



Center for Advanced Decision Support for
Water and Environmental Systems (CADSWES)

UNIVERSITY OF COLORADO **BOULDER**

RiverSMART, Cloud Computing, Excel DMI

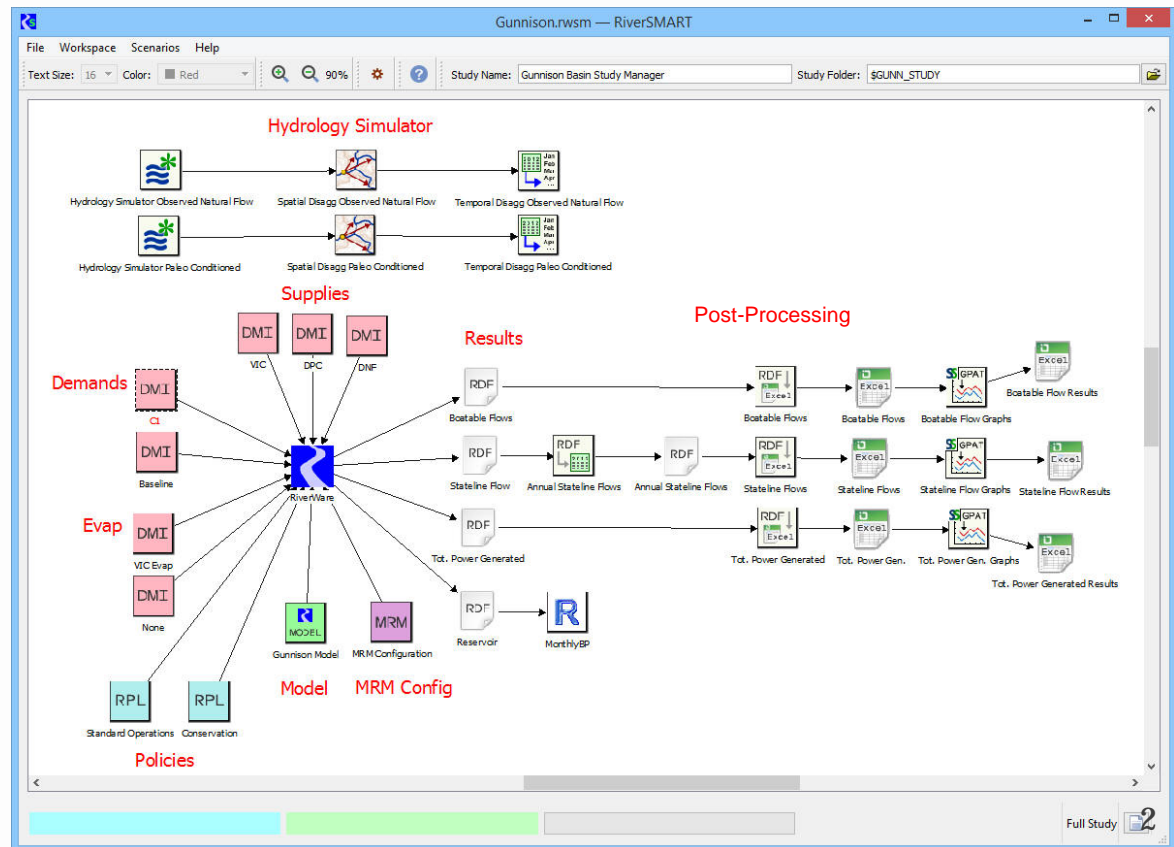
2019 RiverWare User Group Meeting
Mitch Clement

RiverWare Study Manager and Research Tools (RiverSMART)



Facilitates large studies with many combinations of inputs by organizing and executing scenarios

- Develop Scenarios that consist of combinations of alternative
 - Ensembles of Hydrologies
 - Demands
 - Operating Policies
 - Infrastructure
 - ...
- Provide Graphical Representation
- Manage Execution
- Organize Outputs
- Archive the study

