Accelerating the Disaster Data to Knowledge Life Cycle through Coordinated Reconnaissance: The StEER Perspective

StEER
STRUCTURAL EXTREME EVENTS RECONNAISSANCE

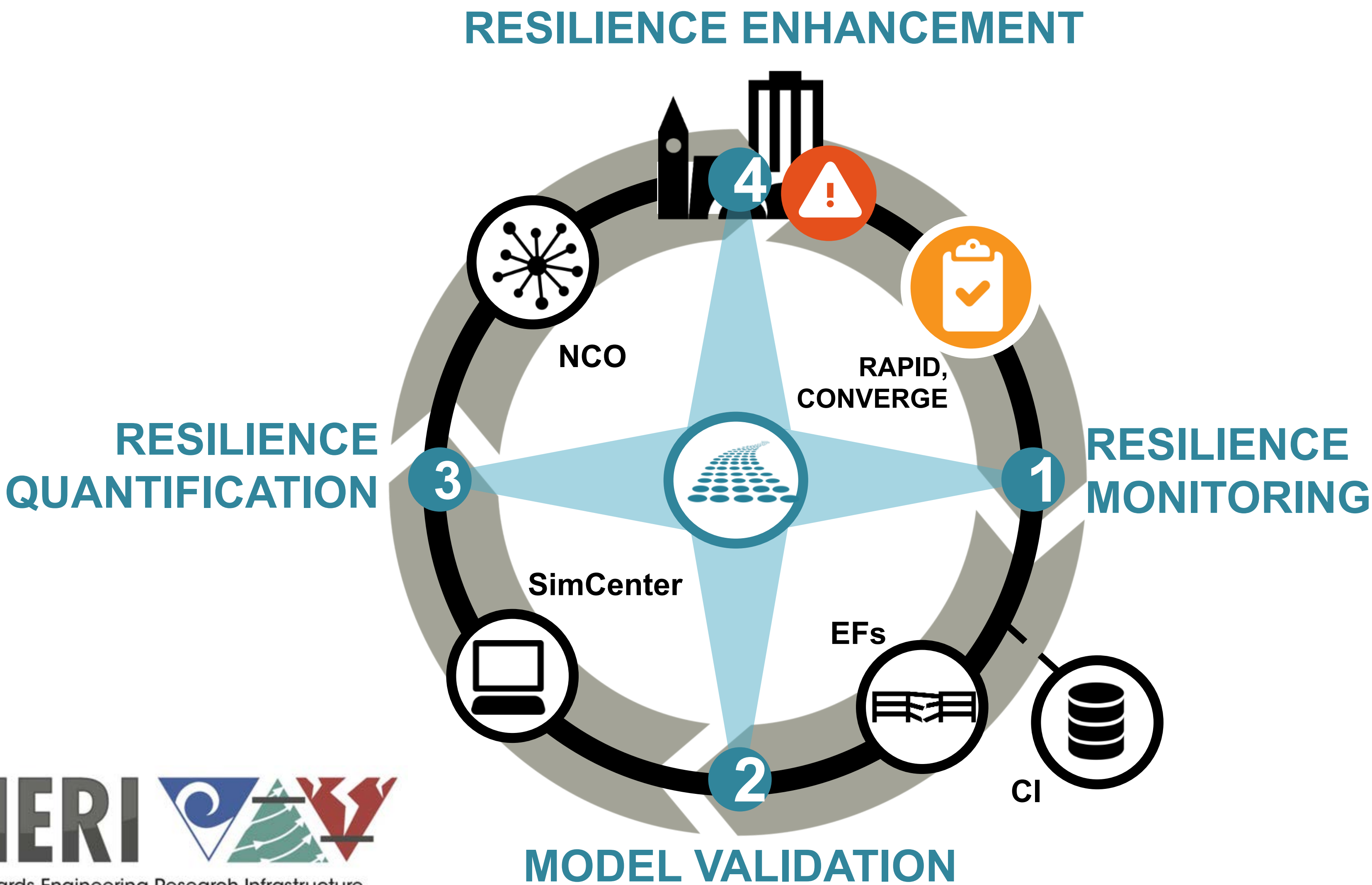
Tracy Kijewski-Correa	Khalid Mosalam	David O. Prevatt	Ian Robertson	David Roueche
Director	Associate Director for Seismic Hazards	Associate Director for Wind Hazards	Associate Director for Coastal Hazards	Associate Director for Data Standards
University of Notre Dame	University of California, Berkeley	University of Florida	University of Hawaii, Manoa	Auburn University

OVERVIEW OF PRESENTATION



StEER approach to coordinated reconnaissance	Tracy Kijewski-Correa
Origins of approach	David O. Prevatt
StEER data workflows	David Roueche

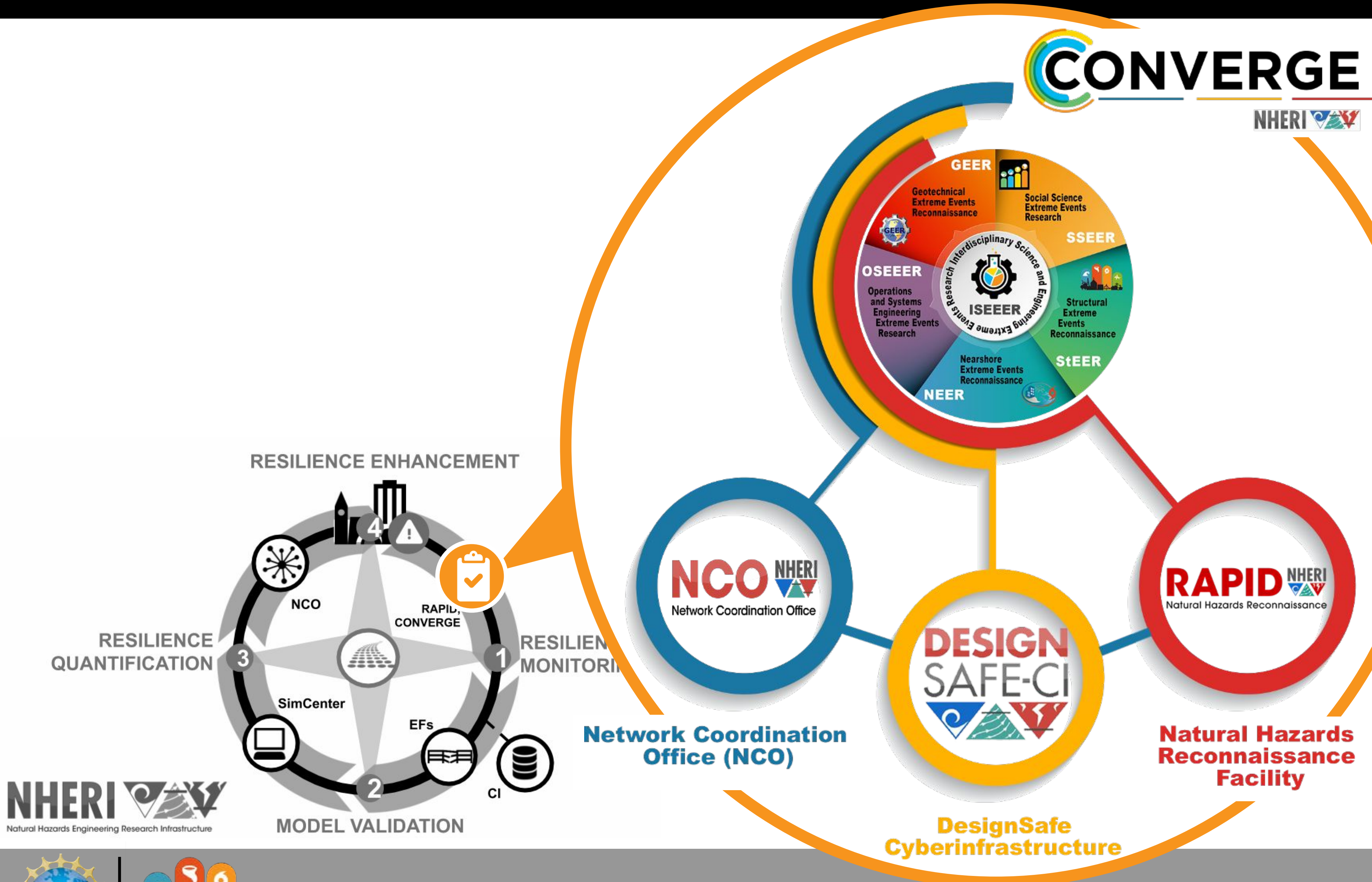
DISASTER DATA-TO-KNOWLEDGE LIFE CYCLE



NHERI
Natural Hazards Engineering Research Infrastructure

StEER: Building Resilience through Reconnaissance

DISASTER DATA-TO-KNOWLEDGE LIFE CYCLE



VISION & MISSION

StEER
STRUCTURAL
EXTREME EVENTS
RECONNAISSANCE

VISION: StEER **builds societal resilience** by generating new knowledge on the performance of the built environment through impactful post-disaster reconnaissance disseminated to affected communities.

MISSION: StEER deepens the structural natural hazards engineering (NHE) community's capacity for reliable post-event reconnaissance through:

CAPACITY
promoting **community-driven standards**, best practices, and training for field reconnaissance

COORDINATION
coordinating **early, efficient and impactful** event responses

COLLABORATION
broadly engaging communities of **research, practice and policy** to accelerate learning from disasters

OUR COMMUNITY & HAZARD PROFILE

OUR COMMUNITY

StEER broadly serves any and all stakeholders invested in or affected by the performance of buildings and other infrastructure, including academia, public and private sectors, government, non-profit, and public-at-large.

TARGETED HAZARDS

StEER focuses on natural hazards causing structural damage to the built environment, including:

Hurricanes

Tornadoes

Earthquakes

Storm Surge and Tsunami

APPROACH

- Collect and curate high-quality perishable evidence of the damage to built environment
- Enables others to use data to conduct research, including RAPIDs

GOVERNANCE STRUCTURE

External & Internal Governance

Kijewski-Correa

Data Service Providers & Data Librarians

Roueche

Coastal Reconnaissance Community

Robertson

Earthquake Reconnaissance Community

Mosalam

Wind Reconnaissance Community

Prevatt

StEER MEMBERSHIP STRUCTURE

Formal training or experience as structural engineer or allied field of natural hazard engineering		*Data or computer scientists*
VAST: VIRTUAL ASSESSMENT STRUCTURAL TEAM	**FAST: FIELD ASSESSMENT STRUCTURAL TEAM**	**DATA ENRICHMENT AND INTEGRATION WORKING GROUP**

LEVEL 1	**LEVEL 2**	**LEVEL 3**	**LEVEL 4**
No prior field experience or substantive participation on Virtual Assessment Structural Teams	No prior field experience, but substantive participation on Virtual Assessment Structural Teams	Some prior field experience	Significant prior field experience
VAST only	VAST FAST Trainee	VAST FAST member Working Groups	VAST FAST Lead Working Groups Steering Committee Host Regional Node

RESPONSE LEVELS

Active monitoring by StEER leadership

Outreach by community

Communications through CONVERGE

Major hazard event with little potential to generate new knowledge	• No VAST or FAST • **Event Briefing**
Major hazard event with potential to generate new knowledge	• Activate VAST • **Preliminary Virtual Reconnaissance Report (PVRR)**
Major hazard event with ability to generate new knowledge	• Continue with VAST, Activate FAST • **Early Access Reconnaissance Report (EARR)** • **Curated dataset**

