Decision tools for water planning at the Decision Center for a Desert City (DCDC)

D.A.Sampson

Decision Center for a Desert City

ASU

One Project:

Implications of simultaneous extreme heat and drought events for electricity generation and consumption and water shortage in the desert Southwest

Multiple Institutions: K. Hayhoe-Texas Tech, D. Sailor-Portland State, D.A.Sampson and P. Gober- ASU

Funding Agency: Bipartisan Policy Center

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Colorado River Commission of Nevada 2010 Symposium;
"Implications of Lower Lake Levels": 21-22 April, Las Vegas, NV.

My Focus:

Water availability and use as influenced by drought and climate change in the Phoenix metropolitan area

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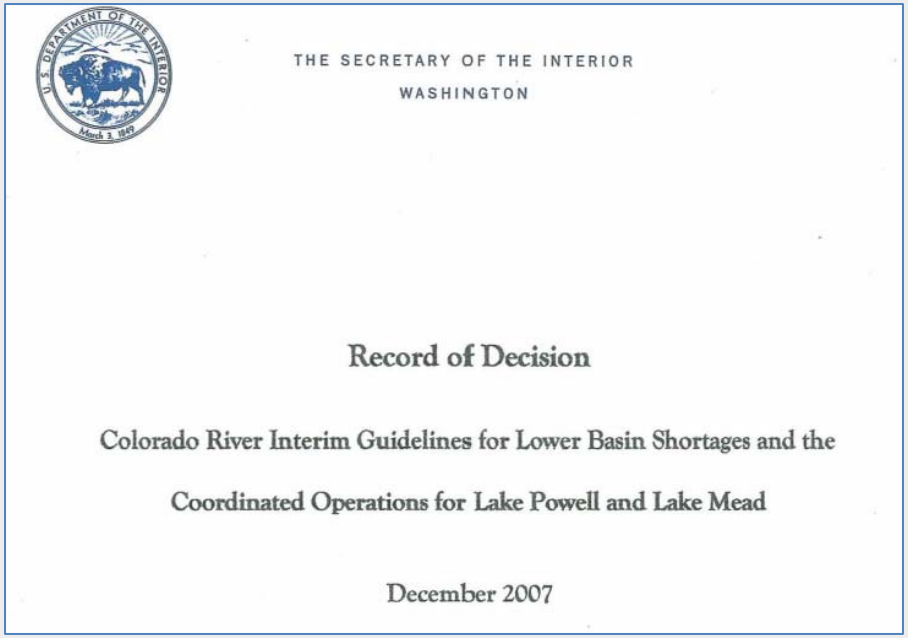
Relevance:

- Phoenix-Metro uses Colorado River water (via CAP).
- ~ 1.4 to 1.7 million acre-feet conveyed annually.
- About 72% to 78% of the CAP water stays Maricopa Co.
- Arizona has junior rights: a shortage on the Colorado River gravely effects AZ.



THE SECRETARY OF THE INTERIOR
WASHINGTON

Record of Decision

Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead

December 2007

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Rationale (for the study):

- Rapid urban growth: water demand increasing
  - Spatially disaggregated (growth on the urban fringe).
- Differential designations: settlement history
  - Multiple water providers; portfolios are provider-specific (variable sensitivities to climate change).
- Urban Heat Island
  - Daily minimum temperatures are increasing.
- Uncertain water supplies
  - Runoff expected to **decrease 33%** on a major river supply (Salt-Verde-Tonto) and **9%** for Colorado River supplies.
  - Drought periodicity and duration uncertain.

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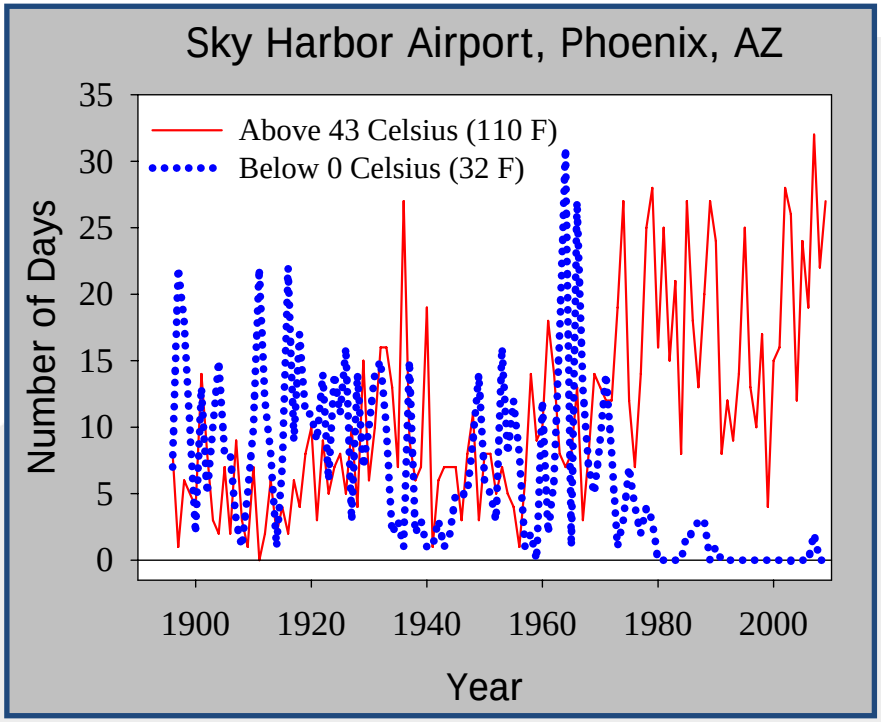
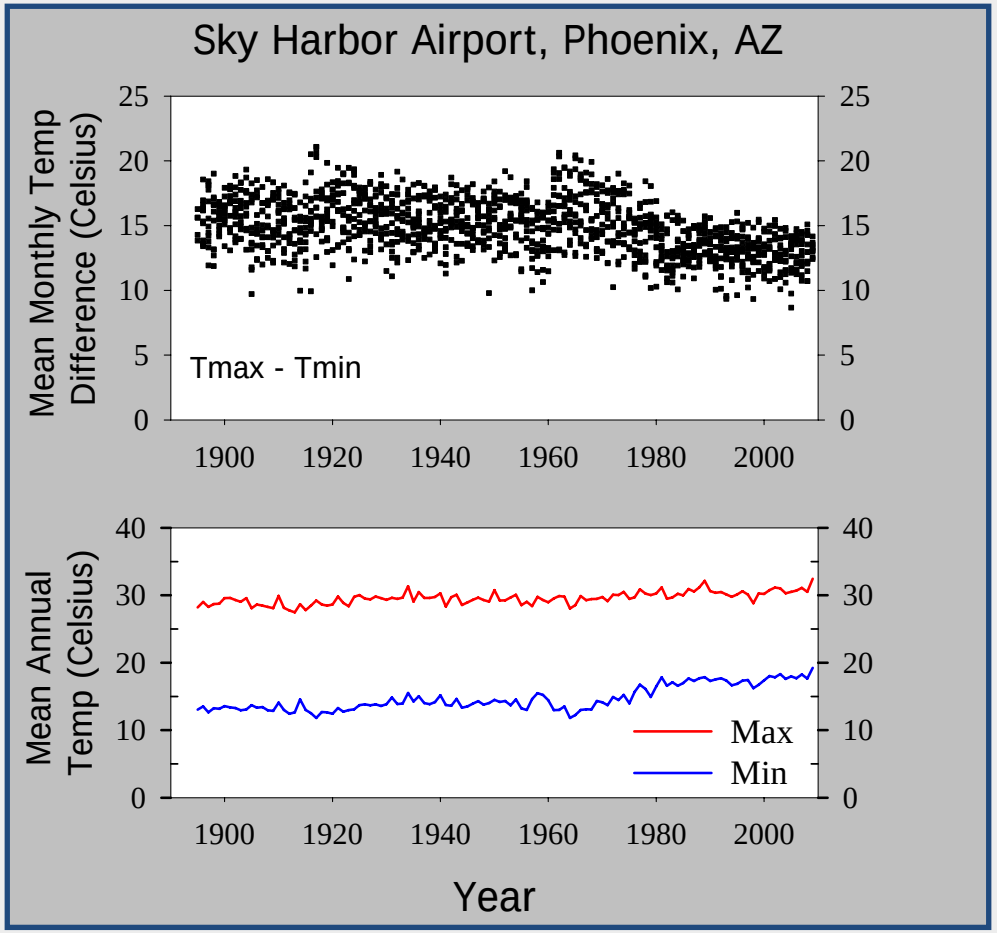
Evidence:



Source: Arizona State Climate Office (D. Hoffman, D. M. Ruddell, and O. Ahmad- CAP LTER 2010)