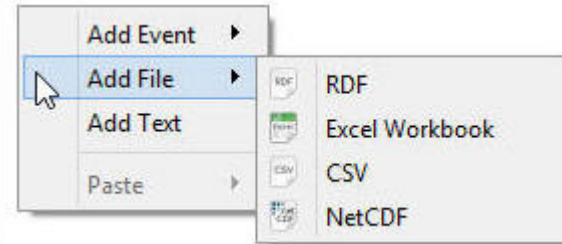
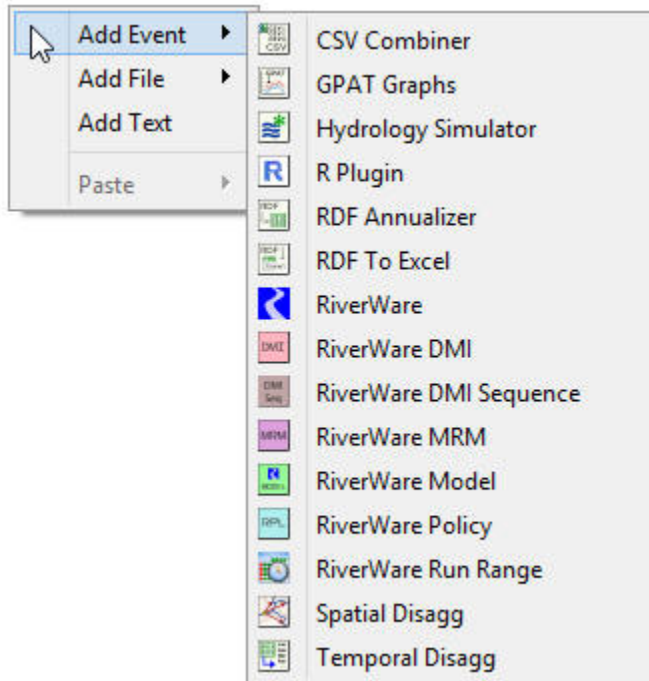




RiverSMART

A **study** is comprised of **events** linked by **files**

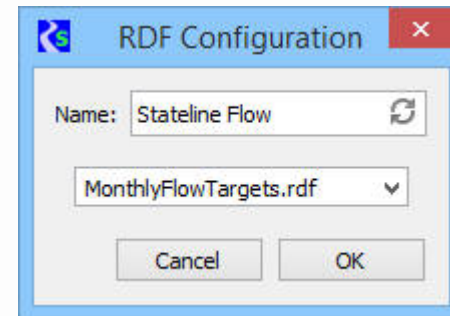
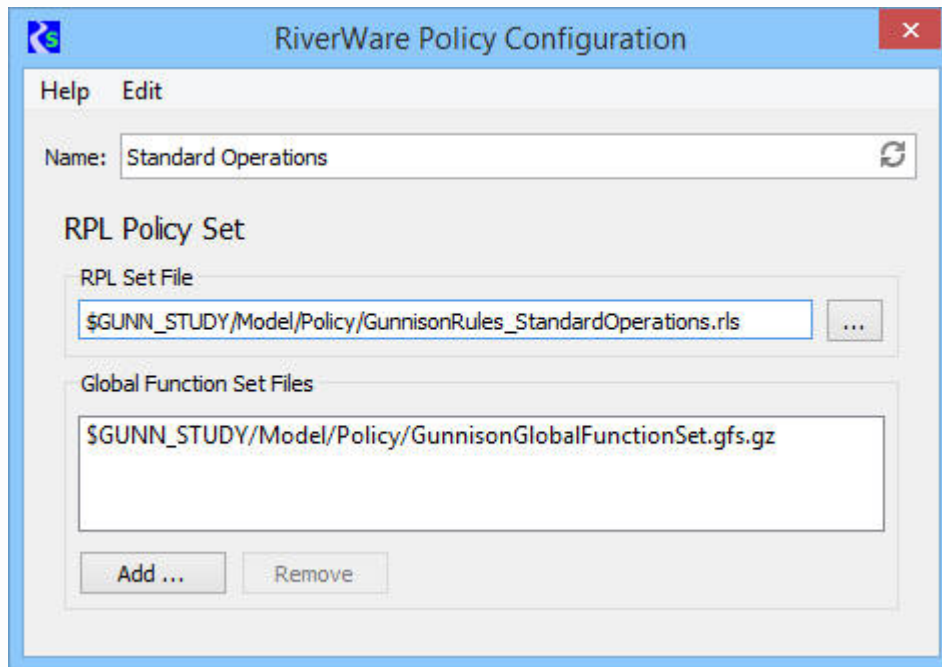
- Event: a software component which performs a particular task