StEER PRODUCTS & TYPICAL RESPONSE TIMELINE

~24 hrs
Event Briefing Released*

~2-3 days
PVRR Released

~2 days post-FAST
EARR Released

~30 days
Dataset Curated

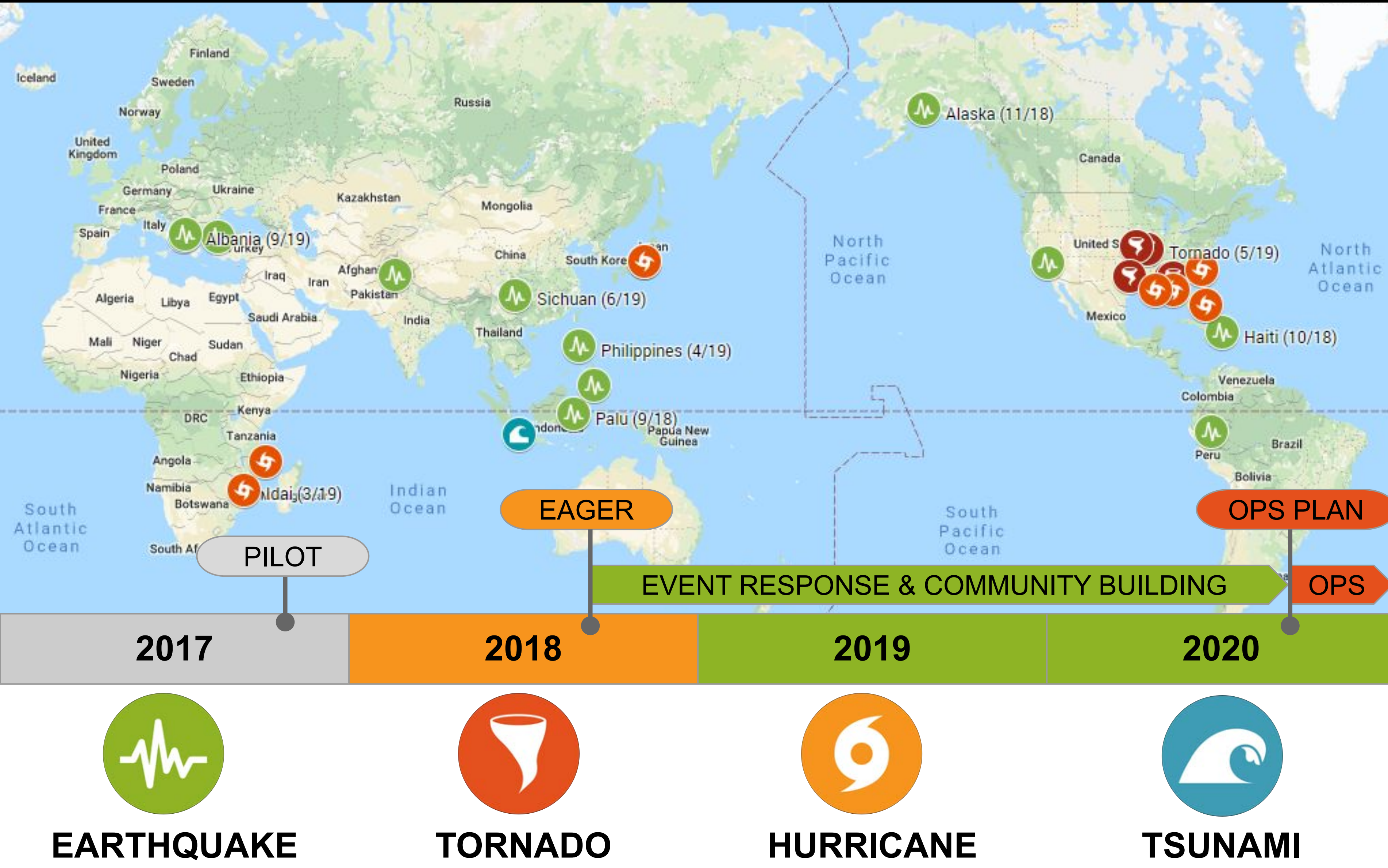
EVENT

VAST: Compile Preliminary Data → **FAST: Deploys; VAST: Rapid Screen Data** → **VAST+FAST: DE/QC & Data Curation**

VAST	1. Collect public information for **PVRR** 2. Author **EARR**
Data Librarians	Lead **Data Enrichment and Quality Control (DE/QC)** process & author **Data Report**

FAST	• Deploys for targeted sampling rapidly after event • **Daily Summaries** inform the EARR • Supports DE/QC process and report preparation

CHRONOLOGY & GEOGRAPHIC COVERAGE



BENEFITS OF STEER APPROACH

EARLY.

Swift deployment with pre-approved funding

Centralized event coordination with targeted sampling strategies

Network of regional nodes with access points

Tiered membership and capacity building initiatives

EFFICIENT.

Real-time collaboration and coordination, shared assets

Data standards, handbooks, templates, training resources

Streamlined data collection, reporting, curation workflows

Coordinated virtual reconnaissance support

IMPACTFUL.

Real-time open data sharing in Fulcrum

Expansive datasets with rigorous quality control and data enrichment

Robust dissemination and long-term curation promoting re-use, collaboration

Consistency through community-wide standards

ORIGINS

My research mission - why study hurricanes?



Hurricane Andrew 1992 - Miami, FL

Hurricane Hugo 1989 - Montserrat and Charleston, SC

Hurricane GIlbert 1988 - Jamaica

- Profoundly affected housing stock of these communities
- The housing stock consists of non-engineered structures

Tornadoes in 2011 - a similar problem

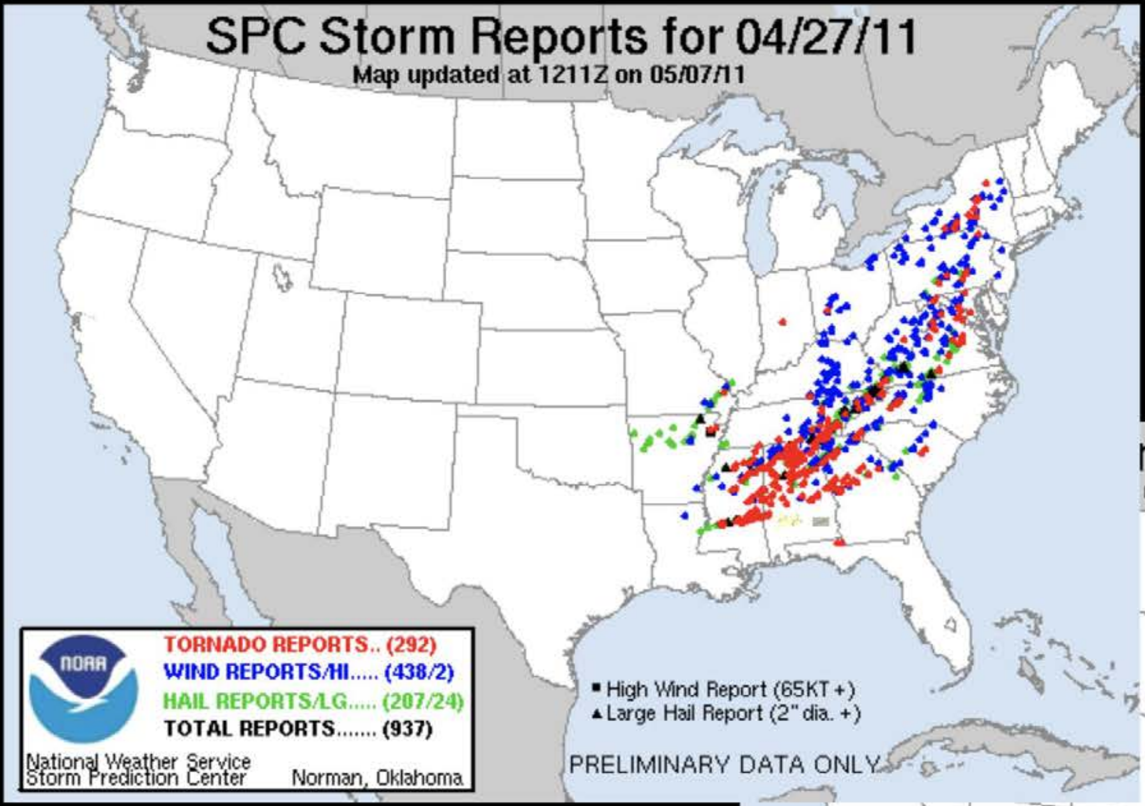
Tuscaloosa

5,144 homes damaged - 1,240 destroyed
95% of damaged homes were single-family
3 area Elementary Schools destroyed
64 Fatalities, 1500+ injuries
$4 Billion in insured losses

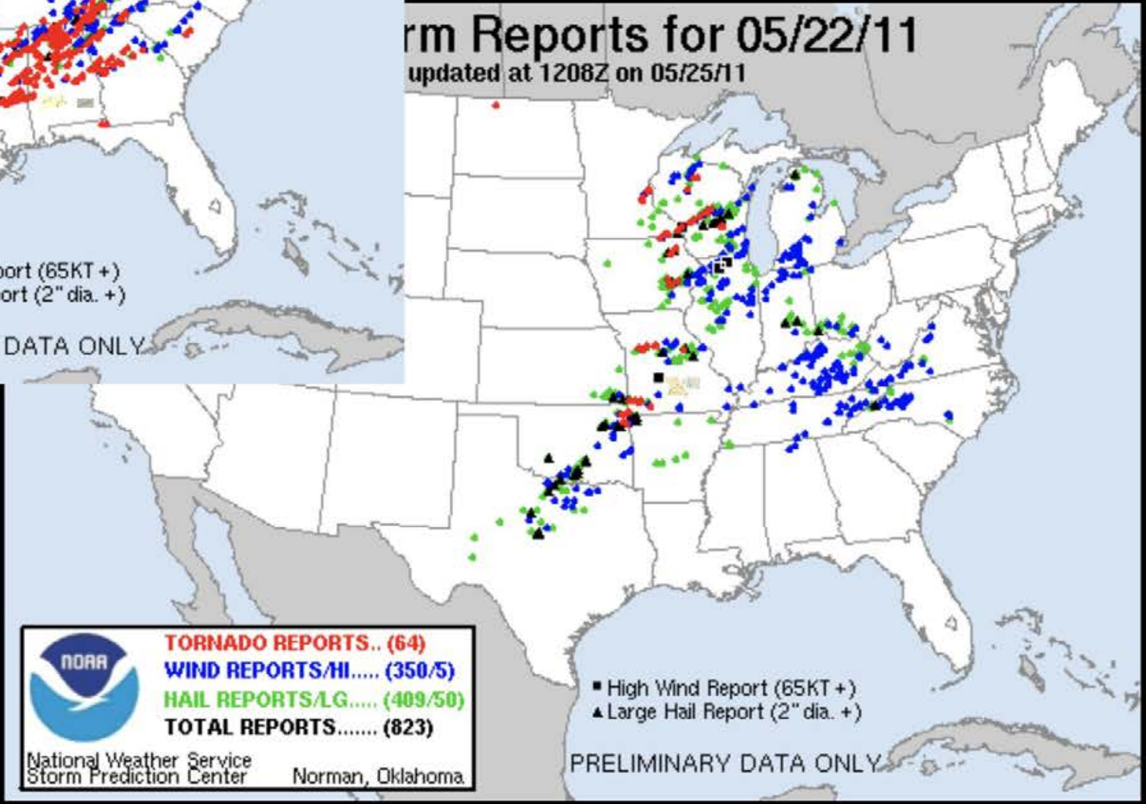
Joplin

7000 homes damaged - 4700 destroyed
95% of damaged homes were single-family
Substantial damage to Joplin High School
5 Other schools also impacted
Significant damage to St. John's Regional Hospital
159 Fatalities, 1150+ injuries
$3 Billion in insured losses