Source: Arizona State Climate Office

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Approach:

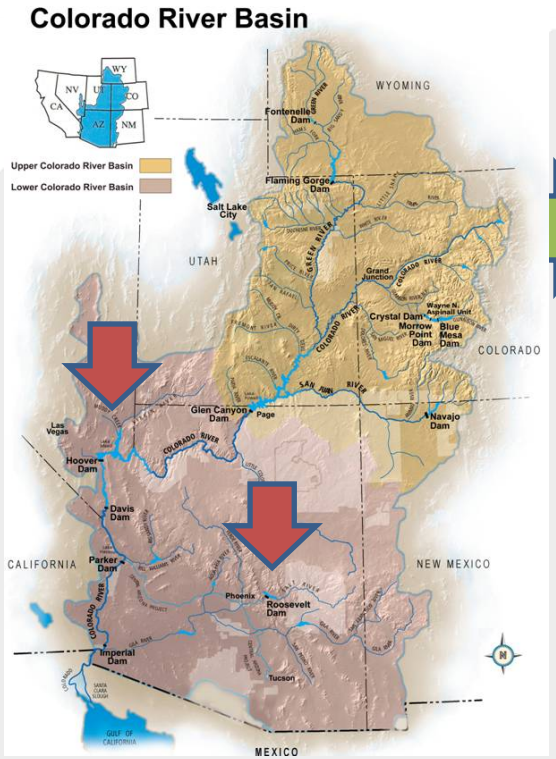
- WaterSim-Urban
  - Structure: Conceptual diagram
  - Water Providers in the Phoenix-Metro Area (portfolios)
- Climate Uncertainty
- Preliminary Results
  - Energy
  - Water
  - Energy and water
- Future Directions

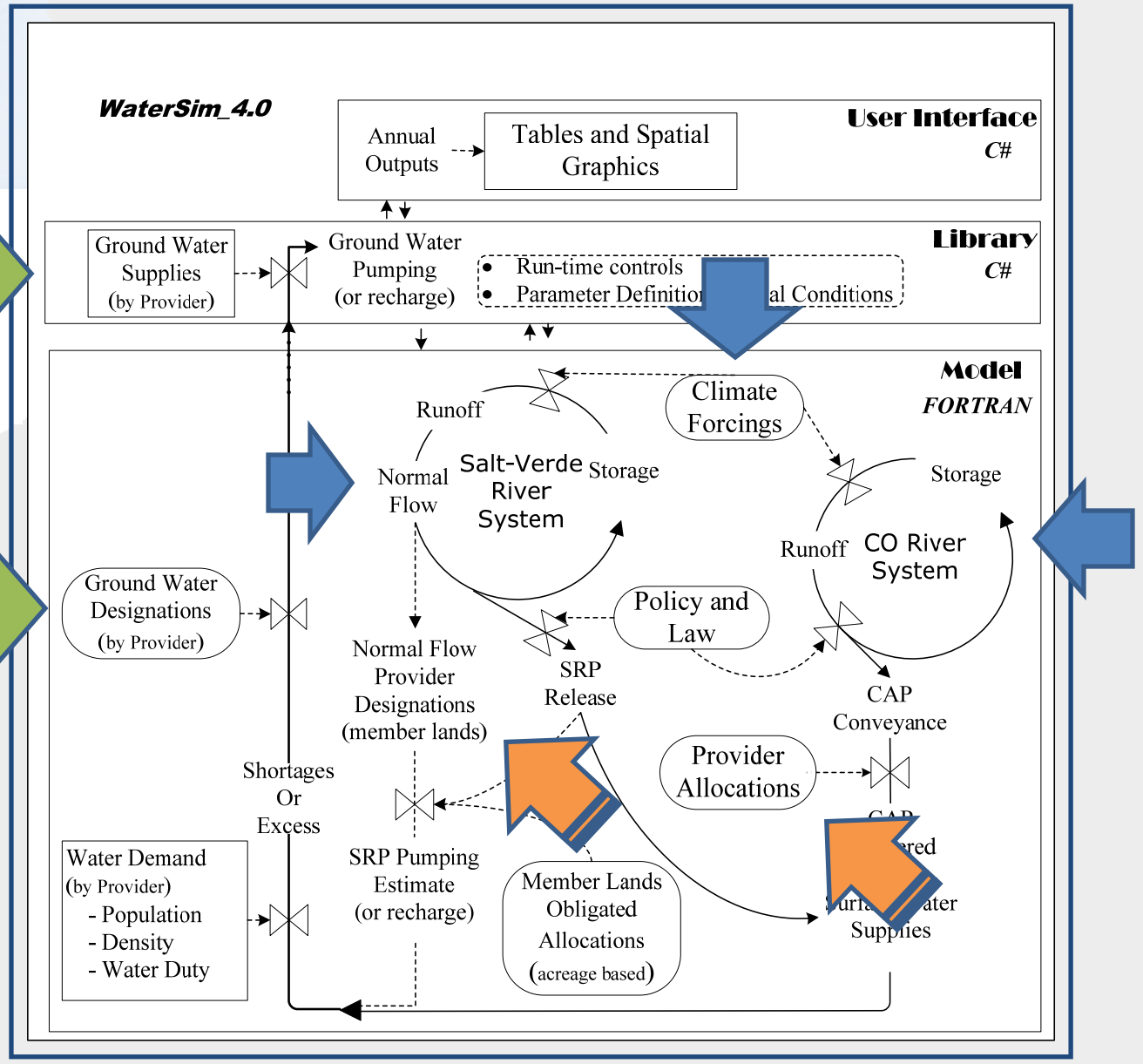
WaterSim-Urban

Conceptual Model

MODFLOW

Two primary surface Water sources





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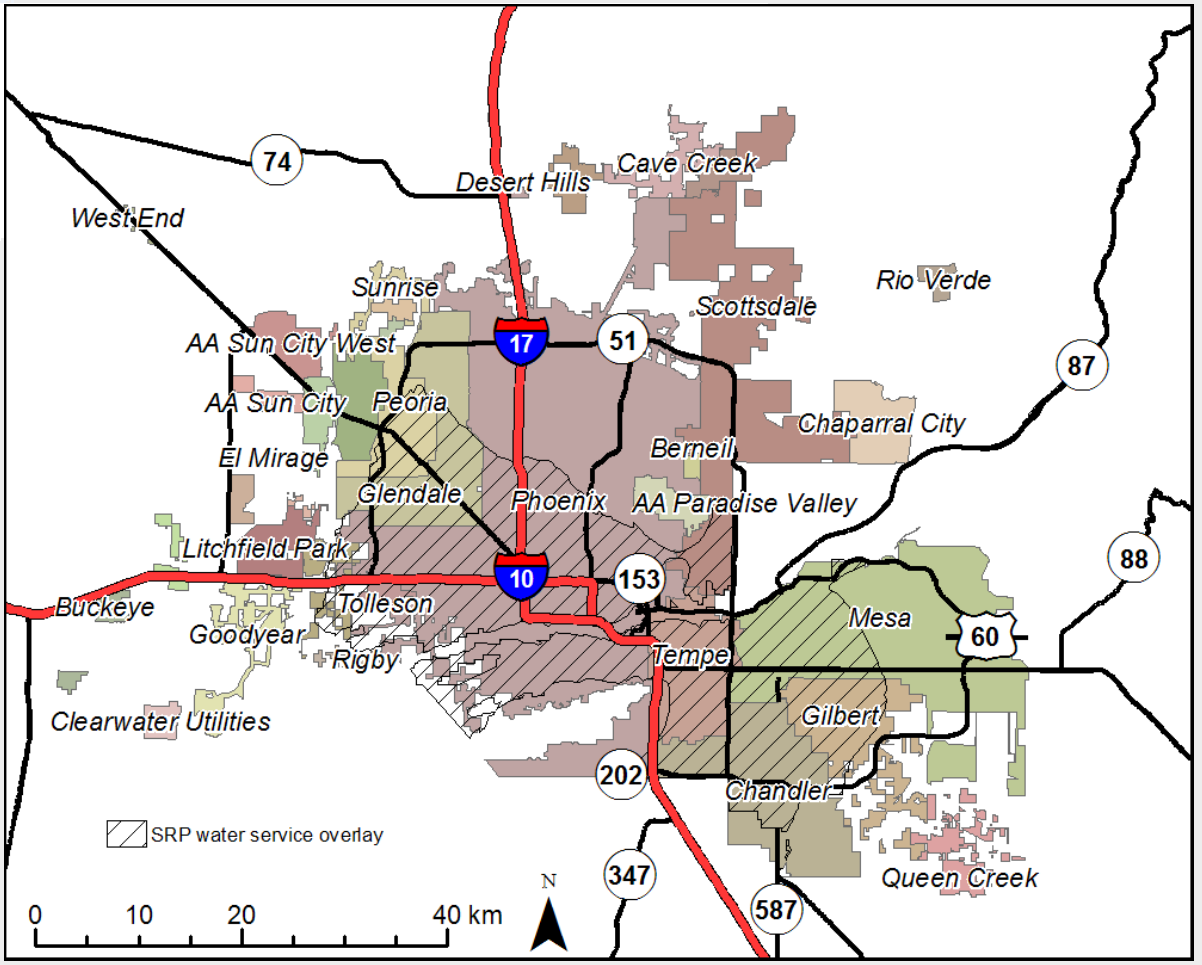
Water Providers

