Revolutionizing Flood Forecasting for Resilience and Recovery: Statewide Insights

1:00 PM – 3:00 PM / Wednesday, June 11, 2025

- *Nick Charnas, PE, CFM, Director of Water Resources, Halff (Moderator)*
- *F. Warren McKinnie, PE, CFM, GISP, Senior Manager, Streamline Technologies*
- *Muthu Narayanaswamy, PhD, Director of Coastal and Compound Flood Risk, The Water Institute*
- *Ed Torres, PE, LEED AP, Utilities Director, Orange County*
- *Thomas Frick, Chief Resilience Officer, SJRWMD*
- *Scott Letasi, PE, PMP, Engineering & Project Management Bureau Chief, SWFWMD*

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Florida Stormwater Association Annual Conference

Revolutionizing Flood Forecasting for Resilience and Recovery: Statewide Insights

June 11, 2025

Nick Charnas, PE, CFM
Director, Water Resources

MEET **NICK**

21

Years Of Experience

NICK CHARNAS, PE, CFM

Director, Water Resources

Tampa, FL

- Nick brings over 21 years of expertise dedicated to managing and executing water resources/civil works projects focused on flood control and ecosystem restoration.
- A dedicated advocate for addressing sea level rise, Nick has worked in the development of model tools to assess community vulnerabilities and enhance capital project resilience.
- Nick has worked diligently with Florida municipalities and military to develop hydrodynamics models, obtain resiliency-focused funding, and design and construct flood protection projects that incorporate sea level rise risks and resiliency.

OUR PANEL OF EXPERTS

Tom Frick
St. Johns River Water Management District

F. Warren McKinnie, PE, CFM, GISP
Streamline Technologies

Muthu Narayanaswamy, PhD
The Water Institute

Ed Torres, PE, LEED AP
Orange County

Scott Letasi, PE, PMP
Southwest Florida Water Management District

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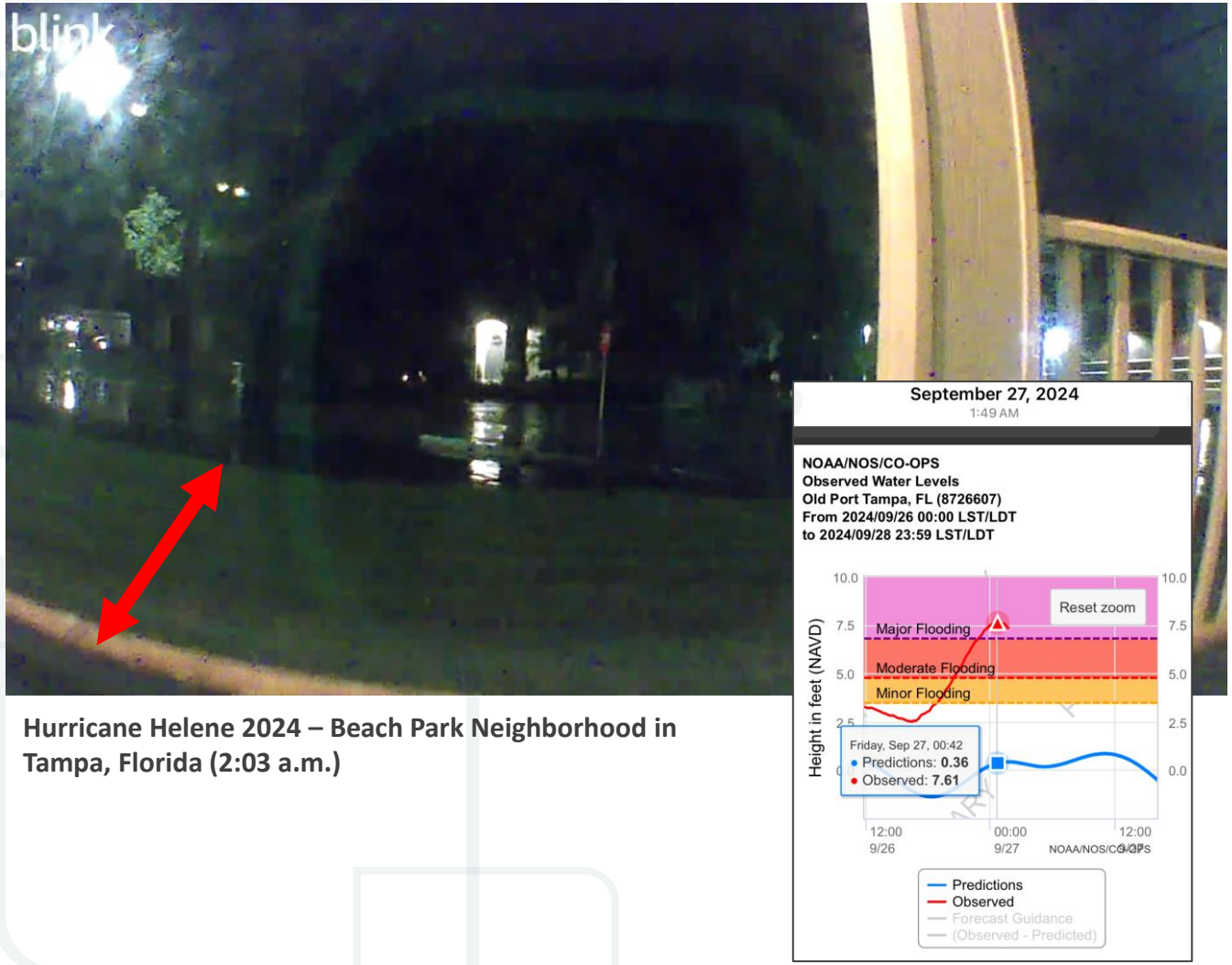
MORE EXTREME / FREQUENT WEATHER PATTERNS

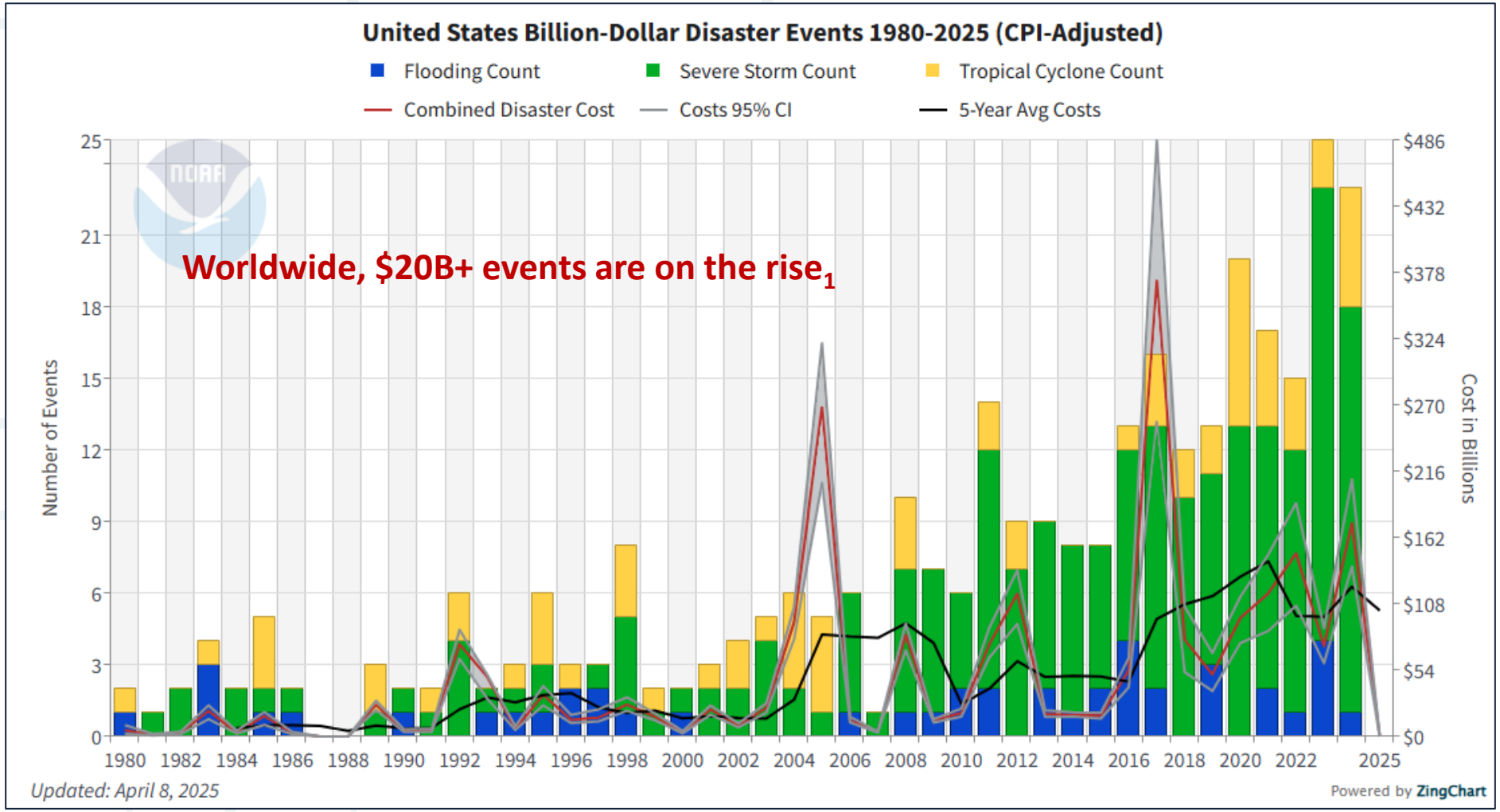


Hurricane Helene 2024 – Beach Park Neighborhood in Tampa, Florida (2:03 a.m.)

- Cost = $50B / year
- US fatalities = ~220 / year
- 5 - “billion dollar” tropical cyclones struck the US in 2024
- 1/3 of all "billion dollar" climate disasters have occurred in the last 5 years
- 23 – “billion dollar” storm/flooding disasters in US in 2024
- Hurricane Ian = $20B+ event in Florida in 2022

Source of Statistics: NOAA website (https://www.ncei.noaa.gov/access/billions/summary-stats)

MORE EXTREME / FREQUENT WEATHER PATTERNS

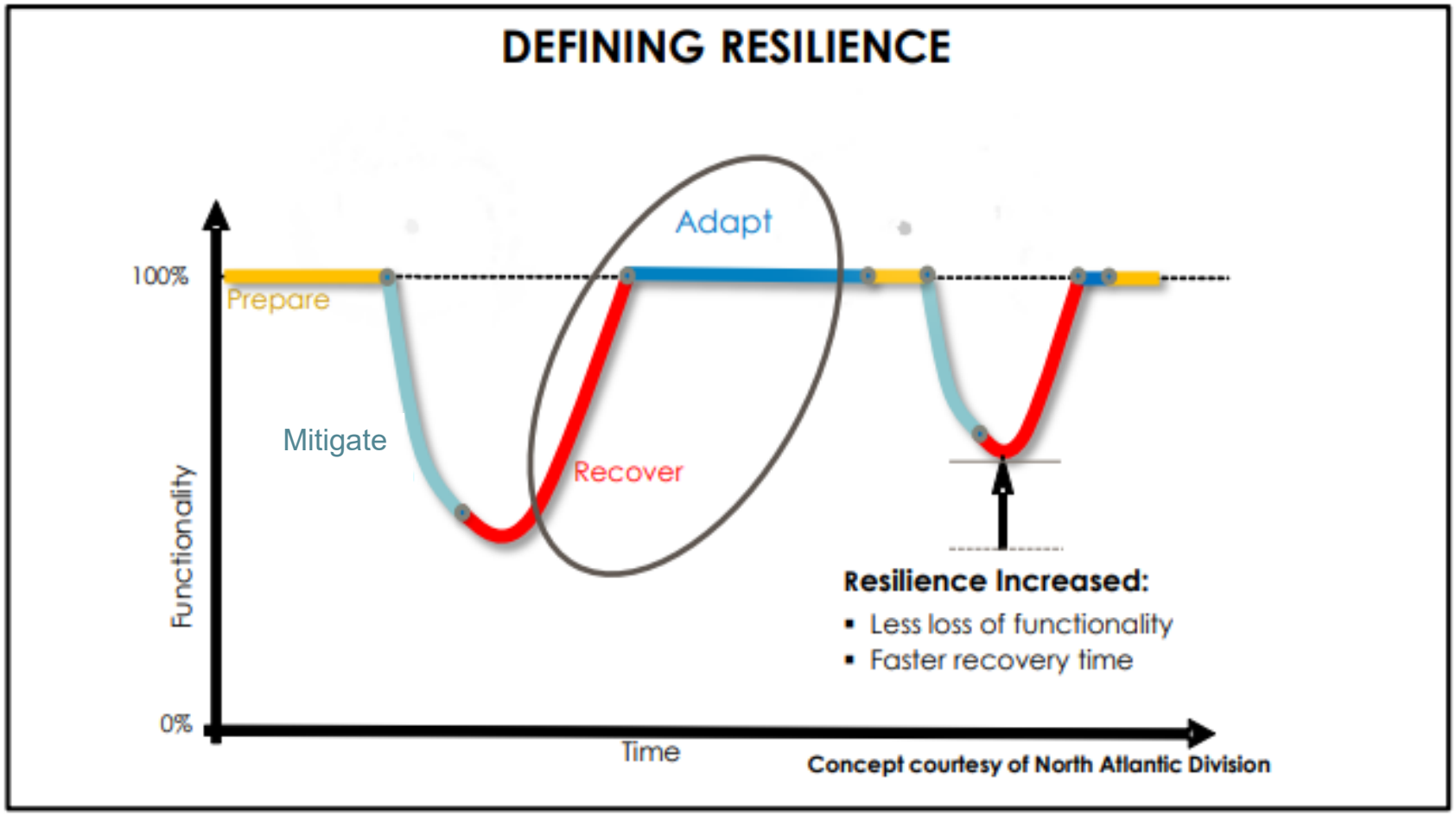


1. https://yaleclimateconnections.org/2022/10/world-rocked-by-29-billion-dollar-weather-disasters-in-2022/
2. https://www.ncei.noaa.gov/access/billions/time-series

FLOOD RISK IDENTIFICATION

Crowds panic as flooding threatens Ireland...

A FOCUS TOWARD RESILIENCY



Source: Adapted from a presentation: US Army Corps of Engineers Considerations for Climate Preparedness and Resilience, 01/27/2020, http://apps2.coj.net/City_Council_Public_Notices_Repository/20200127%20USACE%20presentation%20Resiliency%20Mtg.pdf

BUILDING COMMUNITY RESILIENCE
REAL TIME FLOOD FORECASTING TOOLS

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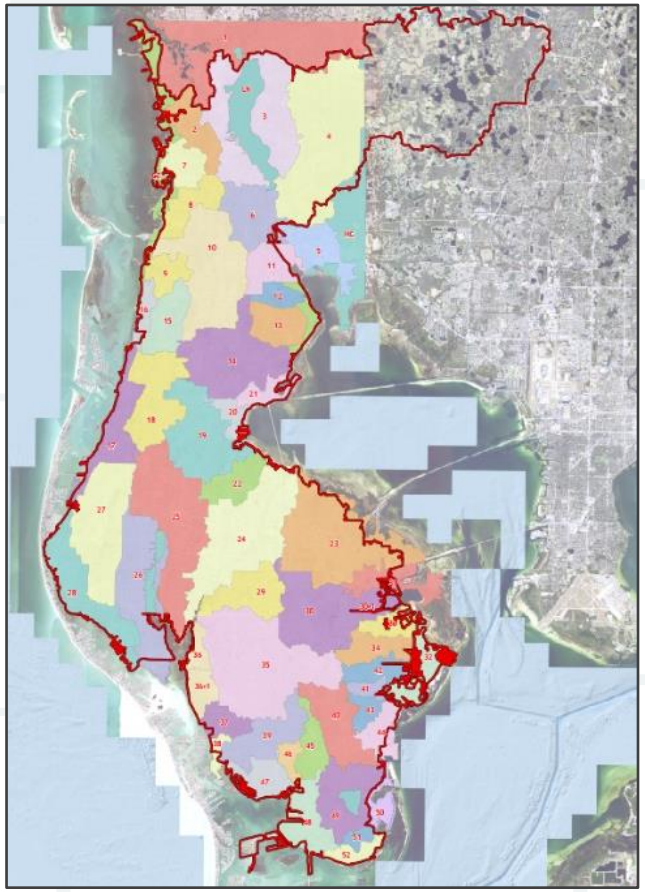
FLOOD FORECASTING

Flood forecasting involves using data and models to anticipate flood risks in advance

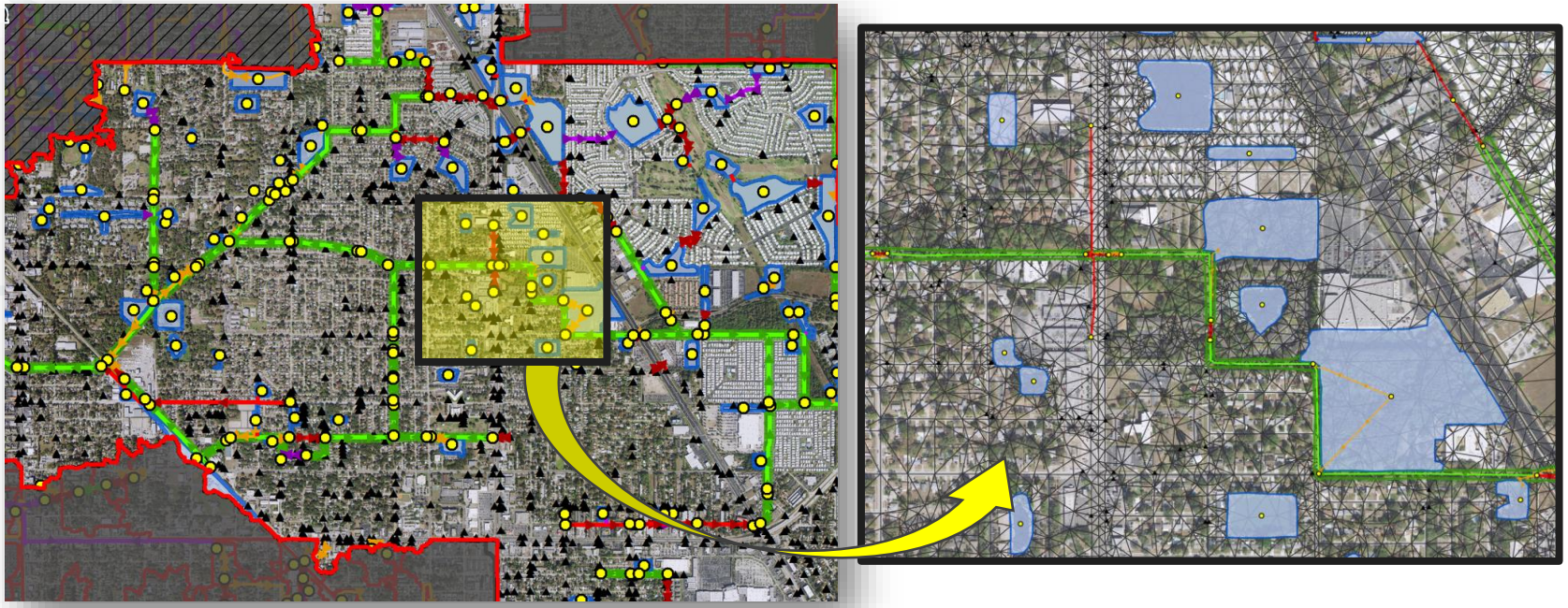
- Flood Inundation Mapping / Visualizations
- Real Time Flood Forecasting

FLOOD INUNDATION MAPPING / VISUALIZATIONS

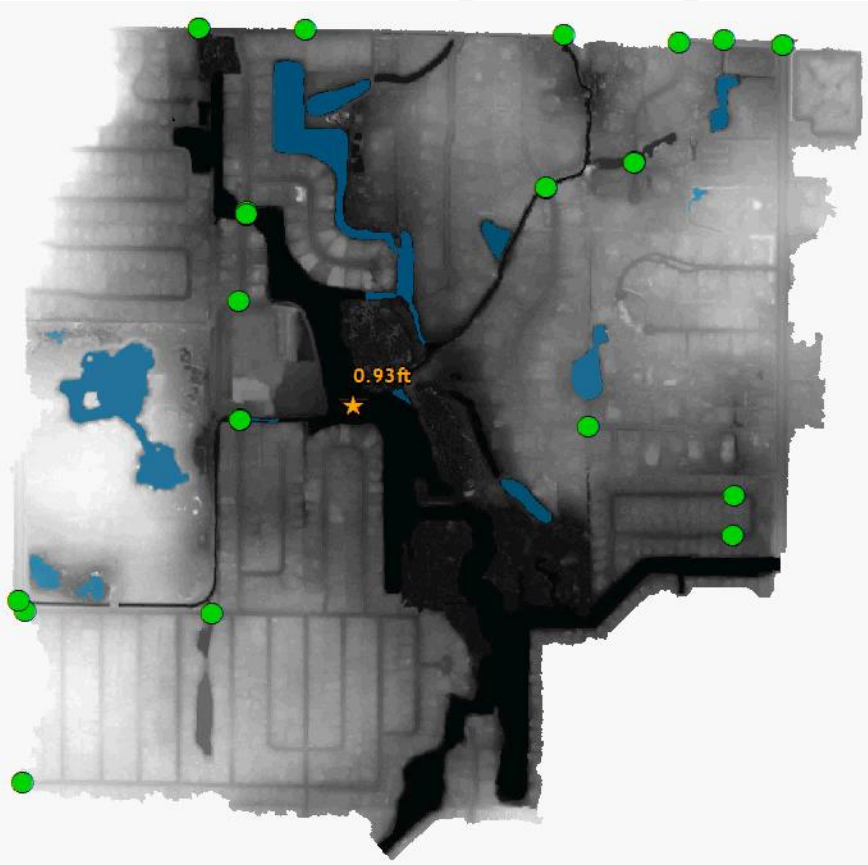


Pinellas Countywide Model Development and Flood Risk Mapping

- **270 mi^2** - 52 watersheds
- **Modeled: 206 mi^2** (extends outside county) - 14 ICPR models; 15 SWMM models
- **Unmodeled: 78 mi^2** - Rapid Flood Hazard Assessment Approach



FLOOD INUNDATION MAPPING / VISUALIZATIONS



- **Simulated 57 combinations of various storm scenarios**
- **Developed Risk Points – over 1M (roads, structures, etc.)**
- **Symbolized Flood Depths**
- **Developed Flood Inundation / Risk Animations – 30-min increments**
- **Correlated to Gage Locations**

= No Flooding

= Less than 3” Flooding

= Greater than 3” but less than 6”

= Greater than 6”

REAL-TIME FLOOD FORECASTING

What if we could predict flooding at the street and structure level 2-4 days before it occurs?

Prepare
More specific emergency management coordination

Mitigate
Advance actions to minimize risks, consequences, damages

Recover
Accelerate recovery by initiating specific recovery effort coordination earlier


(Source: 178wing.ang.af.mil)

High water vehicle – Hurricane Florence (Source: AP Photo/David Goldman)

- ✓ Anticipate road closures
- ✓ Pinpoint evacuations / notifications
- ✓ Move vehicles out of harm's way
- ✓ Smart sandbag & flood wall deployment
- ✓ Reduce or eliminate wastewater overflows
- ✓ Optimize water control structure operation
- ✓ Lower lake levels to create more storage
- ✓ Plan recovery efforts sooner

Source: The graphics on this slide were provided by Pete Singhofen, Streamline Technologies, Inc.

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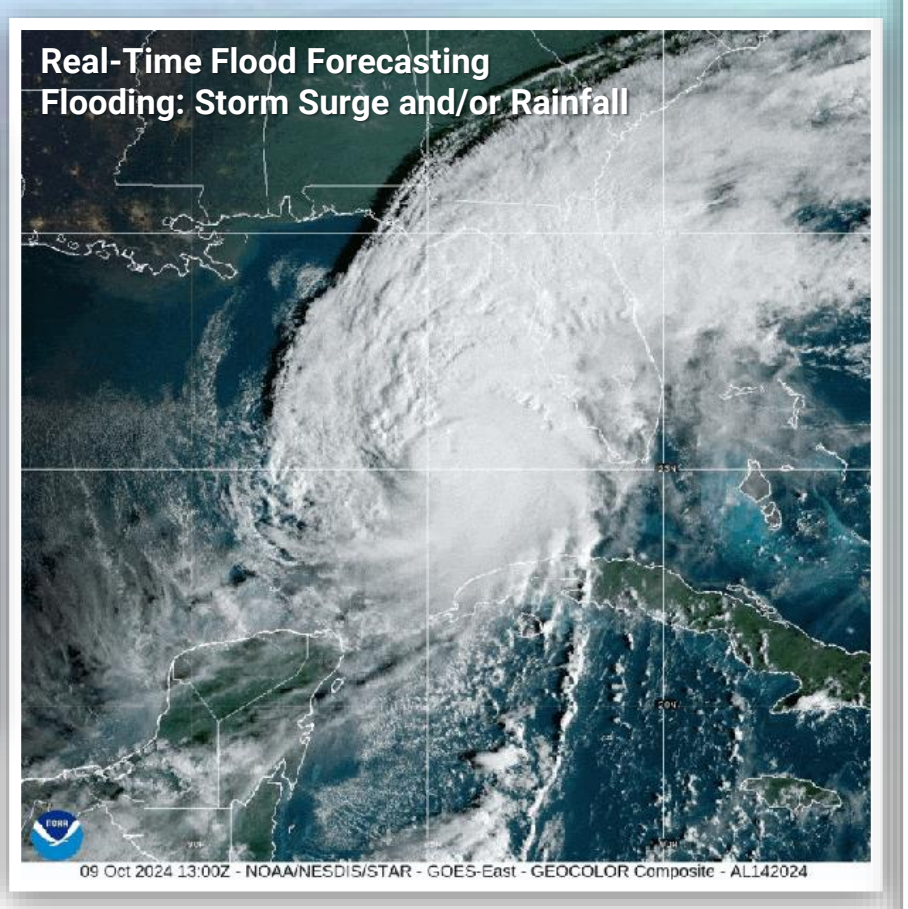
Real-Time Flood Forecasting for Resilience and Recovery: Statewide Insights

Presented by:
F. Warren McKinnie, PE, CFM, GISP
Senior Manager, Water Resources Engineering
June 2025

Moments Matter During Storm Preparation

Source: www.wusf.org/weather/2024-09-27/storm-surge-distant-helene-creates-major-problems-tampa-bay-area



Source: https://www.scientificamerican.com/article/hurricane-milton-spins-toward-florida-as-a-category-5-storm/

Source: https://knightnews.com/2022/09/hurricane-ian-leaves-apartment-complex-without-power-flooded-around-ucf/

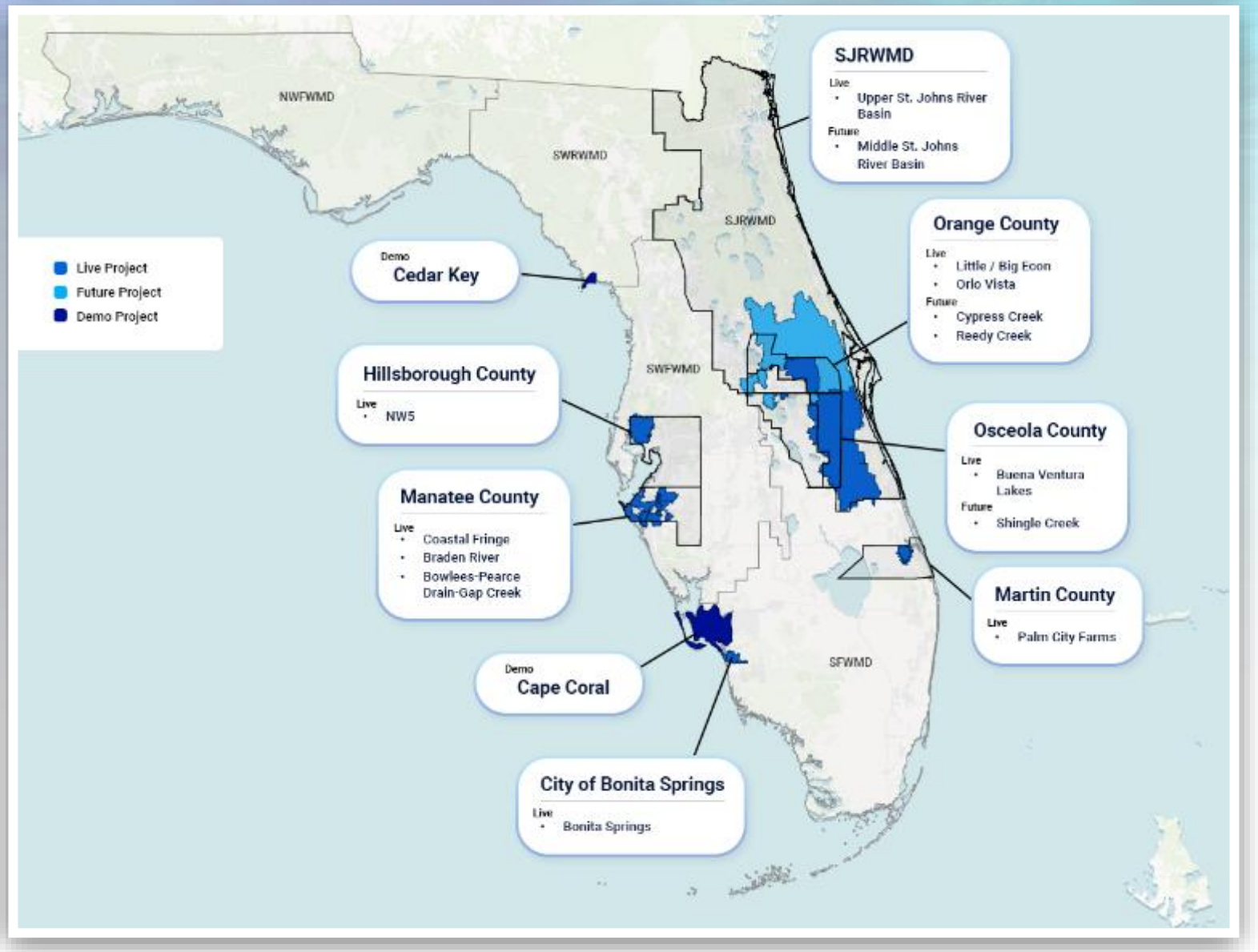
Agency Acceptance

Florida

- SJRWMD – FloodWise USJRB since 2021, MSJRB planned for FY'25
- SWFWMD – FloodWise planned for three major watersheds FY'25-26
- SFWMD – FloodWise staff training recently completed
- Current operational systems in Martin, Orange, Seminole, Manatee, Sarasota, and Lee Counties
- Making Communities Resilient

