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.

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.
How does FAS5 work?

**Data Acquisition**
- Radar rainfall (NEXRAD)
- Flow & stage gauge data
- Bayou camera water level

**Hydrologic / Hydraulic Analysis**
- Hydrologic & hydraulic models (HEC-HMS & HEC-RAS)
- Floodplain mapping

**Real-Time Flood Warning Data**
- Real-time rainfall and flow hydrographs at watch points
- Floodplain map library (FPML)

**Communication**
- Establish warning thresholds
- Automatic communication via text, email and the FAS website

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**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).

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.
Flood Alert Systems

FAS5 History & Authors

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 surfac 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.