33 major water providers

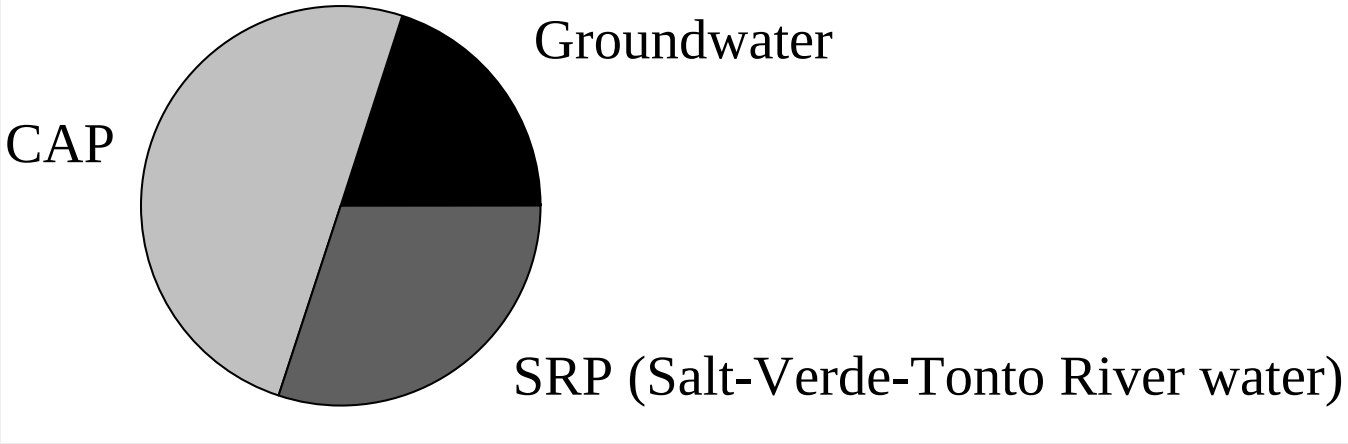


Maricopa County, AZ

Provider Portfolios

- CAP water (Colorado River water)
- SRP water (Salt-Verde-Tonto River water)
- Groundwater
- Some combination (10 providers have SRP water)

Example:



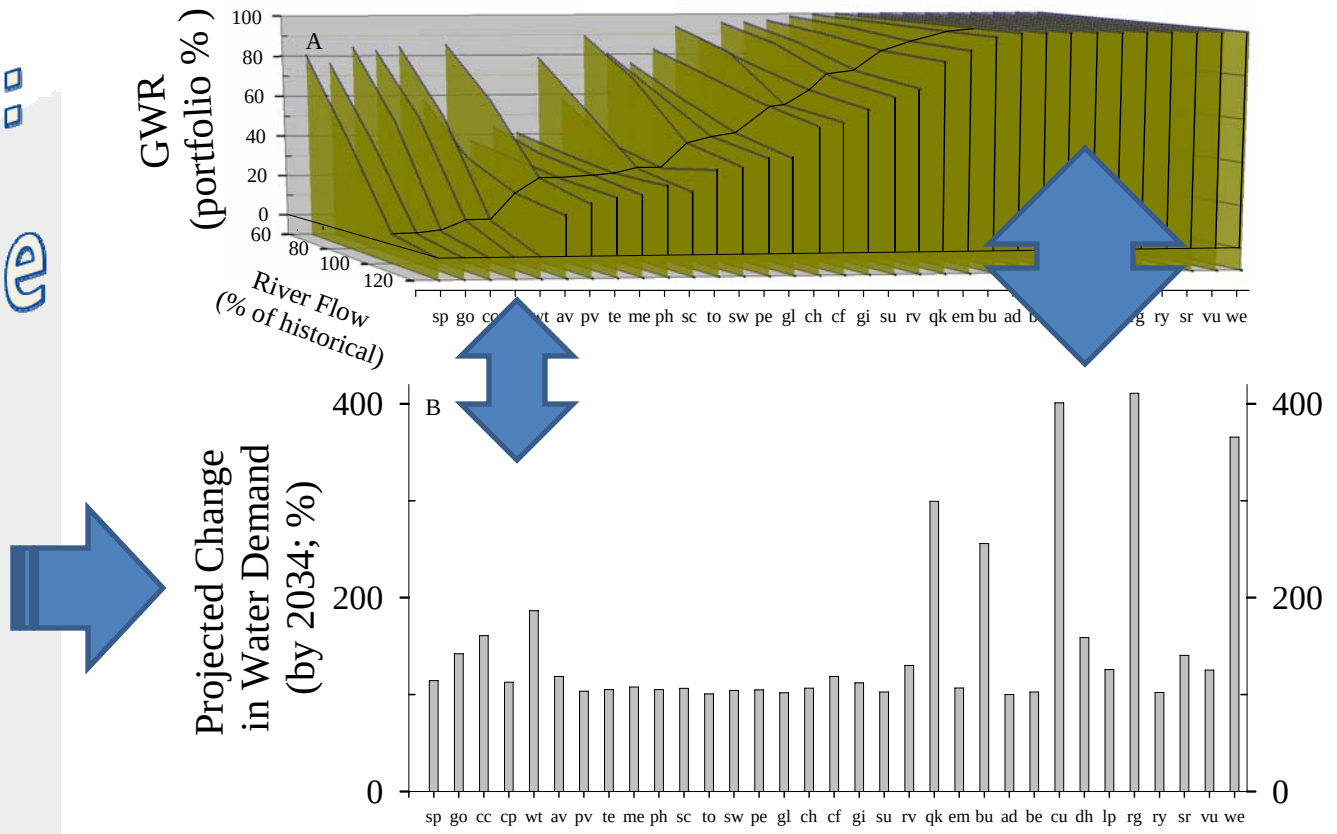
Groundwater Reliance

GWR=(Groundwater/ (Groundwater & surface water)) * 100

Sensitive to Climate

Sensitive to Groundwater

Sensitivities: climate change



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Climate/Uncertainty

Climate

Salt-Verde-Tonto 

Colorado River 

Climate Change

Salt-Verde-Tonto: Ellis et al. (2008) 

Colorado River: Christensen et al. (2004) 

Christensen and Lettenmaier (2007)

