A Scenario Based Assessment of Future Groundwater Resources in the Phoenix Active Management Area

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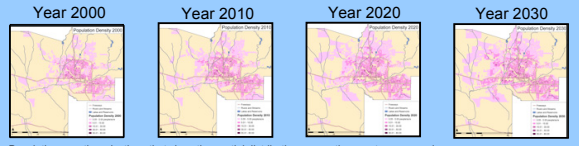
Introduction

The availability of future water supplies in central Arizona depends on the interaction of multiple physical and human systems: climate, hydrology, water and land-use policy, urbanization, and regulation. The problem in assessing future water supplies requires untangling these drivers and recasting the issue in a way that acknowledges the inherent uncertainties in climate and population growth predictions while offering meaningful metrics for outcomes under alternative scenarios. Further, the drivers, policy options, and outcomes are spatially heterogeneous – surface water supplies, new urban developments and changes in land-use will not be shared uniformly across the region. Consequently, different geographic regions of the Phoenix metropolitan area will be more vulnerable to shortages in water availability, and these potential vulnerabilities will be more or less severe depending on which factors cause the shortage.

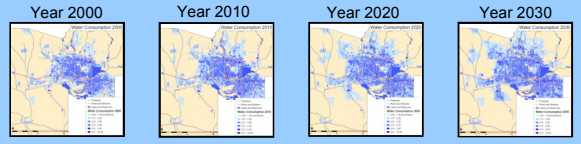
The results of this research will make several contributions to existing literature and research products for groundwater conservation and future urban planning. It will provide location specific metrics of water vulnerability and offer a novel approach to groundwater analysis; it will demonstrate the XLRM framework with an application to central Arizona Water resources. Lastly, it will add to WaterSim climate model by spatializing the groundwater component for the Phoenix Active Management Area.

Population Scenarios



Population growth projections that show the spatial distribution across the county were used.

Water Demand



GIS system allows us to predict water demand for future years.

Purpose

- Investigate the sensitivities from climate change and population growth on groundwater supplies in the Phoenix Active Management Area.
- Understand the spatial distribution of groundwater and identify the vulnerable regions.
- Develop scenario-based dynamic visualization tools to help policy-makers understand uncertainties in future water resource management.

Hypothesis

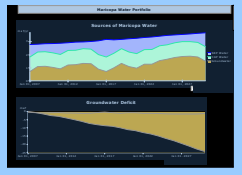
- Different geographic regions of the Phoenix area will be more vulnerable to water shortages than others.
- Population growth, climate change and groundwater policy will have different spatial outcomes of water shortages for each city in the Phoenix area
- Surface water supply, new urban developments, changes in land use are not regionally uniform and will impact the aquifer differently .

Photo By: Dustin Hampton

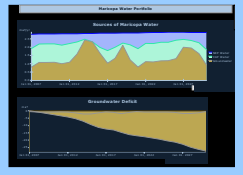
WaterSim

WaterSim produces these outputs for every scenario. WaterSim will calculate a groundwater deficit for the Phoenix Active Management Area in terms of population growth and climate change. WaterSim will also calculates allocations of water to the PHX AMA in accordance with the 7 Basin States and Mexico Agreement, it incorporates regional water portfolios and calculates a groundwater deficit based on the demands.

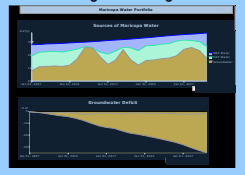
Scenario 1
Rapid Population Growth



Scenario 2
Long Term Drought



Scenario 3
Rapid Population Growth Combined with Long Term Drought



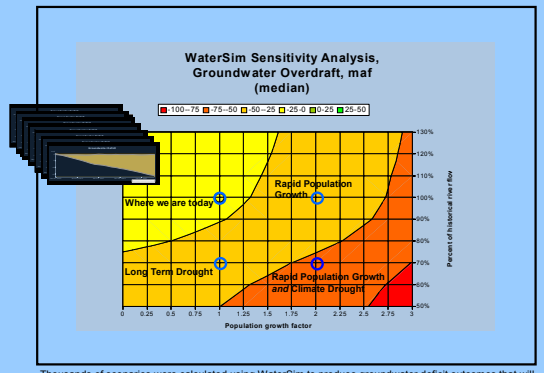
Methods

WaterSim will run several scenarios to predict groundwater pumping and recharge schedules. The WaterSim scenarios are based on population growth, long-term drought, retirement of agricultural land, and water conservation policies. I perform sensitivity analyses from the many scenarios run in WaterSim. Scenario Landscapes are created to represent the severity and sensitivity of groundwater required to meet demands under thousands of scenarios.

The output from WaterSim is plugged it into MODFLOW. Each MODFLOW run is based on an individual scenario which corresponds to a location within the scenario landscape diagram. Outputs from MODFLOW are visualized in the Rich Client Platform (RCP), Helios, a 3D groundwater visualization application written for the visualization of groundwater in the Decision Theater.

The integrated system is used in focus groups and for policy discussions in the Decision Theater at ASU. Related social-science studies use this tool to assess the use of visualization, modeling & simulation and collaborative decision support in the Decision Support. WaterSim is an evolving application that makes use of the concept of boundary modeling – building models together with stakeholders assessment at the interface of science and policy.

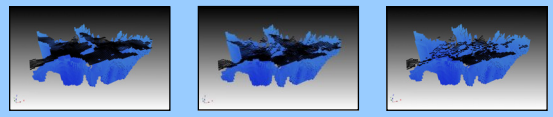
Groundwater Overdraft Isocontours



Thousands of scenarios were calculated using WaterSim to produce groundwater deficit outcomes that will be incorporated into MODFLOW for a spatial interpretation of groundwater sensitivity and severity.

Scenarios	Average Surface Water Colorado and Salt/Verde River (MAF/YR) 2030	Population Growth 2030	Agricultural Acres Available 2030	Groundwater Deficit (MAF) 2030
Base	16.68	6,019,923	231,166	-16.35
Rapid Growth (1)	16.68	9,813,583	65,346	-24.27
Long Term Drought (2)	12.46	6,019,923	231,166	-27.33
Rapid Growth and Long Term Drought (3)	12.52	9,813,583	65,346	-34.77

Visualization



Results from WaterSim scenarios are used to generate pumping and recharge schedules for use in MODFLOW. The Helios Rich Client Platform (RCP) 3D MODFLOW viewer can be used to easily explore groundwater results including head, volume, pumping, and recharge. The software, which is being developed at the Decision Theater and Fulton High-Performance Computing center at ASU will be dynamically linked to future versions of WaterSim for use in the Decision Theater.

Acknowledgment

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