "welcome" page carefully:



...

- If you consent to participate in this study, please, press the forward button at the bottom of the page to sign this document on the next page:



Step 3:

- Follow the instructions on each page and press the forward button at the bottom of each page to access the next page.

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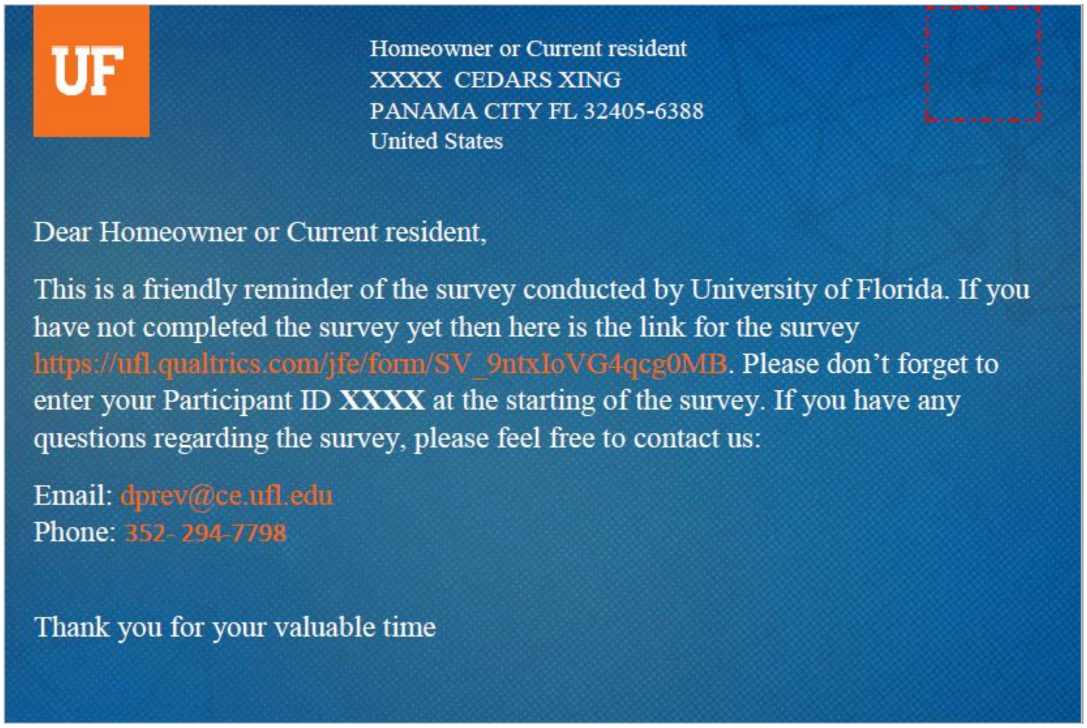

UF

Homeowner or Current resident
XXXX CEDARS XING
PANAMA CITY FL 32405-6388
United States

Dear Homeowner or Current resident,

This is a friendly reminder of the survey conducted by University of Florida. If you have not completed the survey yet then here is the link for the survey https://ufl.qualtrics.com/jfe/form/SV_9ntxIoVG4qcg0MB. Please don't forget to enter your Participant ID **XXXX** at the starting of the survey. If you have any questions regarding the survey, please feel free to contact us:

Email: dprev@ce.ufl.edu
Phone: 352- 294-7798

Thank you for your valuable time

Appendix B. Copy of approval letter

Institutional Review Board
UNIVERSITY of FLORIDA

Behavioral/NonMedical Institutional Review Board
FWA00005790

PO Box 112250
Gainesville FL 32611-2250
Telephone: (352) 392-0433
Facsimile: (352) 392-9234
Email: irb2@ufl.edu

DATE: 5/24/2019
TO: David Prevatt
365 Weil Hall
Gainesville , Florida 32611
FROM: Ira Fischler, Ph.D., Professor Emeritus
Chair IRB-02

IRB#: **IRB201901290**
TITLE: Understanding Water Leakage and Interior Damage to Single-Family Homes in Florida During the Landfall of the 2018 Hurricane Michael.

Approved as Exempt

You have received IRB approval to conduct the above-listed research project. Approval of this project was granted on 5/24/2019 by IRB-02. This study is approved as exempt because it poses minimal risk and is approved under the following exempt category/categories:

> 2. Research that includes only interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of 3 criteria are met: (i) the information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; (ii) any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; OR (iii) the information obtained is recorded by the investigator in such a manner that the identity of human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited review to make the determination required by 45 CFR 46.111(a)(7) (which relate to there being adequate provisions for protecting privacy and maintaining confidentiality) AND the research is not subject to subpart D.

