Final Report:

Survey and Investigation of Buildings Damaged by Category III Hurricanes in FY 2016-17 – Hurricane Matthew 2016

Project #: 0004029

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)

Kurtis R. Gurley, PhD.
Co-Principal Investigator
Professor (Structures)

David B. Roueche, Ph.D.
Postdoctoral Researcher

Gabrielle Wong-Parodi, Ph.D.
Social Science Consultant
Assistant Research Professor (Carnegie-Mellon University)

Research Assistants:
Rodrigo Castillo-Perez, Mark Mimms, Quinten Ozimek, Alyssa Egnew, Hamid Yaghoubi

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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

When Hurricane Matthew formed in the Caribbean in late September 2016, the National Hurricane Center monitored its movement and eventually issued a warning to residents along Florida's east coast to prepare for the imminent landfall of a Category 3 hurricane. The NHC announcement triggered the Florida Building Commission to request mobilization of the Florida Coastal Monitoring Program to conduct surveys on buildings affected by extreme winds. Hurricane Matthew did not make landfall but the eye of the storm approached to within 40 miles of the coast on 7 October 2016. The maximum wind speed was 120 mph, well below the design level wind speeds for coastal Florida. Tropical-storm force winds extended up to 80 miles inland.

On 8 October 2016, the University of Florida Wind Hazard Damage Assessment Team (WHDAG) deployed to conduct the initial damage assessment on the barrier islands in Flagler County. The UF team assessed damage to nearly 100 houses distributed between one coastal community in Flagler Beach and a coastal subdivision near Marineland. The gust wind speeds at these two sites were less than 90 mph, or just 60% of the design wind speed for the area.

We observed damage to 1 in 6 houses (16%) of the houses we surveyed. The most common damage was failure of roof cover (e.g., asphalt shingles) materials and damaged soffits. We reported our preliminary findings to the Florida Building Commission, who requested we conduct a detailed damage assessment study. The objective of this detailed study was to ascertain the extent of interior damage and other hidden damages sustained, as well as to gauge perceptions of homeowners regarding their risk tolerance, evacuation plans, and economic costs of repairs.

This report presents our objectives, a description of methodology and main observations from our survey. For the first time, we used an unmanned aerial vehicle to better capture the extent of damage to structures. Using the UAV was helpful in our survey as it leverages effort by extending the coverage area from a small crew to cover more houses. The vantage point also made ascertaining of roof damage easier. For our follow-up detailed damage assessment, we developed a novel approach to conduct open-ended interviews with homeowners from the affected communities to solicit their input on the damage. The process was considerably more involved than was the preliminary damage assessment, requiring, firstly formal approval of the interview protocol, from the Institutional Review Board (IRB) mailing of solicitations to homeowners, direct placement of door hangar placards at each house, and the interview process themselves. In the end the team was able to conduct 22 1-hour in-person interviews, (out of 140 solicitations sent to homeowners).

Of the homeowners interviewed, seven reported their homes experienced damage. We noted that homeowners living in newer (post-2001) houses were three times more likely to say they suffered little or no damage, (up to $5,000), versus homeowners living in older houses before adoption of the 2001 Florida Building Code (FBC). Losses ranged from $1,000 to $200,000. Homeowners of newer houses were also more likely to understand which features of their homes contributed to its improved wind-resistant performance. 29% of the post-2001 homeowners stated that building codes were one such important feature. In both pre- and post-2001 FBC groups, damage to asphalt shingle roofing systems was the main source of damage, reported by over 50% of respondents. We include conclusions on other common wind failures in our report.

The Flagler County Division of Emergency Management provided high-resolution aerial photographs of an 8-mile stretch of coastline to us. While our analysis of this data is ongoing we were able to identify wind damage among roofs of 366 structures located immediately adjacent to the main coastal road (Highway A1A). This strip of homes was unsheltered and would have experienced the highest winds. Our analysis includes meta-data on building age, shapes and other characteristics. As expected newer houses suffered less damage. For the strip of buildings along the coast, 38% of the pre-2001 FBC buildings had visible damage compared to just 12% of the post-2001 FBC buildings.

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1 HURRICANE MATTHEW

Hurricane Matthew became the 13th named storm of 2016 in the Atlantic season on September 28th, reaching maximum wind speeds of 160 mph on October 1st, making Matthew the first Category 5 hurricane of the season, and the first since Hurricane Felix in 2007. Hurricane Matthew first made landfall in Haiti on October 4th as a Category 4 storm, and leaving widespread destruction in its wake. The storm continued through the Caribbean, affecting Cuba and the Bahamas before skirting the coast of Florida and Georgia as a Category 3 hurricane on October 7th, and finally making landfall as a Category 1 hurricane near McClellanville, South Carolina on October 8th. The storm track is shown in Figure 1.

Hurricane Matthew caused catastrophic damage across vast swathes of Haiti, and greatly impacted both Cuba and the Bahamas. Loss of life and property were widespread in Haiti, as sadly over 1,000 fatalities were reported. Firsthand damage surveys conducted by the first author reveals that the extensive damage to houses in the Tiburon Peninsula in Haiti were principally due to the poor siting of structures at or near coastlines, poor construction practices and material selection. The loss of life may also be attributable to inadequate forewarning of the impending hurricane to this remote locations nearest the hurricane path.

Hurricane Matthew approached the United States eastern seaboard as a Category 3 hurricane. The eye of the storm passed within 30 miles of Melbourne, Florida with sustained wind speeds in the eye-wall of 130 mph on October 6th 2016. Matthew continued to track northwards, skirting the First Coast while causing historic flooding to areas in Northeast Florida. A record storm surge of 9.88 ft was recorded in Fernandina Beach, Florida on October 7th, 35 miles north of Jacksonville. Mandatory evacuations were ordered for many parts of Jacksonville and all areas of downtown St. Augustine and the inter-coastal waterway along the First Coast. Bridges across the inter-coastal waterway were closed after

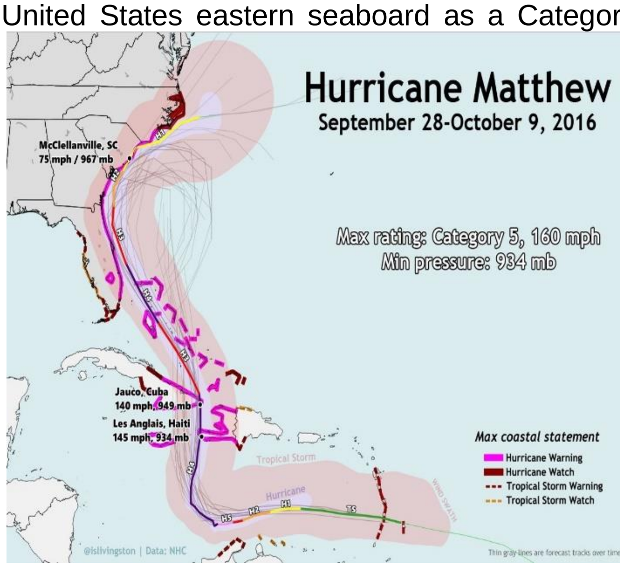

Figure 1: Hurricane Matthew track (graphic created by Ian Livingston, [Washington Post Capital Weather Gang)](#).

evacuations were completed and blockaded by the National Guard until the storm had moved further north on October 8th.

As Matthew continued up the coast, the storm steadily weakened and wind speeds dropped. However the heavy rainfall continued, causing erosion along hundreds of miles of beaches. In total, flooding and storm surges were seen throughout Florida, Georgia, and the Carolinas. Hurricane Matthew dropped nearly 15 inches of rain in Goldsboro and Fayetteville, North Carolina as well as over a foot of rain in other areas of South Carolina and Virginia before turning out to sea on October 9th.

Hurricane Matthew claimed at least 36 lives in the United States, and over 1,000 lives in total through its 10 days as a hurricane. However, the damage and loss of life associated with Matthew could have been much worse if the hurricane path did not follow the slight eastern shift as the storm passed over the islands of the Bahamas. Despite the shift, AON Benfield estimated insured costs in the US were still close to $4 billion, and the total economic losses at near $10 billion (AON Benfield 2017). In Florida specifically, the insured losses were estimated at $1.5 billion with total economic costs of $2.25 billion.

The highest impacts in Florida were in the counties of Duval, St. Johns, Flagler, Volusia and Brevard. Table 1 summarizes the impacts in these counties using data reported in Aon Benfield (2017).

Table 1: Summary of Hurricane Matthew impacts to homes in select Florida counties (AON Benfield 2017)

County	Number of Homes in County	Number of Homes Damaged by Matthew	% Damaged
Volusia	165,861	12,000	7.2%
Flagler	49,273	1,276	2.6%
Brevard	176,095	1,628	0.9%
St. Johns	63,230	2,000	3.2%
Duval	238,772	498	0.2%

2 OVERVIEW AND SCOPE OF WORK

The University of Florida research team conducted an initial damage assessment on 8 October upon the request of the Florida Building Commission. Following this initial damage assessment in accordance to our contract, the University of Florida reported preliminary findings to the Roofing TAC Florida Building Commission (FBC) at their 13 October 2017 meeting in Gainesville, FL (Facilitator's Summary Report of the May 12, 2017 Meeting). A preliminary report of those findings was submitted to the FBC (). FBC staff requested us to submit a proposal to conduct more detailed investigation of the wind damage sustained to residential structures. In our proposal we offered to conduct interviews with homeowners from the two communities (Flagler Beach and Marineland, FL), that UF Triage Assessment of Damage from Hurricane Matthewwe surveyed initially in order to determine the extent, if any, of interior damage to the homes and extent of other damage we were unable to observe from the public street during our post-hurricane survey.

The scope of this task, "*Comparison of Hurricane Matthew Damage Patterns for Two Coastal Communities and Homeowner/Occupant Survey on Risk Perceptions, Mitigation and Evacuation,"* includes the following:

- Conduct interviews with approximately 20 homeowner/occupants to supplement the UF Team's preliminary database of exterior damage. Interviews will enable the UF Team to gather data interior damage, and specific information on components damages and overall economic loss (including deductibles) data for the homes that experienced damage.
- Conduct interviews of approximately 20 additional homeowner/occupants of an adjacent (undamaged) single-family residences to determine the extent of hidden damage (if any) that the UF Team was unable to observe during their preliminary damage survey.

3 DESCRIPTION OF SURVEY SITES

The investigation presented in this report primarily focus on two communities in Flagler County, FL – one in Flagler Beach, FL and the other 15 miles north near Marineland, FL. In the aftermath of Hurricane Matthew, the UF research team identified the general region of Flagler Beach as a good candidate for a triage damage assessment for the following reasons:

- Coastal suburban population reported building damage through social media and local news reports,
- Wide variation in age of the housing stock,
- Region was accessible without major flooding concerns, and
- The peak wind speed observations were in line with those observed along the majority of the Florida coast during the passage of Hurricane Matthew.

On the morning of 8 October 2016, the Wind Hazard Damage Assessment Group at the University of Florida, led by Dr. David O. Prevatt, left for Flagler Beach, Florida to conduct damage surveys. The WHDAG identified two areas: the 1400-1500 block from A1A to Flagler St. in Flagler Beach, FL, and a newly built community near Marineland, FL approximately 15 miles due north. Figure 2 shows the two communities and the observed wind speed contour map. Demographically, these two areas were quite different – the Marineland subdivision consisted of brand new construction, with most homes built after 2015 and some houses still under construction. Homes in the Flagler Beach area, were built between 1954 and 2016, with an average construction year of 1984 (based on the Flagler County Property Appraiser). The number of homes surveyed are reported in Table 2 for each community, divided into two groups by date of construction, namely pre-1 March 2002 homes and post-1 March 2002 homes. We selected 2002 as the cut-off because the first statewide Florida Building Code was enacted in that year, following lessons learned from Hurricane Andrew. A summary of the code improvements brought about in the 2001 Florida Building Code is provided in Appendix A.

