Herbert Wertheim College of Engineering
UNIVERSITY of FLORIDA

Interim Report

Survey and Investigation of Buildings Damaged by Category III, IV and V Hurricanes in FY 2022-2023

Hurricane Ian - 28 September 2022

Investigators:

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Sponsor: Florida Building Codes and Standards (Florida DBPR)

10 May 2023 Project Manager: Mo Madani

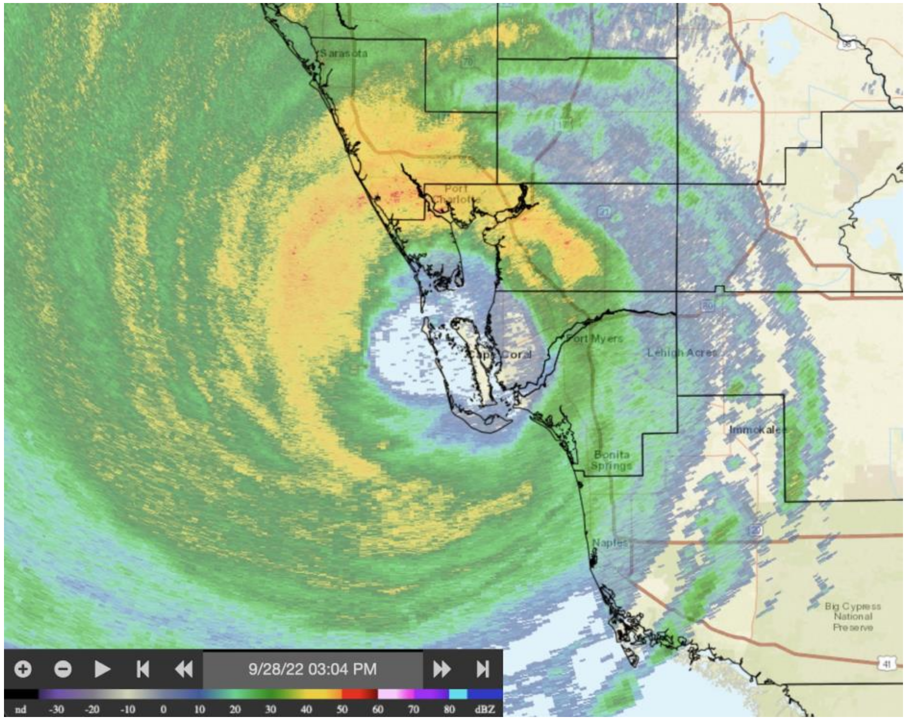
POWERING THE NEW ENGINEER TO TRANSFORM THE FUTURE

Agenda:

- Introduction
- Recap on Work to Date
  - Deployment
  - Initial Triage Assessment of Building Performance
  - Formal Surveys (with StEER and others)
- Enrichment of Reconnaissance Data
- Summary
- Questions and Comments?