Florida FloodWise Systems

Future / Current



FloodWise

System Overview

Real-Time Flood Forecasting

At the Street Level

FloodWise™ | Streamline™ TECHNOLOGIES

- **Prepare**

  More specific emergency management coordination

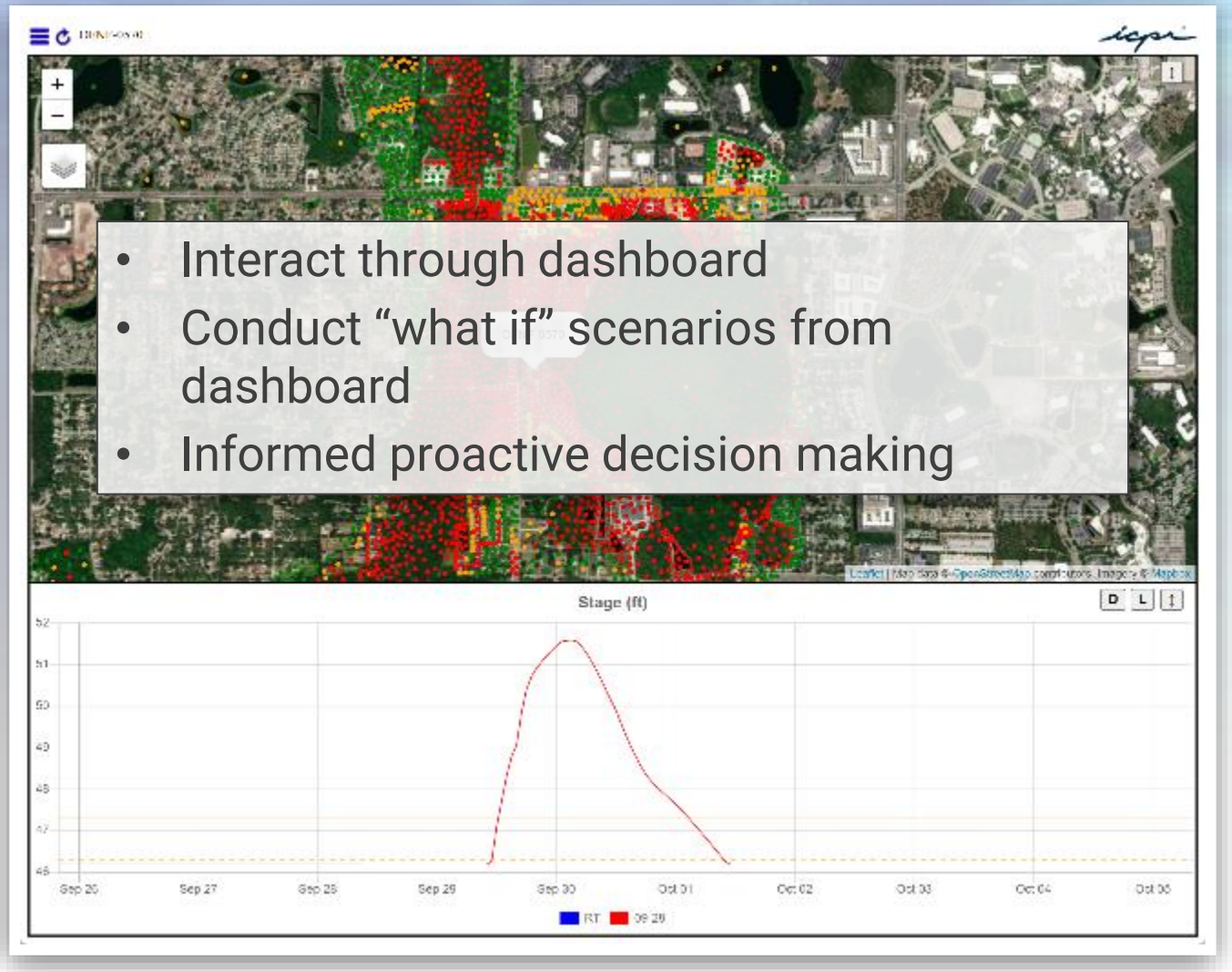
- **Mitigate**

  Advance actions to minimize risks, consequences, damages

- **Recover**

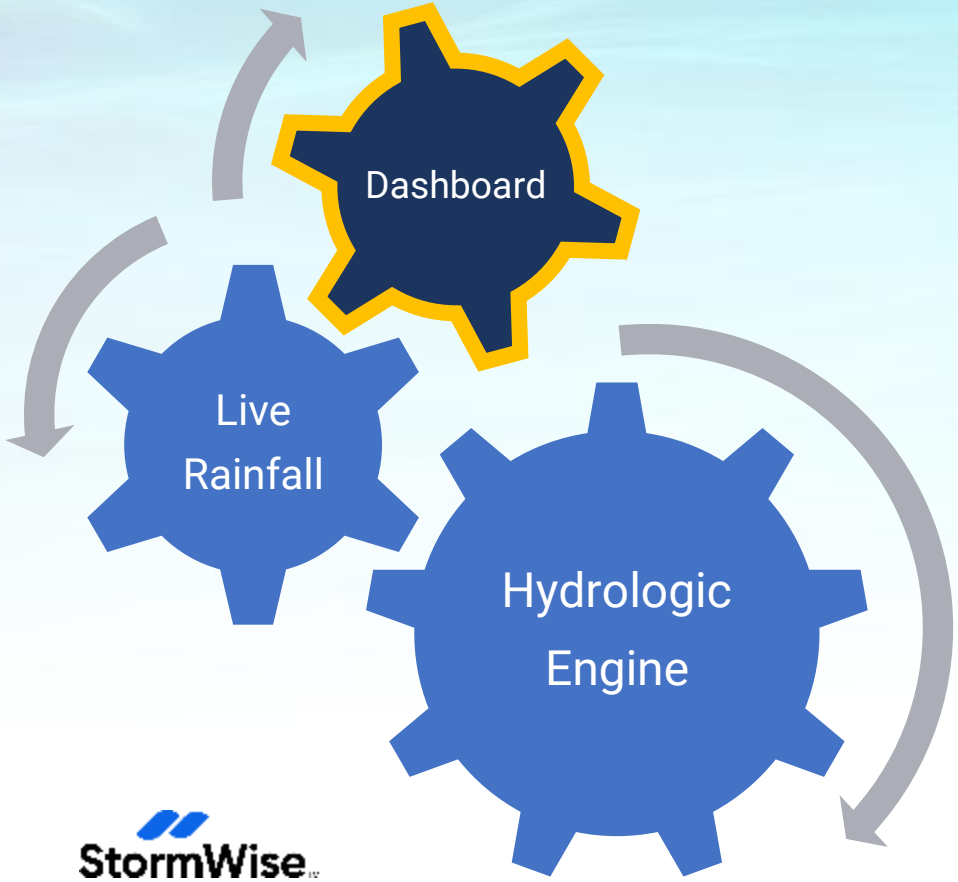
  Accelerate recovery by initiating specific recovery effort coordination earlier

FloodWise
Components



- Interact through dashboard
- Conduct “what if” scenarios from dashboard
- Informed proactive decision making

Green – No Flooding Orange – Shallow Flooding RED – Deep Flooding



StormWise
Powered By

FloodWise

Decision Support & Operational Tools

Decision Support & Operational Tool

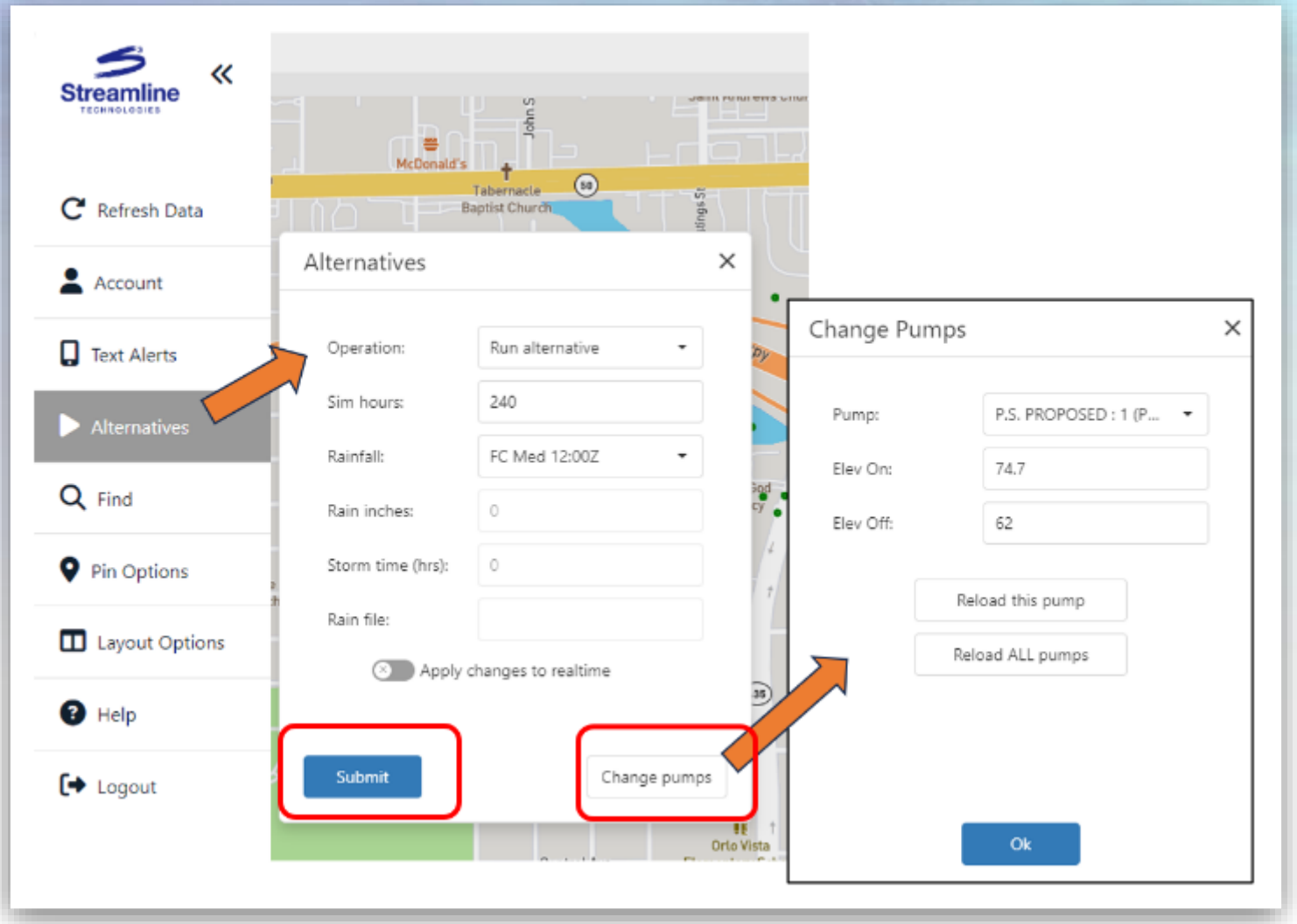
Orlo Vista, Orange County, FL

- Ability to focus recovery efforts following events based on forecast
- Advance actions to minimize risks, consequences, damages
- Additional time for resiliency efforts to protect critical infrastructure and lives
- Accelerate recovery by initiating specific recovery effort coordination earlier

Source: Streamline Technologies, Inc.

Decision Support & Operational Tool

Orlo Vista, Orange County, FL



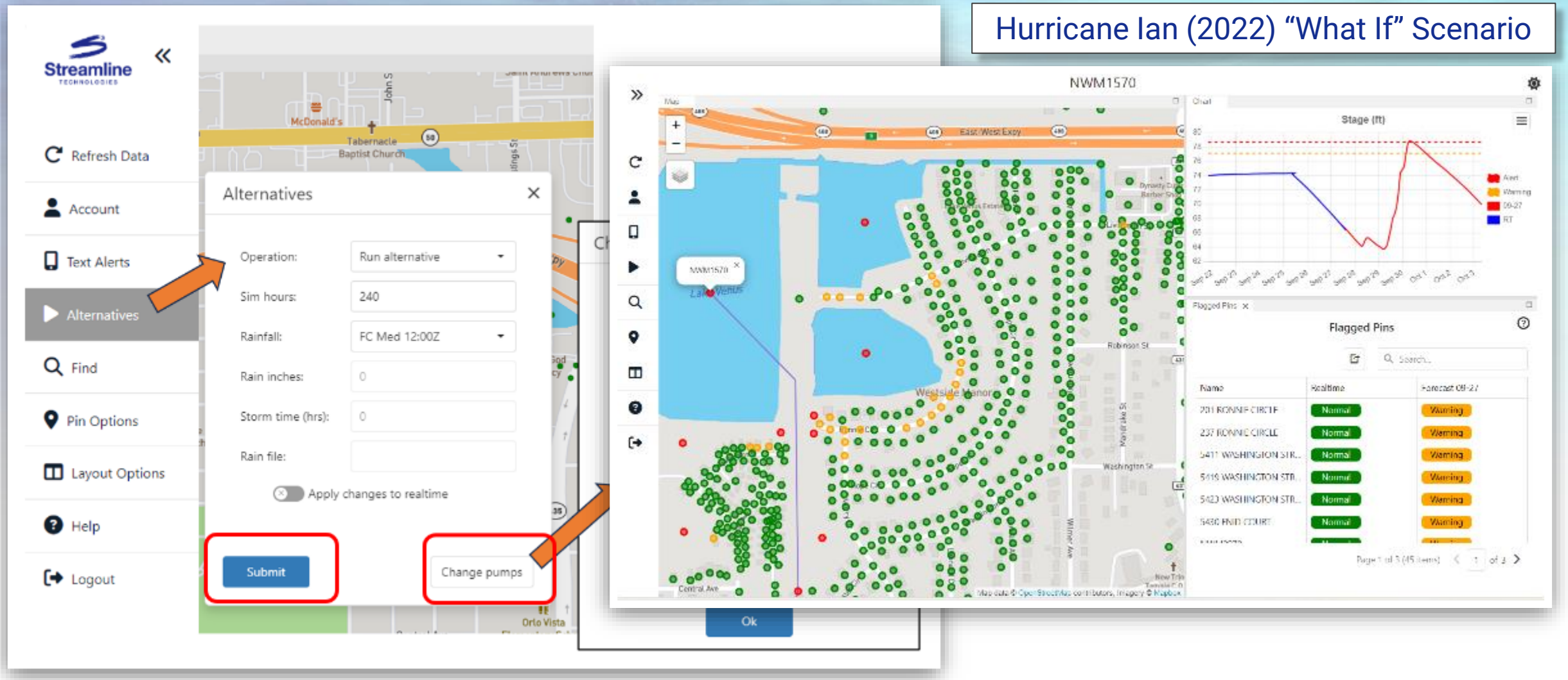
Hurricane Ian (2022) “What If” Scenario

Decision Support & Operational Tool

Orlo Vista, Orange County, FL

FloodWise | Streamline TECHNOLOGIES

Hurricane Ian (2022) “What If” Scenario



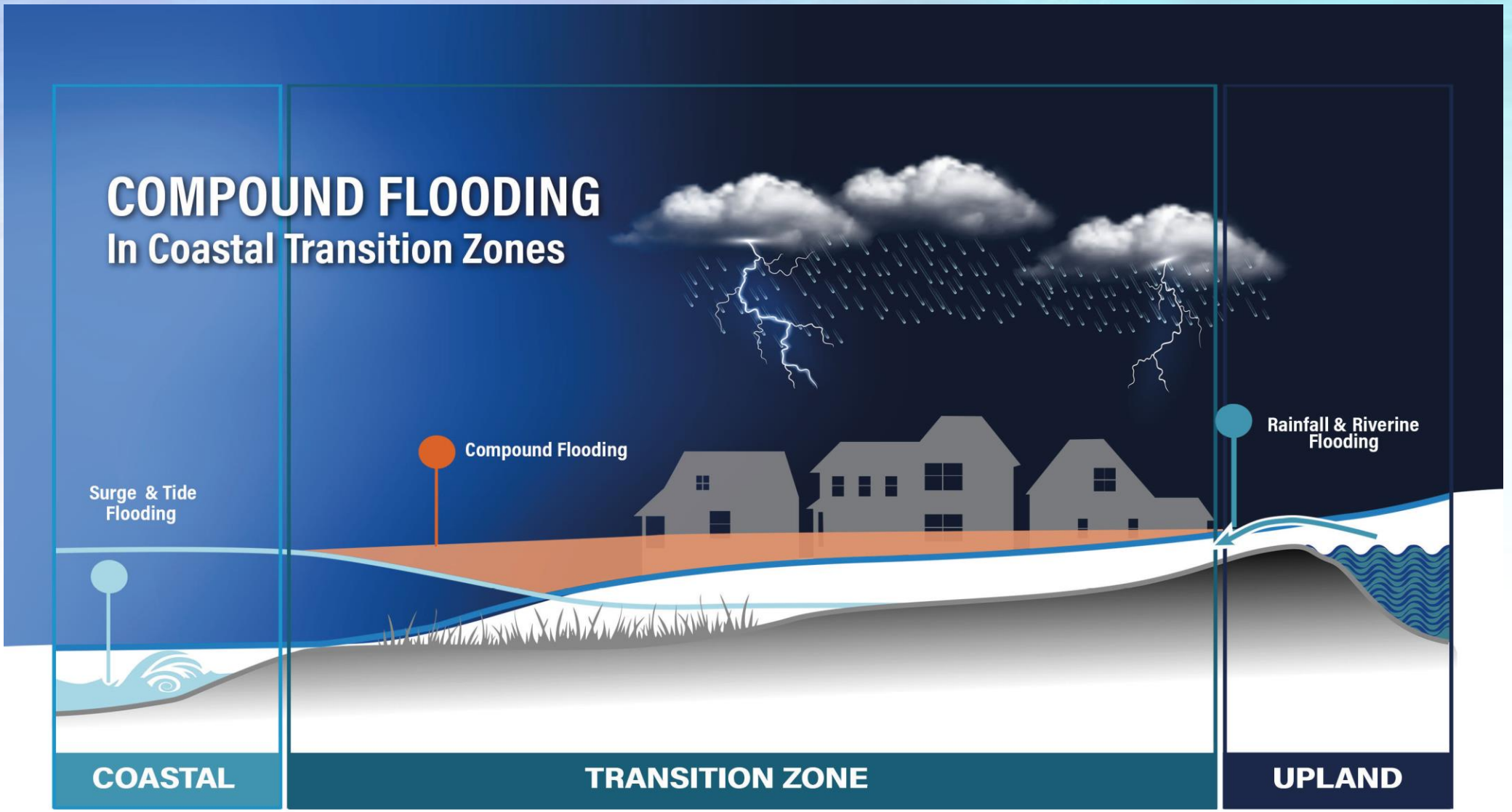
FloodWise

Case Study:

Hurricane Irma
Bonita Springs, FL

Compound Flooding

Bonita Springs, FL (Southern Lee County)

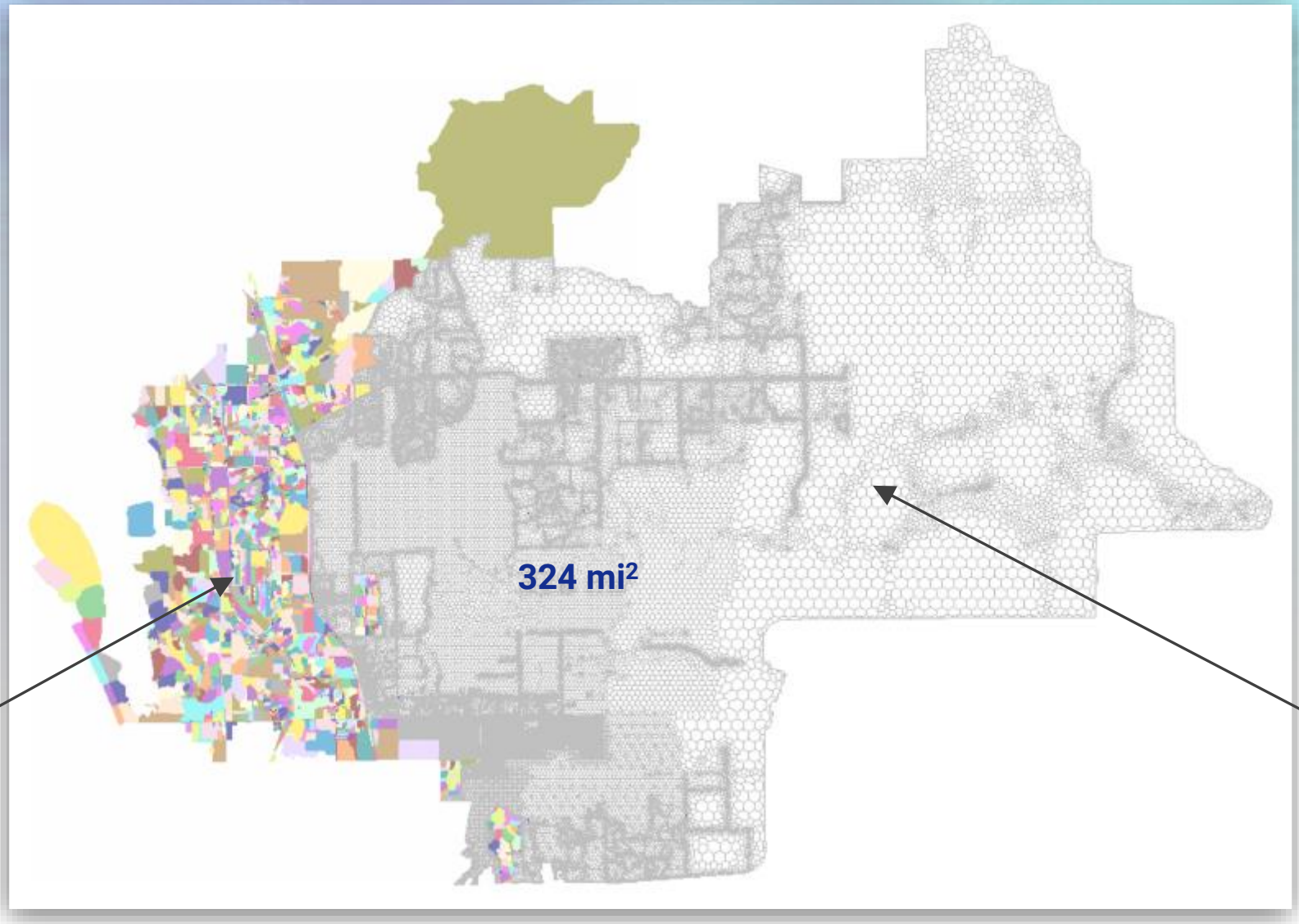


Case Study

Bonita Springs, FL (Southern Lee County)

StormWise™

Inland Hybrid H&H Modeling System

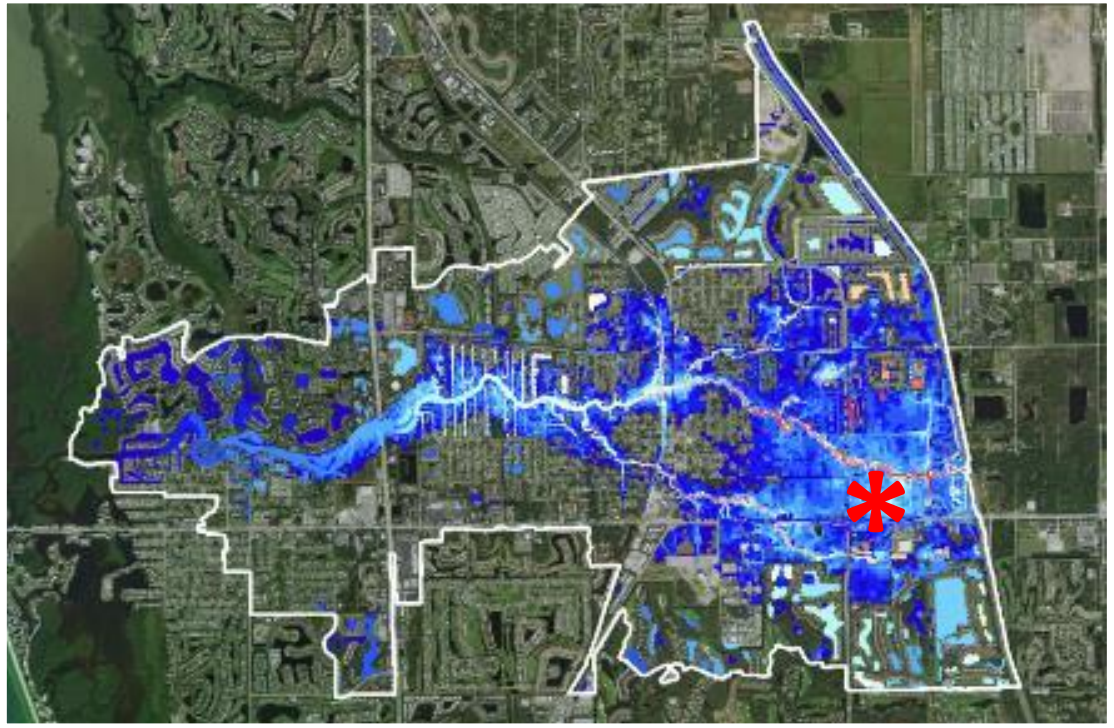


Case Study

Bonita Springs, FL (Southern Lee County)

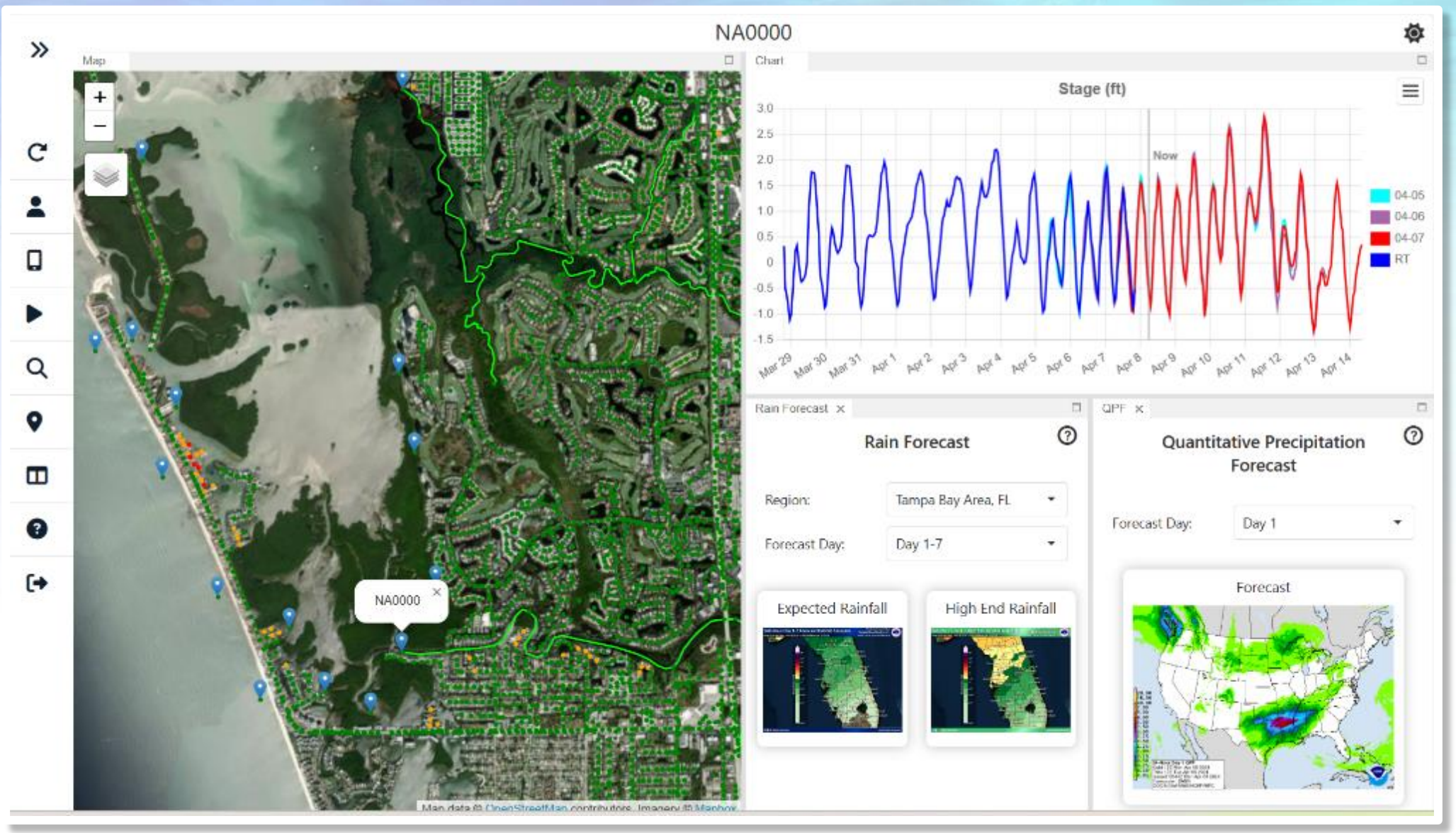
FloodWise™ | Streamline™ TECHNOLOGIES

Flooding Along the Imperial River
Hurricane Irma



Hurricane Irma (Sept. 2017)