Pre-event aerial imagery of the two sites from Google Earth is shown in Figure 3. Both communities are located within 500 yards of the coastline. The Marineland site is located in a FEMA flood zone AE, meaning a 1% annual chance of flooding, with base flood elevation of 7 ft. The Flagler Beach site is mostly in a FEMA flood zone X, indicating minimal flood hazard risk. The terrain exposure is generally suburban terrain to the north, south and west and open water to the east. There was light to moderate tree-cover in Flagler Beach and light tree cover within the Marineland site.

Estimated 3 second gust wind speeds at 33 ft (10 m) height were less than 90 mph at both sites, based on observations from nearby ASOS and mesoWest towers, with the highest wind speeds coming out of the North. Winds from due North would have come off the ocean for the Flagler Beach area, thus homes directly on the coastline would have experienced slightly higher wind speeds than those further inland due to the marine exposure. The design wind speed in this region from the 2014 Florida Building Code is approximately 135 mph. Observed wind speeds were then 67% of design, and all things being equal a reasonable expectation for the wind loads is approximately 44% of design wind loads ($(90/135)^2 = 0.44$).

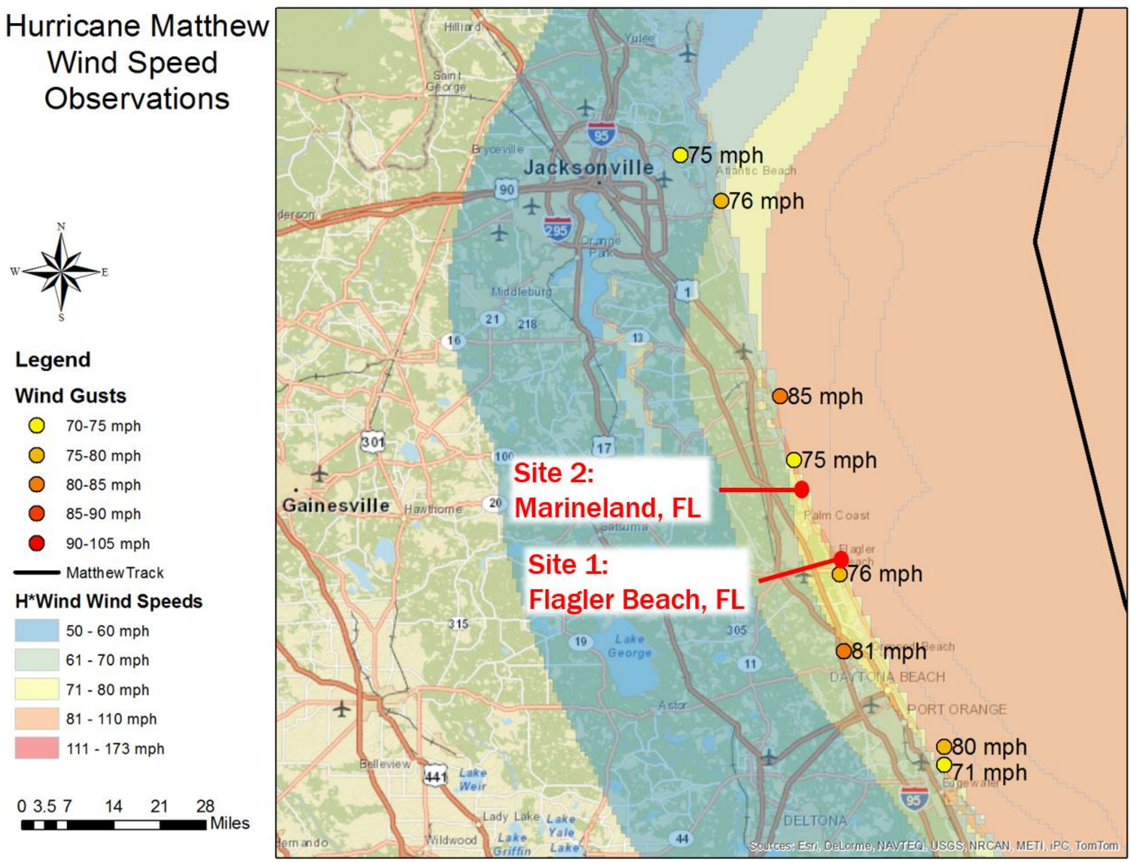

Figure 2: Estimated and observed 3-second gust wind speeds at 10 m height along the NE coast of Florida. Colored dots and labels represent wind speed observations from weather observation towers. Colored contours are provided by H*Wind (Powell et al. 1998).

Table 2: Homes built before and after 2002 included in the two ground-survey sites.

	Flagler Beach (Site 1)	Marineland (Site 2)
Houses built before 2002:	41	0
Houses built after 2002:	9	46

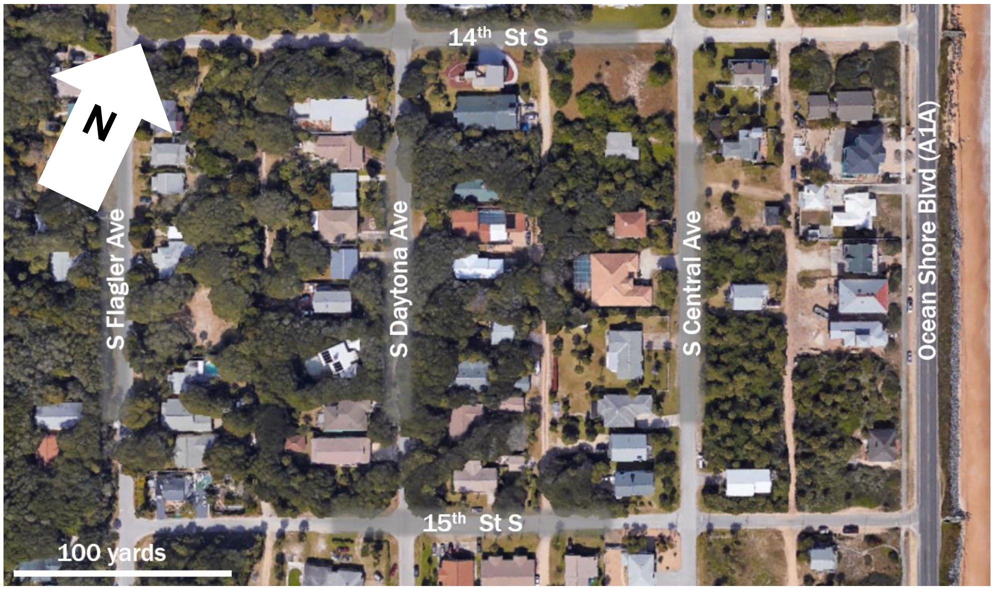

Figure 3: The two survey sites that are the focus of this study. Top: Site 1, Flagler Beach, FL. Bottom: Site 2, Marineland, FL.

4 HOMEOWNER INTERVIEWS

The WHDAG followed up on the initial damage assessment survey by conducting open-ended, in-person interviews with homeowners. The survey approach was necessary to gauge the extent of damage to the interior of the home and ensuing economic losses. We solicited interviews from homeowners living in buildings in which we observed exterior damage, but also solicited interviews with homeowners in adjacent structures that did not show any visible damage. We anticipated learning whether specific characteristics that affected damage levels in these paired houses nominally experienced the same wind speeds and direction. We also recognized the opportunity to learn about the perceptions of Florida residents towards hurricane risk, evacuation, mitigation, and building strength.

4.1 Literature Review

Previous studies have shown that few homeowners take adaptive measures to enhance their resilience to high impact storm events such as hurricanes voluntarily (Kunreuther, 1996) and they are often underprepared when disaster strikes (Donahue et al. 2013). However, recent research also suggests that those with recent direct experience are more open to taking such protective measures (Bubeck, Botzen & Aerts, 2012). Most of this literature review focuses on intentions to take smaller protective measures (e.g. sandbags, evacuation plans, flood provisions, etc.) rather than more substantive protective steps (e.g., additions of metal roof, wind-resistant shingles, impact resistant windows, etc.). Hurricane Matthew offers a unique opportunity to conduct an exploratory study examining how direct experience, and the nature of that experience, influences these decisions and the potential role for policy.

4.2 Methodology

4.2.1 Institutional Review Board

Before any research involving human subjects can be conducted, federal regulations stipulate the research scope must receive approval from the Institutional Review Board (IRB) at the Investigator's institution. The IRB reviews such research to ensure that the welfare and rights of the subjects are protected in accordance with federal regulations. The University of Florida has three IRBs, which review specific types of research from clinical trials to surveys. UF IRB 02 reviews social, behavioral, and educational research and other research involving surveys, which is most closely aligned with the current project. Descriptions of the research project objectives and personnel, the interview protocol, and the recruitment material were all submitted to UF IRB 02 through an online interface for review by the board.

On 28 March 2017, Dr. Ira Fischler, Chair of IRB-02 at UF, provided the approval for us to conduct the research project #IRB201700282. The study was granted exempt status because it poses minimal risk to the participants. The draft interview protocol is provided in Appendix B.

4.2.2 Interview Protocol

The interviews consisted of open-ended questions on topics such as the performance of the home during Hurricane Matthew, incurred damage and losses, understanding of the risk, perceptions about future preparedness, demographics, and impacts of Hurricane Matthew on emotional, physical and financial well-being. The interview protocol included the gathering information on the house itself, such as distance from the shoreline, age, roof shape, number of stories, materials, applicable building code, presence of retrofits, etc. The draft interview protocol is provided in Appendix B.

4.2.3 Recruitment

Interviewees were recruited from homes identified with visible damage from the on-site assessment, and an adjacent (or nearby) residence. A recruitment flyer was created and was mailed to each of the 140 targeted residents. The recruitment flyer briefly describes the research objectives of the study and invites those interested in participating to contact the research team via phone or email. Participants were offered $40 in compensation for taking part in the interview, which was expected to require an hour of the interviewee’s time. The draft recruitment flyer is provided in Appendix C. As an exempt approved study, no IRB approval stamp was placed on the consents, fliers, emails or any other recruitment document. Door hangers were also produced and distributed to the houses in those neighborhoods. Phone calls were also made by UF WHDAG members to contacts in the areas that were referred to us by some of the interviewees.

4.2.4 Training with Carnegie-Mellon University

The draft interview protocol was written under guidance of co-PI Wong-Parodi, a research scientist at the Center for Climate and Energy Decision Making at Carnegie Mellon University. The University of Florida engineering students and staff were trained by Dr. Parodi and her staff in how to properly conduct an open-ended interview, how to make the interviewees feel comfortable, and how to purse topics of interest during the interviews. University of Florida faculty, staff and students involved in the process also completed training requirements necessary for submitting an IRB related to privacy laws and storage of data.

4.2.5 Data collection and archival

In order to effectively gather and analyze the data gathered from the in-person interviews, audio recorders were chosen for usage during each interview to have documentation of everything discussed, in addition to notes taken by the WHDAG members while facilitating the interview. These audio files were saved on the recorders, transferred to a computer, and then sent to Dr. Wong-Parodi for transcribing. As per the IRB submission, the data gathered was all stored safely as computer-based files that are only available to personnel involved in the study through the use of access-restricted privileges, passwords, and encryption.

The transcripts were analyzed using NVivo, a qualitative data analysis software suite. The researchers first completely read through the transcripts, then coded the transcripts for unique concepts (e.g., “damage impact”) and then coded again for sub-codes (e.g., sub-code of “damage impact” is “residence, interior”) and sub-sub-codes (e.g., sub-code of “residence, interior” is “major water damage”).

4.2.6 Location of Interviews

All of the interviews between the prospective interviewee homeowners and the UF WHDAG were scheduled to take place in the homes of the homeowners. One, two, or three members from the team drove to Flagler Beach and/or Marineland to meet with the homeowners. All interviews were conducted in-person between 2 May 2017 and 9 May 2017.

