



Integrating Scalable Roadway-Level Flood Warning Sensors with Dynamic 2D Floodplain Modeling: A “Bottom-Up” Approach

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& ASSOCIATES, LLC

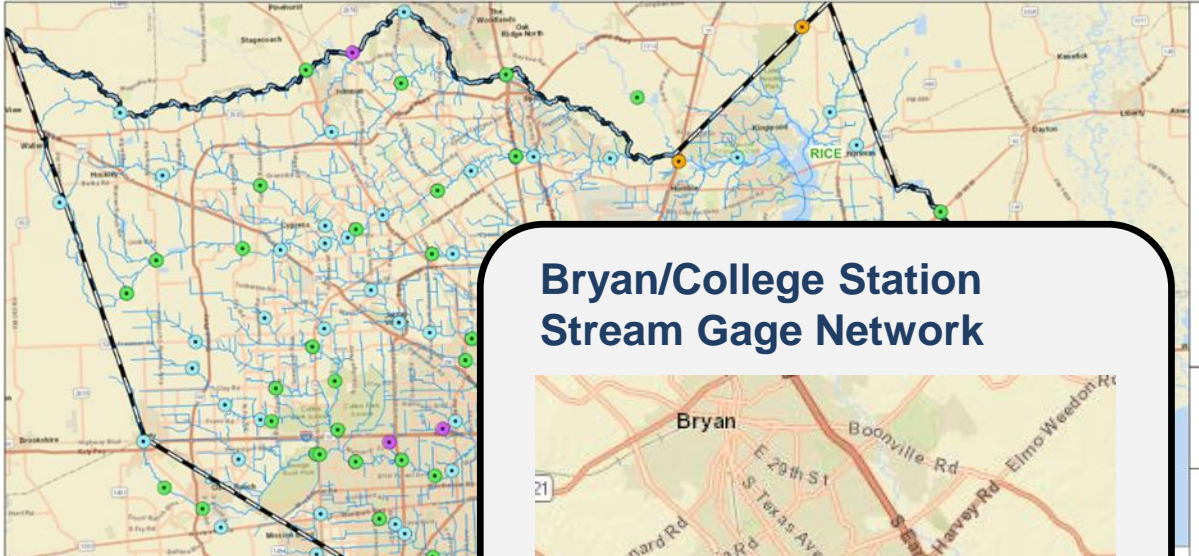
In the News



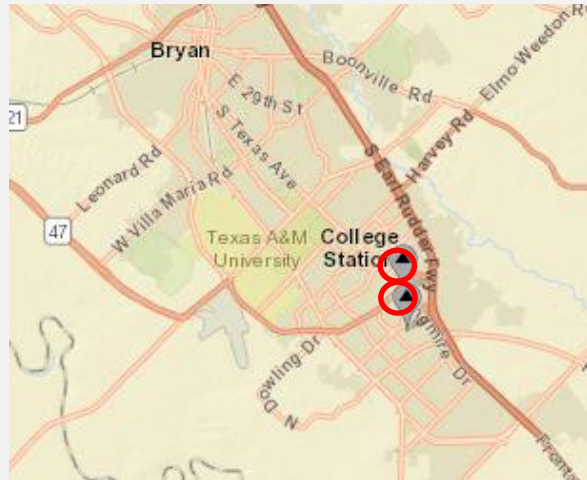
May 8th, 2019 Rainfall Events (Grimes County)

“Gedon Bowman with **Grimes County** Road and Bridge says due to flooding, they've been **shutting down roads all day**. ‘We have been putting out ‘High Water’ signs road closed signs. **There is just water everywhere,**’ says Bowman. It's not just the FM and County Roads flooding. Water is only a few feet away from parts of Highway 30.”

Harris County Stream Gage Network



Bryan/College Station Stream Gage Network



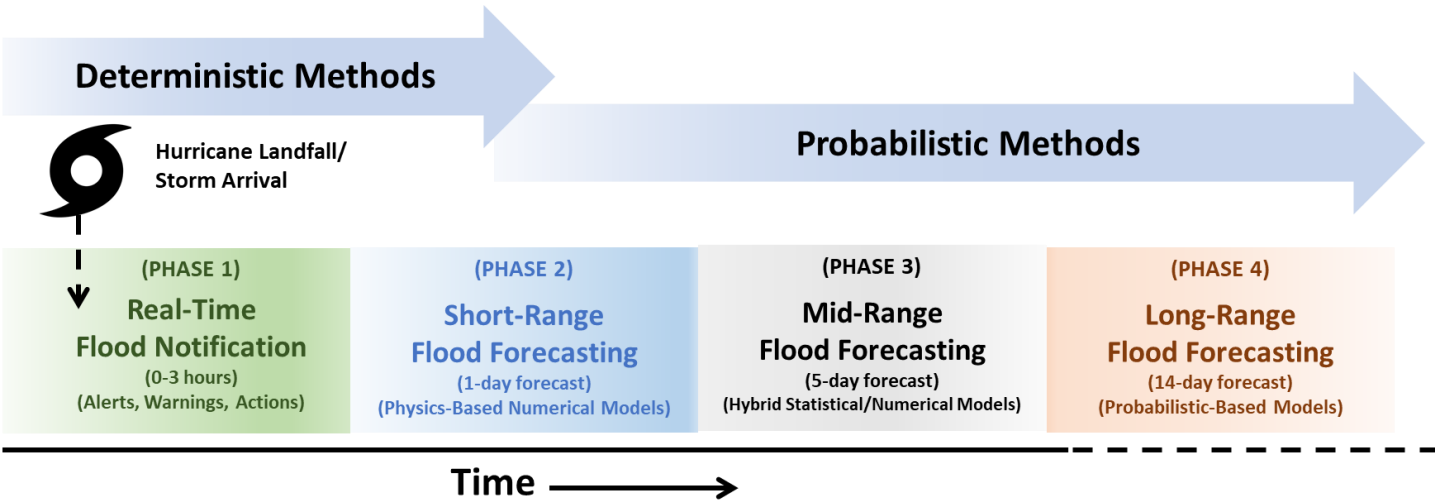
Motivation

- Inform roadway closures
- Have stream gauges (1D measurements)
- Need overland gauges (2D measurements)
- Improved OEM/Citizen **MOBILITY**
- Notify at Neighborhood-Block Levels
- Cost of traditional gages
- Ground truthing forecast models
- Serve rural and under gauged communities



