COE Flood Control

Design and development of enhancements to support modeling of COE flood control releases in RiverWare

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Objective of flood control algorithm

Calculate a set of flood releases for all reservoirs in a basin or sub-basin that:

- ❖ Respect downstream channel constraints
- ❖ Balance reservoir storages to extent possible
- ❖ Consider operations and inflows over a specified forecast period
- ❖ Consider routing via linear routing coefficients
- ❖ Make new forecast and new plan each timestep
- ❖ Execute current timestep from a rule in RiverWare

4 Major Areas of Development
to Support COE Flood Control Computations

1. Reservoir Methods

2. Control Point Object

3. Computational Subbasin

4. Rule Functions

1.   Reservoir Methods

❖ Surcharge Release method and flag
   Dispatch conditions to execute surcharge release

❖ Forecasted Hydrology
   Computes at beginning of each timestep based on deterministic inflows

❖ Flood Control Supporting Methods
   ❖ *Operating Levels (periodic slot)*
   ❖ *Dispatch methods for flood release*

2. Control Point Object

❖ Regulation Discharge

❖ Empty Space Hydrograph

❖ Maps to upstream constrained reservoirs
  - ❖ List of upstream reservoirs (List Slot)
  - ❖ Linear routing coefficients

❖ Key Control Point Toggle (visual)
  - ❖ Balancing level calculations

❖ Forecasted Hydrology (Accumulated Local Flows

3.   Computational Subbasin

❖ Collection of objects (not new)
New: an object with Attributes

  ❖ *Can be seen on the workspace as open obj*

❖ Method Categories, e.g., Flood Control

❖ Methods within Categories

  ❖ *Operating Level Balancing;
  Lake Phase Balancing*

❖ Slots associated with methods

  ❖ *Forecast Period, Balance Period*

4. Rules Function

FloodControl("basin name")

Executes the default Flood Control method on the designated subbasin.

Returns a list of slots and values, two pairs for each reservoir in the subbasin

{resA.FloodRelease 3570.0 resA.Outflow 5579.0
  resB.FloodRelease 933.2 resB.Outflow 933.2 ....}

Execution of Flood Control in Simulation
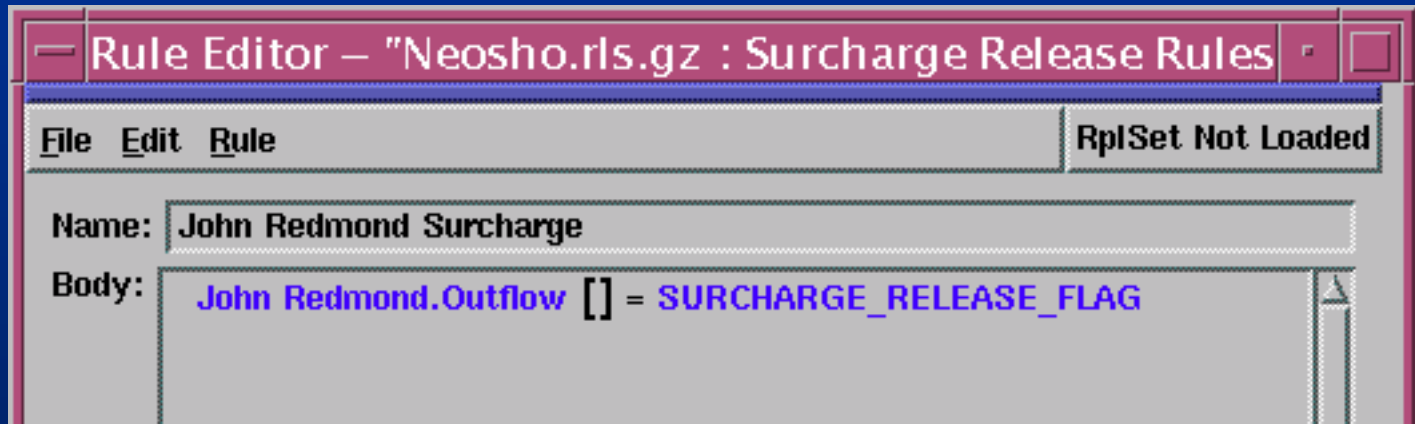## ..... At Each Timestep:

1. Beginning of Timestep
    Reservoirs, Reaches, Control Points

    Execute Inflow Forecast Methods to set Hydrologic Inflow Forecast for current timestep and all timesteps in the Forecast Period.

