Real-Time Forecasting Using HEC-HMS and HEC-MetVue

EXTENDED ABSTRACT

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The procedures and methods used in developing HEC-HMS models by the Corps of Engineers, Tulsa District provide the functionality to predict inflow volumes, rates, and elevations into the reservoirs of the district. This information is used by water managers to make key decisions on the operations of the reservoirs and the consequences of these actions resulting at downstream locations. Tulsa District has been actively pursuing and developing HEC-HMS models for several years to replace the legacy forecast tools with the CWMS (Corps Water Management System) suite of programs by the HEC (Hydrologic Engineering Center). The existing real time rainfall/runoff models are HEC-1 based, in conjunction with various utility programs used for data management.

In order to show how Tulsa District is performing real-time forecasting in lieu of having a complete CWMS package and database setup, a model demonstration using HEC-MetVue, HEC-DSSVue, and HEC-HMS will be shown. The demonstration shows how Tulsa District is extensively testing our HEC-HMS models in preparation for unplugging our legacy WCDS database, programs, and forecasting methods in the interim period while we complete the various tasks involved with completing our full CWMS initiative.

The HEC-HMS models are calibrated using three historical events for each HMS model. Selection of the historical event involves consideration of many factors, such as an isolated storm event, basin wide runoff, variations of rainfall magnitude, observed data availability, and availability of digital precipitation from radar. Archived digital stage III radar files are obtained from the National Weather Service Arkansas-Red River Forecast Center's (ABRFC) office. The program, HEC-MetVue, is used to develop subarea hyetograph data sets using watershed model subbasin shapefiles from the stage III radar files. The hyetographs are used in HEC-HMS to calculate the rainfall runoff volume.

The transform method used is a modified Tulsa regional Snyder's unit hydrograph method. Stream routing methods are primarily Modified Puls routing method for most reach elements. Where Modified Puls storage discharge relationship data is unavailable, the Muskingum routing method is used. Routing lags are also used in the models where there may be significant backwater effects that would cause timing issues with the flow when routing to downstream calibration points. Overall, the routing method chosen is based on available data as well as the most appropriate method for the routing reach.

The base flow method used is Initial Recession, where an initial flow, ratio to peak, and recession constant parameters are used. The reservoirs are modeled using pool routing elements. Paired data for uncontrolled spillway outflow potential is configured using elevation-discharge relationships. Other releases are configured using a user specified controlled release component of the total outflow. Some dams have totally controlled releases, while others have a combination of controlled and uncontrolled releases. This approach allows data for observed inflow, outflow, and elevation to be used in calibration of HEC-HMS models for both historic and real-time events.

Once a full CWMS package is developed and unrolled, we will have HEC-MetVue, HEC-HMS, HEC-ResSim, HEC-RAS, and HEC–FIA, and HEC–CAVI watershed models to use over our entire district. This will allow us to work within the HEC-CAVI program, using a native model implementation approach, to access all the modeling

programs within a single interface. Our current Water Control Data System (WCDS), a database for all our water information including gage and reservoir data, will be transferred onto a new Oracle database to be used with the CWMS system.

The following is a very brief rundown of each piece of software that will be used in CWMS. HEC-MetVue will provide the hyetograph data from radar precipitation data files. HEC-HMS will process the inflow hydrographs at reservoirs and gages, HEC-ResSim will provide reservoir simulation with release logic built for each dam. HEC-RAS will provide in depth flow analysis and inundation mapping. HEC-FIA will provide damage and risk economic assessments. All these programs will be run from inside the HEC-CAVI environment. Any refining or adjustments to observed data in the database will be performed in HEC-CWMSVue, which is very similar to HEC-DSSVue, but has the ability to connect to the CWMS Oracle database and edit that data as well as DSS data.

At this time, Tulsa District is in the model building phase. Recently, CWMS 3.0 was released and is currently being tested with the suite of CWMS models for one of our watersheds. This process is ongoing and will require extensive testing, debugging, time, and effort. Our CWMS Oracle database is also being built at this time. In order to ease the transition to CWMS and ensure we are maintaining all our current abilities to forecast and provide high quality flood control information to the water managers in Tulsa District, we are testing our HEC-HMS models with HEC-Metvue and HEC-DSSVue to compare these results to our legacy software results for the same events and observed data. This allows us to be testing the software and models that are critical to forecasting without having a full CWMS package developed. The current methods and procedures used for real-time forecasting using HEC-HMS models should provide insight on how the hydrological modeling is progressing and evolving within the Corps of Engineers, Tulsa District.