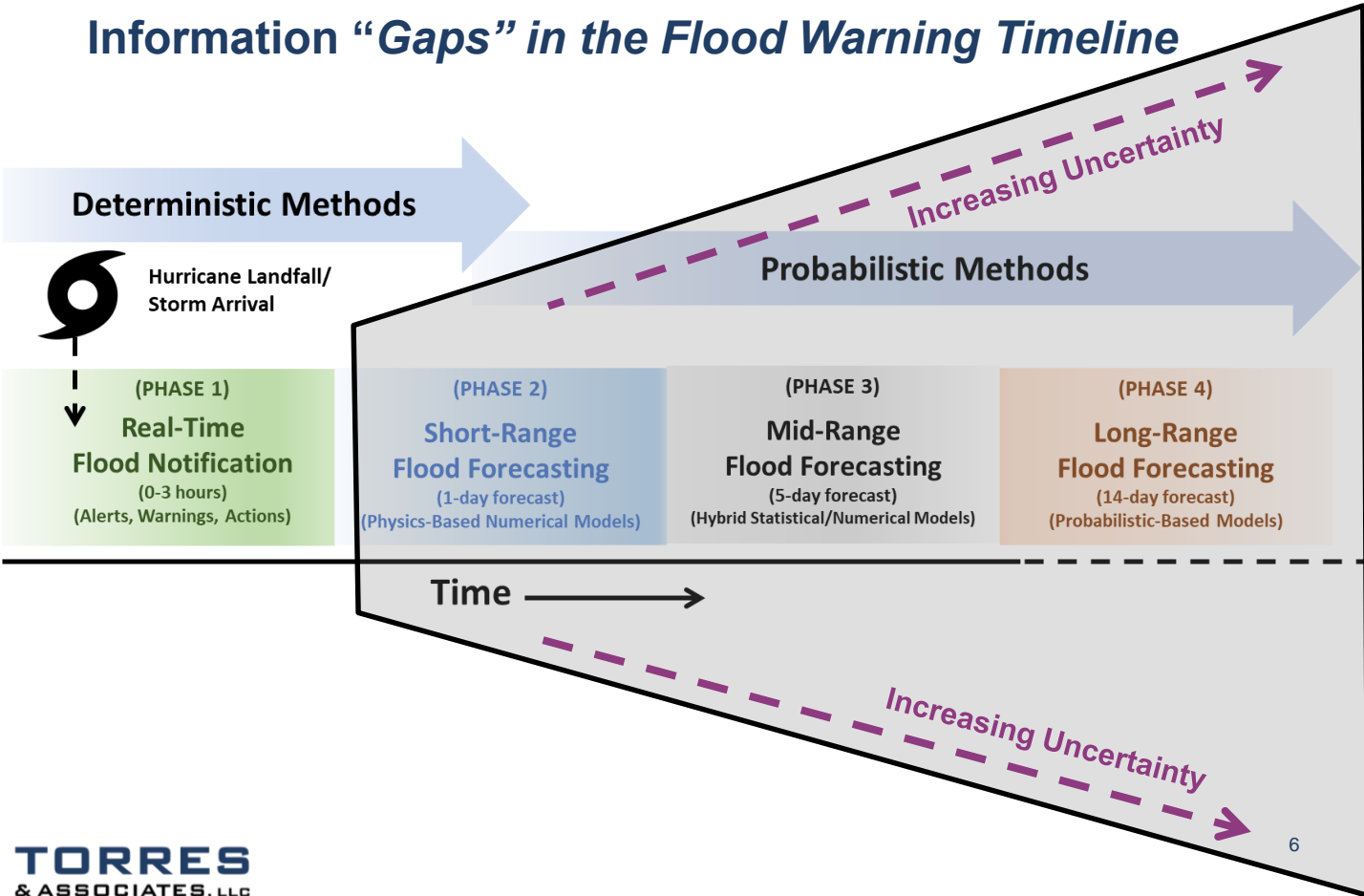
Motivation

Information “Gaps” in the Flood Warning Timeline



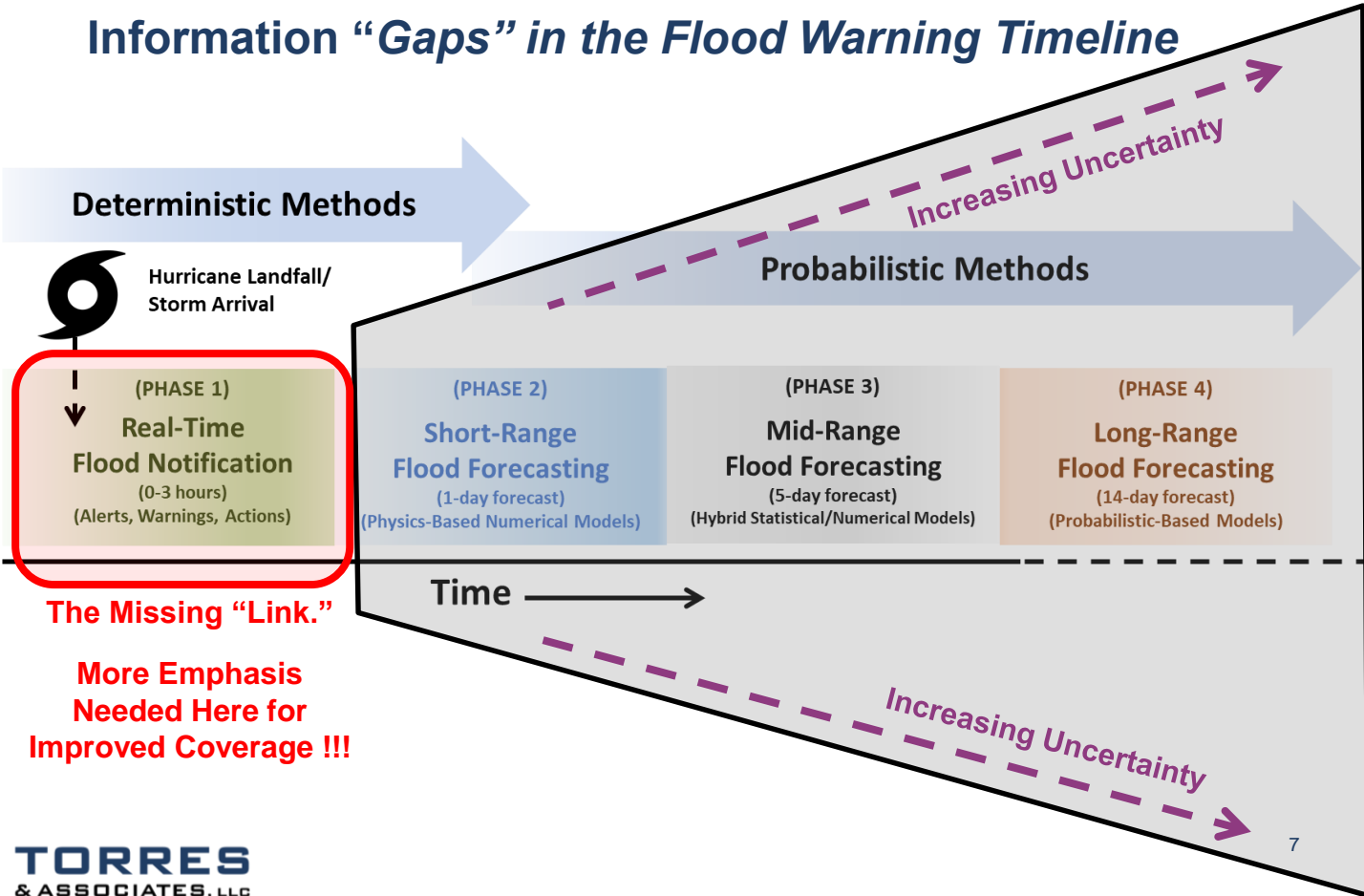
Motivation