4.2.7 Duration of Interviews

In the training phases of preparing for these open-ended interviews, the target time to reach for a typical interview was a one-hour duration. All of the interviews conducted varied from this time for several reasons. The times of the interviews ranged from approximately 20 minutes to over one hour. Reasons for the disparity in times included willingness of the interviewees to speak more on issues with their homes, significant events that the homeowner experienced during Hurricane Matthew, the speed that they/the interviewer spoke at, etc.

4.3 Analysis of Conducted Interviews

4.3.1 Participants

Our participants reported being on average 59.9 years old, with 62.1% being female, 68.8% holding a bachelor's degree or higher, and all reporting that English is the primary language spoken at home. They are also affluent, with 75.7% reporting an average annual household income of $156K and the rest preferring not to respond. All of our participants own their home, with 54.1% reporting they live with 1 other person, followed by 18.2% reporting that they live alone, 18.2% reporting they live with 2 other people, 4.5% reporting they live with 4 other people, and 4.5% reporting they live with 5 other people. About 18.2% of our participants reported that they lived with children under the age of 18.

4.3.2 Important themes

Through our analysis of the interviews, five main themes emerged: (a) predictability of hurricanes, (b) risk of significant hurricane is low, (c) self-reported acceptance of risk, (d) influence of social cues on behaviors, and (e) damage perceptions and impacts. Here, we briefly summarize our findings for themes a-d and describe theme e in more detail in section 3 below.

Predictability of hurricanes. Many participants expressed skepticism about forecaster's ability to predict future hurricanes, however many did mention a periodicity with respect to hurricanes from their own observation. Among those who noticed a pattern, many cited a return period of 10 years for a hurricane to occur anywhere in Florida. However, some participants did think that frequency *and* intensity of hurricanes was increasing. With the most likely culprit being climate change (or global warming, as put by most participants):

> *I do, because I feel like with global warming… I believe in global warming, I believe it's all happening. So, I do, and I'm very nervous about… When I bought this house, my oldest son was like, "Well, you know, you're going to wind up in the ocean one of these days," so. (ID1006)*

Risk of significant hurricane is low. Participants expressed the belief that the chances of a hurricane that causes significant damage occurring in the area (Flagler Beach, Marineland) is low because of the area's unique geography ("*Well, you know, one of the charms of this particular area is they very, very seldom get direct hits*" (ID1009)). Indeed, some of the participants had very detailed mental models of how the geography affects the chances of significant events:

> *Because of the way the state is shaped. That's what's always protected, like Jacksonville Beach, because it comes up here, and because the land comes out right up here, north of here, and then goes back in and it has a tendency to—you know, it follows the Gulf stream, so it has a tendency to take off and stay offshore more, up in northeast Florida. (ID1007)*

Another reason why people believe the chances are low, is the way that they understand and make implicit calculations about return periods. Since an event has occurred, its chance has therefore been "used up" and won't occur again for a long time (P: "*So I would say in our lifetime, we may not see another one like that." I: And why is it that you think that?" S: Just statistics. You know, they say there's really no better predictor of the future than the past*" (ID1009)).

Self-reported acceptance of risk. Participants in general expressed the sentiment that to live in Florida is to accept the risk of hurricanes ("*It's [hurricanes] just…the price of living here*" (ID2003)). Some also expressed the sentiment that hurricanes neither worried them in particular ("*I am not fearful of other hurricanes. As Floridians, I mean, it's just a fact of life"* (ID1002)) nor surprised them when they did occur ("*I was born and raised in Florida, hurricanes are not a surprise to me*" (ID1003)). Others who were new to Florida expressed different reasons for accepting risk – to do otherwise would shake the very foundations of their sense of well-being and happiness ("*Why? Well, because I already finally found my dream community and dream house, and it's taken me 50 years to get here, and I don't want to lose it*" (ID1006)).

Influence of social cues on behaviors. In general, we found that how other people around the participants were behaving in the days leading up to Hurricane Matthew influenced whether they prepared and eventually evacuated:

> *I was going to stay, and so were my neighbors. I've never left before. And my neighbors called me from across the street and said, "We're leaving. It sounds like it's worse." And next door, they were packed up and ready, and I said, "Okay, I'm going." (ID1004)*

We also found that some participants wanted to set a good example for their friends and neighbors who they worried about, and so they decided to prepare and evacuate when they may have otherwise done nothing ("*We also go the guy down the street in the wheelchair, convinced him to leave, had him picked up by an ambulance*" (ID1007)). Finally, some participants were coerced to leave by friends and family ("*Well we decided to stay and then at the last minute my son from Gainesville tried to shame us off the island*" (ID2001)).

4.3.3 Damage (physical and financial) impacts

Interview participants made observations about damages not only to themselves, but also about community-wide impacts (A1A), damages to neighbors (many noted neighbors who endured significant damage, such as losing a roof or flooding), and the location of those damages. When talking about the damages they incurred, participants noted damages that occurred to outdoor property (e.g. landscaping, outdoor furniture, etc.). They also spoke in detail about the damages to their homes, both inside and out. Figure 4 shows the two most commonly mentioned areas of damage to the home as a result of Hurricane Matthew were shingles and soffits, with those living in homes built after 2002 reporting the most damage. When considering interior damage, the most frequently mentioned was major water damage (general), windows and walls, with those living in older homes reporting more of these damages (Figure 5). However, those living in newer homes reported a greater variety of damages.

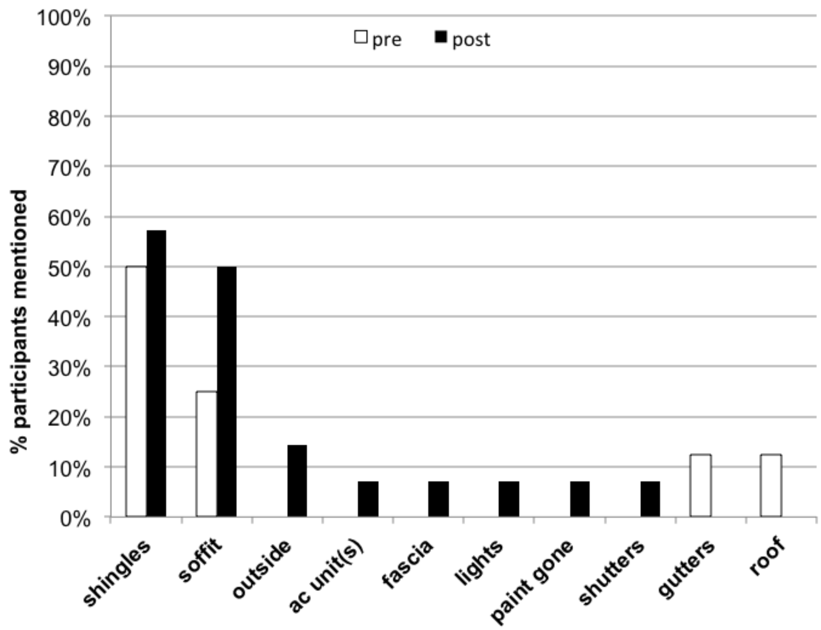

Figure 4: Types of exterior damage mentioned for pre- versus post-2001 FBC construction

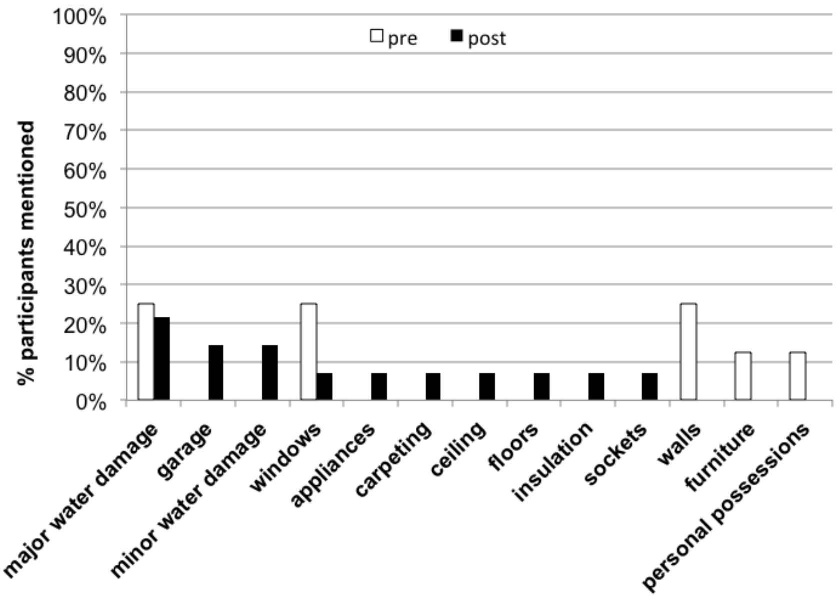

Figure 5: Types of interior damage mentioned for pre- versus post-2001 FBC construction

Despite being able to list more exterior and interior damages, as shown in Figure 6 those living in homes built before 2002 mentioned incurring damages exceeding $5K+ more than those living in newer homes. Moreover, those living in newer homes were better able to identify specific reasons or features of their homes that prevented water or wind-related damages such as new building codes, stem walls, impact resistant windows, poured concrete, and homes being tied down (Figure 7). Conversely, those who lived in older homes were able to point to specific reasons or features of their homes that failed resulting in water or wind-related damages such as shingles, garage, roof, and sliders (Figure 8).

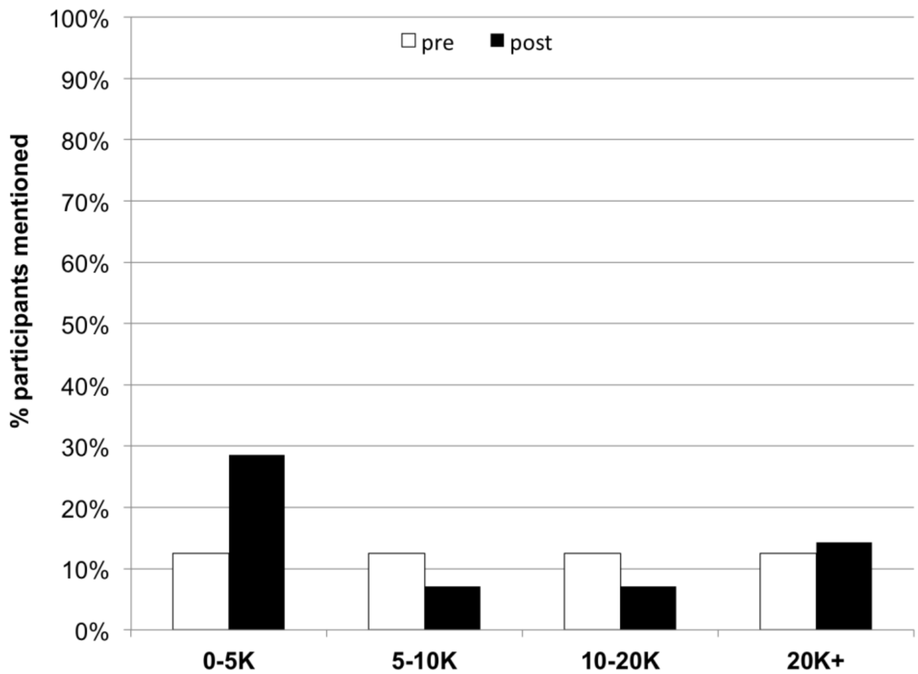

Figure 6: Reported damage estimates for pre- versus post-2001 FBC construction.