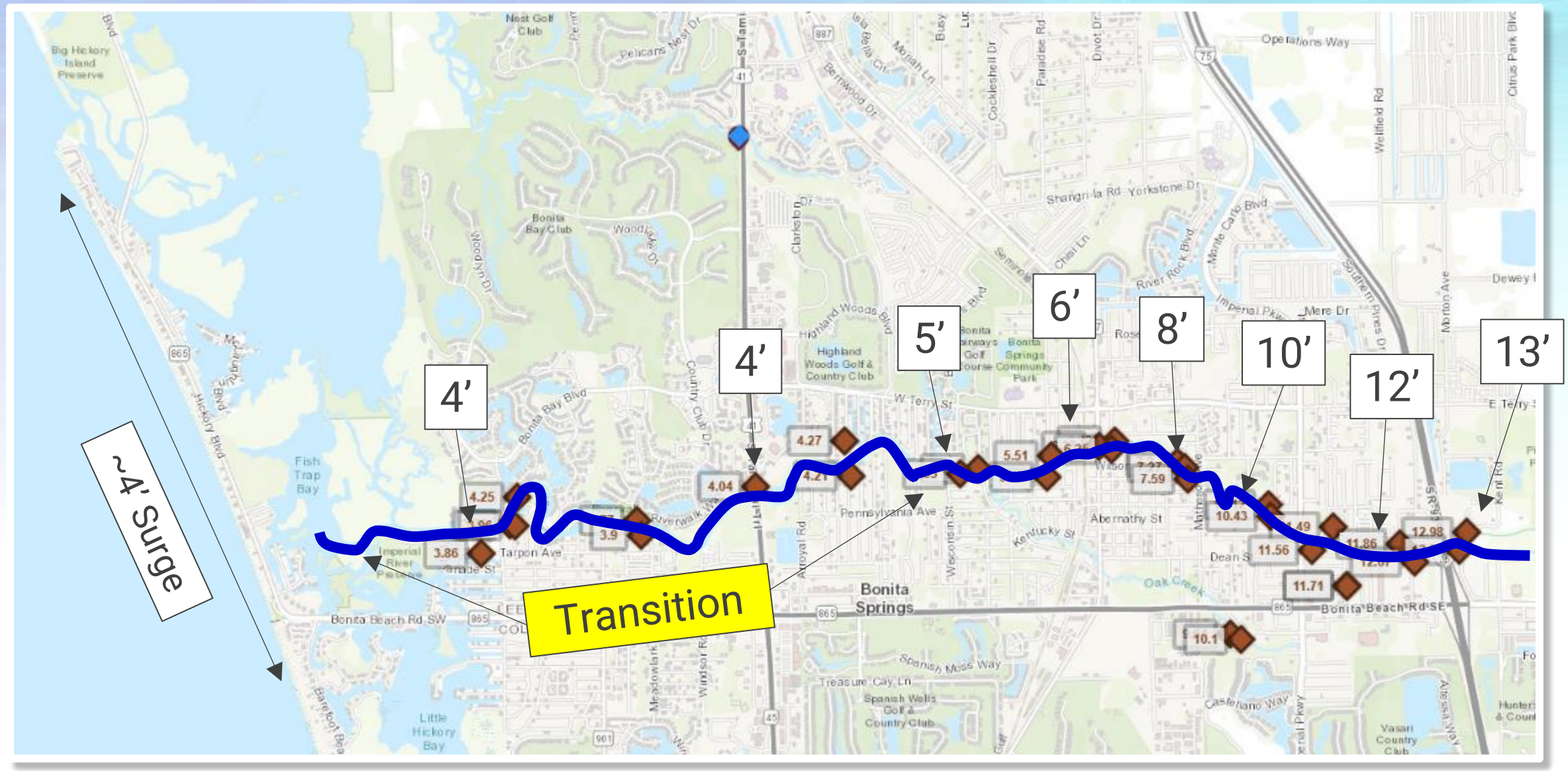
Imperial River; Bonita Springs, FL



Hurricane Irma (Sept. 2017)

Imperial River; Bonita Springs, FL

FloodWise | Streamline TECHNOLOGIES



FloodWise

Benefits

Potential and Observed Benefits

What if we could know 1 to 3 days in advance precisely where flooding will occur and how long it will last?

Real-Time Benefit

- Anticipate road closures
- Pinpoint evacuations
- Move vehicles/resources out of harm's way
- Smart sandbag & flood wall deployment
- Reduce or eliminate wastewater overflows
- Optimize water control structure operations/maximize storage
- Plan recovery efforts sooner and preposition response assets
- Making communities more resilient

Benefits with Advance Warning Minor Flooding

Central Florida

(Predicted 42 Hours in Advance)

The Place at Alafaya

Arden Villas

(Photo Credits: Ricardo Ramirez Buxeda, Orlando Sentinel, Sept. 30, 2022)

How many cars were lost that could have been easily moved? 100? 200?

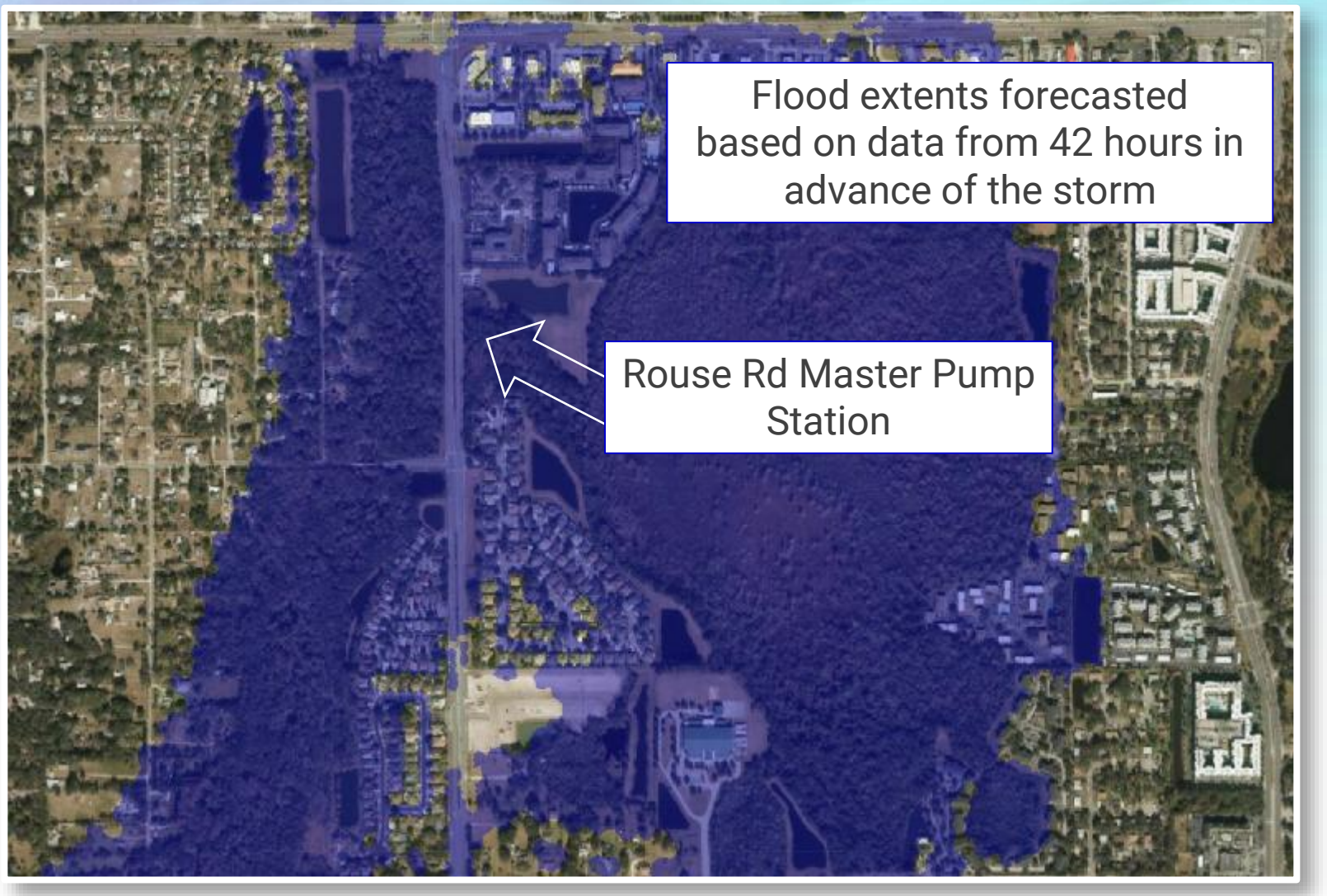
Cost: 200 x $10K / car = $2M

Insurance Claims Reduced or Avoided

FloodWise

Fiscal Benefits Example

- The Rouse Rd Master Wastewater Pump Station sustained about $7 million in damage during Hurricane Ian
- If RTFF model had been in place, the pump station could have been protected with a tiger dam and the damage prevented or mitigated



Streamline™ TECHNOLOGIES

Real-Time Flood Forecasting for Resilience and Recovery: Statewide Insights

Thank You!

Presented By:

F. Warren McKinnie, PE, CFM, GISP

CustomerSuccess@Streamline.tech

407.679.1696

StormWise™ | FloodWise™

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THE WATER INSTITUTE

FLOODID AND SAFE ROADS: INTEGRATED FORECASTING AND SITUATIONAL AWARENESS USING RESPONSIBLE AI

Muthu Narayanaswamy

Jun 11th 2025

THE MISSION + THE METHOD

SCIENCE
Solving complex societal and environmental challenges with transdisciplinary research

SOLUTIONS
Innovative, solution-driven tools for a dynamic world

STANDARDS
Identifying and advancing methods, approaches, and policies for wide-scale adoption

THE VISION

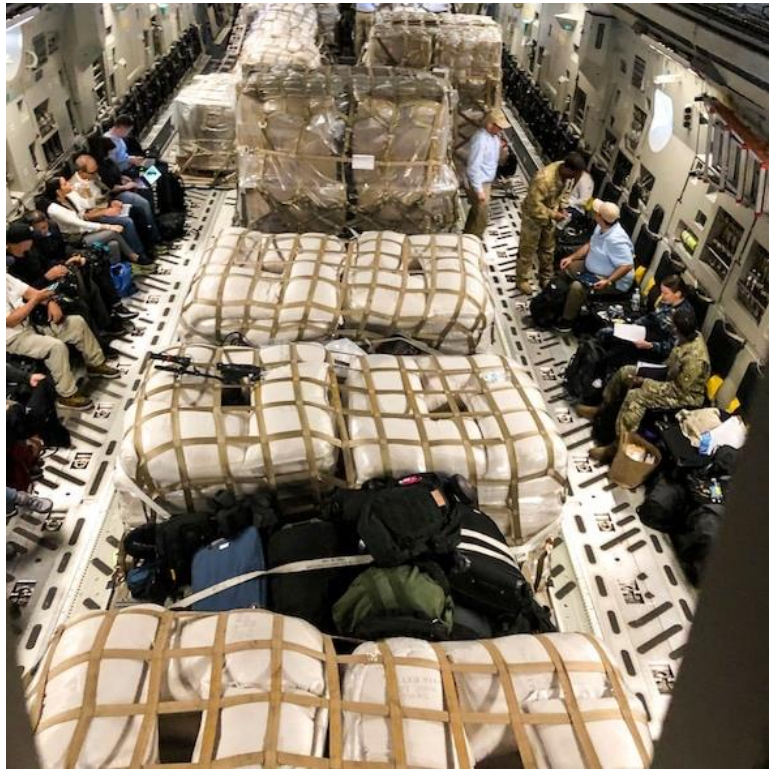
RESILIENT & EQUITABLE COMMUNITIES

SUSTAINABLE ENVIRONMENTS

THRIVING ECONOMIES

NEED BETTER, ACTIONABLE INFORMATION TO MAKE DECISIONS ON

Positioning supplies



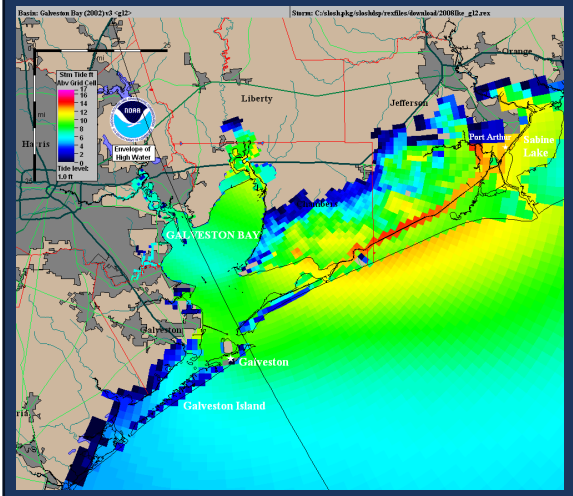
Identifying access restrictions

Prioritizing search and rescue

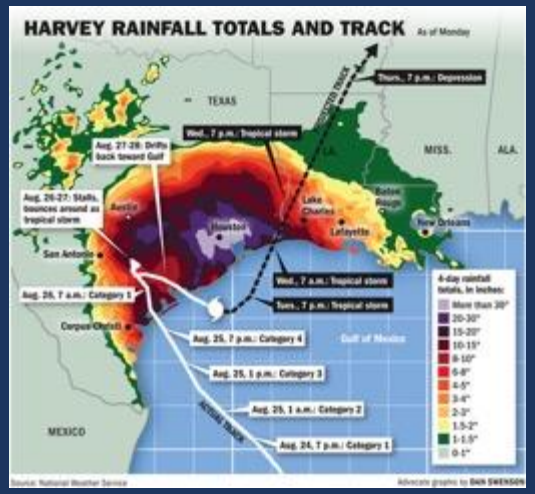
RICE

VARYING FLOOD HAZARD AWARENESS NEEDS

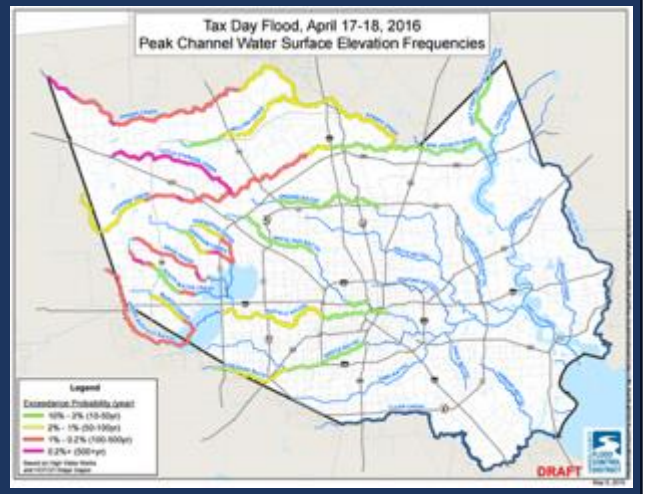
FORECASTS AND HINDCASTS



Hurricane Planning and Response

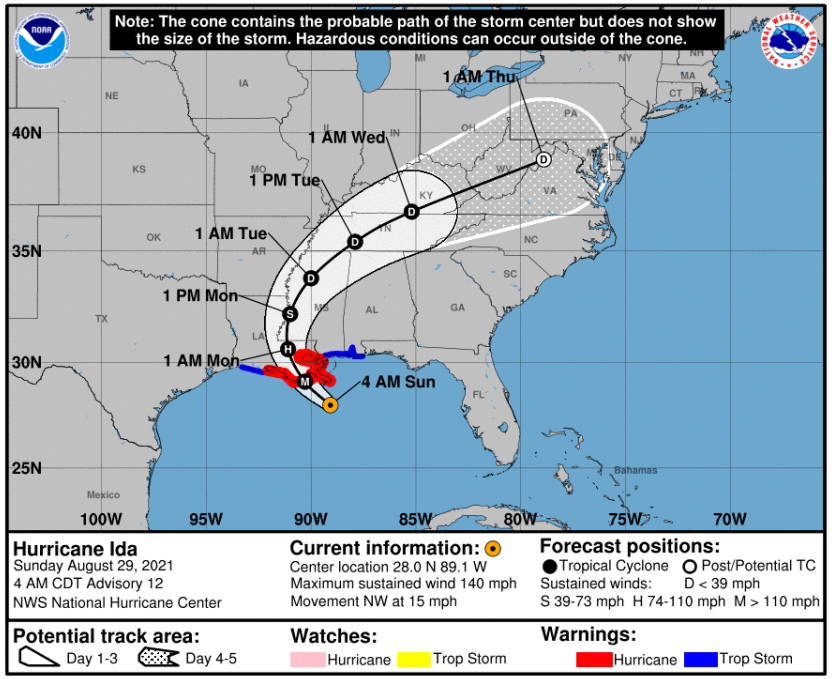


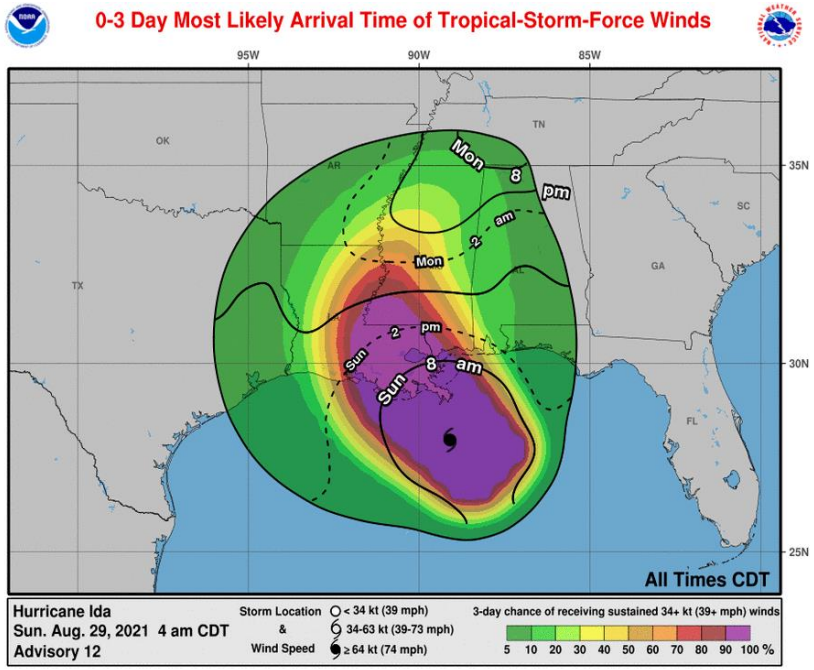
Compound Flood

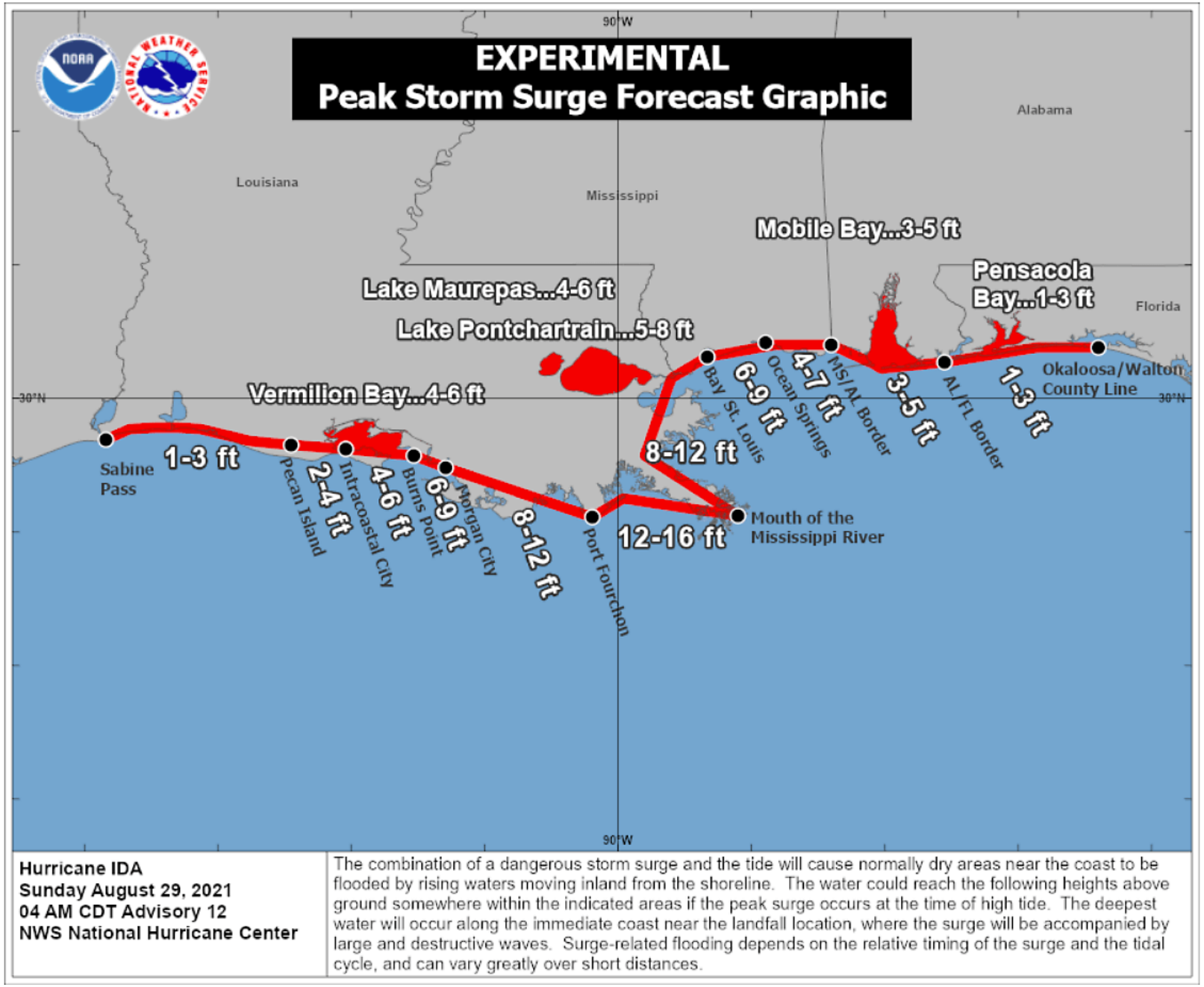


Extreme Rainfall Flood Forecast

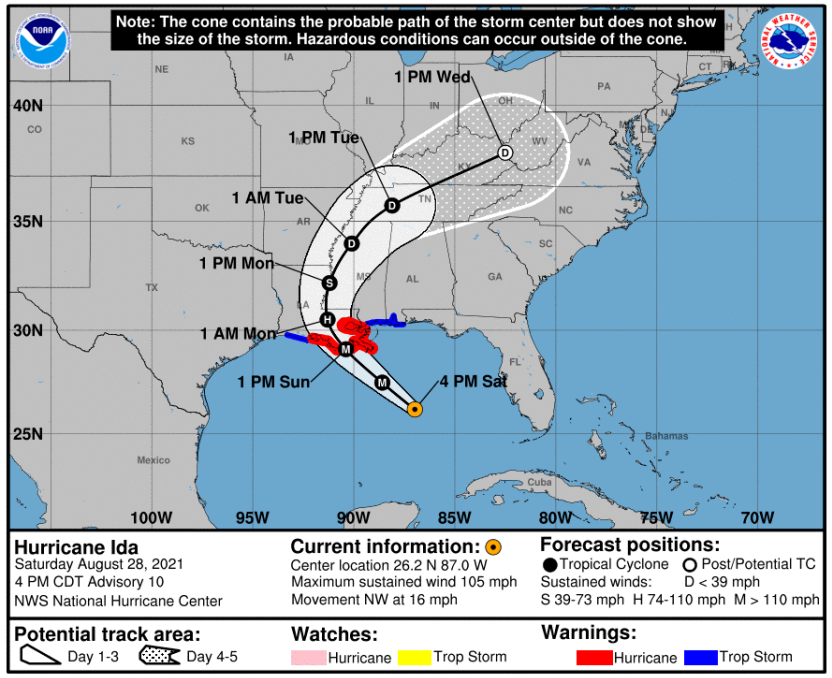
NOWCASTS


Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.
1 AM Thu
1 AM Wed
1 PM Tue
1 AM Tue
1 PM Mon
1 AM Mon
4 AM Sun
40N
35N
30N
25N
100W
95W
90W
85W
80W
75W
70W
Hurricane Ida
Sunday August 29, 2021
4 AM CDT Advisory 12
NWS National Hurricane Center
Current information:
Center location 28.0 N 89.1 W
Maximum sustained wind 140 mph
Movement NW at 15 mph
Forecast positions:
Tropical Cyclone
Post/Potential TC
Sustained winds:
D < 39 mph
S 39-73 mph
H 74-110 mph
M > 110 mph
Potential track area:
Day 1-3
Day 4-5
Watches:
Hurricane
Trop Storm
Warnings:
Hurricane
Trop Storm

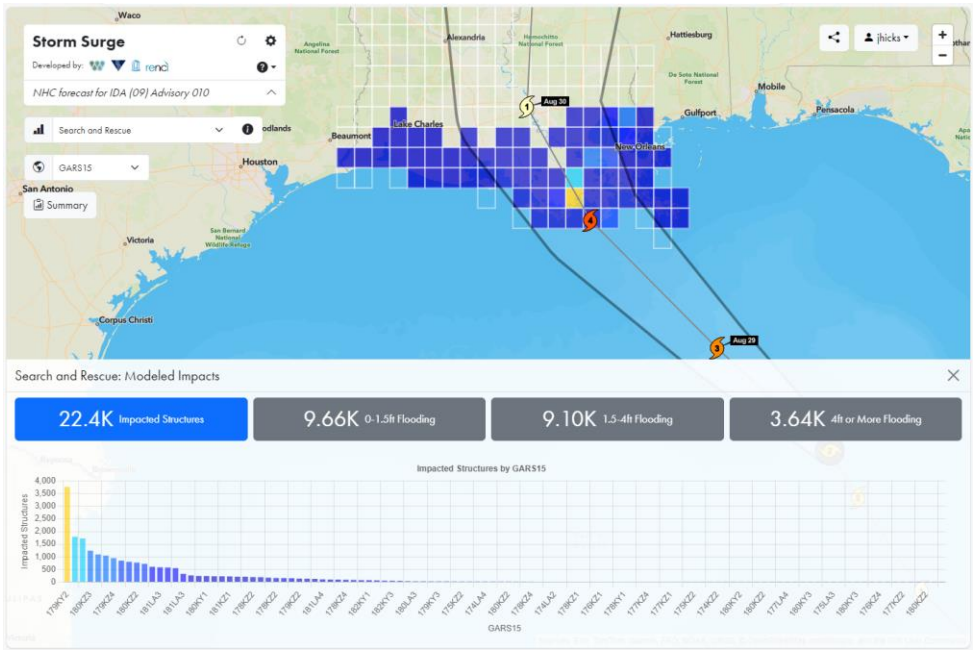

0-3 Day Most Likely Arrival Time of Tropical-Storm-Force Winds
95W
90W
85W
35N
30N
25N
Mon 8 pm
Mon 2 am
Sun 2 pm
Sun 8 am
All Times CDT
Hurricane Ida
Sun. Aug. 29, 2021 4 am CDT
Advisory 12
Storm Location
Wind Speed
< 34 kt (39 mph)
34-63 kt (39-73 mph)
≥ 64 kt (74 mph)
3-day chance of receiving sustained 34+ kt (39+ mph) winds
5 10 20 30 40 50 60 70 80 90 100 %


EXPERIMENTAL
Peak Storm Surge Forecast Graphic
90°W
Alabama
Louisiana
Mississippi
Florida
30°N
Mobile Bay...3-5 ft
Pensacola Bay...1-3 ft
Lake Maurepas...4-6 ft
Lake Pontchartrain...5-8 ft
Vermilion Bay...4-6 ft
Okaloosa/Walton County Line
Bay St. Louis
Ocean Springs
MS/AL Border
AL/FL Border
6-9 ft
4-7 ft
3-5 ft
1-3 ft
8-12 ft
Sabine Pass
1-3 ft
Pecan Island
2-4 ft
Intracoastal City
4-6 ft
Burns Point
6-9 ft
Morgan City
8-12 ft
Port Fourchon
12-16 ft
Mouth of the Mississippi River
Hurricane IDA
Sunday August 29, 2021
04 AM CDT Advisory 12
NWS National Hurricane Center
The combination of a dangerous storm surge and the tide will cause normally dry areas near the coast to be flooded by rising waters moving inland from the shoreline. The water could reach the following heights above ground somewhere within the indicated areas if the peak surge occurs at the time of high tide. The deepest water will occur along the immediate coast near the landfall location, where the surge will be accompanied by large and destructive waves. Surge-related flooding depends on the relative timing of the surge and the tidal cycle, and can vary greatly over short distances.

