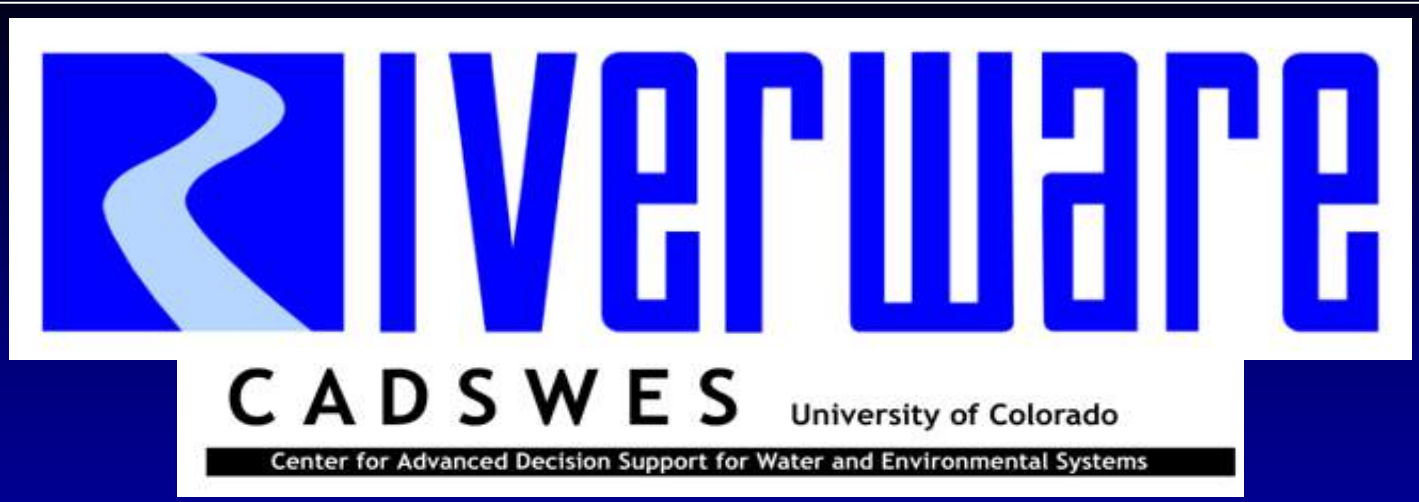


Water Accounting Modeling

Overview, Training, and Enhancements

RiverWare User Group Meeting
August 13-14, 2008

David Neumann

Presentation Outline

- Water Accounting Overview
  - Water Accounting Motivation
  - Accounts
  - Supplies
  - Solution Algorithm
  - User Defined Accounting Methods
  - Exchanges
- Accounting Class Outline
- Recent and Upcoming Enhancements

Motivation

- In many basins, it is necessary to track not only volume of water but the ownership and type
- Operating decisions are dependent on a user's available water, legal restrictions, physical constraints, exchange mechanism, and priority water rights allocation

Solution:

Water Accounting

How is water accounting modeled in RiverWare?

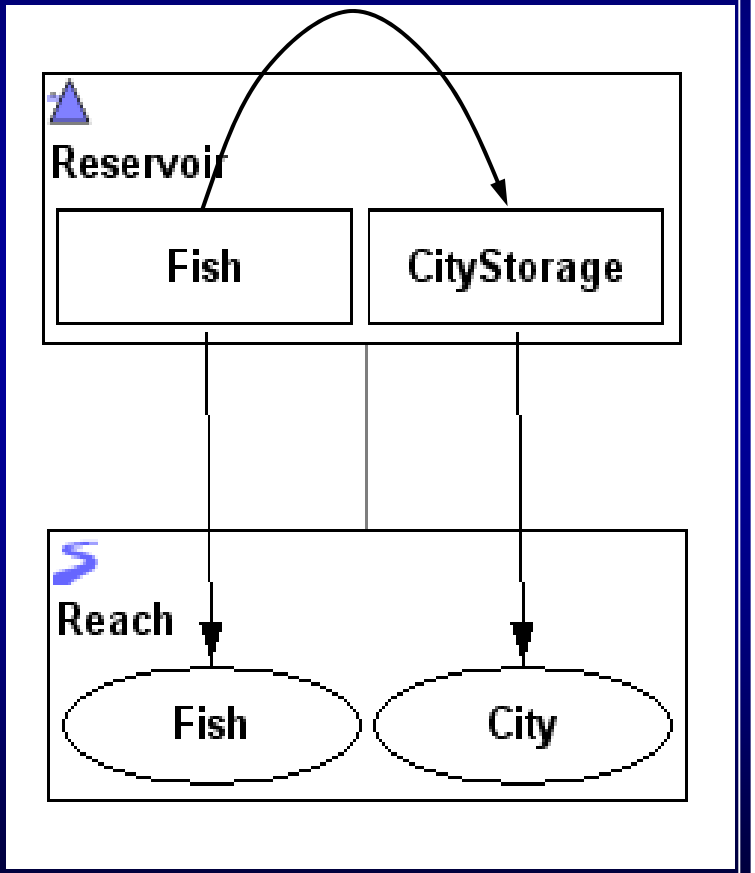
- Physical and Paper water are modeled separately;
  - Network of accounts on the simulation objects
  - Accounts are linked indicating the possible transfers
- Legal Accounts – Storage, Diversion, Instream Flow
- Non Legal - Passthrough accounts track transfer of water between legal accounts
- Accounts are labeled by ownership and type and can be given a priority date
- Rules can access accounting information and also set account transfers
- Can simulate water accounting components like accrual, exchanges, carryover, allocation, etc.