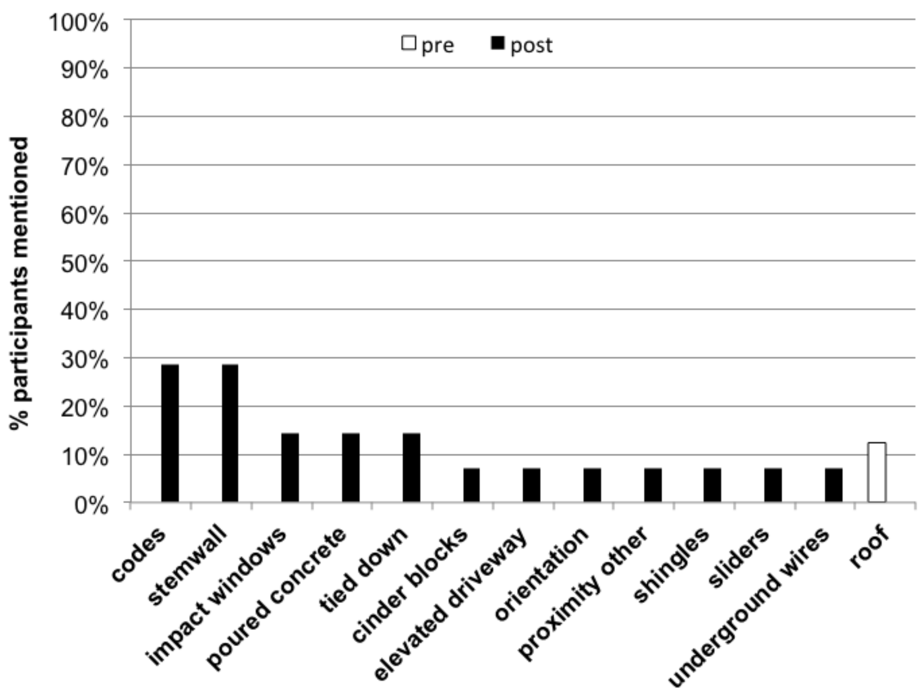

Figure 7: Features that prevented damage for pre- versus post-2001 FBC construction

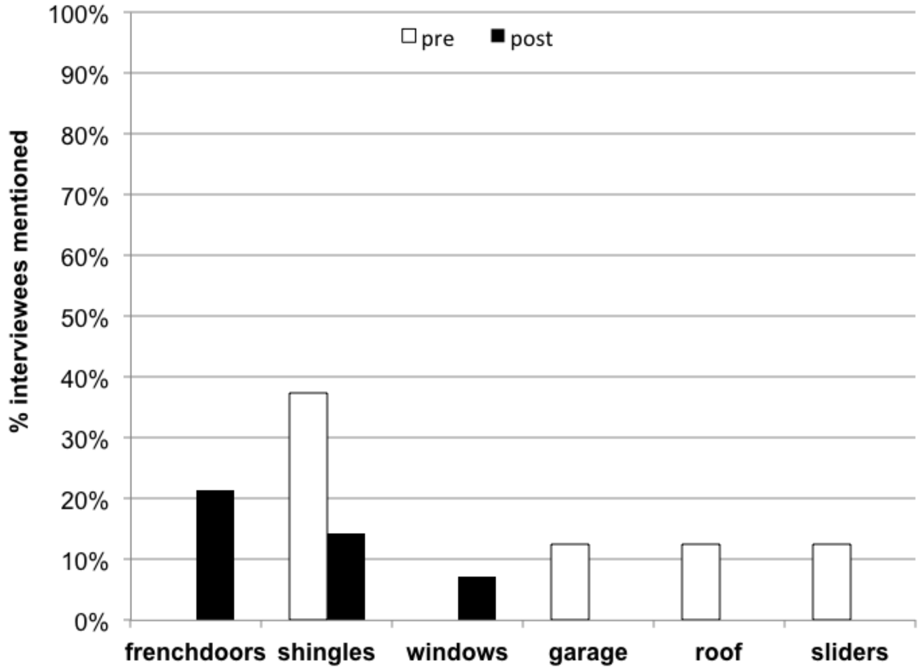

Figure 8: Features that failed for pre- versus post-2001 FBC construction

This trend continued when participants were asked to consider damages that could occur if sustained winds exceeded 120 miles per hour. Those participants living in newer homes mentioned specific reasons or features that are likely to prevent serious wind, rain and flooding damage such as stricter building codes, metal roofs, and shutters (Figure 9). It is notable that that participants living in older homes did not mention any of these. Moreover, while all participants were able to mention building features that are likely to fail in stronger, sustained winds, those living in older homes underscored their concern about the construction of their roofs, windows and doors as possible points of vulnerability (Figure 10).

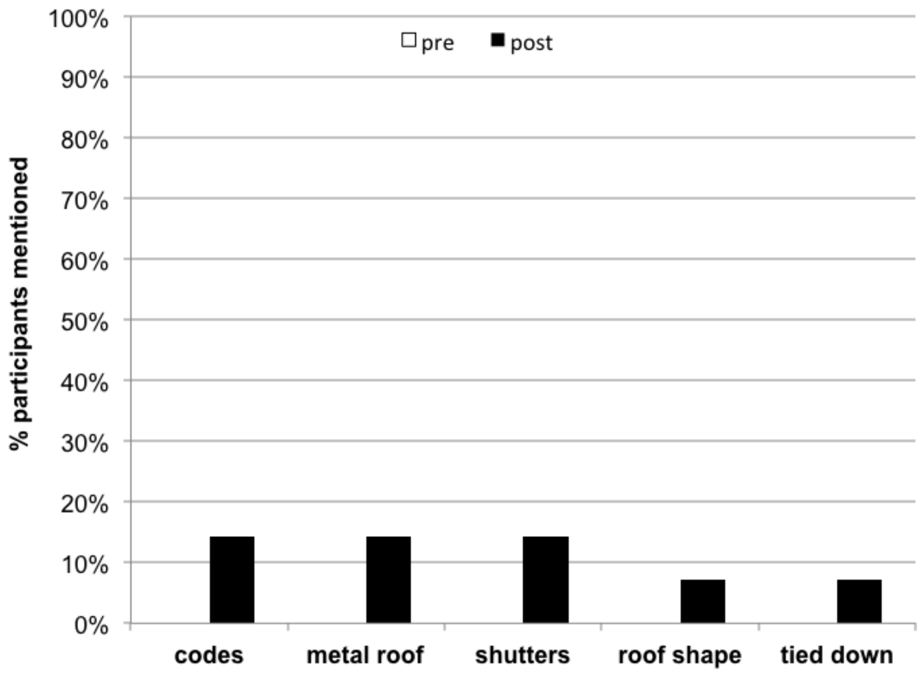

Figure 9: Features likely to protect during 120 mph hurricane (pre- vs. post-2001 FBC construction)

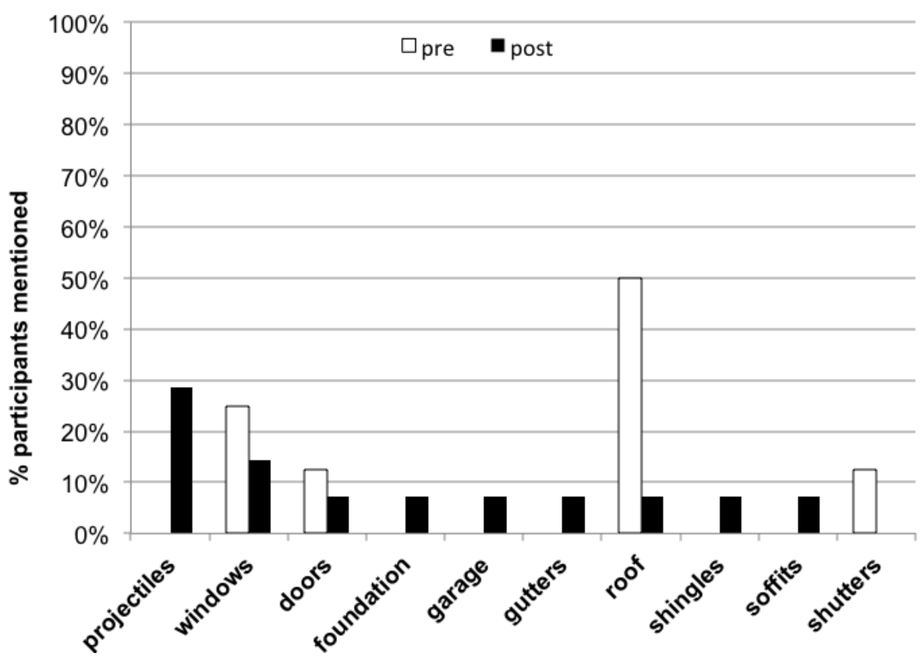

Figure 10: Features likely to fail during 120 mph hurricane (pre- vs. post-2001 FBC construction)

4.3.4 Damage (physical and financial) Perceptions

On balance, participants did not feel as if their lives were in danger due to Hurricane Matthew, with many explaining that they had already evacuated or happened to be elsewhere at the time *("No. Because I was gone"* (ID2005)). However, many did worry that their homes may become uninhabitable due, primarily, to not knowing what was going on *("…there was not a great deal of communication letting people know what was happening, so you just had to wait and hope" (ID4002)*) and to the images they were getting from the news and people who stayed behind:

> *Well, when I was seeing the pictures of the total destruction of the road, I just couldn't imagine that within a half a mile of that, my house would be, I just really anticipated it being bad. (ID2005)*

Others qualified their responses by stating they would have expected their homes to be uninhabitable if the hurricane was a category 4, as was thought at one point ("*When I thought it was a category 4 coming through the county, I absolutely did*" (ID3001)).

Many participants, particularly those in newer homes, affirmed that they would be willing to pay to avoid damages from Hurricane Matthew or a similar, stronger storm event. As shown in Figure 11, people living in homes built after 2002 were more willing to pay between $5K and $10K or some other unspecified amount (among those expressing difficult estimating a numeric value). Whereas many of those living in older homes believed it wasn't possible to quantify avoided damages (*"I don't know if I could put an absolute price on it, because it depends on how much would need to be done*" (ID1003)) or they weren't willing to spend the money to do so *("I am not willing to do anything possible to make it safe. If I were willing to do anything possible, I'd probably move"* (ID2005)).

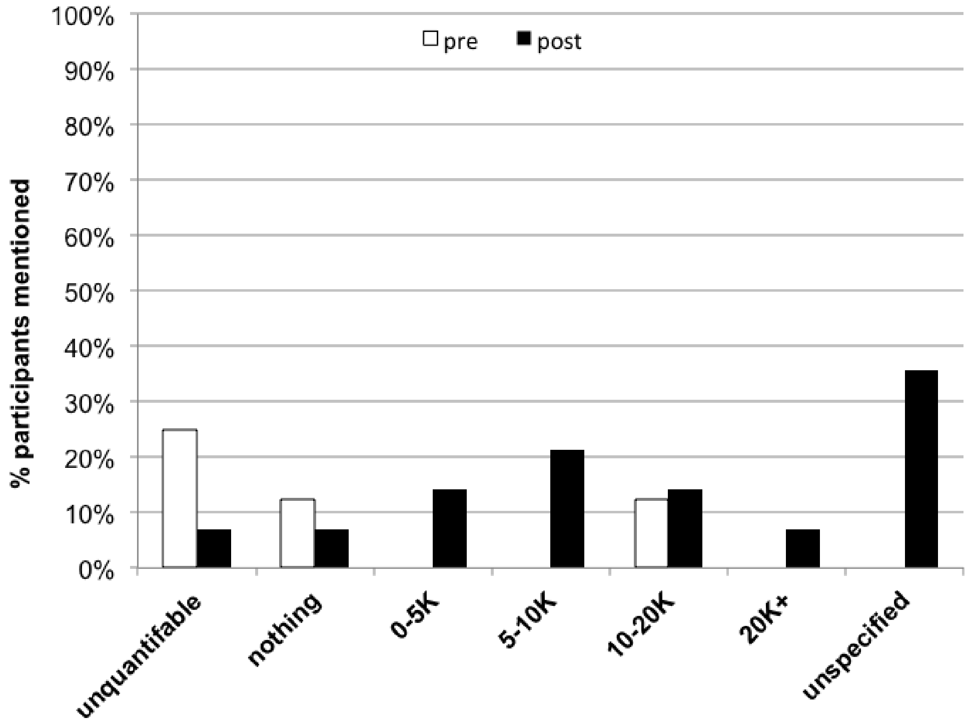

Figure 11: Reported willingness to pay to avoid damage from 120 mph winds (pre- versus post-2001 FBC construction)