SUPPORT SCALES



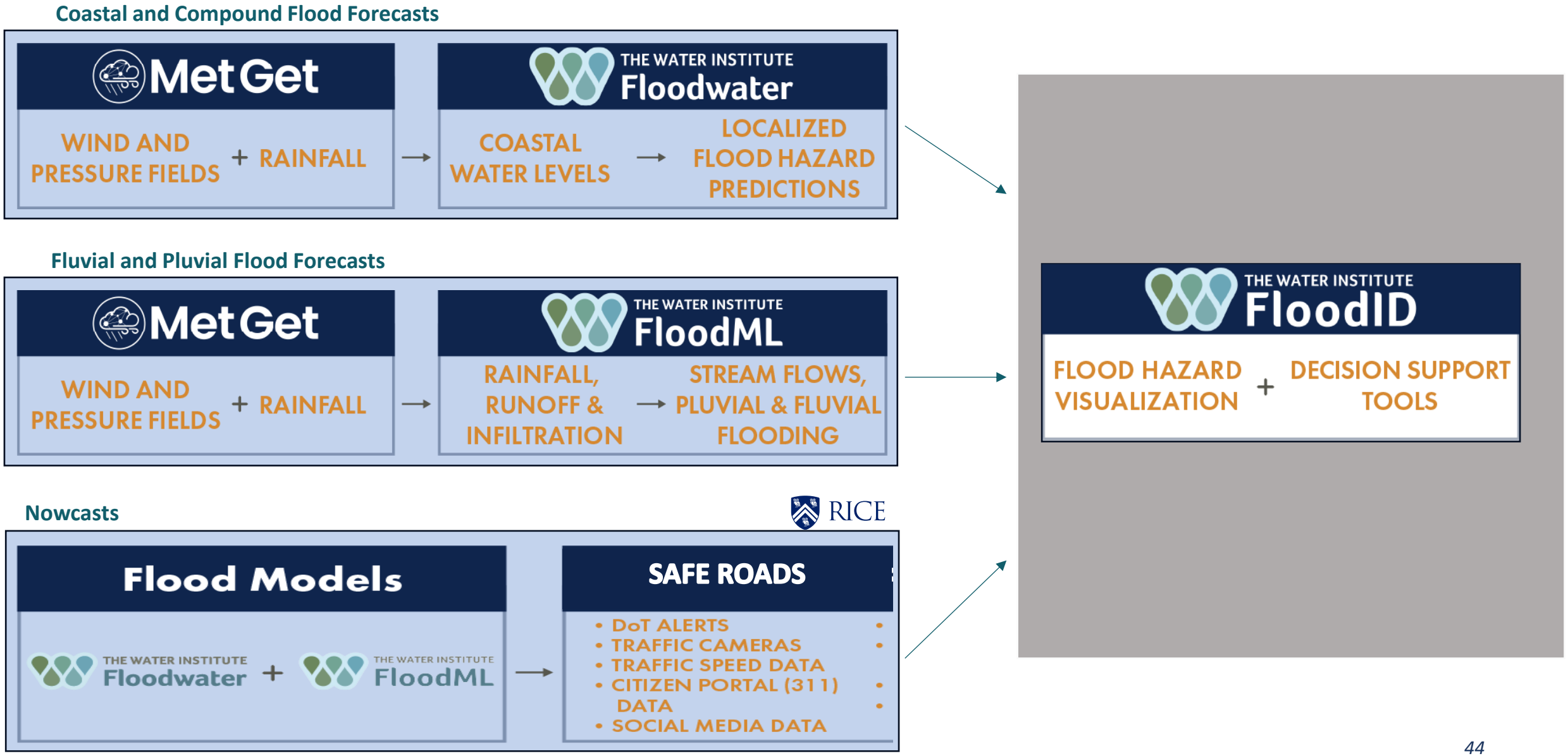
Coastal flooding
National/Regional Products
Wide Distribution
Wide Relevance



Coastal, riverine, & rainfall flooding
State/Local Decision Support
Tightened Data Stack
Tailored Relevance/Distribution

Different remit, same goal:
protect lives, lifelines, and livelihoods

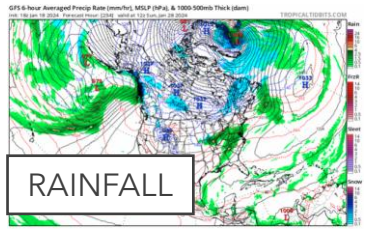
FLOOD INTELLIGENCE ECOSYSTEM OVERVIEW

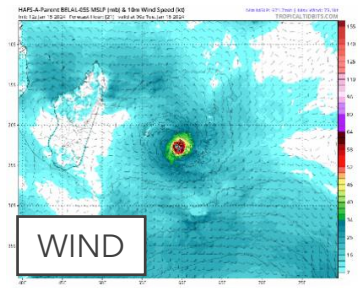


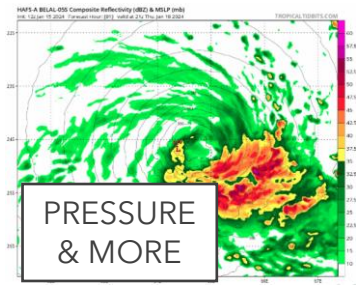
THE WATER INSTITUTE FloodID

Flood forecasts for better-informed pre-disaster emergency operations.

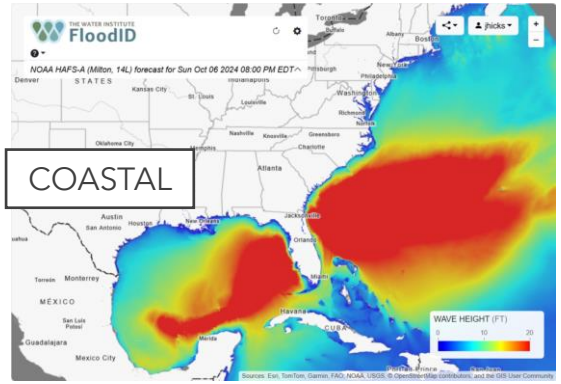
Near real-time met updates

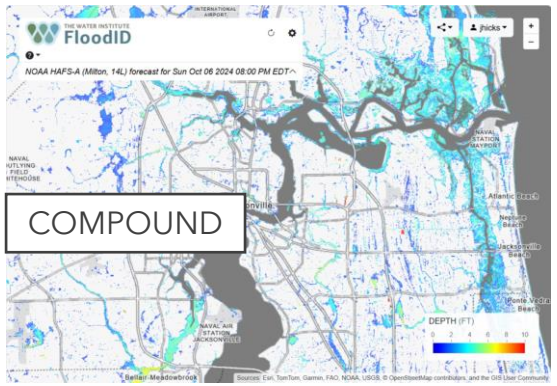




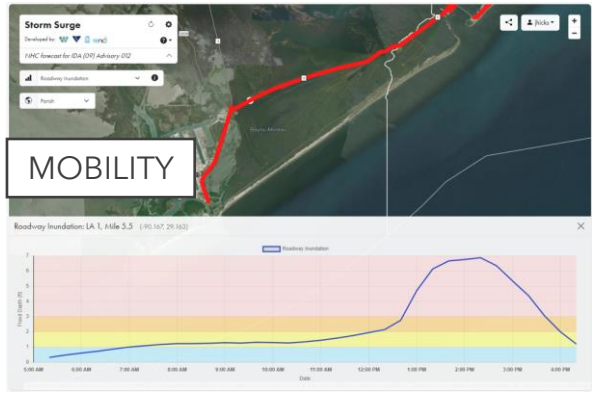


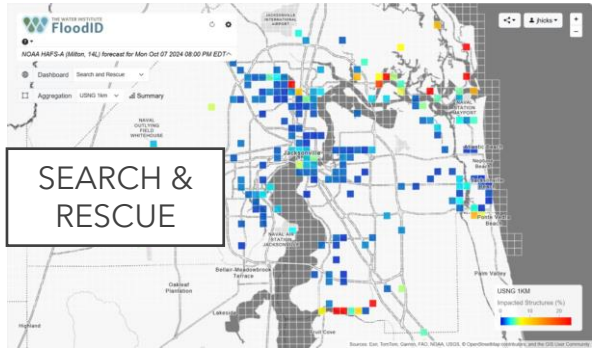
Localized flood hazard models



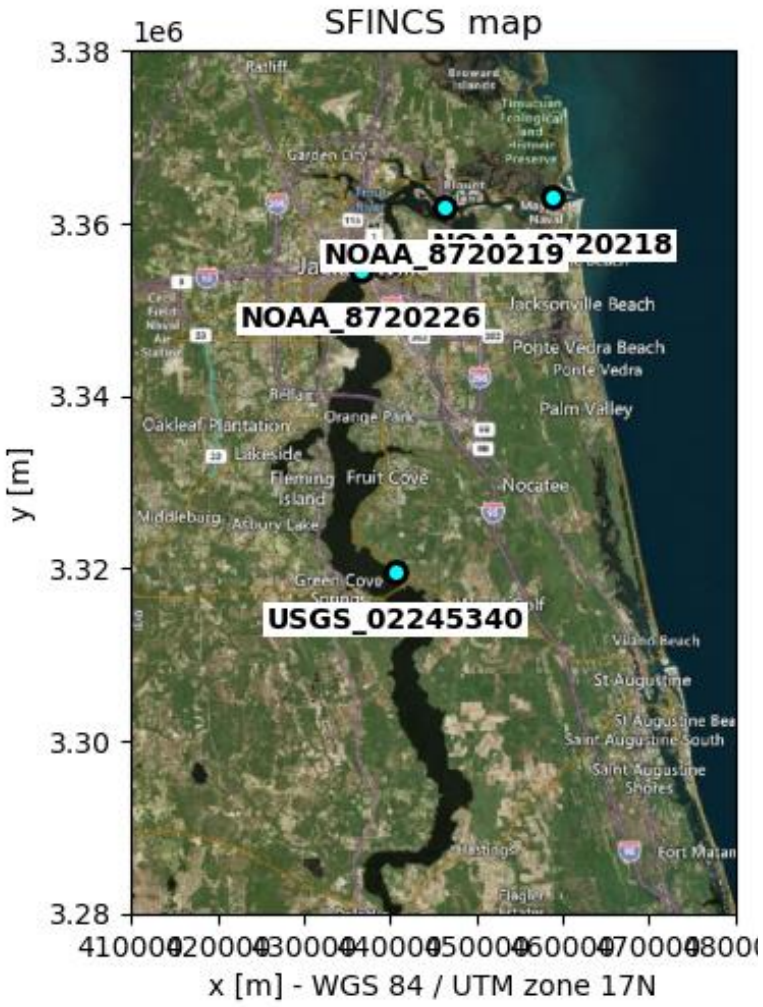


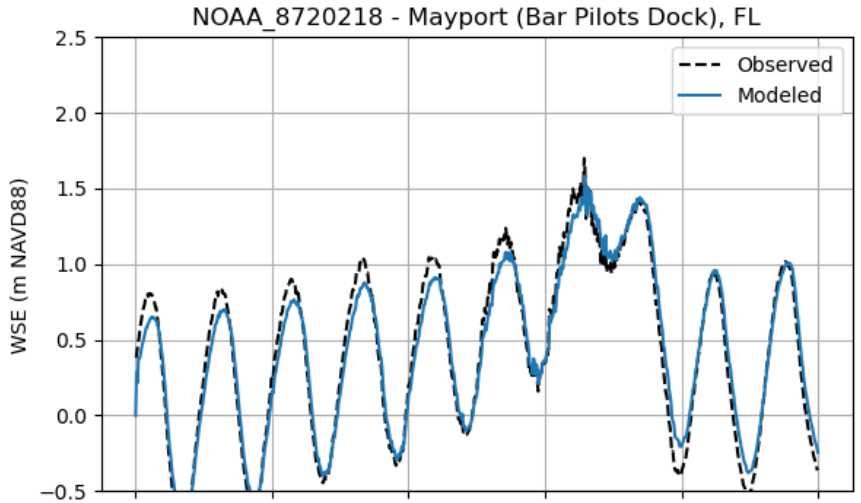
Tailored impact dashboards

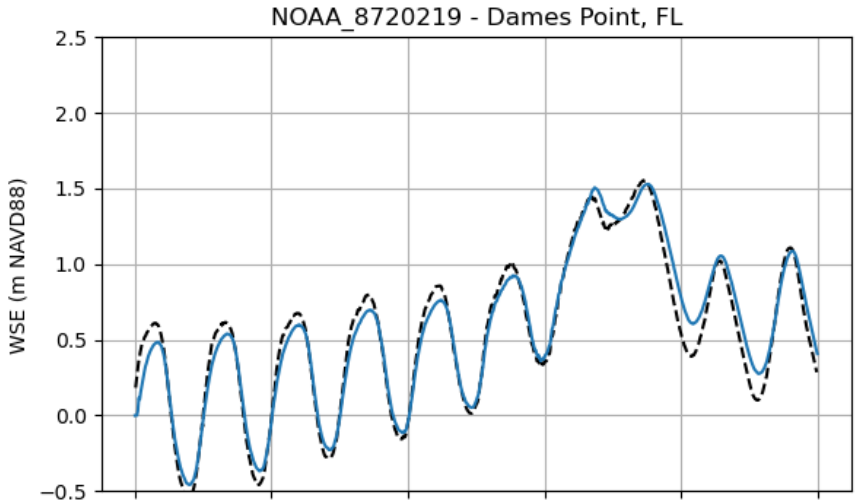


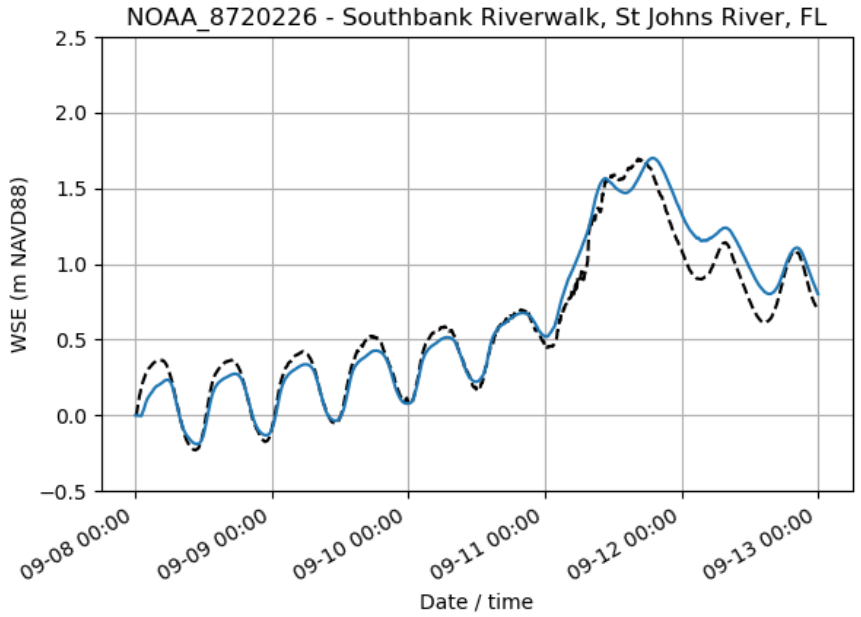


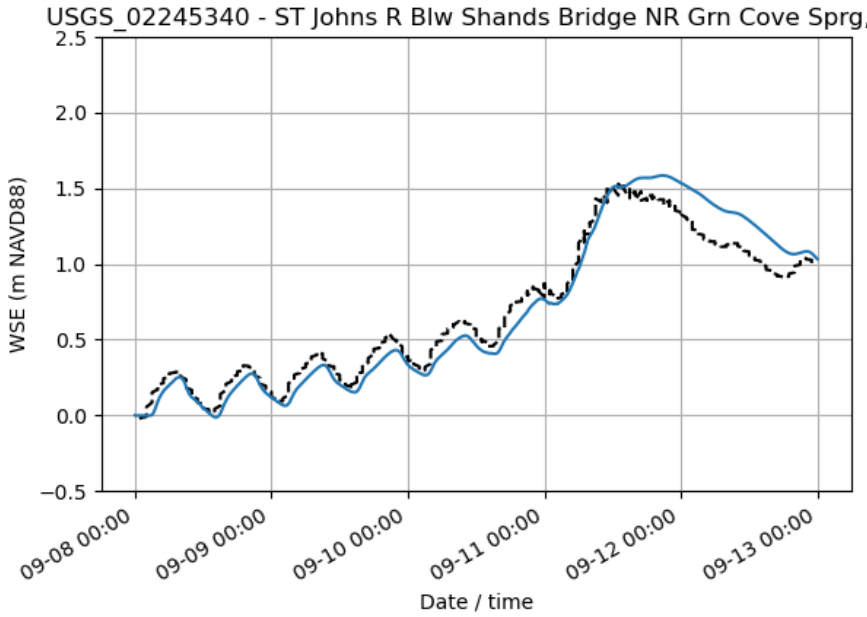
MODEL CALIBRATION (HURRICANE IRMA)





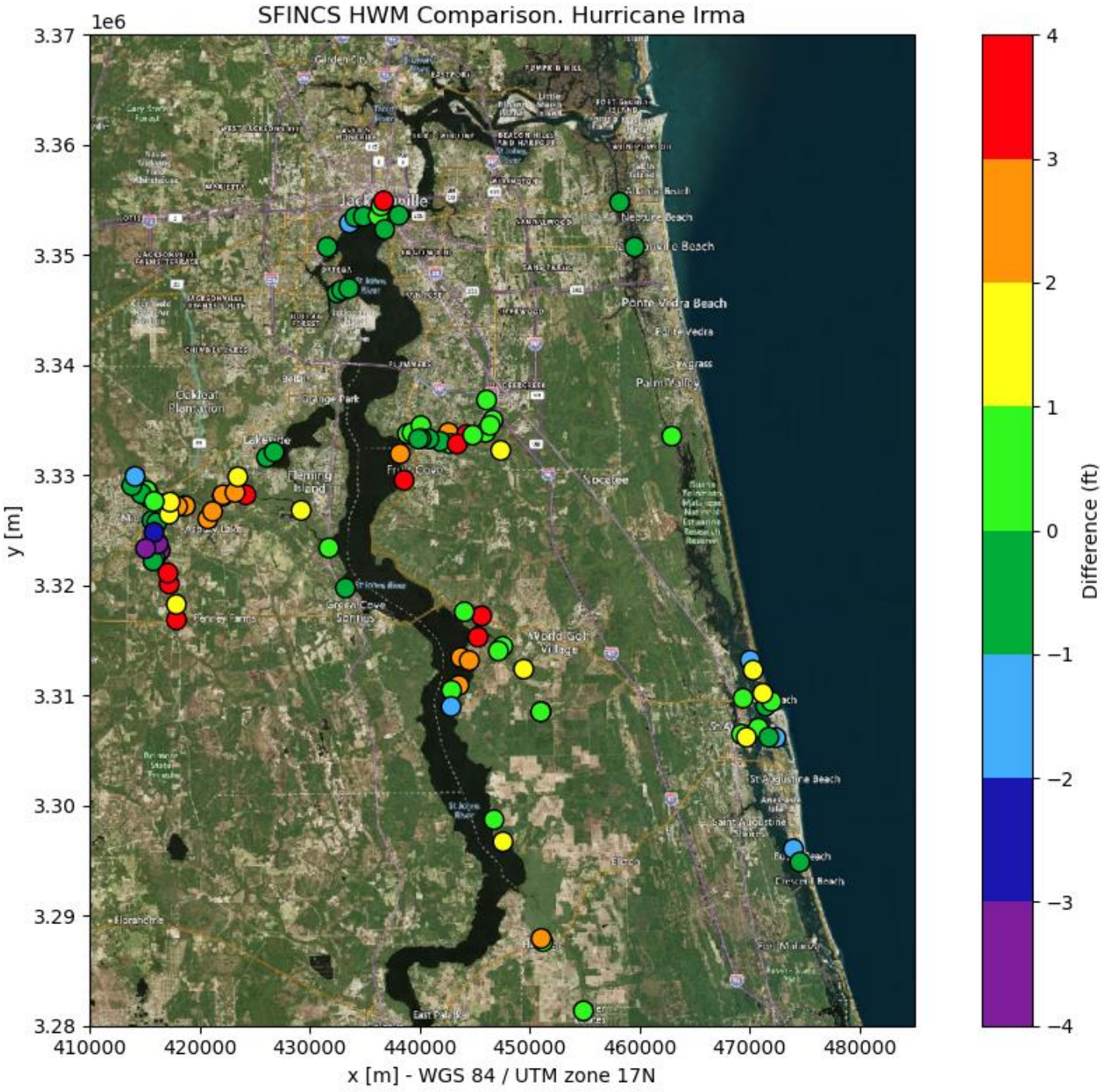




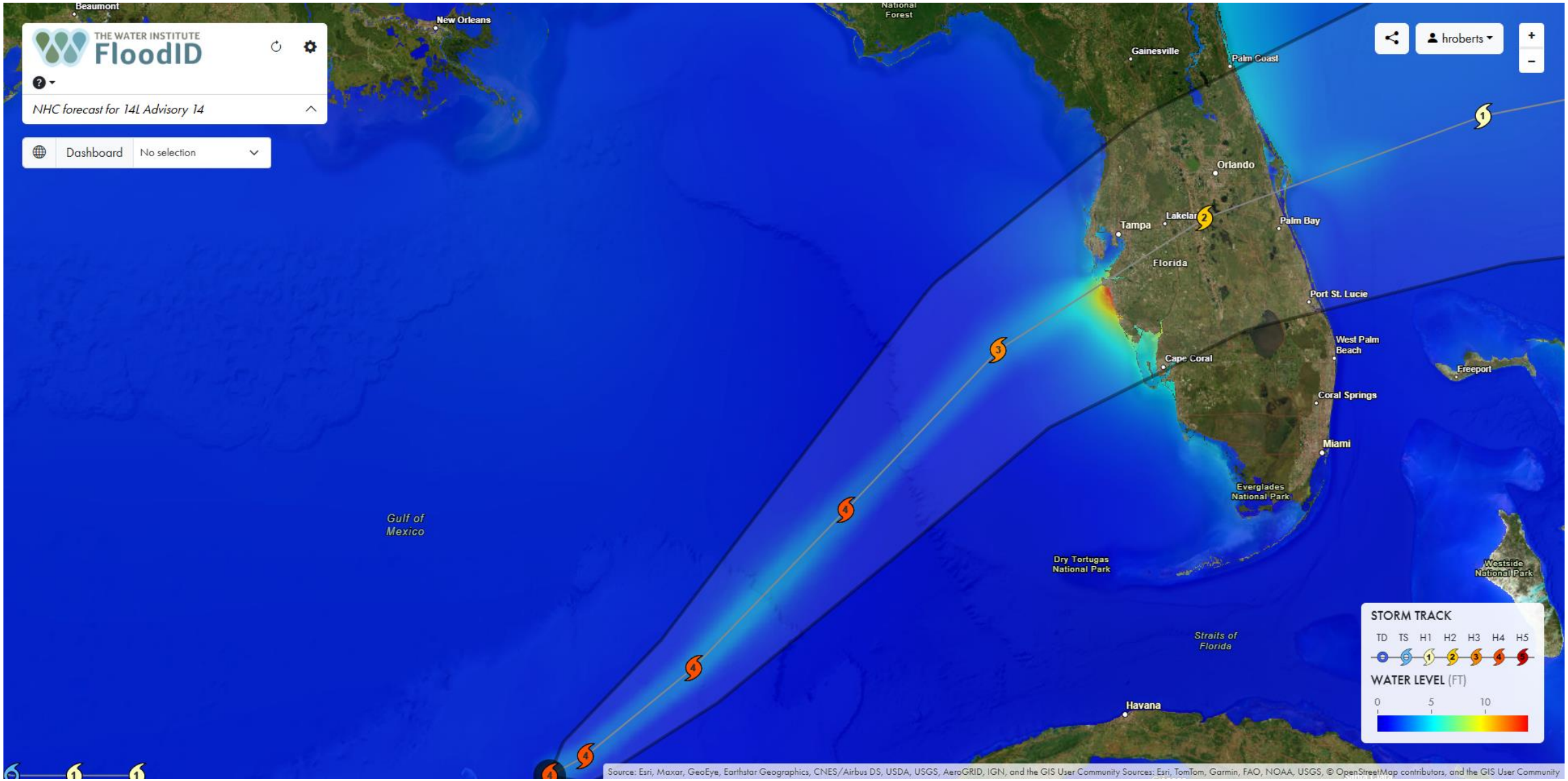


HIGH-WATER MARKS (HURRICANE IRMA)