Special notes to Investigator (if applicable):

In the myIRB system, Exempt approved studies will not have an approval stamp on the consents, flyers, emails, etc. However, the documents reviewed are the ones that should be used. So, under ATTACHMENTS you should find the document that has been reviewed and approved. If you need to modify the document(s) in any manner, then you'd need to submit to our office for review and approval prior to implementation.

Principal Investigator Responsibilities:

The PI is responsible for the conduct of the study. Important responsibilities described at the above link include:

- Using currently approved consent form to enroll subjects (if applicable)
- Renewing your study before expiration
- Obtaining approval for revisions before implementation
- Reporting Adverse Events
- Retention of Research Records
- Obtaining approval to conduct research at the VA
- Notifying other parties about this project's approval status

Should the nature of the study change or you need to revise the protocol in any manner please contact this office prior to implementation.

Study Team:

Alina	Gautam Acharya	Other
Rodrigo Castillo Perez		Study Coordinator

Appendix C. Copy of survey

Final- Hurricane Michael Questionnaire

Start of Block: INTRODUCTION

University of Florida

Thank you for your interest in this important study. Your name and home address were obtained through public records from the Florida Department of Revenue as living in the Cedar's Crossing Subdivision, Panama City, FL. The purpose of this research is to better understand the impact of Hurricane Michael and its aftermath on single-family structures in Florida. Your participation is completely voluntary. Your personally identifiable information will only use for compensation purposes and will not be attached to any response.

On the next page, you will see a brief consent form, which you should read before participating in the survey.

INFORMED CONSENT
UNIVERSITY OF FLORIDA

Understanding Water Leakage and Interior Damage to Single-Family Homes in Florida during the landfall of the 2018 Hurricane Michael

Please read this consent document carefully. If you consent to participate in this study, please say "yes" to this document on page 2.

Who is doing this study
This study is being conducted by Dr. David O. Prevatt at the University of Florida in Gainesville, FL. The study is funded by the Florida Department of Business and Professional Regulation.

Purpose of the research study
The purpose of this study is to learn how Florida single-family residential structures were affected by water leakage caused during the landfall of the 2018 Hurricane Michael. The researchers had previously collected exterior damage observations from houses located in Cedar's Crossing subdivision and they will use your responses collected in this study to determine the effects of age, building code and materials on the extent of water leaks and

interior damage.

What you will be asked to do in the study

You will be asked to describe your knowledge and opinions regarding hurricanes and the risk they pose to your family and your property.

Time required

20-30 min

Compensation

In return for your participation in this research, you will receive via Amazon gift card, worth $20.00. If you would like to be considered for $20 gift card, you will need to enter your e-mail address in a separate link at the end of the survey.

Risks and Benefits

This research has been reviewed by the Institutional Review Board of the University of Florida. To the best of their ability, they have determined that the interview questions involve no invasion of privacy and no ethically objectionable or stressful subjects. There are no direct benefits to you for participating in the study other than the gift card.

Confidentiality

Your identity will be kept confidential to the extent provided by law. Once you complete the survey, you will be redirected to another link in which you will have the opportunity to provide the best e-mail address to send you the gift card. As soon as, you receive your gift card, this information is destroyed. Neither your name nor your address will appear in any report from this study.

Voluntary participation

Your participation in this study is completely voluntary. There is no penalty for not participating, or for stopping your survey at any time after it has begun.

Who to contact if you have questions about the study

Dr. David O. Prevatt
Associate Professor,
Engineering School of Sustainable Infrastructure and Environment
University of Florida
Gainesville, FL 32611-2250
Phone: 352-294-7798

