Finite Difference Groundwater Model Calibration: The Arkansas River Valley Experience

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Calibration

Adjusting model variables to insure model predictions reasonably match measurements of modeled system.

Testing

Checking calibrated model predictions against an additional set of measurements of the modeled system.
Model Calibration & Testing for Lower Arkansas River Aquifer

- MODFLOW-UZF Groundwater Model
- Automated Calibration Using UCODE and PEST Optimization
- Manual Calibration
- Calibration Periods
  - USR: 5 years
  - DSR: 4 years
- Testing Periods
  - USR: 3.5 years
  - DSR: 1.5 years
Monitoring Wells and Pumping Wells

Legend:
- CSU Monitoring Well
- Gaging Station
- Pumping Well
- Canal
- Drain/Tributary
- Arkansas River
- Irrigated
- Fallow
- Naturally Vegetated
- Riparian
River Water Balance

USR

Fort Lyon Storage Canal

Precipitation Runoff From Natural Areas

Model Boundary

DSR

Arkansas River at Catlin Dam

Flow From Dryland?

Hyde Ditch

Model Boundary

48 miles

Legend

Main branch of the Arkansas River

Gage

Inflow/Outflow

Overland return flow (runoff)

MODFLOW grid cells used to specify observations of flow through River boundaries for use in the Observation process.

44 miles
820 ft x 820 ft grid: 15,600 15-ac cells
two vertical layers
447 weekly time steps

125,000 ac
DSR Finite Difference Grid

820 ft x 820 ft grid: 18,600 15-ac cells
two vertical layers
291 weekly time steps

136,000 ac
Calibrated Variables

- Aquifer Hydraulic Conductivity
- Aquifer Specific Yield
- Saturated Hydraulic Conductivity in Vadose Zone
- Canal Conductance
- Water Table Upflux Extinction Depth
- Reference Evapotranspiration

Calibration Target Variables

- Observed Groundwater Levels
  - USR: 5000 measurements from 100 wells over 5 years
  - DSR: 5500 measurements from 118 wells over 4 years
- Groundwater Return Flows from River Mass Balance
- Aquifer Stratigraphy from 250 Boreholes
- Observed Canal Seepage from 6 Canals
- Actual ET from Satellite Imagery and RESET
- Field Measurements of Upflux from Ground Water
- Deep Percolation Est from 242 Irrigation Measurements
Average Residual Error in Ground Water Levels

- **USR:** - 0.16 ft calibration, - 0.37 ft testing
- **DSR:** - 2.07 ft calibration, + 0.82 ft testing
Average Residual Error in Ground Water Return Flow

- **USR:** +660 ac-ft/wk calibration, -13 ac-ft/wk testing
- **DSR:** +310 ac-ft/wk calibration, +540 ac-ft/wk testing
Recharge to Groundwater

Water Table Depth

Upflux from Groundwater
Lessons Learned

• Calibration/Testing with Large Data Sets Rewarding but Challenging
• Data Over Range of Hydrologic Conditions Important
• Multiple Target Variables Important
• Hydraulic Head Targets Easier than Groundwater Return Flow Targets
• Stratigraphic Data Valuable Enhancement
• Satellite Data Valuable Enhancement
• Measurement Uncertainty Important