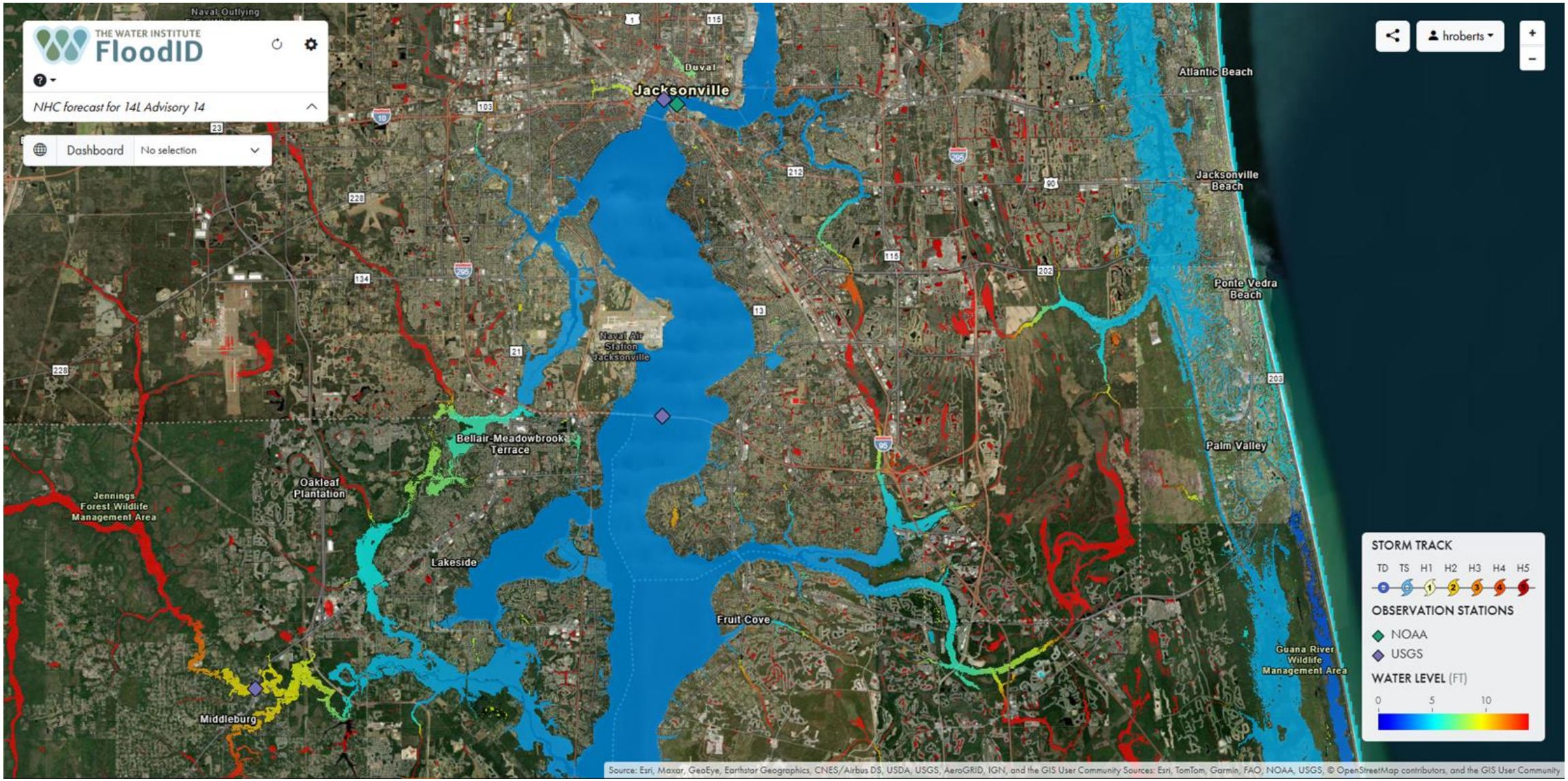
USGS/Public Domain



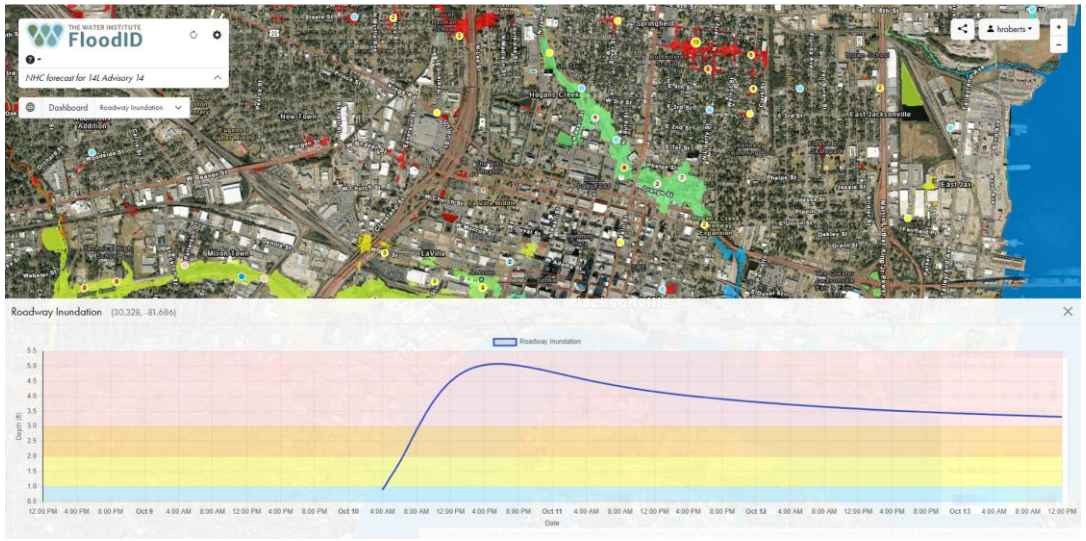
REGIONAL VIEW

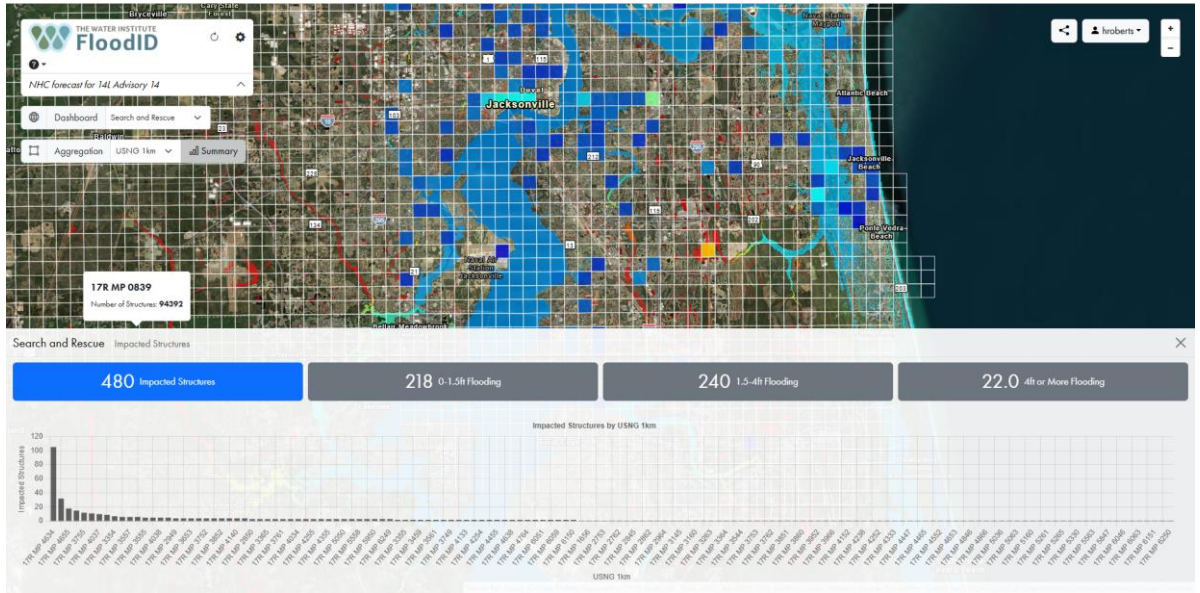


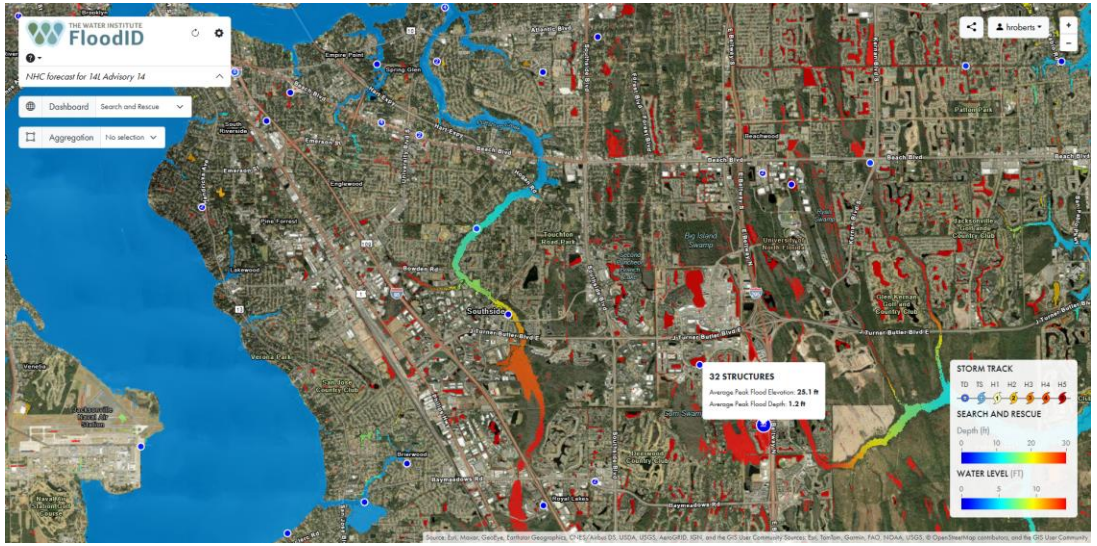
LOCAL VIEW


THE WATER INSTITUTE
FloodID
NHC forecast for 14L Advisory 14
Dashboard
No selection
hroberts
Jacksonville
Duval
Atlantic Beach
Jacksonville Beach
Ponte Vedra Beach
Palm Valley
Naval Air Station Jacksonville
Bellair-Meadowbrook Terrace
Oakleaf Plantation
Jennings Forest Wildlife Management Area
Lakeside
Middleburg
Fruit Cove
Guana River Wildlife Management Area
STORM TRACK
TD TS H1 H2 H3 H4 H5
OBSERVATION STATIONS
NOAA
USGS
WATER LEVEL (FT)
0 5 10
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

DECISION SUPPORT DASHBOARDS

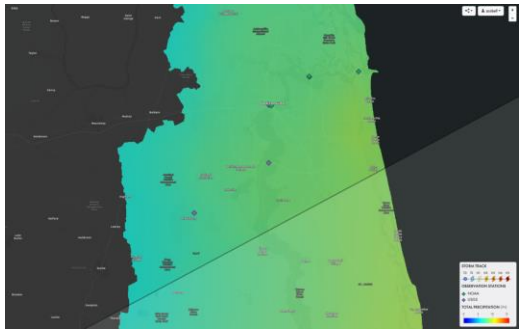
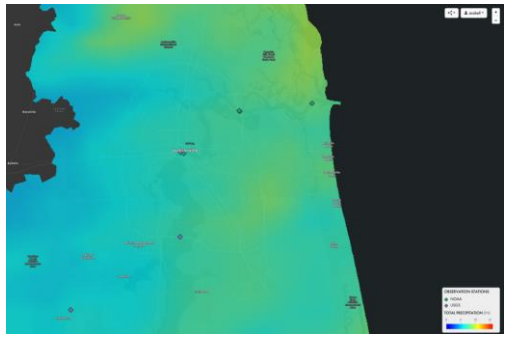
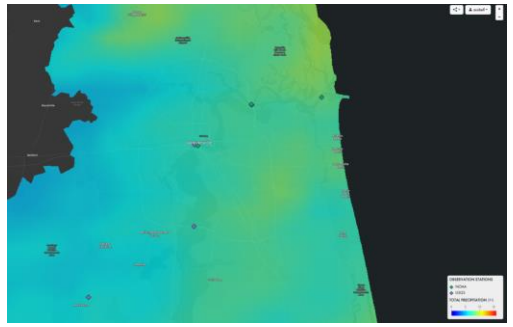
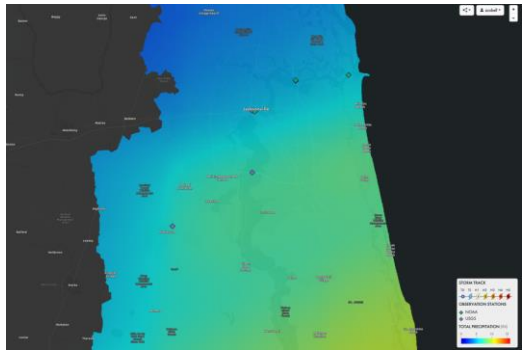
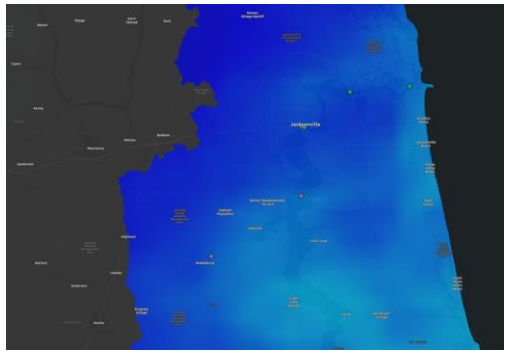
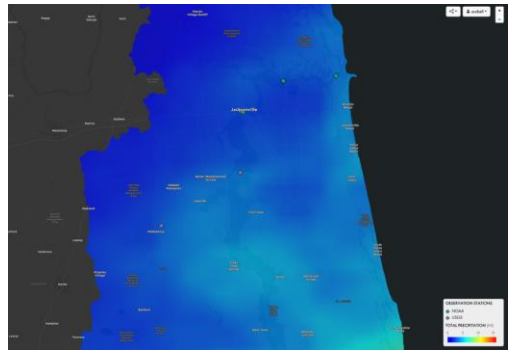
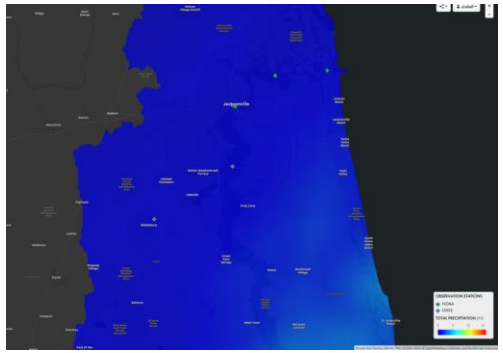


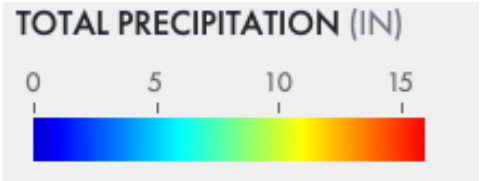




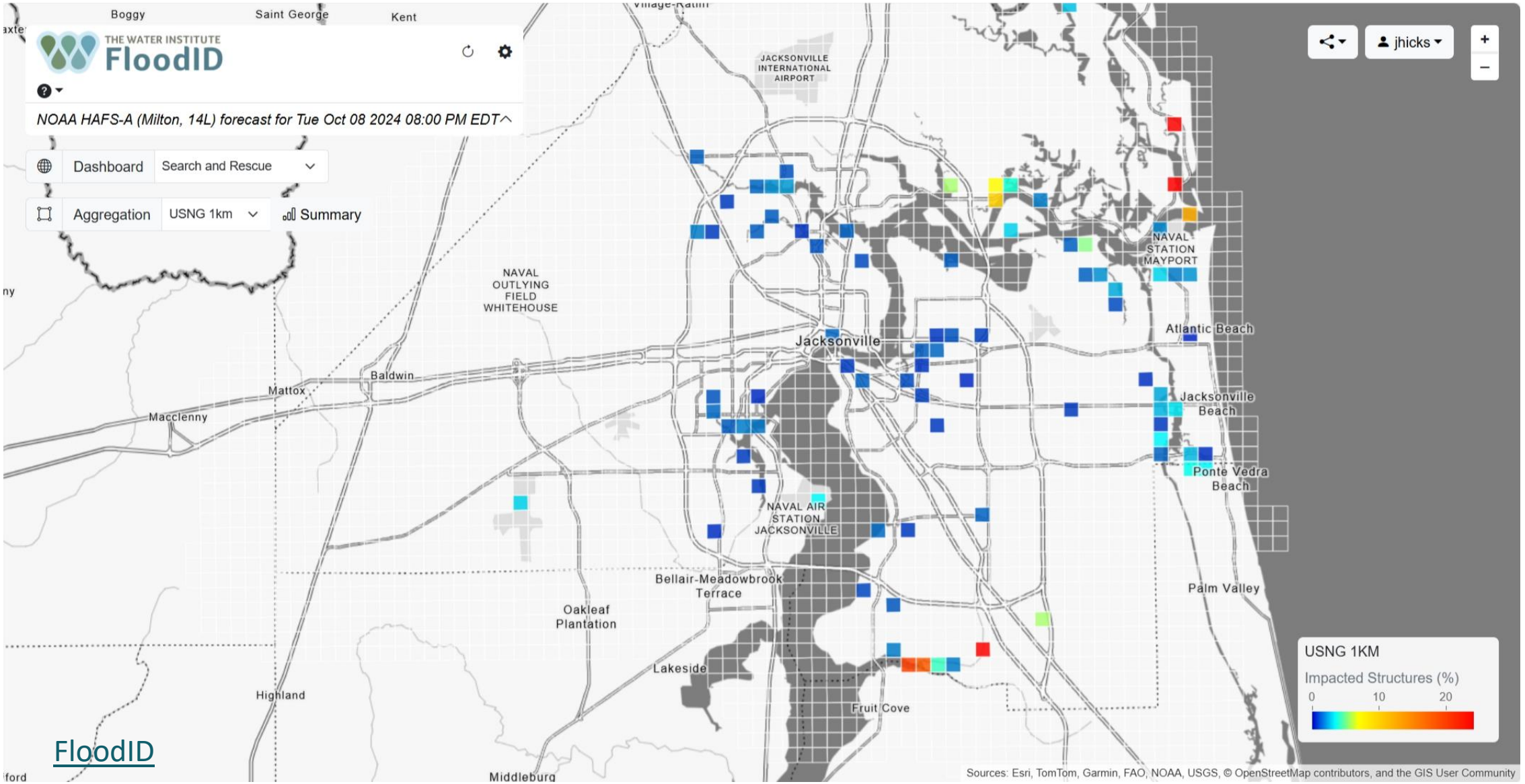
4 FORECASTS DURING STORMS EVERY 6 HOURS

Landfall

	NHC+WPC	HAFS-A	HAFS-B	COAMPS-TC
~72 hrs				
~24 hrs				



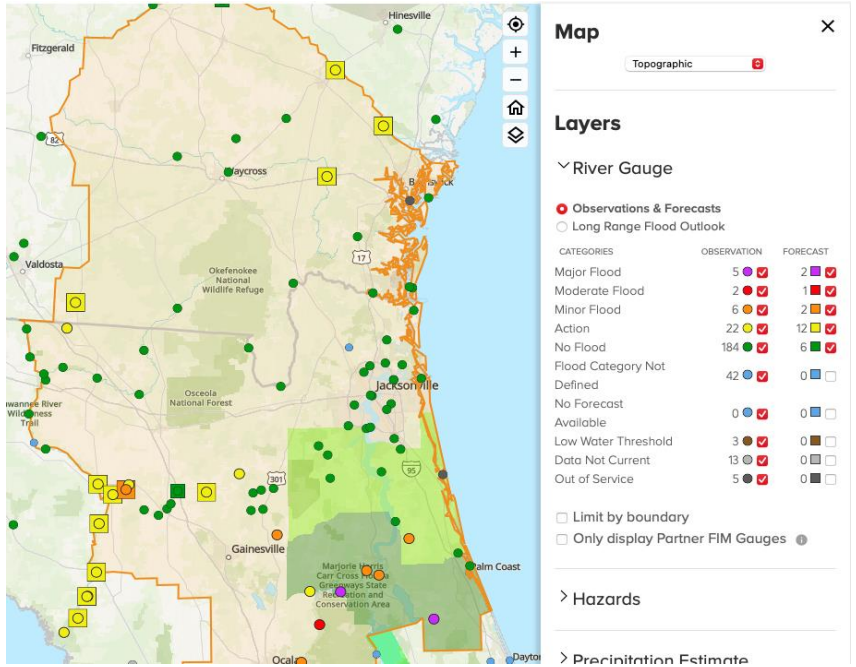
WHERE ELSE MIGHT WE LOOK?

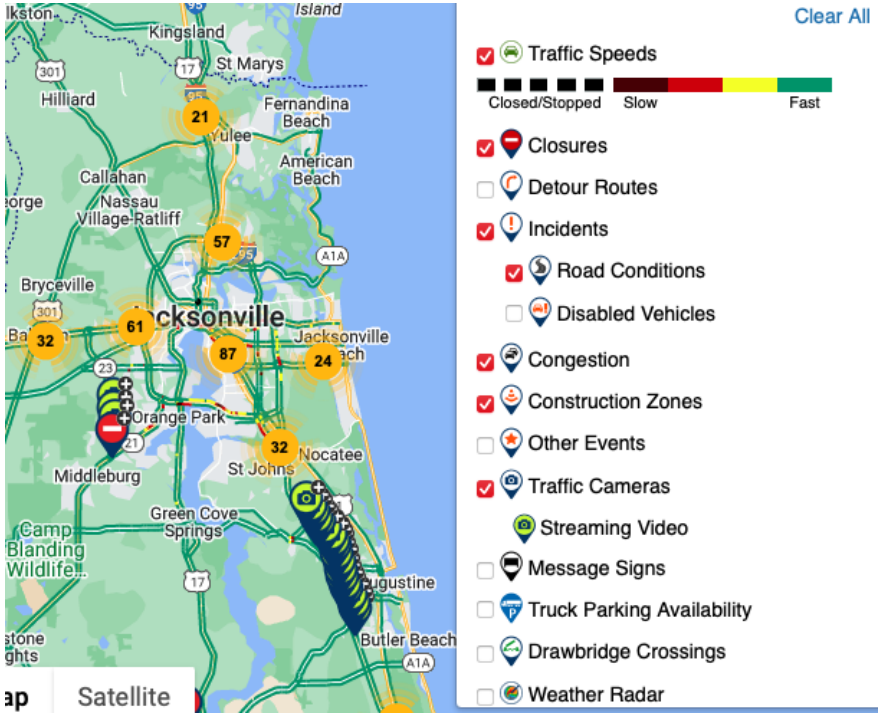


FloodID

PART II - RESPONSIBLE AI DRIVEN AFFORDABLE FLOOD SENSING

Urban areas are replete with data sources that observe flooding or impacts. Combining observations from the existing sources could significantly enhance flood situational awareness.



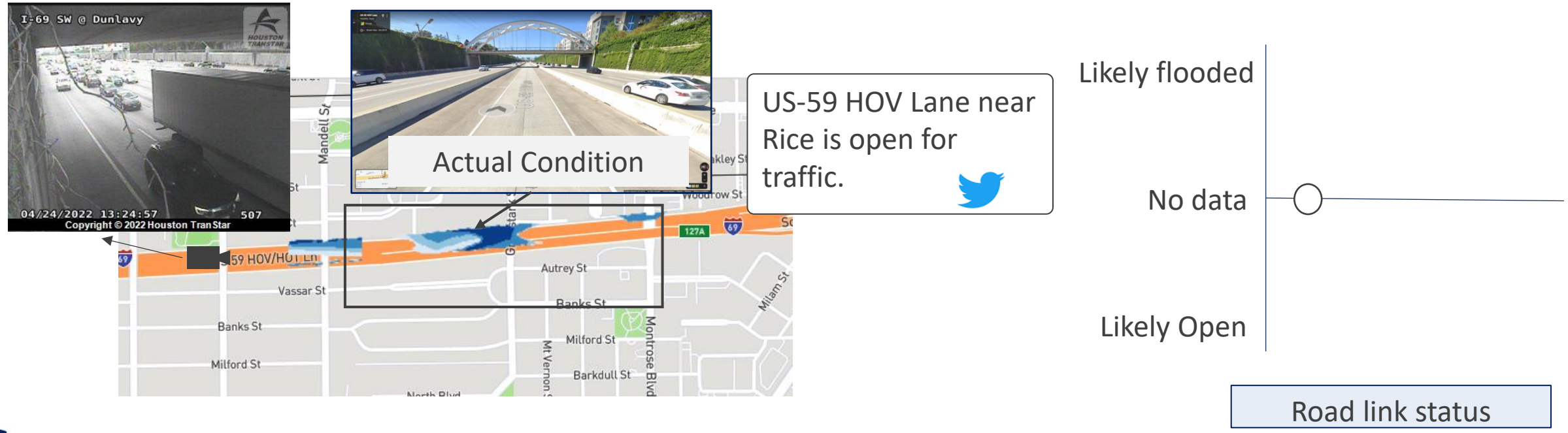


RICE

National Water Prediction Service
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

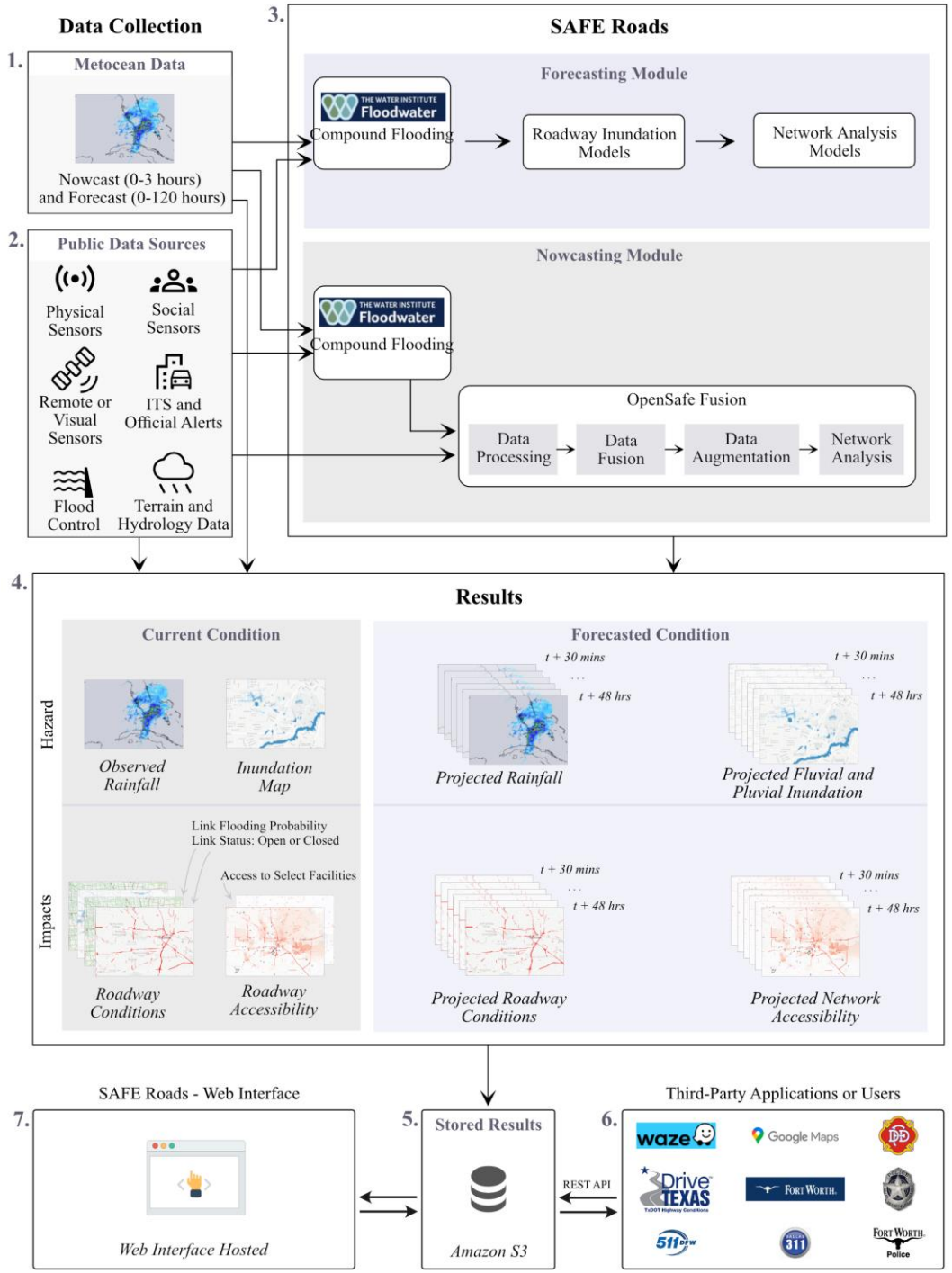
SITUATIONAL AWARENESS FRAMEWORK FOR MOBILITY USING DATA FUSION

- A new AI system for flood situational awareness
- Better situational awareness by real-time fusion of existing urban data sources



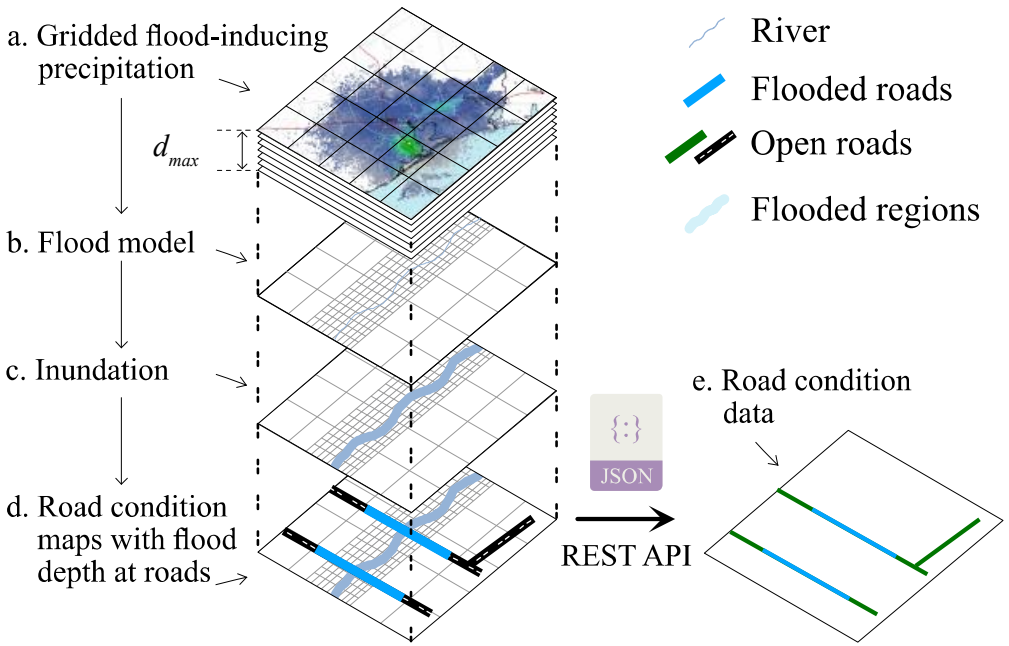
Panakkal, P., & Padgett, J. E. (2024). More eyes on the road: Sensing flooded roads by fusing real-time observations from public data sources. Reliability Engineering & System Safety, 251, 110368.

