# Watershed Hydrology Assessments & Suggested Additional Research

InFRM – Watershed Hydrology Assessments

- Statistical hydrology
- Rainfall-runoff modeling
  - Existing conditions
  - Future conditions
  - Ultimate development conditions
- Period of record (POR) simulations
  - Regulated
  - Unregulated watershed conditions
- Reservoir studies
- Stochastic methods in hydrology
- Comparison and convergence of methods
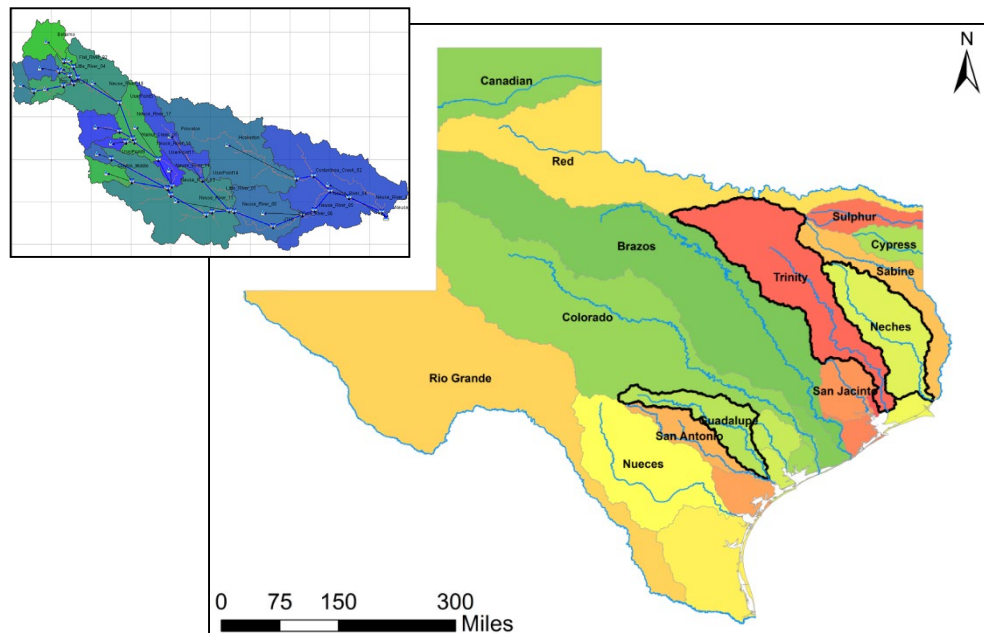
InFRM – Watershed Hydrology Related Research Needs

- CWMS models for the remainder of Texas

- Extreme storms
  - Extreme storm DB
    - QPE based
    - Constructed from gage records
  - Analysis
    - Depth-area-duration
    - Intensity-area-duration
    - Storm size/extents (moments of inertia)
    - Regional storm transposition research and guidance
  - Design storms
   - Static
    - Dynamic storm generation
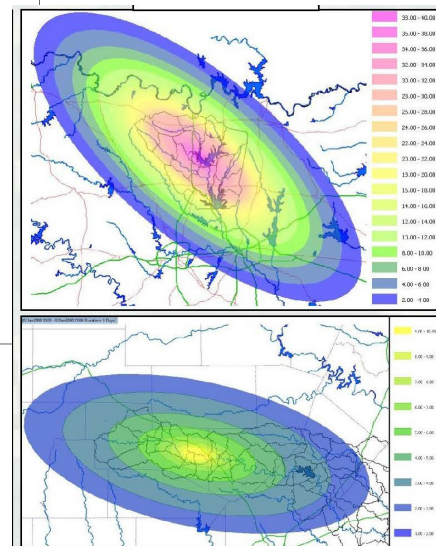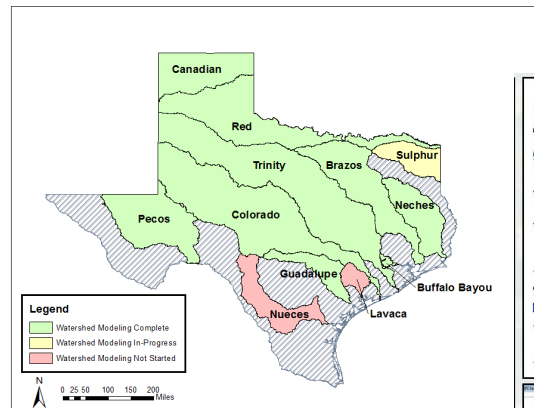
Storms Exceeding Infrastructure and NFIP Standards

