TRWD Upper Trinity River Flood Operations Decision Support System

TFMA 2012 Fall Conference – Rockwall, Texas
September 20, 2012

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Overview

• Background and Objective of Project
• Data Inputs
• Models (HEC Tools)
• Making a Forecast – System Components
• Lessons Learned
Background & Objectives

- Real-Time Decision Support System utilizing HEC products.
  - Upper Basin – More Lead Time for Gate Operations
  - Floodway - Improve Operations Personnel Response
Solution

• Aviso FS and Aviso Watch
  • What does it do?
    • Allows forecasters to interact with HEC software through an easy to use GUI
      • Loss parameter adjustment
      • Reservoir release alternatives
    • Gathers observed data for HEC models
    • Prepares HEC-HMS output for input to HEC-RAS & HEC-ResSim
    • Real-time data viewing
    • Monitors and warns based on observed and forecasted data
Data Inputs for Models

Rainfall
Streamflow
Reservoir & River Stage
Reservoir Release
Reservoir Inflow
TRWD Model Integration

HEC-HMS → HEC-RAS → HEC-ResSim

Lake Worth releases only
Models Behind Aviso FS

- **HEC-HMS**
  - Compute inflows for Upper Basin HEC-ResSim Model
  - Compute inflows for Floodway/Sump HEC-RAS Model
- **HEC-ResSim**
  - Simulates reservoir operations at Lake Bridgeport and Eagle Mountain Lake based on TRWD operational guidelines
  - Allows TRWD to evaluate impacts of alternative reservoir operations
- **HEC-RAS**
  - Unsteady flow computations of the Trinity River in the Fort Worth Floodway
  - Model sump stages and gravity sluice discharges to Trinity River
Forecasting Timeline

Lookback period

Simulation start

Forecast period

Time of forecast (now)

End of forecast
Making a Forecast

- Set forecast window
- Fetch observed data
- View observed data
- Model Calibration/Adjustment
  - View MAP
  - Adjust Loss and Baseflow Parameters
  - Validate results with preconfigured plots
- Run Forecast
  - Models are re-run with QPF
  - Forecasted reservoir releases can be adjusted
  - Floodway inundation maps are queried
- Publish Forecast
  - Model input/output archived
  - Results published to a database for monitoring
Setting a Forecast Time Window

Look Forward
- Forecast period

Look Backward
- “Calibration” period
- Observed data
Fetching the Current Data

Fetch
• Gets the data from the Hydromart DB

Enter Observed Reservoir Releases
• Eagle Mtn Lake
• Lake Bridgeport
What’s Happening Now?
Viewing the Data - HEC-DSSVue
Evaluating Observed Rainfall - MAP
Forecasting Runoff - (HEC-HMS)

Run Calibration

• Runoff forecast from HEC-HMS without QPF

Run Forecast

• Runoff forecast from HEC-HMS (both with and without QPF)
Evaluating the Forecast - Plots
# Adjusting Model Runoff Parameters

## Zone Parameters

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<th>Zone</th>
<th>Initial loss (in)</th>
<th>Constant loss (in/h)</th>
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*Edit Zone Parameters*
Model Adjustment – Base Parameters

- Examples of the 3 different moisture conditions with the same storm
- Average appears to be a good starting point
Model Adjustments

Calibration
Simulating Reservoir Releases - (HEC-ResSim)

Run Forecast
• Runoff forecast from HEC-HMS as input

Adjust Forecasted Releases
• Specify desired releases
• Re-simulate release
Evaluating the Forecast - Reservoir Release Plots

[Image of a computer interface showing graphs and options for viewing plots.]
Adjusting Forecasted Reservoir Releases

Specify release
- By outlet setting
- By total release

Approach
- HEC-ResSim will try to match releases if possible
- (Other rules or physical constraints may prohibit desired release)
Routing Flows - (HEC-RAS)—Floodway only

Run Calibration
- Runoff (HEC-HMS) w/o QPF as input

Run Forecast
- Runoff (HEC-HMS) as input (w/ and w/o QPF)
Viewing the Results
Viewing Inundation Maps
Publishing the Forecast