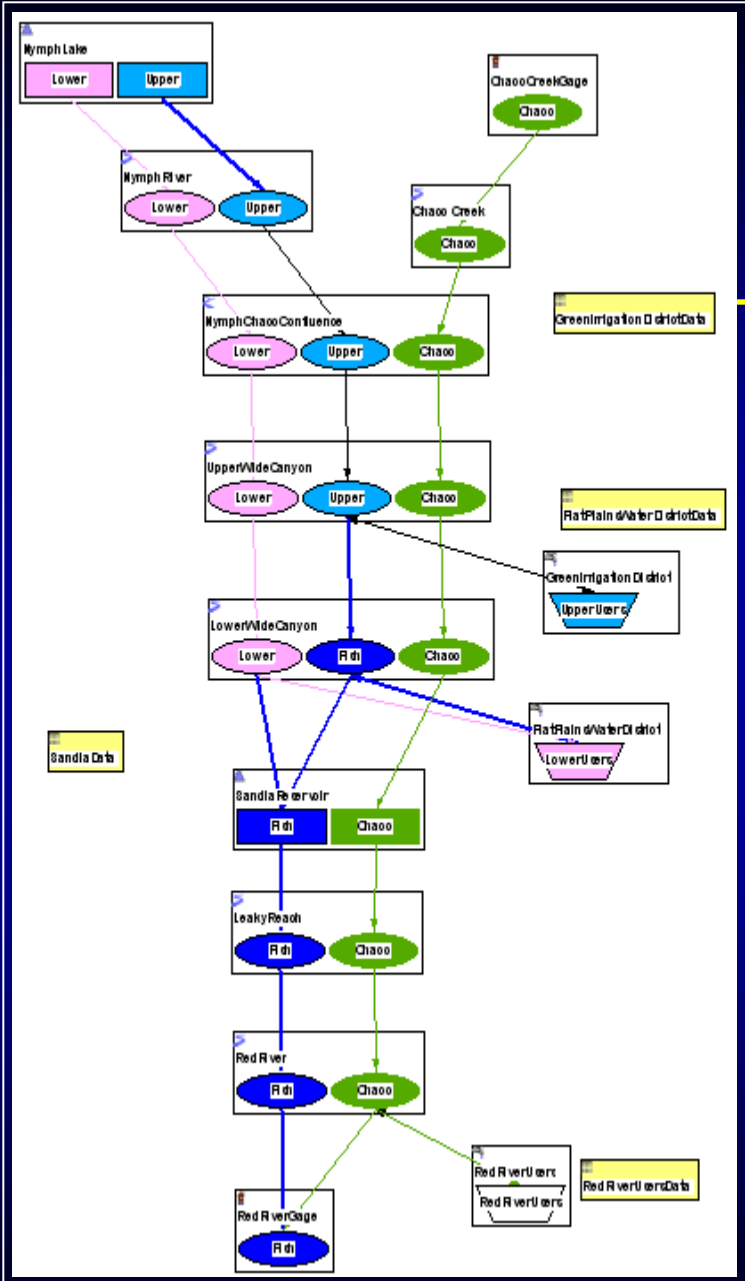
Types of Accounts

- Legal Accounts:
  - Storage Account - on Reservoirs:
    Storage, gain/loss, accrual, carry-over, inflow and outflow, transfers
  - Diversion Account - on Water Users, Aggregate Diversions:
    diversion, consumption, and return flow
  - Instream Flow – on Control Points: Track total flow into all accounts
- Non-Legal Accounts
  - Passthrough Accounts - Reaches, Confluences, Gages, Reservoirs:
    keep track of water moving between legal accounts
- Properties of Accounts
  - Water Type – E.g., trans-basin or local water
  - Water Owner – E.g., Contractor A, Contractor B, and City

Linking Accounts - Supplies

- Accounting network is formed by links between accounts called “supplies”: represent movement of paper water
- Supply Properties:
  - Type – Inflow/Outflow, Diversion/Return Flow, Transfer
  - Destination – E.g., Diversion A, Red Reach
  - Release Type – E.g., Diversion, Fish





Accounting View

- Display the system to stakeholders and water managers
- Allows for color coding, formatting, and aggregation of accounts and supplies
- Useful to:
  - Create
  - Reorganize
  - Link

Accounting Solution

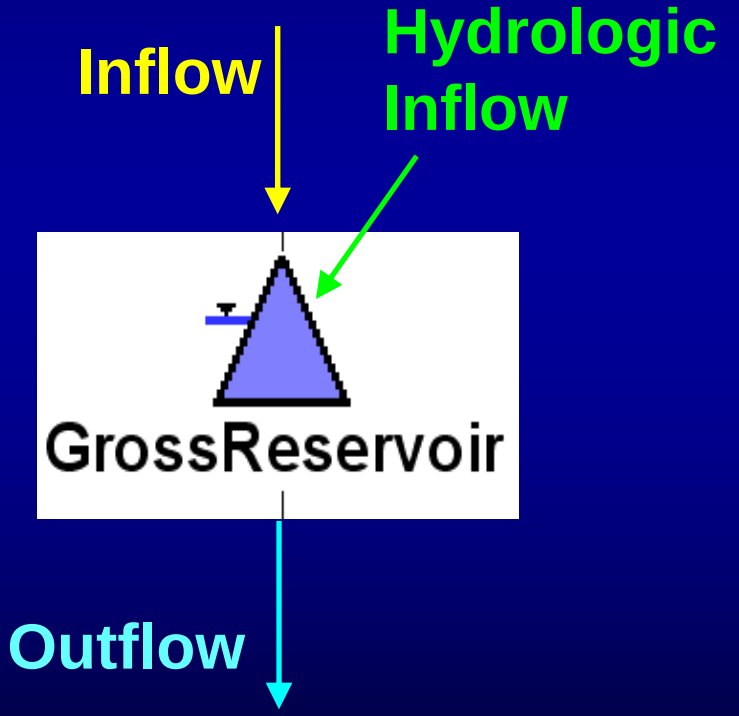
- "Spreadsheet" type solution
  - Account solves when it has the required knowns
  - Account solves whenever it gets a new value (not controlled by dispatcher during a run)
  - Account slots and supplies are set by user input, methods, or rules
- Mass balance solutions:
  - Storage accounts solves for Storage and Accrual
  - Diversion accounts solve for Depletion and/or Return flow
  - Instream Flow accounts solve for Flow and Outflow
  - Passthrough accounts solve only downstream for outflow