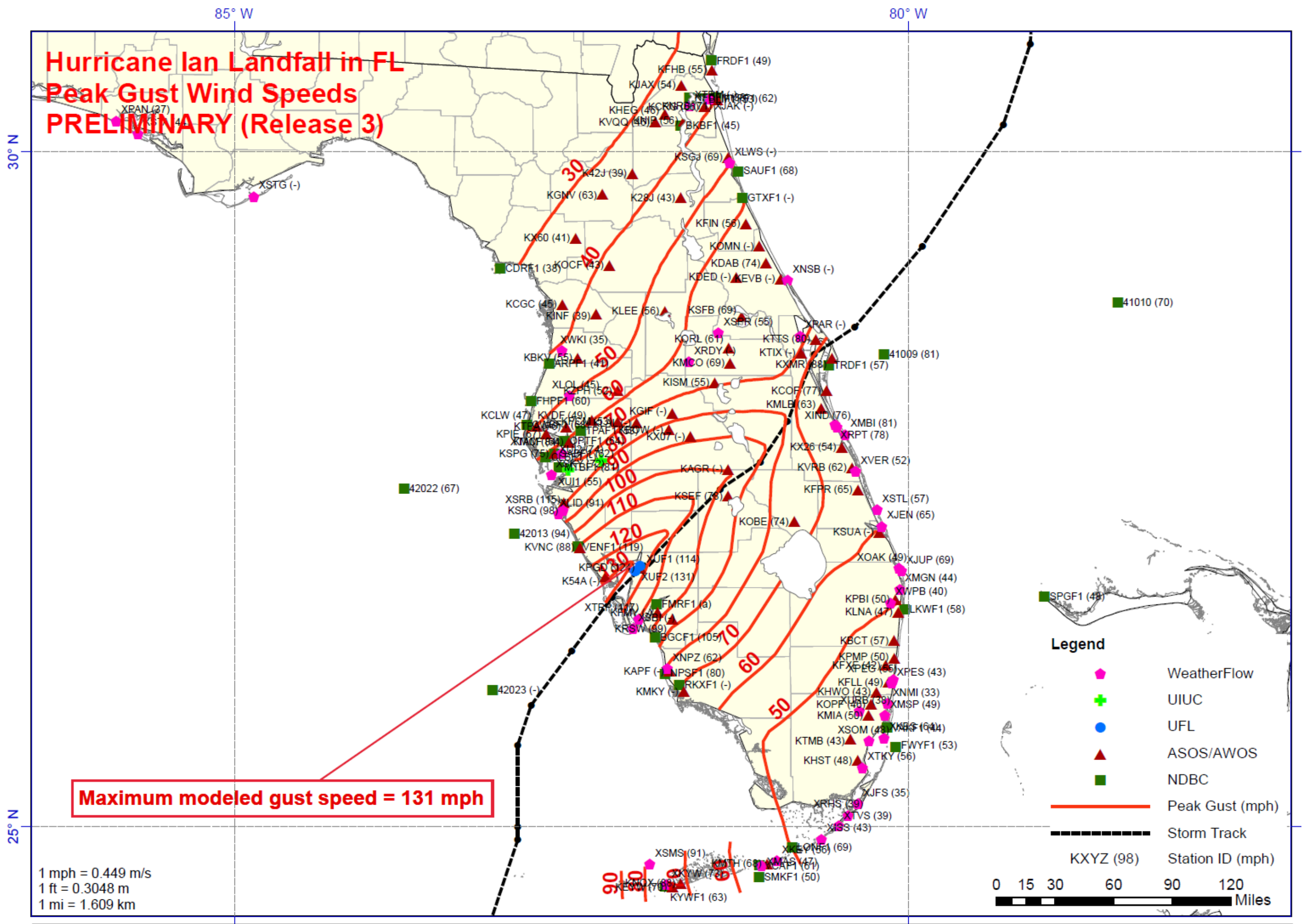
Hurricane Ian (2022) Summary

Landfall Date	28-Sept. 2022
Landfall Location	Cayo Costa, FL
Landfall Intensity	Category 4
Max Sustained Winds at Landfall (NHC)	150 mph
Minimum Surface Pressure at Landfall (NHC)	941 mbar
Peak Surge Inundation	~ 15 ft above ground level
Economic Losses	$113 billion (NCEI)
Fatalities	156 total / 66 direct (all in FL)



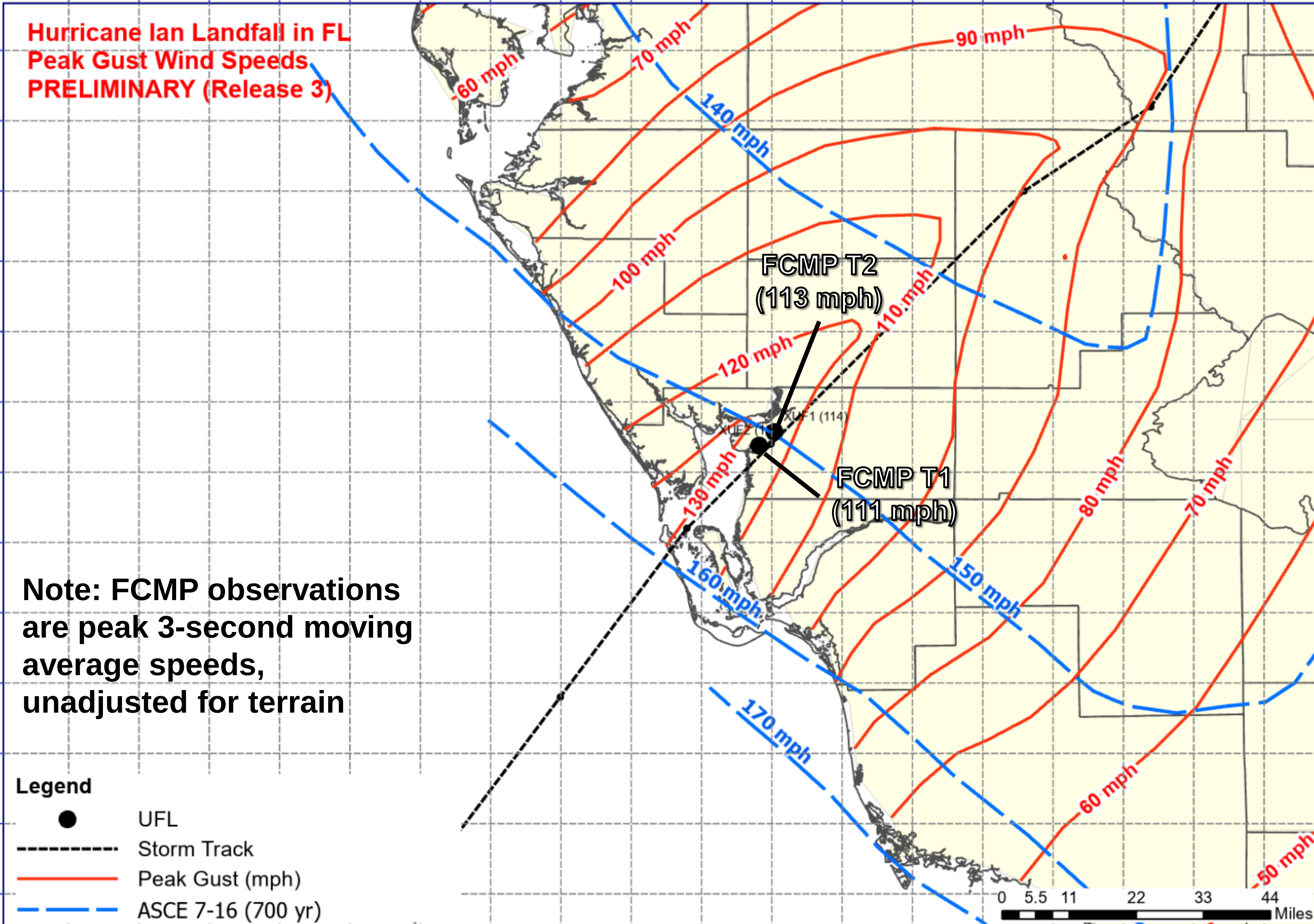
>50% of deaths were persons over 70 years old
59% deaths by drowning, 13% lack of medical access

Hurricane Ian – Wind Hazard Ob



Hurricane Ian (2022): Preliminary Peak Wind Gust (mph)

Estimated 3-second gust wind speeds (mph) at 33 ft above ground over flat open terrain from ARA model fit to surface level observations using storm track and central pressure data from NHC through Forecast Advisory Number 35 and observations through 1200 UTC on 10/1/2022. The values of peak gust winds in mph are shown after station names; Values have been adjusted for anemometer height and terrain; "-" means station failed before the arrival of the peak wind; "a" indicates a potentially anomalous value. The maps have been produced for the **National Institute of Standards and Technology** under Contract 1333ND22PNB730388. Maps are subject to change.
Created on: 10/13/2022