Information “Gaps” in the Flood Warning Timeline



Motivation

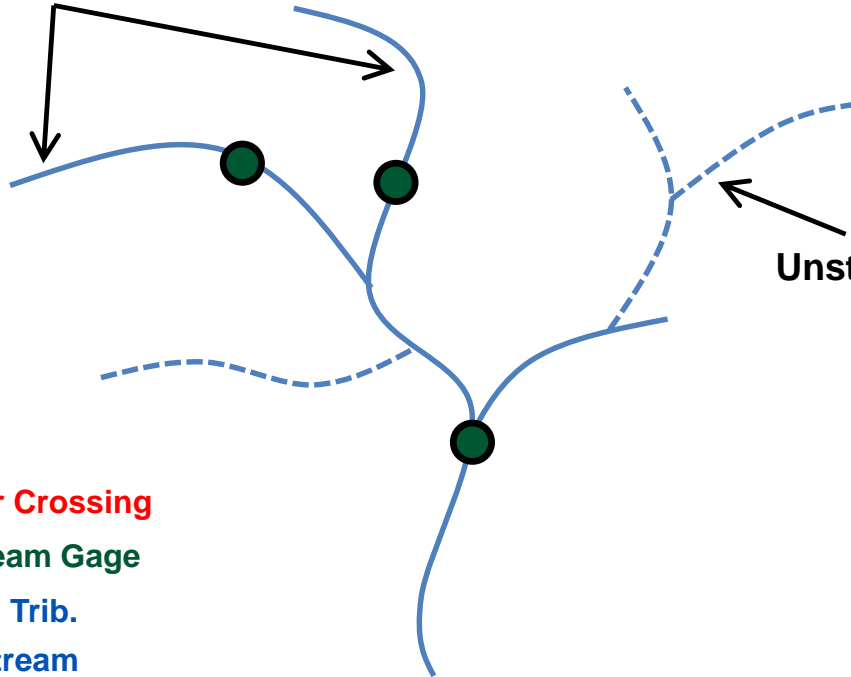
Information “Gaps” in the Flood Warning Timeline