RiverSMART

Events and files are configurable





Manage Scenarios

Sort by reordering columns

Scenario List Simulator

Edit View Scenarios

Check:

		Supply	Demand	Policy
▶	<input type="checkbox"/>	DNF	Baseline	Conservation
▶	<input type="checkbox"/>	DNF	Baseline	Standard Operation
▶	<input type="checkbox"/>	DNF	C1	Conservation
▶	<input type="checkbox"/>	DNF	C1	Standard Operation
▶	<input type="checkbox"/>	DPC	Baseline	Conservation
▶	<input type="checkbox"/>	DPC	Baseline	Standard Operation

12 Scenarios (12 Visible, 0 Hidden, 0 Checked)

Scenario List Simulator

Edit View Scenarios

View: Ascending A-Z

		Supply	Policy	Demand	Evap	MRM Config	Model
▶	<input type="checkbox"/>	DNF	Conservation	Baseline		MRM Configuration	Gunnison Model
▶	<input type="checkbox"/>	DNF	Conservation	C1		MRM Configuration	Gunnison Model
▶	<input type="checkbox"/>	DNF	Standard Operations	Baseline		MRM Configuration	Gunnison Model
▶	<input type="checkbox"/>	DNF	Standard Operations	C1		MRM Configuration	Gunnison Model
▶	<input type="checkbox"/>	DPC	Conservation	Baseline		MRM Configuration	Gunnison Model
▶	<input type="checkbox"/>	DPC	Conservation	C1		MRM Configuration	Gunnison Model

12 Scenarios (12 Visible, 0 Hidden, 0 Checked)



Manage Scenarios

Deactivate, hide and show scenarios

Scenario List Simulator

Edit View Scenarios

Check: View: Ascending A-Z

		Supply	Policy	Demand	Evap	MRM Config	Model	
▶	<input type="checkbox"/>	VIC	Conservation	Baseline	VIC Evap	MRM Configuration	Gunnison Model	
	<input type="checkbox"/>	VIC	Conservation	C1	VIC Evap	MRM Configuration	Gunnison Model	
	<input type="checkbox"/>	VIC	Standard Operations	Baseline	VIC Evap	MRM Configuration	Gunnison Model	
	<input type="checkbox"/>	VIC	Standard Operations	C1	VIC Evap	MRM Configuration	Gunnison Model	

12 Scenarios (4 Visible, 8 Hidden, 0 Checked)



Manage Executions

Simulation status

- Successful
- Unsuccessful
- Not yet Simulated

Scenario List Simulator

Edit View Scenarios

Check: View: Ascending A-Z

		Supply	Policy	Demand	Evap	MRM Config	Model	
▶	<input type="checkbox"/>	DPC	Conservation	Baseline		MRM Configuration	Gunnison Model	📁
▶	<input type="checkbox"/>	DPC	Conservation	C1		MRM Configuration	Gunnison Model	📁
▶	<input type="checkbox"/>	DPC	Standard Operations	Baseline		MRM Configuration	Gunnison Model	📁
▶	<input type="checkbox"/>	DPC	Standard Operations	C1		MRM Configuration	Gunnison Model	📁
▶	<input type="checkbox"/>	VIC	Conservation	Baseline	VIC Evap	MRM Configuration	Gunnison Model	📁
	<input type="checkbox"/>	VIC	Conservation	C1	VIC Evap	MRM Configuration	Gunnison Model	📁

12 Scenarios (12 Visible, 0 Hidden, 0 Checked)



Manage Executions

Diagnose simulation errors

The image shows two overlapping windows from the RiverWare software. The background window is titled "Scenario List Simulator" and displays a list of scenarios. The foreground window is titled "Traces 1 - 2" and shows a detailed log of simulation errors.