SAFE ROADS

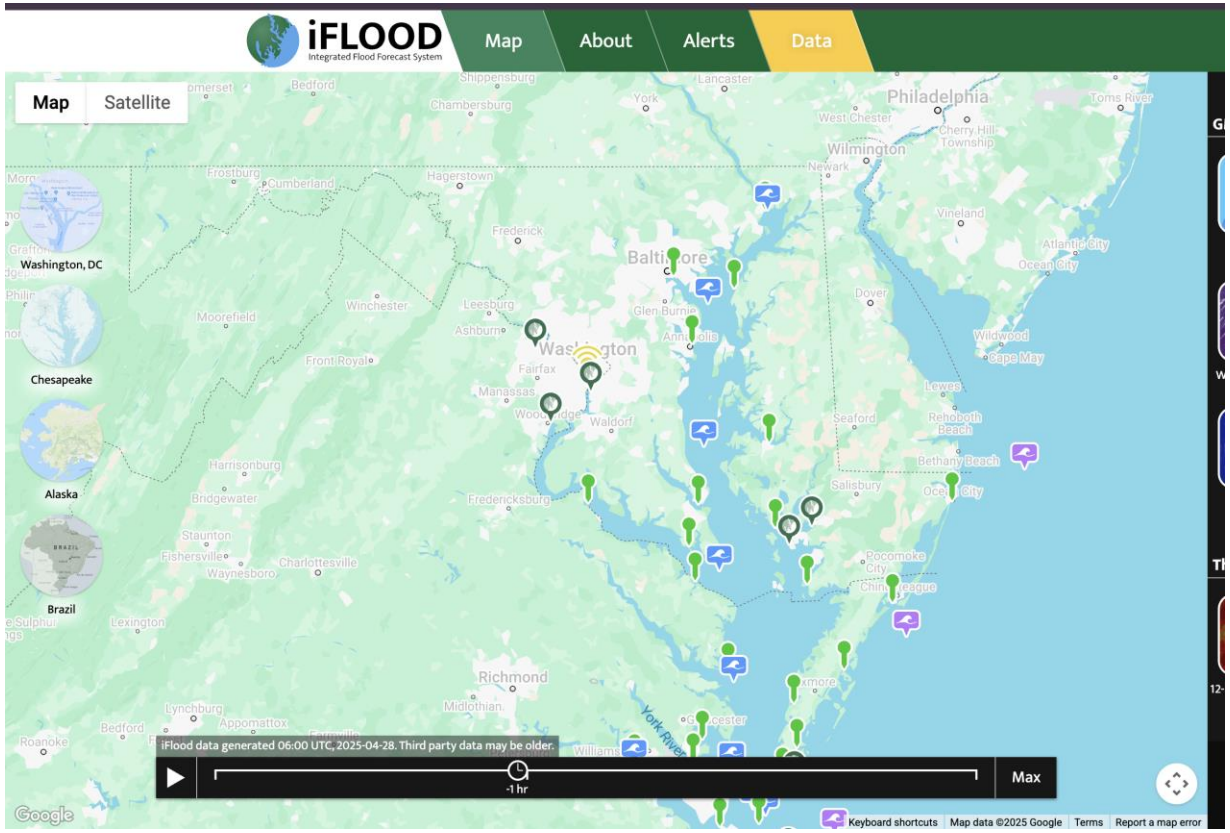

Data Collection
1.
Metocean Data
Nowcast (0-3 hours) and Forecast (0-120 hours)
2.
Public Data Sources
Physical Sensors
Social Sensors
Remote or Visual Sensors
ITS and Official Alerts
Flood Control
Terrain and Hydrology Data
3.
SAFE Roads
Forecasting Module
Compound Flooding
Roadway Inundation Models
Network Analysis Models
Nowcasting Module
Compound Flooding
OpenSafe Fusion
Data Processing
Data Fusion
Data Augmentation
Network Analysis
4.
Results
Current Condition
Forecasted Condition
Hazard
Observed Rainfall
Inundation Map
t + 30 mins
t + 48 hrs
Projected Rainfall
Projected Fluvial and Pluvial Inundation
Impacts
Link Flooding Probability
Link Status: Open or Closed
Access to Select Facilities
Roadway Conditions
Roadway Accessibility
Projected Roadway Conditions
Projected Network Accessibility
SAFE Roads - Web Interface
7.
Web Interface Hosted
5.
Stored Results
Amazon S3
REST API
6.
Third-Party Applications or Users
waze
Google Maps
Drive Texas
Fort Worth
511
311
Fort Worth Police

Data Source: Real-Time Flood Models

- models that can rapidly ingest precipitation, wind, tides, surge, flows
- USACE, FEMA RiskMAP, other existing models models etc. can be leveraged.



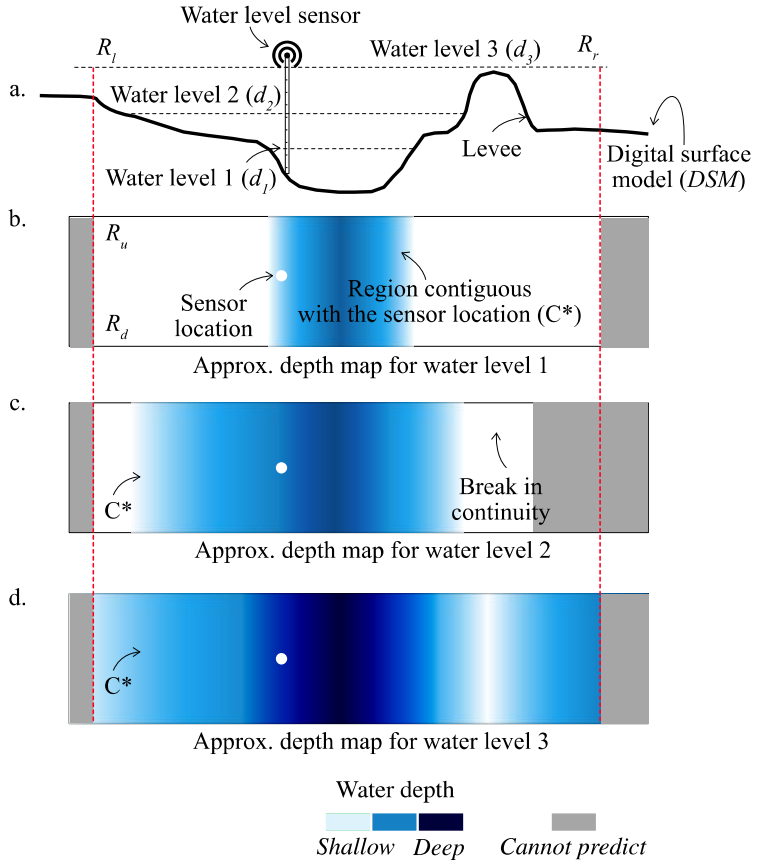
OpenSafe Mobility methodology



kal, P., Wyderka, A. M., Padgett, J. E., & Bedient, P. B. (2023). Safer this way: Identifying flooded roads for facilitating mobility during floods. Journal of Hydrology, 625, 130100.

Data Source: Water Level Sensors

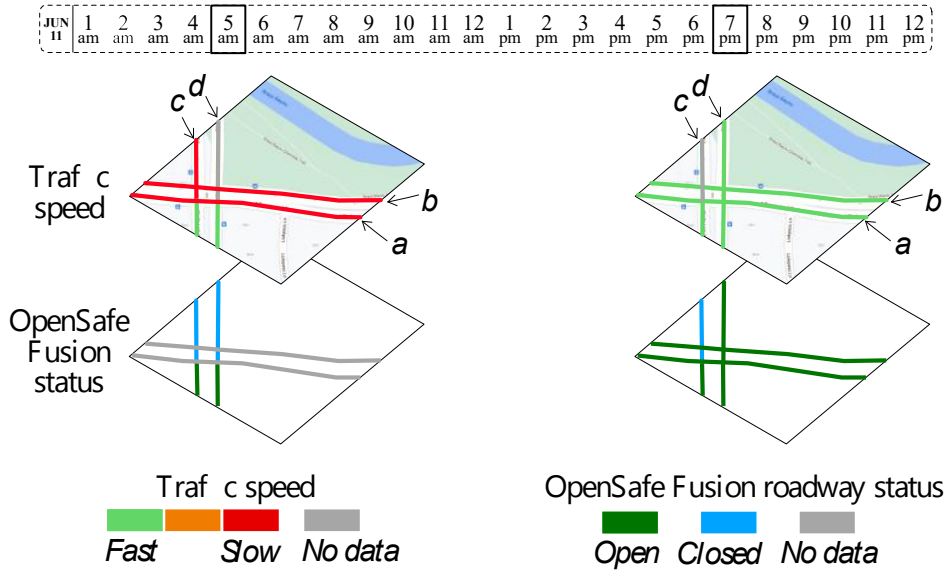
- Real-time water level data and digital elevation models to estimate flooded roads

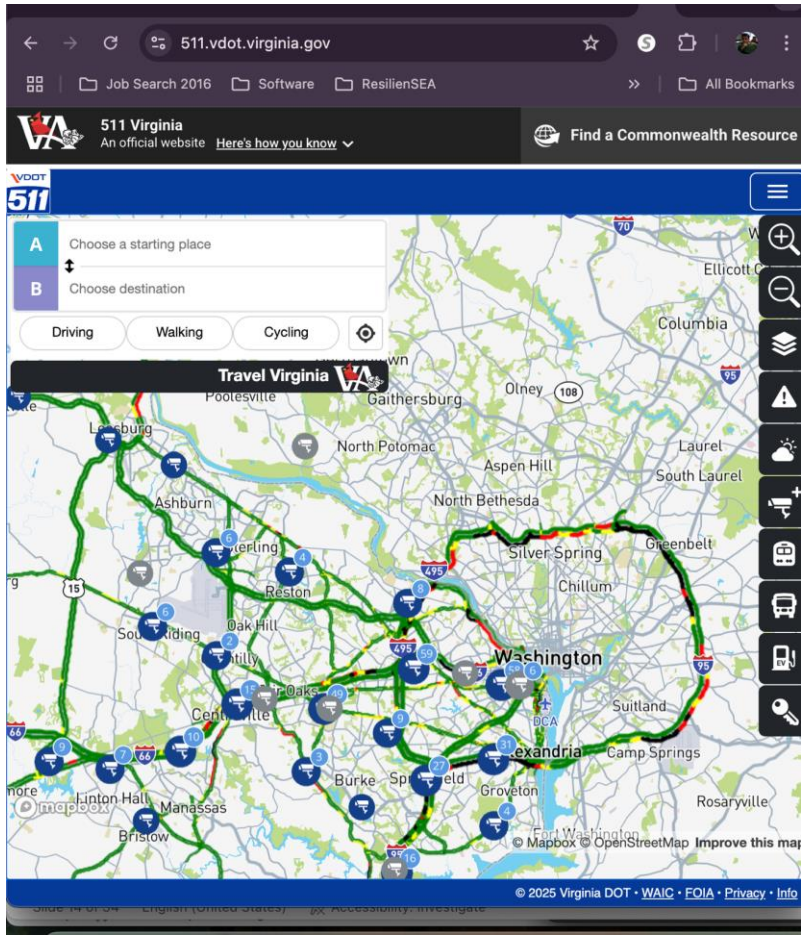


OpenSafe Fusion Sensor Methodology

Data Source: Traffic Speed

- Real-time traffic speed data is used to sense passable roadways
- DOT offers similar data (511 Virginia) in addition to private providers such as Google





If *speed > threshold speed*:

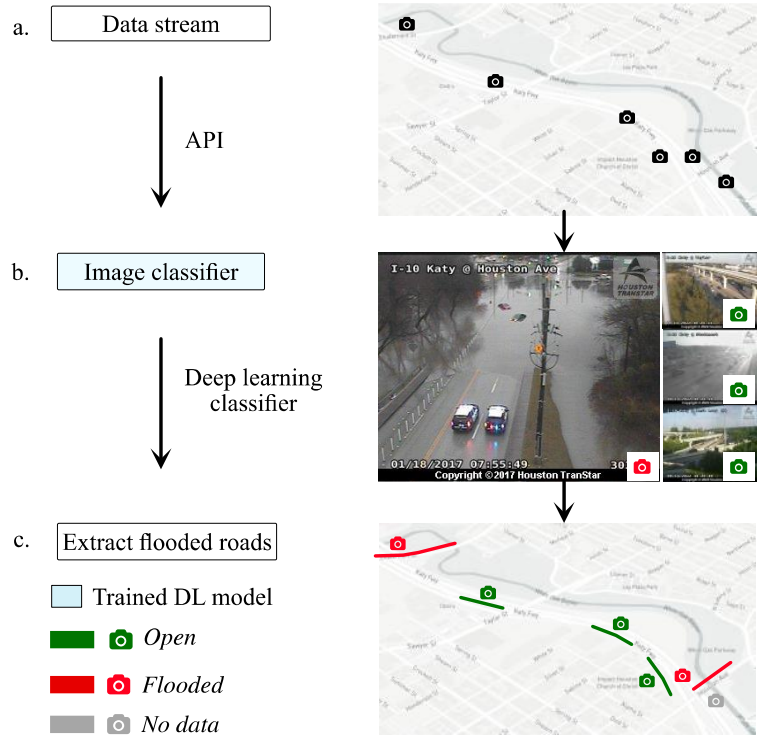
Road = Open

else:

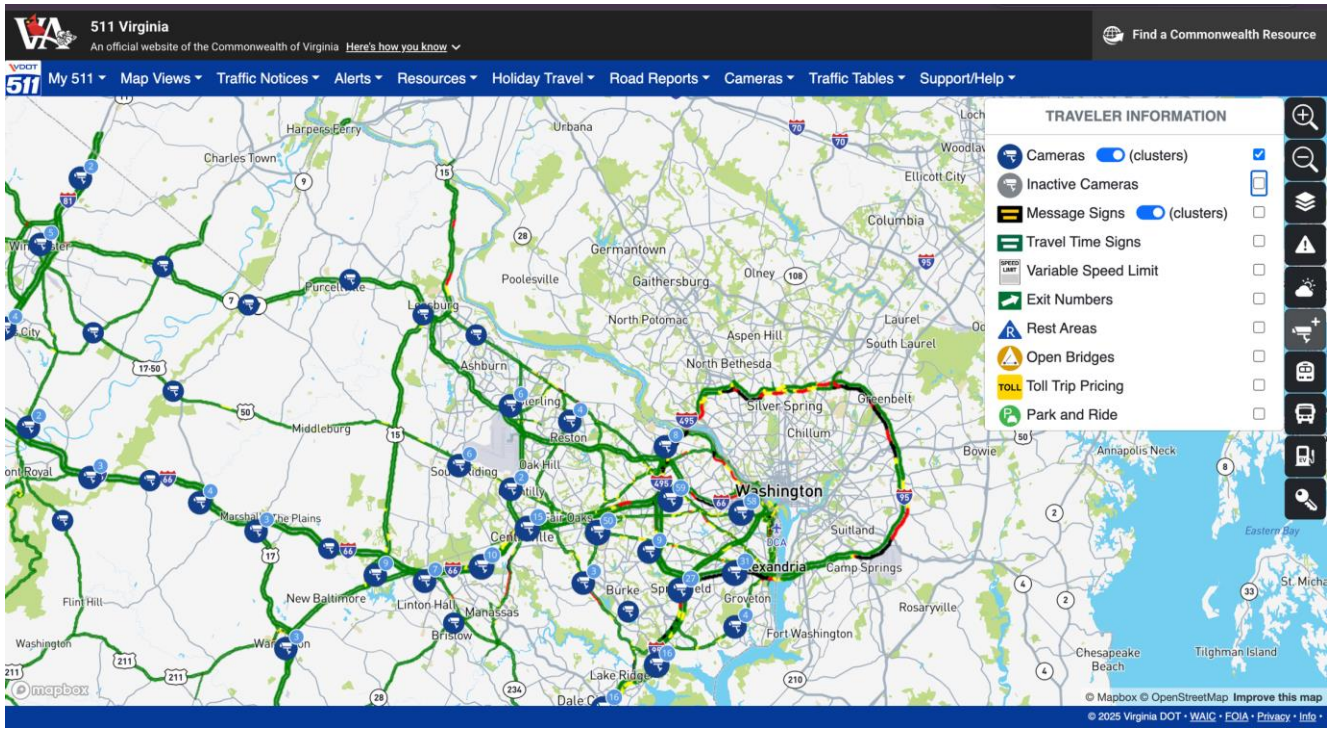
No data

Data Source: Traffic Camera

- SAFE ROADS uses deep learning model and real-time camera feed to detect flooded streets
- DOT and other live camera data can be used for this pipeline



SAFE Roads Method for sensing flooded roads from live camera data

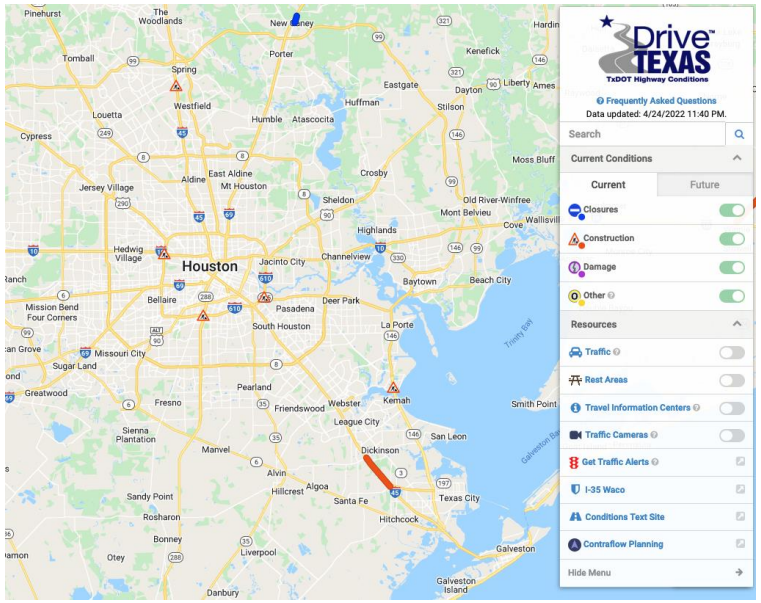


DOT Cameras

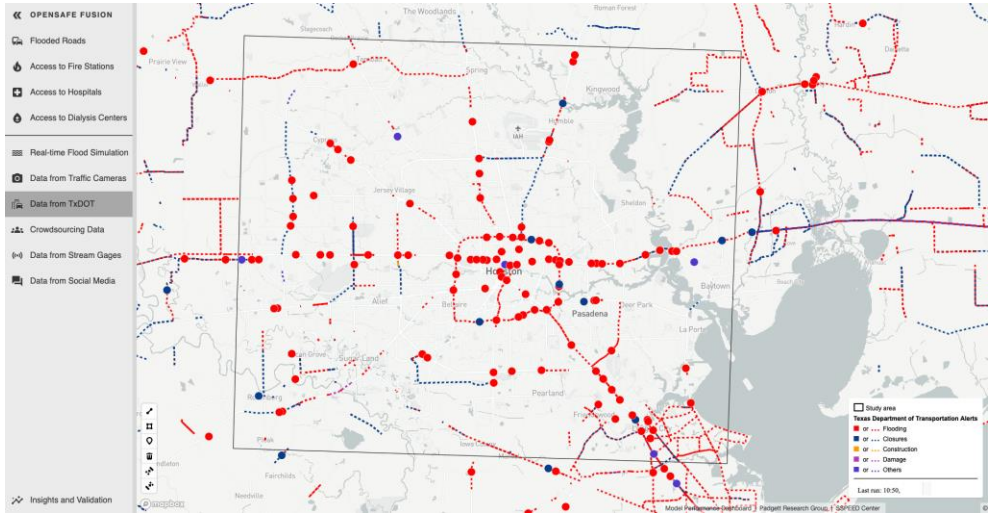
Data Source: Department of Transportation Alerts

- Real-time traffic alerts are used to sense roadway condition

First responders and officials



API

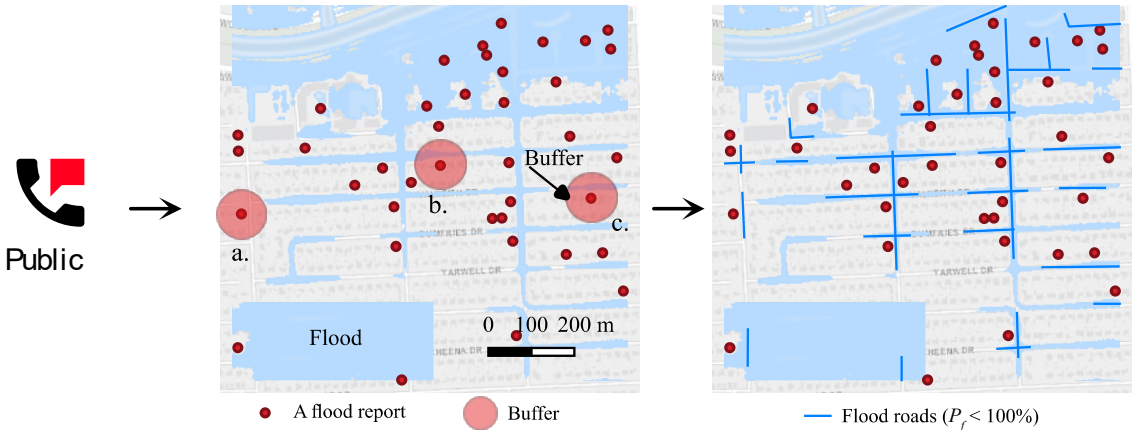


Texas Department of Transportation DriveTexas

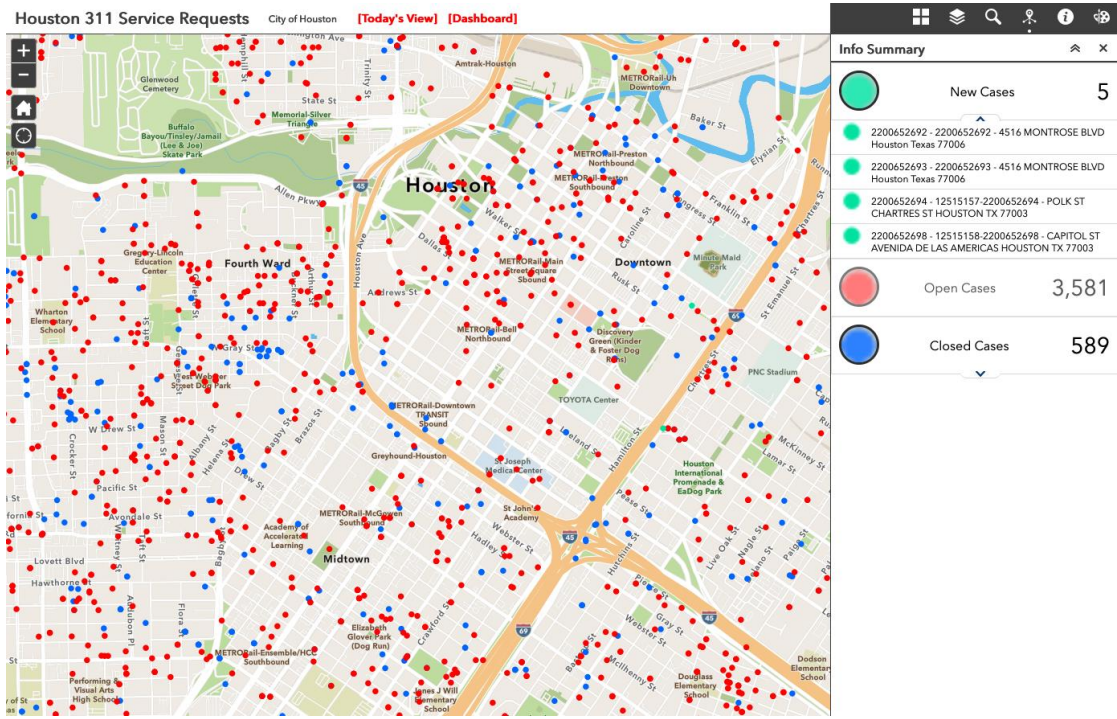
SAFE ROADS

Data Source: Citizen Service Portals

- Real-time data from a citizen service portal (Houston 311) is used to infer potential roadway conditions



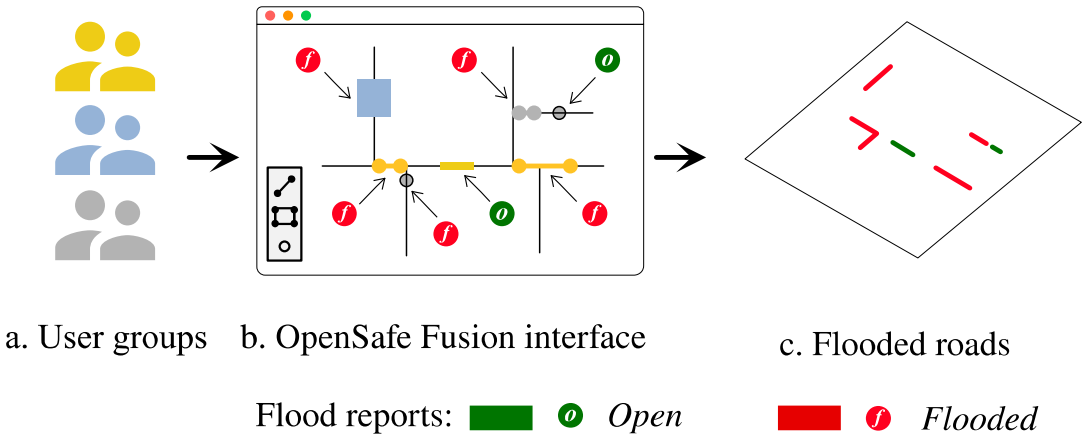
methodology to identify possibly flooded streets



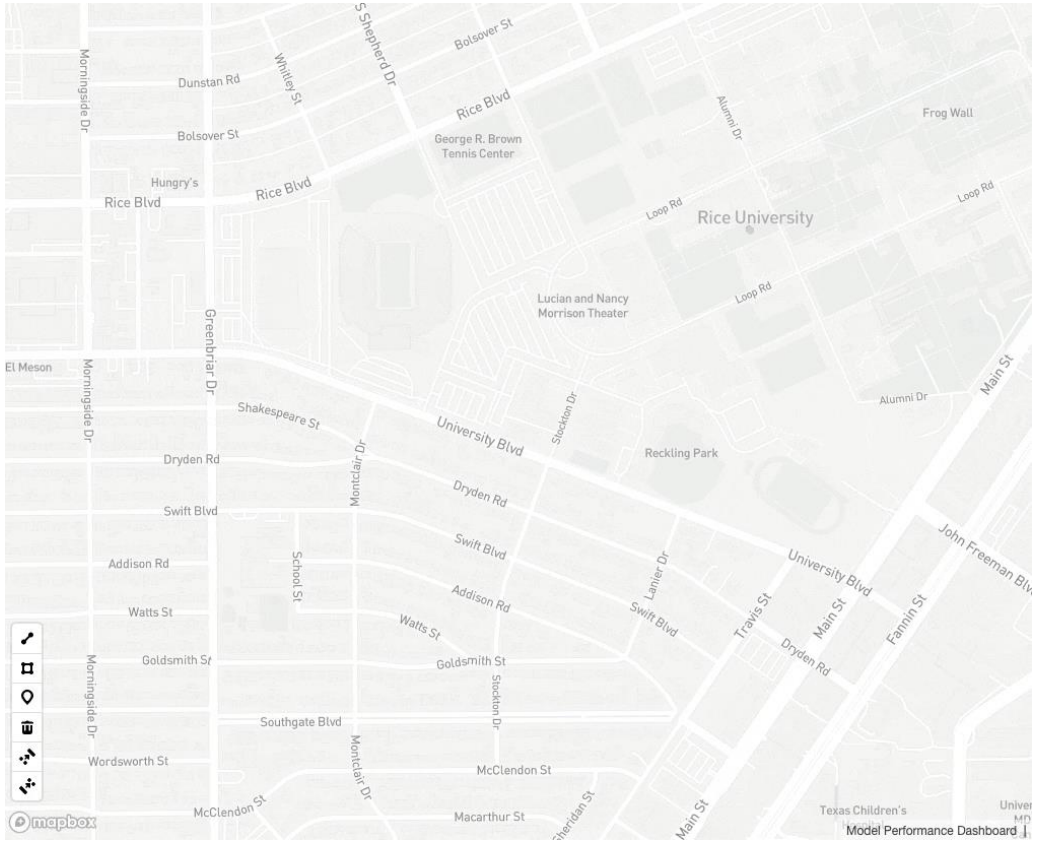
Houston 311 Citizen Service Requests

Data Source: Crowdsourcing

- SAFE ROADS enables stakeholders to share information through a crowdsourcing interface
- Stakeholders are classified into three trust categories: high, moderate, and unknown