Motivation

Traditional Stream Gauge Network

Studied Streams



Unstudied Tribs

 = Low Water Crossing

 = USGS Stream Gauge

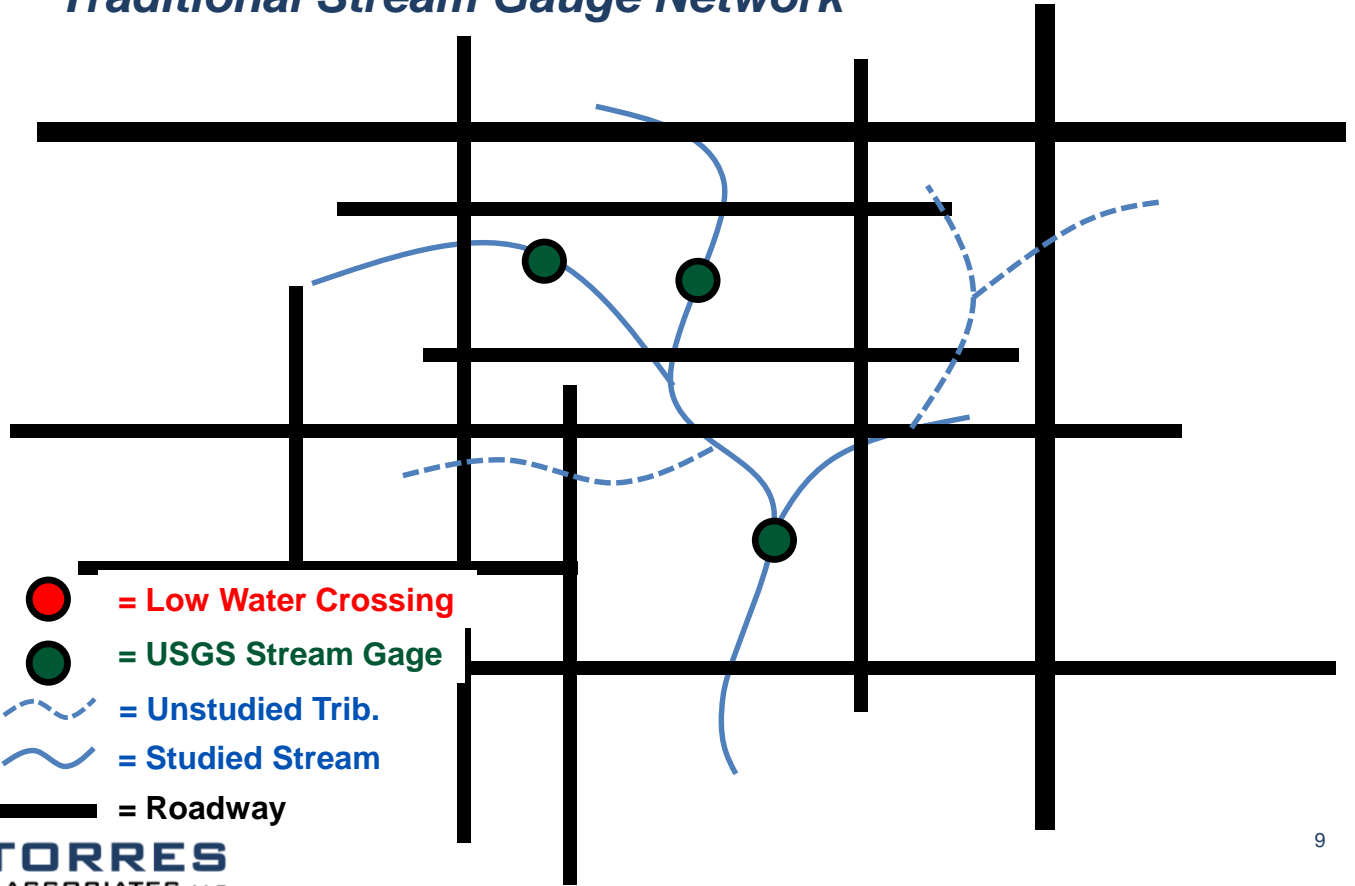
 = Unstudied Trib.