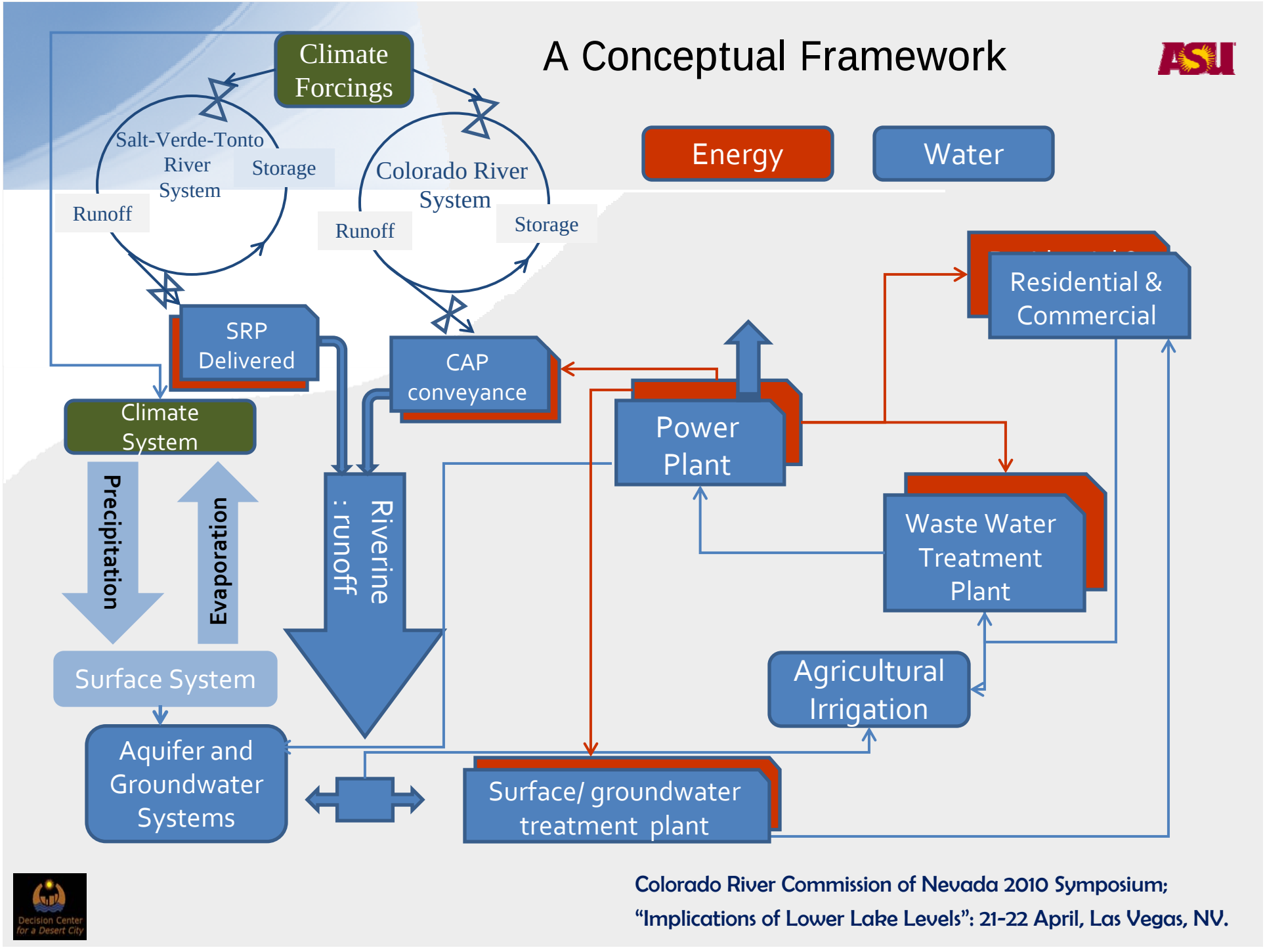
Runoff

Phoenix-Metro Area: Hayhoe (in progress)

Rainfall and temperature

Preliminary Results

A Conceptual Framework



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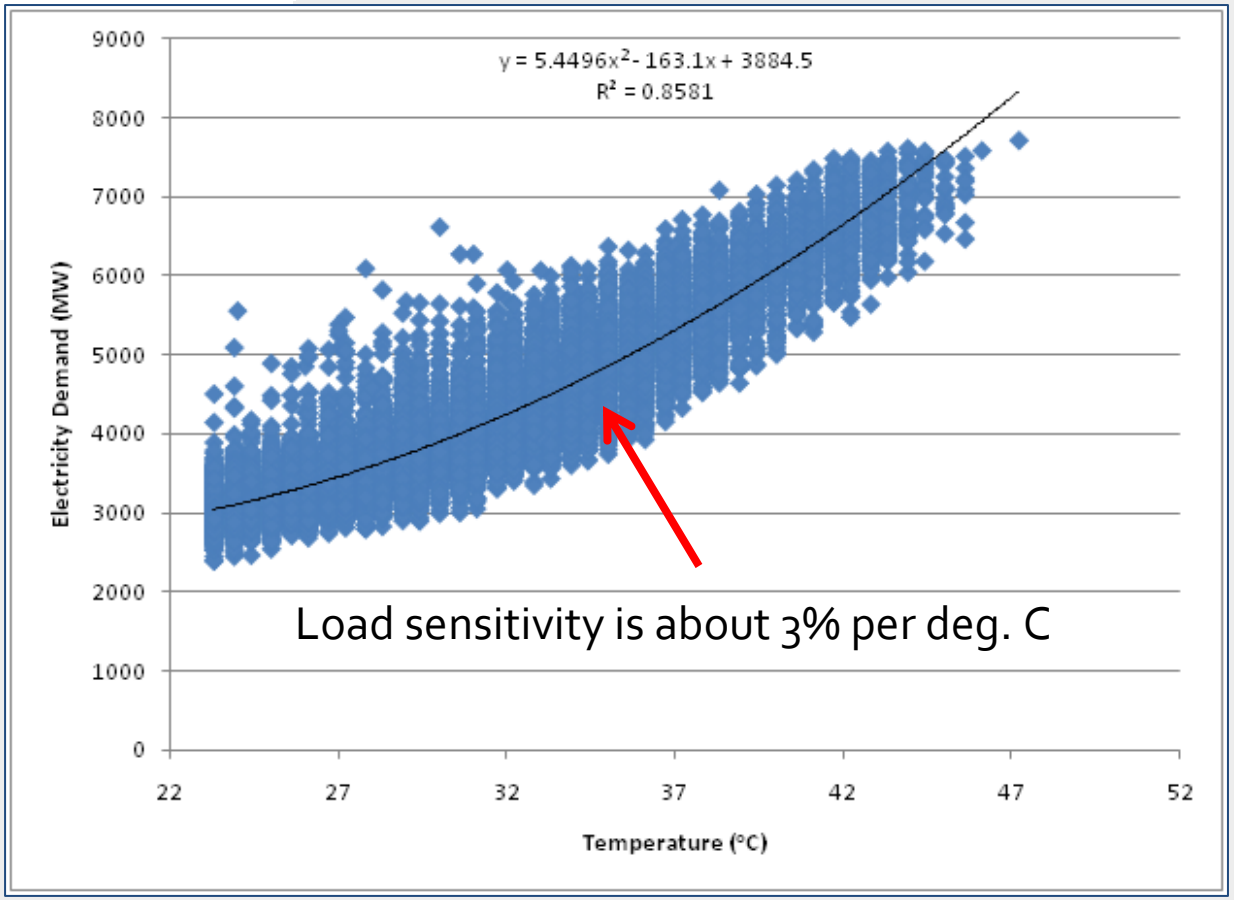
Preliminary Results- electricity

Empirical Data



Source:
D. Sailor

Hourly demand and hourly temperature in Phoenix.

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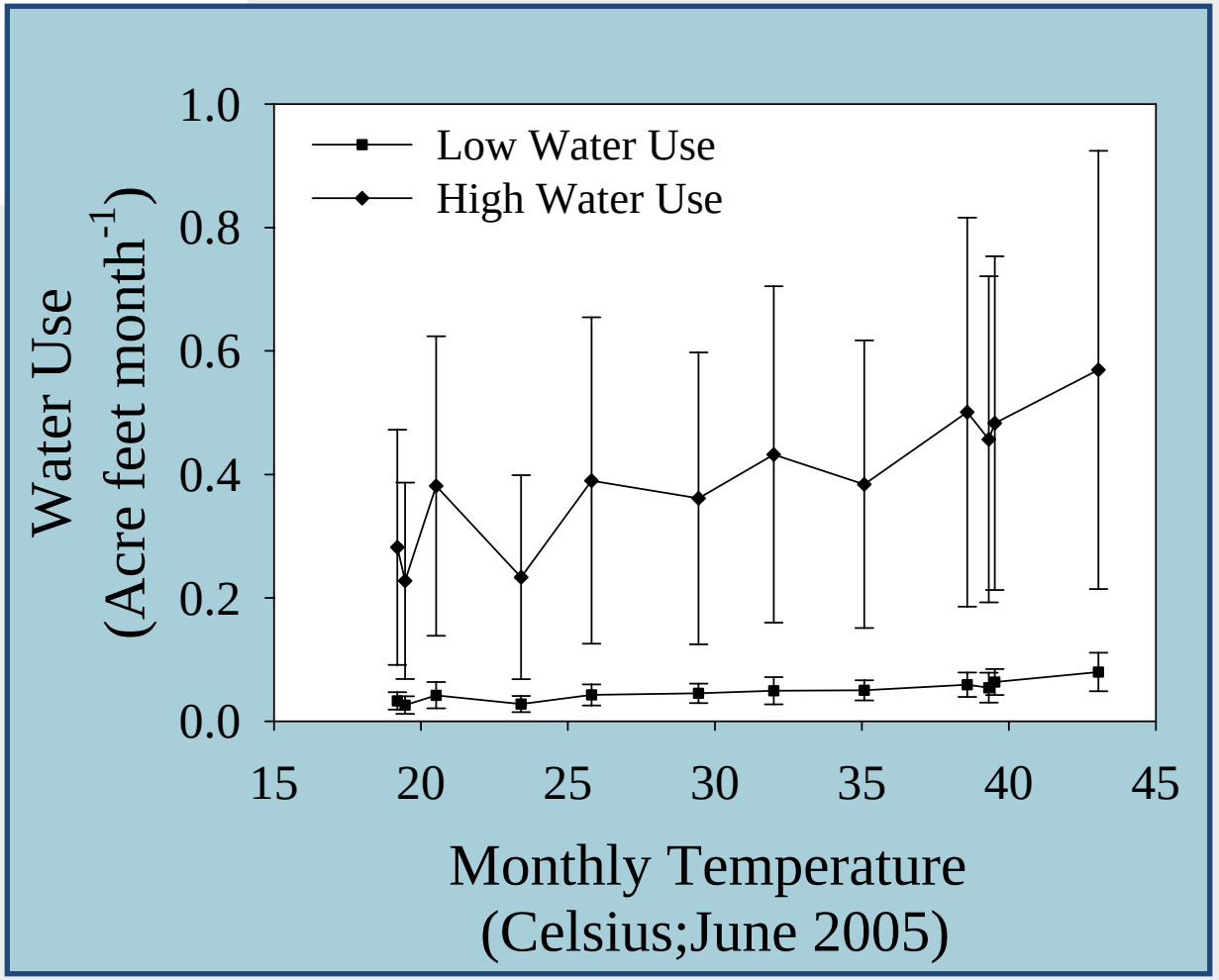
Preliminary Results- water use