Scenario List Simulator

Check:	Supply	Policy	Demand	Evap
<input type="checkbox"/>	DPC	Standard Operations C1		
<input checked="" type="checkbox"/>	VIC	Conservation	Baseline	VIC Eva
<input checked="" type="checkbox"/>	Simulate Scenario			
<input checked="" type="checkbox"/>	Execute RiverWare			
<input checked="" type="checkbox"/>	Execute Distrib M...			
<input checked="" type="checkbox"/>	Init Distrib MRM ...			
<input checked="" type="checkbox"/>	Traces 1 - 2			
<input checked="" type="checkbox"/>	Traces 3 - 4			
<input checked="" type="checkbox"/>	Traces 5 - 6			
<input checked="" type="checkbox"/>	Traces 7 - 8			

Activity "Traces 1 - 2" performed unsuccessfully @ Sun Aug 18 16:37:21
RiverWare exited with code 1

12 Scenarios (12 Visible, 0 Hidden, 0 Checked)

Traces 1 - 2

Scenario: VIC,Baseline,Conservation,VIC Evap
Activity: Traces 1 - 2

```
__WARNING__: GROUP: A1566167818; DMI: VIC Evap; " No objects with name "Powell"."  
__WARNING__: GROUP: A1566167818; DMI: VIC Evap; "Control file line 14:"  
__WARNING__: GROUP: A1566167818; DMI: VIC Evap; " No objects with name "Powell"."  
__ERROR__: GROUP: A1566167818; DMI: VICNaturalFlowInput; "The DMI executable failed:  
__ERROR__: "StartController: Run aborted."  
__REQINFO__: "----- MRM RUN ABORTED -----"  
__REQINFO__: "'RwModel.mdl at 16:37:21 August 18, 2019 (0 seconds)'"  
__REQINFO__: "-----"  
__ERROR__: GROUP: A1566167818; DMI: VICNaturalFlowInput; "Invoking executable produc  
__ERROR__: GROUP: A1566167818; DMI: VICNaturalFlowInput; "Trace directory is: D:\Gunn  
__WARNING__: GROUP: A1566167818; DMI: VICNaturalFlowInput; "STOPPING EXECUTION (o  
__WARNING__: GROUP: A1566167818; DMI: VICNaturalFlowInput; "STOPPING EXECUTION"  
__WARNING__: GROUP: A1566167818; DMI: VIC Evap; "STOPPING EXECUTION"
```




Manage Executions

Track changes to the study

The screenshot shows the 'Scenario List Simulator' window with a table of 12 scenarios. The table has columns for Supply, Demand, Policy, and Evap. A red arrow points from the 'C1' demand in the second scenario to the 'Evap' policy in the third scenario. Red text labels 'Demands' and 'Evap' are placed next to their respective columns.

	Supply	Demand	Policy	Evap
▶	DNF	Baseline	Conservation	
▶	DNF	Baseline	Standard Operations	
▶	DNF	C1	Conservation	
▶	DNF	C1	Standard Operations	
▶	DPC	Baseline	Conservation	
▶	DPC	Baseline	Standard Operations	
▶	DPC	C1	Conservation	
▶	DPC	C1	Standard Operations	

12 Scenarios (12 Visible, 0 Hidden, 0 Checked)



Post-Processing Scenarios

- Convert outputs (RDF, CSV and NetCDF) to formats appropriate for analysis
- Perform the analysis with R code or the GPAT Excel add-in
- Most of the capabilities available for simulating scenarios are available for post-processing scenarios



Post-Processing Scenarios

Supply	Demand	Policy
DNF	Baseline	Conservation
Boatable Flows		
Annual Stateline Flows		
Tot. Power Generated		
MonthlyBP		
Stateline Flows		
DNF	Baseline	Standard Operations
DNF	C1	Conservation
DNF	C1	Standard Operations

Scenario "DNF,C1,Conservation,None"