Who to contact about your rights as a research participant in the study

IRB02 Office
Box 112250
University of Florida
Gainesville, FL 32611-2250

Phone 352.392.0433

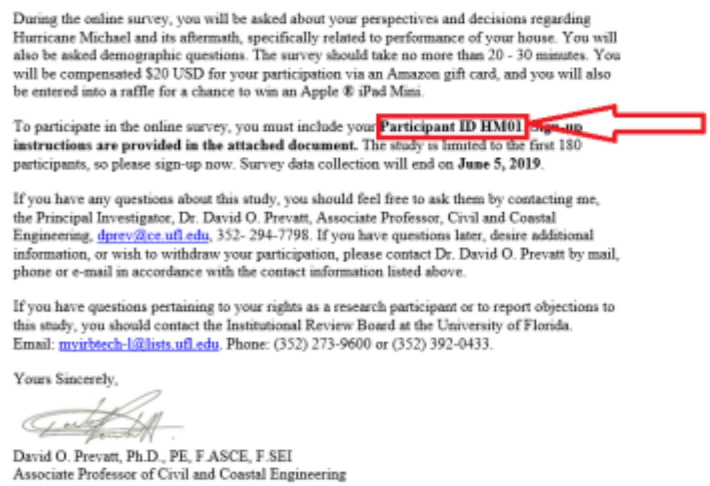
Consent
By answering "yes" below, I acknowledge that I have read the above conditions I voluntarily agree to participate in this survey I give my permission for the researchers to quote my responses anonymously.

- ◯ Yes (1)
- ◯ No (2)

End of Block: INTRODUCTION

Start of Block: PARTICIPANT ID

In order to participate, you need to enter your valid participant ID. The Participant ID# can be found in the letter that you received in the mail, and should look something like this:



During the online survey, you will be asked about your perspectives and decisions regarding Hurricane Michael and its aftermath, specifically related to performance of your house. You will also be asked demographic questions. The survey should take no more than 20 - 30 minutes. You will be compensated $20 USD for your participation via an Amazon gift card, and you will also be entered into a raffle for a chance to win an Apple ® iPad Mini.

To participate in the online survey, you must include your **Participant ID HM01**. **Sign-up instructions are provided in the attached document.** The study is limited to the first 180 participants, so please sign-up now. Survey data collection will end on **June 5, 2019**.

If you have any questions about this study, you should feel free to ask them by contacting me, the Principal Investigator, Dr. David O. Prevatt, Associate Professor, Civil and Coastal Engineering, dprev@ce.ufl.edu, 352- 294-7798. If you have questions later, desire additional information, or wish to withdraw your participation, please contact Dr. David O. Prevatt by mail, phone or e-mail in accordance with the contact information listed above.

If you have questions pertaining to your rights as a research participant or to report objections to this study, you should contact the Institutional Review Board at the University of Florida. Email: myirbtech-l@lists.ufl.edu. Phone: (352) 273-9600 or (352) 392-0433.

Yours Sincerely,

David O. Prevatt, Ph.D., PE, F.ASCE, F.SEI
Associate Professor of Civil and Coastal Engineering

Can you please confirm your participant ID?

____

Page Break

Q3 Why did you evacuate? (please check all that apply)

- ☐ Because I live in an evacuation zone (1)
- ☐ Because I had somewhere to go (2)
- ☐ Because I had pets I could take with me (3)
- ☐ Because I could afford to (4)
- ☐ Because I felt at risk (5)
- ☐ I evacuated for another reason (please specify) (6) ____________________

Display This Question:

If Why did you evacuate? (please check all that apply) , Because I live in an evacuation zone Is Displayed

Q4 How many times did you evacuate?

____

Page Break

End of Block: EVACUATION BEHAVIOR

Start of Block: RISK PERCEPTIONS

Q5 The next questions ask you to give the percent chance that something will happen. Use a '0' to indicate the event will not happen and a '100' to indicate it will be certain to happen. Before Hurricane Michael hit, what did you think was the percent chance that:

	0 10 20 30 40 50 60 70 80 90 100
% your home would be severely damaged or destroyed because of the hurricane or its aftermath? ()	
% sure that any damages would be covered by insurance? ()	
% you would never be able to return to your current home as a result of the hurricane or its aftermath? ()	
% you would be seriously injured by the hurricane or its aftermath? ()	
% someone close to you would be seriously injured by the hurricane or its aftermath? ()	

End of Block: RISK PERCEPTIONS

Start of Block: PREPARATION

Q6 There are many things that people might do to prepare for natural disasters, like hurricanes. Please check all those that you were able to do before Hurricane Michael.

- ☐ Learn about the risks from hurricanes and how to prepare for them (1)
- ☐ Move vehicles to a safe location (2)
- ☐ Put together an emergency kit (e.g., food, medical supplies, flashlight) (3)
- ☐ Develop and practice an emergency plan (4)
- ☐ Identify shelter locations in the event of an evacuation (5)
- ☐ Copy important documents (e.g., birth certificates, driver's licenses) (6)
- ☐ Get a row boat or inflatable raft (7)
- ☐ Make my home more hurricane proof (e.g., install hurricane shutters, sand bags) (8)
- ☐ Have flood insurance (9)
- ☐ Other (please specify) (10) ____

Q7 How much do you think these actions will protect you from future hurricanes and their aftermath?