Empirical Data

A few block groups in Phoenix



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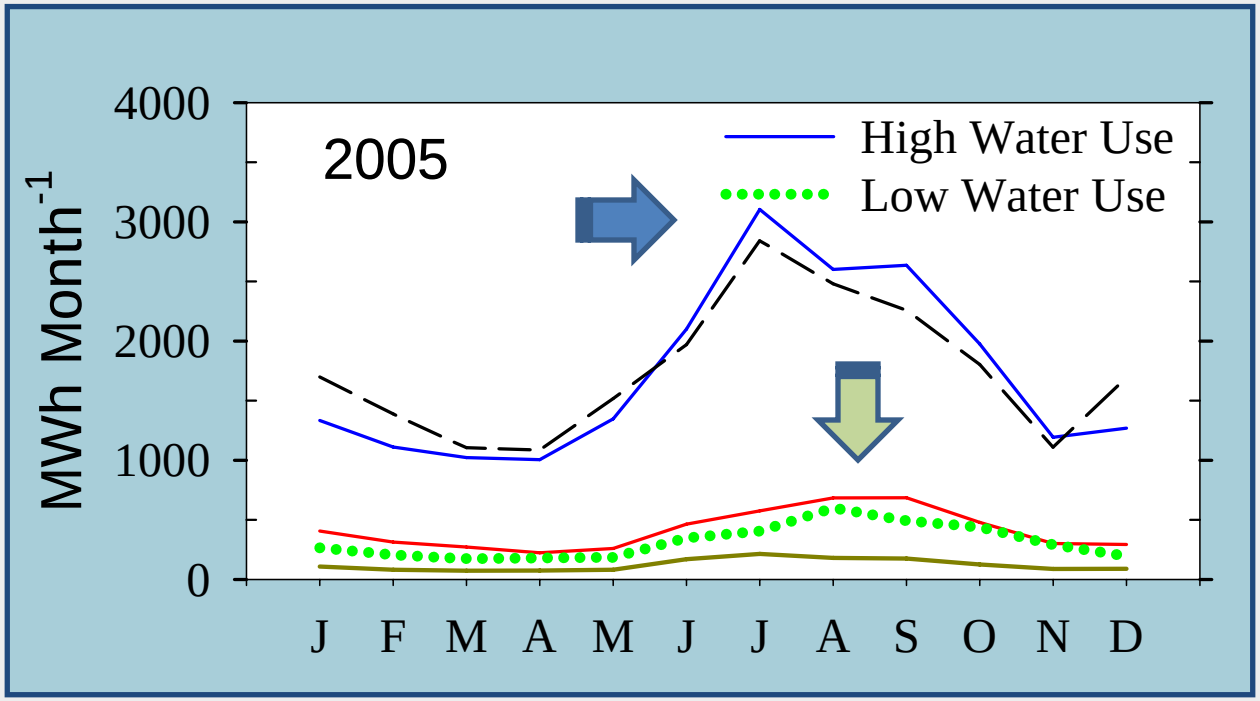
Preliminary Results- energy/water

Empirical Data



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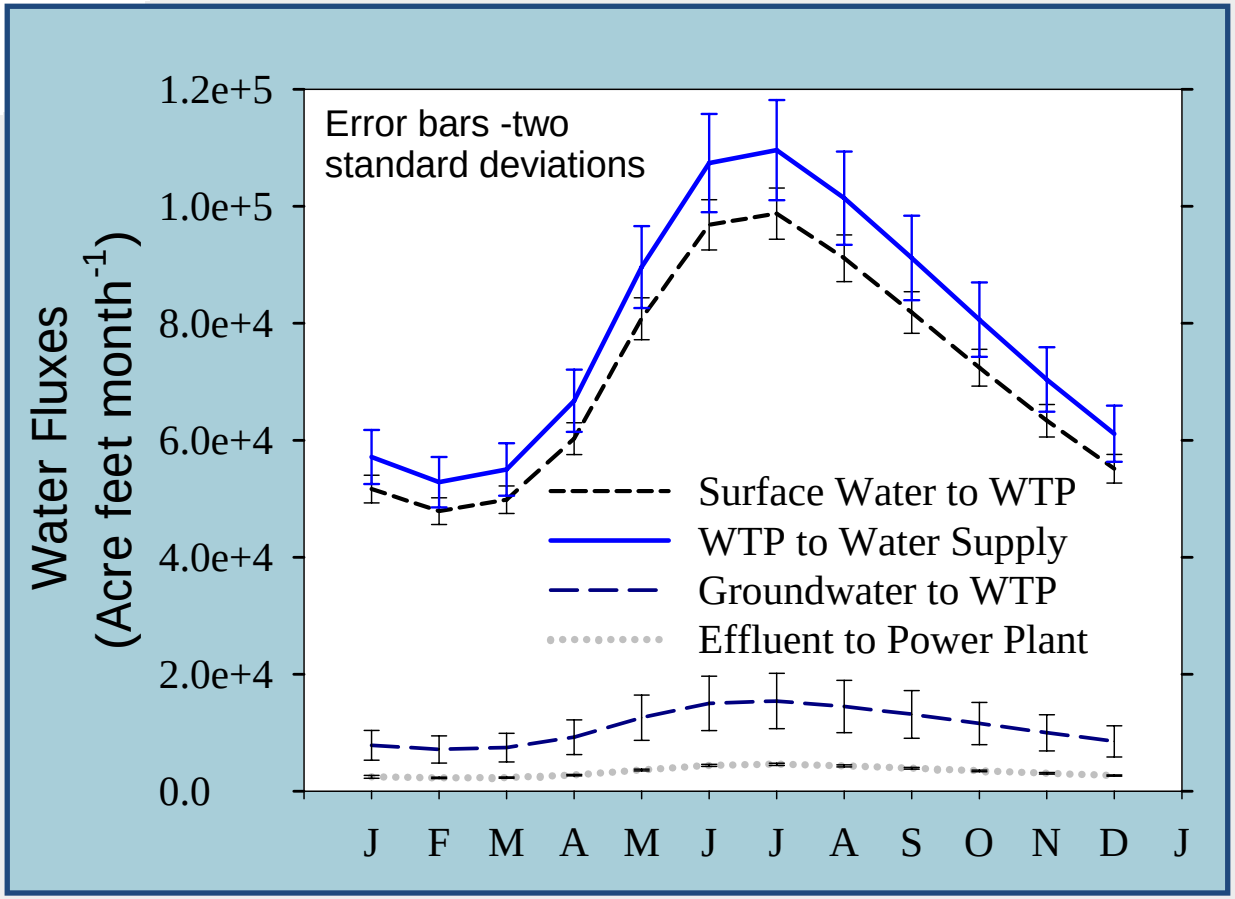
Preliminary Results- water and energy: (Phoenix-Metropolitan Aggregated)