- Regional observed storms
  - USACE extreme storm database
- 24-hour rainfall for 10 mi²
- Plotted in descending order
- Grey band is current design standard (100-year) for all of TX
- Blue X's points are 2010-2017 storms that exceed 100-year
- 18 events exceeded the 100-yr design standard

24-Hour Precipitation for 10 Square Miles
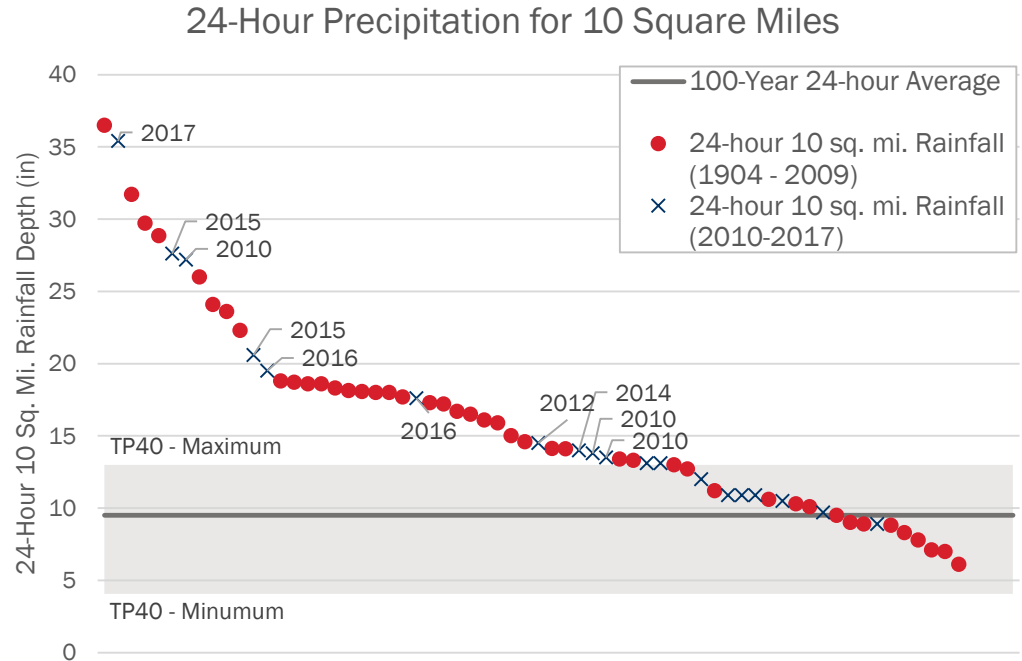
InFRM – Watershed Hydrology Related Research Needs

- Loss rates associated with extreme storm events

- Methods to account for small impoundment and drought related storage structures and discharges