- ○ Not at all (1)
- ○ Just a little (2)
- ○ Somewhat (3)
- ○ Mostly (4)
- ○ Completely (5)

Q8 Do you think hurricanes during future hurricane seasons will be

○ less intense than the ones in the 2018 season (1)

○ about the same intensity (2)

○ more intense than the ones in the 2018 season (3)

Q9 Do you think hurricanes during future hurricane seasons will

○ happen less frequently than the ones in the 2018 season (1)

○ happen with about the same frequency (2)

○ happen more frequently than the ones in the 2018 season (3)

End of Block: PREPARATION

Start of Block: INTERIOR HOME DAMAGE

Q10 Did your home experience any **interior damage** from the following due to Hurricane Michael and its aftermath? (please check all that apply)

▢ Water Leak (1)

▢ Storm surge or flood (2)

▢ Wind (3)

▢ Other (please specify) (4) ____

Page Break

Display This Question:

If Did your home experience any interior damage from the following due to Hurricane Michael and its... = Water Leak

Q11 Consider the **water leak damage** to your home. In your own words, please describe the following:

- ◯ Where did the water leak damage occur? (1) ____
- ◯ What was the extent of the damage to your home? (2) ____
- ◯ What was the extent of the damage to your belongings? (3) ____
- ◯ Why do you think the water leak occurred? (4) ____

Display This Question:

If Did your home experience any interior damage from the following due to Hurricane Michael and its... = Water Leak

Q12 Has the damage been repaired?

- ◯ Yes (1)
- ◯ No (2)

Display This Question:

If Has the damage been repaired? = Yes

Q13 Approximately, how much did it cost to repair ($USD)?

____

Display This Question:

If Has the damage been repaired? = Yes

Q14 Who did the repairs? (check all that apply)

- ☐ Me or someone else I live with (1)
- ☐ A friend, coworker, neighbor or family member (2)
- ☐ A professional contractor (3)
- ☐ Other (please specify) (4) ____________________

Display This Question:

If Has the damage been repaired? = No

Q15 What didn't you repair the damage? (check all that apply)

- ☐ Too expensive to do repairs (1)
- ☐ It takes too much time to do repairs (2)
- ☐ I or someone else I live with do not have the expertise to do repairs (3)
- ☐ Repairs will happen in the future (4)
- ☐ Other (please specify) (5) ____________________

Page Break

Display This Question:

If Did your home experience any interior damage from the following due to Hurricane Michael and its... = Storm surge or flood

*

Q16
Approximately how high did the water reach in your main living area (feet)?

____

Display This Question:

If Did your home experience any interior damage from the following due to Hurricane Michael and its... = Storm surge or flood

Q17 Consider the **water damage** to your home. In your own words, please describe the following:

○ Where did the water damage occur? (1) ____

○ What was the extent of the damage to your home? (2) ____

○ What was the extent of the damage to your belongings? (3) ____

○ Why do you think the water damage occurred? (4) ____

Display This Question:

If Did your home experience any interior damage from the following due to Hurricane Michael and its... = Storm surge or flood

Q18 Has the damage been repaired?

○ Yes (1)

○ No (2)

Display This Question:

If Has the damage been repaired? = Yes

Q19 Approximately, how much did it cost to repair ($USD)?

____

Display This Question:

If Has the damage been repaired? = Yes

Q20 Who did the repairs? (check all that apply)

- ☐ Me or someone else I live with (1)
- ☐ A friend, coworker, neighbor or family member (2)
- ☐ A professional contractor (3)
- ☐ Other (please specify) (4) ____

Display This Question:

If Has the damage been repaired? = No

Q21 Why have you not repaired the damage? (check all that apply)

- ☐ Too expensive to do repairs (1)
- ☐ It takes too much time to do repairs (2)
- ☐ I or someone else I live with do not have the expertise to do repairs (3)
- ☐ Repairs will happen in the future (4)
- ☐ Other (please specify) (5) ____

Page Break

Display This Question:

If Did your home experience any interior damage from the following due to Hurricane Michael and its... = Wind

Q22 Consider the **wind damage** to your home. In your own words, please describe the following:

○ Where did the wind damage occur? (1) ________________

○ What was the extent of the damage to your home? (2) ________________

○ What was the extent of the damage to your belongings? (3) ________________

○ Why do you think the wind damage occurred? (4) ________________

Display This Question:

If Did your home experience any interior damage from the following due to Hurricane Michael and its... = Wind

Q23 Has the damage been repaired?