As shown in Figure 12, participants were by far most interested in using rebates to pay for improvements to the home to avoid damages, followed by an increase in taxes and paying for the improvements out of pocket. Rebates seemed like an especially popular option among those living in homes built before 2002. Participants, particularly those living in newer homes (28.6% mentioned), seemed to dislike the thought of higher insurance premiums to pay for improvements:

> *Nobody wants higher insurance premiums. We pay so much for insurance premiums, so I would not want it to be through premiums. I think that takes away the person's option. (ID1003)*

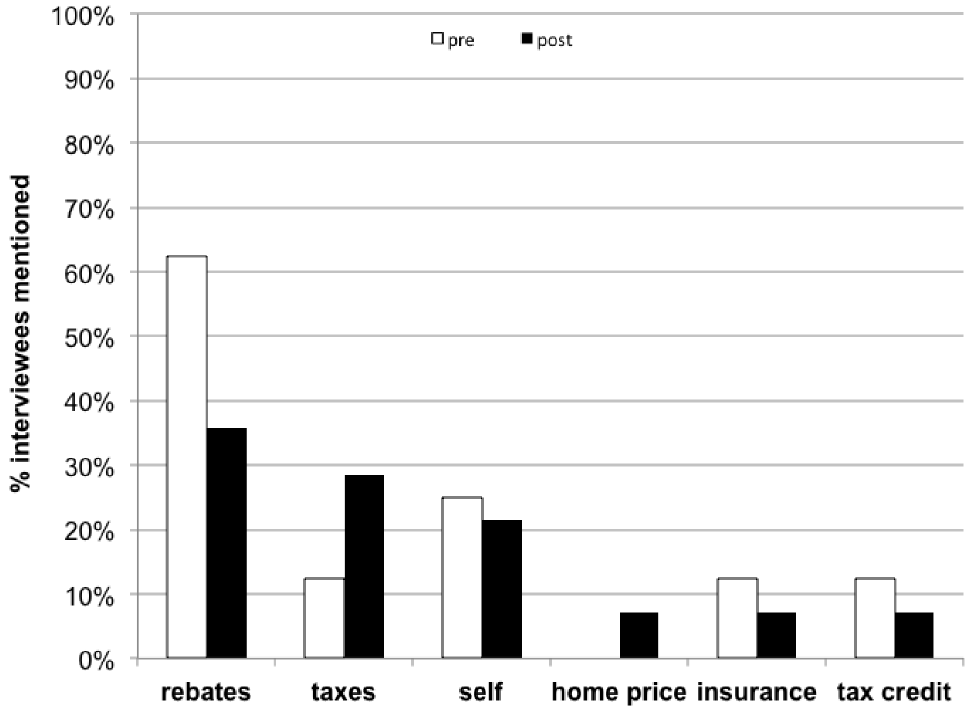

Figure 12: Mentioned strategies for paying to avoid damages (pre- versus post-2001 FBC construction)

4.3.5 Insurance

Most participants report having wind or rain insurance, with fewer reporting they have flood (since they don't live in a flood zone) or storm surge insurance. As shown in Figure 13, those living in older homes appear to be less likely to mention having any type of insurance than those living in newer homes. As shown in Figure 14, there appears to be a lot of variability in the terms of the amount of their insurance deductible, which is calculated as a combination of their risk tolerance and the value of their home. Those living in homes built after 2002 appear to have the lowest deductible, suggesting higher insurance premiums and lower tolerance for risk.

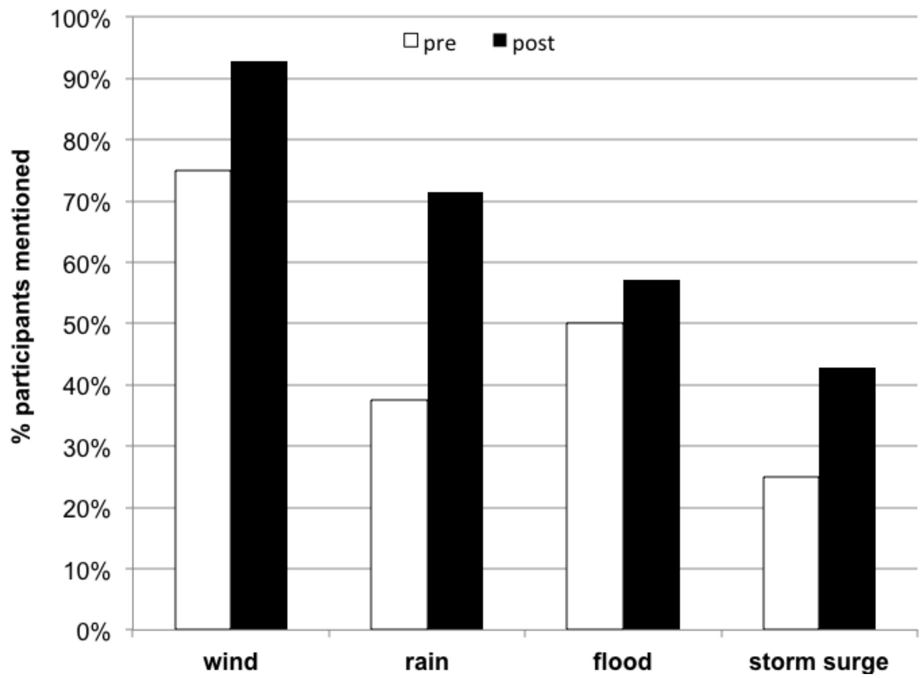

Figure 13: Type of insurance by pre- versus post-2001 FBC construction

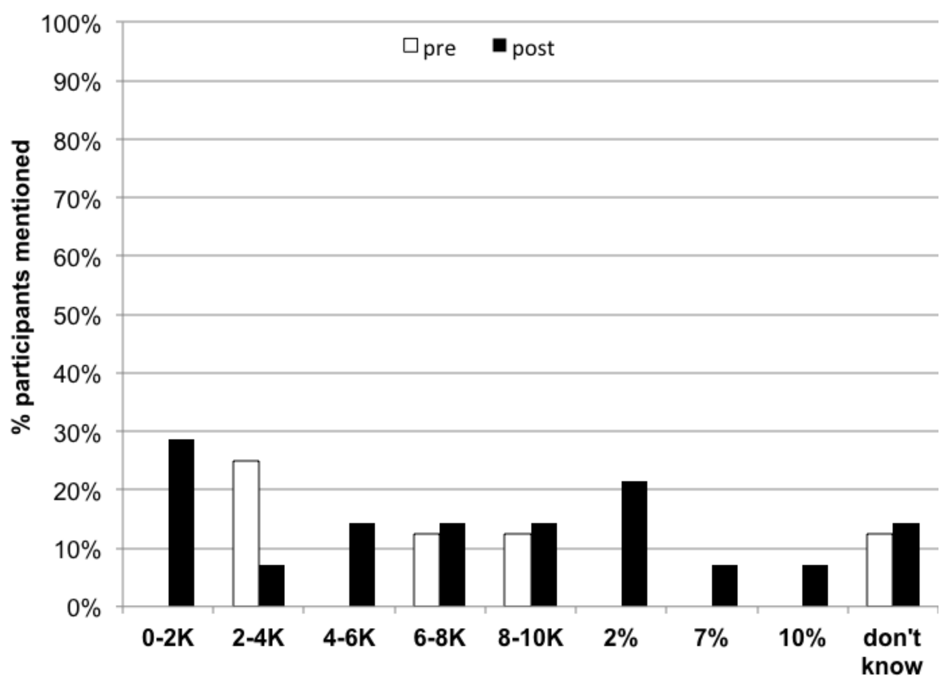

Figure 14: Deductible for pre- versus post-2001 FBC construction

5 DAMAGE ASSESSMENT

Our damage assessment consisted of three main efforts, given as follows:

1) The triage assessment immediately following the passage of Hurricane Matthew. A team of engineering students and faculty went house-to-house in a ground-based survey of 96 homes, augmented to 120 homes using photos from a UAV of the same area, in Flagler County on 8 October 2016, one day after the worst effects of Hurricane Matthew had impacted the region.
2) Follow-up interviews with 22 homeowners, most of whom owned homes that were part of the ground-based triage assessment. Portions of the interview asked the homeowners about damage and economic losses sustained to the interior of the building, since such damage was not accessible during the triage assessment.
3) Estimation of damage to 366 homes along the Flagler Beach coastline, using high-resolution aerial photographs from the Flagler County Division of Emergency Management (FCDEM).

The objective of these assessments was to document the performance of buildings during the hurricane with respect to the building code in place at the time the building was constructed. The three methods used by our team varied in scope and scale, as summarized in Table 3. From the 22 interviews, detailed information of damage to the exterior and interior of the building was obtained directly from the homeowner. In the ground-based assessment of homes, damage to all exterior portions of the building and appurtenances, including soffits, fences, siding and roof shingles, was quantified from the photographs and notes taken by the survey team. In the analysis of aerial imagery from FCDEM, exterior roofing damage was the primary type of damage that could be reliably identified.

Table 3: Summary of assessment methodologies used by the team

	In-Home Survey	**Ground-based Survey**	**Analysis of Aerial Imagery from FCDEM**
Data Source	Homeowners	Photographs and notes from the survey team	High-resolution, aerial photographs
Sample Size	22	96 (ground), 120 (ground + UAV-surveyed)	366
Scope of the Data	Interior and exterior damage; economic losses	Exterior damage to a building and its appurtenances	Exterior damage to roof of building
Time of Data Collection	5/2/2017 – 5/9/2017	10/8/2016	11/4/2016

5.1 Ground-based damage assessment

The WHDAG used high-resolution aerial images collected from a UAV alongside a novel smartphone app called Survey123 to collect data on 96 residential structures, 50 in Flagler beach, and 46 in Marineland. The smartphone app, named Survey123 for ArcGIS, was developed by esri™ as an "intuitive data gathering solution that makes creating, sharing, and analyzing surveys possible in just three steps." For each home assessed, the user input values for damages of varying degrees to the different components of the roof and walls of the home. At the same time, the user used the camera built into the phone to snap pictures of the house from every possible elevation, and at the end was able to save the survey so it could be uploaded to a central database after the collection had ended.

Using the data obtained from our 8 October 2016 field survey, the WHDAG prepared a preliminary assessment of the damages caused by the high winds of Matthew which can be accessed through the following link, UF Triage Assessment of Damage from Hurricane Matthew.

Damage from the ground surveys was observed on thirteen homes in Flagler Beach, and six homes in Marineland. Of the nine homes in Flagler Beach that were built after 1 March 2002, five were observed with damage. Eight, or 20%, of homes built before 1 March 2002 were observed with damage from Hurricane Matthew. Of the 46 houses surveyed in the Marineland subdivision, in which all houses were built after 1 March 2002, only 4, or 9%, sustained hurricane-related damage.

The UAV imagery captured the homes included in the ground-based survey as well 24 additional homes in the same vicinity that were not included in the original ground survey. Analyzing the high-resolution UAV imagery, damage observed from above yielded similar proportions. In Flagler Beach, all of the homes within the 1400 block (between 14th St S and 15th St S) were observed. This sample size was 57 homes. All of the homes from the ground survey were within this block as well. Of those 57 homes, 14, or 25% of them, had visible roof damage in the aerial imagery. In Marineland, nearly the entire subdivision was captured by the aerial imagery, and it included all of the homes that were surveyed from the ground, along with additional ones. Out of 63 homes observed, 5, or 8% of them, had visible roof damage in the aerial imagery. It is expected that the maximum wind speeds in both sites were nominally the same. Data regarding the age of homes in Flagler Beach was found via the Flagler County Tax Assessors Office. See

Table 4 below for the number of observations in Flagler Beach and Marineland.

