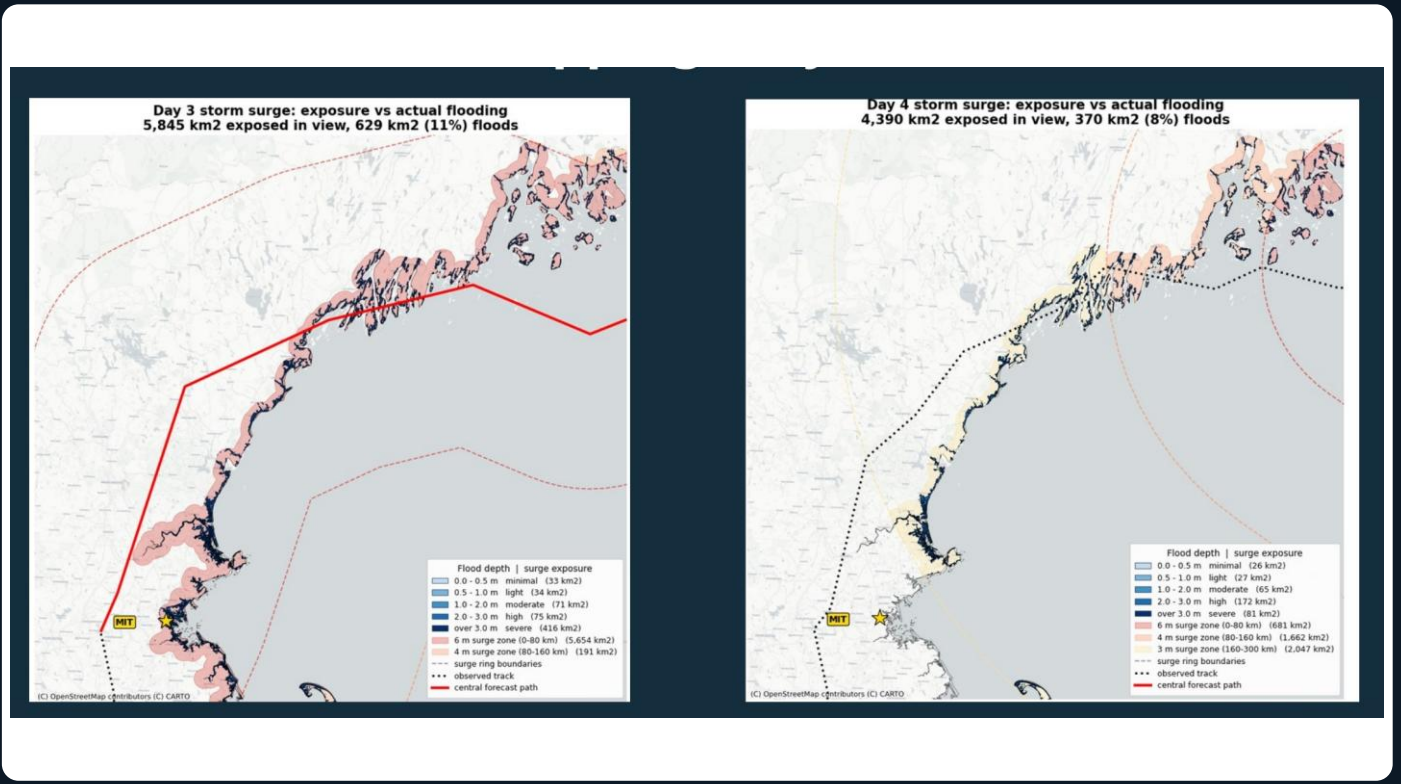
MIT BEAVER WORKS SUMMER INSTITUTE

Hurricane Claude

Mapping flood risk for disaster response



Cleo Balaranjith · Planning / Flood Mapping + Operations support

Student-team simulation | July–August 2026

What needed to be decided?

A storm track alone could not answer which areas would flood or who might need help.