○ Yes (1)

○ No (2)

Display This Question:

If Has the damage been repaired? = Yes

Q24 Approximately, how much did it cost to repair ($USD)?

____

Display This Question:

If Has the damage been repaired? = Yes

Q25 Who did the repairs? (check all that apply)

- ☐ Me or someone else I live with (1)
- ☐ A friend, coworker, neighbor or family member (2)
- ☐ A professional contractor (3)
- ☐ Other (please specify) (4) ____________________

Display This Question:

If Has the damage been repaired? = No

Q26 Why didn't you repair the damage? (check all that apply)

- ☐ Too expensive to do repairs (1)
- ☐ It takes too much time to do repairs (2)
- ☐ I or someone else I live with do not have the expertise to do repairs (3)
- ☐ Repairs will happen in the future (4)
- ☐ Other (please specify) (5) ____________________

Page Break

Display This Question:

If Did your home experience any interior damage from the following due to Hurricane Michael and its... = Other (please specify)

Q27 Consider the **other damage** to your home. In your own words, please describe the following:

- ◯ Where did the other damage occur? (1) ____
- ◯ What was the extent of the damage to your home? (2) ____
- ◯ What was the extent of the damage to your belongings? (3) ____
- ◯ Why do you think the other damage occurred? (4) ____

Display This Question:

If Did your home experience any interior damage from the following due to Hurricane Michael and its... = Other (please specify)

Q28 Has the damage been repaired?

- ◯ Yes (1)
- ◯ No (2)

Display This Question:

If Has the damage been repaired? = Yes

Q29 Approximately, how much did it cost to repair ($USD)?

____

Display This Question:

If Has the damage been repaired? = Yes

Q30 Who did the repairs? (check all that apply)

- ☐ Me or someone else I live with (1)
- ☐ A friend, coworker, neighbor or family member (2)
- ☐ A professional contractor (3)
- ☐ Other (please specify) (4) ____________________

Display This Question:

If Has the damage been repaired? = No

Q31 Why didn't you repair the damage? (check all that apply)

- ☐ Too expensive to do repairs (1)
- ☐ It takes too much time to do repairs (2)
- ☐ I or someone else I live with do not have the expertise to do repairs (3)
- ☐ Repairs will happen in the future (4)
- ☐ Other (please specify) (5) ____________________

End of Block: INTERIOR HOME DAMAGE

Start of Block: EXTERIOR HOME DAMAGE

Q32 Did you have any fascia damage as shown in the figure?

◯ Yes (5)

◯ No (6)

Q33 Did you have any soffit damage as shown in the figure?

◯ Yes (1)

◯ No (2)

Q34 Did you have any Vinyl Siding damage as shown in the figure?

◯ Yes (6)

◯ No (7)

End of Block: EXTERIOR HOME DAMAGE

Start of Block: STRUCTURAL RETROFITS

Q35 Have any major hurricane retrofits (post-construction modifications) been made to your home that you may know of?

◯ Yes (1)

◯ No (2)

Display This Question:

If Have any major hurricane retrofits (post-construction modifications) been made to your home that... = Yes

Q36 Please list the improvements you've made since owning the home (or moving in), and indicate whether the work was done through local permitting and inspection.

	B	Was the work done through local permitting and inspection?	
	Improvement (1)	Yes (1)	No (2)
1 (1)		○	○
2 (2)		○	○
3 (3)		○	○
4 (4)		○	○
5 (5)		○	○

Page Break

Q37 How much do you agree or disagree with the following statements?

	Agree or Disagree					In one or two sentences, please explain your answer.
	1=completely disagree (1)	2=disagree (2)	3=neither agree nor disagree (3)	4=agree (4)	5=completely agree (5)	In one or two sentences, please explain your answer. (1)
My home held up very well in the face of Hurricane Michael and its aftermath (1)	○	○	○	○	○	
I would consider doing structural retrofits to protect against future hurricanes (2)	○	○	○	○	○	

End of Block: STRUCTURAL RETROFITS

Start of Block: DEMOGRAPHICS

Q38 In what year were you born?

▼ 1918 (1) ... 2002 (85)

Q39 What is your gender?

- ○ Male (1)
- ○ Female (2)
- ○ Other (3)
- ○ Prefer not to answer (4)

Q40 What is your annual household income?

