RIVERWARE DEMONSTRATION

EXTENDED ABSTRACT

David Neumann, Senior Research Assistant, Center for Advanced Decision Support for Water and Environmental Systems, University of Colorado, Boulder, CO, david.neumann@colorado.edu
Edie Zagona, Director, Center for Advanced Decision Support for Water and Environmental Systems, University of Colorado, Boulder, CO, zagona@cadswes.colorado.edu;

RiverWare is a river and reservoir modeling tool used by water managers, planners, consultants, utilities, researchers and stakeholders for forecasting and scheduling reservoir and hydropower operations, water rights and water accounting, developing and evaluating alternative operating policies and planning new projects. Developed by the University of Colorado Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) with sponsorship of the Tennessee Valley Authority, the Bureau of Reclamation and the U.S. Army Corp of Engineers, RiverWare simulates the hydrologic response of a river/reservoir system given inflows and multi-objective operating policies. This demonstration will show how the object-oriented models are constructed from the palette of objects and linked together to form a river system network as shown in Figure 1.

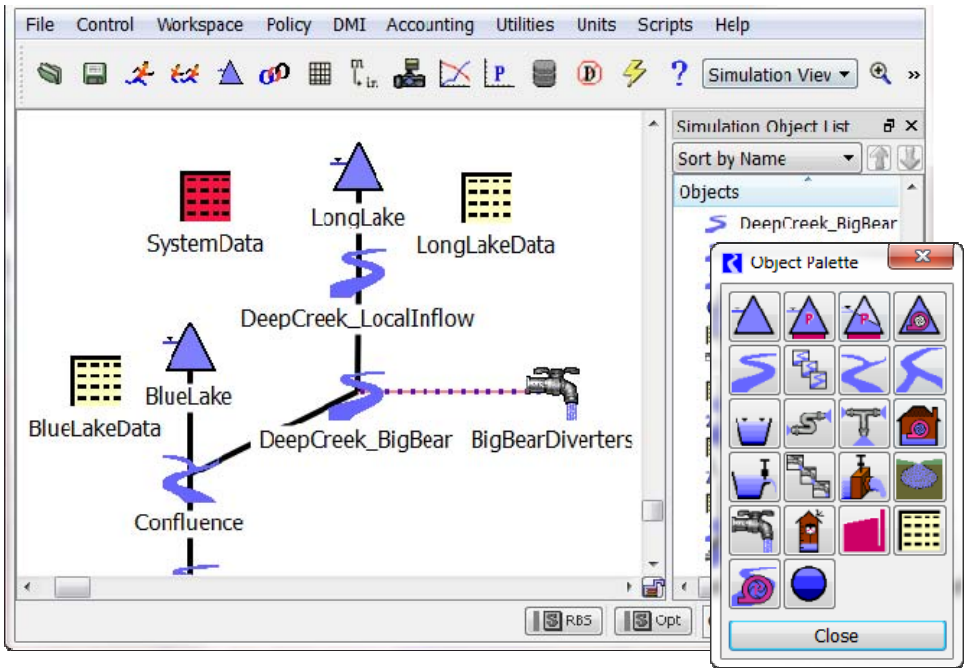

Figure 1 RiverWare Workspace and Object Palette

Simulation demonstrations will include hydrologic processes in rivers and reservoir, consumptive uses and return flows, distribution canals, groundwater interaction and pumping, pipe flows, hydropower and pumped storage, inline pumping and hydropower plants. A water quality module tracks salinity, temperature and dissolved oxygen throughout the system using

ether a simple well-mixed or layered/discretized approach. In the demonstration, we will show how to model the salinity and flow interaction of the surface water with groundwater including inflows from surface water (including point sources), pumping, deep aquifer brine inputs, evaporation, and evapotranspiration.

The rulebased simulation solution is driven by prioritized, logical rules that represent the multi-objective operating policies such as flood control, water supply, environmental flows and hydropower production. We'll show how to create and execute these policies, using them to produce operating schedules, manage flood events or evaluate alternatives for EIS analysis. RiverWare also models water ownership and can perform water accounting calculations – we'll demonstrate how agencies use RiverWare for prioritized water allocation, to operate with rules based on water ownership, and to perform after-the-fact legal accounting.

The optimization solution is driven by prioritized goals that represent policy constraints and objectives. We'll demonstrate how utilities use RiverWare's pre-emptive linear goal programming to optimize hydropower production while meeting water management constraints.