- Observed Data
- Results
- Loss and Baseflow Parameters
- Release Overrides

Compressed files for each forecast

HEC-DSS forecast data cache

Aviso Watch
- Automated alerts
Aviso Watch

Monitors observed data and forecasted results to provide customized warnings via e-mail and text messaging.
Lessons Learned

• Data, data, data.....
  • Formats
  • Time intervals and time steps
  • Missing??
• Run times are critical
• IT department coordination
• Forecasting model is different than a planning model
• Devil is in the details...
Questions

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System Goals/Objectives

1. Operate in “real-time” environment
2. Forecast flood flows and elevations along the Fort Worth Floodway
3. Provide decision support for Upper Basin reservoir operations
4. Provide inundation mapping along the Floodway and sumps
5. Provide automated warnings/alerts
System Requirements

1. Utilize HEC modeling software
2. Secure
3. Fit within context of existing TRWD system
4. Fit within existing agency arrangements
5. Limit disclosure of sensitive information
HEC-HMS – Basin Setup

- Two Models
  - Upper Basin
    - Headwaters to Lake Worth
    - 2,052 sqmi/62 Sub-basins
  - Floodway/Sump
    - Lake Worth and Benbrook Lake to Precinct Line Rd
    - 295 sqmi/41 Floodway Sub-basins & 32 Sump Sub-basins
- Loss Model – Initial and Constant
- Transform Model – Snyder UH
- Baseflow Model (Upper only) – Recession
- Routing – Modified Puls
  - Upper – WFTR and Tribs
  - Floodway/Sump – Tribs only
HEC-HMS – Meteorology Setup

- Precipitation Sources
  - NWS MPE
    - Data stored as a time series for each HRAP cell
    - 3-hr Lag between Real-Time and most recent data value
  - TRWD, USGS, and City of Ft Worth gauges
  - NWS QPF
    - Data stored as a time series for each HRAP cell
    - Forecasted Precipitation
    - 6-Hour blocks
- Upper Basin
  - NWS MPE and QPF data used
  - MAP computed with Gage Weights method
- Floodway/Sump
  - All sources utilized
  - MAP computed with IDW method
  - Precipitation data is clipped for a seamless transition from MPE→Gauge→QPF
HEC-ResSim

- 3 Reservoirs
  - Lake Bridgeport
    - Low Flow Valve
    - Service Spillway
    - Emergency Spillway*
  - Eagle Mountain
    - Lake Low Flow Valves
    - Old Service Spillway*
    - New Side Delivery Spillway
    - Emergency Spillway*
  - Lake Worth
    - Service Spillway *
    - Emergency Spillway*
- Modified Puls river routing
- Rules based on TRWD operational guidelines

*Uncontrolled spillway
HEC-RAS Geometry

- Fort Worth Floodway
  - Based on existing hydraulic model provided by TRWD
  - Halff’s Modifications
    - Sumps and Levees added
    - Clear Fork cross-sections georeferenced
  - Extents:
    - Clear Fork – Benbrook Lake to West Fork Confluence
    - West Fork – Lake Worth to Precinct Line Rd
  - Nearly 30 River miles
  - 617 Cross-sections
  - 45 Bridges
  - 22 Inline Structures (Dams)
  - 30 Lateral Structures (Levees)
  - 29 Storage Areas (Sumps)
  - 18 Storage Area Connections (Sump to sump flow)
  - 1 Pump Station
HEC-RAS Sumps and Levees

• Sumps and Levees

• Sumps
  • Elev.-Vol. Curves
  • 2009 TNRIS LiDAR
  • City of Fort Worth storm sewer plans
  • Flow between sumps modeled with storage area connections
    • 2009 TNRIS LiDAR
    • Weir Equtation

• Levees
  • 2009 TNRIS LiDAR used for levee profiles
  • TRWD sump plans and field survey used for sluice dimensions and elevations
  • Flap gates modeled with a one-way flow restriction
Two-Phase Approach

- **Phase I**
  - Scoping/Planning
  - Goals of System
  - Constraints
  - Existing Models, Tools, Databases, etc...
  - Meeting w/ USACE, USGS, NWS WGRFC, City of Fort Worth, TRWD
  - Needs Assessment
  - Plan Formulation
  - Cost-Schedule

- **Phase II**
  - Development
  - Testing
  - Deployment
  - Training
Run Forecast

Adjust Forecasted Releases

View Inundation Maps