

## DSS-WISE: Decision Support System for Water Infrastructural Security

### Floods Change Faster Than Software Can Predict

**Dams and levees** comprise one of 18 Critical Infrastructure and Key Resource sectors identified by the National Infrastructure Protection Plan. Their failure can generate catastrophic floods,



leading to loss of life, urban and agricultural property damage, environmental degradation, and cascading failures in other critical sectors. Several thousand high- and significant-hazard

U.S. dams have no emergency action plan (EAP). Moreover, 114,000 miles of levee systems protect highly developed areas with critical infrastructures. Current engineering practices based on one-dimensional (1D) modeling can't handle mixed-flow regimes and may lead to large errors in flood depth and arrival time in case of nonchanneled flow over flat areas. Moreover, the generation of two-dimensional (2D) flood maps for consequence analysis involves time-consuming interpolation based on a digital elevation map.

### What is DSS-WISE?

DSS-WISE is an integrated software package that combines a state-of-the-art, 2D numerical flood model and a series of geographic information system (GIS)-based decision support tools. It is designed for water infrastructural safety studies. DSS-WISE can simulate dam/levee breach floods, fluvial floods, storm/tidal surges, landslide waves, and their consequences. It was designed to eliminate scientific and technological gaps of existing flood simulation and flood damage evaluation practice and to improve engineering and decision-making practice by providing simulation and analyses capabilities with unprecedented realism and robustness. Developed by researchers at the National Center for Computational Hydroscience and Engineering (UM-NCCHE) of the University of Mississippi, DSS-WISE has three principal modules:

- a GIS-based preprocessor and graphical user interface (GUI) to set up a problem and prepare data to input;
- a 2D numerical model, CCHE2D-FLOOD, to handle mixed-flow regimes, wetting, and drying; and
- a GIS-based postprocessor with modules for flood mapping and consequence analysis.

The GUI is programmed as an extension of ESRI's ArcGIS. The user carries out operations using specially designed toolbars. Simulations can be set up and run with various levels of data availability, using the GIS-based GUI.

"DSS-WISE was designed to facilitate problem definition and scenario setup for large-scale dam/levee break/breaching studies," says Mustafa Altinakar, Director and Research Professor at UM-NCCHE, the project's principal investigator.

The numerical model CCHE2D-FLOOD uses a shock-capturing, cell-centered finite-volume upwind scheme that can handle mixed-flow regimes, complex terrain topography, wetting, and drying while preserving oscillation-free sharp discontinuities. The Digital Elevation Model (DEM) is used as a computational mesh.

To meet users' needs, DSS-WISE offers many advanced features:

- A cut-cell immersed-boundary technique is used for representing linear terrain features (such as road and railroad embankments) not captured by DEM, and for coupled 1D-2D modeling.
- Multiple dams can be defined, each with its own breaching sequence.
- Automatic local mesh refinement, using a quadtree method, lets gradual dam breaching details be resolved.
- Sources and sinks can be defined to model reservoir operations and flow-through hydraulic structures, such as spillways and bottom outlets.
- Boundary conditions can be specified.
- Variation of Manning's roughness coefficient over the computational domain can be automatically computed using classified land-use data.
- A user can define a series of observation points, lines, and profiles to monitor simulation results.

The result files—a flood depth grid, velocity components in two horizontal directions, flood arrival time, and flood duration—can be directly imported into ArcGIS for mapping and consequence analysis, using built-in tools or HAZUS-MH.

### Current Users of DSS-WISE

DSS-WISE is used by the Department of Homeland Security Dams Sector Branch; the National Geospatial Intelligence Agency; the Mississippi Department of Environmental Quality. The U.S. Army Corps of Engineers (USACE) alone uses the software in its Vicksburg and Nashville Districts, at its Engineering Research and Development Center (ERDC), and at headquarters. In 2010, ERDC used DSS-WISE to simulate Pakistan floods, providing 'round-the-clock situational awareness to the U.S. and Pakistani governments. The next year, DSS-WISE aided emergency preparedness and management efforts in the Mississippi Delta during the 2011 Mississippi River floods.

