Assessment of Climate Change Impact on Groundwater Reservoirs and Water Resources Management in the Upper Santa Cruz River, Arizona

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Abstract

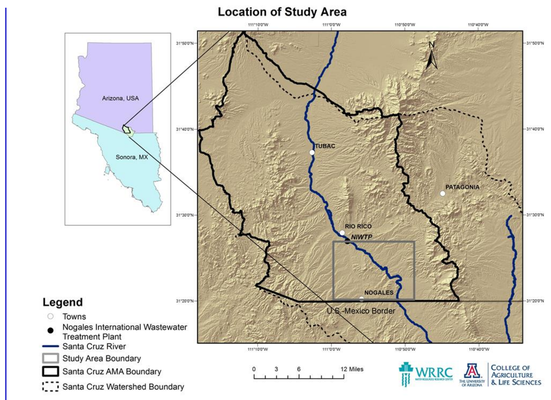
Planning to meet water demands in semi-arid regions is particularly challenging for groundwater dependent communities where aquifers are being replenished by intermittent streamflow events. We employed a modeling framework that addresses climate uncertainties in the Upper Santa Cruz River near the US-Mexico border crossing. At the heart of this modeling framework is a weather generation model that simulates likely-to-occur hourly rainfall scenarios. The weather generation model was further modified to reflect future climate projection that are based on analyses of carefully selected dynamically downscaled global climate models that well represent tele-connection features between the Southwest climate and the eastern Pacific. Rainfall realizations from the weather generation model were used as forcing for a series of hydrologic models that simulate likely scenarios of streamflow, recharge to the groundwater reservoirs, and various groundwater states. This modeling framework enables for a reliability assessment of various water resources management scenarios.

The development of the case study that demonstrates the modeling framework utility was conducted through three stakeholders workshops.

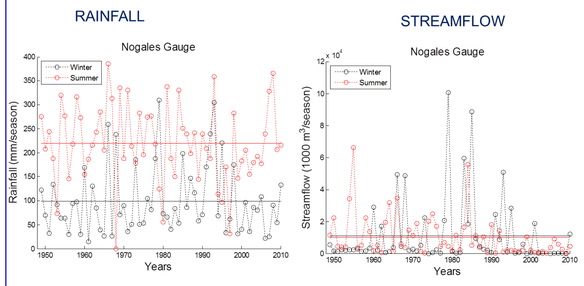
Project's Web Site: wrrc.arizona.edu/GCASE

Project Workshops

- Kickoff Workshop
  – October 18, 2012
  - Presented modeling framework and developed case study; discussed stakeholder concerns
- Milestone No. 1 Workshop
  – April 11, 2013
  - Presented case study for comments and revised modeling framework; presented climate projection findings for the region
- Milestone No. 2 Workshop
  – November 20, 2013
  - Presented revised case study and discussed transferability
- Four additional workshops
  – Transferability



Seasonal Precipitation & Streamflow



Regional Hydrological Modeling Framework

Hourly Rainfall Generator

↓

Streamflow Model (Nogales)

↓

Santa Cruz R. Flow Routing and Groundwater Recharge

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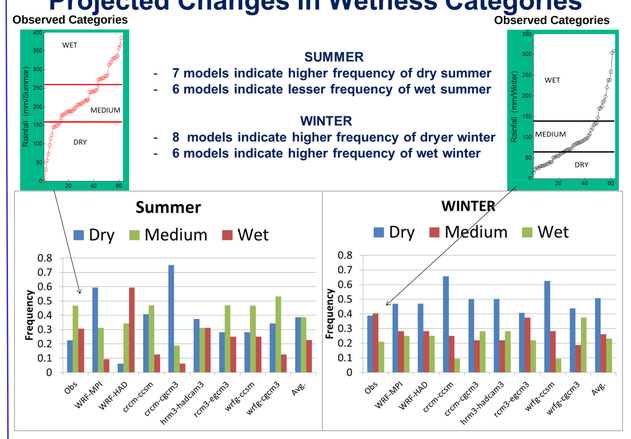
Groundwater Model

Precipitation from Downscaled Regional Climate Models

University of Arizona: Dynamically (WRF) downscaled HADCAM and MPI (Castro et al. 2012)

North American Regional Climate Change Assessment Program, Six selected models (Bukovski et al. 2013)

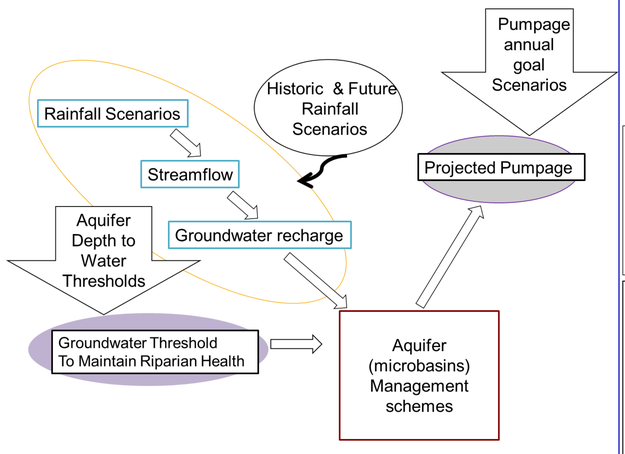
Projected Changes in Wetness Categories



SUMMER
- **7 models indicate higher frequency of dry summer**
- **6 models indicate lesser frequency of wet summer**

WINTER
- **8 models indicate higher frequency of dryer winter**
- **6 models indicate higher frequency of wet winter**

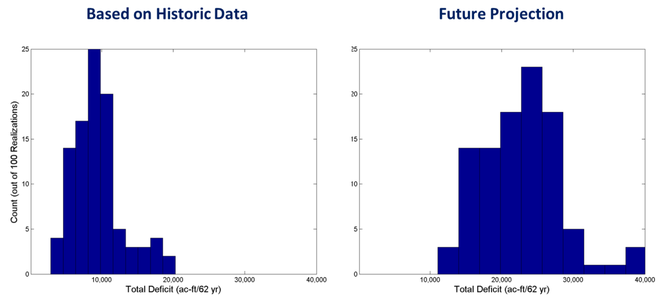
A Case Study Example



Climate Projection Impact on Water Resources Deficit

an example when pumpage goal is 3000 ac-ft per year and groundwater Depth to Water threshold is 20 feet

62-year Total Water Deficit (acre-ft)
[based on 100 likely realizations]



Accomplishments to Date

Incorporated downscaled climate information into integrated surface water-groundwater model for an arid to semi-arid environment along the US-MX border

Established robust dialogue with informed stakeholders throughout development of the case study, which involves multiple scenarios

Connecting the scientific results to water resources planning and management

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References

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