Simulated Data



Water Fluxes

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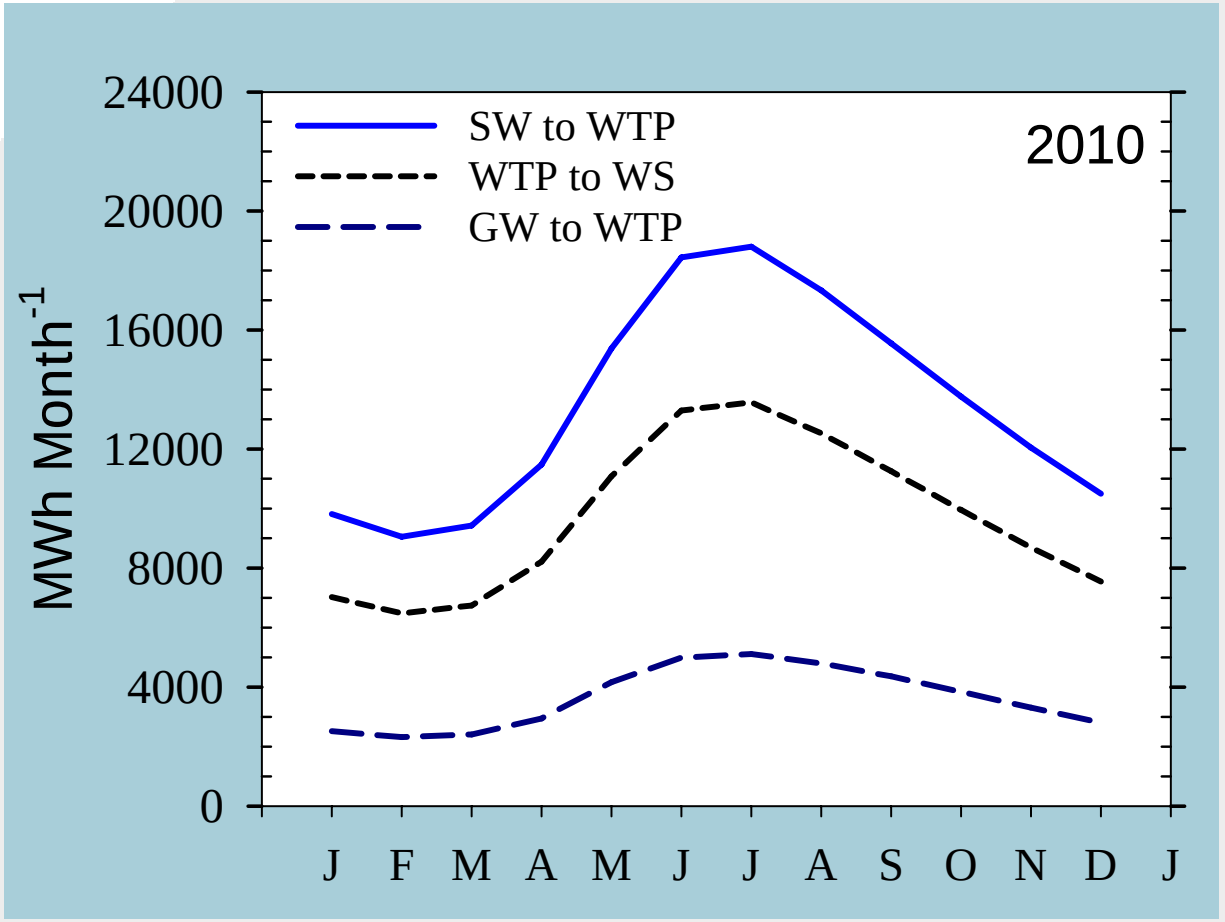
Preliminary Results- water and energy: (Phoenix-Metropolitan Aggregated)

Simulated Data

Energy used in transporting water



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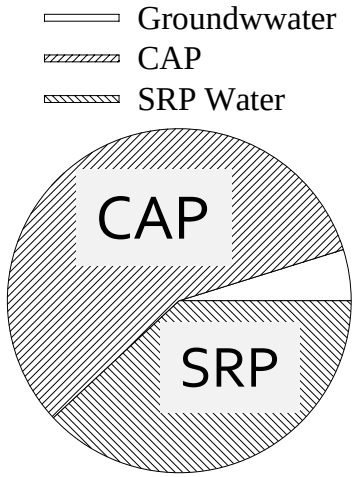
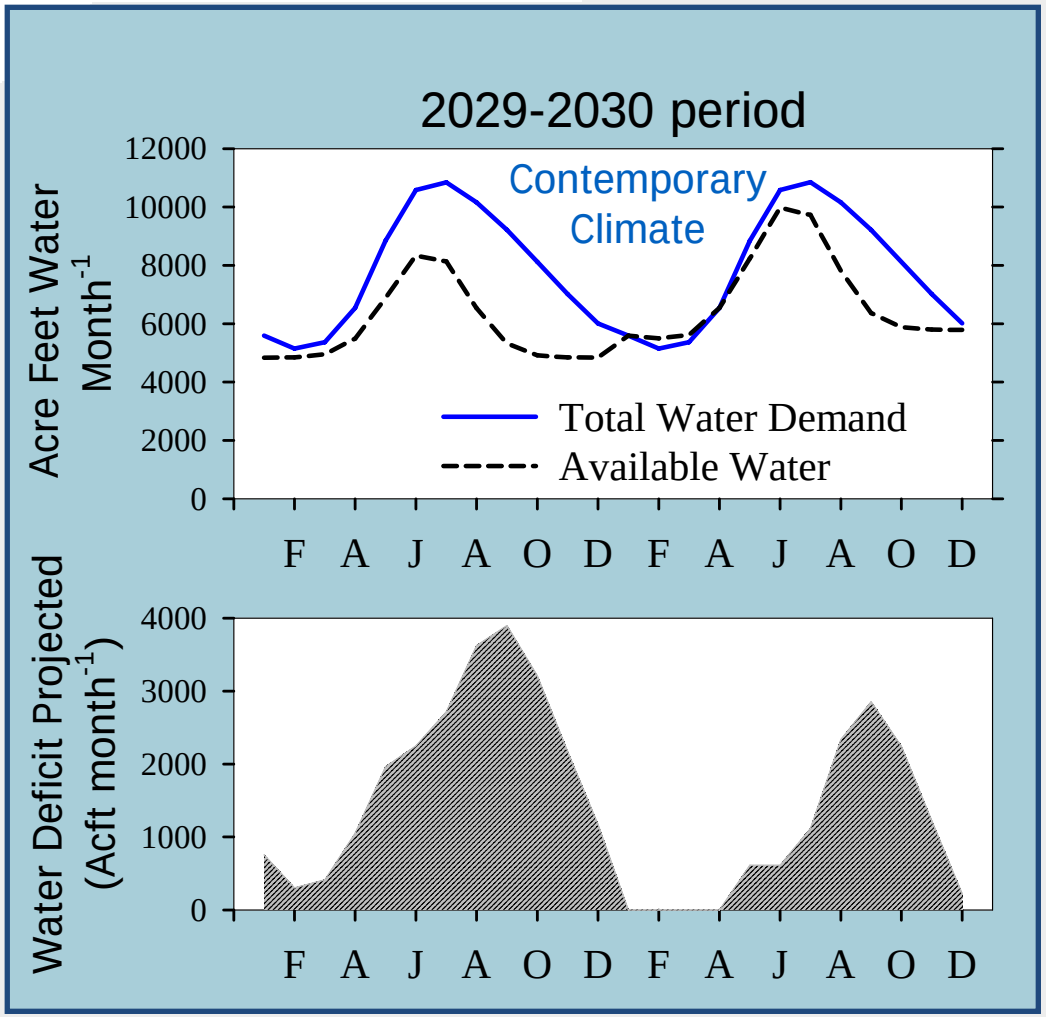
Preliminary Results- water:
Scottsdale, AZ

Simulated Data

Portfolio





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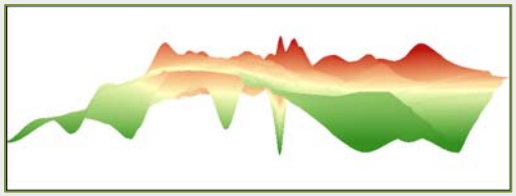
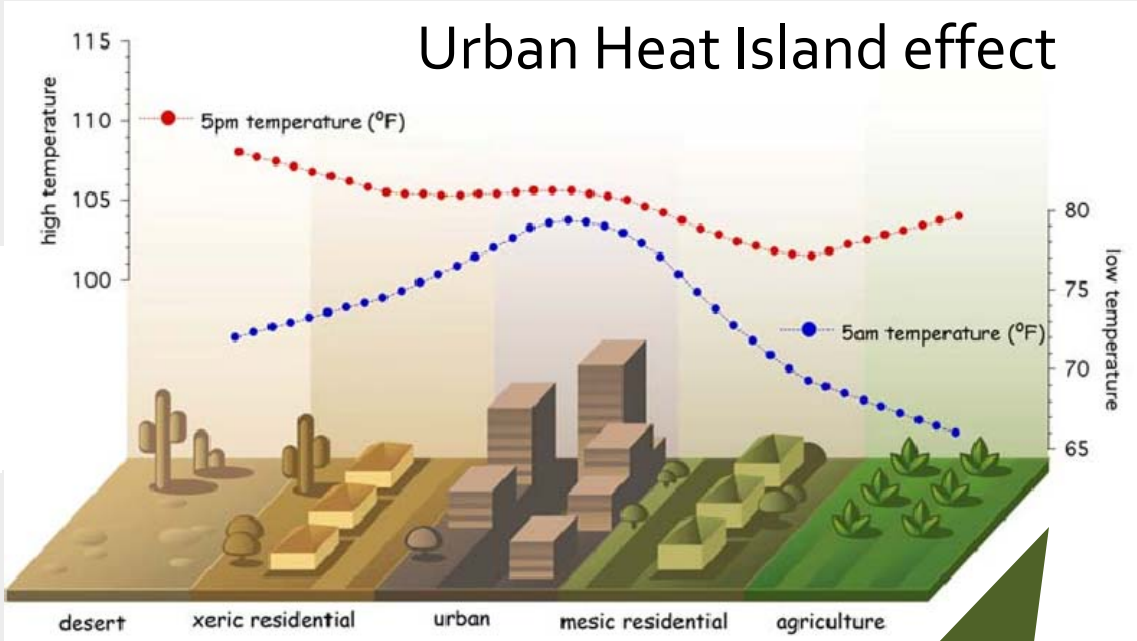
Future Directions