20

ensemble tracks

per daily forecast

4

simulation days

new storm information

6 / 4 / 3 m

surge heights

distance-based bands

370 km²

modeled flooding

shown on Day 4

MY PRIMARY ROLE

Planning: flood mapping and geographic risk analysis

ADDITIONAL SUPPORT

Operations: imagery analysis and SAR tracking

From forecast to a usable risk map

Each layer answered a question the previous one could not.

01

Ensemble paths paths

Where might the center travel?

→

02

Surge bands

How far could water reach?

→

03

Terrain (DEM)

Where is land low enough to flood?

→

04

CDC SVI

Where does exposure overlap vulnerability?

→

05

Response maps

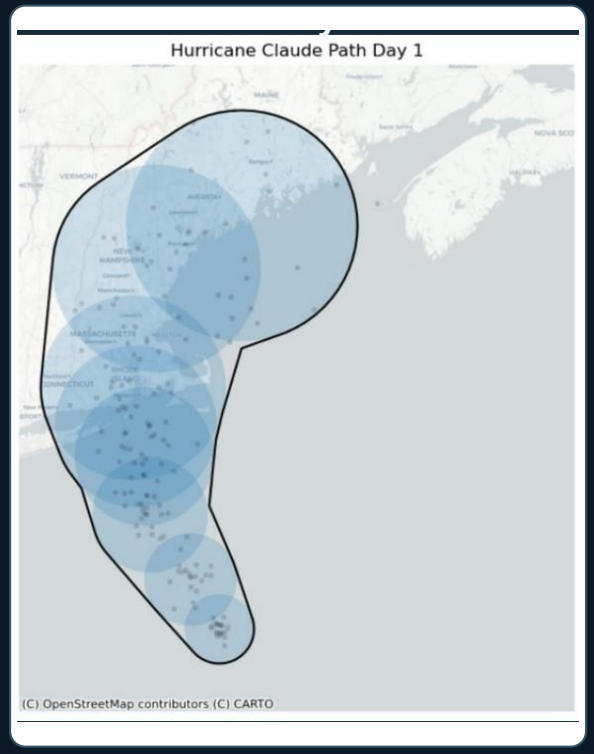
Which zones deserve attention?

Methods: Shapely / GeoPandas geometry, UTM 19N buffering, 30 m DEM analysis, SVI overlay

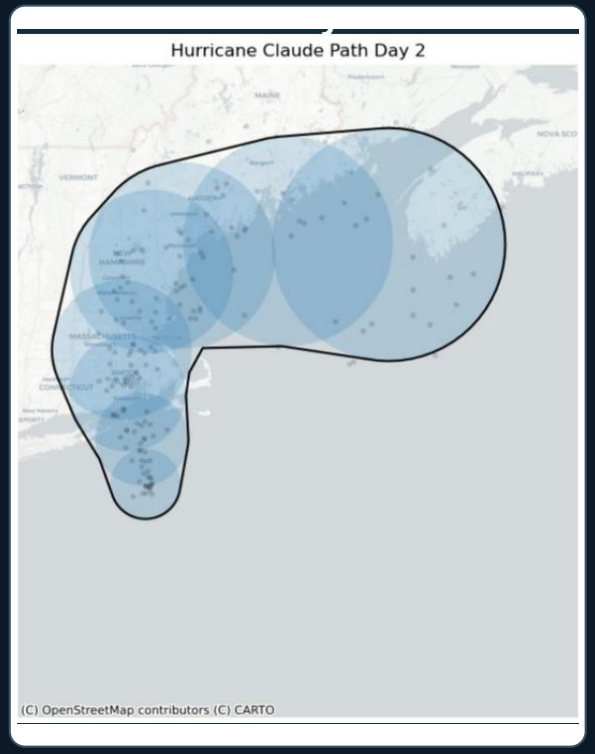
Twenty possible paths. One changing forecast.

Ensemble members were summarized into a central track; uncertainty did not disappear.