Object Level Accounting Methods

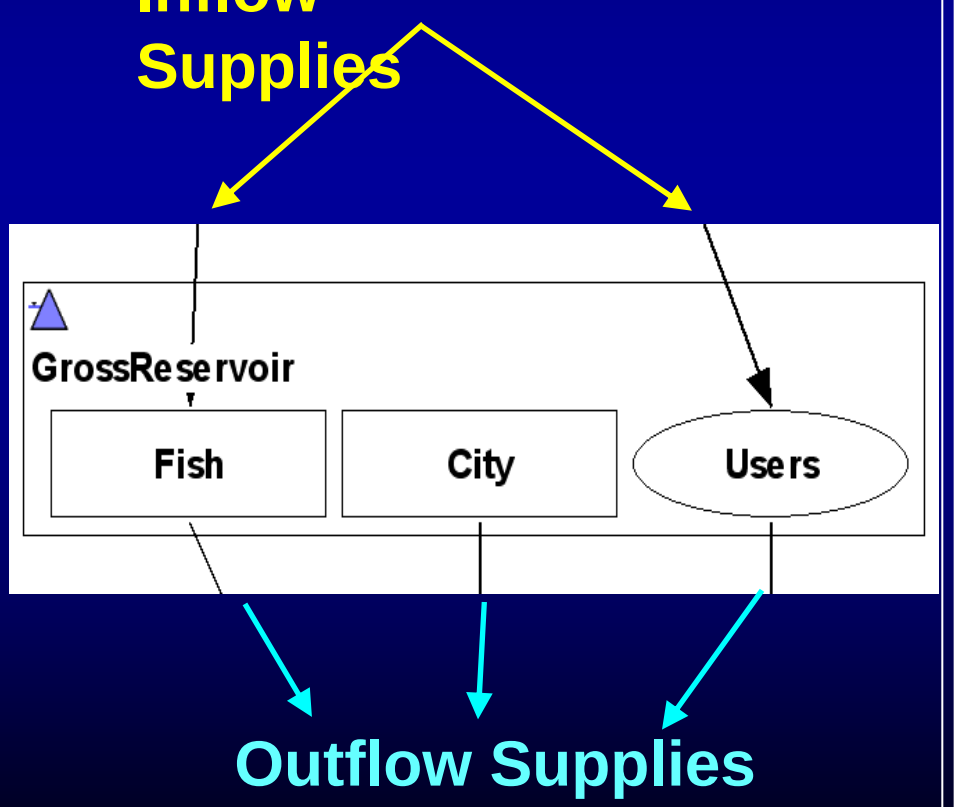
- Purpose: Distribute physical water on simulation objects to the accounts
- Methods are on the object and apply to all accounts
- Categories
  - Gain Loss: allocate physical gains and losses
  - Slot Inflow: allocate local inflows
  - Reconciliation: match accounting and physical systems
- Two ways to specify the methods
  - Compiled: Simple methods or basin specific
  - User Defined: Written in RiverWare Policy Language (RPL)