- ◯ Less than $10,000 (1)
- ◯ $10,000 - $19,999 (2)
- ◯ $20,000 - $29,999 (3)
- ◯ $30,000 - $39,999 (4)
- ◯ $40,000 - $49,999 (5)
- ◯ $50,000 - $59,999 (6)
- ◯ $60,000 - $69,999 (7)
- ◯ $70,000 - $79,999 (8)
- ◯ $80,000 - $89,999 (9)
- ◯ $90,000 - $99,999 (10)
- ◯ $100,000 - $149,999 (11)
- ◯ More than $150,000 (12)
- ◯ Prefer not to answer (13)

Q41 In what year did you move into your home?

▼ 1918 (1) ... 2019 (102)

Q42 When was your home built?

▼ 1918 (1) ... 2019 (102)

Q43 Do you own or rent your home?

- ◯ Own (1)
- ◯ Rent (2)
- ◯ Other (please specify) (3) ____________________
- ◯ Prefer not to answer (4)

Q44 How many adults over the age of 65 live in your home?

▼ 0 (1) ... 10 (31)

Q45 How many children under the age of 5 live in your home?

▼ 0 (1) ... 10 (32)

Q46 What is your highest level of education?

- ◯ Less than high school (1)
- ◯ High school graduate (2)
- ◯ Some college (3)
- ◯ 2 year degree (4)
- ◯ 4 year degree (5)
- ◯ Professional degree (6)
- ◯ Doctorate (7)
- ◯ Prefer not to answer (8)

Q47 What is your current employment status?

- ◯ Employed full time (1)
- ◯ Employed part time (2)
- ◯ Unemployed looking for work (3)
- ◯ Unemployed not looking for work (4)
- ◯ Retired (5)
- ◯ Student (6)
- ◯ Disabled (7)
- ◯ Prefer not to answer (8)

Q48 Comments?

____

End of Block: DEMOGRAPHICS

Start of Block: Compensation purposes

Q49 Click on the link below to enter your e-mail address for the compensation.

https://ufl.qualtrics.com/jfe/form/SV_eLrqRimqMfYVaPH

End of Block: Compensation purposes

Compensation purposes

Start of Block: Email Address

Q1 In order to receive your $20 Amazon gift card, please enter your email address.

____

End of Block: Email Address

Appendix D. Original Survey Data

Participant ID	Q1	Q2_1	Q2_2	Q2_3	Q2_4	Q2_5	Q2_6	Q2_7
HM326	No	-	-	-	4	-	-	-
HM114	No	-	-	-	4	-	-	-
HM192	yes	-	-	-	-	-	-	-
HM40	No	1	-	-	-	-	-	think it
HM8	YES	-	-	-	-	-	-	-
HM362	NO	-	-	-	-	-	-	Did not wa
HM416	NO	1	-	3	4	-	6	-
HM472	YES	-	-	-	-	-	-	-
HM120	NO	1	-	-	-	-	-	-
HM77	YES	-	-	-	4	-	-	-

Participant ID	Q2_8	Q3_1	Q3_2	Q3_3	Q3_4	Q3_5	Q3_6	Q4
HM326	8	-	-	-	-	-	-	-
HM114	8	-	-	-	-	-	-	-
HM192	-	-	-	-	-	-	6=Millitary	1
HM40	-	-	-	-	-	-	-	-
HM8	-	1	-	3	-	5	-	1
HM362		-	-	-	-	-	-	-
HM416	8	-	-	-	-	-	-	-
HM472	-	-	-	-	-	-	We have a handicapp	1
HM120	-	-	-	-	-	- -		-
HM77	-	-	-	-	4	- -		1

Participant ID	Q5_1	Q5_2	Q5_3	Q5_4	Q5_5	Q6_1	Q6_2	Q6_3
HM326	80	80	10	20	20	1	-	3
HM114	0	80	5	2	0	-	2	3
HM192	50	70	20	0	30	1	2	-
HM40	20	100	0	0	0	1	2	-
HM8	75	60	80	90	90	-	-	3
HM362	30	100	20	20	30	1	2	3
HM416	15	100	0	1	0	-	-	3
HM472	15	80	10	5	5	1	2	3
HM120	10	69	5	0	0	-	2	3
HM77	51	92	92	21	10	1	-	3

Participant ID	Q6_4	Q6_5	Q6_6	Q6_7	Q6_8	Q6_9	Q6_10	Q7
HM326	-	-	-	-	-	-	-	3
HM114	-	-	-	-	-	-	-	3

