

The background image shows a city skyline with several tall skyscrapers under a cloudy sky. In the foreground, there is a wide river with brown, murky water. A line of green trees separates the river from the city buildings. A semi-transparent white horizontal band is overlaid across the middle of the image, containing the FAS5 logo and text.

# FAS5

FLOOD ALERT SYSTEM



RICE

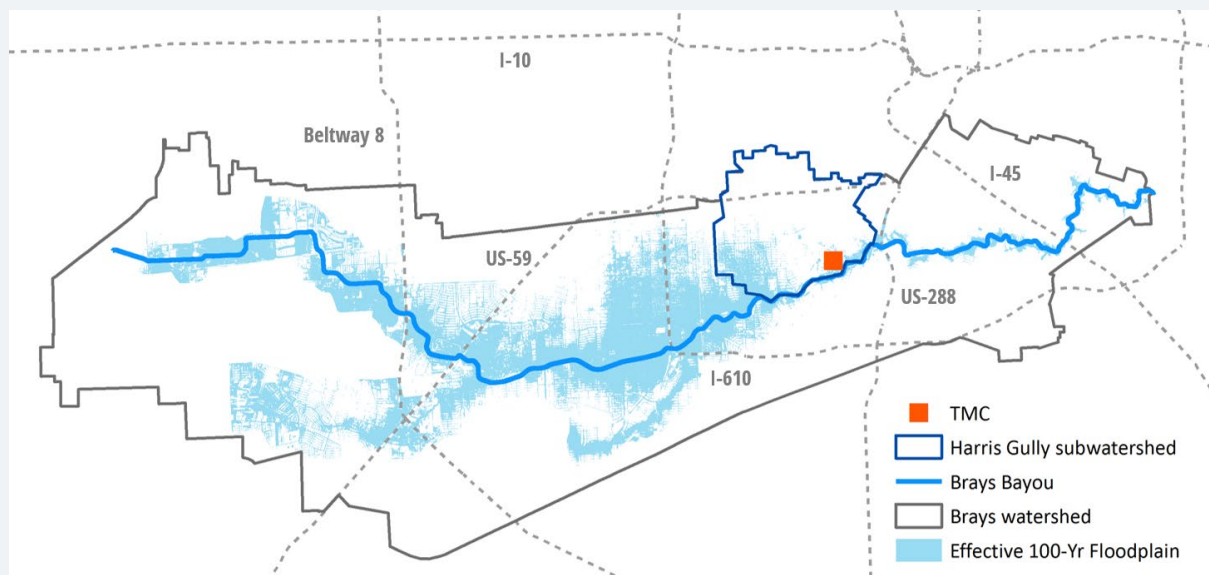
TMC

TEXAS  
MEDICAL  
CENTER

## Flood Alert Systems

# What is FAS5?

FAS5 is the latest version of the Rice/TMC Flood Alert System designed by Dr. Philip Bedient, Dr. Nick Fang, and Dr. Baxter Vieux. FAS5 uses real-time radar rainfall data to predict flood levels at critical locations. Over the last twenty years, TMC has used the FAS system to determine when to implement emergency protocols regarding the placement and/or closing of gates and doors in order to prevent flood damage to the Texas Medical Center. These systems are designed for specific TMC end-users, and real-time predictions and flood warnings are also available to the public online.



Overview of Brays Bayou Watershed and the effective 100-Yr Floodplain, including TMC's critical watch point, Harris Gully.

## FAS5 Results



Reliable and robust flood prediction with excellent performance for the past 20 years.



Increased lead time for flood warning and response.



Visualized Radar Rainfall over the watershed and individual sub-basins.