 = Studied Stream

 = Roadway

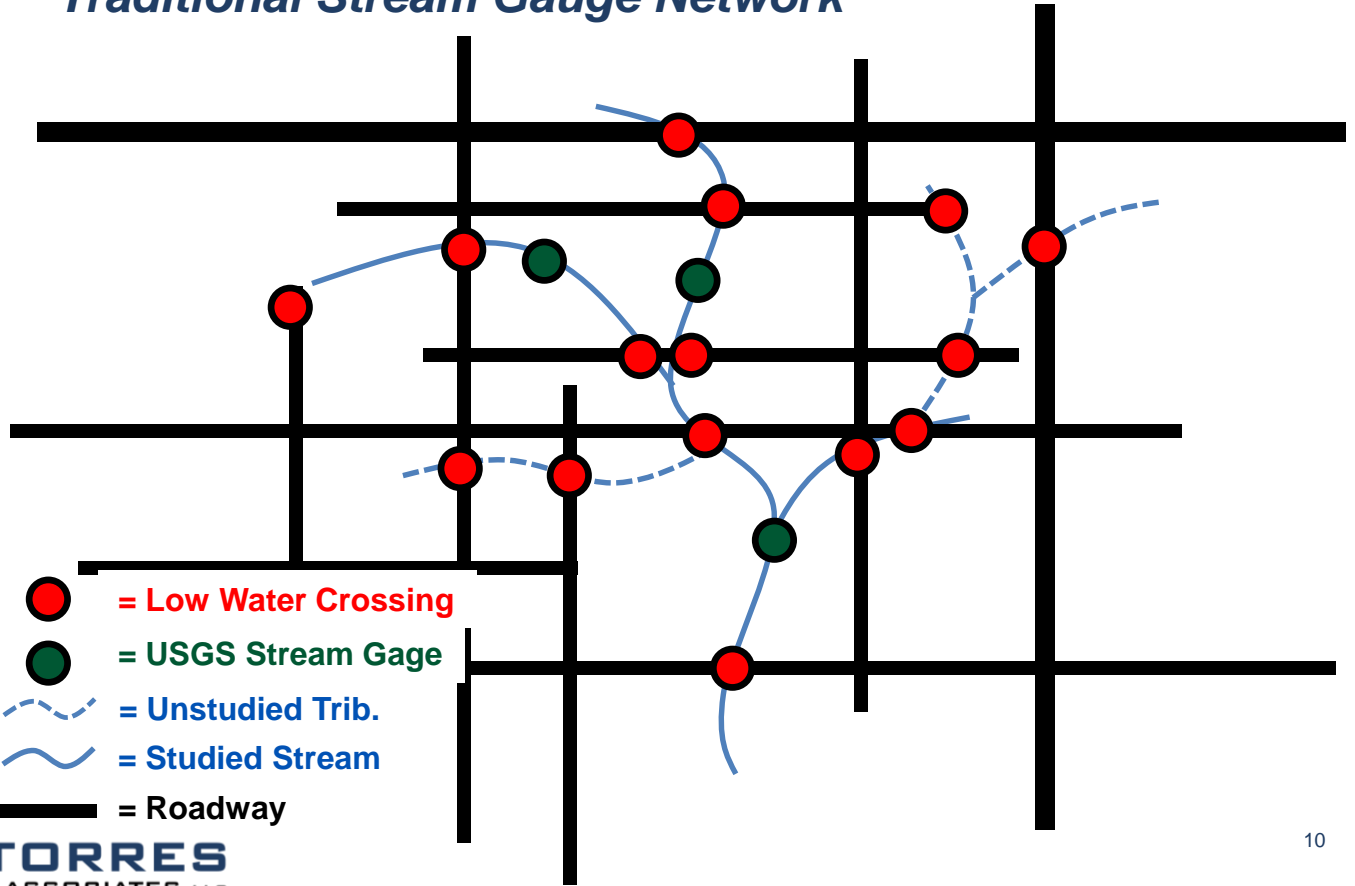
Motivation

Traditional Stream Gauge Network



Motivation

Traditional Stream Gauge Network



Flood Notification: The “Bottom-Line”

- **A**nalyze data
- **M**ap flood risks in real-time
- **C**ommunicate flood hazard information to emergency managers and the greater public
- **A**ction
 - Evacuation
 - Flood gate operation
 - Protection of property



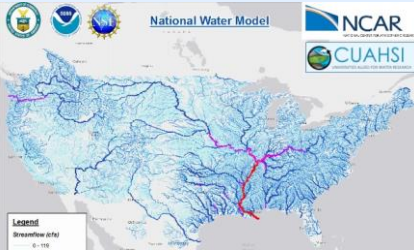
KHOU



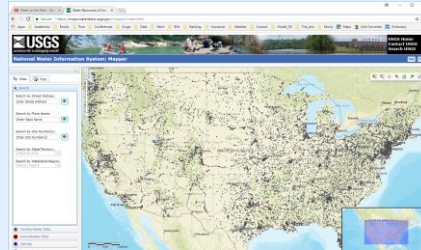
Houston OEM

Modern Day Flood Warning Systems ...

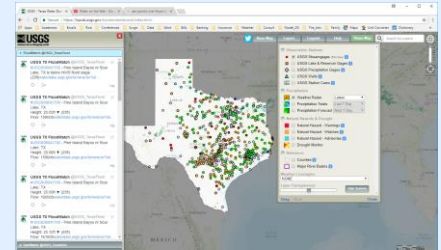
National Water Model



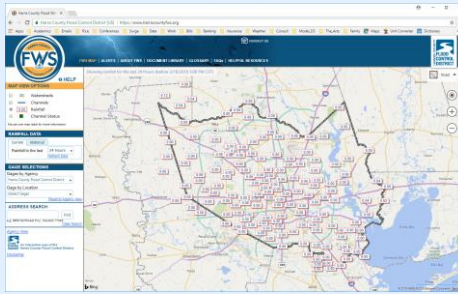
National Water Info. System



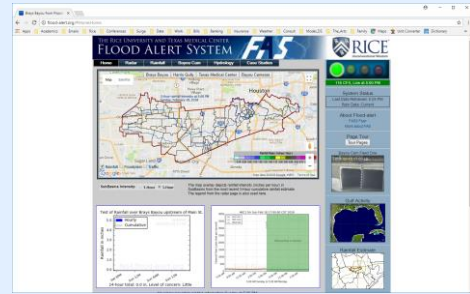
Texas Water Dashboard



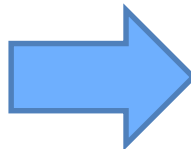
HC Flood Warning System



Rice/TMC Flood Alert System



Thinking Outside the Stream Overbank



Re-Imagining Flood Gauge Signage

The “Bottom Up” Approach for Unstudied Crossings, Neighborhoods, and & Rural Areas



Trends in Road Signage



Re-Imagining Flood Gauge Signage

The "Make Over" (Proof-of-Concept)

Led Lights



Control Box

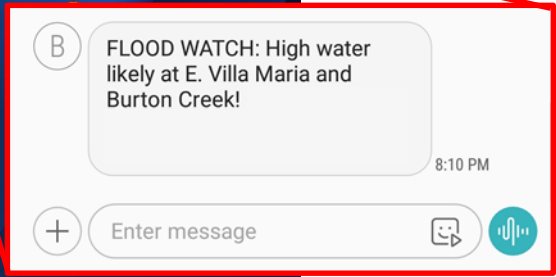
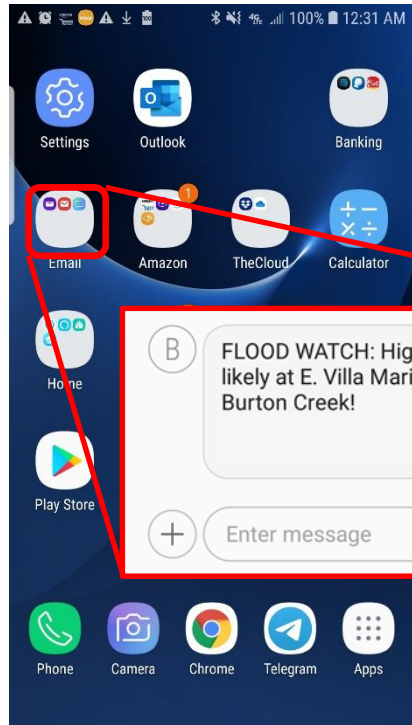
- Microcontroller
- Pressure/Humidity
- GSM
- GPS
- Power Supply