Both tornadoes a part of larger storms systems

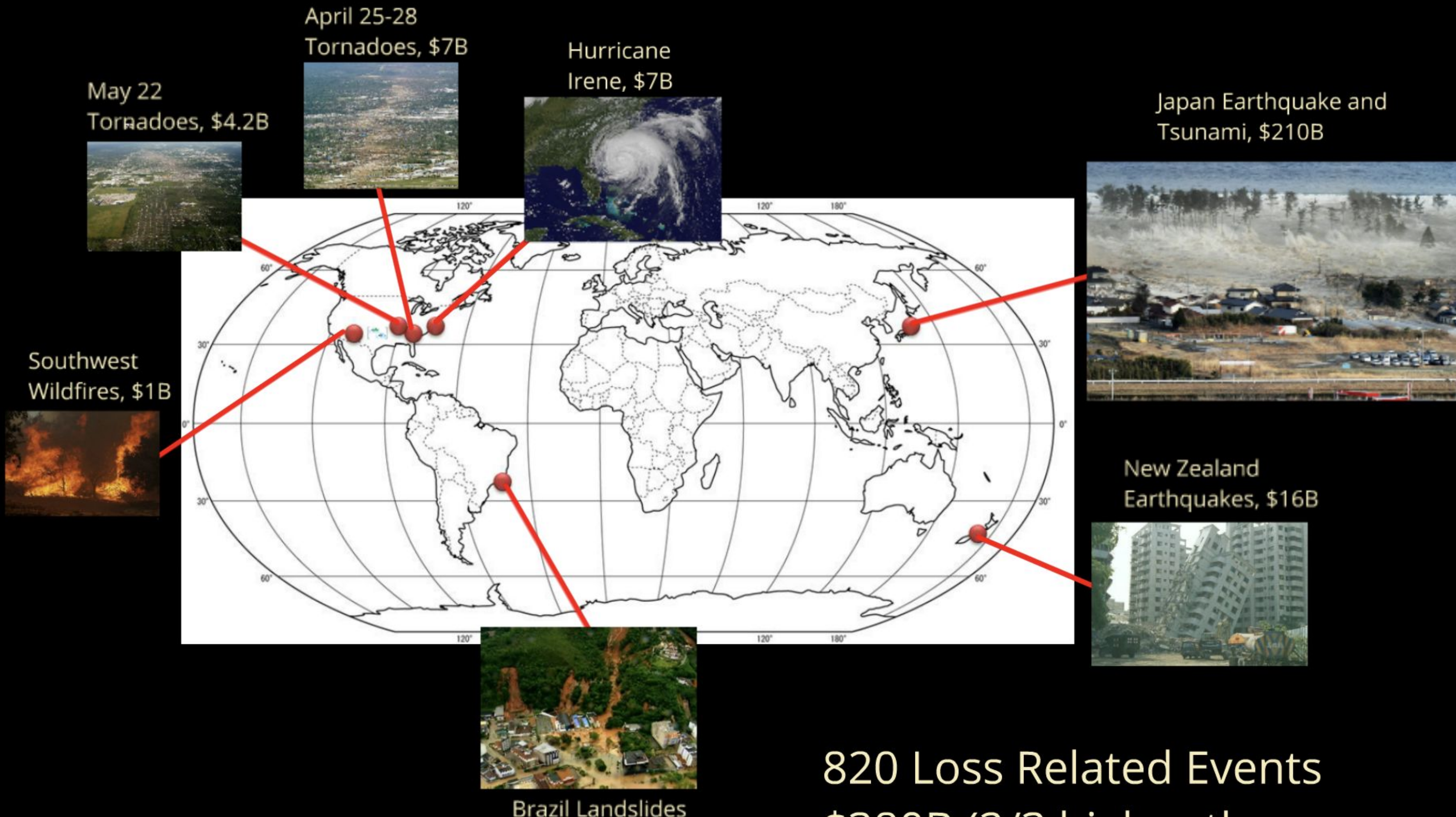


April 25-28
- 359 tornadoes confirmed
- 346 Fatalities
- $7 Billion in Damages



May 21-26
- 180 Tornadoes confirmed
- 186 Fatalities
- $4 Billion in Damages

2011 Natural Disasters



820 Loss Related Events
$380B (2/3 higher than previous record year, 2005)

Source: Re Munich

A second mission - why study tornadoes?

Tri-State Tornado of 1925

Deadliest US tornado with 695 fatalities in MO, IL, IN

Extensive destruction of houses

MONTHLY WEATHER REVIEW

Editor, ALFRED J. HENRY — Assistant Editor, BURTON M. VARNEY

Vol. 53, No. 4
W. B. No. 867

APRIL, 1925

Closed June 3, 1925
Issued June, 1925

THE TORNADOES OF MARCH 18, 1925[1]

By Alfred J. Henry

The destructive tornado that swept eastward over parts of Missouri, Illinois, and Indiana, together with those of shorter path in Kentucky and Tennessee, on March 18, 1925, created a new record of destruction both of human life and property from these much-dreaded storms. Seven separate and distinct tornadoes were observed on the date mentioned, the most destructive of which was the one starting near Annapolis, Mo., which moved in an almost straight line to the Mississippi River, crossing that stream into Jackson County, Ill. It laid waste a number of towns and villages as it crossed Illinois, continuing its devastating course into Indiana and finally disappearing 3 miles southwest of Petersburg, Pike County, Ind.

Two Weather Bureau officials, William E. Barron, of the Cairo station, and Clarence J. Root, of the Springfield station, were at once directed to survey the path of the storm.

Grateful acknowledgment is here made for the matter I have drawn from the report of these two officials. Information as to the remaining tornadoes was drawn largely from the printed issues of "Climatological Data" for the States in which the storms occurred.

THE CYCLONIC STORM THAT GAVE RISE TO THE TORNADOES

The previous history of the cyclonic storm with which the tornadoes were associated is not illuminating; evidently the storm was an offshoot from a cyclone which occupied the northeast Pacific from March 13 to 18. This offshoot was first recognized on the p. m. chart of the 16th as a depression centered over western Montana. At that time and during the next 24 hours, this depression gave no evidence of anything out of the ordinary; on the morning of the 18th it was centered in northwestern Arkansas, as shown in Figure 1 (A). At this time, 7 a. m. 90th meridian time, the center of lowest pressure was shown by the isobars of 29.8 and 29.7 inches, respectively, both isobars being within a trough of low pressure that extended in a NE.-SW. direction.

Movement of the cyclone.—During the daylight hours of the 18th the center of lowest pressure was displaced northeastward a distance of about 500 miles to southeastern Indiana, as shown in Figure 1 (B), or at the rate of about 40 miles per hour.

For the purpose of better relating the progression of the center of lowest pressure with that of the formation and progression of the tornadoes, weather charts covering the lower Ohio Valley for the hours 1, 2, 3, and 4 p. m., central meridian time, were constructed. The charts for 1 and 4 p. m. have been reproduced in the lithograph charts in Figure 2 (A and B).

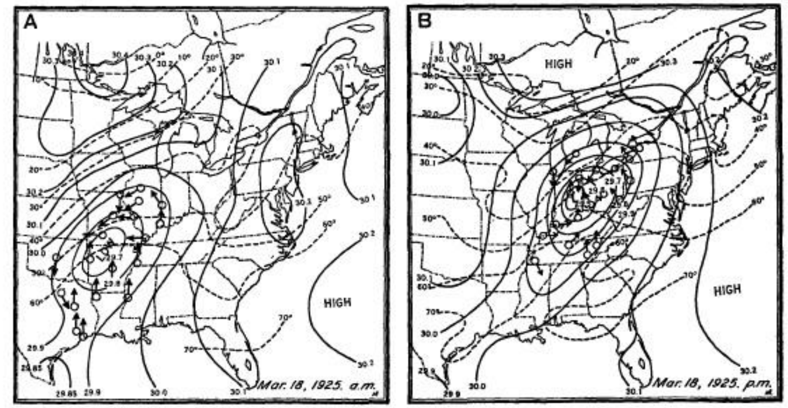


Fig. 1.—Weather maps for 8 a. m. and 8 p. m., March 18, 1925

[1] Condensed from reports by the following field officials: J. H. Armington, William E. Barron, James L. Kendall, Roscoe Nunn, George Reeder, Clarence J. Root, and Geo. B. Wurtz, with discussion by the editor on the meteorological aspect of the phenomenon. Details of loss of life and damage to property were included in this Review for March, 1925, and may also be found in the publication "Climatological Data" for Missouri, Illinois, Indiana, Kentucky, and Tennessee for the same month.—Ed.