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Created on: 10/2/2022

Post-Ian Assessments

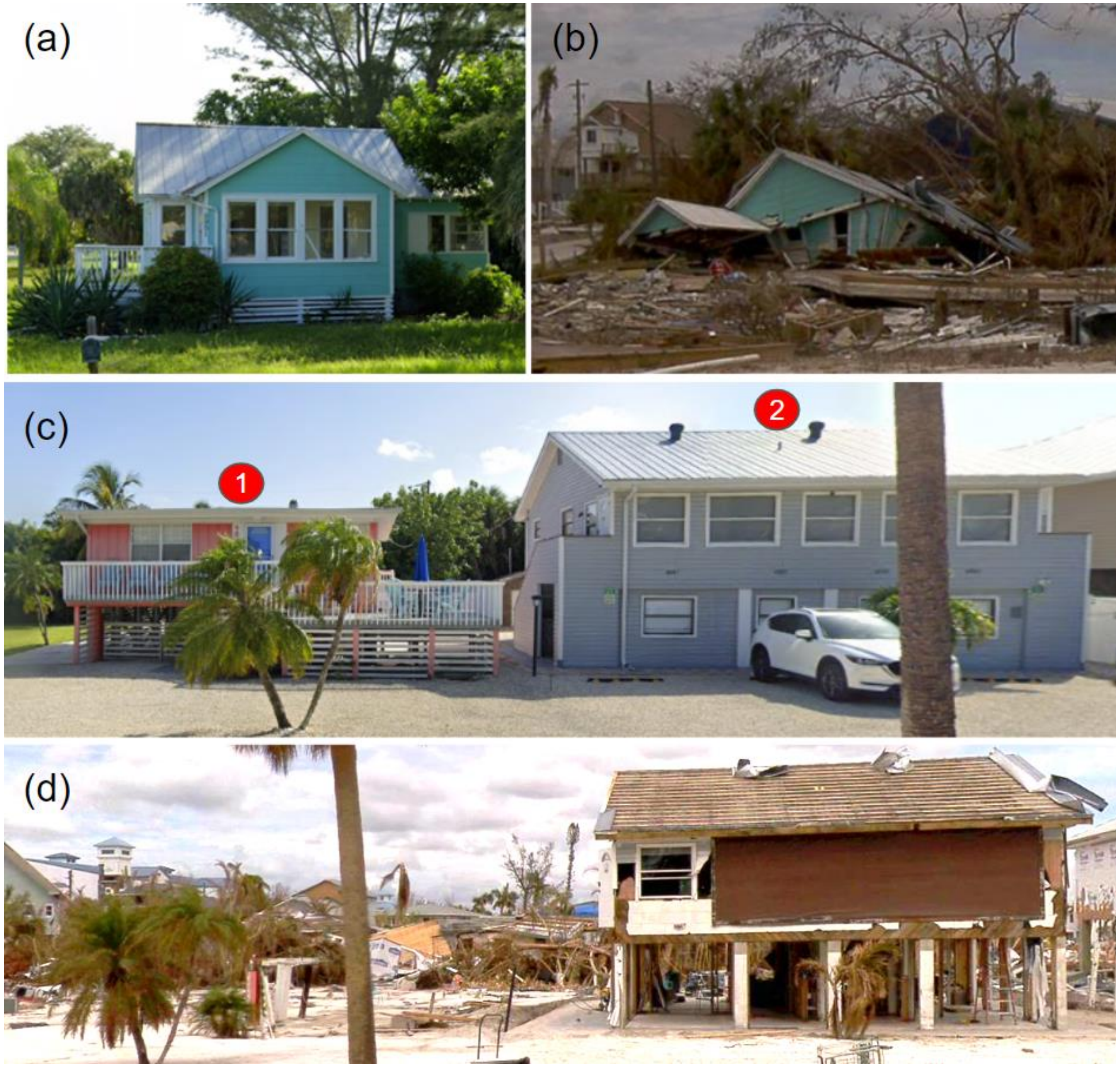
- Two triage assessments performed

Date	September 29, 2022	October 2-3, 2022
Personnel	(4) UF personnel, led by PI Prevatt	(3) UF personnel, led by PI Prevatt
Locations Assessed	Punta Gorda, Port Charlotte	Fort Myers, Orlando, Osceola County,

- One formal assessment conducted in collaboration with the Structural Extreme Events Reconnaissance (StEER) network

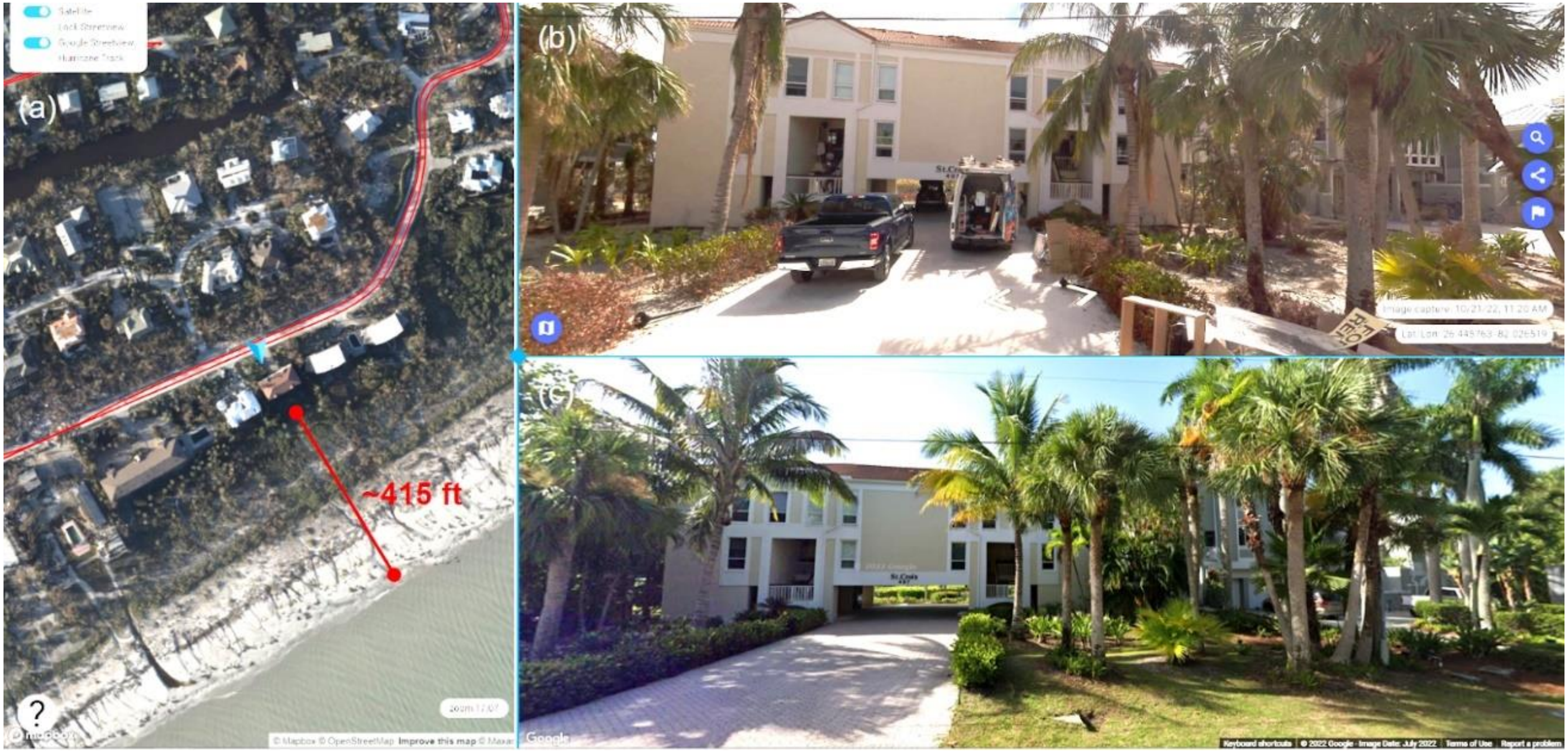
Date	October 19-23, 2022
Personnel	(12) StEER personnel, including co-PI Gurley
Locations Assessed	Fort Myers Beach, San Carlos Island, Sanibel Island