- Analysis of 17B/C related flood flow frequency determinations in TX

- Additional methods of determining flood flow frequency (technology)
  - Space for time
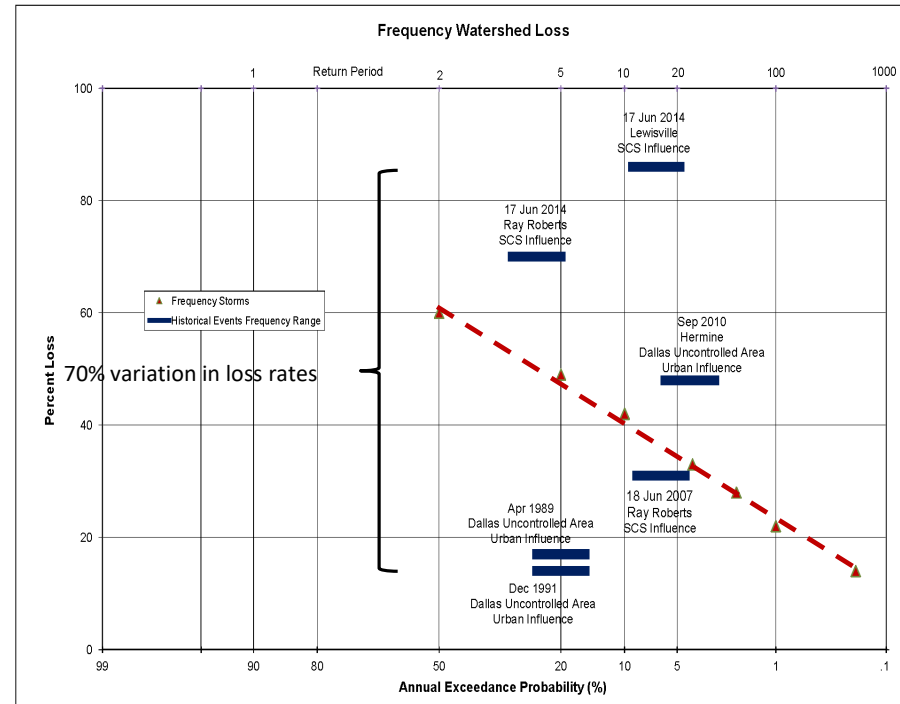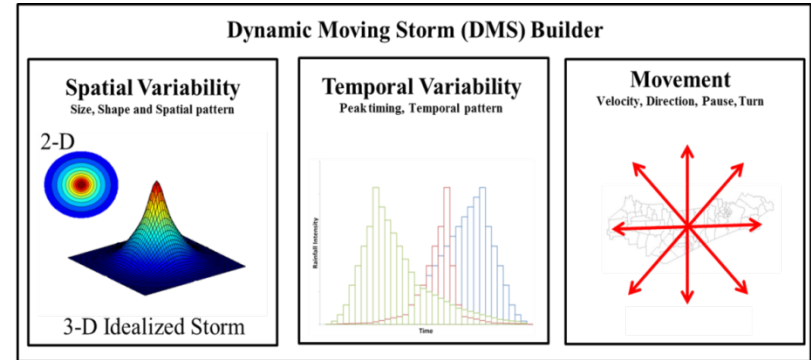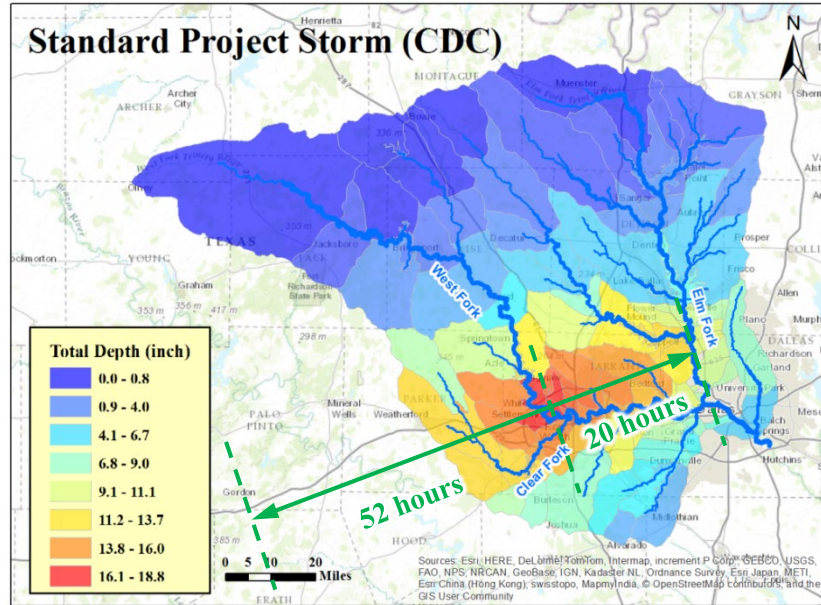
# SPS Moving Storm Study

Figure: Framework of the Dynamic Moving Storm (DMS) Generator

▶ Parameters:

  ▶ Moving velocity: 1.98 mph

  ▶ Moving direction: 5 degree

  ▶ Start point: 103 mi from the Lake Worth centering

  ▶ Duration: 72 hours

Inundation Mapping – A Useful Tool

- Map showing area that would be flooded from a particular flood event.
  - Mitigation (Emergency preparedness)
    - Frequency Based
      - 100-year, 500-year
    - Historical and transposed storms
      - What if?
      - Can be from another location in the region
  - Emergency response
    - Real-time in advance or during the event
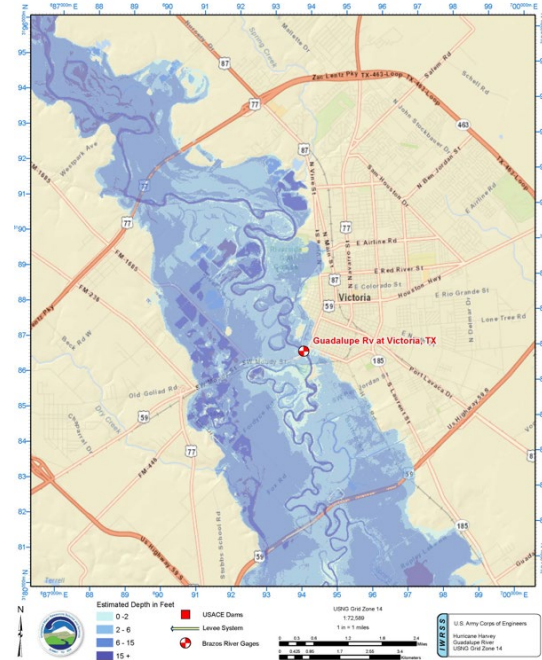
Floodplain Mapping with LiDAR Data
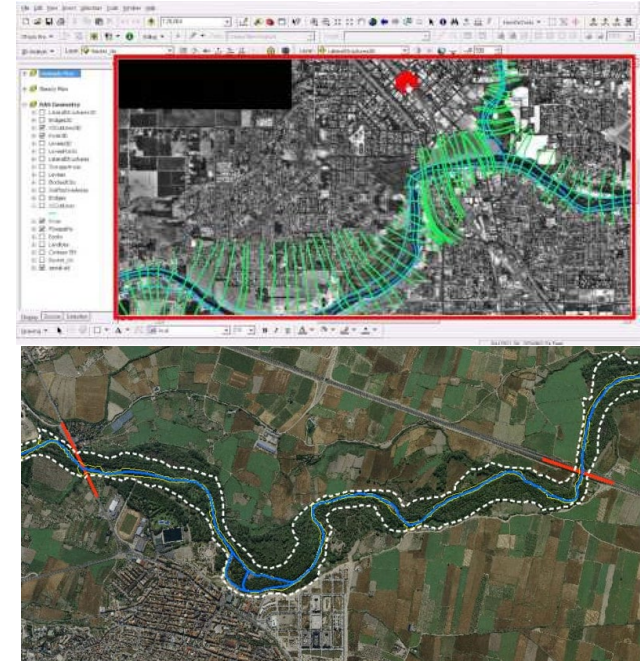

1-D vs. 2-D HEC-RAS

Memorial Day 2015

Harvey 2017
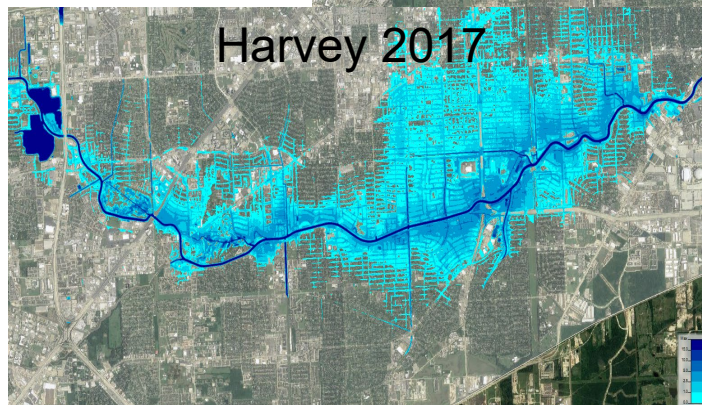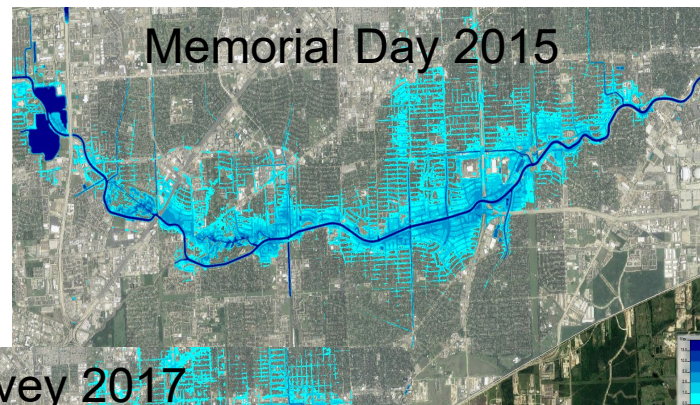
Flood Inundation Mapping Requirements