Simulation Tools

LUMPS
(**L**ocal-scale
Urban
Meteorological
Parameterization
Scheme)



Urban Heat Island effect



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Acknowledgements

- National Commission on Energy Policy
  - Bipartisan Policy Center
- Colorado River Commission
- DCDC staff and post-doctoral students

Thank-you!

Any Questions?

Conceptual Linkages: WaterSim-Urban

UI = User Interface

NUnit = Testing Program

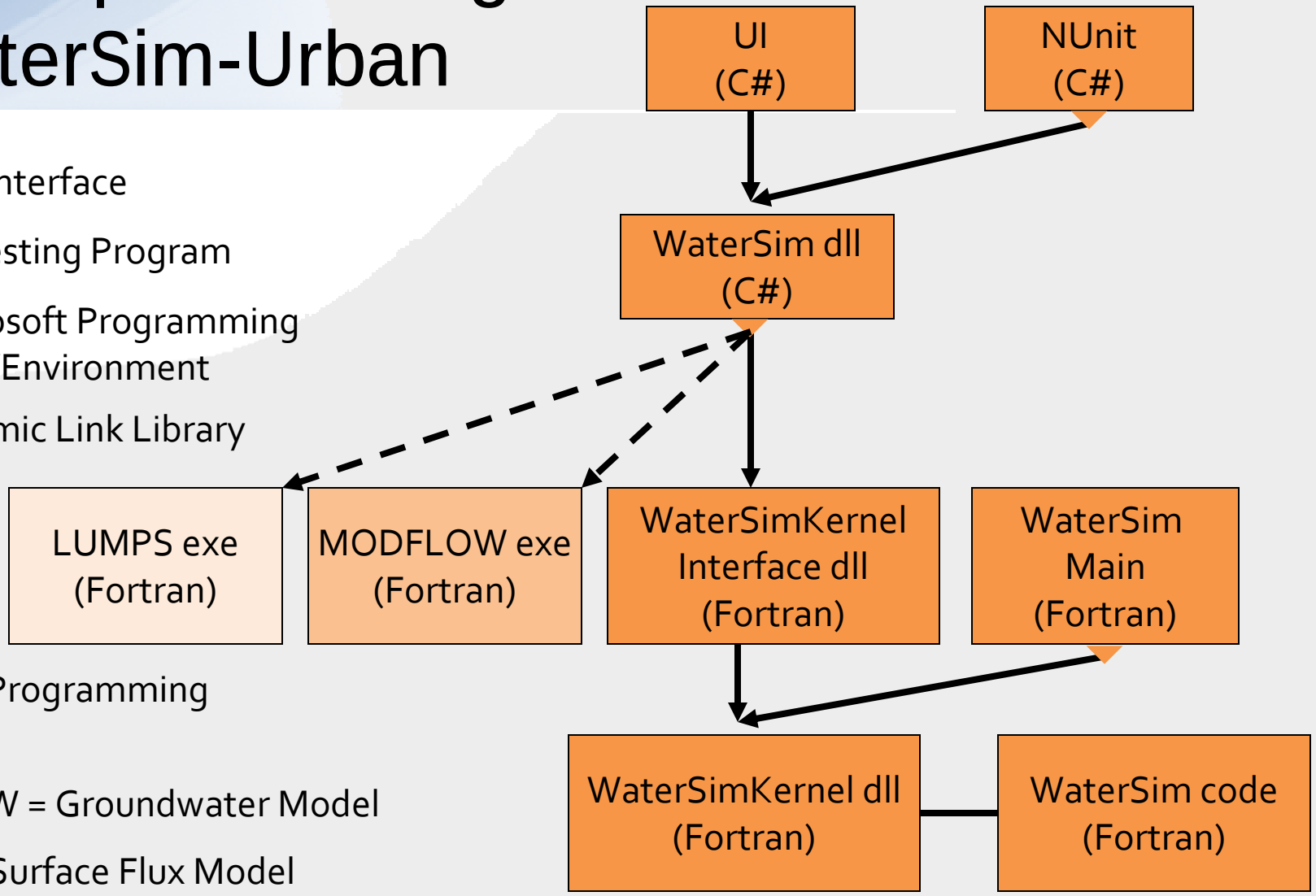
C# = Microsoft Programming Language/Environment

dll = Dynamic Link Library

Fortran = Programming Language

MODFLOW = Groundwater Model

LUMPS = Surface Flux Model



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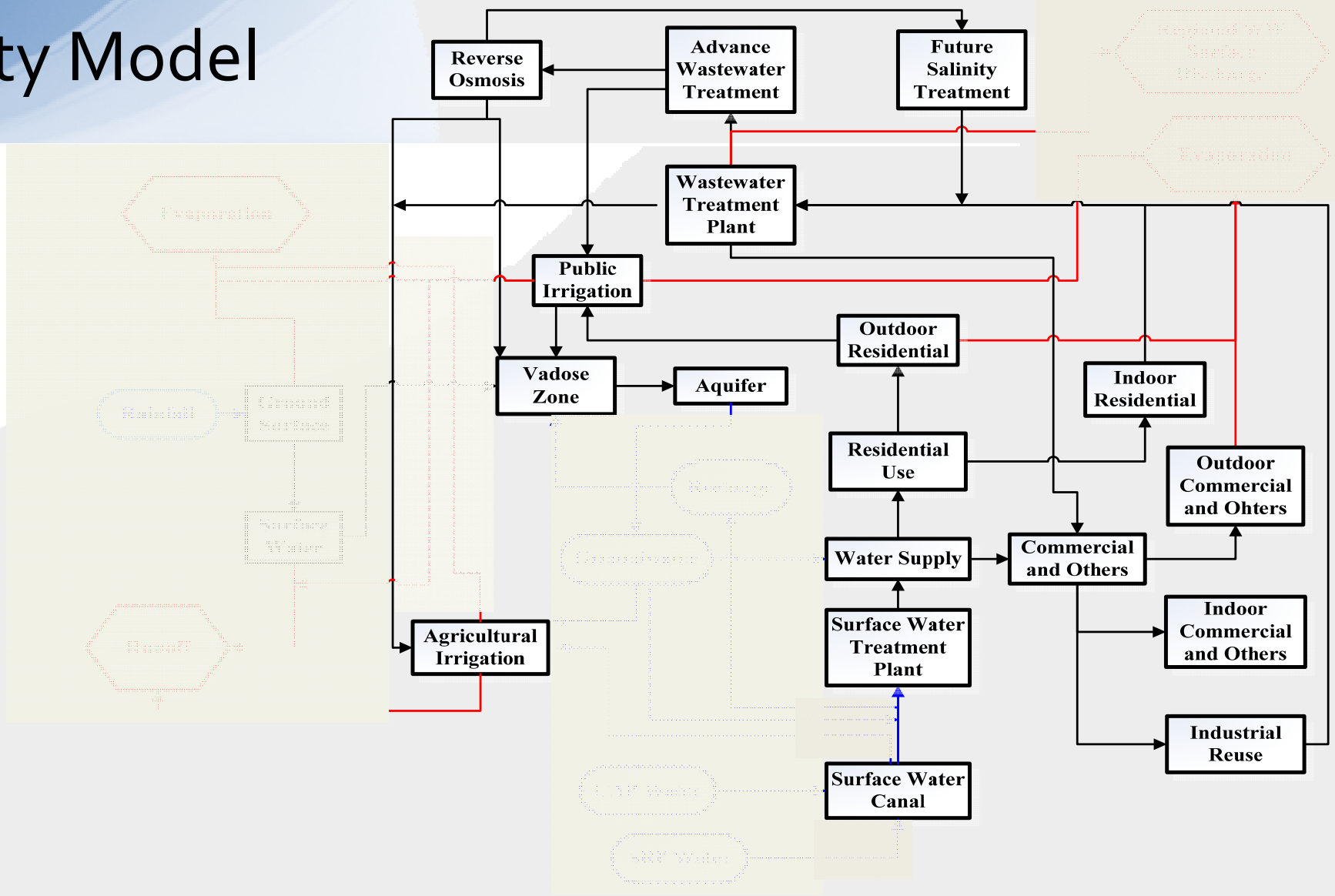
City Model