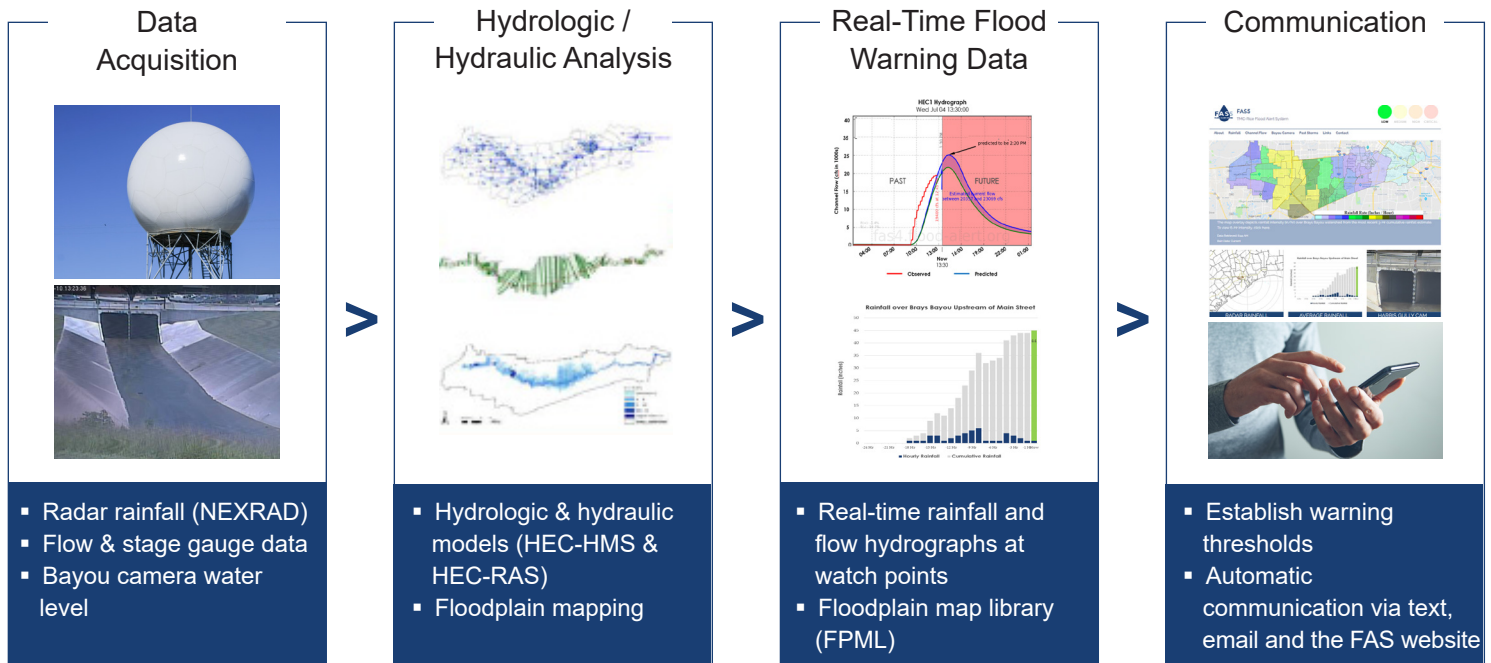


Communication for emergency response and operations.



## Flood Alert Systems

# How does FAS5 work?



### NEXRAD Radar Rainfall

Radar data reflects off of raindrops and is processed and calibrated by Vieux and Assoc., Inc. (VAI) in Oklahoma every 5 minutes. During a rainfall event, VAI radar rainfall data is delivered to Rice for 43 subbasins over Brays in 5 minute intervals. This process is repeated every 5-10 minutes during a storm as the overall hydrograph is developed and plotted within FAS5.

### Flow & Stage Gauge Data

A USGS stream flow gauge at TMC records the elevation and flow of water in Brays Bayou. FAS output is compared with this gauge data in real time to validate the model performance.

### Bayou Cameras

Bayou cameras provide vital water levels and visual confirmation during a flood event. The Harris Gully Gauge was selected as the critical point to view gauge activity for the Rice/TMC system. Gully levels are automatically communicated to TMC.