Illustrative Case Studies



Importance of freeboard elevation to survivability, including (a) before and (b) after views of a single-family home on Estero Island constructed in 1950 that collapsed during Hurricane Ian; (c) before and (d) after views of two homes with disparate performance on Estero Island. Home (1) was constructed in 1956, while home (2) was constructed in 1950, but home (2) was elevated approximately 3 ft higher than home (1) and its breakaway walls performed as intended.

Illustrative Case Studies



Illustrative effect of the vegetation and extended setback in Sanibel potentially mitigating surge impacts to structures. Subset (a) provides the post-storm aerial view showing a setback of approximately 415 ft from the shoreline, (b) the post-storm surface-level view, and (c) the pre-storm surface-level view.

Illustrative Case Studies

Examples of the performance of breakaway walls during Hurricane Ian, including (a) before and (b) after views of a home on Estero Island constructed in 2000 with acceptable performance of the breakaway walls; and (c) before and (d) after views of a two-story structure with garage at ground level constructed in 2020 in which the breakaway CMU walls on the back side of the structure only partially broke away.

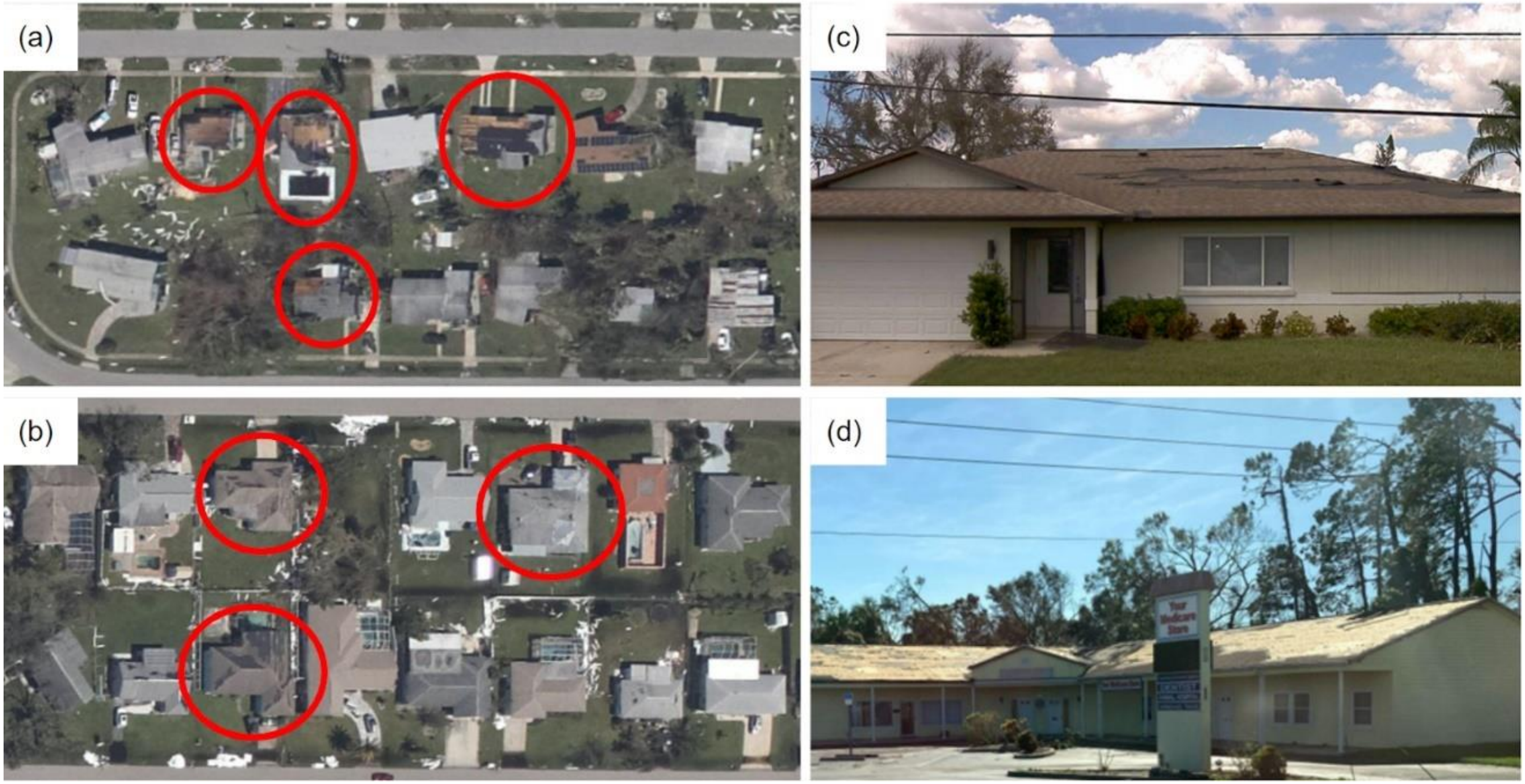
Illustrative Case Studies

Examples of scour, uplift, and other surge effects on buildings during Hurricane Ian, including (a) debris transport and breakaway wall performance, (b) scouring and pavement washout, (c) scour around piers, and (d) effects of hydrodynamic uplift forces on a wood-framed floor system