HM192	-	-	-	-	8	-	-	5
HM40	-	5	6	-	8	-	-	4
HM8	-	-	6	-	-	-	-	3
HM362	-	-	-	-	-	-	10-Generat	3
HM416	-	5	-	-	-	9	-	4
HM472	-	-	-	-	8	9	e to flee to	4
HM120	-	-	6	-	-	-	-	4
HM77	-	5	-	-	-	9	-	4

Participant ID	Q8	Q9	Q10_1	Q10_2	Q10_3	Q10_4	Q11_1	Q11_2
HM326	2	2	1	-	3	-	Sky Light le	Roof, 5 of 7
HM114	3	3	1	-	3	-	Rooms nea	Cracking in
HM192	1	2	1	-	3	-	via bedroo	carpet dam
HM40	2	2	-	-	-	ior damage	-	-
HM8	2	2	1	2	3	-	A tree fell i	damaged,
HM362	1	2	1	-	-	-	Ceiling	Repaint Cei
HM416	3	3	1	-	3	-	All four roc	Total remo
HM472	2	2	1	-	-	-	Water cam	About $150
HM120	1	2	1	-	-	-	Living room	$153,000 ir
HM77	3	3	1	-	-	-	north side of house wh	
							blew the ra	30% of roo

Participant ID	Q11_3	Q11_4	Q12	Q13	Q14_1	Q14_2	Q14_3	Q14_4
HM326	severe, clo	wind and d	No	-	-	-	-	-
HM114	minimal	Wind spee	No	-	-	-	-	-
HM192	Mattress, c	Rain entere	YES	-	1	2	3	-
HM40	-	-	-	-	-	-	-	-
HM8	None, everything impo		YES	32000	1	-	3	-
HM362	NONE	Loss of roo	YES	300	1	-	-	-
HM416	Total loss i	-	-	-	-	-	-	-
HM472	Inside was	The wind d	YES	150	-	-	3	-
HM120	total loss, $	high winds	YES	153000	-	-	3	-
HM77	Some mold	90% of	YES	40000	-	-	3	-

Participant ID	Q15_1	Q15_2	Q15_3	Q15_4	Q15_5	Q16	Q17_1	Q17_2
HM326	-	-	-	4	-	-	-	-
HM114	-	-	-	4	-	-	-	-
HM192	-	-	-	-	-	-	-	-
HM40	-	-	-	-	-	-	-	-
HM8	-	-	-	-	-	3	living room	everything
HM362	-	-	-	-	-	-	-	-
HM416	-	-	-	-	-	-	-	-
HM472	-	-	-	-	-	-	-	-
HM120	-	-	-	-	-	-	-	-

HM77	-	-	-	-	-	-	-	-

Participant ID	Q17_3	Q17_4	Q18	Q19	Q20_1	Q20_2	Q20_3	Q20_4
HM326	-	-	-	-	-	-	-	-
HM114	-	-	-	-	-	-	-	-
HM192	-	-	-	-	-	-	-	-
HM40	-	-	-	-	-	-	-	-
HM8	only minor	falling tree:	yes	32000	1	-	3	-
HM362	-	-	-	-	-	-	-	-
HM416	-	-	-	-	-	-	-	-
HM472	-	-	-	-	-	-	-	-
HM120	-	-	-	-	-	-	-	-
HM77	-	-	-	-	-	-	-	-

Participant ID	Q21_1	Q21_2	Q21_3	Q21_4	Q21_5	Q22_1	Q22_2	Q22_3
HM326	-	-	-	-	-	Mostly to r	severe, san	severe, san
HM114	-	-	-	-	-	Rooms nea	Cracking in	minimal
HM192	-	-	-	-	-	house exte	severe to tl	bathroom r
HM40	-	-	-	-	-	-	-	-
HM8	-	-	-	-	-	everywhere	shingles rip	landscaping
HM362	-	-	-	-	-	-	-	-
HM416	-	-	-	-	-	Lifted up	Basically a	T otal loss.
HM472	-	-	-	-	-	-	-	-
HM120	-	-	-	-	-	-	-	-
HM77	-	-	-	-	-	-	-	-

Participant ID	Q22_4	Q23	Q24	Q25_1	Q25_2	Q25_3	Q25_4	Q26_1
HM326	velocity an	No	-	-	-	-	-	
HM114	Wind spee	No	-	-	-	-	-	4
HM192	Because a (	YES	-	1	2	3	-	-
HM40	-	-	-	-	-	-	-	-
HM8	a 155mph l	YES	32000	1	-	3	-	-
HM362	-	-	-	-	-	-	-	-
HM416	Global war	NO	-	-	-	-	-	-
HM472	-	-	-	-	-	-	-	-
HM120	-	-	-	-	-	-	-	-
HM77	-	-	-	-	-	-	-	-