Table 4: Number of homes surveyed on the ground and using the UAV

	Flagler Beach		Marineland	
	Pre-2001 FBC	**Post-2001 FBC**	**Pre-2001 FBC**	**Post-2001 FBC**
Homes observed with damage from ground survey	8	5	0	4
Total number of homes assessed from the ground	41	9	0	46
Homes observed with damage from UAV aerial imagery	10	4	0	5
Total number of homes assessed from UAV aerial imagery	40	17	0	63

Specific failure mechanisms are summarized in the following subsections.

5.1.1 Roof Cover Failure

The majority of the failures observed in the survey were related to roof cover. Asphalt shingles were the predominant roof cover type, athough in the Marineland site, many homes had metal roofing over portions of the roof and asphalt shingles over the remainder. The roof cover failure mechanisms observed are summarized as follows:

Failures in Field Regions of the Roof

Out of the 96 homes surveyed, eight had significant loss of shingles primarily in the field regions of the roof. Failures predominately occurred on the north face of the roof as the oncoming wind out of the north would have accelerated over the sloped roof, increasing the loads on shingles as discussed in Dixon et al. (2014). Figure 15 and Figure 16 illustrates these failures for a new home (built in 2015) and an older home (built in 1978). One possible explanation for the failures is unsealed shingle tabs, which has been shown by Dixon et al (2014) to prematurely initiate and propagate failures in the field regions of the roof. An inspection of one of the failed shingles in the new home showed evidence of seven properly placed fasteners in the shingle. In the interview of the homeowner, the homeowner stated that the roofing contractor indicated the roofing nails used were not stainless steel and had rusted. The contractor also stated that in some shingles only four fasteners were used.

Figure 15: Approximately 20% of the laminated shingles removed from a two-story home at 30 Sandy Beach Way in the Marineland site, viewed from the ground (a) and a UAV (b). One of the failed shingles is shown in (c) with seven holes where fasteners were installed.

Figure 16: Scattered shingle damage to a one-story home at 1416 S Daytona Ave.

Failures to Edge/Corner/Ridge Regions of the Roof

In at least three homes, roof cover failures was observed at corners or ridges of the roof as illustrated in Figure 17. This damage may have been more common but was difficult to observe from either the ground or the UAV. In interviews, homeowners mentioned missing ridge caps several times as well.

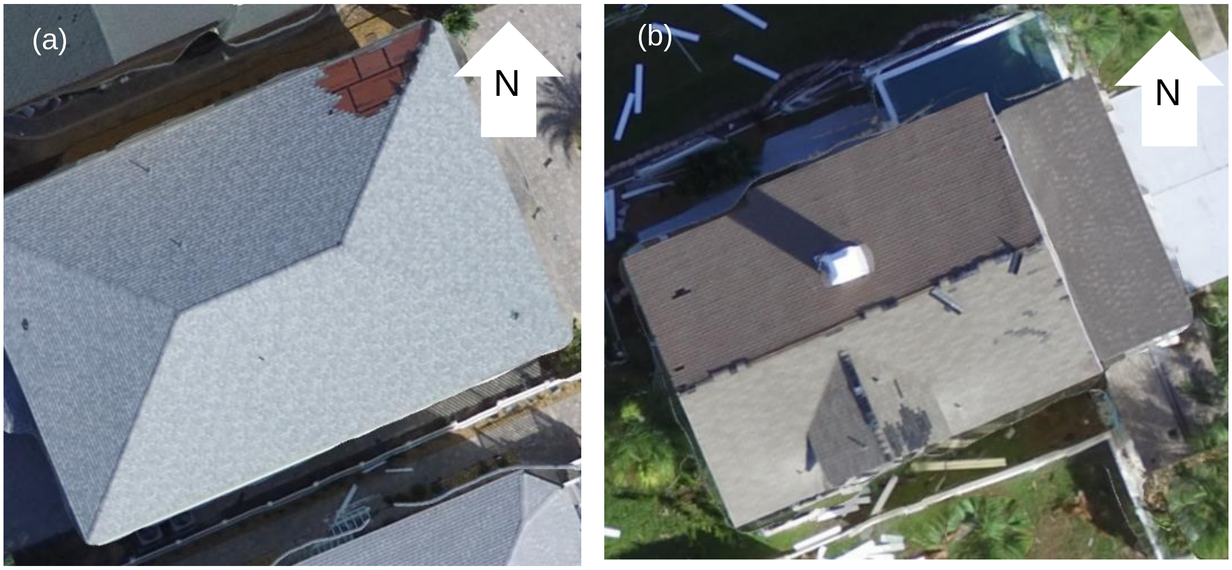

Figure 17: Shingle failure in a corner of a two-story home along Ocean Shore Blvd built in 2015 (a), and along the ridge of a 1995 home in Flagler Beach (b).

5.1.2 *Failure of Soffits*

Soffit damage was observed to at least three homes in the Flagler Beach site and three more in the Marineland site, as illustrated in Figure 18. The failures in Marineland are of particular concern since every home was built no earlier than 2015, the wind speeds were well below design, and soffit failures are known sources of rain water intrusion and interior losses (Masters 2006).

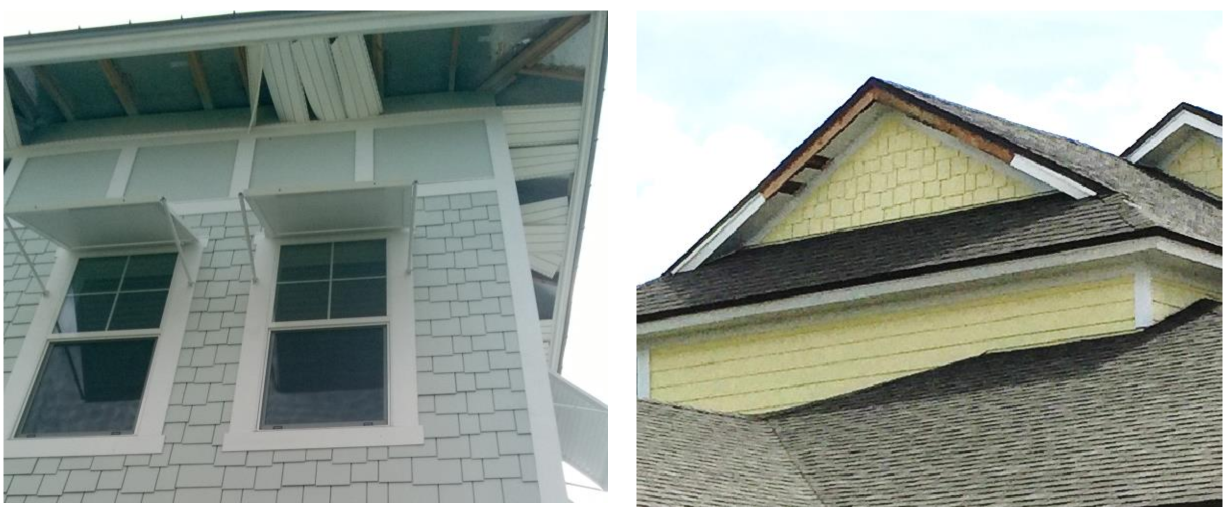

Figure 18: Soffit and flashing failure observed in several homes built after 2015.

Failure of Fencing

We observed failure of vinyl fencing in at least four plots in the Flagler Beach site. Failed fencing become debris objects during high winds and increase the probability of broken glass or other damage in adjacent homes. Figure 17b shows the vinyl fencing strewn around a home in Flagler Beach. Figure 19 shows failed slats at a home along Ocean Shore Blvd and an aerial view of another damaged fence off of S. Central Ave.

(a)

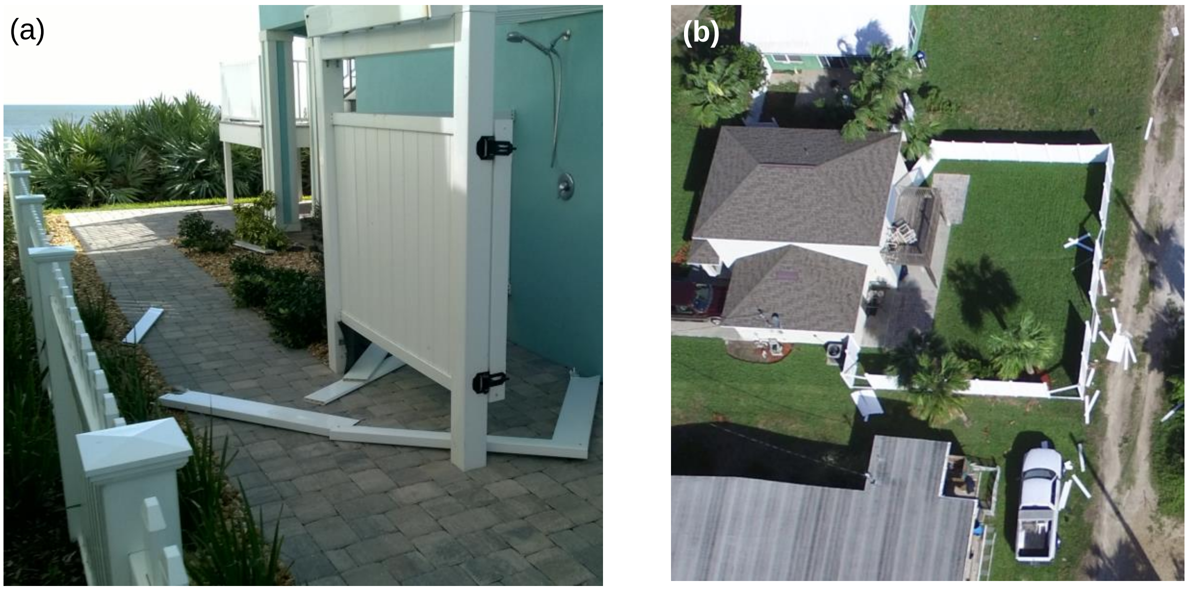

Figure 19: Failed vinyl fence slats at a home on Ocean Shore Blvd (a) and an aerial view of damaged vinyl fencing at a home along S. Central Ave (b).

5.1.3 Windows

In our survey sites, we observed two window failures, one in a home at 1424 S Ocean Shore Blvd and another at 1401 S. Daytona Ave, both in Flagler Beach. The home at 1424 S Ocean Shore Blvd also experienced some failure of the laminated roof shingles in the same corner of the house where the window failure was observed. The broken window is shown in Figure 20a. An aerial view of the area (Figure 20b) shows that the home just upwind experienced shingle blow off, which may have caused the window failure observed. There were several blown off shingles laying in the general area of the broken window. However, the home was built in 2015 so it should have had impact resistant windows to prevent such damage. Unfortunately we did not get a response to our interview solicitation at this home, and so have no further information on the failure.

The home at 1401 S Daytona Ave was also built in 2015 and did have impact rated windows rated to 170 mph according to the homeowner. During the interview the homeowner reported that a single hole punctured through the window, and the ensuing wind-driven rain contributed to $38,000 in losses. The damage was not observed in the ground survey.

Figure 20: Ground view of broken window at 1424 S Ocean Shore Blvd (a) and aerial view of home with broken window and adjacent home which lost roof shingles (b).

5.2 Interior damage and economic losses

Our only information on interior damage and economic losses came from the interviews with the homeowners. Out of the twenty-two interviews we conducted, eighteen of the interviewees had homes which were part of the triage damage assessment. Of those eighteen, we observed damage to four. The damage descriptions and information from the interviews are summarized in Table 5. Further details on interior damage as reported by the interviewees is provided in Section 4.3.3.

Of the interviewees that reported damage costs, six of the seven $10,000+ loss estimates involved interior water damage. The interior water damage in all but one of the six cases was due to rainwater intrusion rather than storm surge or flooding. Roof cover failure and soffit failure were typically associated with the rainwater intrusion and interior damage.

Table 5: Summary of observed damage and self-reported damage and loss for homes where interviews were conducted.