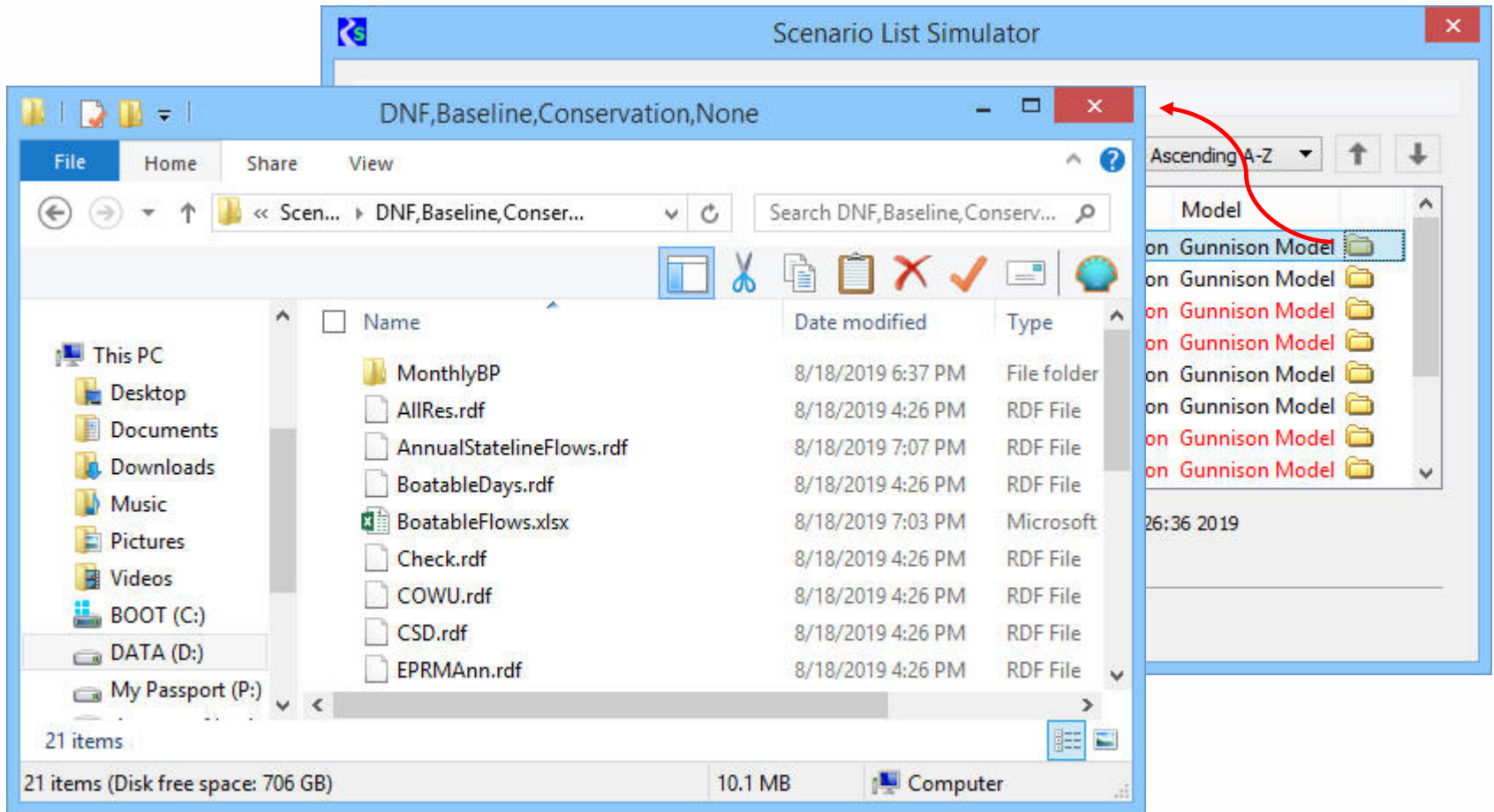
12 Scenarios (12 Visible, 0 Hidden, 0 Checked)