- – Topographic data
  - • Entire state currently being mapped
- – Bathymetry
- – Engineering scale models
  - • Accurate results
  - • Depth and velocity grids
- – FISM GIS approximate method
  - • No depth and velocity grids
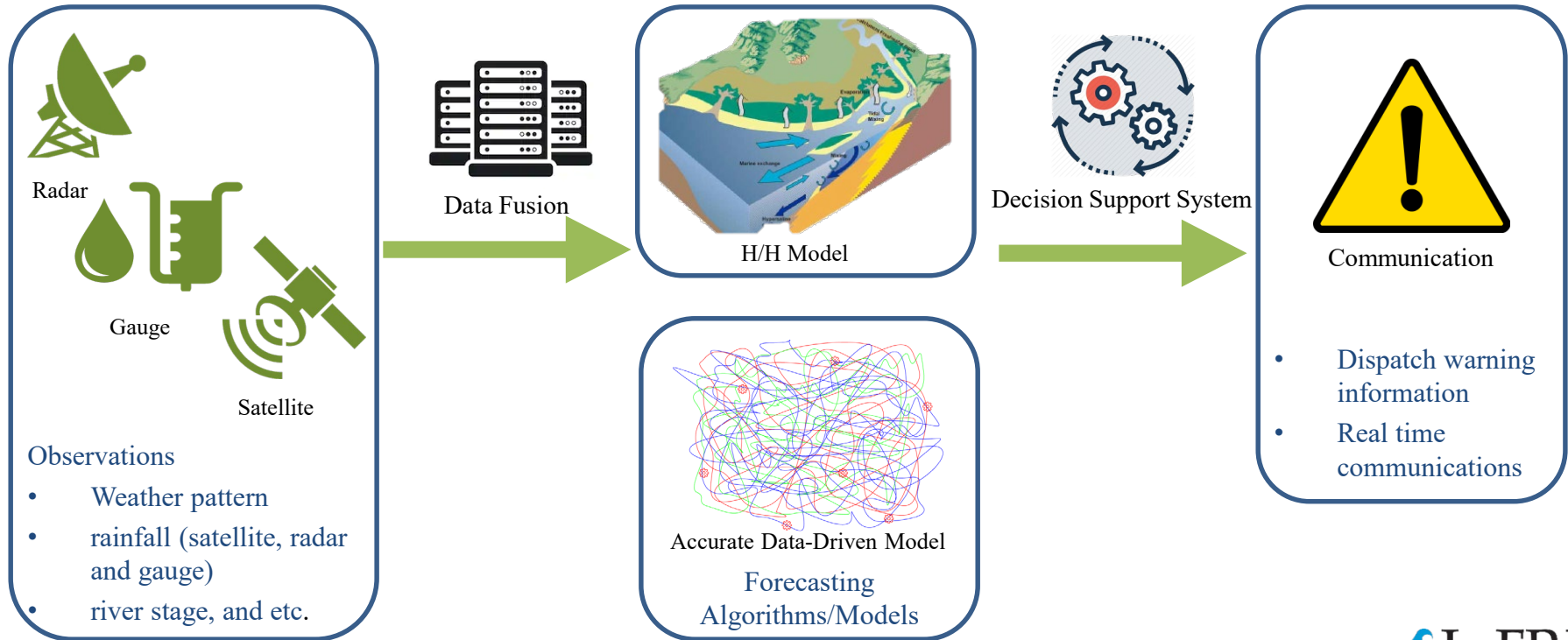- – Other methods (Iowa system)