Interview ID	Year Built	Damage Observations by UF Team	Self-Reported Damage from Interviews	Self-Reported Damage Costs
1002	1998	Not part of survey	1.5 ft storm surge in first floor	$200,000
1004	1978	<10% damaged roof shingles	Roof replaced, windows and screens blown out in Florida room, fencing panels damaged.	$15,000
1005	2016	A few ridge shingles damaged	Minor roof cover loss, minor fencing damage, walkway.	$6000
1007	2007	None	No exterior damage, loss of food from power shutoff	$300
1008	2014	None	Window damage, water intrusion, repainting, landscaping	$38,000
1009	2000	Not part of survey	Roofing tiles, interior damage, HVAC unit	$11,000
2003	2015	None	Water intrusion through door, minor fascia damage	$2,000
2005	1988	Not part of survey	Shingle loss, gutter failure, interior water damage, fencing damage	$10,000
3001	2004	Not part of survey	A few shingles damaged	$3,000
3002	1983	<5% roof cover loss	Shingles lost, minor interior water damage	$12,600 [1]
4001	2015	None	Eight ridge cap shingles failed, minor soffit damage.	$650
4002	2013	20% roof cover loss	2/3 of shingle roof failed, rain water intrusion destroyed interior flooring, soffit failure.	$32,000

[1] Out-of-pocket expenses of $1,000, remainder covered by insurance. $11,600 for roof replacement according to Flagler Beach public permit records.

5.3 Analysis of aerial imagery provided by Flagler County

On 2 May 2017, our study team met with Mr. Steve Garten, Public Safety Manager of Flagler County, and other members of the Flagler County Division of Emergency Management (FCDEM) to discuss the impacts of Hurricane Matthew to the county. The FCDEM described conditions during and immediately after the hurricane, and made available to us a dataset of high-resolution aerial photographs for use in the study. The aerial photographs were taken with a digital camera at a resolution of 39 Megapixels from a helicopter flying just off-shore. Photographs were taken at regularly spaced intervals along an 8-mile stretch of the Flagler County coastline with approximately 67% overlap between photographs, meaning a single point within the viewing area was typically visible in three different photographs. Figure 22shows one of the photographs along with a closer look at damage to one home within the field of view.

Using this database, we visually identified exterior roofing damage to 366 buildings between 3777 North Ocean Shore Blvd and 3700 South Ocean Shore Blvd – a nearly 8 mile stretch shown in Figure 21. Only homes located on Ocean Shore Blvd were included in this initial assessment for the following reasons:

- They were expected to have sustained the highest wind speeds and the most damage,
- They would have been impacted the least by changes in terrain and local sheltering, since the highest winds impacted the region from the North.

We estimated damage to roof cover, roof sheathing and the roof structure as damage ratios, representing the proportion of damaged area to total area of the roof. Estimates were made visually, which introduces uncertainty to the recorded values. Shadows, discolorations of shingles, trees and limited resolution of the photographs added to the uncertainty. But for the majority of homes the presence of damage was easily visible, even if precise damage quantities could not always be accurately quantified. Figure 23 illustrates damage states that could be observed from the aerial photographs.

In addition to building damage, the roof type (e.g., gable, hip) and number of stories were also determined from the photographs. To link observed damage with year of construction, the research team collected the address and parcel identification number for all 366 buildings included in the study. The parcel identification number was used to pull information from the Flagler County property appraisal website (http://www.flaglerpa.com), including year built, property use code, frame type, and roof cover material.

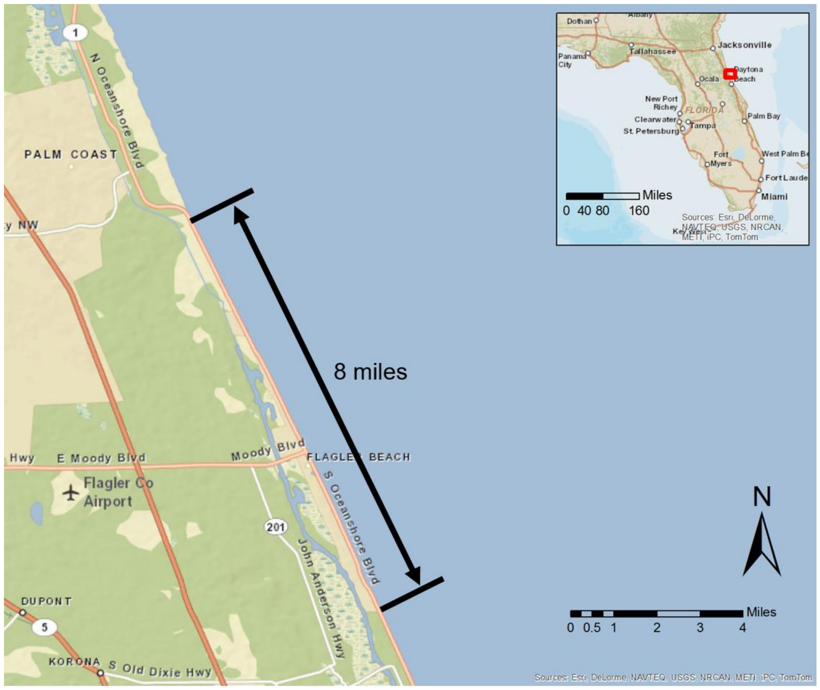

Figure 21: Coverage of aerial photographs provided by the Flagler County Emergency Management Division.

Figure 22: Photo “2016obP28253668.jpg” from a database of aerial photographs provided by the Flagler County DEM, with inset showing zoomed in view of roof sheathing and shingle damage to a multi-family home (far right of inset) at 1908 S Ocean Shore Blvd. Damage ratios for roof cover and roof sheathing were estimated to be 15%.

Figure 23: Examples of roof structure damage (left) and roof cover damage (right) visible in the aerial photographs provided by FCDEM.

A summary of the dataset is provided in Table 6. Most of the buildings (72%) in this remote assessment were single-family homes based on the property appraisal data. The mean year built for all 366 buildings was 1986, with 302 built pre-code and 64 built post-code. We observed damage to the roof cover in 92 out of the 366 buildings.

Analysis of the aerial photographs revealed a stark difference in performance of buildings built before and after the 2001 FBC, as shown in Figure 24. Overall, only 12% of the post-2001 FBC buildings in Flagler Beach along Ocean Shore Blvd had observable damage, while 39% of pre-2001 FBC buildings in Flagler Beach along Ocean Shore Blvd had observable damage. Of the 25 buildings that experienced roof sheathing damage, none were built after 1992.

While there is clear evidence that pre-2001 FBC buildings overall performed worse than post-2001 FBC buildings, a closer look does not reveal a sudden decrease in damage rates in 2002 with near uniform damage rates in pre-2002 buildings. Instead, as shown in Figure 25 and Figure 26, there is an overall trend of a steady increase in number of damaged buildings with age of the building. Thus while there is undoubtedly a lower damage rate in post-code buildings, it is unclear how much of the reduced damage rate is attributable to code improvements and how much is attributable to effects of aging and deterioration. Further, with the majority of the observed damage being related to the roof cover, it should be noted that the age of the roof is not necessarily the same as the age of the building, and so older homes may have had newer roofs that prevented more damage from occurring.

Table 6: Summary of the dataset collected from post-event aerial photographs provided by the Flagler County Emergency Management Division.

		Property Use Category			
		Single Family	Multi Family	Other	All
Mean Year Built		1989	1981	1979	1986
Total Count		265	38	63	366
Pre-2001 FBC		205	37	60	302
Post-2001 FBC		60	1	3	64
Damage	**Roof Cover**	68	10	14	92
	Roof Sheathing	12	6	5	23
	Roof Structure	1	0	2	3
	Any Damage	68	10	14	92

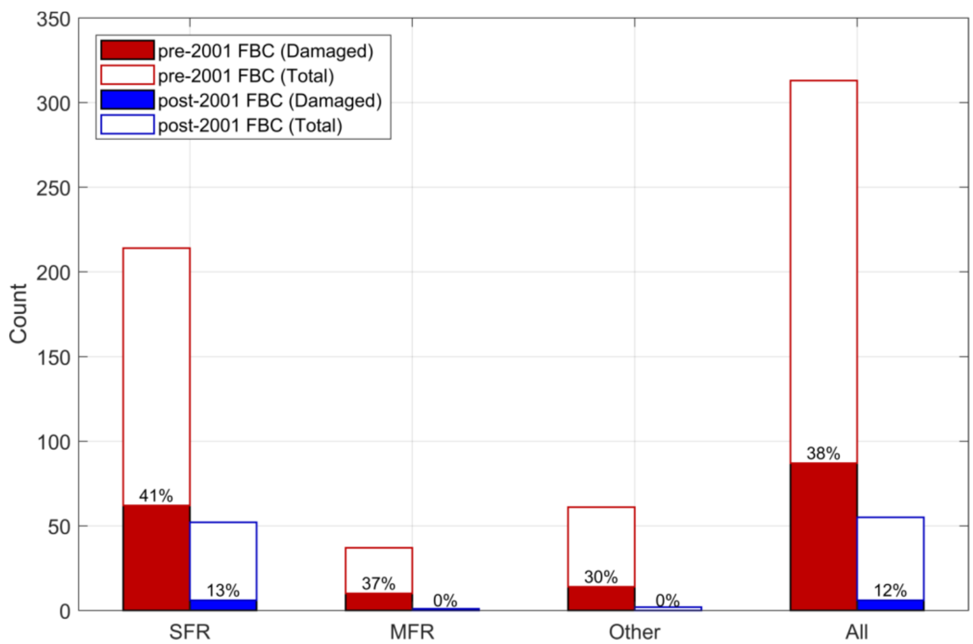

Figure 24: Number of buildings with observable damage by building type and year built. SFR = single family residence, MFR = multi-family residence, and Other = motels, restaurants and other buildings.

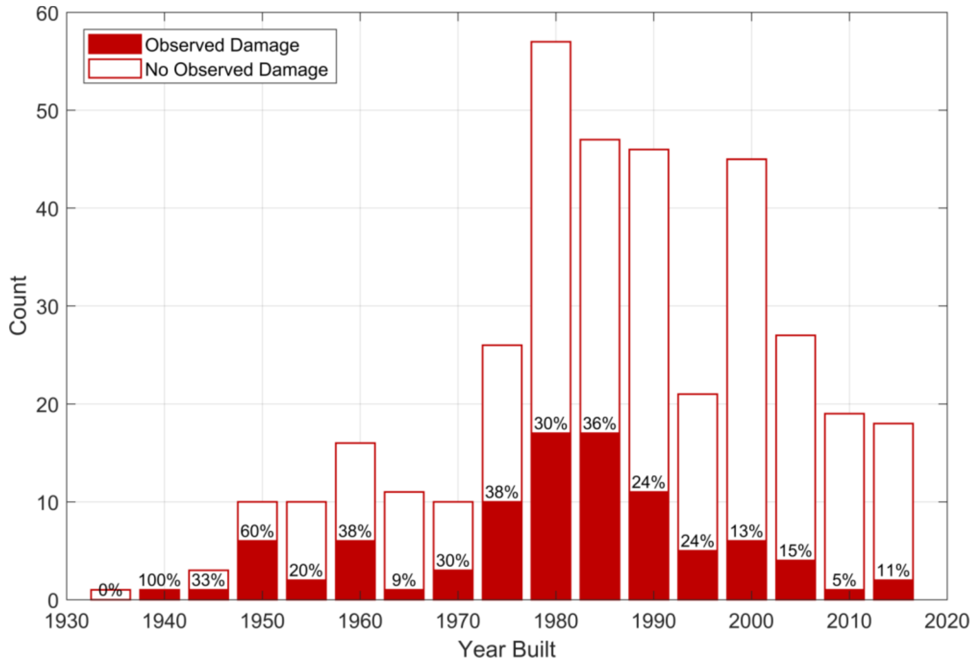

Figure 25: Number of damaged and undamaged buildings in five year bins.