Capacitance Based Water Sensor ("Wet/Dry")



Cell Phone Home Screen



SMS Text Message Notification

Re-Imagining Flood Gauge Signage

The “Make Over” (Proof-of-Concept)

Led Lights



Control Box

Microcontroller
Pressure/Humidity
GSM
GPS
Power Supply



Capacitance
Based Water
Sensor
 (“Wet/Dry”)

→ **Pros**

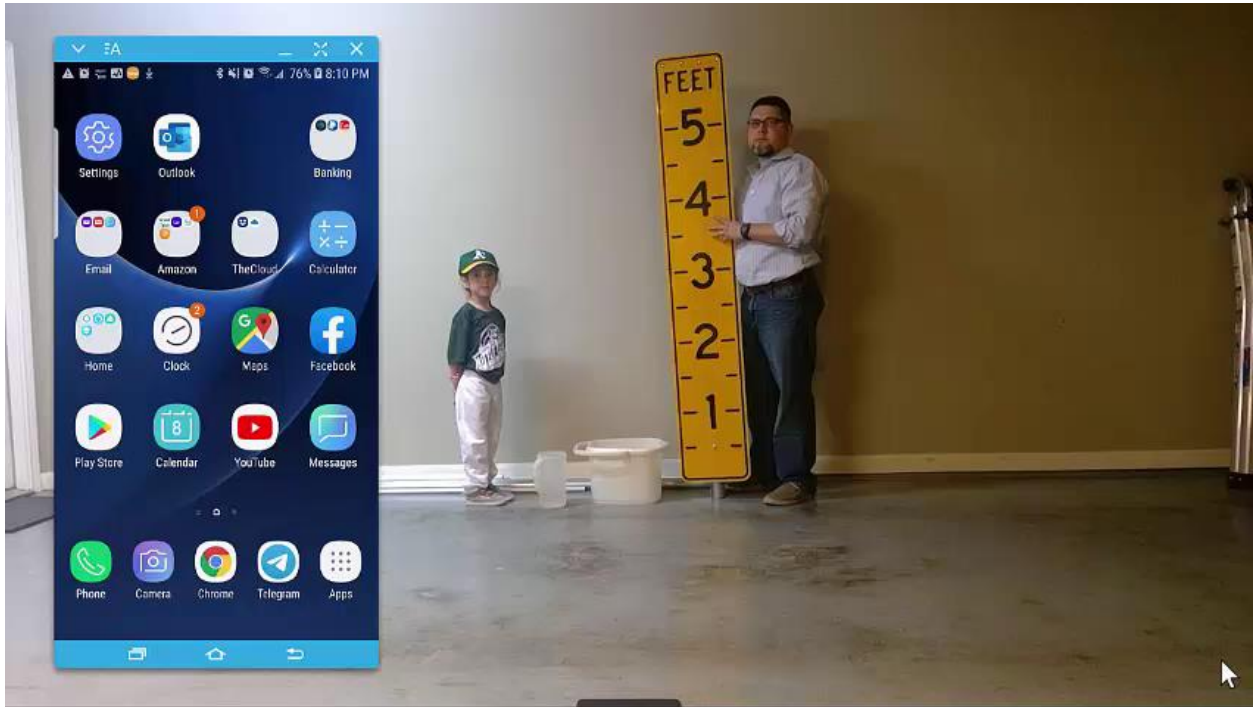
- Lack of moving parts
- Operates in “sleep mode” (long battery usage, 9 to 12 months)
- Can retrofit existing signs
- Wet/Dry Notification
- Can add more sensors in series to indicate depth

→ **Cons**

- Needs improved safeguarding
- Point-based sensors
- No time-series based observations