Minor J - R172

TTU SRR 03

THE LUBBOCK STORM

MAY 11, 1970

RESPONSE OF STRUCTURAL SYSTEMS TO THE LUBBOCK STORM

TEXAS TECH UNIVERSITY

ance

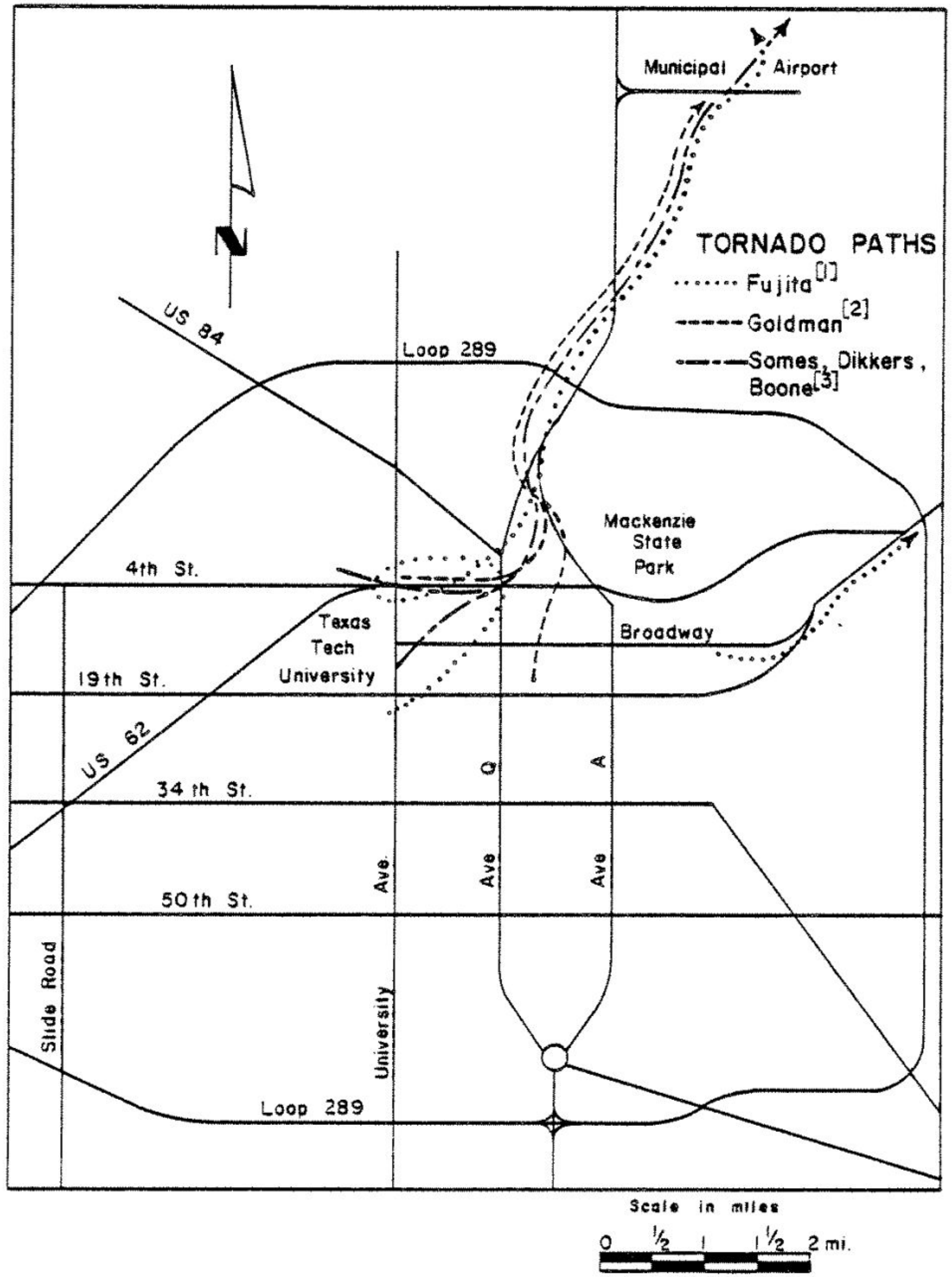


FIGURE 1. SUMMARY OF THREE THEORIES REGARDING THE CONFIGURATION AND PATH OF THE LUBBOCK STORM

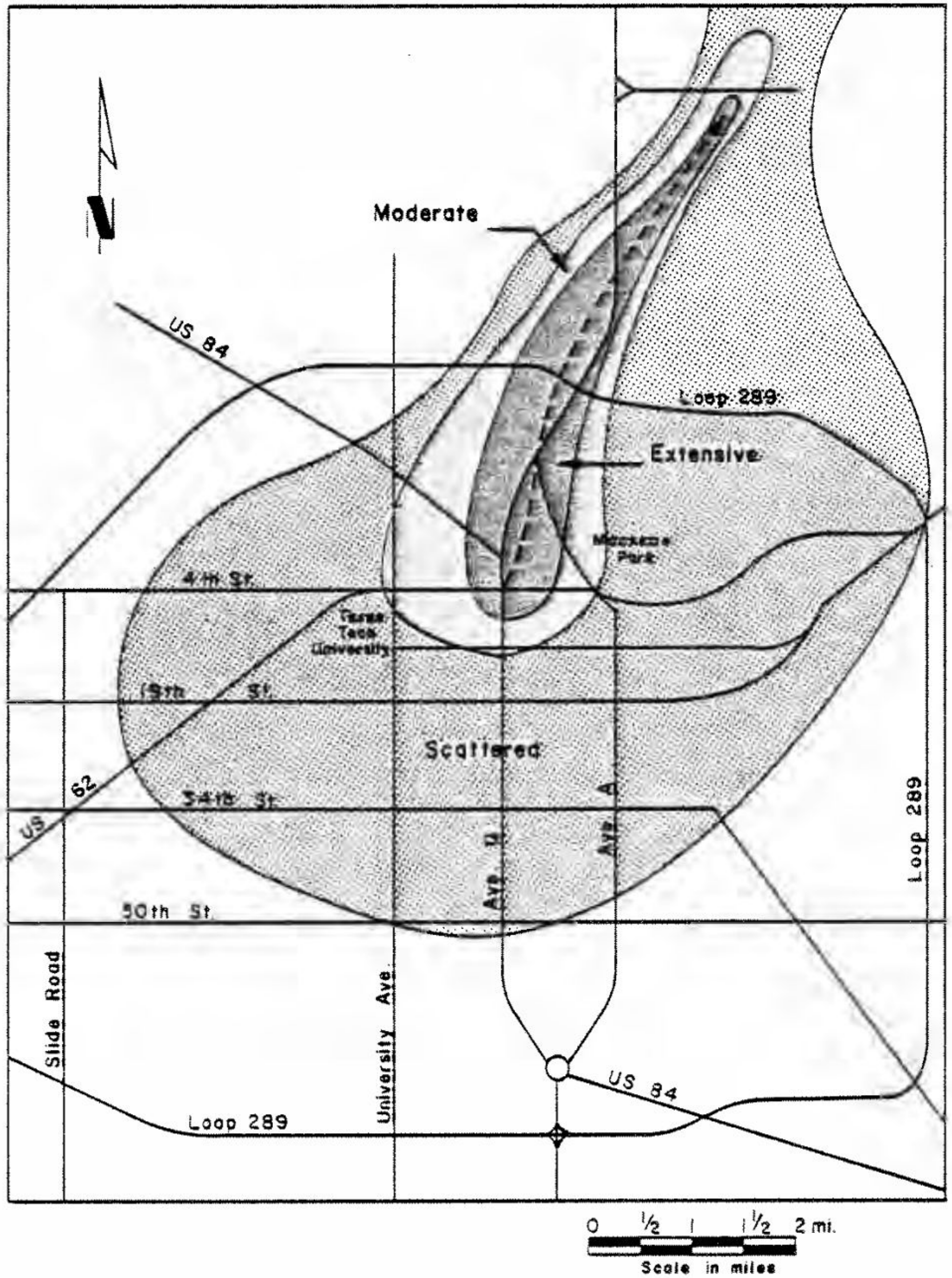


FIGURE 2. PATTERN OF DAMAGE CAUSED BY THE LUBBOCK STORM

93 Case Studies of Lubbock Tornado

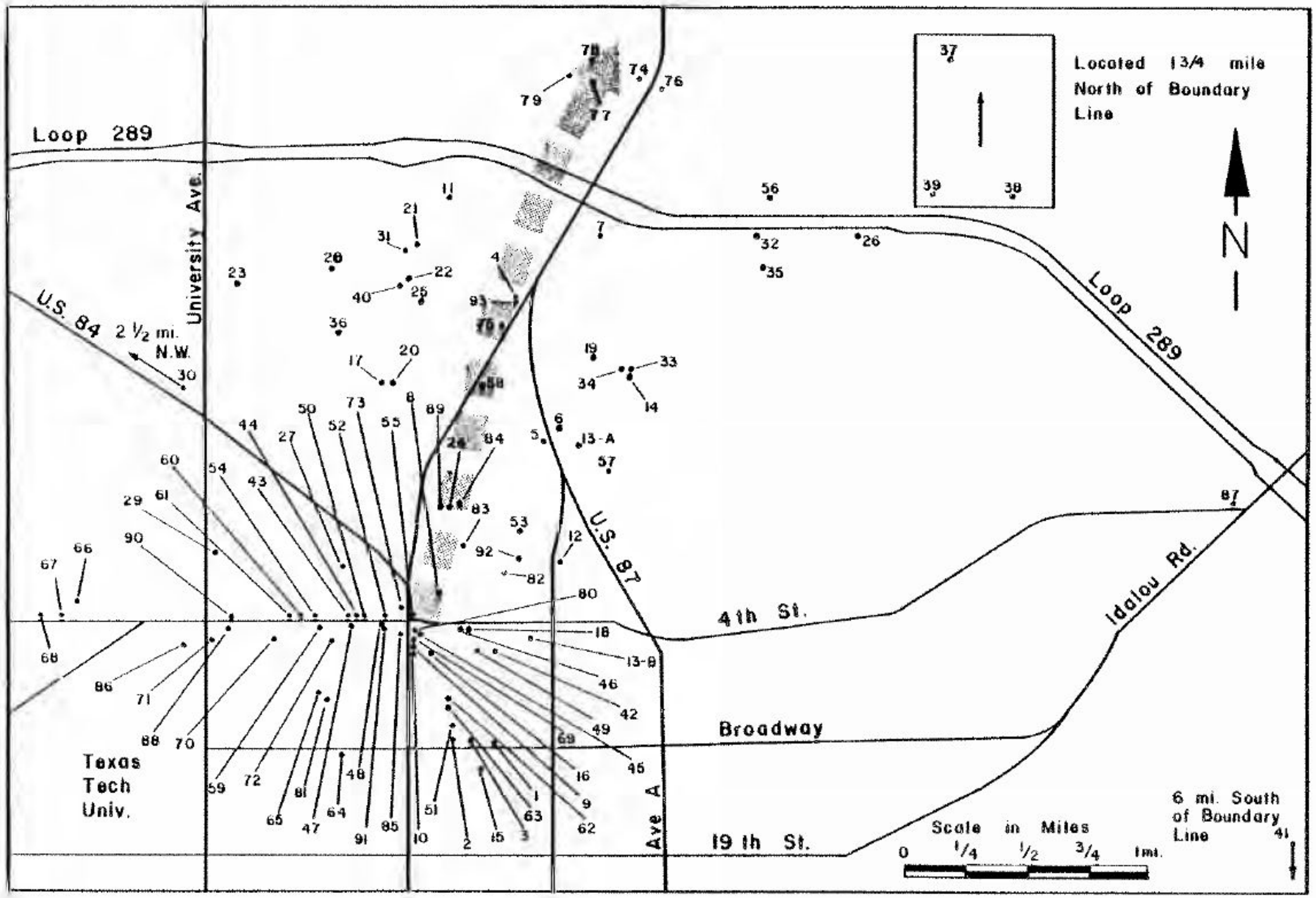


FIGURE 4. LOCATIONS OF 93 DOCUMENTED STRUCTURES

Recommendations from the Lubbock Tornado

The best estimate of the highest wind velocity generated near ground level by the Lubbock Storm is 200 mph. No evidence was observed that would indicate a value of wind velocity at ground level greater than 200 mph.

Most of the damage sustained by structures in Lubbock was caused by winds in the range of 75 to 125 mph.

Interdisciplinary Teams:

Engineers, Meteorologists, FEMA Officials, Social Scientists

UF UNIVERSITY of FLORIDA
The Foundation for The Gator Nation

THE UNIVERSITY OF ALABAMA

South Dakota State University SDSU

Oregon State UNIVERSITY OSU

IOWA STATE UNIVERSITY

ROSE-HULMAN INSTITUTE OF TECHNOLOGY

J&M ENGINEERING

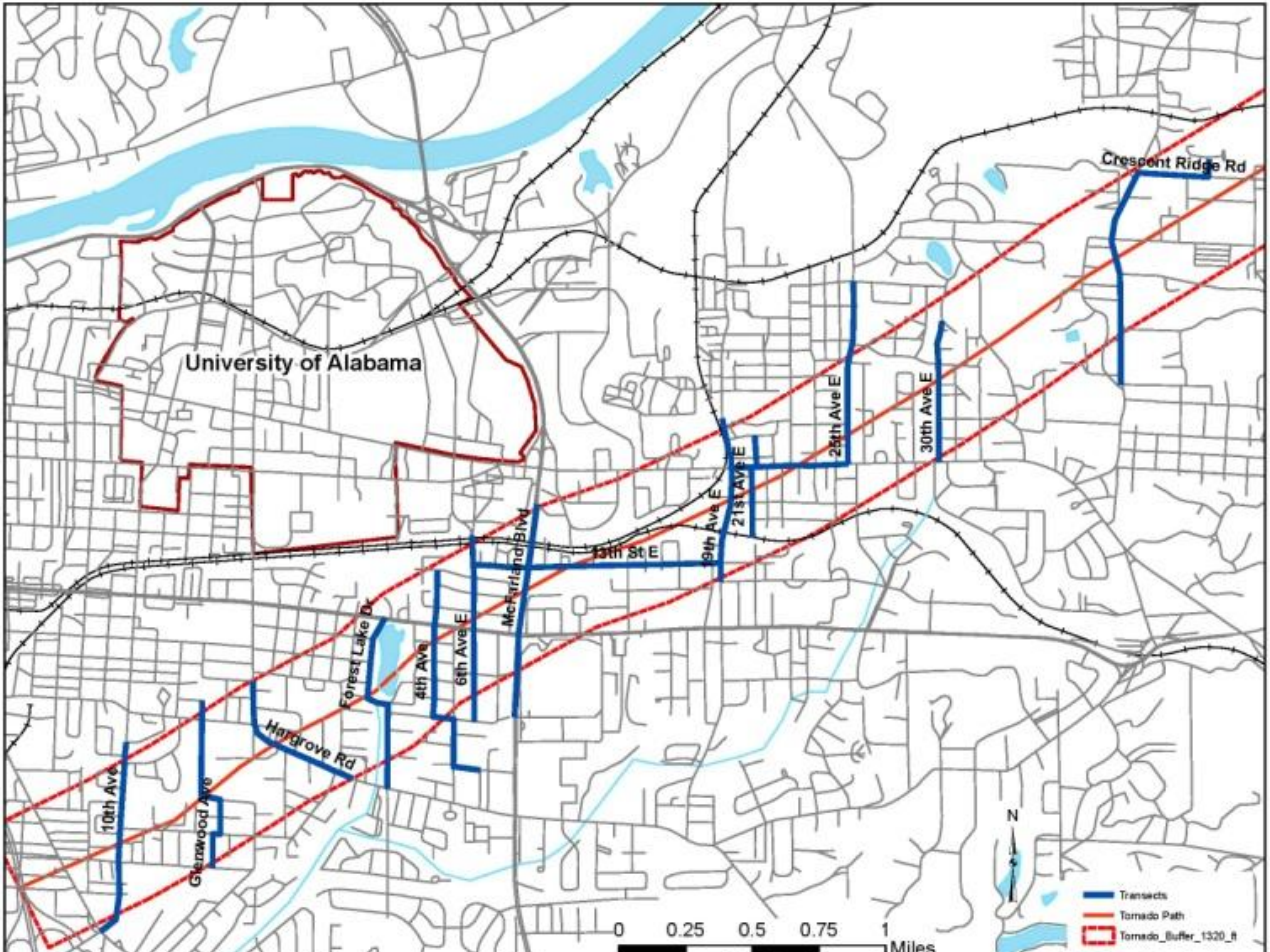
SIMPSON Strong-Tie

ATC

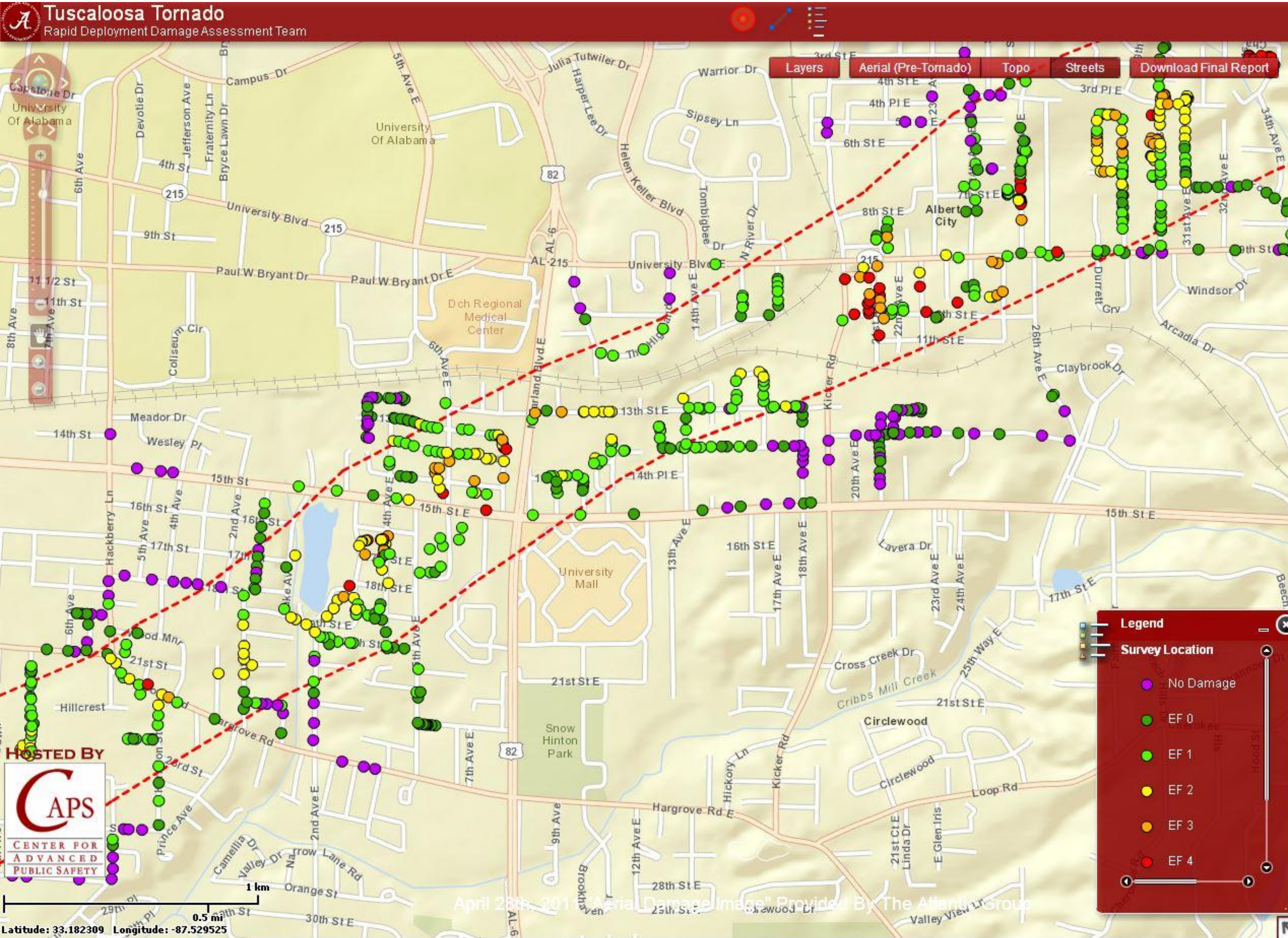
Sponsors:

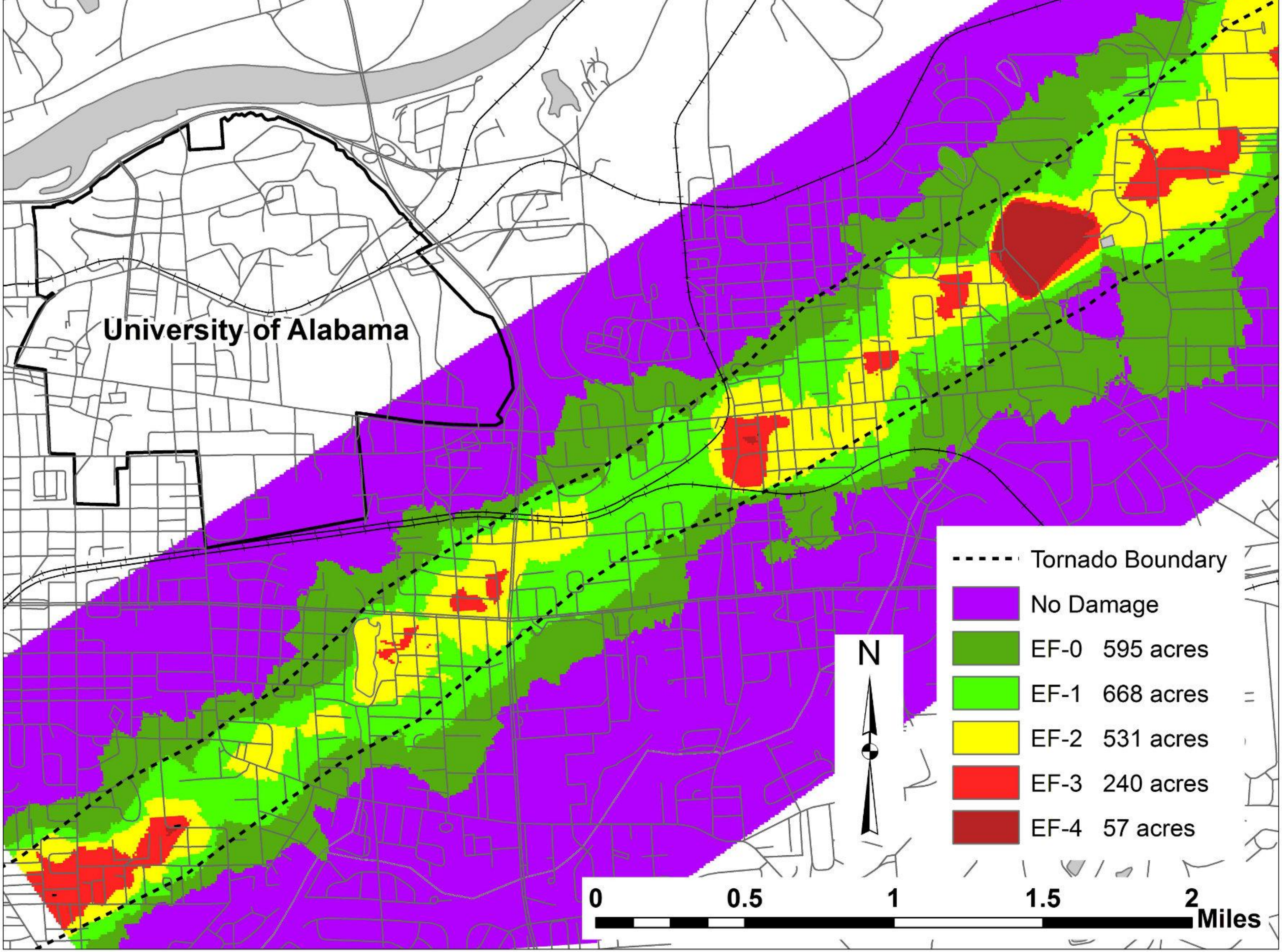
NSF

ASCE
American Society of Civil Engineers


University of Alabama
Crescent Ridge Rd
25th Ave E
30th Ave E
21st Ave E
19th Ave E
13th St E
McFarland Blvd
6th Ave E
4th Ave
Forest Lake Dr
Hargrove Rd
Glenwood Ave
10th Ave
N
0
0.25
0.5
0.75
1
Miles
Transects
Tornado Path
Tornado_Buffer_1320_ft

Geolocation turns photos into data points


Tuscaloosa Tornado
Rapid Deployment Damage Assessment Team
Layers
Aerial (Pre-Tornado)
Topo
Streets
Download Final Report
Legend
Survey Location
No Damage
EF 0
EF 1
EF 2
EF 3
EF 4
Hosted By
CAPS
Center for Advanced Public Safety
University Of Alabama
Dch Regional Medical Center
University Mall
Snow Hinton Park
Alberta City
University Blvd
Paul W Bryant Dr
15th St E
Hargrove Rd E
Campus Dr
Julia Tutwiler Dr
Helen Keller Blvd
13th St E
14th Pl E
21st St E
Circlewood
Cribbs Mill Creek
Loop Rd
Kicker Rd
1 km
0.5 mi
Latitude: 33.182309 Longitude: -87.529525
April 28th, 2011 "Aerial Damage Image" Provided By The Atlantic Group


University of Alabama
Tornado Boundary
No Damage
EF-0 595 acres
EF-1 668 acres
EF-2 531 acres
EF-3 240 acres
EF-4 57 acres
N
0
0.5
1
1.5
2
Miles

Damage Survey available online within 3 months

Damage Study and Future Direction for Structural Design Following the Tuscaloosa Tornado of 2011

David O. Prevatt, Ph.D., P.E., University of Florida, Gainesville, FL
John W. van de Lindt, Ph.D., University of Alabama, Tuscaloosa, AL
Andrew Graettinger, Ph.D., University of Alabama, Tuscaloosa, AL
William Coulbourne, P.E., Applied Technology Council, Rehoboth Beach, DE
Rakesh Gupta, Ph.D., Oregon State University, Corvallis, OR
Shiling Pei, Ph.D., P.E., South Dakota State University, Brookings, SD
Samuel Hensen, P.E., Simpson Strong Tie, Pleasanton, CA
David Grau, Ph.D., University of Alabama, Tuscaloosa, AL