Simulation Output Files

- RDF
 - Boatable Flows
 - Reservoir
 - Stateline Flow
 - Tot. Power Generated



Organize Outputs





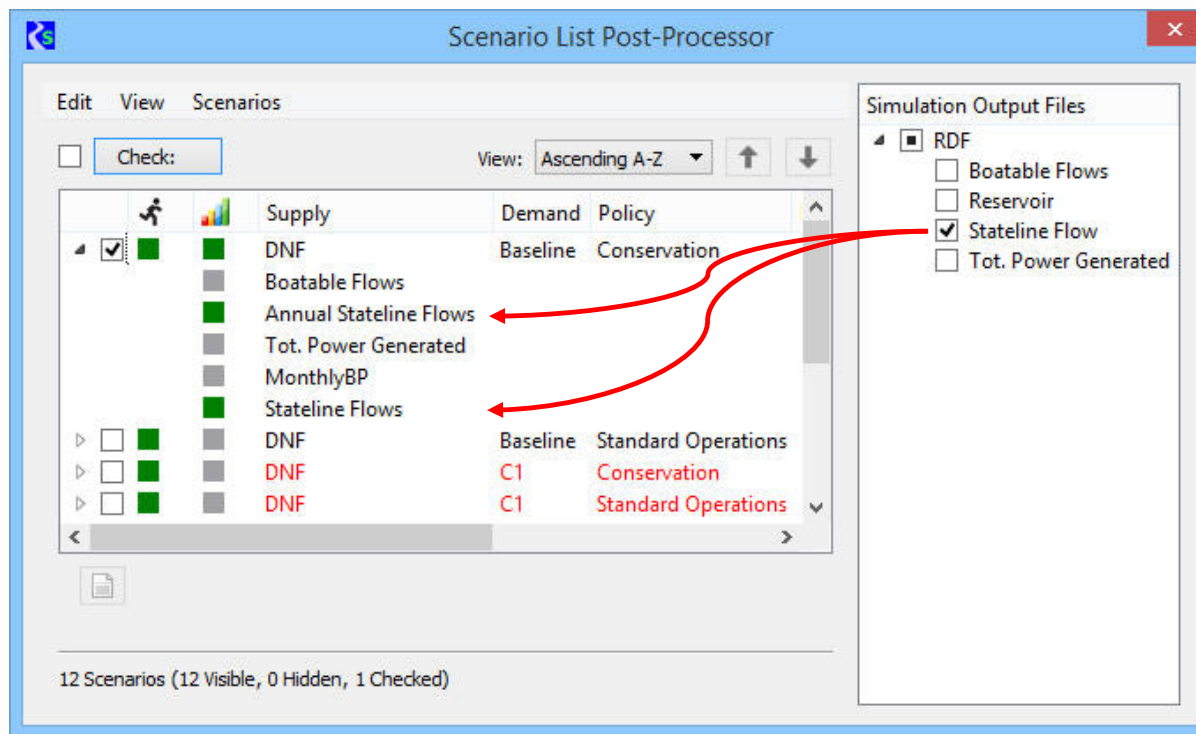
Recent Features

- Selectively post-process simulation outputs
- Archiving scenarios
- User specified RiverWare batch mode commands
- Read/write Excel data directly (without Excel)