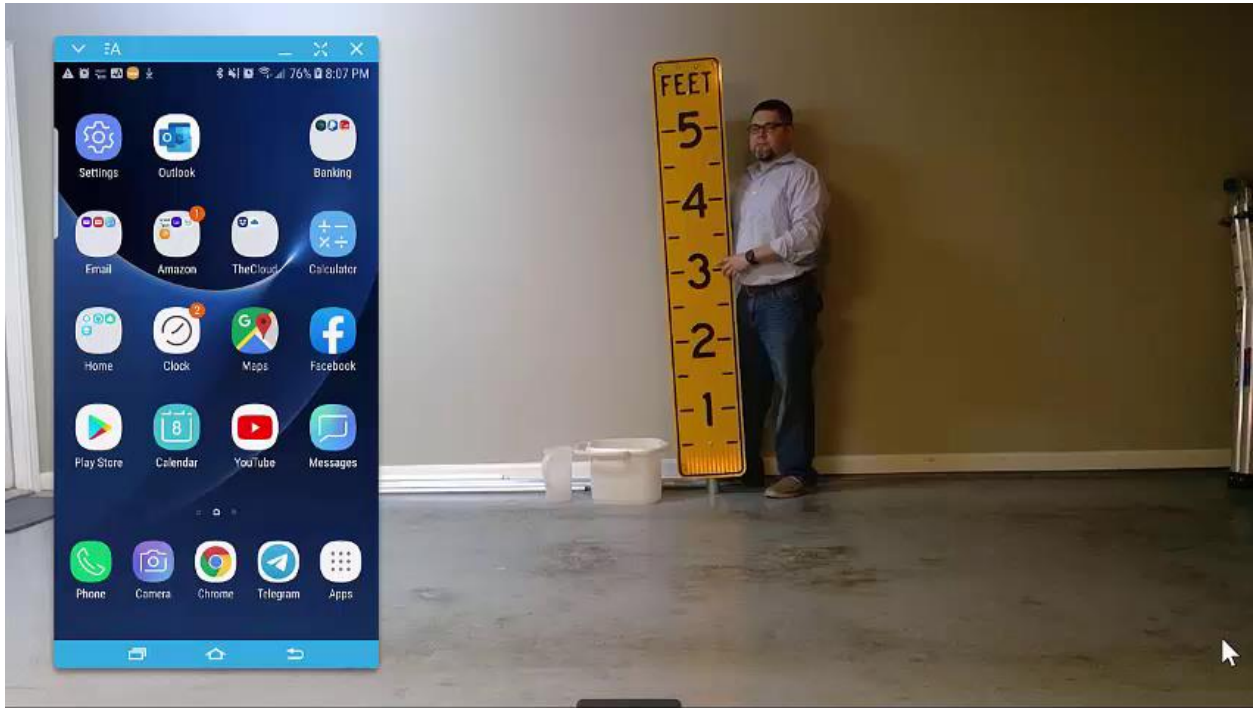
Re-Imagining Flood Gauge Signage

The “Make Over” (Proof-of-Concept, Demo 1)



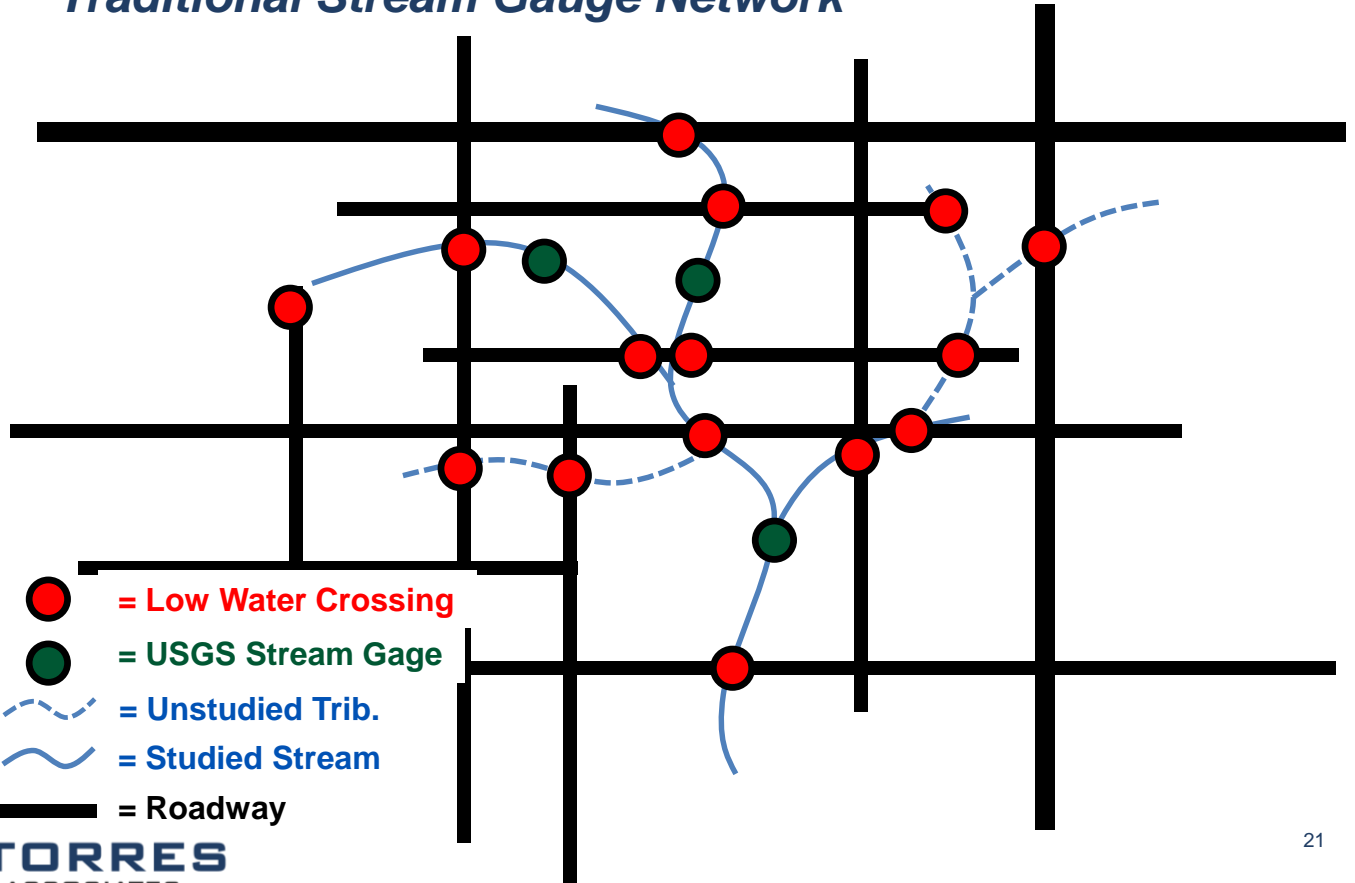
Re-Imagining Flood Gauge Signage

The “Make Over” (Proof-of-Concept, Demo 2)