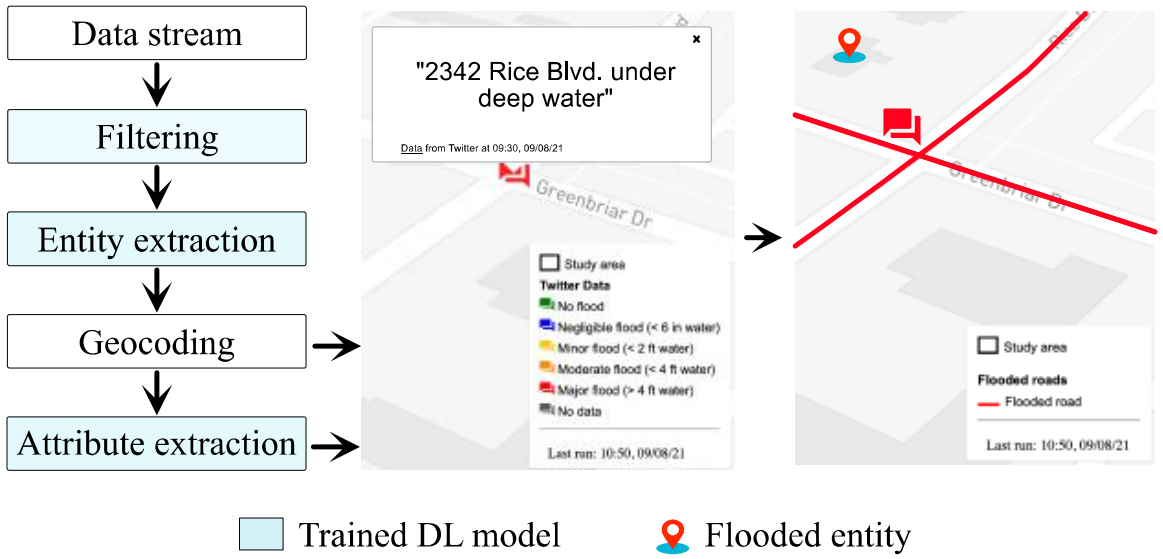
crowdsourcing framework



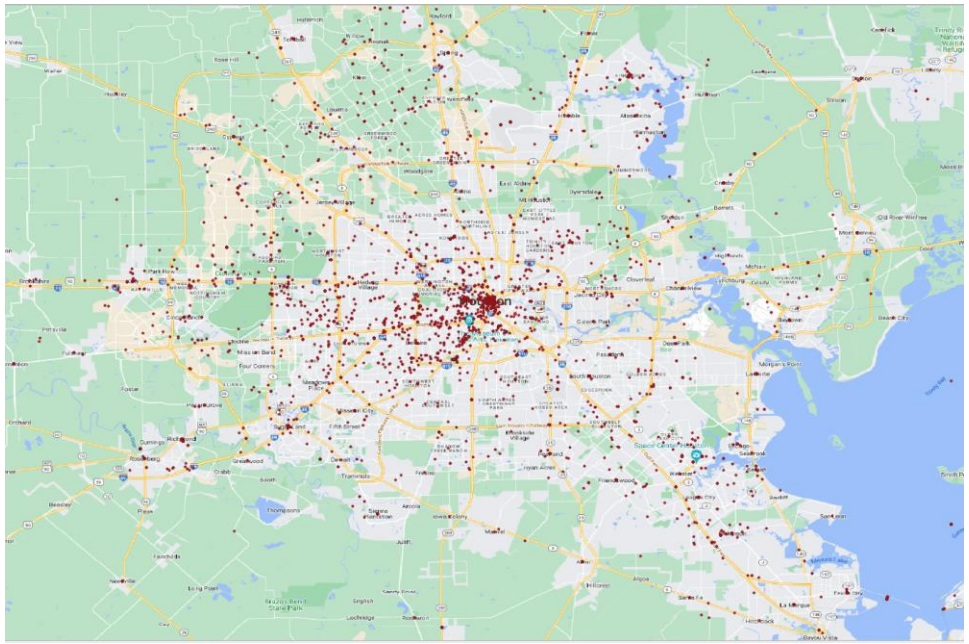
crowdsourcing interface

Data Source: Social Media

- Social media data can be used to extract information on road condition



social media conceptual methodology



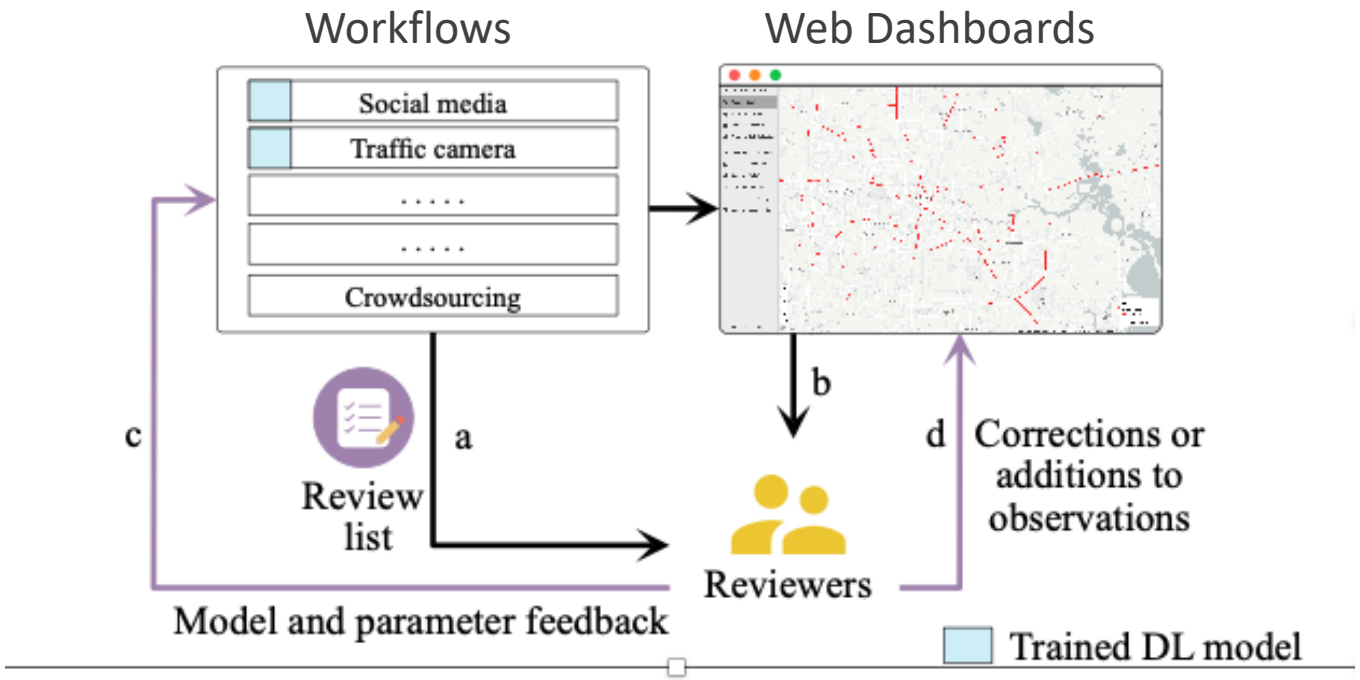
Spatial distribution of relevant tweets during Hurricane Harvey

Harvey dataset[1], Annotated dataset[2], Architecture[3]

1 Phillips, Mark Edward. Hurricane Harvey Twitter Dataset, dataset, 2017-08-18/2017-09-22; (https://digital.library.unt.edu/ark:/67531/metadc993940/), University of North Texas Libraries, UNT Digital Library, https://digital.library.unt.edu 2 Firoj Alam, Ferda Ofli, and Muhammad Imran, CrisisMMD: Multimodal Twitter Datasets from Natural Disasters, In Proceedings of the 12th International AAAI Conference on Web and Social Media (ICWSM), 2018, Stanford, California, USA. 3. DistilBERT (via Hugging Face) + Google Geocoding API

Data Source: Human-in-the-Loop

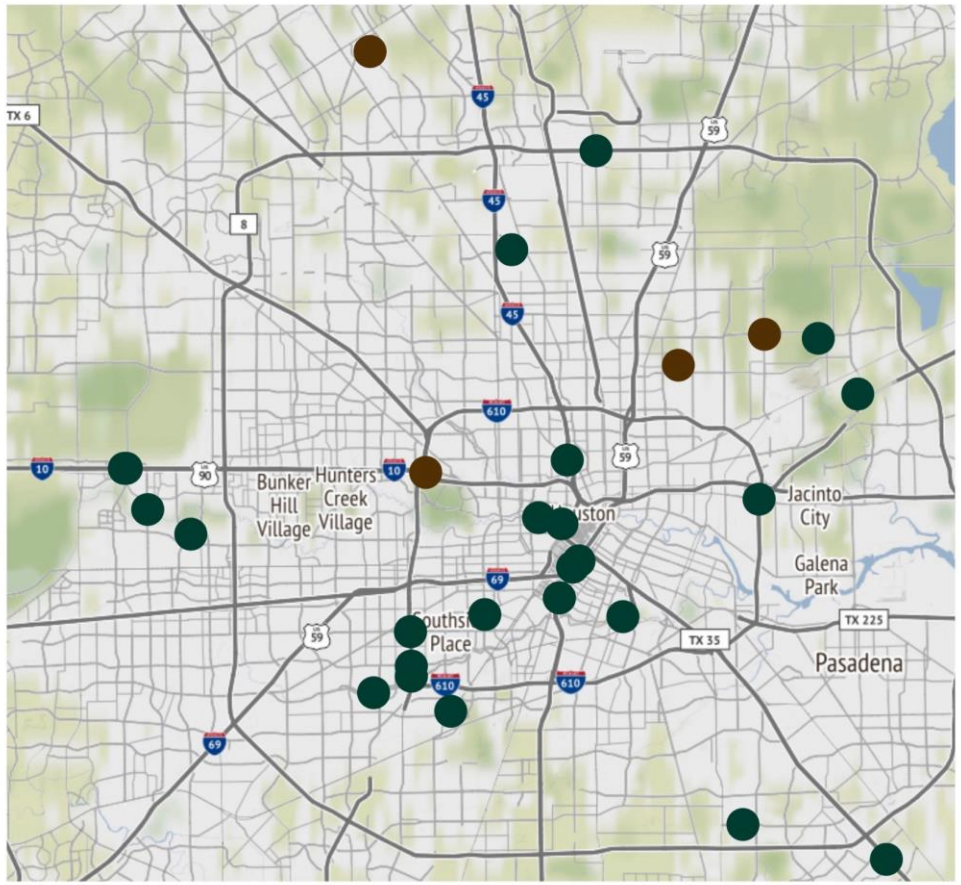
- SAFE ROADS uses human-in-the-loop strategy
- Principles of responsible and human-centered AI



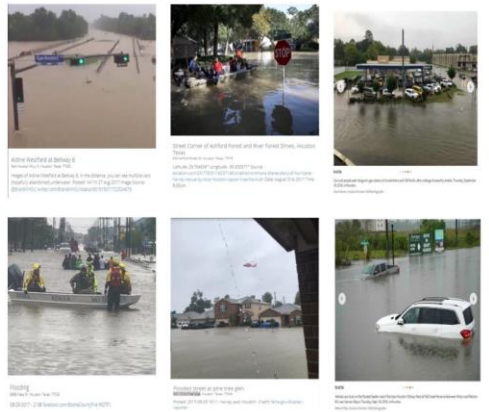
Human-in-the-loop strategy

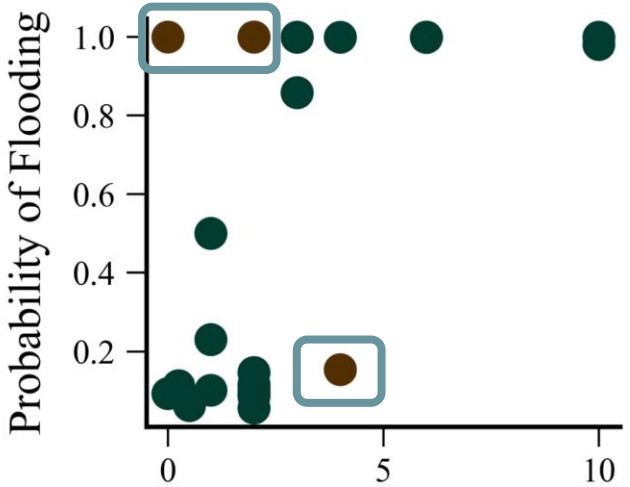
Houston TranStar Control Center

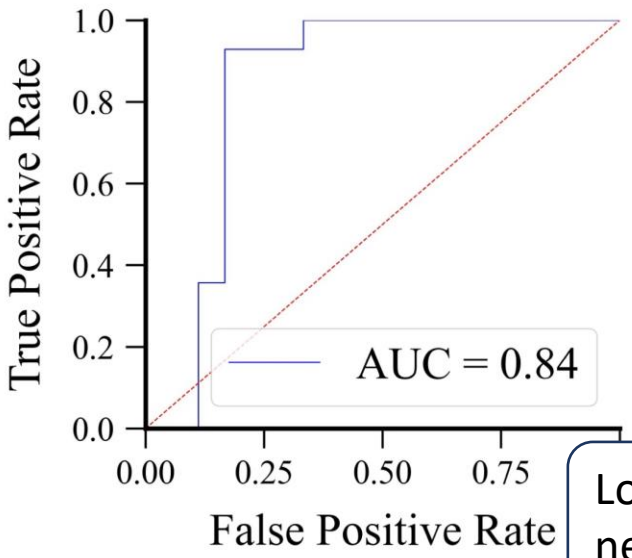
Results from Hurricane Harvey Validation

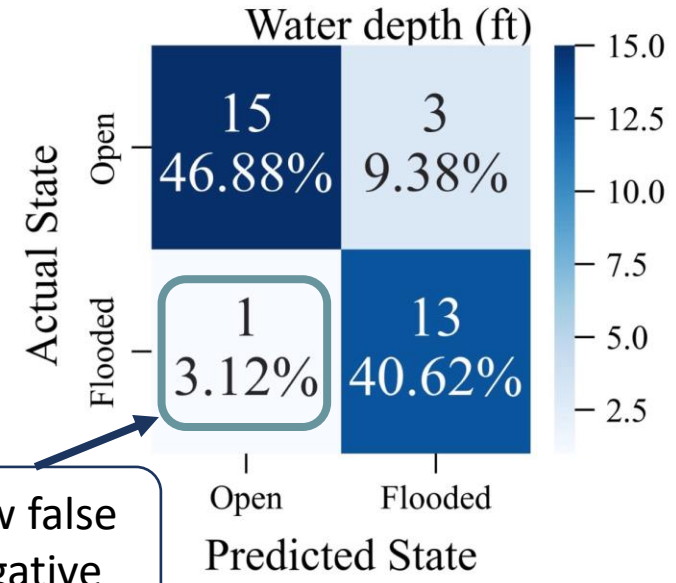


Observations



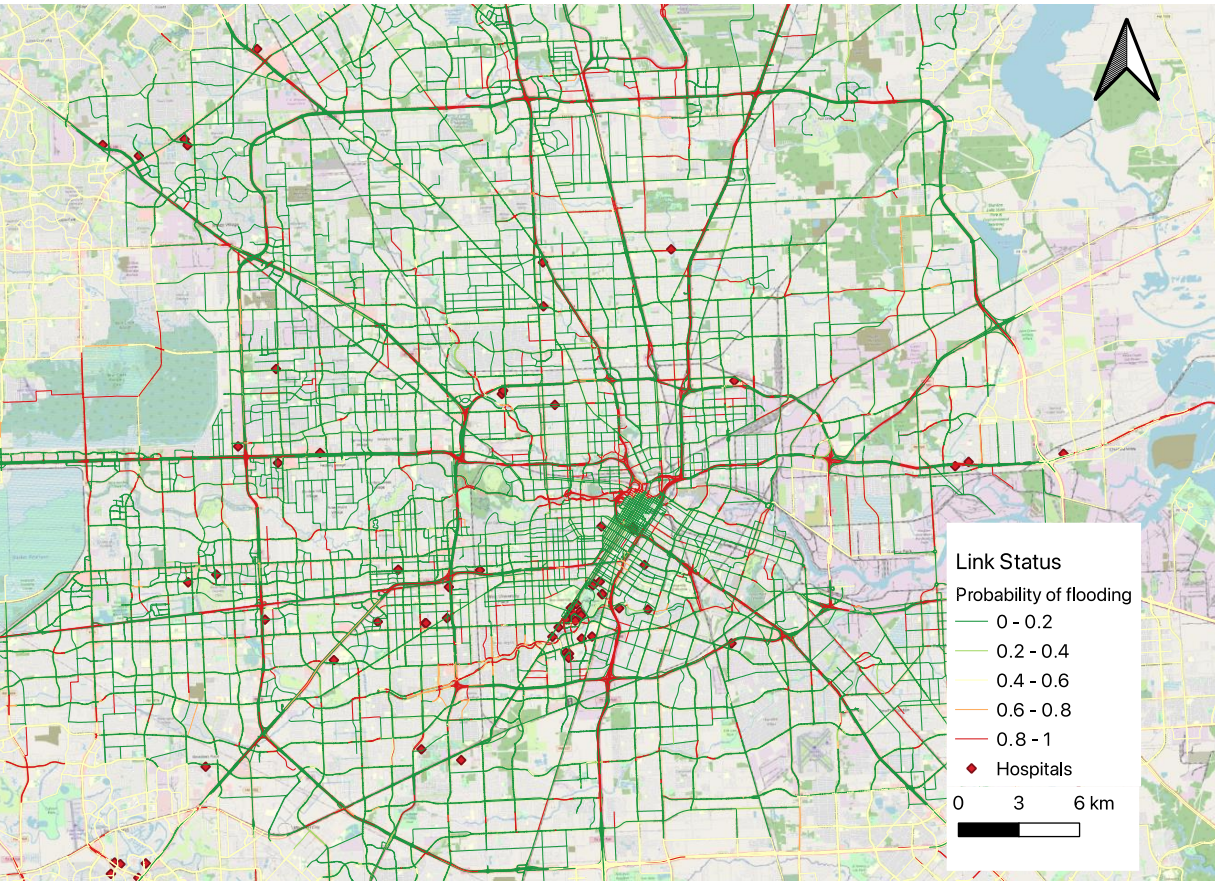




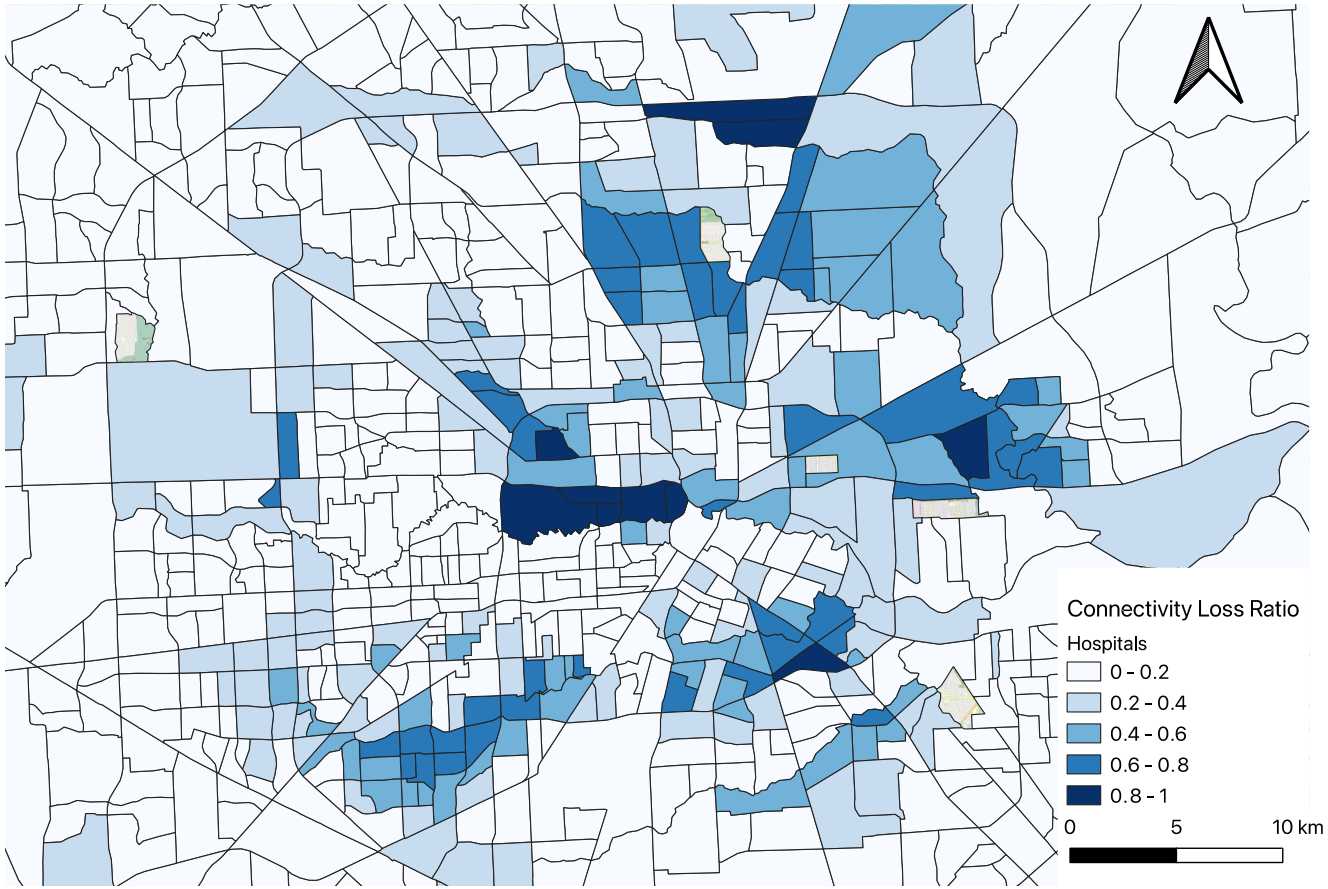


Low false negative

Results: Road Condition Data and Network Impacts



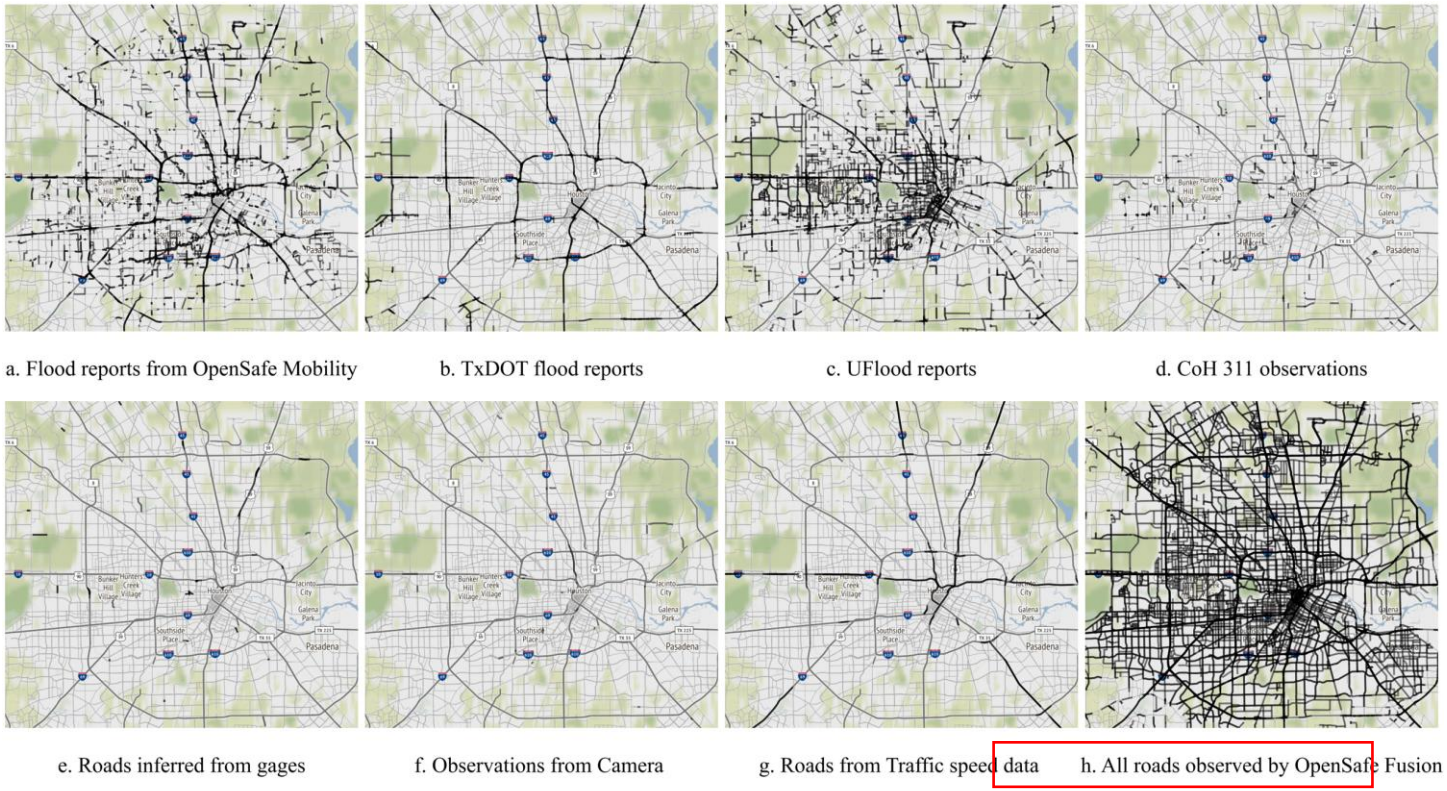
can track the status of 37,000+ links
(example from Hurricane Harvey at time 8/28/2017 5 am)

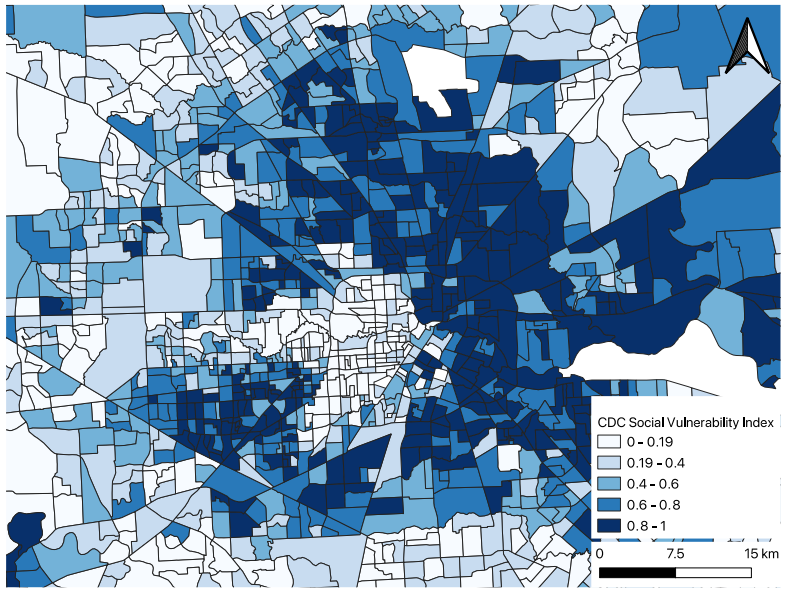


Network-level impacts of flooding on access to hospitals

OpenSafe Fusion Can Facilitate Reliable and Equitable Flood Sensing

- Communities can use their existing sources to improve situational awareness
- Equitable situational awareness data





Improved data availability by fusing observations from existing sources

RICE

THE WATER INSTITUTE

THANK YOU

MNARAYANASWAMY@THEWATERINSTITUTE.ORG

832-477-4404

Revolutionizing Flood Forecasting for Resilience and Recovery: Statewide Insights

1:00 PM – 3:00 PM / Wednesday, June 11, 2025

- *Nick Charnas, PE, CFM, Director of Water Resources, Halff (Moderator)*
- *F. Warren McKinnie, PE, CFM, GISP, Senior Manager, Streamline Technologies*
- *Muthu Narayanaswamy, PhD, Director of Coastal and Compound Flood Risk, The Water Institute*
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- *Thomas Frick, Chief Resilience Officer, SJRWMD*
- *Scott Letasi, PE, PMP, Engineering & Project Management Bureau Chief, SWFWMD*

Background: OCU Infrastructure

Orange County Utilities provides water resources and solid waste recovery services to protect and enrich the lives of the citizens and guests of Orange County

Population Served

- Water: 855,000
- Wastewater: 1,098,000
- Reclaimed Water: 415,000
- Solid Waste: 660,000