Slot Inflow Example

- Physical

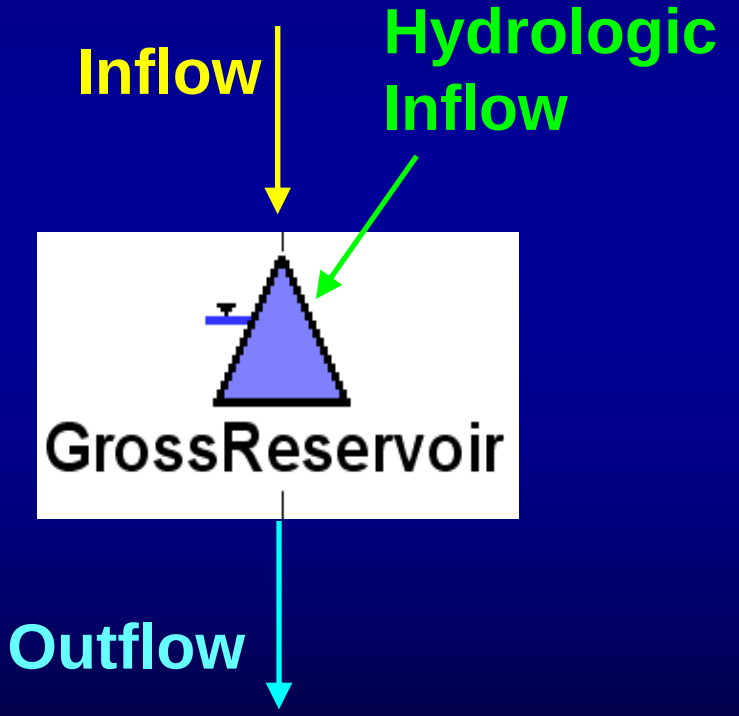


- Accounting

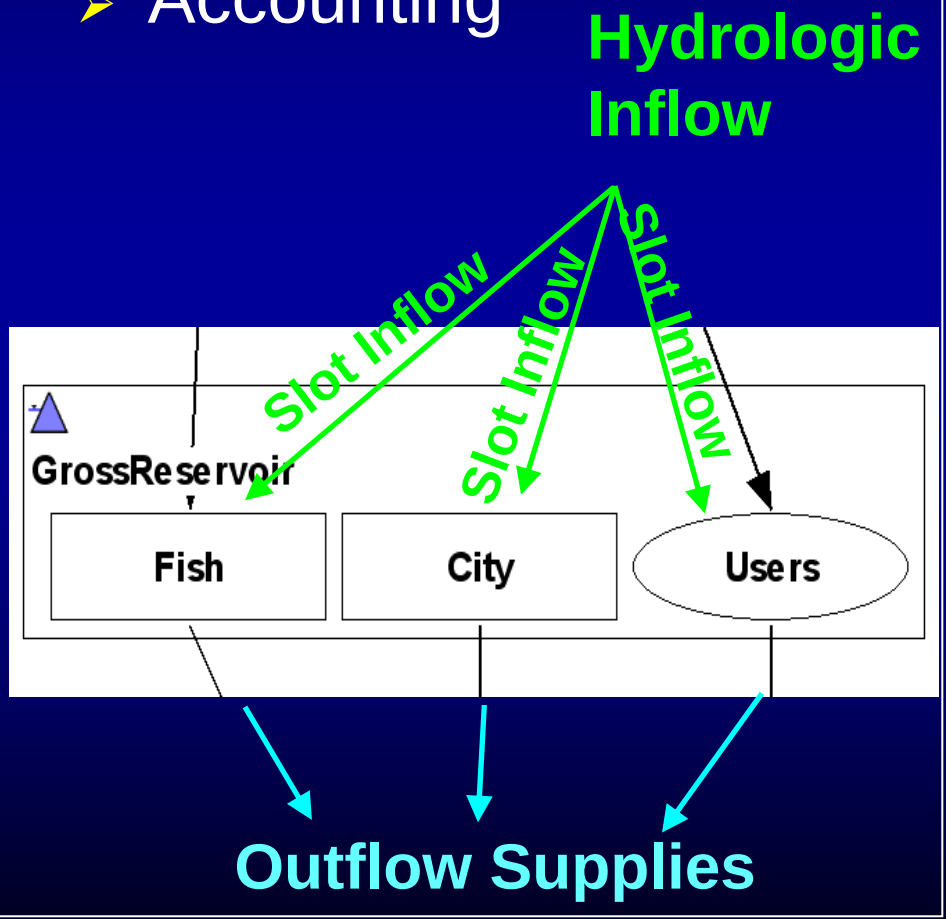


Slot Inflow Example