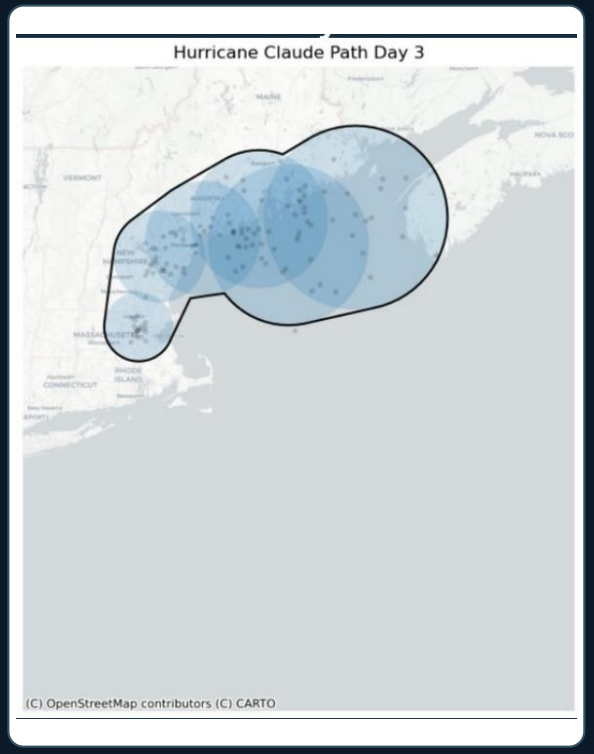
DAY 1



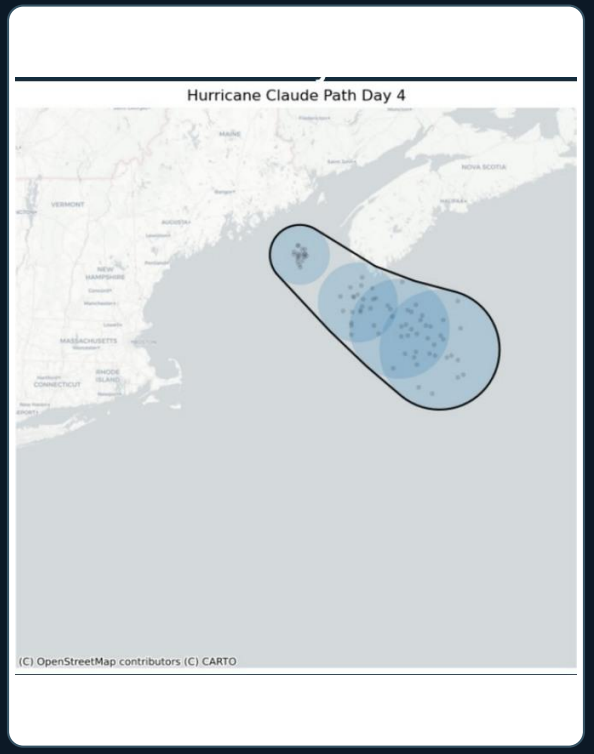
DAY 2



DAY 3



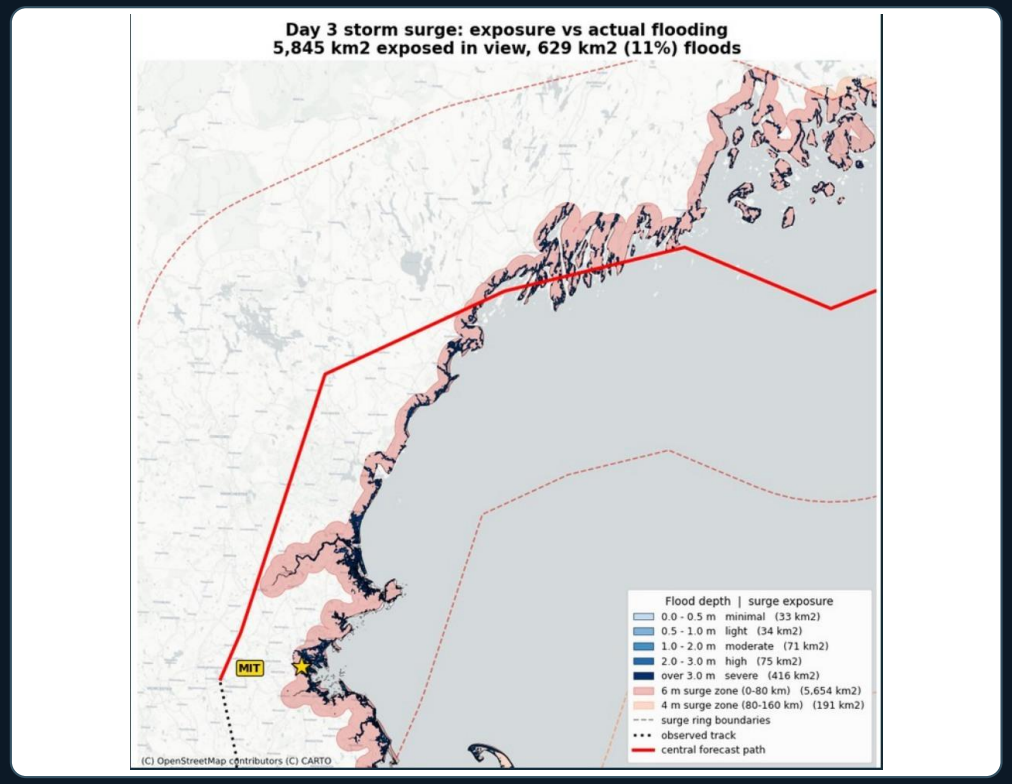
DAY 4



By Day 4, the forecasted storm had moved largely offshore. The planning maps changed with it.

Surge exposure ≠ actual flooding

Adding a digital elevation model removed large areas that were exposed but too high to flood.



