Texas Flood Response System
Developing Near-Real-Time Flood Impact Mapping in Texas

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Presentation to H-GAC Geographic Data Workgroup, 3 October 2018

Acknowledgments: David Maidment, Harry Evans, Michael Ouimet, Xing Zheng, Texas DPS Division of Emergency Management, City of Austin, National Weather Service, University of Illinois Urbana-Champaign, Utah State University, Esri, Kisters, Interagency Flood Risk Management (InFRM) Group, Dept of Homeland Security
Texas Flood Response System

Key Topics

• Purpose & objectives
• Address Points
• Height Above Nearest Drainage (HAND)
• Estimating inundation from streamflow forecasts
• Adapting NOAA National Water Model outputs for use by public safety community across Texas
• Major test: Hurricane Harvey
• Developments needed for use at county level
• Methodology and next steps with HAND
Texas Flood Response System

The QUESTION: How do you go from a radar rain map to a flood inundation map showing impacts?

Keeping in mind… “we’re predicting a flood based on a prediction of rain, neither of which has happened”
- Greg Waller, WGRFC
Texas Flood Response Project

**County Partners**
- Travis County Commissioners
- Capital Area Fire Chief Association
- Travis County Emergency Management
- Blanco County Emergency Management
- Williamson County Emergency Management
- Wharton County Emergency Management
- Williamson County Fire Chiefs
- Upper Brushy Creek Water Control District
- San Marcos Emergency Management
- Hays County Emergency Management

**State Partners**
- Texas Division of Emergency Management (*TDEM*)
- Texas Natural Resource Information Systems (*TNRIS*)
- Texas Water Development Board (*TWDB*)
- Texas Commission on Environmental Quality (*TCEQ*)
- Texas Department of Transportation (*TxDOT*)
- Texas Floodplain Managers

**City Partners**
- City of Austin
- Austin Fire Department
- Austin Flood Early Warning System (*FEWS*)
- Austin Homeland Security Emergency Management (*HSEM*)
- Houston Office of Emergency Management

**Federal Partners**
- National Weather Service (*NWS*)
- National Oceanic Atmospheric Administration (*NOAA*)
- Federal Emergency Management Agency (*FEMA*)
- US Geological Survey (*USGS*)
- US Army Corps of Engineers (*USACE*)
Proposed Approach

Texas Flood Response System

Three key elements:
- Strategic Flood Base Map
- Real-Time Inundation Map
- Flood Impact Assessment System
Key ingredient: Address Points...

Used for dispatching emergency response equipment in 9-1-1 systems
So where are the address points?
What we collected...

Texas Address Points as of Aug 2017

Who helped us:

CSEC/Geo-Comm:
- 213 counties, ~3 million addresses

Texas 9-1-1 Alliance & EGRT:
- 41 counties, ~6.2 million addresses

Totals:
- 254 counties, ~9.2 million addresses
Then merged...

Created one feature class for flood risk study and planning

Simpler schema, with county, COG, district & region ID’s for easy aggregation

Who helped us:
CSEC/Geo-Comm:
  213 counties, ~3 million addresses
Texas 9-1-1 Alliance & EGRT:
  41 counties, ~6.2 million addresses
Totals:
  254 counties, ~9.2 million addresses
Next: A method for estimating flood risk…

Height Above Nearest Drainage (HAND)

*Flooding occurs when* Water Depth *is greater than HAND*
Height Above Nearest Drainage for Texas

Computed on Univ of Illinois CyberGIS supercomputer from 10m National Elevation Dataset: CONUS HAND computed in ~ 1 day

Method can be performed on moderate basins with desktop GIS
Last step: add HAND elevation to address points...

Simple raster operation

Further development and testing is in progress to refine HAND values along coast and wherever else needed.
HAND value assigned to each address point
Useful for planning responses and mitigations…
Detailed engineering modeling on creeks
Austin, Texas: A data rich community
The Goal:
Identify potentially impacted structures for a given flood event *in advance if possible, or in near-real time*
National Water Model
Operational since August 2016

Legend
Streamflow (cfs)
- 0 - 119
- 119 - 7,520
- 7,521 - 88,700
- 88,701 - 201,900
- 201,901 - 460,000
- 460,001 - 1,200,000

05/01/2015 00:00
National Water Model
http://water.noaa.gov/map

Streamflow – Analysis with Assimilation

![Map of a river network with various markers indicating streamflow analysis and assimilation. The map includes locations such as College Station, College Station FR, Galveston, and Port Arthur.]
National Water Model
http://water.noaa.gov/map

Streamflow – Anomaly based on ~30 yr history
National Water Model
http://water.noaa.gov/map

Stream reach selected (Trinity R. at Cleveland)
National Water Model
http://water.noaa.gov/map

Forecast charts (Trinity R. at Cleveland)
Forecasts
Version 1.1 operational on 5 May 2017

Now
Analysis
Best estimate of current conditions

Short Range
Hourly for 18 hours ahead, updated hourly

Medium Range
3 Hourly for 10 days ahead, updated 6-hourly

Long Range
Daily for 30 days ahead
Ensemble of 4 forecasts each 6 hours (24 forecasts total)

ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/nwm/prod/
Automated workflow for translating NWS forecasts into TDEM impact

Two Commercial Firms: Esri and Kisters

National Water Model discharge forecasts

Assessment of impact

Conversion of discharge to depth

Convert depth to flood inundation
Then Hurricane Harvey arrived August 25
72-hour precipitation forecast, 9:40am
National Water Model: August 31 Streamflow
10 day anomaly forecast on August 25…

The only USGS gage flooded on Aug 25
Day 2: TX DPS Harvey Dashboard online

Hurricane Harvey Situation Viewer

1. Map & Data Disclaimer
2. Hurricane Harvey Impact Summary
3. Shelters
4. Resource Requests
5. Road Closures
6. Critical Infrastructure
7. Situation Awareness

This map is for informational purposes and is not suitable for legal, engineering or surveying purposes.
Click HERE for the full disclaimer.