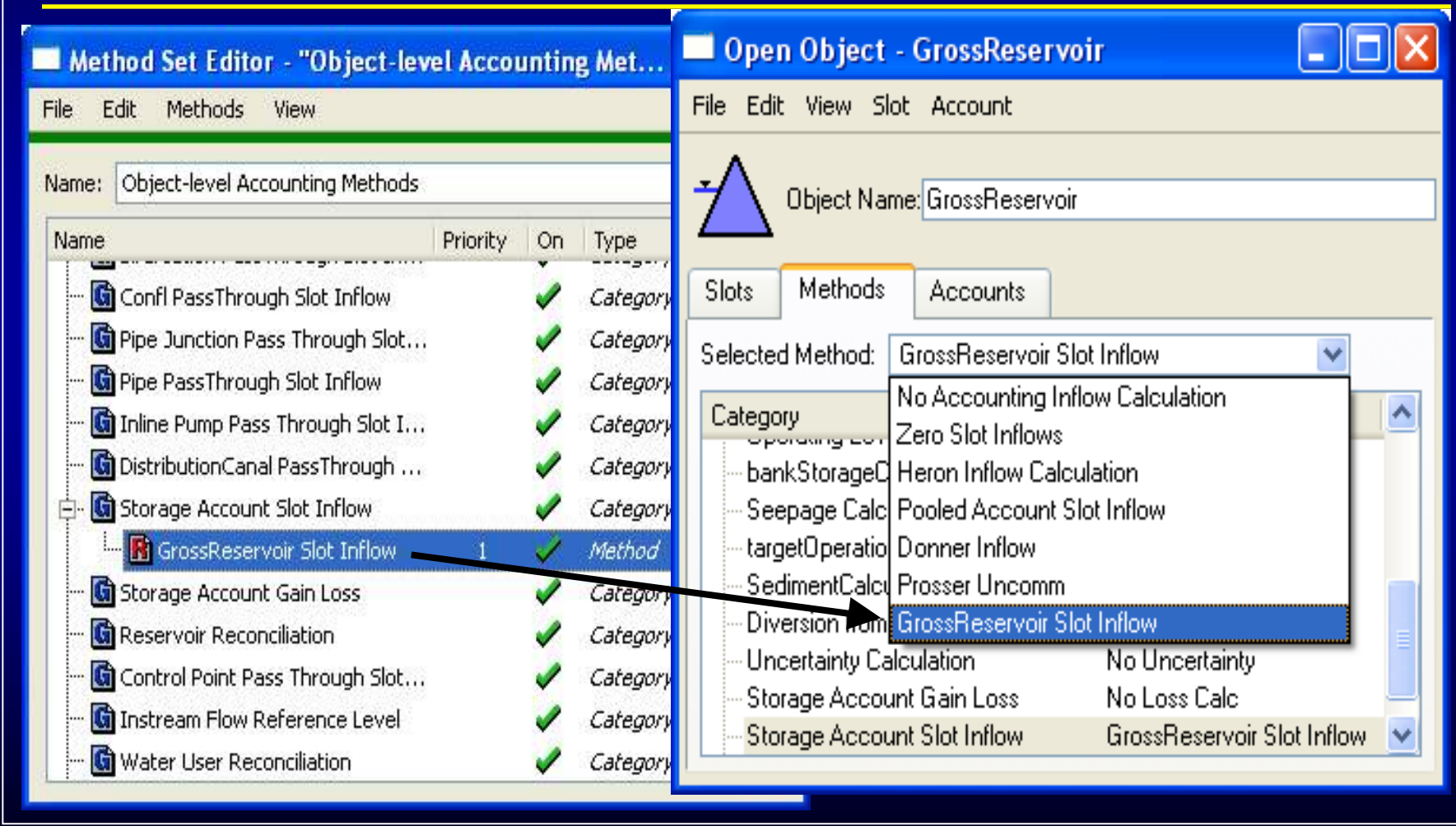
- Physical



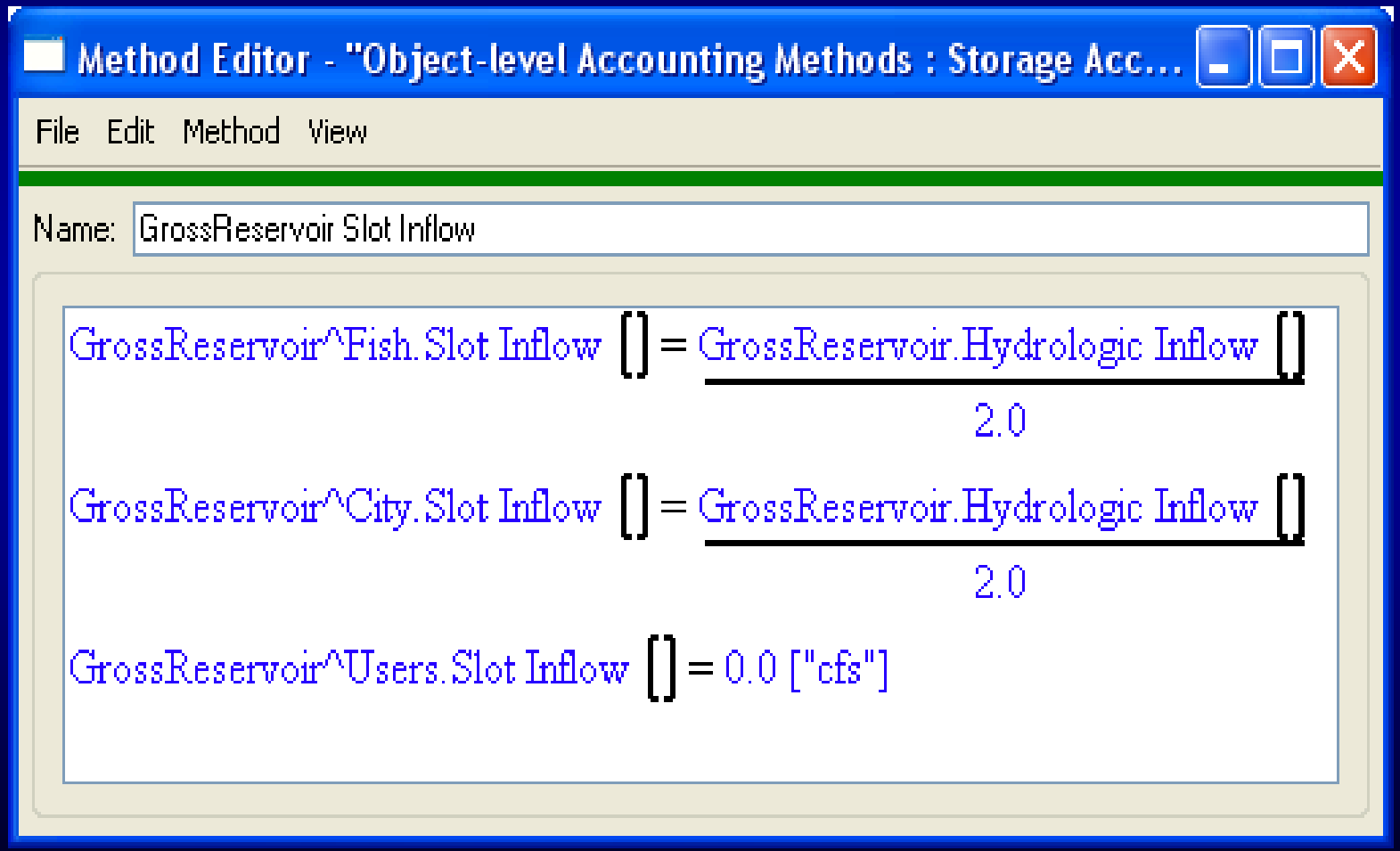
- Accounting



Slot Inflow Example (cont.)



Slot Inflow Example (cont.)