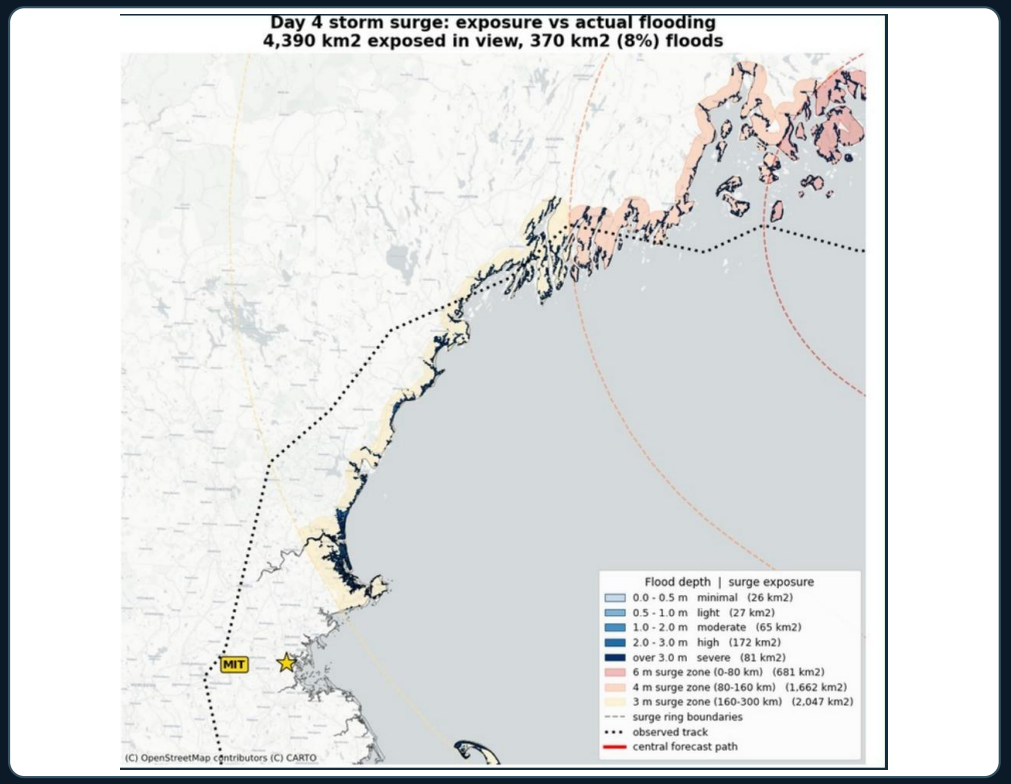
DAY 3

5,845

km² exposed

629

km² flooded

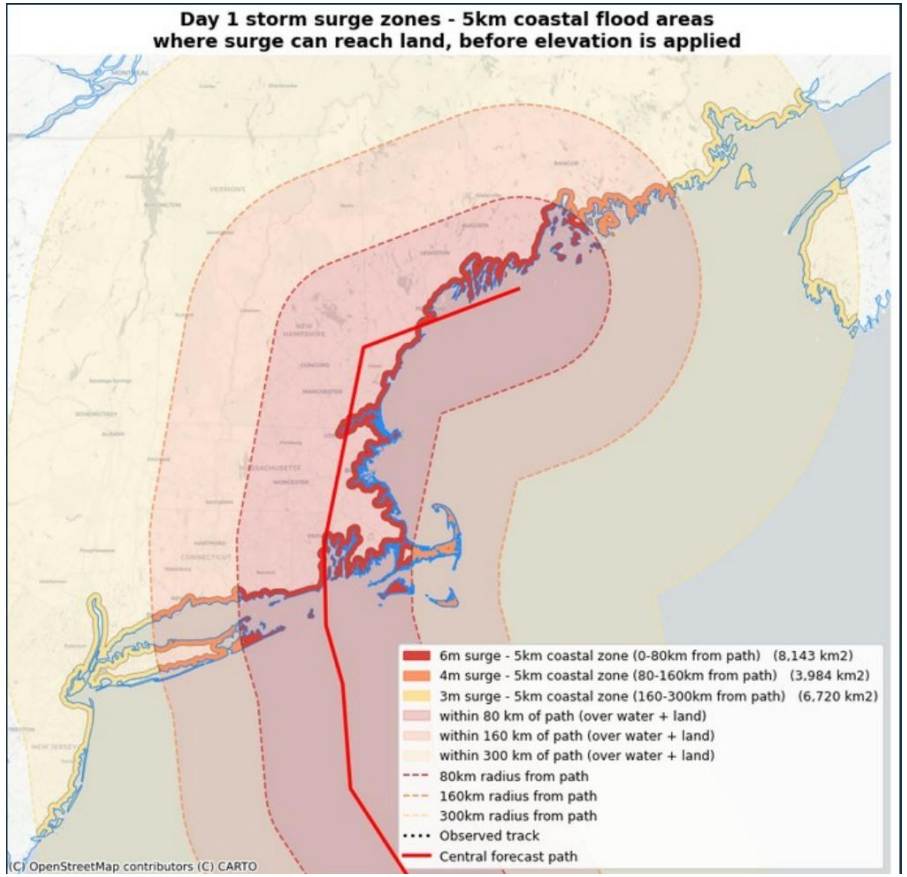


DAY 4 **4,390 km² exposed → 370 km² modeled flooding (8%)**

Figures are from the Planning Team map extent; simulation estimates, not observed damage.

The five-kilometer buffer looked wrong. It wasn’t.

Boston’s harbors, islands, and inlets changed how a correct distance looked on a map.