Additional Research Needs

- Management and use of crowd sourcing data
- Development and/or testing use of distributed modeling systems on various watersheds
  - NWM
  - Iowa system, etc.
  - Small -> large
  - Undeveloped -> fully developed
- WEB applications and BIG DATA MGT
  - Information on multiple flood claims and locations
  - Information consolidations for various audiences – EM community, infrastructure professionals
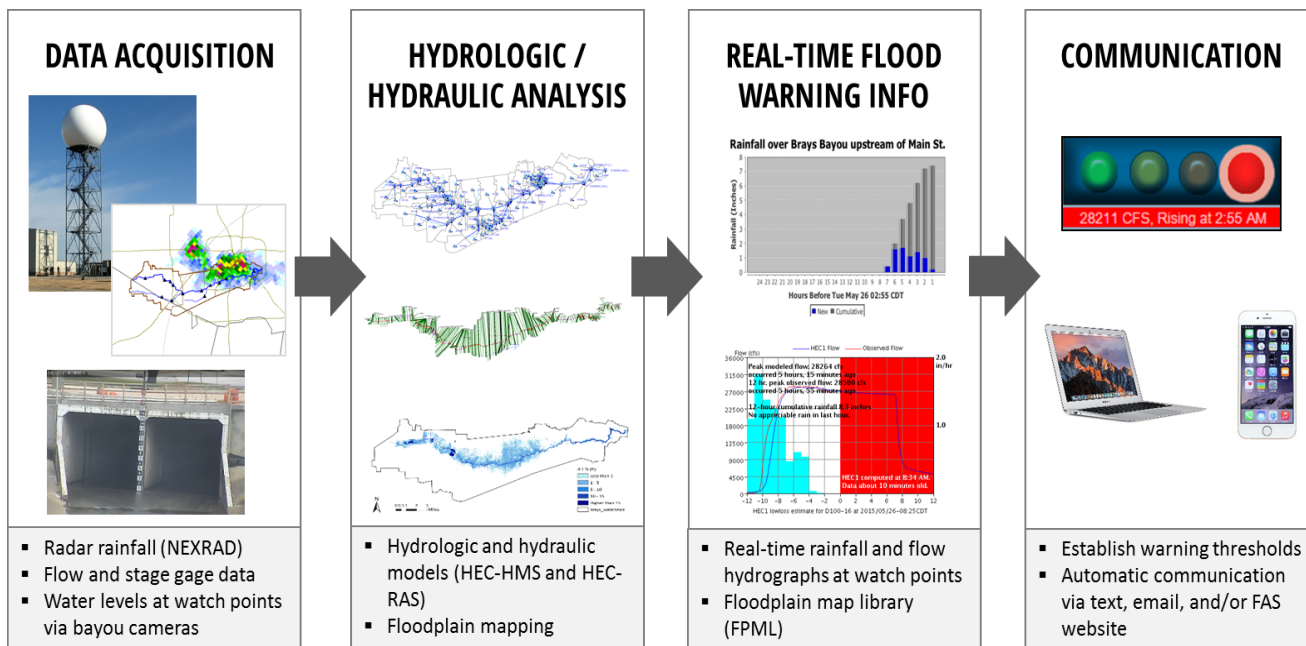
USACE – UTA Cooperative Agreement

- A five-year agreement with $750k
  - Infiltration loss study for major watersheds in Texas
  - Review of technical reports on hydrology and hydraulics
  - Storm and rainfall analysis (Atlas14)
  - Watershed characteristics
  - Software development and enhancement
- More SOW will be needed from the academic council members

Flood ALERT System-Concept

Radar

Gauge

Satellite

Observations
- Weather pattern
- rainfall (satellite, radar and gauge)
- river stage, and etc.

Data Fusion

H/H Model

Accurate Data-Driven Model

Forecasting Algorithms/Models

Decision Support System

Communication

- Dispatch warning information
- Real time communications

Rice / TMC FAS4 Flowchart

DATA ACQUISITION

- Radar rainfall (NEXRAD)
- Flow and stage gage data
- Water levels at watch points via bayou cameras

HYDROLOGIC / HYDRAULIC ANALYSIS

- Hydrologic and hydraulic models (HEC-HMS and HEC-RAS)
- Floodplain mapping

REAL-TIME FLOOD WARNING INFO

- Real-time rainfall and flow hydrographs at watch points
- Floodplain map library (FPML)

