Tucson AMA MODFLOW Sensitivity Analysis

Background

Tucson AMA Model

- Created by ADWR using MODFLOW
- Estimates the inflows and outflows of water in the Tucson Active Management Area (AMA)
- Applies Darcy's Law in the saturated zone and solves for flow

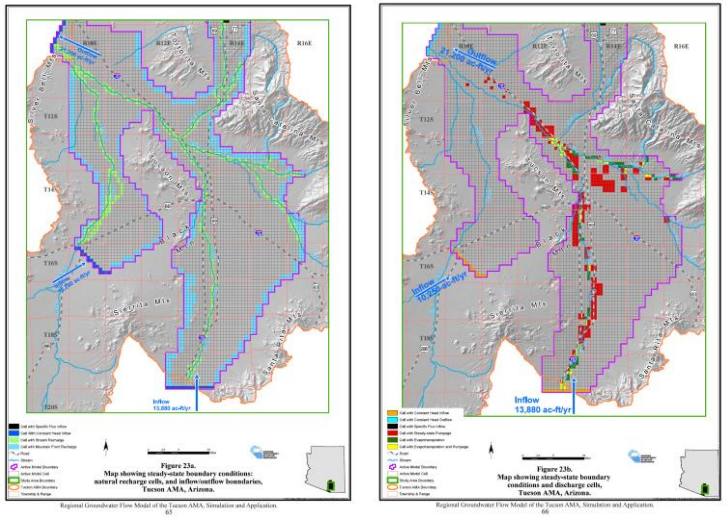

Figure 1. *MODFLOW cell definitions and boundary conditions*

Major Assumptions

- Type I (constant head) boundaries at the Santa Cruz, Avra Valley, and Pinal AMA boundaries
- Type II (constant flux) at Cañada del Oro
- Mountain-front recharge is constant throughout each year
- There are no unaccounted inflows/outflows.

Research Question:

- Can the model be used to assess uncertainty of recharge in the Tucson Basin?

Current Research

Reconstructing Parameter Space

- When parameters are adjusted during sensitivity analysis, they should undergo the same process as the original data.
- Make all the same assumptions the original model made.
- Make all the same calculations the original model made.

Weighted MAE

- The AMA model used the mean absolute error (MAE) of well head residuals as one of its most important objective functions.
- Residuals were weighted based on the accuracy of the altitude of each monitoring well.

Primary MAE Goals

- No residual should be greater than 10% of the total drop in elevation.
- MAE should be less than 2% of the total drop in elevation.

GWSI Altitude Accuracy (Ft)	Estimated Standard Deviation	Calculated Weighting Factor (1/SD)	Assigned Weighting Factor
0.1	0.06	16.5	1.0
0.2	0.12	8.250	0.990
0.5	0.30	3.300	0.952
1.0	0.61	1.650	0.909
2.0	1.21	0.825	0.825
2.5	1.52	0.660	0.660
5.0	3.03	0.330	0.330
10.0	6.06	0.165	0.165
15.0	9.09	0.110	0.110
20.0	12.12	0.083	0.083
25.0	15.15	0.066	0.066
40.0	24.24	0.041	0.041
50.0	30.30	0.033	0.033

Table 1. *Weighting factor based on altitude accuracy*

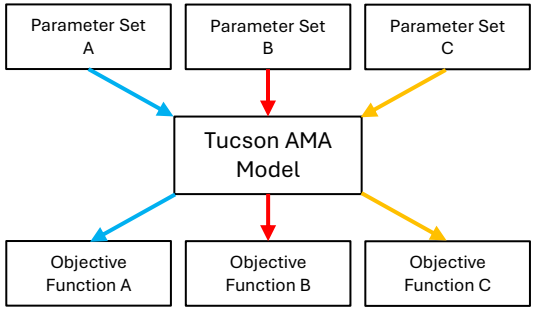

Figure 2. *Parameter adjustment during sensitivity analysis*

Sensitivity Analysis

- Adjusting the parameters of the model to see how the objective function changes
- See how reliable the modeled parameters are

Future Plans

- Conduct sensitivity analysis.
- Use PEST to modify the recharge and the model parameters to determine uncertainty.

Relevance to ATUR

ATUR Overview

- The Arizona Tri-University Recharge and Water Reliability Project (ATUR) is looking for ways to increase Arizona's natural water resources and have set multiple goals. They include but are not limited to:
  - Identify methods to capture precipitation before it evaporates or is used by plants.
  - Locate areas where recharge can be enhanced.
  - Use water that would not reach a natural channel.

Tucson AMA Relevance

- Understanding the Tucson Basin can help us see places to intervene, but that understanding is only as good as the accuracy of the models which simulate flow in the basin. Knowing how uncertain the models are is important when deciding how to increase recharge. If the model is very certain about its parameters, then its weight when making decisions will be greater than if its uncertainty is larger.
- Knowing the uncertainty of the model can help us determine the impact of future ATUR activities. How certain are we that the recharge modeled is accurate? Can we use it as a metric for changes in recharge due to ATUR activities?