Flood Studies within Combined River Basins: Flood Model Development Plan

“We work to rebuild communities, to put Texans back in their homes and help businesses recover after the trauma of disaster.”
- George P. Bush, Commissioner

Presentation Outline

- Project Overview
- Flood Model Development Plan (FMDP):
  - Hydrology SOP
  - Hydraulics SOP
  - Coastal SOP
- Regional Updates:
  - East Region
  - Central Region
  - West Region
  - Valley Region
- Q/A

GLO-CDR Planning Mission

Mission:
Provide decision makers with accurate information to better protect Texans from disasters.

What do community decision makers want? Survey Results:
1. Funding
2. Accurate/Reliable Risk Maps
3. Cost Effective Mitigation Strategies
4. Regional Planning/Projects
Regional Flood Study Design

1. How can we bring more mitigation funds to the state? Regional Projects: USACE level efforts

2. Is it possible to create models that benefit the entire region, but can also be upgraded for high-risk communities?
   - Base Regional Model: Base Level Engineering (BLE)
   - Upgraded: USACE Minimum Modeling Standards

3. How do we complement and standardize current H&H efforts with partner agencies, obtain more funding for the state, and create scalable regional models?
   - USACE Technical Assistance Contract
   - Flood Model Development Plan (FMDP)
   - Texas Integrated Flood Framework (TIFF)
Next tasks:
- Prepare Flood Model Development Plans
- Evaluate baseline flood risk
- Leverage existing H&H models and create new ones to fill the gaps
- Need some consistency and standard operating procedures

US Army Corps of Engineers – GLO’s technical advisor
- Member of Interagency Flood Risk Management (InFRM) team
- Developed InFRM Watershed Hydrology Assessments and Sabine Pass to Galveston Bay Program
- Developed Minimum Standards for Hydrologic, Hydraulic, and Coastal Analysis for GLO

USACE Minimum Standards
- Provides high-level structure

Standard Operating Procedures (SOPs)
- Evaluation of existing models
- Detailed H&H/coastal methods
  - Joint riverine/coastal flood risk
  - Model calibration/validation
  - Uncertainty and sensitivity analyses
- Submittal/review processes, QA/QC checklists, prioritization criteria
Standard Operating Procedures – Hydrology

• Goal of hydrologic analysis
  • Calibrated HEC-HMS model with reasonable, conservative flow estimates that can support alternatives analysis

• Initial steps
  • Evaluate existing models, potential upgrades
  • Statistical frequency flow analysis
  • Hydrologic flood model development plan

Standard Operating Procedures – Hydrology

• Rainfall-runoff modeling software
  • HEC-HMS 4.8
  • Supported by HEC-RAS 6.0 rain-on-mesh

• Flexible methods
  • Loss
    Green-Ampt, Initial/constant loss, Curve number
  • Transform
    Clark, modified Clark, Snyder
  • Routing
    Modified Puls (1D/2D), Muskingum-Cunge

Standard Operating Procedures – Hydrology

• Historical storm calibration
  • Gauge-adjusted radar (NOAA Stage IV)
  • Stream gage data (USGS)
  • Secondary target: RAS 2D rain-on-mesh

• Frequency storm parameters
Standard Operating Procedures – Hydrology

- Storm shifting
  - Can be used to illustrate “near misses,” sensitivity of statistical gage analysis
- Areal reduction, elliptical storms
  - Optimization scripts developed by HEC, based on USACE/UTA study
- Reservoir analysis

FMDP Hydraulics Overview

Goal of Hydraulic Analysis
- Calibrated RAS model with reasonable, conservative water surface elevation estimates that can support alternative analysis

Initial Model Setup
- Assess existing models for upgrades and inclusion
- Determine model extents and modeling approach

Model Development
- Define time step, cell sizes, and roughness
- Select appropriate inflow locations and boundary conditions

Model Execution
- Perform model calibration and validation
- Perform sensitivity and uncertainty analysis