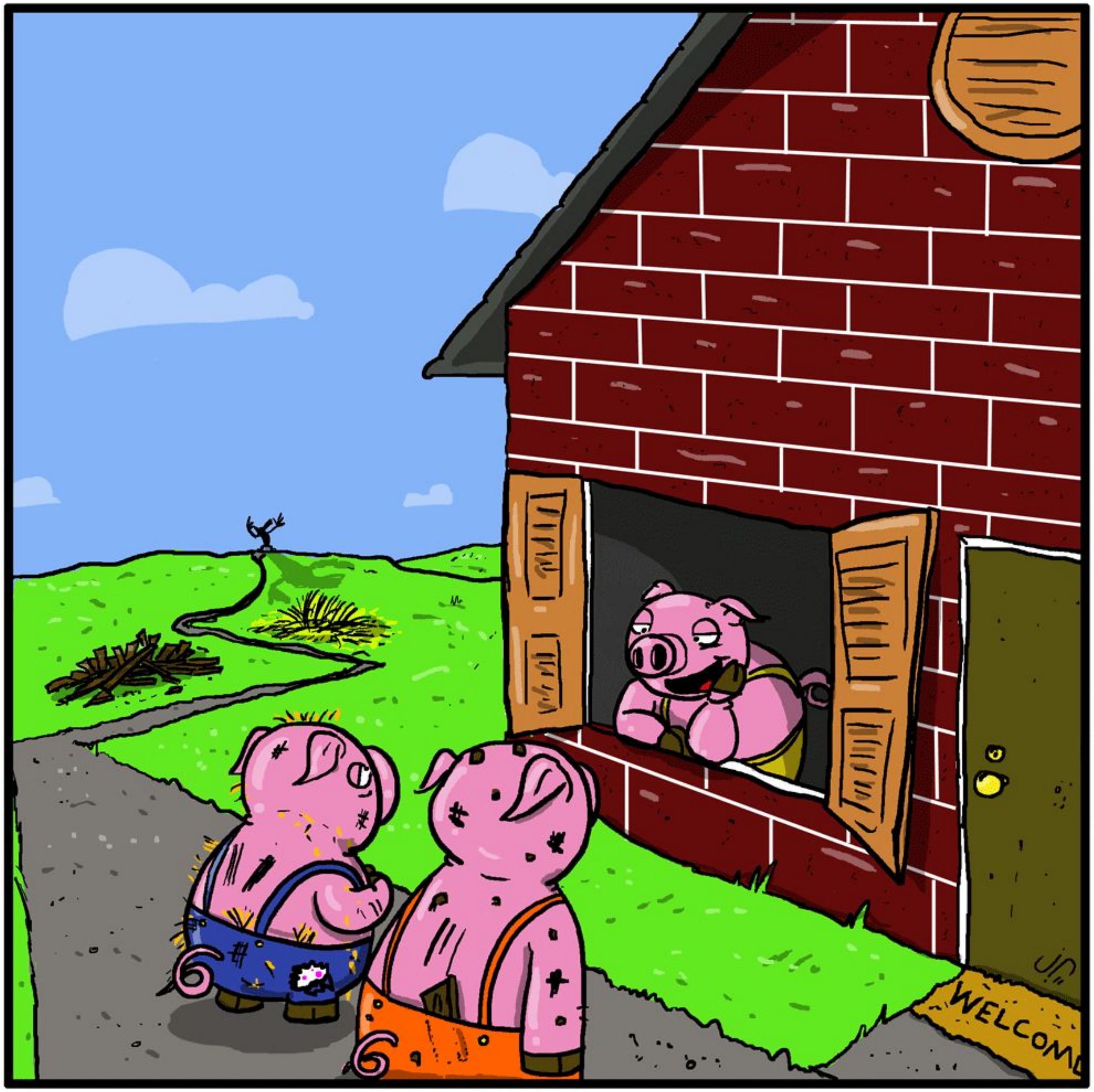
July 27, 2011

windhazard.davidoprevatt.com

The deafening silence of disasters

StEER: Building Resilience through Reconnaissance

Haiti (Matthew 2016) - Health facility unscathed



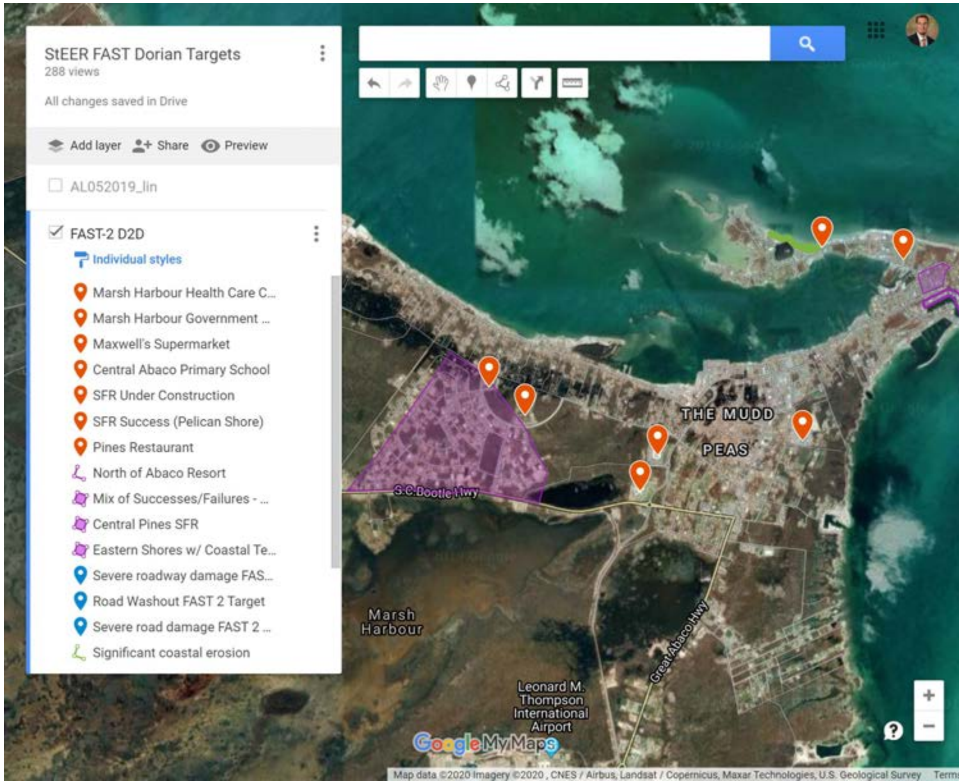
"Mitigation isn't so funny now, is it?"

WORKFLOWS

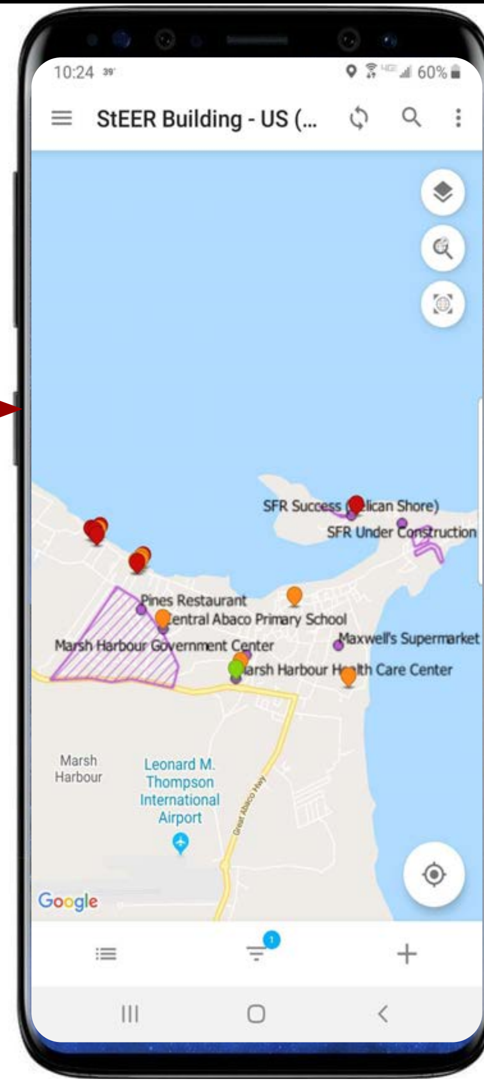
VAST AND FAST IN StEER EVENT RESPONSE WORKFLOW

	PRE-DEPLOYMENT	DURING DEPLOYMENT	IMMEDIATE POST-DEPLOYMENT	LONG-TERM POST-DEPLOYMENT
VAST TASKS	VAST formed, VAST Lead appointed	VAST reviews Fulcrum entries submitted by FAST	VAST leads **Data Enrichment/Quality Control** Process	VAST leads **Data Enrichment/Quality Control** Process
VAST TASKS	VAST seeks information on event, collaborates on Slack	VAST reviews **Daily Summary** from FAST	VAST publishes **EARR**	Publish **Data Report** and curate final data set in DesignSafe
VAST TASKS	Author and publish **PVRR**	VAST initiates **EARR**	VAST interacts with FAST on Slack to initiate **DATA Report**	
JOINT TASKS	Prepare supplies, StEER Apps, templates and other resources for field	Disseminate preliminary observations and media to raise awareness of StEER response	Possibly secure additional RAPID funding for research inspired by FAST observations	Co-author journal papers(s) and pursue long-term funding opportunities
FAST TASKS	FAST secures reservations and coordinates logistics on dedicated Slack channel	Collect data using targeted sampling strategy; synchronize Fulcrum entries and backup/transfer data daily	Ensure all data collected outside Fulcrum is transferred to DesignSafe and that all Fulcrum data has synchronized	Assist with **Data Report** and final curation in DesignSafe
FAST TASKS	FAST formed, FAST Lead appointed	Prepare **Daily Summary** and share with VAST	Assist with **EARR** Complete Google Form with expenses	Possibly present findings at conferences

PRE-DEPLOYMENT TARGET SELECTION



Targets synced to Fulcrum for offline access by FAST



- Satellite imagery, social media used to identify points of interest (successes and failures)
- Representative samples chosen across a diversity of structure typologies
- Typologies matched with expertise of FAST members where possible
- **Pre-selected targets are recommendations - not absolute**

TYPICAL ASSESSMENT TECHNOLOGIES

Door-to-Door (D2D) Damage Assessments using Mobile Apps

Unmanned Aerial Surveys

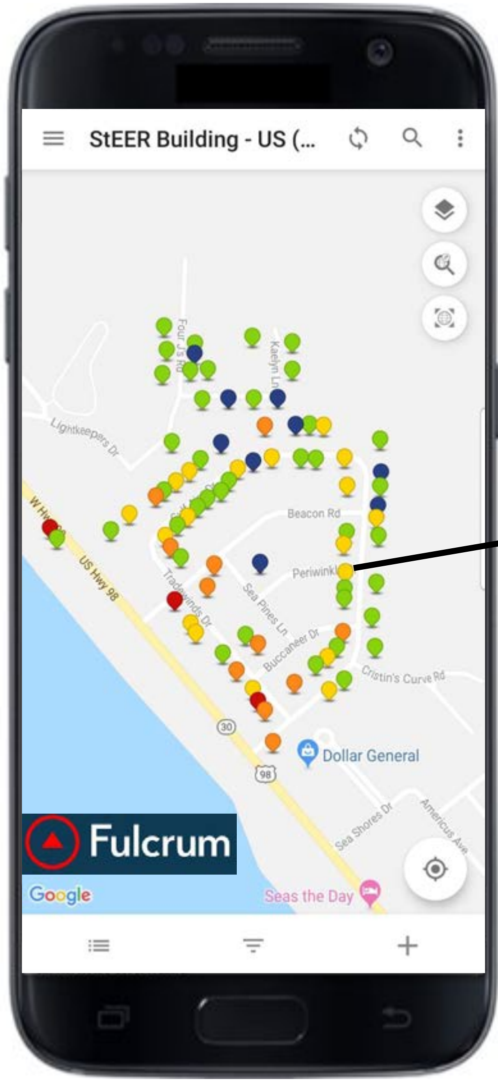
Applied StreetView and 360 imaging technologies