COMMUNICATION

- Establish warning thresholds
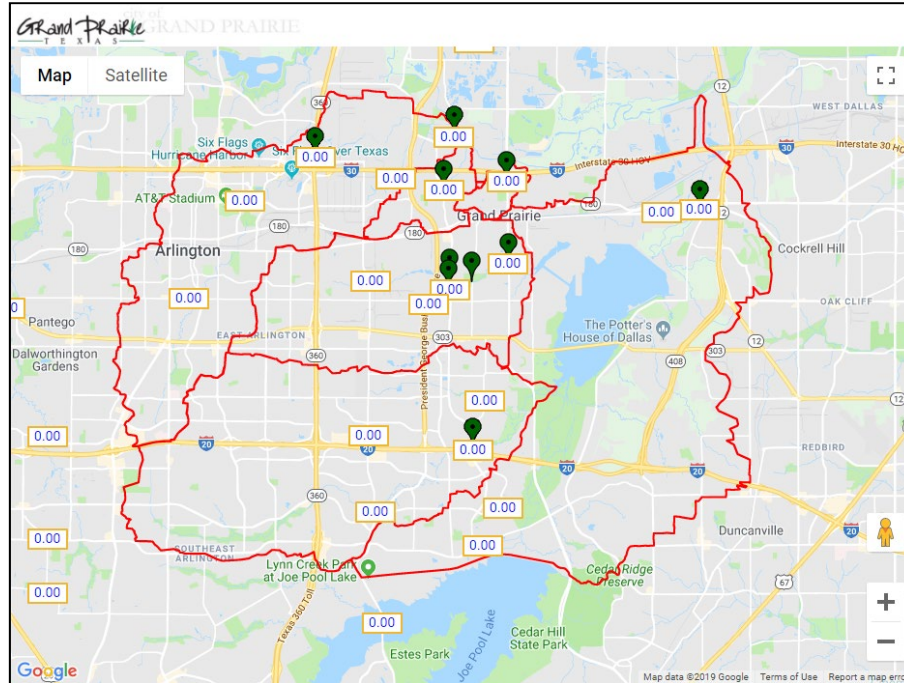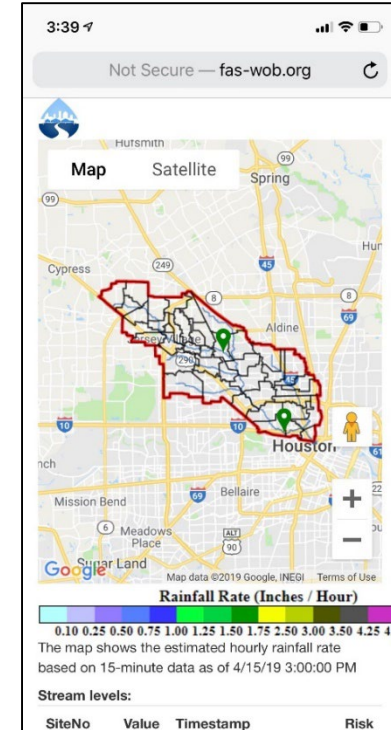- Automatic communication via text, email, and/or FAS website

Developed Flood Alert Systems

Flood Alert System for Grand Prairie

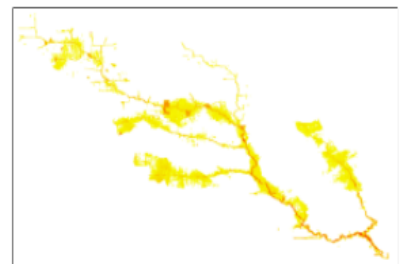## Flood Alert System for White Oak Bayou

Flood Mitigation - Brays

Channel Widening

ONGOING RESEARCH: INTEGRATED FAS-ACF for Houston Mobility   Harvey
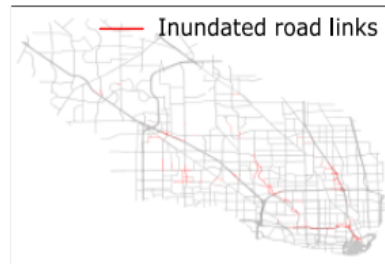