Service Area

- Over 660 Square miles

Major infrastructure

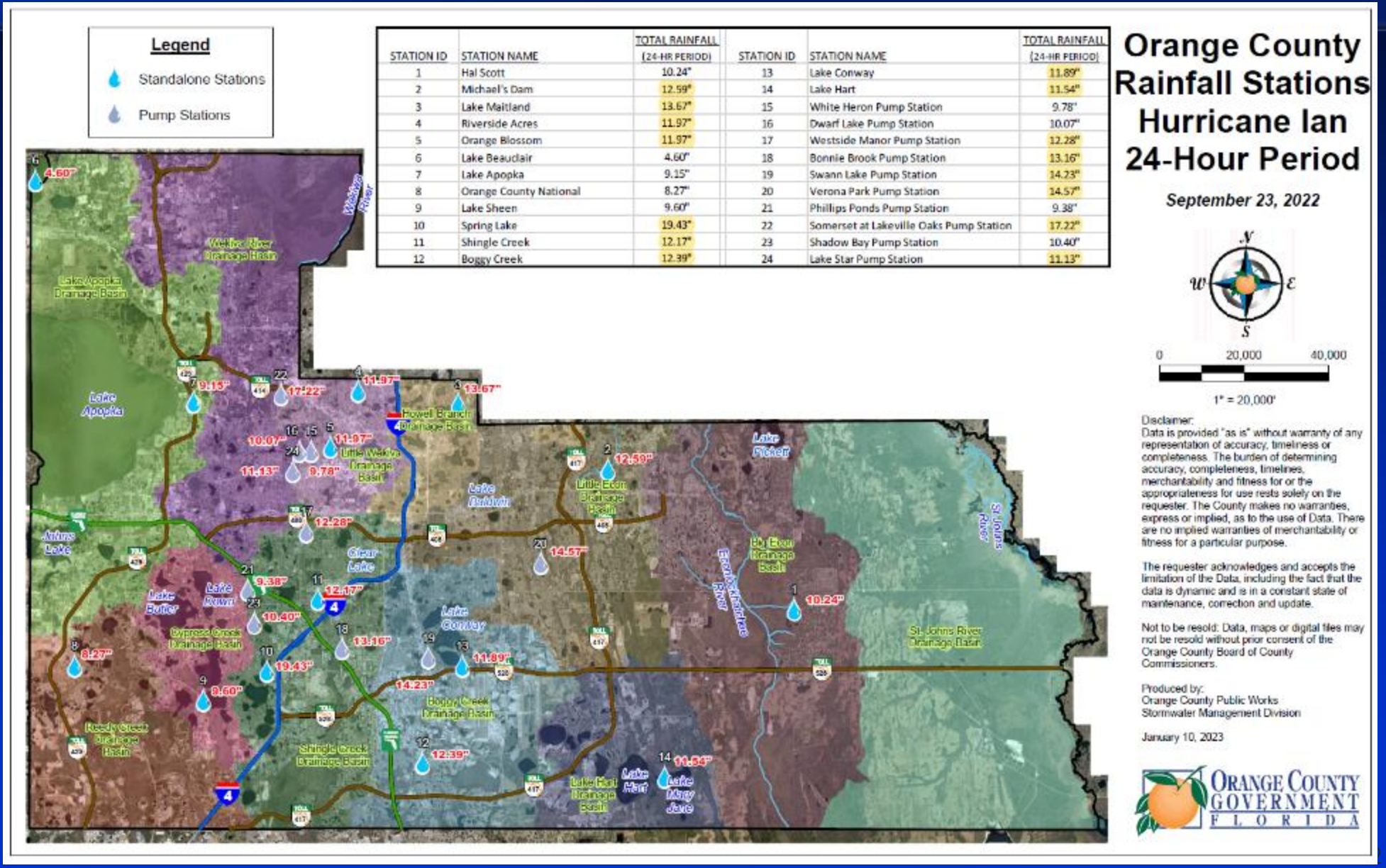
- 12 Water Treatment Plants
- 4 Regional Water Reclamation Facilities
- 870+ Wastewater Pump Stations
- Landfill and 2 Solid Waste Transfer Stations

OCU Storm Preparations & Recovery

- Goal of providing continuity of services and avoiding sanitary sewer overflows (SSOs)
- Orange County Utilities storm preparations and recovery involve <u>deploying and staging resources</u> throughout a large service area
- **Is there a better way?**

Hurricane Ian Rainfall Totals

- Almost 20” rainfall in a 24 - hour period in parts of Orange County
- 4.6” in other parts
- Not your uniform design storm!
- Flooding in areas outside the floodplain

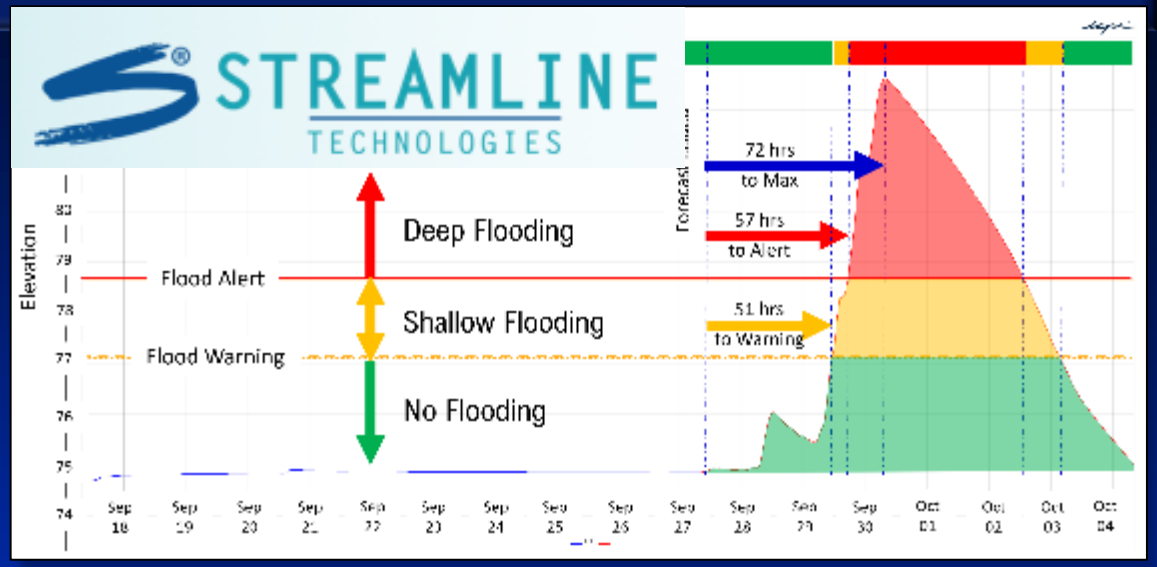


STATION ID	STATION NAME	TOTAL RAINFALL (24-HR PERIOD)	STATION ID	STATION NAME	TOTAL RAINFALL (24-HR PERIOD)
1	Hal Scott	10.24"	13	Lake Conway	11.89"
2	Michael's Dam	12.59"	14	Lake Hart	11.54"
3	Lake Maitland	13.67"	15	White Heron Pump Station	9.78"
4	Riverside Acres	11.97"	16	Dwarf Lake Pump Station	10.07"
5	Orange Blossom	11.97"	17	Westside Manor Pump Station	12.28"
6	Lake Beaudair	4.60"	18	Bonnie Brook Pump Station	13.16"
7	Lake Apopka	9.15"	19	Swann Lake Pump Station	14.23"
8	Orange County National	8.27"	20	Verona Park Pump Station	14.57"
9	Lake Sheen	9.60"	21	Phillips Ponds Pump Station	9.38"
10	Spring Lake	19.43"	22	Somerset at Lakeville Oaks Pump Station	17.22"
11	Shingle Creek	12.17"	23	Shadow Bay Pump Station	10.40"
12	Boggy Creek	12.39"	24	Lake Star Pump Station	11.13"

Real-Time Flood Forecasting (RTFF) Predictive Modeling

FloodWise Flood Forecasting

- Real-Time: Indicating what's happening right now based on surface and groundwater modeling
- Flood Forecasting: Predicting flooding up to 3 days in advance of storms based on forecasted rainfall
- Tied to NOAAs forecast and to Surge and Tidal Operational Forecast System (STOFS)
- Flooding at Street Level: Flood depths and durations at streets, homes, buildings, and critical infrastructure



- Identified "Risk Points" & critical elevations
  - 870 pump stations
  - 12 water supply facilities
  - 4 regional water reclamation facilities
  - 4 storage/repump & booster pumps

Rouse Road Master Pump Station

Fiscal Benefits Example

- Master Wastewater Pump Station sustained $7 million in damage during Hurricane Ian
- If RTFF models had been in place, the pump station could have been protected and the damage prevented or mitigated

Plan Emergency Preparedness

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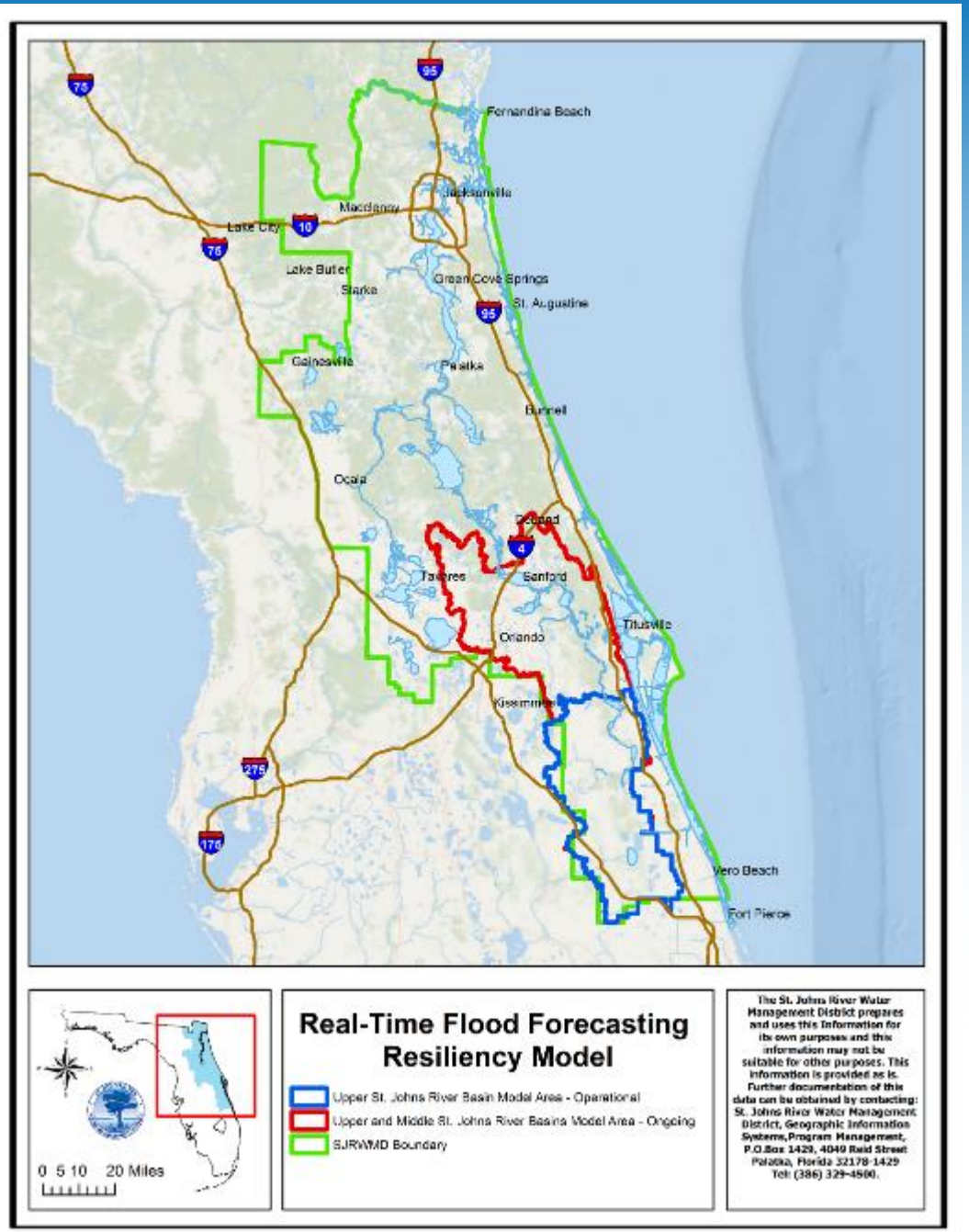
Upper & Middle St. Johns River Basin RTFF Model (Ongoing)

- Project goal:
  - Provide forecasts of water levels, flows, and flood inundations up to 10 days in advance
- Capabilities:
  - Forecast flood conditions at key water bodies and roads
- Completion date:
  - Upper – September 2024
  - Middle - October 2027 (Anticipated)

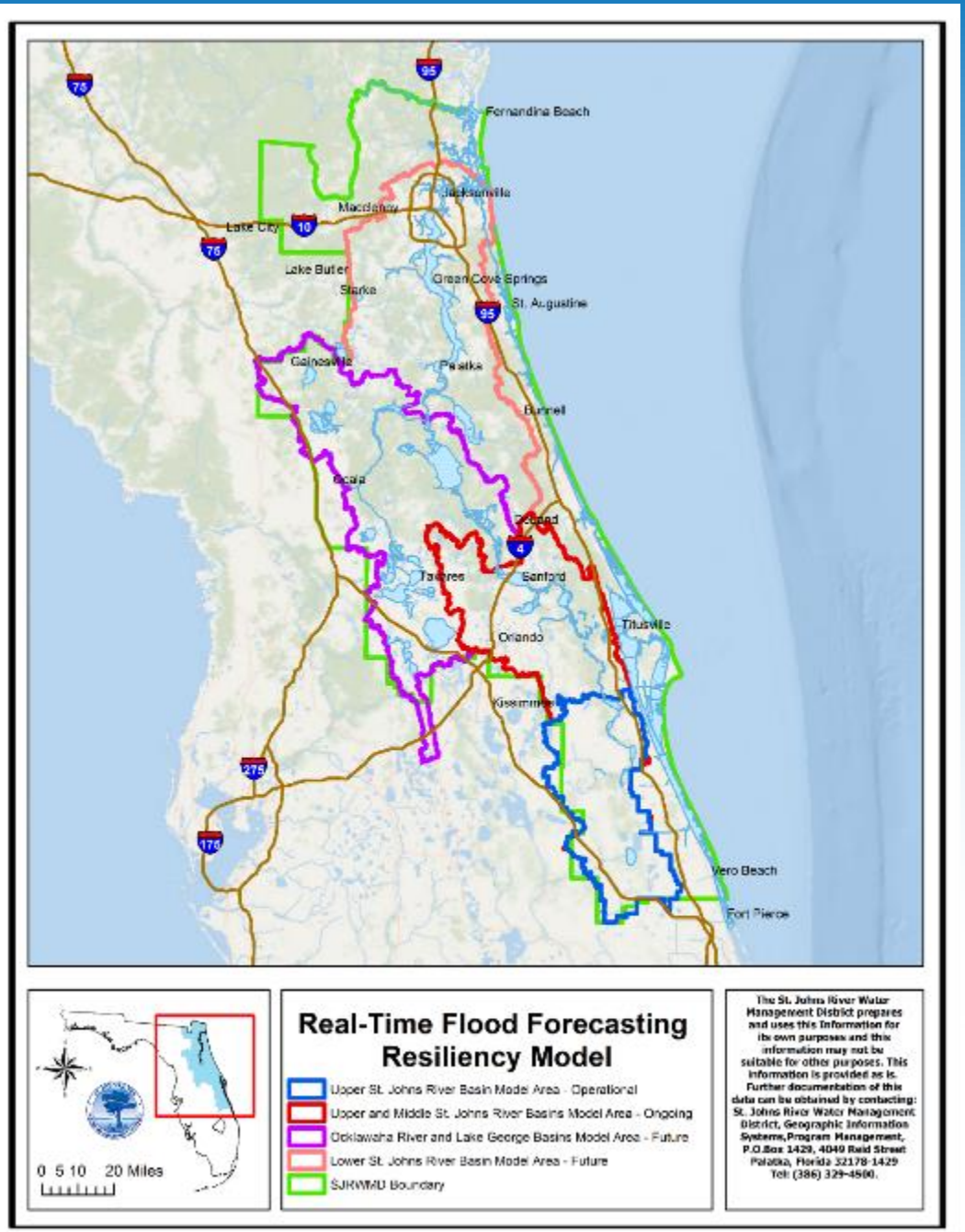


St. Johns River Water Management District

Future RTFF Models

- Project goal:
  - Expand the model to cover the entire St. Johns River
  - Incorporate real time structural operations

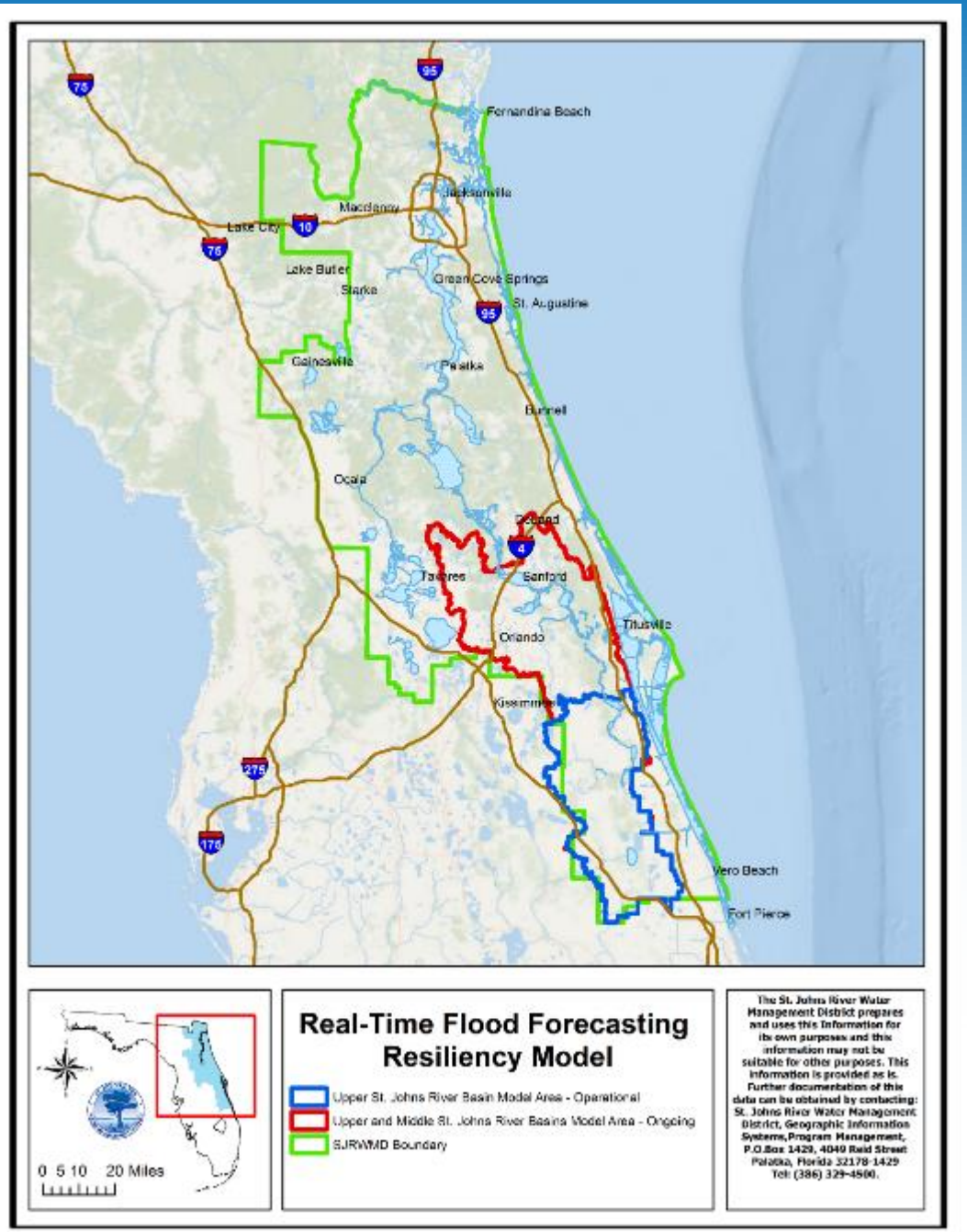
Model	Funding	Anticipated Completion Date	Capabilities
Lake George Basin & Ocklawaha River Basin	SJRWMD plans to apply for a Resilient Florida Grant in 2026	September 2030	Forecast flood conditions at key water bodies and roads
Lower St. Johns River Basin	SJRWMD plans to apply for a Resilient Florida Grant in 2027	September 2031	Forecast flood conditions at key water bodies and roads



St. Johns River Water Management District

Hurricane Exercise Collaboration (Future)

- Project goal:
  - Support the annual hurricane exercise to enhance emergency preparedness and response capabilities
- Capabilities:
  - Forecast flood conditions from a hypothetical hurricane event
  - Provide forecasted flood stages and inundation extents before, during, and after the event
- Funding: SJRWMD
- Tentative date: May 2025 or 2026



St. Johns River Water Management District

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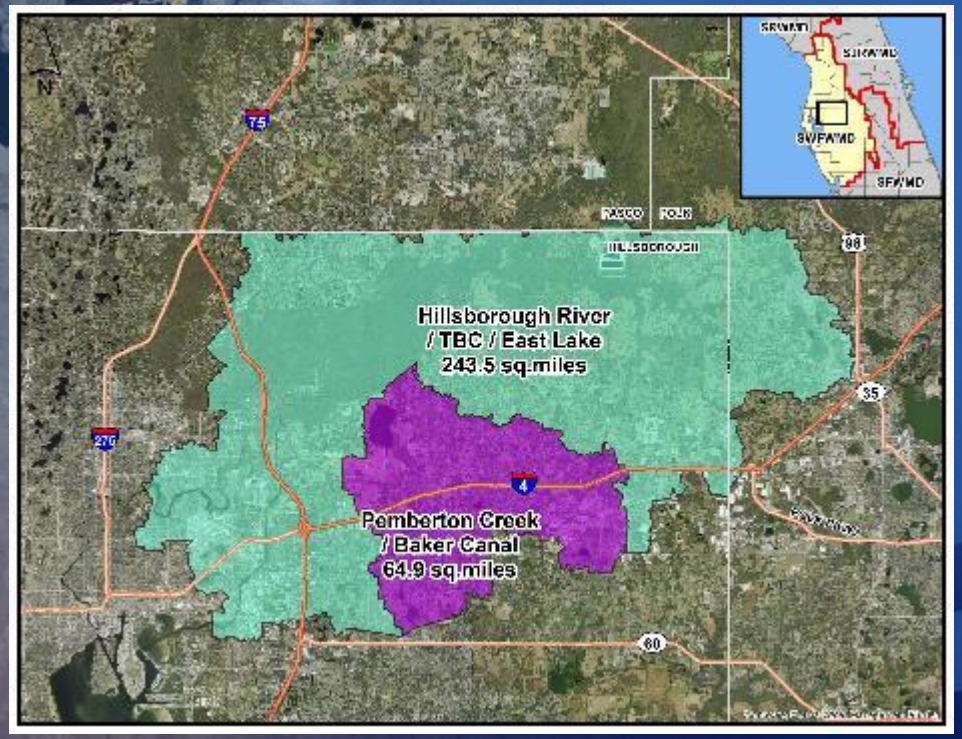
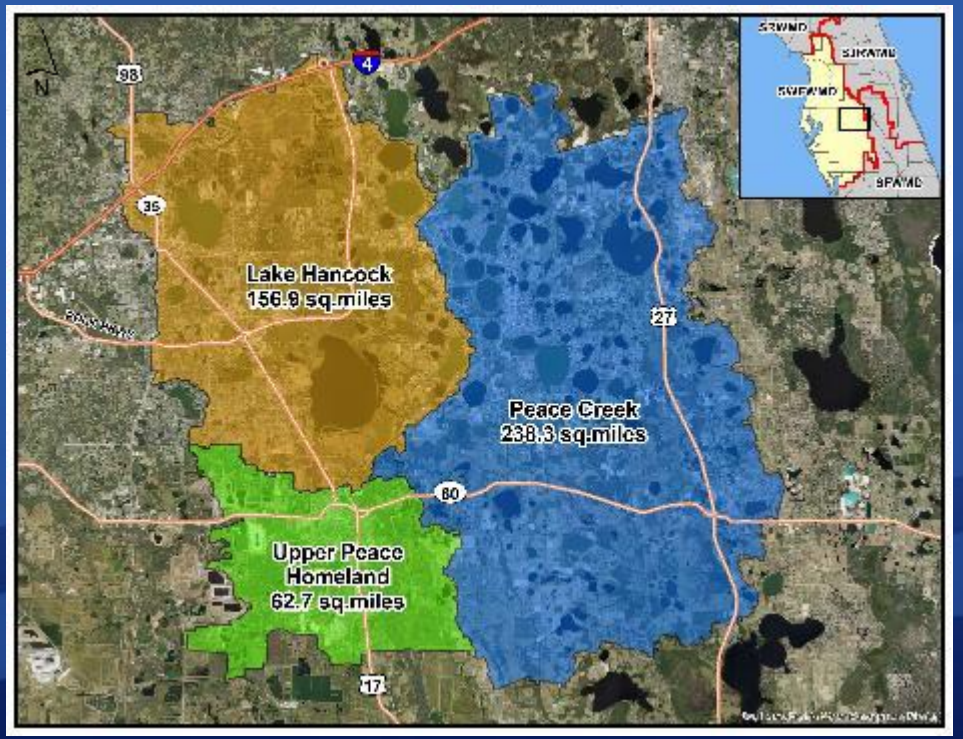
Ongoing District Initiative Projects

Hillsborough River RTFF

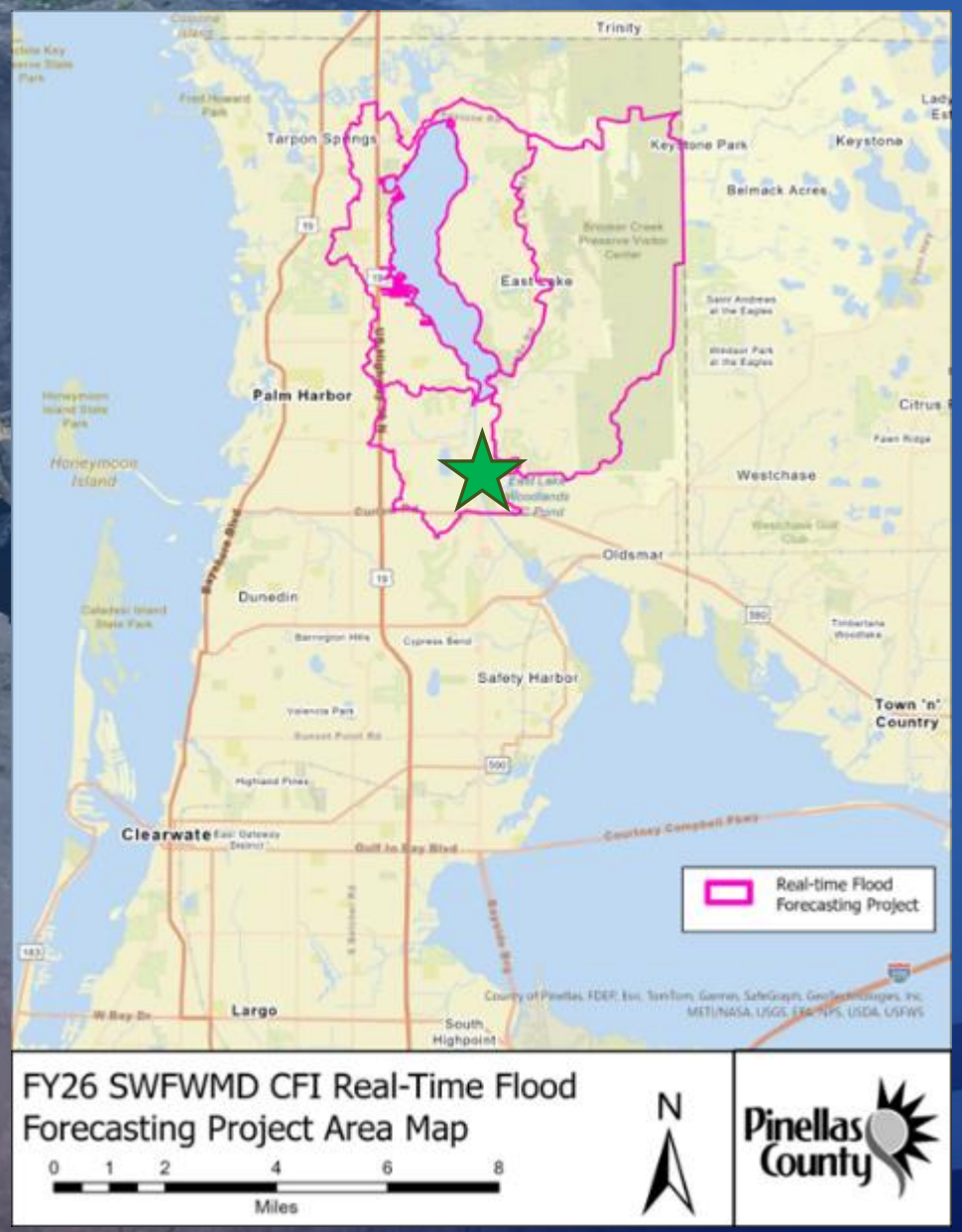
Flint Creek RTFF

Upper Peace River RTFF





Southwest Florida Water Management District



(Q431) PINELLAS COUNTY RTFF – PHASE 1

- Real Time Flood Forecasting project for Brooker Creek, Lake Tarpon and South Creek watersheds
- Combining existing models with future rainfall and surge predictions
- Assist in prediction of water levels upstream of District water control structure S-551
- $600,000 ($300,000 District)
- Score 90