Evaluation and Results
- Develop final hydraulic products

Hydraulics – Model Setup

Hydraulic Models
- HEC-RAS 6.0
- 2D recommended

Leverage Existing Model Data
- FS models, Base Level Engineering, back studies, design models
- 1D and 2D

Include Other Existing Data
- All Dams, TxDOT, National Bridge Inventory, National Levee Database, National Land Cover Database

Newly Acquired Data
- Field Reconnaissance, Structure Survey
Hydraulics – Nuts & Bolts

Model Development
- Mesh Size, Breaklines
- Structures (Bridge, Culvert, Dam, Levee)
- When to include
- What required data
- Roughness: National Land Cover Database 2019, USACE Coastal Study, NOAA Coastal Change Analysis Program
- Inflows
  - Rainfall
  - Upstream boundary
- Outflows
  - Coastal
  - Downstream river

Hydraulics – Model Execution

Sensitivity Analysis
- Assess numerical methods and physical parameters that affect model results.
  - Mesh size, time step, roughness, weir coefficients, computational options

Calibration Data
- Coordinated with hydrology
- Begin with storm-related model inputs
  - Rainfall, reservoir operations, levee pump station operations
- Compare model results to observed data
  - High water marks, photographs, stream flow and stage gages
  - Roughness, bridge/culvert, road refinement, breaklines

Frequency Storms
- Full range of storms for Benefit Cost Analysis

Hydraulics – Evaluation and Results

Comparison & Evaluation
- Prepare comparison maps to assess differences with prior studies
- Investigate areas of uncertainty and justify deviations from effective models
- Coordinate with adjacent models

Model Reviews
- Submittal and review process will include submittals to USACE and GLO

Final Hydraulic Products
- Prepare model files and spatial data in a standard folder structure
- Create flood risk maps for calibration and frequency storms
- Develop a written hydraulic report for GLO and presentations for stakeholders
Coastal Influenced Areas

• Goal of coastal influenced areas
  • Develop HMB and RAS models capable of capturing the key compound flooding considerations near the coast.
  • Identify a set of storm conditions that represent the range of flood hazards in these zones.
  • Align with existing coastal flood hazard studies (e.g., FEMA, USACE, GLO) near the coast and consistent with hydrology and hydraulics SOPs inland.

Coastal Influenced Areas – where are they?

Where are the zones of potential compound flooding?
• Evaluating existing information
  • USACE Coastal Texas Study (ADCIRC)
  • NOAA Maximum of the Maximum (MOM) data (SLOSH)
  • FEMA 0.2% Coastal Zone

• Factoring in future conditions
  • Extent will change with sea level rise and other changes in future landscapes

<table>
<thead>
<tr>
<th>USACE Coastal Texas Model Domain</th>
<th>NOAA MOM</th>
<th>FEMA 0.2% Coastal</th>
</tr>
</thead>
</table>

LRGV Region
West Region
Central Region
East Region
Coincident Hazard Analysis

- Methods for assessing coincident rainfall and coastal water levels are under development in coordination with USACE
- Will leverage observational data, model outputs (e.g., USACE studies), and methodologies based on current literature

Coastal Influenced Areas – Model Setup

- Expand Hydrology and Hydraulics SOPs
  - Hydrology
    - HEC-HMS where necessary and appropriate
    - HMS has limitations in routing flows in coastal regions due to tidal and backwater effects.
  - Hydraulics
    - HEC-RAS 6.0
    - Largely 2D domains to capture inter-basin and multi-directional flows

Coastal Influenced Areas – Future Conditions

- Evaluating treatment of
  - Sea level rise
  - Future land use and land cover
- Aligning with related studies within the state and federally
  - Texas Coastal Resiliency Master Plan
  - USACE studies
East Region Overview:
- 1.2 M people, 16 Counties, covering 10,922 square miles
- Three major river basins (Trinity, Neches, and Sabine)
- Nine major flood events since 2001