Terrestrial Scanning Technologies

TYPICAL DATA COLLECTION STRATEGY

Overlapping data collection technologies ensure D2D teams can sample efficiently in the field while still capturing the context and broad damage patterns

LEVERAGING MOBILE APPS IN DISASTER RECONNAISSANCE



Photographs

Audio

Free-form Text

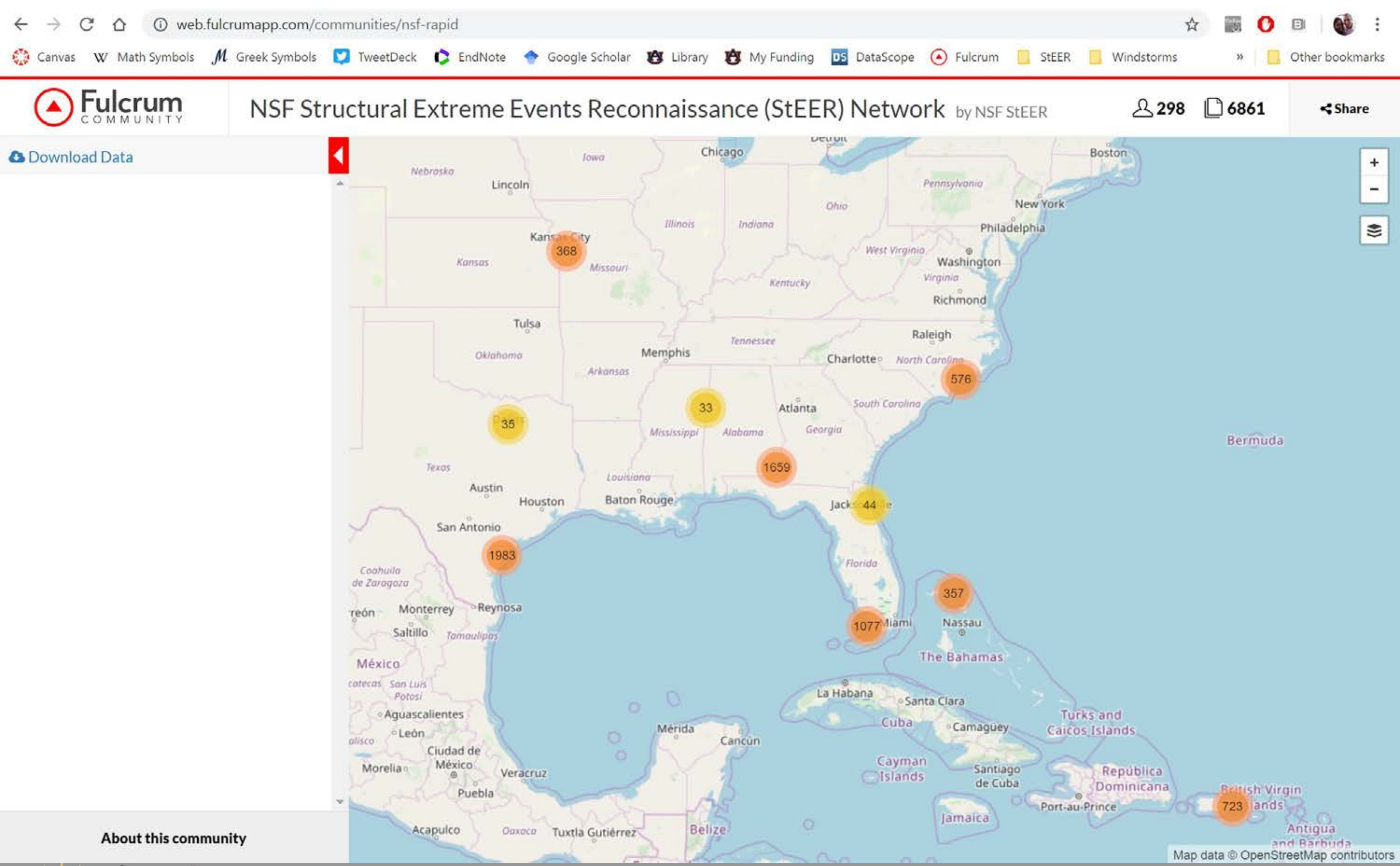
Upper story soffits gone
Garage door gone
Siding failure on right and left wall
Right wall window damaged

Standardized Data Fields

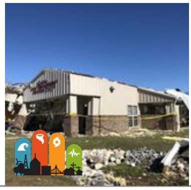
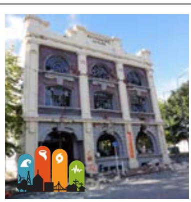
- Investigation Notes
- Building Attributes
- Structural Attributes
- Walls and Foundation
- Fenestration
- Roof Structure
- Wind-induced Damage
- Surge-induced Damage

Multiple data types contained within a single, geolocated record that is easily exportable to common formats: Excel, ESRI Shapefile, GeoJSON, etc

REAL-TIME DATA SHARING THROUGH FULCRUM COMMUNITY



CURRENT StEER APP LIBRARY

	Name and Description	Availability
	**StEER Building - US (Windstorm)** *D2D assessment form for coastal and inland buildings affected by severe windstorms such as hurricanes and tornadoes.*	In-use
	**StEER Non-Building (Windstorm)** *General assessment form for non-building structures - such as towers, bridges, and dams - affected by severe windstorms.*	In-use
	**StEER Earthquake Rapid Evaluation Form** *D2D assessment form loosely based on the ATC-20 Rapid Evaluation Safety Assessment form, modified to include basic capabilities for non-building structures to be assessed.*	Available
	**StEER Earthquake Detailed Evaluation Form** *Detailed D2D assessment form for buildings and possibly non-buildings, responsively developed to meet the needs of the structural earthquake engineering community.*	Coming soon
	**StEER Tsunami** *Assessment form for documenting performance of buildings and other structures impacted by tsunami-induced hazards*	Coming soon

PARTITIONING DATA COLLECTION RESPONSIBILITIES

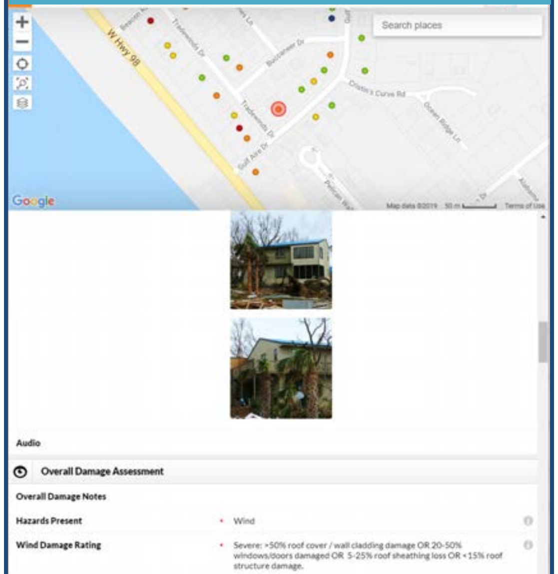
Other Attributes:

- Year Built
- Occupancy Category
- Footprint Area
- Roof Slope
- Roof Cover Material
- etc

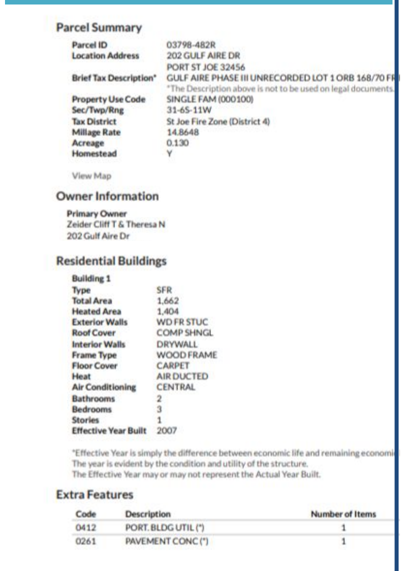
PARTITIONING DATA COLLECTION RESPONSIBILITIES

SUPPLEMENTAL DATA SOURCES FOR DE/QC

Fulcrum



County Records



Parcel Summary

Parcel ID	03798-482R
Location Address	202 GULF AIRE DR PORT ST JOE 32456
Brief Tax Description*	GULF AIRE PHASE III UNRECORDED LOT 1 ORB 168/70 FR *The Description above is not to be used on legal documents.
Property Use Code	SINGLE FAM (000100)
Sec/Twp/Rng	31-6S-11W
Tax District	St Joe Fire Zone (District 4)
Millage Rate	14.8648
Acreage	0.130
Homestead	Y

View Map

Owner Information

Primary Owner
Zeider Cliff T & Theresa N
202 Gulf Aire Dr

Residential Buildings

Building 1

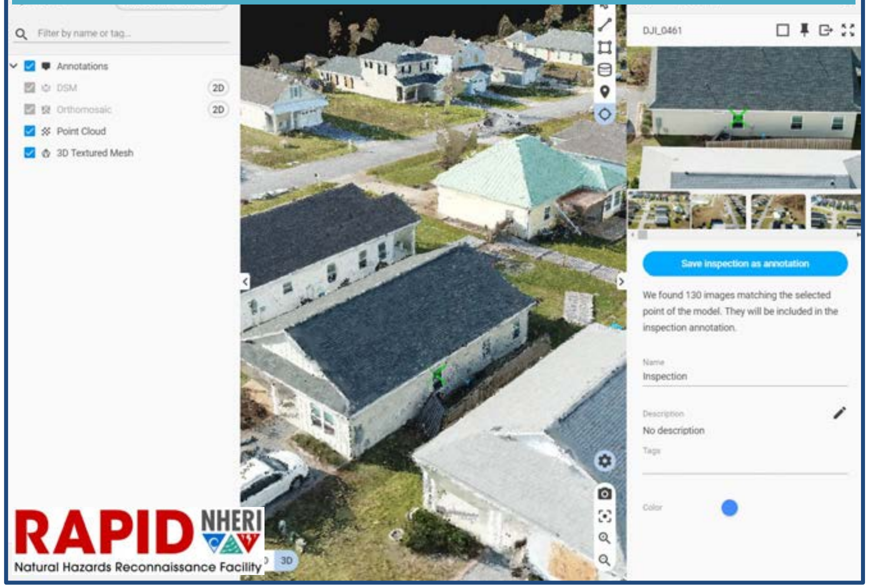
Type	SFR
Total Area	1,662
Heated Area	1,404
Exterior Walls	WD FR STUC
Roof Cover	COMP SHNGL
Interior Walls	DRYWALL
Frame Type	WOOD FRAME
Floor Cover	CARPET
Heat	AIR DUCTED
Air Conditioning	CENTRAL
Bathrooms	2
Bedrooms	3
Stories	1
Effective Year Built	2007

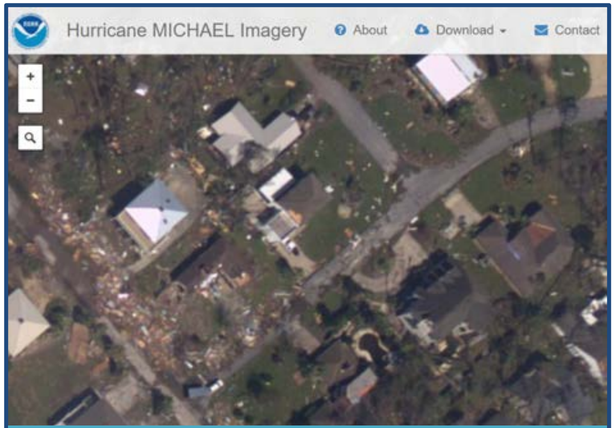
*Effective Year is simply the difference between economic life and remaining economi
The year is evident by the condition and utility of the structure.
The Effective Year may or may not represent the Actual Year Built.