We'll show how data can be easily loaded into RiverWare from various sources using the input Data Management Interface (DMI) which allows data to be automatically loaded from text files, Excel spreadsheets, HEC DSS files, HDB database or any other database.

We will demonstrate RiverWare's many utilities for viewing, analyzing and visualizing data including a fully featured plotting utility, outputs to HTML model reports and tabular series slot reports, pie charts, and tea cup diagrams. There are many options for exporting data from RiverWare including the output DMIs to any database, direct export to Excel, HEC DSS, and HDB. We'll show how to export RiverWare results to netCDF files and files that can be used directly in the Tableau Software for data processing, analysis, and visualization.

RiverWare's multiple run management utilities can be used to automate thousands of runs, and produce probabilistic outputs, or to perform yield studies. This concept of running many runs can be further structured using the RiverWare Study Manager and Research Tools (RiverSMART). This tool automates a planning study by organizing and running scenarios of hydrologic inputs, demand inputs and policy sets and then provides utilities to analyze and compare the results from these scenarios. Using this approach, water managers can run proposed operating policy changes through climate change hydrologies to analyze impacts and compare alternatives. We'll show how to define a RiverSMART study, generate scenarios, simulate the scenarios and then post process the results of either scenarios or sets of scenarios. We'll describe and show the various plugins that can be used within RiverSMART including the R plugin, the GPAT graphs plugin, and the Hydrology Simulator plugins.

RiverWare's script utility can be used to automate many of the processes that are performed on a day to day basis. Scripts contain actions which execute a process in RiverWare. For example, a script that load a ruleset, import observed data from a database, configure initial conditions, make a run, and generates output plots. Scripts are run from a configurable Script Dashboard, as shown in Figure 2, in which model operators can also view and change key decision variables. We will demonstrate how scripts and dashboards can be used to simplify modeling processes.

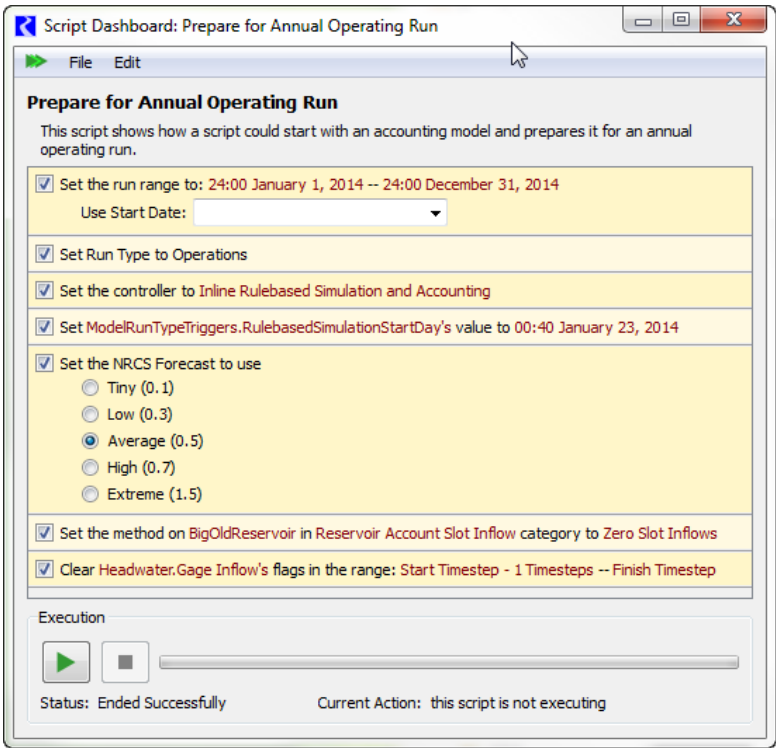

Figure 2 RiverWare Script Dashboard

RiverWare is integrated into the U.S. Army Corp of Engineers Corp Water Management System (CWMS). Further, it is integrated as a component of multiple Flood Early Warning Systems (FEWS) developed by Deltares. This integration allows for tighter coupling of RiverWare with other modeling tools for real time operations and management.

RiverWare's easy-to-use graphical user interface, statistical post-processing, script management, spreadsheet-view of data, direct database connection configurations, and powerful diagnostic and analysis utilities will complement as we show examples of the application of RiverWare to numerous river basins. Free evaluation versions of the software with demo models will be given to interested visitors.