    (objects do NOT dispatch as a result of this setvalue)
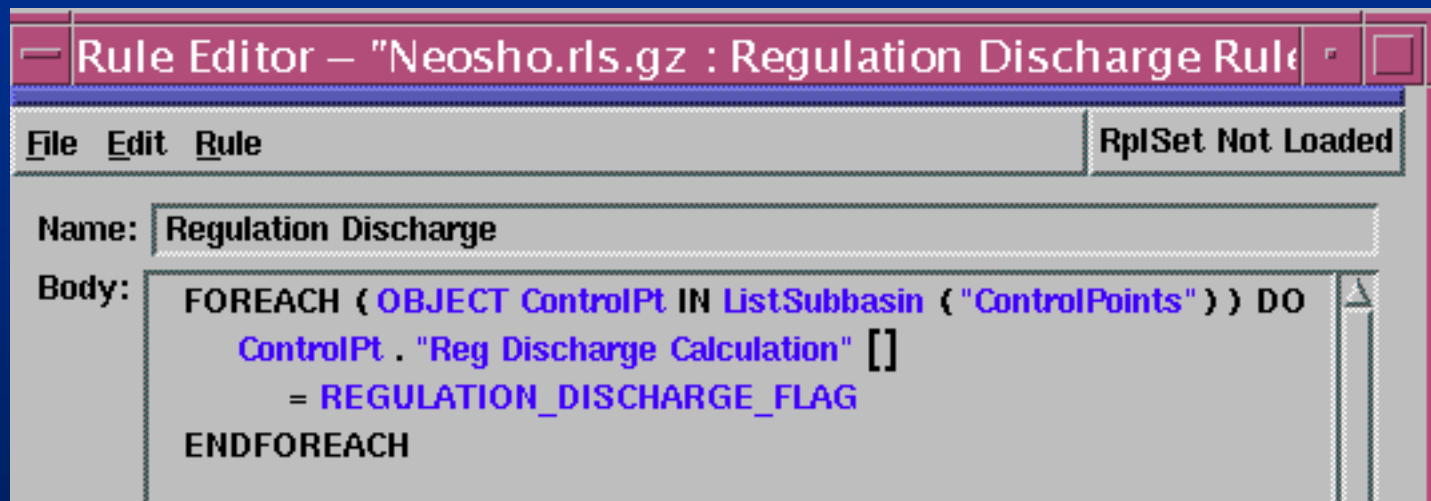
Execution of Flood Control in Simulation
..... At Each Timestep:

> **Rule Editor – "Neosho.rls.gz : Surcharge Release Rules**
>
> File Edit Rule   RplSet Not Loaded
>
> Name: John Redmond Surcharge
>
> Body: John Redmond.Outflow [] = SURCHARGE_RELEASE_FLAG

2. **Rule: Set Surcharge Release Flag (S) on Res.Outflow**
    slot of each Reservoir in Comp Subbasin
    (separate rule for each reservoir starting at u.s. and working d.s.)

    Simulation: Surcharge releases and Outflows are computed and
    set by the resulting dispatch method for entire forecast period;
    S flag is removed from Outflow slot.

Execution of Flood Control in Simulation
..... At Each Timestep:

Rule Editor – "Neosho.rls.gz : Regulation Discharge Rule"