WHAT I CHECKED

01 Reprojected to UTM Zone 19N

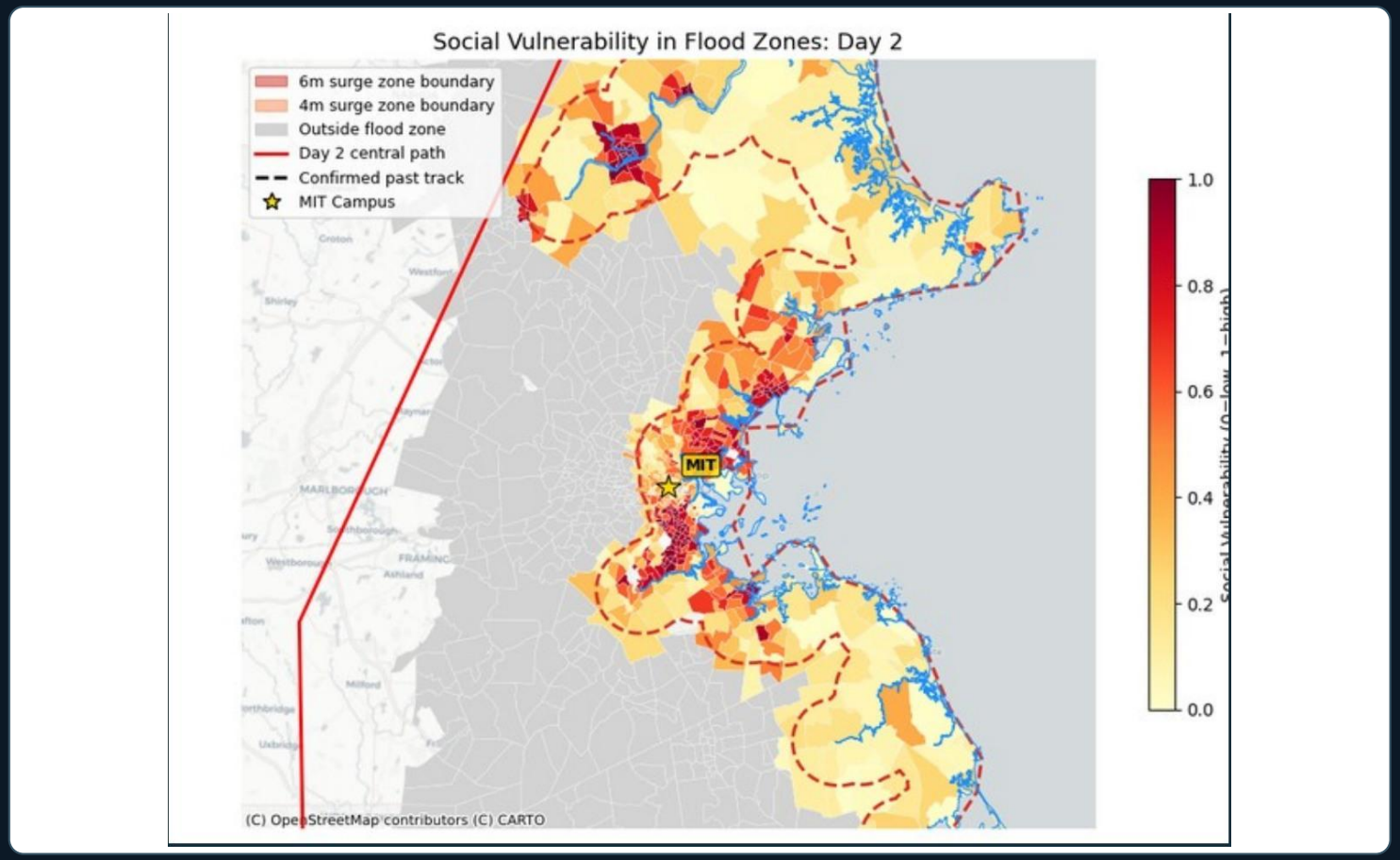
02 Verified the distance independently

03 Re-examined the coastline geometry

Overlapping buffers along narrow coastal features made the map look bigger than the math suggested.

Hazard mapping needs people in the picture

The CDC Social Vulnerability Index added context that the water layer could not show.