Extra Features

Code	Description	Number of Items
0412	PORT. BLDG UTIL (*)	1
0261	PAVEMENT CONC (*)	1

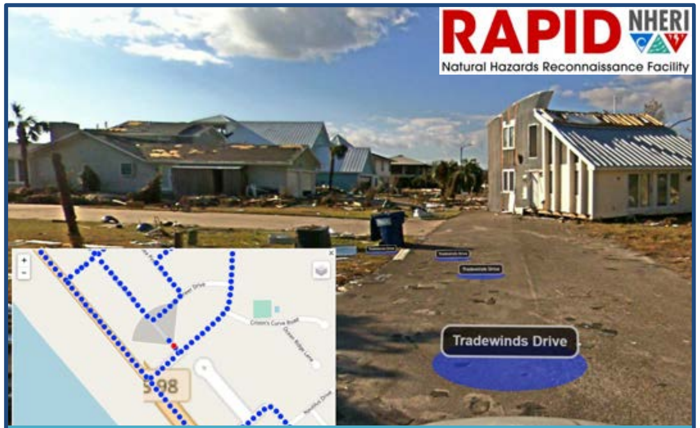
SfM Models / Point Clouds





Aerial Imagery

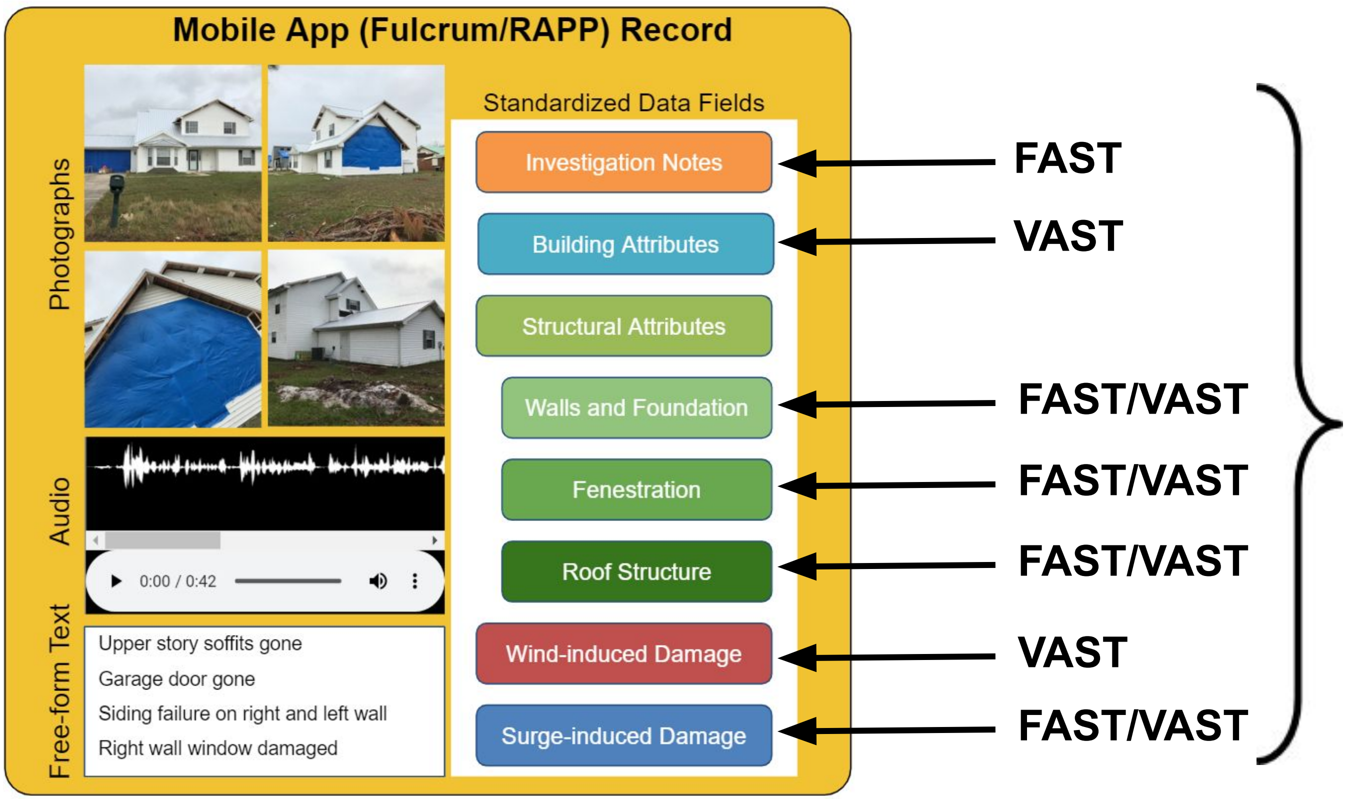
Pictometry



Streetview Panoramas

DATA ENRICHMENT AND QUALITY CONTROL

Field Priority data is captured by FAST on-site. Remaining data is collected by the VAST using the FAST data (all contained within the Fulcrum record) and any available supplemental data.



After all data is collected, VAST perform a rigorous Quality Control process on all data to ensure consistency, accuracy, and validity of the data.

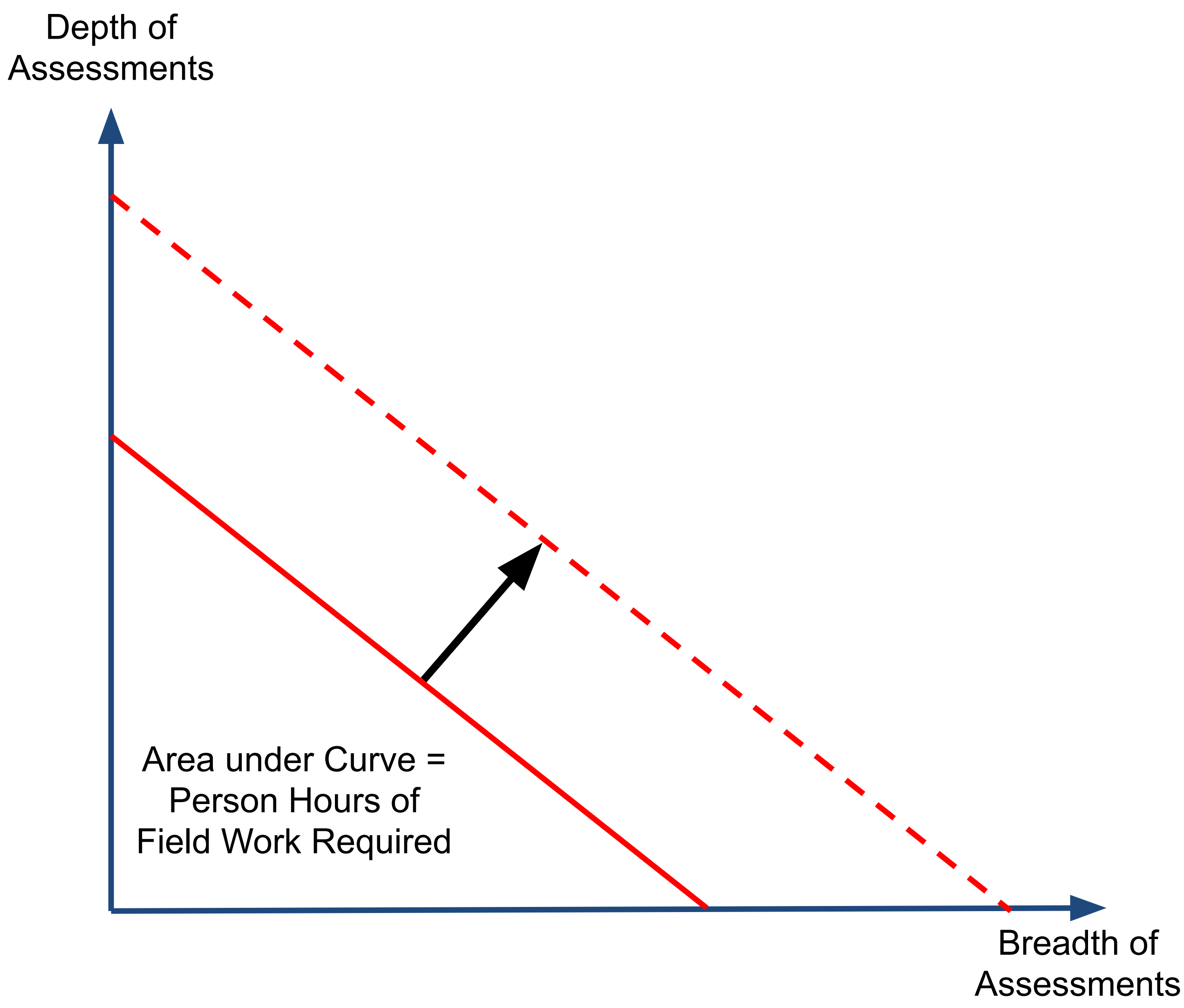
Data Enrichment and Quality Control (DEQC) process is an excellent training opportunity for StEER Level 1 and 2 members and students.

DATA ENRICHMENT AND QUALITY CONTROL

Stage	Purpose	Target Timeframe
1	Verify the location of the record.	1 week after FAST deployment completes
2	Validate or fill out the minimum fields that can be considered a complete record in accordance with the StEER data standards.	1-3 weeks after FAST deployment completes
3	Verify, update, or add missing information in the records for parameters that should be available through photographs, or supplementary data sources for the majority of records, e.g., damage ratios, building attributes.	3-6 weeks after completion of DE/QC Stage 1
4	Verify, update or add information that was not captured in the field and may not be available or applicable for all buildings. 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.	3-6 weeks after completion of Stage 1
5	Final QC validation and checks in preparation for curation on DesignSafe. Check for blank fields, inconsistencies (e.g., Gulf vs GULF County), etc.	6-7 weeks after completion of Stage 1

The goal of the DE/QC process is to curate and publish complete, accurate and standardized reconnaissance datasets in a timely manner for use by the broader structural engineering community.

StEER RECONNAISSANCE STRATEGY



BENEFITS OF STEER APPROACH

EARLY.

Swift deployment with pre-approved funding

Centralized event coordination with targeted sampling strategies

Network of regional nodes with access points

Tiered membership and capacity building initiatives

EFFICIENT.

Real-time collaboration and coordination, shared assets

Data standards, handbooks, templates, training resources

Streamlined data collection, reporting, curation workflows

Coordinated virtual reconnaissance support

IMPACTFUL.

Real-time open data sharing in Fulcrum

Expansive datasets with rigorous quality control and data enrichment

Robust dissemination and long-term curation promoting re-use, collaboration

Consistency through community-wide standards

ACKNOWLEDGEMENTS

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- CONVERGE node and wider Extreme Events consortium:
  - Geotechnical Extreme Events Reconnaissance (GEER)
  - Nearshore Extreme Event Reconnaissance (NEER)
  - Interdisciplinary Science and Engineering Extreme Events Research (ISEEER)
  - Operations and Systems Engineering Extreme Events Research (OSEER)
  - Social Science Extreme Events Research (SSEER)
  - NHERI RAPID equipment facility
  - NHERI DesignSafe CI
  - NHERI Network Coordination Office (NCO)
- Fulcrum Community
- Our members and their institutions

NHERI
Natural Hazards Engineering Research Infrastructure

Fulcrum

JOIN OUR EFFORTS

➢ Learn more at **www.StEER.network**

➢ Become a member:

- Create a DesignSafe account
- Activate your Slack account
- Complete membership form at **www.StEER.network**
- Review Member Guidelines and accept terms

➢ Monitor #steer channel on Slack, email announcements

➢ Training opportunities and event responses in 2020