Participant ID	Q26_2	Q26_3	Q26_4	Q26_5	Q27_1	Q27_2	Q27_3	Q27_4
HM326	-	-	4	-	-	-	-	-
HM114	-	-	-	-	-	-	-	-
HM192	-	-	-	-	-	-	-	-

HM40	-	-	-	-	Garage roo	Exterior da	Minor	Wind & tre
HM8	-	-	-	-	-	-	-	-
HM362	-	-	-	-	-	-	-	-
HM416	-	-	4	-	-	-	-	-
HM472	-	-	-	-	-	-	-	-
HM120	-	-	-	-	-	-	-	-
HM77	-	-	-	-	-	-	-	-

Participant ID	Q28	Q29	Q30_1	Q30_2	Q30_3	Q30_4	Q31_1	Q31_2
HM326	-	-	-	-	-	-	-	-
HM114	-	-	-	-	-	-	-	-
HM192	-	-	-	-	-	-	-	-
HM40	YES	25000	1	-	3	-	-	-
HM8	-	-	-	-	-	-	-	-
HM362	-	-	-	-	-	-	-	-
HM416	-	-	-	-	-	-	-	-
HM472	-	-	-	-	-	-	-	-
HM120	-	-	-	-	-	-	-	-
HM77	-	-	-	-	-	-	-	-

Participant ID	Q31_3	Q31_4	Q31_5	Q32	Q33	Q34	Q35	Q36_1
HM326	-	-	-	Yes	Yes	No	No	-
HM114	-	-	-	Yes	Yes	No	No	-
HM192	-	-	-	No	Yes	No	No	-
HM40	-	-	-	No	No	No	No	-
HM8	-	-	-	YES	YES	NO	No	-
HM362	-	-	-	No	No	No	No	-
HM416	-	-	-	YES	NO	YES	NO	-
HM472	-	-	-	YES	YES	NO	NO	-
HM120	-	-	-	YES	YES	YES	NO	-
HM77	-	-	-	YES	YES	NO	NO	

Participant ID	Q36_2	Q36_3	Q36_4	Q36_5	Q37_1	Q37_2	Q38	Q39
HM326	-	-	-	-	3=neither a	4=agree; b	1959	Male
HM114	-	-	-	-	3=House	5=I want	1978	Female
HM192	-	-	-	-	4=All	5=House	1995	Male
HM40	-	-	-	-	4= Home w	3=No comr	1961	Female
HM8	-	-	-	-	4=My	4=I am alw	1989	Male
HM362	-	-	-	-	5=Minoer c	winodws cc	1961	male
HM416	-	-	-	-	2=Home	5=Would ra	1995	Female
HM472	-	-	-	-	4=We had	3=I don't	1947	Male
HM120	-	-	-	-	4=I	4=I will talk	1968	Male
HM77	-	-	-	-	4=I never	4=I	1964	Male

Participant ID	Q40	Q41	Q42	Q43	Q44	Q45	Q46	Q47
HM326	50k-60k	2011	1997	own	0	0	2 year degr	Employedf
HM114	10k-20k	2006	2006	own	0	0	High schoo	Employed p

HM192	Prefer not t	2017	1997	own	0	0	some colle Employed f
HM40	100K-150K	2002	1998	OWN	0	0	4 year degr Employed f
HM8	70k-80k	2017	2002	own	0	1	4 year degr Employed f
HM362	prefer not t	2006	2005	own	0	0	prefer not t Employed f
HM416	90K-10K	2014	2009	OWN	0	0	2 year degr Employed f
HM472	20K-30K19	2018	1986	OWN	2	0	Doctorate Retired
HM120	80k-90k	2016	1998	own	0	0	4 year degr Employed f
HM77	50k-60k	2008	2007	own	0	0	4 year degr Retired

Participant ID	Q48	Q49
HM326	-	-
HM114		-
HM192	-	-
HM40	-	-
HM8		-
HM362		-
HM416		-
HM472		
HM120	thanks for putting your time into collecting data	
HM77	Good survey. I doubt the speedy repairs I've seen in the neighborhood will stand up to anotl as fast as possible (making money) vs. quality work. The county inspector did a very fast lool	