HOTSPOTS

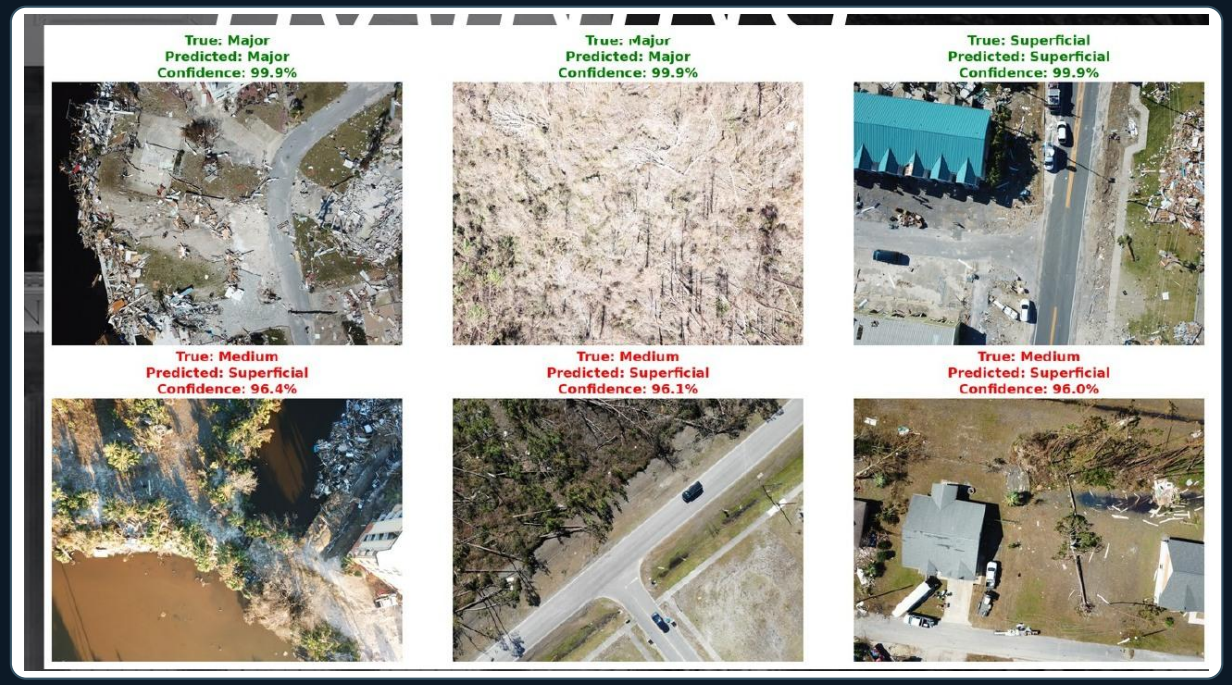
Chelsea
East Boston

The team’s overlays showed significant coastal exposure overlapping with higher social vulnerability.

SVI helps prioritize further investigation; it is not a substitute for local, real-time emergency information.

Supporting damage assessment with imagery

My main ownership was Planning; I also contributed to the Operations Team's image-analysis work.



TEAM DEEP-LEARNING WORK

ResNet-50 / ResNet-152

Damage classification on RescueNet and xView2 imagery

U-Net + Grad-CAM

Segmentation and interpretation of model attention

The source deck reports team model results. I do not present these as solo architectures or solo training results.

Tracking a ship through cloud cover

Synthetic aperture radar (SAR) offered a way to look through a storm when optical imagery could not.

83

SAR scenes

indexed by timestamp

VH + VV

radar channels

combined for detections

Land mask

false positives

reduced along coastline

8

positions

plotted and sanity-checked

WHY WE REVISED IT

Our first coordinates made an implausible zigzagging route. A plausible spatial track mattered more than the fact that the detector returned points.

What the maps actually established

A useful result is one you can explain, inspect, and qualify.

Flood geography

The DEM narrowed broad coastal exposure to lower-lying modeled flood zones.

Vulnerability overlap

East Boston and Chelsea emerged as locations needing particular attention.

Confidence in outputs

Both coastline buffering and SAR detections needed geographic sanity checks.

IMPORTANT LIMIT

A simulation, not a live live flood prediction.

The elevation-based bathtub model is a screening approximation. It does not resolve dynamic water flow or certify evacuation routes.

Full narrative: medium.com/tierra-insights/zoom-out-from-google-maps-to-remote-sensing-at-mit-bwsi-8da153228e6e