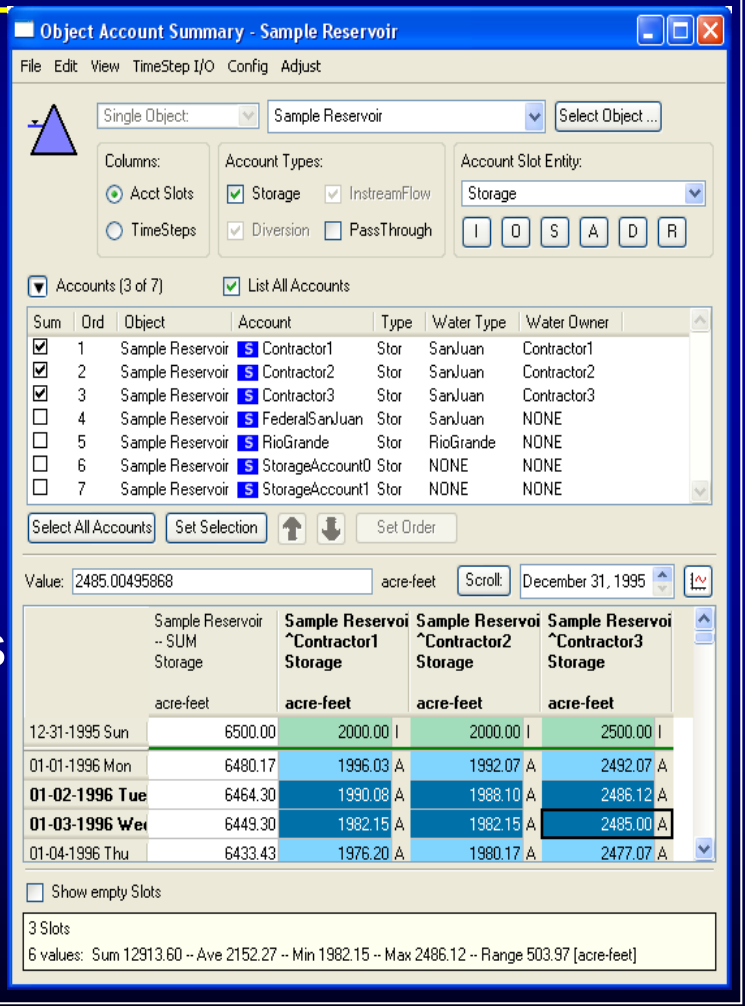


Use Rules to Control Accounting

- Rules can set supplies – may cause the account to solve
- Many predefined functions specific to Accounting

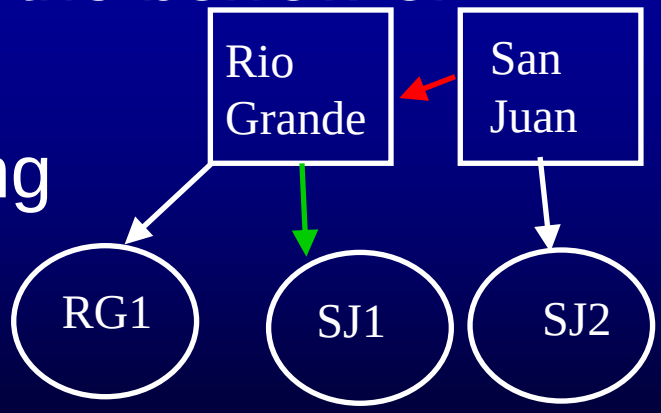
Reconciliation

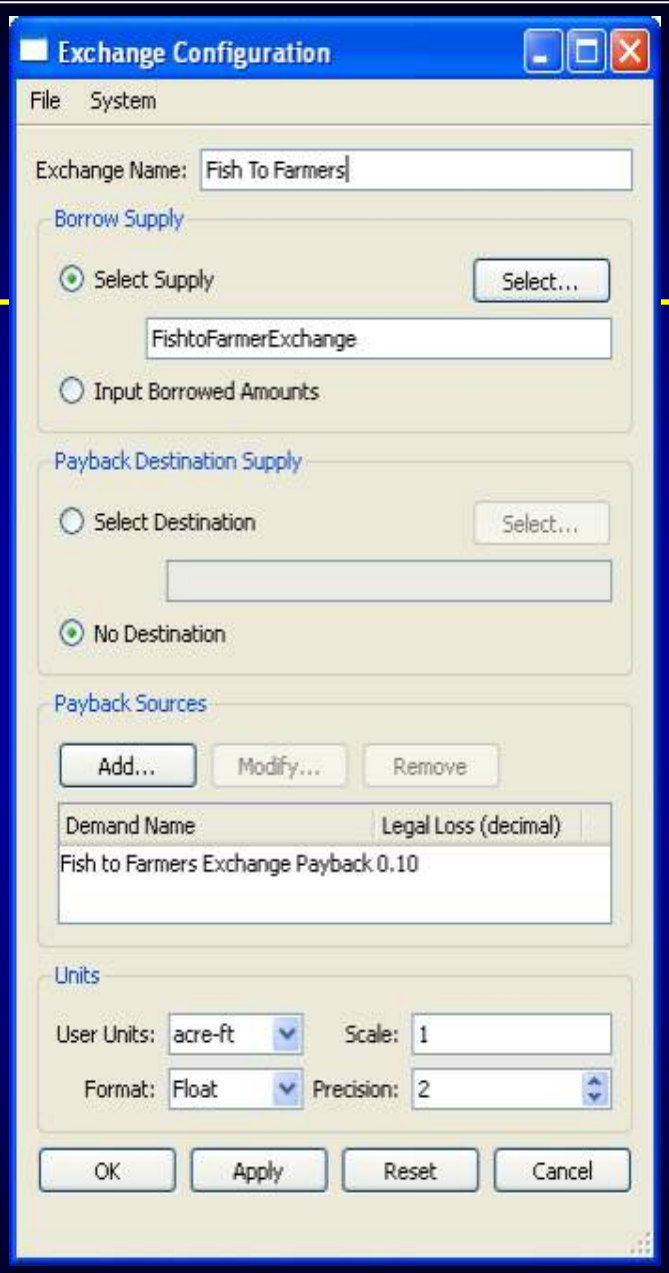
- Total physical releases/storage does not have to equal accounting releases/storage
- Matching the accounting system to the physical system is up to the user using:
  - Object Level Accounting Methods
  - Rules
- Check using Object Account Summary