Recent Features

Selectively Post-Process Simulation Outputs

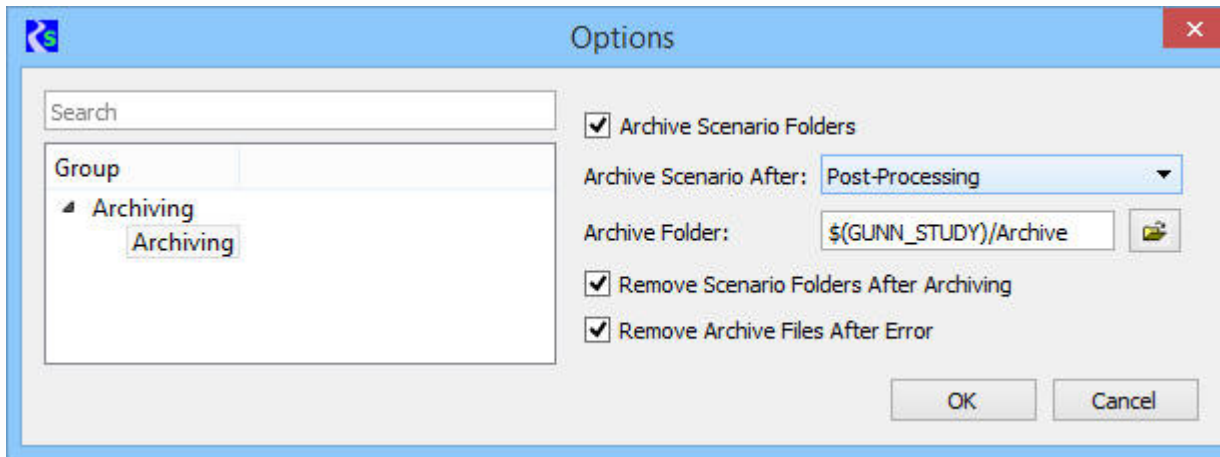




Recent Features

Archiving Scenarios

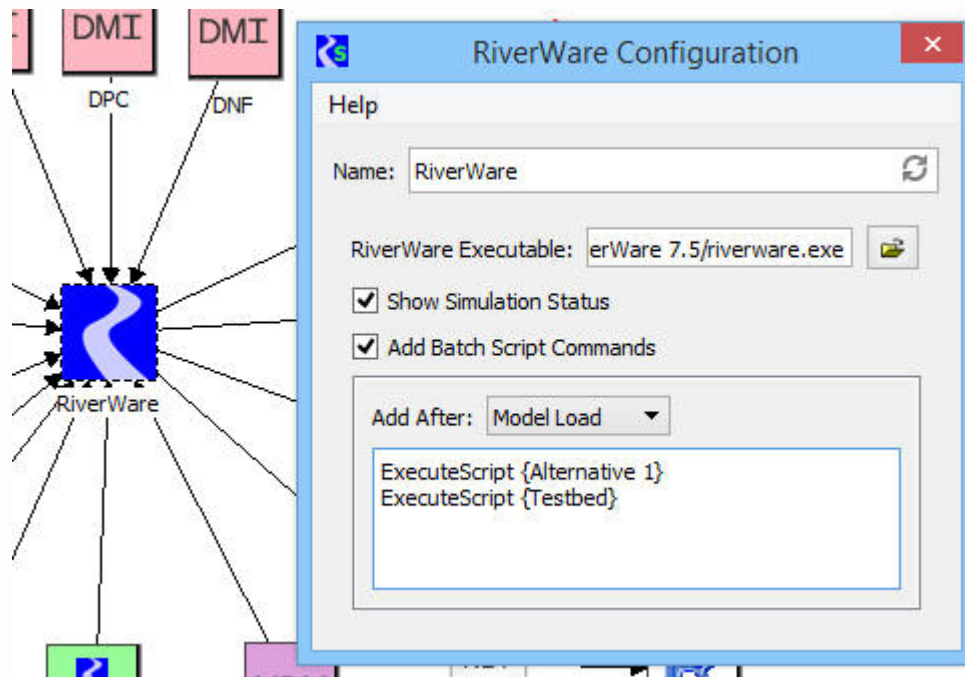
- Archive after simulation or post-processing
- Remove scenario folder after archiving
- Remove archive file after an error





Recent Features

User Specified RiverWare Batch Mode Commands



RiverSMART and RiverWare in the Cloud

- RiverSMART: distributes scenarios to multiple cloud computers for simulation then combines results
- RiverWare: Distributed MRM distributes traces across multiple CPUs
- Utilize all available resources to minimize simulation time

Excel DMI Implementation

- Original Excel DMI implementation starts Excel in the background
- Running in the cloud
 - Require as few additional software components as possible
 - No additional licenses for other software
- New Excel DMI implementation: LibXL reads/writes Excel workbooks directly – eliminates the need for Excel
- Both implementations still supported (new implementation doesn't evaluate formulas)
- New implementation is much faster