Illustrative Case Studies

Examples of poor wind performance on the barrier islands, including (a) a 3-story home constructed in 1999 with partial roof structure removal and wall collapse in the top story, (b) gable end roof structure loss in apartment buildings constructed in 1986; (c) garage door framing blown inward in a home constructed in 1967; (d) roof structure failure in one home adjacent to loss of metal roof cover in another, both of which were constructed in 1978.

Illustrative Case Studies

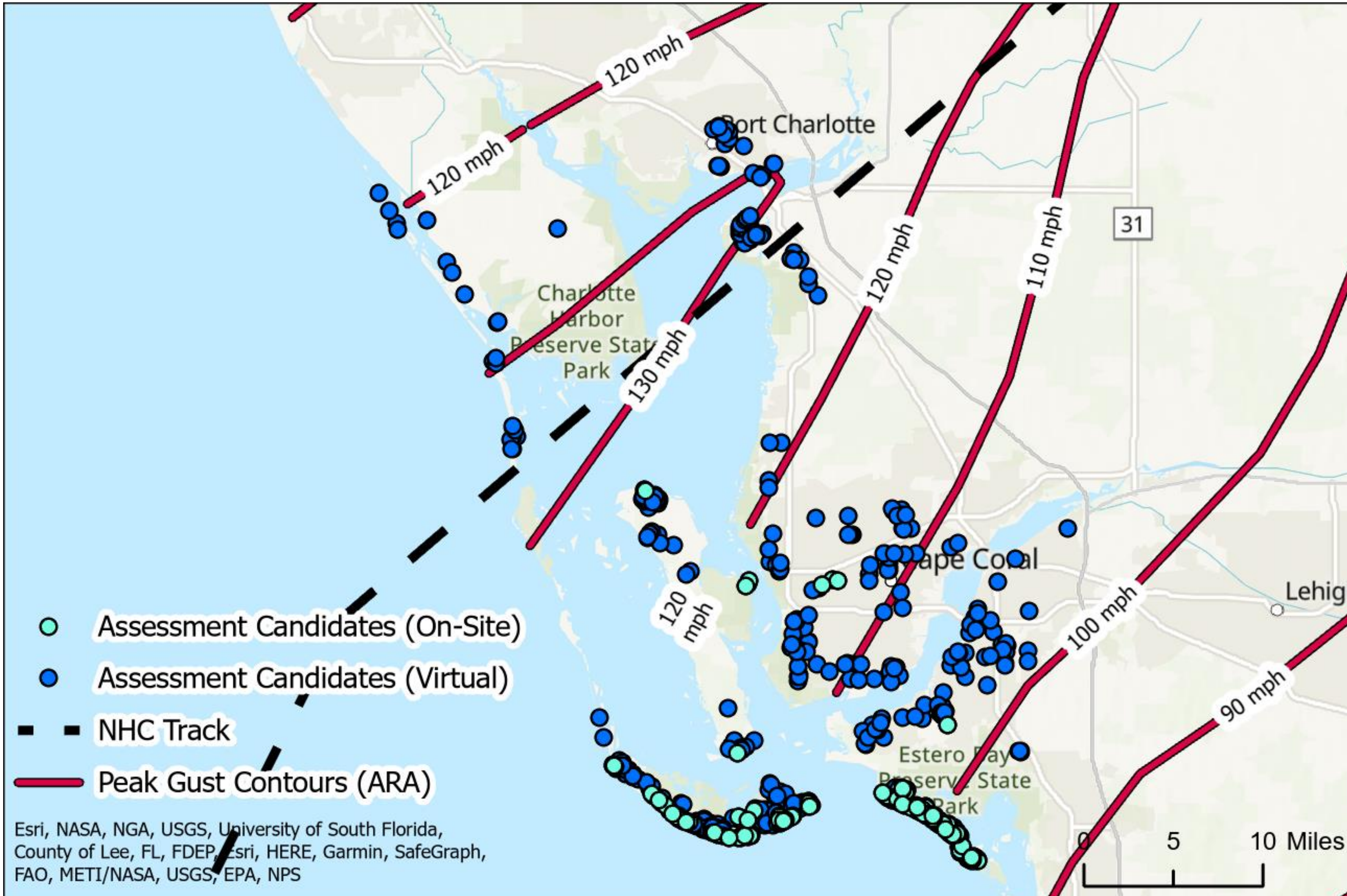


Illustrative performance of asphalt shingle and rolled membrane roofs in Port Charlotte consisting of homes constructed in the (a) 1960s with asphalt shingles and rolled roofs, (b) 1980s, (c) 1980s construction but asphalt shingle roof installed in 2005 but also (d) isolated commercial structures.