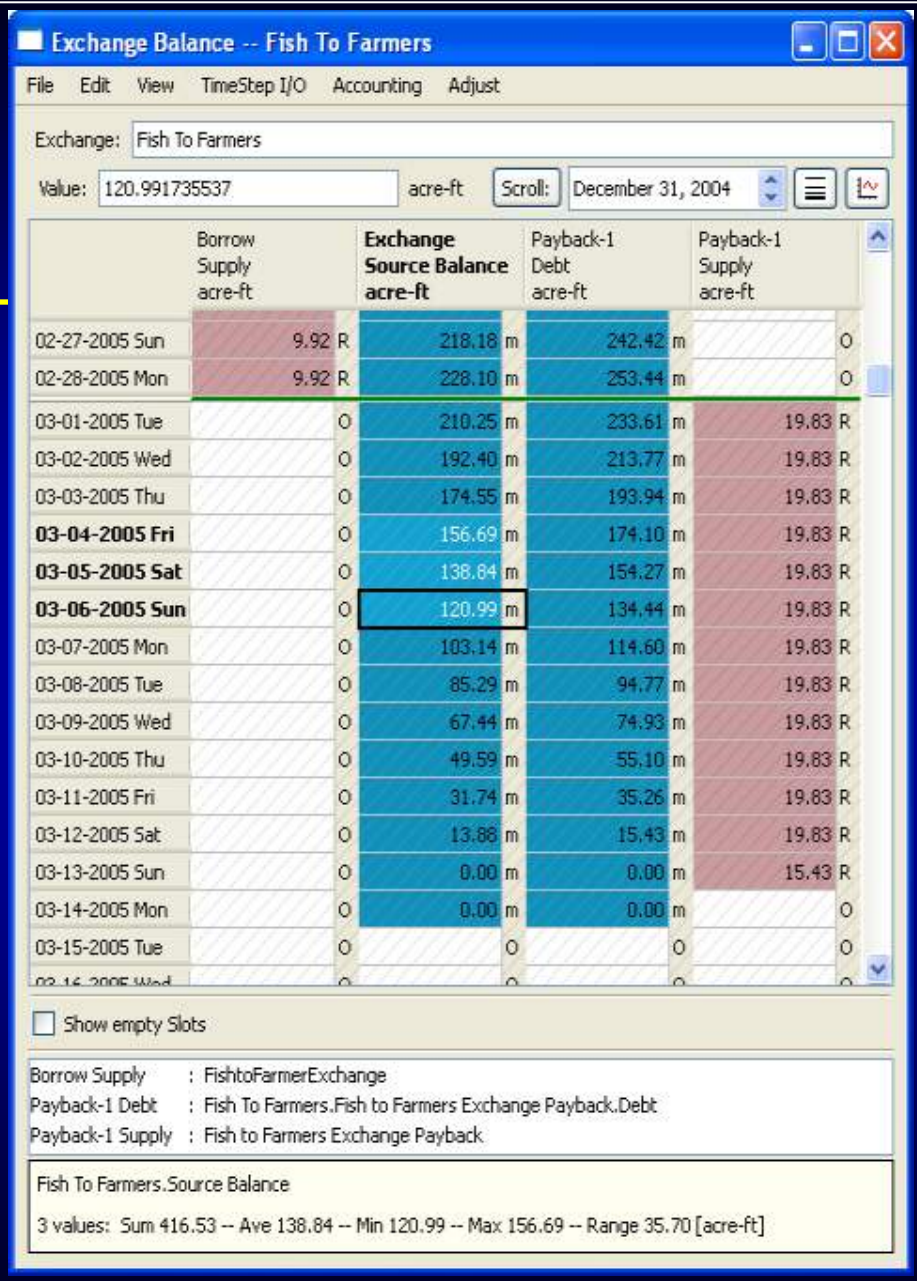


Water Exchanges

- Track water exchanges and transfers
- Borrow - a supply to an account or a user input
- Payback - an outflow (supply) from an account
- In the exchange utility, the debt is updated whenever a new value is set in the borrow or payback
- Rules can access the debt using predefined functions




Exchange Configuration
File System
Exchange Name: Fish To Farmers
Borrow Supply
Select Supply
Select...
FishtoFarmerExchange
Input Borrowed Amounts
Payback Destination Supply
Select Destination
Select...
No Destination
Payback Sources
Add...
Modify...
Remove
Demand Name
Legal Loss (decimal)
Fish to Farmers Exchange Payback 0.10
Units
User Units: acre-ft
Scale: 1
Format: Float
Precision: 2
OK
Apply
Reset
Cancel