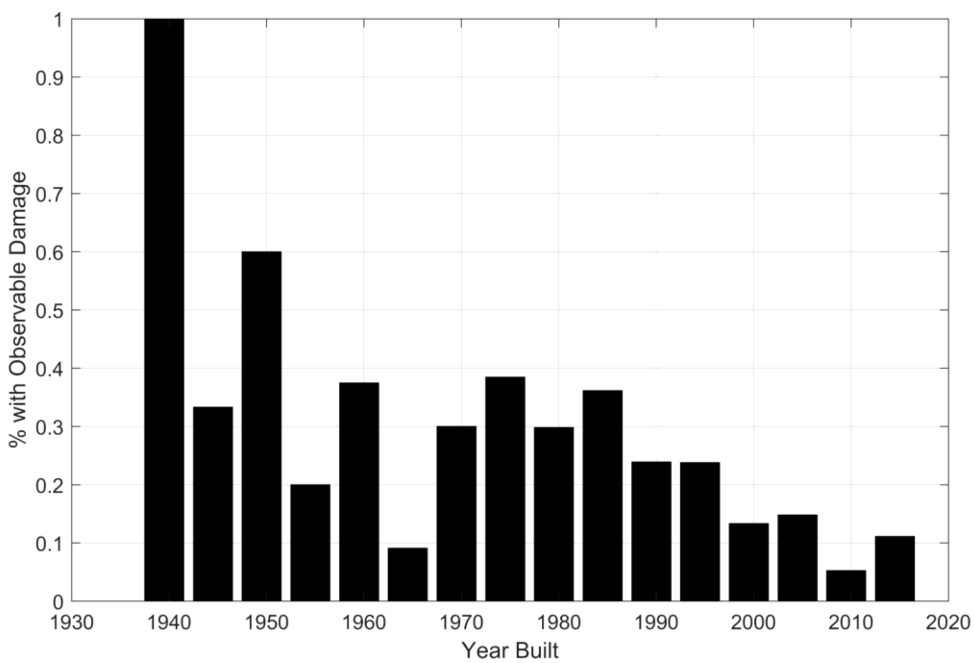

Figure 26: Percent of buildings with observable damage by year built in five year bins.

5.4 Summary of findings

The following summarizes the major findings from the damage assessments performed in this study:

- Even in a wind event with observed wind speeds approximately 60% of design, we observed wind damage of some kind in nearly 25% of the homes.
- The majority of the damage observations were related to roof cover failures, but soffit damage, and failure of vinyl fencing was also observed on multiple occasions.
- Pre-2001 FBC buildings experienced higher damage rates than post-2001 FBC buildings. In the ground-based assessment, nine of the 55 post-2001 FBC homes (16%) had observable damage, compared to 20% of the pre-2001 FBC homes. In the analysis of aerial imagery provided by the FCDEM for buildings directly on the coast, 39% of the pre-2001 FBC buildings had observable damage compared to 12% of post-2001 FBC buildings.
- Damage rates begin to decline in the 1990s, as noted previously by ARA (2008). The relative contributions of aging of the buildings and the improved building standards since Hurricane Andrew in 1992 are unclear at this time.
- Roof sheathing failure occurred in 25 out of 366 homes included in the aerial assessment, all of which were built in 1992 and earlier.
- Interior damage and losses were primarily driven by rainwater intrusion through failed roof cover and failed soffits. Of the homeowners interviewed that reported financial losses, six of the seven $10,000+ loss estimates involved interior water damage. Five of the six were due to rainwater intrusion from roofing and soffit failures, the other was due to storm surge.

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Appendix A. Florida Building Code Changes in Response to Hurricane Andrew

Much of the discussion in this report is centered around the performance of pre- and post-2002 buildings. This demarcation is important because it was in 2002 that the State of Florida developed and enacted the first statewide building code, preempting all local codes.

Prior to 1974, building codes were a local option only in Florida – there was no mandate for county building code adoption or enforcement. That changed in 1974, when Florida law required counties to adopt, amend and enforce a model building code. Most of the state adopted the Standard Building Code, while Miami-Dade and Broward Counties adopted the South Florida Building Code, which contained more stringent high wind velocity requirements. The hurricane protection requirements in these codes were for the most part prescriptive specifications for common construction types with little to no engineering basis.

In 1992, Hurricane Andrew struck the SE coast of Florida and exposed the limitations of the locally managed building code system and the buildings constructed to these codes. The devastation prompted swift action from the state of Florida with the Florida Board of Building Codes and Standards adopting the Minimum Standard for Wind Design throughout the state in 1993. This was in essence the first wind engineering based design requirement for Florida building codes outside Miami-Dade and Broward Counties. The Florida Building Code Study Commission was also created and began developing a single state-controlled building code. This code came to be known as the 2001 Florida Building Code, and took effect in March 1, 2002.

The specific improvements of the 2001 Florida Building Code for wind resistance over previous codes are summarized as follows:

- Higher design wind pressures in South Florida and most coastal areas
- Wind-borne debris protection requirements for windows and glazing in all coastal area
- Improved roof covering system requirements
- Establishment of a product approval system to ensure products comply with wind and impact resistance requirements of the code
- Improved wind performance labeling requirements for more consistent enforcement of the code

Beyond the specific wind resistant improvements to the code, the requirement that it be adopted and enforced throughout the state is also a major factor in expectations of improved wind performance of buildings in Florida built to post-2002 building codes.

The effects of the 2001 Florida Building Code were tested in 2004 and 2005, when hurricanes Charley, Frances, Ivan, Jeanne, Dennis and Wilma all made landfall in Florida with high wind speeds. Studies found a statistically significant improvement in performance for buildings constructed to the 2001 Florida Building Code compared to those built before the code was enacted. Two of the main studies on this topic are listed below.

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Appendix B. Draft Interview Protocol

This interview will ask about your thoughts and experience with Hurricane Matthew as well as about your decisions you had to make before, during and after the event.

Your thoughts are important to us. Please answer the questions to the best of your ability. If you absolutely have no idea at all or feel uncomfortable answering a question, just let me know and we'll move on to the next question.

Do you have any questions before we begin?

Is it OK if I start recording our conversation now?

I. Hurricane Matthew experience

First, I would like to know about your experience with Hurricane Matthew. Can you tell me what happened to you? How are you doing now? How do you feel about what happened?

- *Describe anything you did to prepare your home in the days prior to the arrival of Hurricane Matthew. [Anything else? Did you get any help from friends or family members? Anyone else? If you didn't do anything, why not? How effective do you think the measures you took to protect your home were? What would you do next time? Anything else?]*
- *Describe anything you did to protect your family as Hurricane Matthew arrived? [If you stayed in place, why? If you decided to leave, why? If you decided to leave, where did you go? Why?]*
- *In what ways did your community prepare for Hurricane Matthew? [Anything else? Why?] How would you describe your community?*
- *Describe any previous experience you've had with hurricanes prior to Matthew. Can you tell me what happened to you? [Anything else?]*

II. Causes and the future

Next I would like to know what you think about possible future hurricanes. Can you tell me when you think the next hurricane might happen? When do you think it might happen? Why? Do you think that you or your family will be directly impacted? [Why or why not?] Who do you think will be directly impacted? [Why?]

- *Can you tell me if you think the chances of a hurricane are going to become more frequent? [Why or why not?] How much more (or less) frequent? Why?*
- *Can you tell me if you think that future hurricanes will be more intense? [Why or why not?] How much more (or less) intense? Why?*
- *In your own words, tell me what happens when hurricane forms, gains strength, and then dissipates. [Can you describe that in a little more detail?]*

III. Physical and financial damage

Now, I would like to ask you some specific questions about any physical and/or financial damage you experienced due to Hurricane Matthew.

- *Describe any damage that Hurricane Matthew caused to your home. Describe any financial loss you anticipate experiencing due to this damage.*
    - *Was your home insured against damage from wind? Wind-blown rain? Storm-surge? If so, what was your deductible?*
    - *If you had insurance and your house was damaged, how responsive and accommodating was your insurance company in helping you get restitution for the damage? Did you get the amount of restitution that you expected?*
- *How much damage do you think your home would sustain if it experienced 120 mph winds instead of the ~80 mph winds from Hurricane Matthew? Can you tell me more?*
- *At any point before or during the hurricane, did you think your home might become uninhabitable as a result of the hurricane?*
- *At any point before or during the hurricane did you feel your life was in danger? Why or why not?*
- *At any point during the hurricane did you experience an injury caused by the hurricane?*
- *What indirect costs did you experience due to Hurricane Matthew (e.g., hotel, evacuation, days off work without pay, etc.)?*

I would also like to know more about how much you might be willing-to-pay to avoid any damage to your home you experienced during Hurricane Matthew. How much would you be willing-to-pay if winds were much stronger than Hurricane Matthew, say if they were 120 mph?

- *Describe for me how you would prefer to pay for this? Through a tax? A rebate program? Through higher insurance premiums? Etc.?*

IV. Demographics

Finally, I would like to ask you a few questions about yourself. The answers to these questions will be kept strictly confidential, and will only be used to get a better sense of the people we talked to.

- *What is your age?*
- *Do you identify as male, female or other?*
- *What is your highest level of education?*
- *What is your household annual income?*
- *Do you own your own home or rent or live with friends and/or family without paying rent?*
- *What is the number of people living here, including yourself?*
- *Of those, how many are under the age of 18?*
- *Does anyone who is living here have any illness or other issues that makes mobility difficult?*
- *What is the language that is most often spoken in your home?*

V. Closing and debrief

Those are all of the questions that I have today on your experience with Hurricane Matthew. Are there any questions you have for me? Is there any question I didn't ask that you wished I did? Anything else?

We are planning on interviewing residents over the next few weeks. Once the interviews are complete, we are going to transcribe all of the interviews and summarize our findings in a report. Would you be interested in getting a summary of the report?

Do you know of any neighbors who you think might be willing to talk to me?

Thank you so much for your time.

Appendix C.Recruitment Flyer

Interview subjects needed for a research study of homeowners affected by Hurricane Matthew

Study description

Researchers from the University of Florida and Carnegie Mellon University are interviewing homeowners affected by Hurricane Matthew in 2016. Information collected in this study will be used to better understand homeowner's perceptions of their risk from hurricanes in Florida. The study will also improve how information is communicated to homeowners about ways they can protect themselves and their property against hurricane wind damage.

Who is Eligible?

- Adults over the age of 18 who are the owner of or currently resides in a home within the Flagler Beach or Marineland communities in Flagler County, FL.

What will you be asked to do?

- Participate in one hour long interview with University of Florida researchers
- Provide your name, address, gender, and age (which will be kept confidential)

When and where will interviews be scheduled?

- In-person interviews will be scheduled individually at a site and time of your convenience between April 1, 2017 and May 1, 2017.

How long will the interview take?

- Approximately one hour

Compensation

- $40.00 will be given to the interviewee at the completion of the session.

If you are interested in participating or have questions about this study, contact:

David Roueche, PhD
University of Florida
Phone: (904) 579-6714
E-mail: david.roueche@ufl.edu

Appendix D.University of Florida IRB Exempt Approval Letter

UF | 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: 3/28/2017

TO: David Prevatt
365 Weil Hall
Gainesville , Florida 32611

FROM: Ira Fischler, Ph.D., Professor Emeritus
Chair IRB-02

IRB#: **IRB201700282**

TITLE: Comparison of Hurricane Matthew Damage Patterns for Two Coastal Communities and Homeowner/Occupant Survey on Risk Perceptions, Mitigation and Evacuation

Approved as Exempt

You have received IRB approval to conduct the above-listed research project. Approval of this project was granted on 3/28/2017 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 involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey or interview procedures, or the observation of public behavior, so long as confidentiality is maintained. If both of the following are true, exempt status can not be granted: (a) Information obtained is recorded in such a manner that the subject can be identified, directly or through identifiers linked to the subject, and (b) Subject's responses, if known outside the research, could reasonably place the subject at risk of criminal or civil liability or be damaging to the subject's financial standing or employability or reputation.

Special notes to Investigator:

In the myIRB system, exempt approved studies will not have an approval stamp on the consents, fliers, 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.

- 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