RECALL

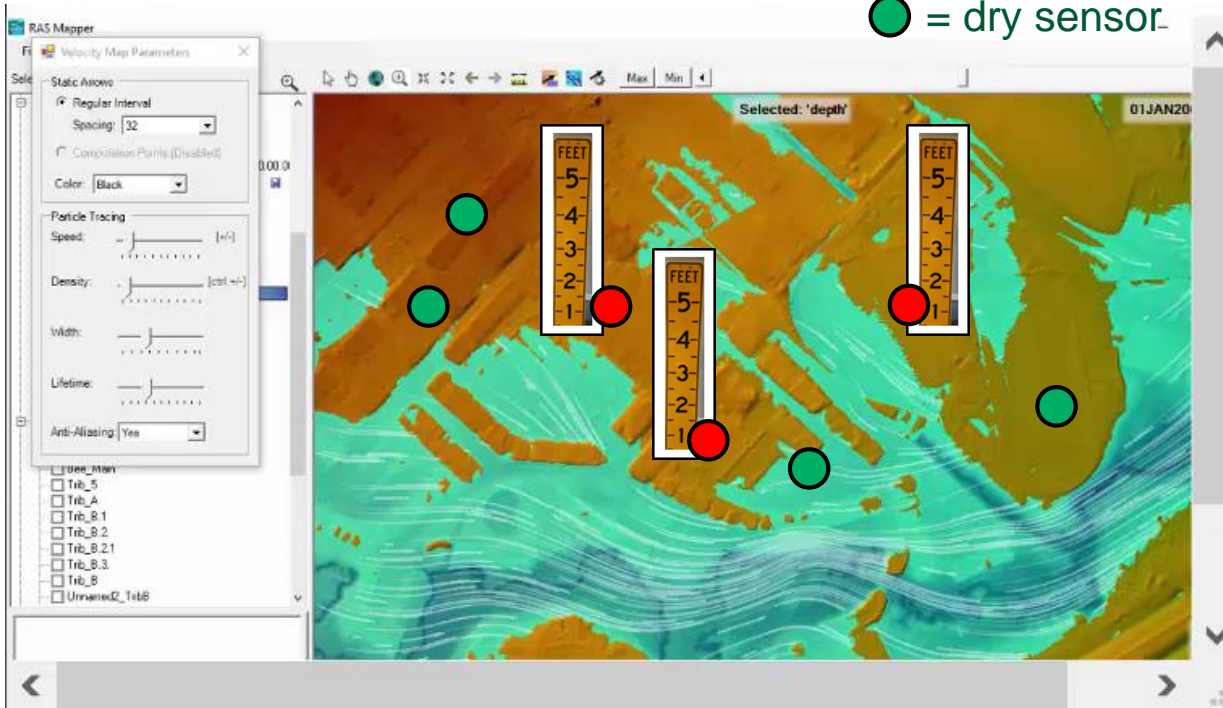
Traditional Stream Gauge Network



Integrating Sensing & 2D Modeling

The “Make Over”

● = wet sensor
● = dry sensor



Next Steps

- Execute Pilot Gauge Network
- Test with Real Storm Events
- Evaluate Seasonal Effects
- Evaluate O&M Costs
- Optimize Performance
- Diversify sensor types
- Polish Mapping Interface
- Integrate 2D Modeling
- Apply Forecasting Methods



Legitimate Trends in FWS

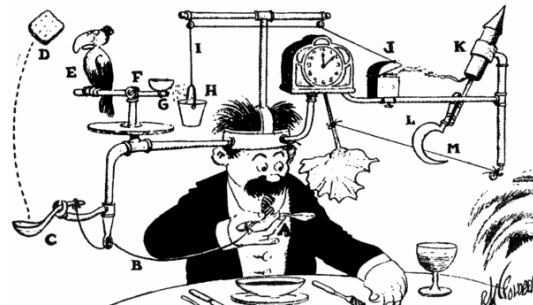
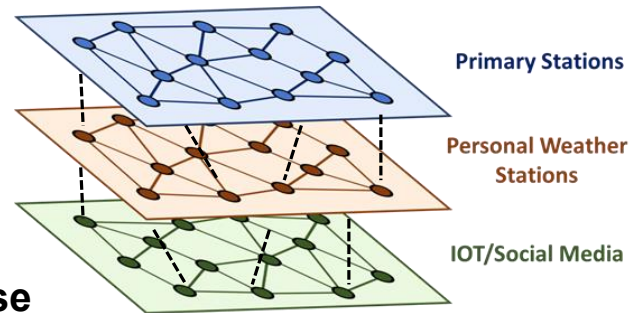
- Accelerated Real-Time (Machine Learning)
- Global standardization of hydrologic time series data (“WaterML”, HydroDatabase)
- USGS providing open data access.
- NOAA Big Data Project with AWS
- **IoT Based Technologies**
- **Real-time water quality monitoring!**



usatoday

Take Home Message

- FWS can be as sophisticated as you need (no silver bullet).
- Technology is not the limiter
- No FWS is going to be 100% accurate. Better to be less wrong more often than the opposite
- **Multiple Lines of “Sensor” Defense**
- **Keep it simple stupid (KISS)**



Questions?

Thank you!

Hardware



Jacob M. Torres,
PhD, PE, CFM
Hydrology & Water
Resources Engr.

Software



Rebecca Carlson,
Graduate Engineer
Computer Science

“With poor assumptions, an engineer can make more mistakes with a computer in a millisecond, than with a lifetime of common sense.”

~ Quote for Modelers, (author unknown)

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