Exchange Balance -- Fish To Farmers
File Edit View TimeStep I/O Accounting Adjust
Exchange: Fish To Farmers
Value: 120.991735537 acre-ft
Scroll: December 31, 2004
Borrow Supply acre-ft
Exchange Source Balance acre-ft
Payback-1 Debt acre-ft
Payback-1 Supply acre-ft
02-27-2005 Sun 9.92 R 218.18 m 242.42 m O
02-28-2005 Mon 9.92 R 228.10 m 253.44 m O
03-01-2005 Tue O 210.25 m 233.61 m 19.83 R
03-02-2005 Wed O 192.40 m 213.77 m 19.83 R
03-03-2005 Thu O 174.55 m 193.94 m 19.83 R
03-04-2005 Fri O 156.69 m 174.10 m 19.83 R
03-05-2005 Sat O 138.84 m 154.27 m 19.83 R
03-06-2005 Sun O 120.99 m 134.44 m 19.83 R
03-07-2005 Mon O 103.14 m 114.60 m 19.83 R
03-08-2005 Tue O 85.29 m 94.77 m 19.83 R
03-09-2005 Wed O 67.44 m 74.93 m 19.83 R
03-10-2005 Thu O 49.59 m 55.10 m 19.83 R
03-11-2005 Fri O 31.74 m 35.26 m 19.83 R
03-12-2005 Sat O 13.88 m 15.43 m 19.83 R
03-13-2005 Sun O 0.00 m 0.00 m 15.43 R
03-14-2005 Mon O 0.00 m 0.00 m O
03-15-2005 Tue O O O O
Show empty Slots
Borrow Supply : FishtoFarmerExchange
Payback-1 Debt : Fish To Farmers.Fish to Farmers Exchange Payback.Debt
Payback-1 Supply : Fish to Farmers Exchange Payback
Fish To Farmers.Source Balance
3 values: Sum 416.53 -- Ave 138.84 -- Min 120.99 -- Max 156.69 -- Range 35.70 [acre-ft]

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Accounting Class Outline - Day 1

- Overview of accounting system
- How accounting works
- Run and view an accounting model
  - Navigate accounting system using new accounting workspace (also through simulation workspace)
  - Become familiar with elements of accounting system
  - Run, observe, and analyze model output
- Building an accounting model

Accounting Class Outline - Day 2

- Rules and Accounting – Strategies and features
- “After-the-fact” Accounting model: Use rules to specify accounting releases and diversions from simulated flows
- Advanced RBS: Accounting Driven Simulation
- Water Rights Allocation

Accounting Class Outline - Day 3

- Group/Interactive Exercise
  - Start with existing simulation model
  - Create accounting system according to specifications
  - Mix of white board session and work on the computer
  - Write rules to implement accounting policy
- Status: Still under development ~85% done

  Test run soon!

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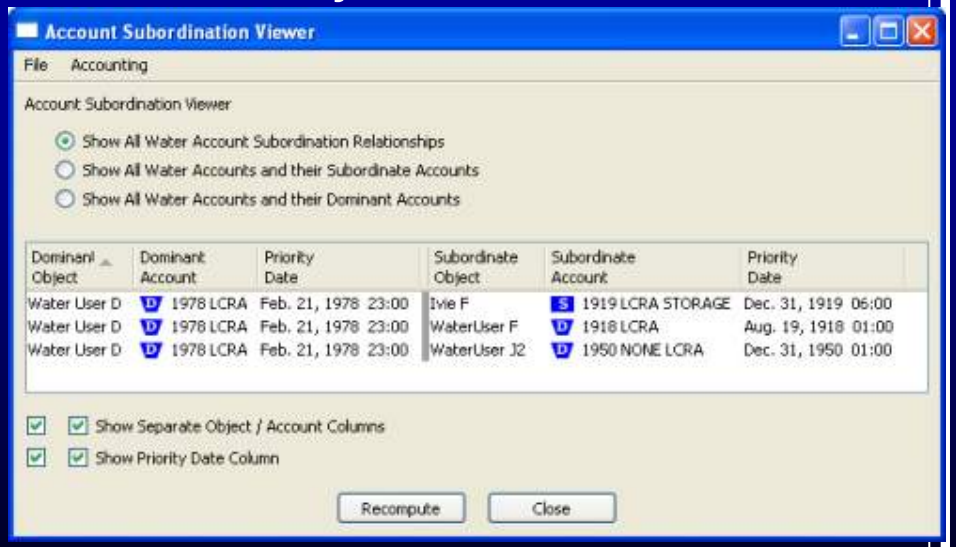
Recent Enhancements

- Exchange dialogs re-implemented
- Convergence on Supply slots
  - Supplies between 2 multi-slot: Convergence is changed to “None” – NOT editable
  - Slots on ends of Supply have “Percent Change” – Value IS editable
  - Result: solution will converge, rules that set supplies may need modification

Recent Enhancements (cont.)

- New RPL Functions
  - AccountAttributes
  - ObjAcctSupplyByWaterType-RelTypDestType
  - ObjectFromAccountName
  - ObjectsFromAccountType
  - ObjectsFromWaterType
  - SourceAccountAndObject
  - SupplyAttributes
  - GetAccountFromSlot
  - GetObjectFromSlot
- Documentation
- Subordination Viewer



Upcoming Enhancements

- New Accounting Controller
  - Current inline controller executes accounting methods after Rules and Physical simulation
  - New controller will execute accounting first – design and details are unknown
- Enhanced exchanges: develop a mechanism to execute both physical and accounting parts of exchanges