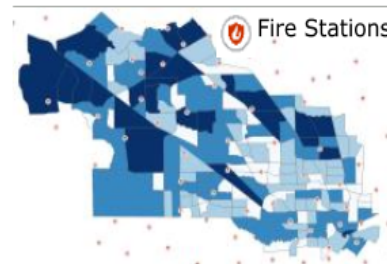Inundation map from the FAS Floodplain Map Library
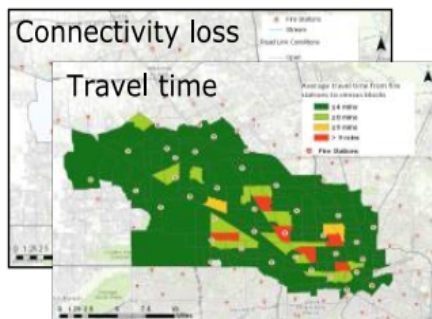
Road network model

Spatial Analysis
python

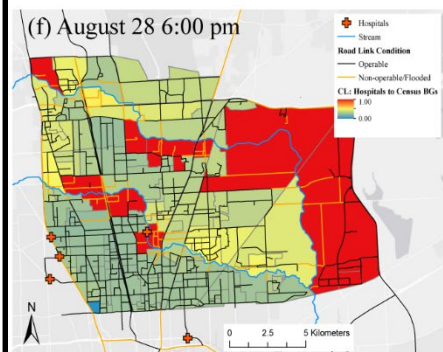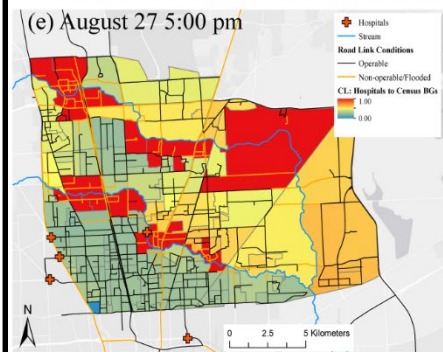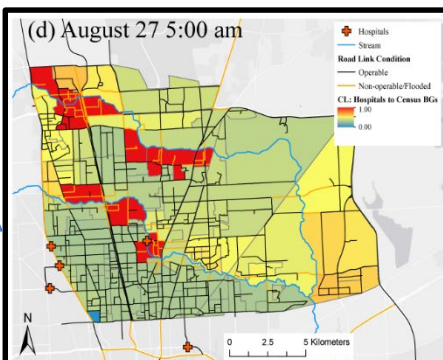Updated road network with inundated road links removed

Inundated road links

Connectivity loss
Travel time

Accessibility measures

Network and Spatial Analysis
python

Fire Stations

Census data and spatial distribution of critical facilities

(d) August 27 5:00 am

(e) August 27 5:00 pm

(f) August 28 6:00 pm

Iowa:

Size: 58,272 sq mi

Total population: 3,2 million (2,018)

Elevation difference : 480 ft to 1,671 ft

Top 4 Metropolitan areas and population (2018)

1. Omaha-Council Bluffs, NE-IA - 942,198
2. Des Moines-West Des Moines, IA - 655,409
3. Davenport-Moline-Rock Island, IA-IL - 381,451
4. Cedar Rapids, IA - 272,295

3 Major Floods:

1. The Great Flood of 1993, heavy early spring rainfall with snow melting, $2.7 billion in damage;
2. The 2008 Flood, Heavy rainfall in the summer of 2007 and a deep snowpack, $10 billion in damage;
3. The Great Flood of 1851, extreme rainfall (74.5 inch), damage data unavailable;

Major Floods after 2010 : 2

Texas:

Size: 268,581 sq mi with 6,784 sq mi of water

Total population: 28.7 million (2,018)

Elevation difference : 0 ft to 8,751 ft

Top 4 Metropolitan areas and population (2018)

1. Dallas-Fort Worth-Arlington, TX - 7,539,711
2. Houston-The Woodlands-Sugar Land, TX - 6,997,384
3. San Antonio-New Braunfels, TX - 2,518,036
4. Austin-Round Rock-Georgetown, TX - 2,168,316

3 Major Floods:

1. Hurricane Harvey Flood, Tropical Storm, $125 billion in damage;
2. Tropical Storm Allison 2001, Tropical Storm, $8.5 billion in damage;
3. 2015 Texas–Oklahoma flood and tornado outbreak, extreme rainfall; damage data unavailable (27 fatalities)

Major Floods after 2010 : 5