### Hydrologic Models

During a rainfall event, VAI radar rainfall data is used in the hydrologic model, HEC-1, to create flow hydrographs. For TMC, HEC-1 predicts the peak flow in Brays Bayou, which triggers a status change on the FAS5 website and sends a notification to TMC.

### Floodplain Maps

SSPEED created a library of floodplain scenarios that are representative of flooding conditions under different rainfall amounts using HEC-RAS. Radar Rainfall data are used to pull the corresponding floodplain during a storm event to give a user the extent of flooding that might be observed.

### Communication

Real-time flood information is communicated automatically via text, email, and/or the FAS website. On the website, warnings are indicated through the status tree. For TMC, a status change triggers a sequence of safety protocols, which could include closing flood gates or doors (example on page 4).

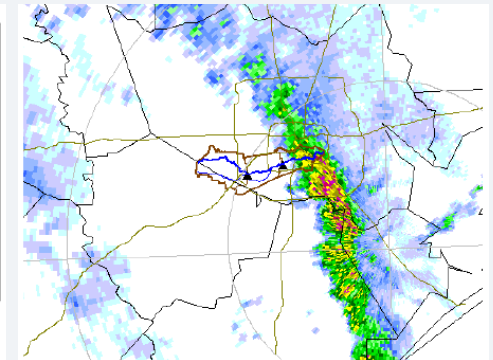
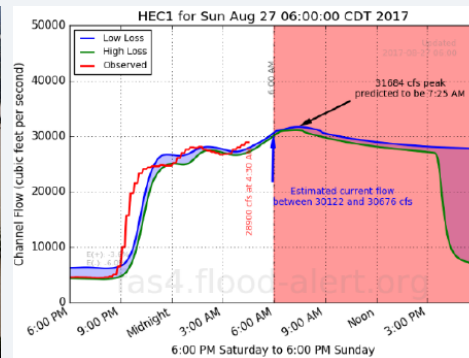


## Flood Alert Systems

# Past Performance

### HURRICANE HARVEY, 2017

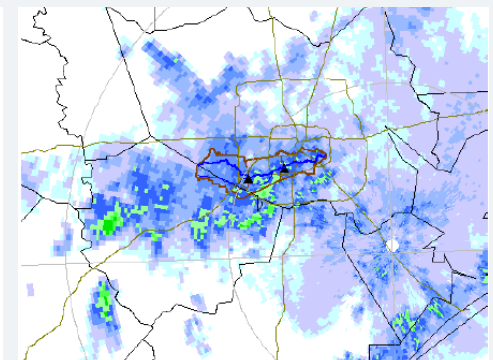
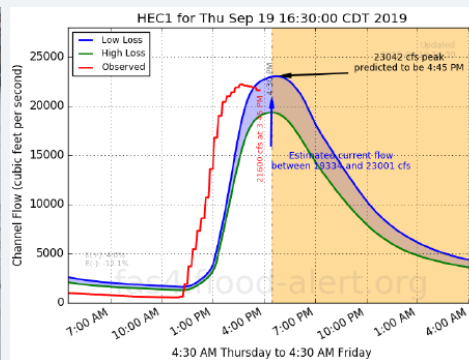
- Dates: August 26 – September 2, 2017
- Storm Duration: 5 days
- The devastating flooding caused more than 100 deaths, & caused \$125 billion in damage (source: Houston Chronicle).
- The Texas Medical Center received over 29 inches of rain over the week of Harvey.
- The USGS Gage for Brays Bayou on Main Street near TMC recorded a maximum gage height of 45 ft, which is 28 feet higher than its normal height.
- To read more about Harvey, follow this [link](#) to the Harris County Flood Control District (HCFCD).



Images taken during Hurricane Harvey: a) Interstate 69 flooded, b) Hydrographs of FAS4 performance, c) Radar Rainfall (Vieux & Associates, Inc.)