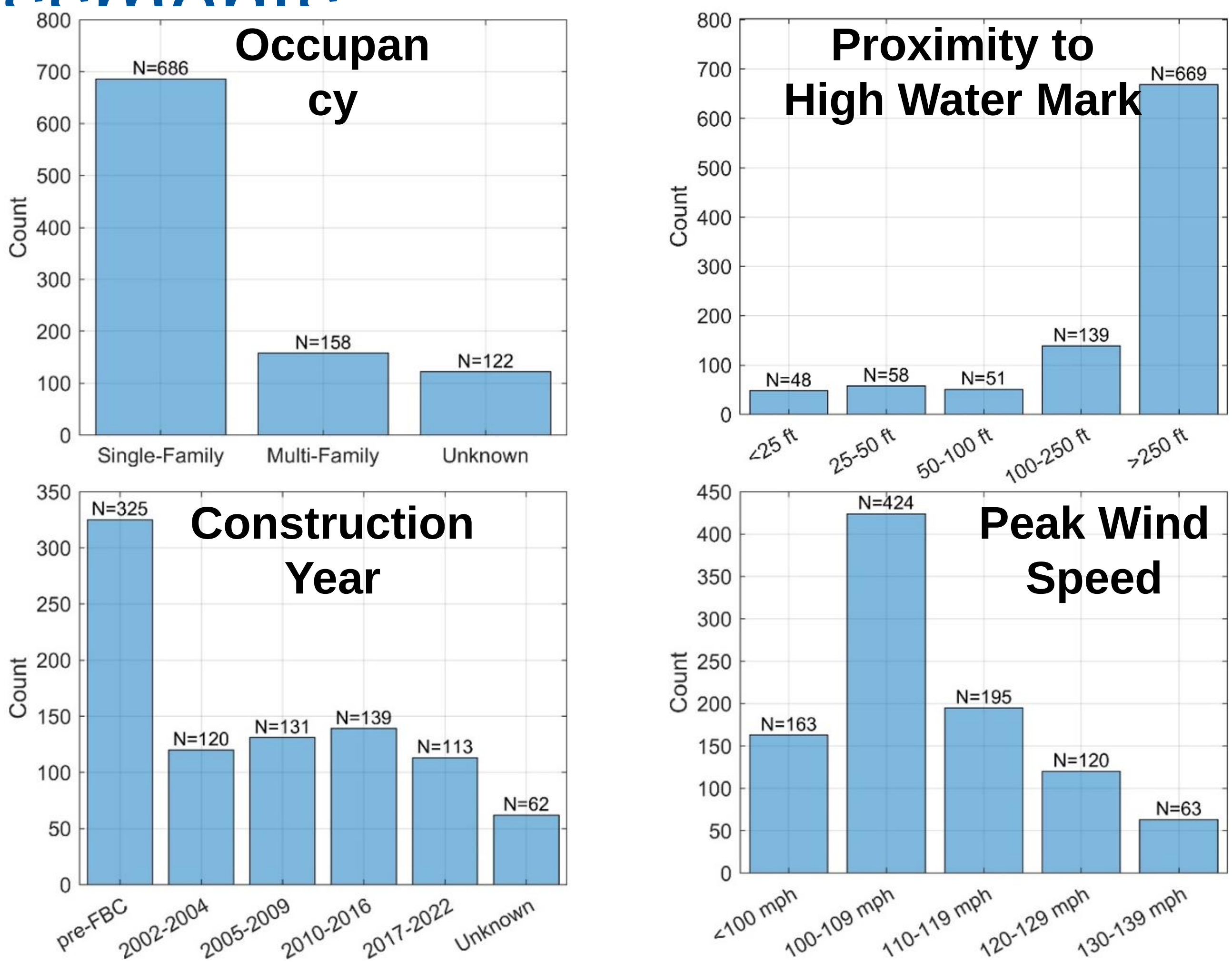
Illustrative Case Studies

Illustrative examples of damage to tiled roofs, including (a) tile uplift (indicated by red ellipses) concentrated along the eaves of a single-family home in Punta Gorda constructed in 1969; (b) loose tiles in the field and ridge regions of the roof on a condominium in Punta Gorda, FL constructed in 1989; and (c) isolated loose tiles on a roof on a multi-family residential unit also in Punta Gorda, FL constructed in 1990.

Virtual Assessments and Data



Stratified Sampling for Virtual Assessments



Standardized Attribute Fields

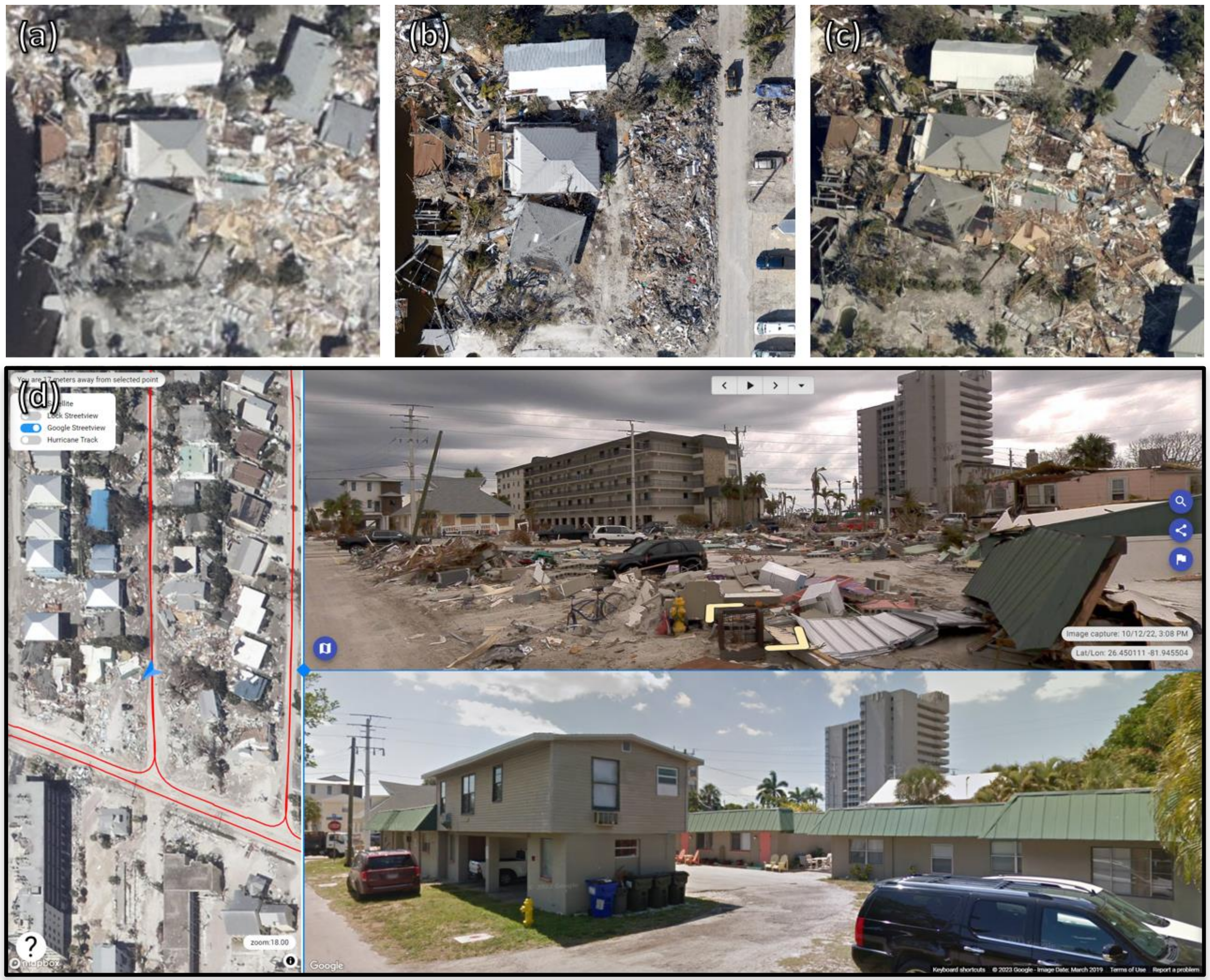
Features	Descriptions
ID	Unique identifier for each building
Latitude	GPS Latitude
Longitude	GPS Longitude
Parcel ID	Unique identifier assigned by county
Occupancy	Occupancy class of building
Address Sub Thoroughfare	Street number
Address Thoroughfare	Street name
Address Locality	City
Address Sub Admin Area	County
Address Admin Area	State
Address Postal Code	Zip Code
Year Built	Original year of construction
Number of Stories	Number of stories above ground
Elevation to LHSM	Elevation to lowest horizontal structural member in feet
Base Flood Elevation	Base flood elevation as determined by the current FEMA FIRM
CCCL Location	Location relative to the Coastal Construction Control Line
Wall Cladding Type 1	Primary wall cladding type
Wall Cladding Type 1 Area	Proportion of primary wall cladding type
Wall Cladding Type 2	Secondary wall cladding type
Wall Cladding Type 2 Area	Proportion of secondary wall cladding type
Roof Cover	Roof cover type
Roof Shape	Shape of roof
Roof Slope	Slope of roof by pitch
Mean Roof Height	Average height of roof
Building Length	Maximum horizontal footprint dimension