Coordination with other studies and projects:
- Central Region
- TWDB Regional Flood Planning Groups
- USACE
- Sabine Pass to Galveston study
- Texas Coastal study
- Trinity and Neches River InFRM studies

Upcoming events:
- Data collection with local entities
- Regional risk management workshops
- Data gap analysis
- Identification of high-risk areas with the region
- Development of future model development work plans

Contact information:
GLOfloodstudies.east@recovery.texas.gov

East Region Stakeholder Update

Central Region Study Team

Contact information:
GLOfloodstudies.east@recovery.texas.gov
Central Region Stakeholder Update

Central Region Overview:
- 6.6 M people, 20 Counties, and over 10,000 miles of streams
- Within the Brazos, San Jacinto and Houston Bayou watersheds
- 1,000 flooding events occurred in the last 25 years
- The City of Houston and Harris County received direct CDBG-DR allocations and will be considered as regional stakeholders only.

Coordination with other studies and projects:
- San Jacinto and Lower Brazos Regional Flood Planning Groups (RFPGs)
- Texas Integrated Flood Framework (TIFF)
- Texas Disaster Information System (TDIS)

Upcoming events and next steps:
- Continue data collection from local entities and in coordination with RFPGs
- Support county level stakeholder engagement meetings
- Finish Pilot Studies and Flood Model Development Plans for Phase 3 baseline modeling

Contact information:
GLOfloodstudies.central@recovery.texas.gov

West Region Study Team

West Region Overview:
- 25 counties, over 1.4 million people, and 5 river basins
- Since 1996, 84% of the counties in the West Region have experienced over 50 flood events
- Nearly a quarter of the counties have experienced over 100 flood events

Coordination with Other Studies and Projects:
- Flood Study Coordination East, Central, and LRGV Regions
- TWDB Regional Flood Planning Groups (RFPGs)
- Texas Integrated Flood Framework (TIFF)
- Texas Disaster Information System (TDIS)

Region Update:
- Kickoff workshops and initial survey recap
- Current local data set collection requests
- Identification of areas of higher risk for future H&H analysis

Contact Information:
GLOfloodstudies.west@recovery.texas.gov
Valley Region Stakeholder Update

Valley Region Overview:
- 1.4 M people, 4 Counties, and 46 Municipalities
- Rio Grande Delta including five regional drainage systems
- Multiple ongoing grant-funded projects (TWDB FIF, CDBG-MIT, etc.)

Coordination with other studies and projects:
- Texas Disaster Information System (TDIS)
- Flood Study Coordination: West, Central, and East Regions
- Region 15 Lower Rio Grande Regional Flood Planning Group
- Texas Integrated Flood Framework (TIFF)

Upcoming events and next steps:
- Deploy stakeholder outreach and schedule workshops
- Deploy data collection with local entities
- Initiate hotspot analysis

Contact information:
GLOfloodstudies.valley@recovery.texas.gov

Primary Points of Contact

Regional Flood Studies
- East: Tyler Payne & Chris Sallese
  - Tyler.payne.glo@recovery.texas.gov
  - Chris.Sallese@decorp.com
- Central: David Mass & Krista Melnar
  - David.Mass.glo@recovery.texas.gov
  - Krista.Melnar@freese.com
- West: Shonda Mace & Elizabeth Levitz
  - Shonda.Mace.glo@recovery.texas.gov
  - Elizabeth.Levitz@aecom.com
- Valley: Shonda Mace & Cindy Engelhardt
  - Shonda.Mace.glo@recovery.texas.gov
  - CEngelhardt@halff.com

U.S. Army Corps of Engineers (USACE)
- C. Landon Erickson
  - Charles.Erickson@usace.army.mil

Texas Integrated Flood Framework (TIFF)
- Armin Kaghazi
  - Armin.Kaghazi@twdb.texas.gov
- Calmer Schnurbachler
  - Calmer.Schnurbachler@twdb.texas.gov