Modelling the effects of maintenance on artificial recharge basins

UA SCIENCE Hydrology & Atmospheric Sciences

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TUCSON WATER

BACKGROUND

CAVSARP and SAVSARP

(Central and Southern) Avra Valley Storage and Recharge Projects

Figure 1. CAVSARP aerial view

- Managed by Tucson Water
- 19 recharge basins
- 543 acres

Biological Clogging

Decreased infiltration:

- Anaerobic conditions (Wood & Bassett 1975)
- Bacterial waste products (Mitchell & Nevo 1964)

Maintenance

- Desiccation
- Surface disturbance (large chisel plow)
- Weed removal

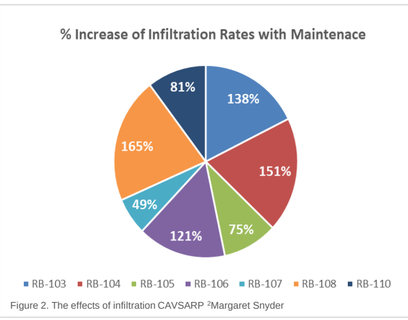

Figure 2. The effects of infiltration CAVSARP [2]Margaret Snyder

OBJECTIVES

The Model

- Create empirically based models that accurately represent CAVSARP and SAVSARP recharge
- Detect patterns that can help Tucson Water improve their maintenance and infiltration cycle efficiency

METHODS

Simple Empirical Model

The model is a function of the flow into the basin, the infiltration rate, and a fitting parameter. It is an iterative process used to model head values in the recharge basin throughout the infiltration cycles.

Table 1. Model Framework

$\boldsymbol{Model\ (Q_{in}, a, b)}$		
Q_{out}	$\max(Area_{i-1} * a\ , Min\ Q)$	Flow out of the basin and into the aquifer
$Area$	$\max(h_{i-1} * b, Min\ A)$	The new wetted area used to determine the flow through the basin
dh	$dt\ (Q_{in_{i-1}} - Q_{out})/Area$	Modeled change in head at each time step
h	$\max(dh + h_{i-1}\ , 0)$	Modeled water level in the basin during time at infiltration
err	$abs(h_{model} - h_{measured})$	Least squares regression analysis

Model Optimization

1. Define initial constraints for a and b
   i. Create parameter space
2. Error surface plots for each cycle
   i. Least square fit
   ii. Refine parameter space by ¼
3. Compare error surface plots
   i. Find average b value
4. Fix the value of b for all cycles
   i. Optimize parameter a

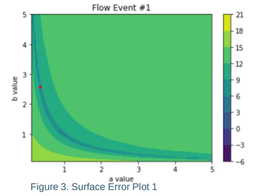

Figure 3. Surface Error Plot 1

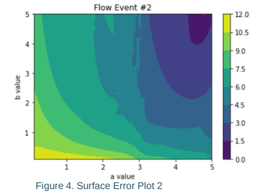

Figure 4. Surface Error Plot 2

RESULTS

CAVSARP Preliminary Results

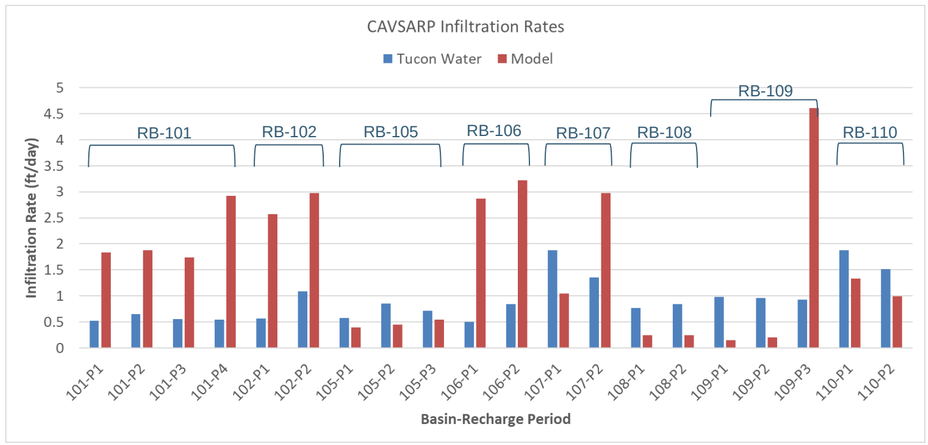

Figure 5. Preliminary comparison of CAVSARP infiltration rates

CONCLUSION

Summary

- The infiltration rates are similar, but not the same
- High amount of variation across and within basins
- Further analysis is necessary

Next Steps

- Run the model for all available years (~20 years)
- Observe long-term patterns and factors in parameter a
- Project optimal maintenance periods for each basin

REFERENCES

Bouwer, H. (2002). Artificial recharge of groundwater: hydrogeology and engineering. Hydrogeology journal, 10(1), 121-142

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