Features	Descriptions
Foundation Type	Type of foundation system
Structural System	Type of primary structural system
Breakaway Wall Performance	Whether breakaway walls are present and if so, whether they failed or not
Flood Slab Uplift	Whether floor slab uplift is observed
Debris Impact Damming	Whether debris impact or damming is present or contributed to damage
Building Collapsed or Partially Collapsed	Whether building is partially or fully collapsed
Shifted Off Foundation	Whether building has been displaced off its foundation
Garage Door Performance	Whether garage door is present, and performance if so
Roof Structure Damage	Percentage of roof structure damaged or missing
Roof Substrate Damage	Percentage of roof decking damaged or missing
Roof Cover Damage	Percentage of roof cover damaged or missing
Wall Structure Damage	Percentage of wall structure damaged or missing
Wall Substrate Damage	Percentage of wall sheathing damaged or missing
Wall Cover Type 1 Damage	Percentage of primary wall cover type damaged
Wall Cover Type 2 Damage	Percentage of secondary wall cover type damaged
Fenestration Damage	Percentage of windows or entry doors damaged or missing
Soffit Damage	Whether soffit damage is observed
Fascia Damage	Whether fascia damage is observed
Surge Damage Rating	Overall surge damage rating
Wind Damage Rating	Overall wind damage rating
Permit Number	Permit number for wind mitigation related permit
Permit Type	Type of wind mitigation related permit
Permit Year	Year permit was closed
Peak Gust Wind Speed	Peak estimated 3-second gust wind speed in mph

Data Sources for Assessments &

Class	Source Name/ID	Provider(s)
Imagery	On-Site Structural Photographs	StEER
	Post-Event Streetview	StEER/SiteTour360
	Aerial Imagery	NOAA, NHERI RAPID EF
	LCPA Pictometry	Lee County
Hazard Intensity	Peak Wind Contours	ARA/NIST/FEMA
	High Water Marks	StEER, USGS
Vulnerability	Design Wind Speeds	ASCE
	Base Flood Elevation	FEMA
Building Attributes	Property Appraisals	Lee County, Charlotte County
	Building Footprints	Lee County, Microsoft
	Elevation Certificates	FEMA
	3D LiDAR Point Clouds	USGS
	Connect Explorer	Eagleview Pictometry

Example Imagery Sources



Primary imagery sources available for conducting virtual assessments, including:

(a) NOAA nadir aerial images, collected 9-September through 3-October 2022,

(b) RAPID nadir aerial imagery, collected 19-23 October 2022,

(c) Pictometry oblique imagery, collected 29-30 September 2022,

(d) the Ian street-level panorama viewer created by SiteTour 360 and StEER, including post-Ian NOAA aerial imagery, post-Ian surface-level panoramas collected by SiteTour 360 and StEER, and pre-Ian Google Streetview imagery.