With permission of TDEM
Day 2: Maps of shelters, road closures, critical infrastructure
Day 3: Inundation Areas

Guadalupe River
Colorado River
Brazos River
Harris County
Trinity River
Neches River

Flood Modeling Credits: Interagency Flood Risk Management (InFRM) Group

With permission of TDEM
Day 3: Inundation Impacts

Guadalupe River: 834
Colorado River: 18,577
Brazos River: 57,986
Harris County: 40,349
Trinity River: 3,354
Neches River River: 863

Address Data Credits: UT Austin Center for Water and the Environment
Flood Modeling Credits: Interagency Flood Risk Management (InFRM) Group

With permission of TDEM
Day 4: National Water Model 10-day forecast

National Water Center provided experimental inundation areas during the first week of Harvey, based on NWM streamflow forecasts, synthetic rating curves, and HAND.
Day 4: Inundation, Harris County

Hurricane Harvey Situation Viewer

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6. Flood Impact

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With permission of TDEM
Day 4: Inundation demographics

With permission of TDEM

Flood Modeling Credits: Interagency Flood Risk Management (InFRM) Group
Day 7: Flood depth grids, Neches & Sabine Rivers

Legend

Potential Flooded Area 09/01/2017 (Some Areas May Have Receded)

- Neches_Depth_Poly
- 0-1 ft. Cars OK
- 1-3 ft. High trucks ok.
- 3-6 ft. Emerg. veh. OK
- 6-10 ft. Emerg. veh. not OK
- >10 ft. First flood under water

With permission of TDEM

Flood Modeling Credits: Interagency Flood Risk Management (InFRM) Group
Day 14: Post-event imagery, status of shelters, stores, insurance claims

With permission of TDEM
Day 23: Final flooding impacts

Early, rough estimates for 56 state and federal disaster-declared counties:
~ 9,000 sq mi flooded
~ 40,000 river-miles
~ 966,000 addresses

Flood Modeling Credits: Interagency Flood Risk Management (InFRM) Group and UT Austin Center for Water and the Environment.
Address Data Credits: US Dept of Homeland Security and UT Austin Center for Water and the Environment

With permission of TDEM
Civil Air Patrol – Aerial Photos

Texas Flood Response System: Accomplishments

• 9.3 million **Address Points** collected for the entire state
• Determined “height above nearest drainage” (HAND) for each point
• Developed statewide synthetic rating curves for all **100K streams in Texas** *(hydrology procedure to relate stream depth to flow rate)*
• **Kisters gauge network** linked to National Water Model
• **Esri statewide impacts map** created
• **Local, engineer scale maps** completed and deployed (City of Austin)
• Extensive collaboration with NWS, University of Illinois, Utah State University, National Science Foundation, Kisters, Esri, TDEM, TNRIS and UT Austin – **Supercomputer computation**
Texas Flood Response System:
Developments needed for use at county level

• HAND from Lidar *(improve resolution from 10m to 1m)*
• Improved rainfall forecasts
• More ground-truth observations *(stream gages)*
• Production-scale services for sustainable use
• Improved collaboration between NOAA National Water Center, Regional Forecast Centers, and local ground truth sources
Hurricane Harvey 2017 Data Archive

https://arcg.is/1GWyKi

Thank you!

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Direct Links to Harvey Data Archive content on HydroShare

Hurricane Harvey 2017 Collection (top-level)

Harvey Flood Data Collections
- NOAA NHC - Harvey 2017 Storm Track
- NOAA NWC - Harvey NWM Streamflow Forecasts
- NOAA NWC - Harvey NWM-HAND Flood Extents
- USGS - Harvey Gaged Streamflow Timeseries
- USGS - Harvey High Water Marks
- ECMWF GloFAS - Harvey Flood Area Grids
- FEMA - Harvey Flood Depths Grid
- FEMA - Harvey Damage Assessments and Claims
- Civil Air Patrol - Oblique Aerial Photo Points

Harvey Basemap Data Collections
- Texas-Harvey Basemap - Addresses and Boundaries
- Texas Basemap - Transportation Map Data
- Harvey Basemap - Hydrology Map Data
- Texas Basemap - Lidar DSM
- Height Above Nearest Drainage (HAND) elevations for CONUS
- Texas Address and Base Layers Story Map
- CDC Social Vulnerability Index

Height Above Nearest Drainage (HAND) Data at TACC
- Top-level folder for 10m HAND for USA
- HAND for Texas Harvey zone

Issues or comments? Please report any errors, gaps, issues, or requests relevant to this story map and the related HydroShare data pages to help@cuahsii.org.

https://arcg.is/1GWyKi