### TROPICAL STORM IMELDA, 2019

- Dates: September 16 – September 20, 2019
- Storm Duration: 3 days
- With some areas in Houston getting over 43 inches of rain, Imelda has caused five deaths and a total damage of over 5 billion dollars.
- TMC received 8.5 inches of rain in three days during Imelda.
- Water in Brays Bayou near TMC has reached a maximum height of 39 ft, in comparison to its normal height at 17 ft.
- To read more about Tropical Storm Imelda, follow this [link](#) to NBC News.



Images taken during Tropical Storm Imelda: a) Interstate 59 flooded, b) Hydrographs of FAS4 performance, c) Radar Rainfall (Vieux & Associates, Inc.)

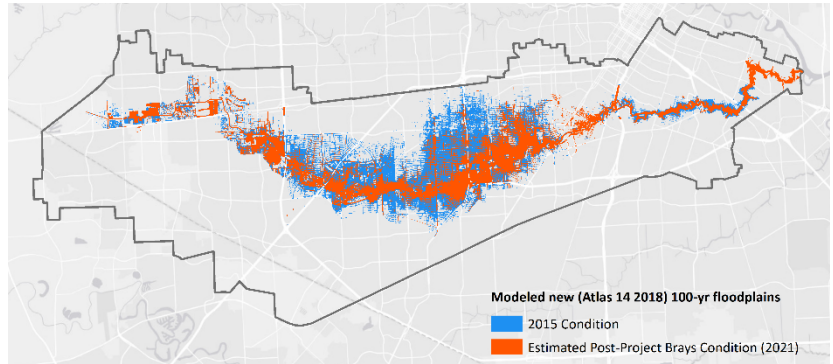
Please visit [speed.rice.edu/past-storms](https://speed.rice.edu/past-storms) to view more.

## Flood Alert Systems

# FAS5 History & Authors



Image of TMC floodgate



Floodplain Map for 2018 Atlas 14 100-yr with and without Project Brays

## Development of FAS (1997-2020)

- **1997** Developed for Brays Bayou (tested on >40 events since 1997)
- **2001** System tested on TS Allison
- **2003** System upgraded to FAS2
- **2005-2013** Core hydrologic model calibrated & improved
- **2009** Floodplain Map Library (FPML) implemented within Google Maps
- **2010** FAS2 upgraded to FAS3
- **2017** FAS3 upgraded to FAS4 & mobile site launched
- **2020** FAS4 upgraded to FAS5 (new site and system)

## Authors



### Philip Bedient

Dr. Bedient is the Herman Brown Professor of Engineering at Rice University in Civil and Environmental Engineering. He teaches and performs research in surface water hydrology and flood prediction systems. He has directed 60 research projects over the past 35 years, and has written over 180 articles in journals and conference proceedings. Dr. Bedient directs the SSPEED Center at Rice for severe storm prediction, consisting of several universities in the Gulf Coast area, which has funding to address the impacts of Hurricane Ike in the Houston area. Dr. Bedient has directed the development of FAS5 since 1997 with funding from The Texas Medical Center and FEMA.



### Nick Fang

Dr. Nick Z. Fang is an assistant professor in the Civil Engineering Department at the University of Texas - Arlington. He obtained his Ph.D. in Civil and Environmental Engineering at Rice University. He has been working on surface water and groundwater problems for over ten years including floodplain studies, hydrologic / hydraulic modeling, water treatment, hydrodynamic simulation, storm water management modeling, and water quality assessment for a number of watersheds in Texas, Florida, and Louisiana. Dr. Fang's Ph.D. research focused on developing the mapped libraries for flood inundation for FAS5.



### Baxter Vieux

Dr. Vieux's professional focus is radar rainfall and distributed hydrologic modeling. He is distinguished in the application of high-resolution rainfall monitoring to hydraulic modeling of collection systems. Dr. Vieux has directed the development of design storms for collection system planning and operations. He has over 100 publications appearing as textbooks, journal articles, and conference proceedings. Dr. Vieux was a full Professor at the University of Oklahoma. His company, Vieux & Associates (VAI), delivers the calibrated radar for use in FAS5, and delivers similar products to clients all over the world.