Summary

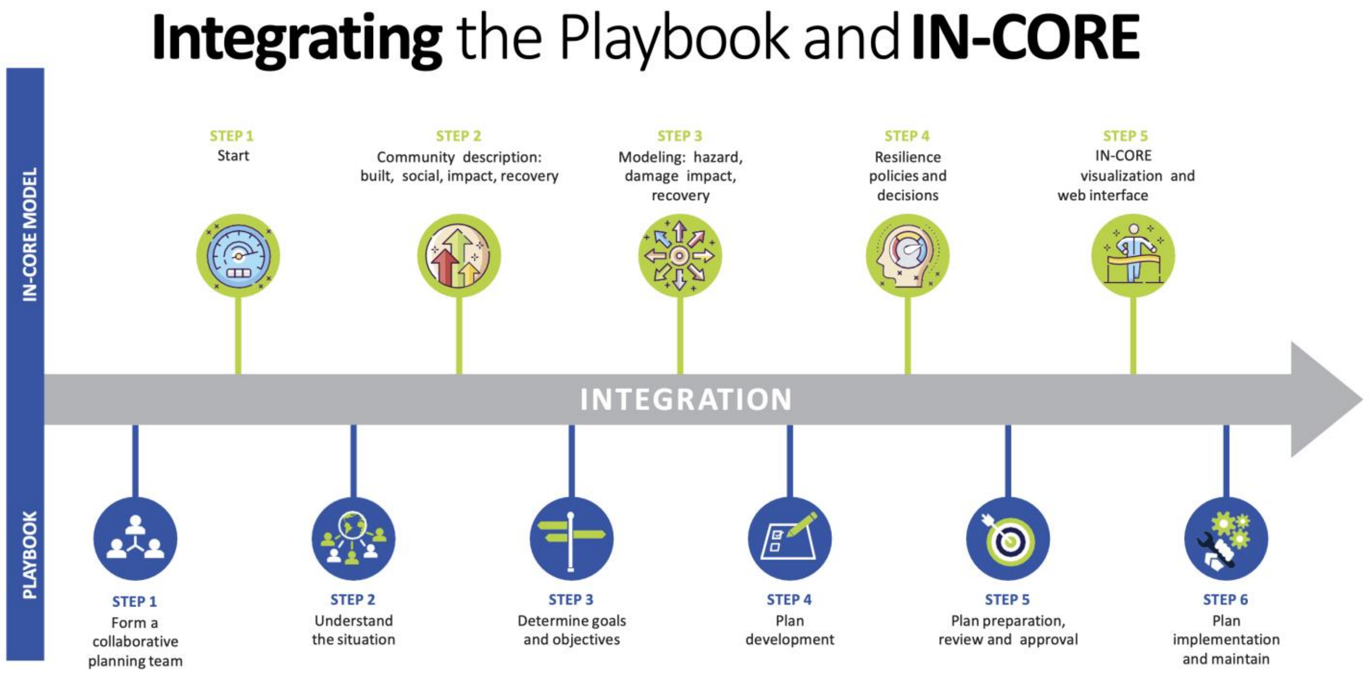
- Complete data enhancement and analysis on ~1,000 structures - report due to FBC by June 2023
- Hurricane Ian's dataset relies on improved virtual assessment methodologies (using Streetview and Aerial asset-based photography)
  - Small sample size: 0.5% of total houses: Ft. Meyers 41,329; Cape Coral 86,896; Port Charlotte 30,378, Northport 30,765 = 189,368
- Longer term Value to the Florida Building Commission
  - Statistically rigorous and consistent evaluation of building performance (2016-2021) in Matthew Irma, Michael, Ian. Geographic comparison possible in Florida
  - The economic and other benefits of FBC's building code can be quantified
- Empirical summaries support further studies for calibrating damage/loss predictive analytical models being developed (next slides)

COASTAL HAZARDS, EQUITY, ECONOMIC PROSPERITY AND RESILIENCE (CHEER) HUB RESEARCH AIMS

1. Model complex interactions of economic prosperity, community resilience and equity
2. Predict hurricane hazards impacts over time accounting for climate change
3. Develop a computational tool to assist communities formulate their polices to achieve sustainable equity, thriving community and resilience

https://www.drc.udel.edu/cheer/

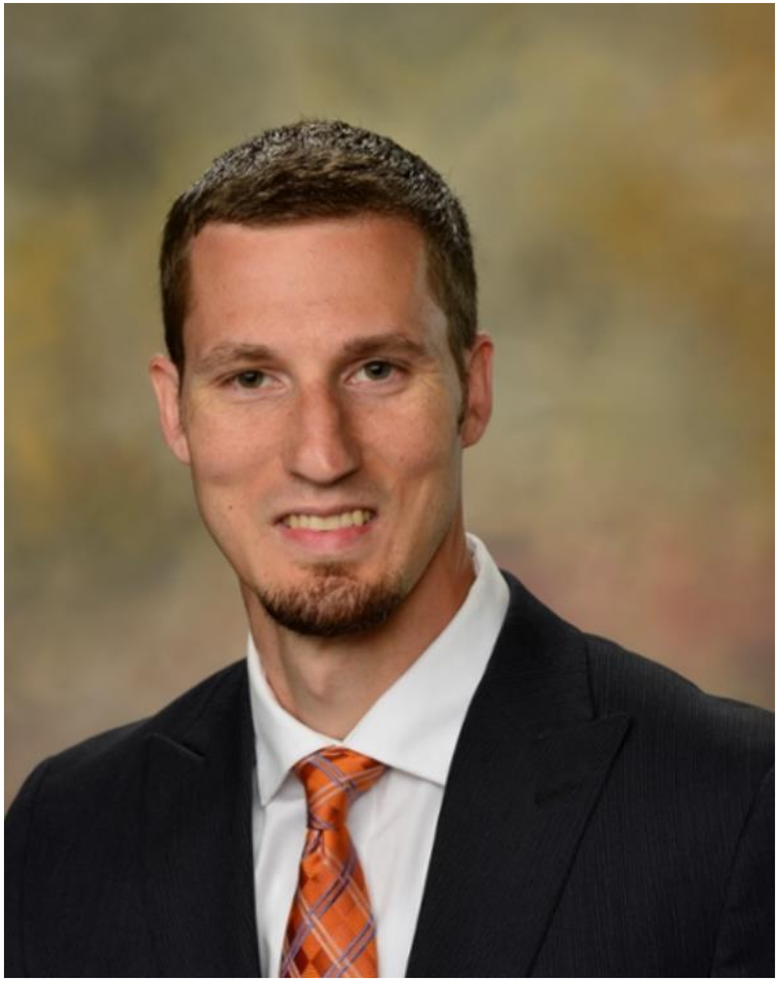
The Center for Risk-Based Community Resilience Planning is unique in merging the disciplines of Engineering, Social Sciences and Economics to model community resilience comprehensively.



http://resilience.colostate.edu/index.shtml

Thank you for your Time!

https://www.essie.ufl.edu/people/name/david-prevatt/



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