File Edit Rule   RplSet Not Loaded

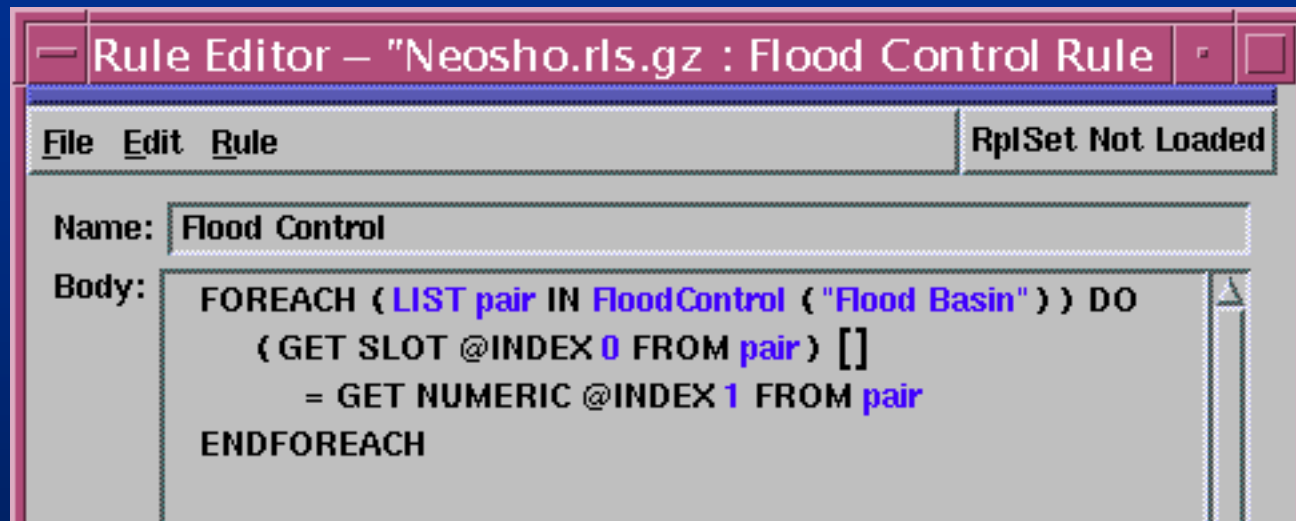Name: Regulation Discharge

Body: FOREACH (OBJECT ControlPt IN ListSubbasin ("ControlPoints")) DO
          ControlPt . "Reg Discharge Calculation" []
              = REGULATION_DISCHARGE_FLAG
       ENDFOREACH

3.   Rule: Set Regulation Discharge (G) Flag on all
      Control Point.RegDischargeCalc slots

      Simulation: Calculate Regulation Discharge and dependent
      methods; remove G flag; do not reset Outflow

Execution of Flood Control in Simulation
..... At Each Timestep:

Rule Editor – "Neosho.rls.gz : Flood Control Rule"

File   Edit   Rule   RplSet Not Loaded

Name: Flood Control

Body: FOREACH (LIST pair IN FloodControl ("Flood Basin")) DO
          (GET SLOT @INDEX 0 FROM pair) [ ]
             = GET NUMERIC @INDEX 1 FROM pair
       ENDFOREACH

4.   Rule: Execute Flood Control Method on subbasin and set Reservoir.FloodRelease and Res.Outflow on subbasin (outflow = surcharge release + flood release)

Simulation: solveMB_givenInflowOutflow flood releases are executed and results propagate downstream

Surcharge Release

❖ Mandatory releases made regardless of downstream channel constraints

❖ when pool elevation exceeds
    top of the flood pool

❖ ensures safety of the structure

Surcharge Release

Flat Top Surcharge method
(COE South West Division)

❖ Takes peak off forecasted flood wave making it "flatter"

❖ Looks out over forecast period and makes releases based on forecasted storages and forecasted flood peak

❖ Curves define forecasted storage vs. release relationships

Surcharge Release in RW

❖ surcharge release method selected on each reservoir

❖ Rule sets the surcharge release flag on Outflow

❖ Surcharge release flag acts as a "known" for choosing a dispatch method

❖ Reservoir solves given inflow and outflow

❖ Surcharge release forecast is computed at each controller timestep based on inflow forecast

General Testing Procedure

❖ **Implement logic** from SUPER into RiverWare – done (flood control)

❖ **Compare** RiverWare results with SUPER

❖ **Extensive testing**, debugging, and changes made to both models

❖ **Testing trick**: Highest priority rule resets RiverWare storage to SUPER storage at every timestep

Regulation Discharge

❖ Methods determine the maximum flow permitted in the channel at the control point.

❖ Also determine the empty space available in the channel based on the regulation discharge and the current flow.

❖ Method dispatching controlled at each timestep by the setting of a regulation discharge flag from a rule.

Regulation Discharge Methods

❖ **Channel Regulation**
  based on data entered for the control point.

❖ **Current Level Regulation**
  based on current level of an upstream reservoir.

❖ **Future Level Regulation**
  Based on predicted maximum level over the forecast period of an upstream reservoir.

❖ **System Percent Full Regulation**
  based on predicted maximum percent of flood pool occupied over forecast period for a system of upstream reservoirs.

Regulation Discharge Modifiers

- ❖ Stage Control Intervals
- ❖ Variable Regulation Intervals
- ❖ Sag Operation
- ❖ Regulation Recession

Key Control Point Balancing

❖ **Determines a balance level** for upstream reservoirs such that the available empty space in the channel at the key control point over the balance period would just be filled by the water above that balance level in the reservoirs at the end of the balance period.

❖ **Allocates empty space** in the channel to specific reservoirs.

❖ Method executes as initial step in flood control's predefined rule function.