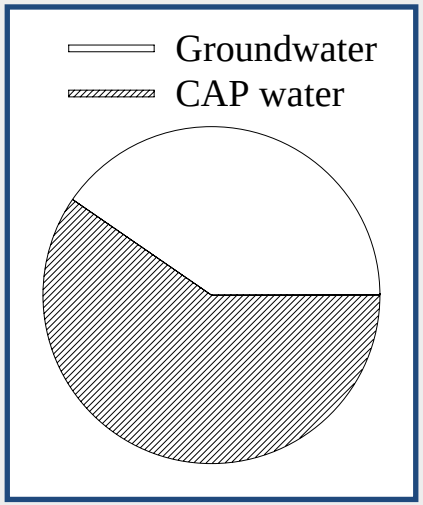


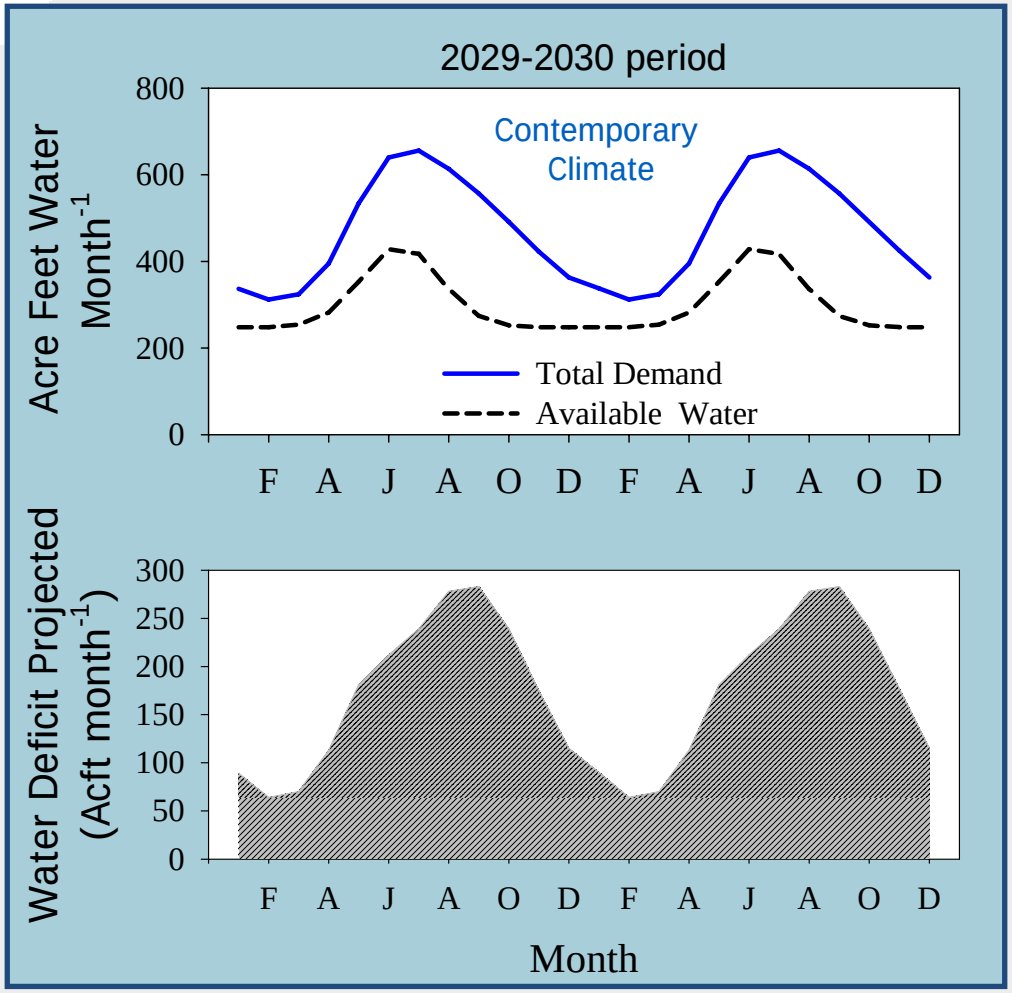
Graphic:Chi Chi Choi

Preliminary Results- water:
Sun City West, AZ

Simulated Data

Portfolio





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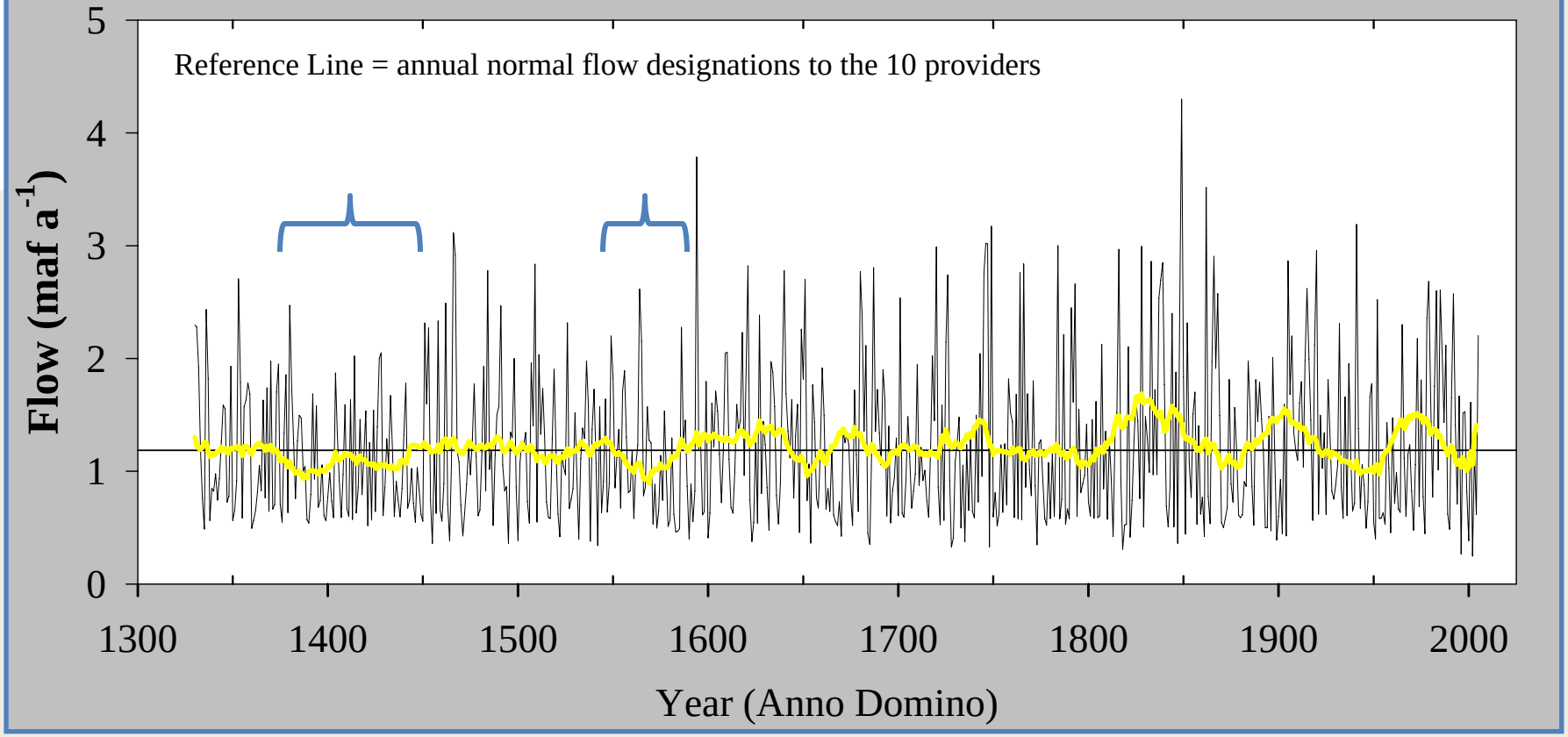
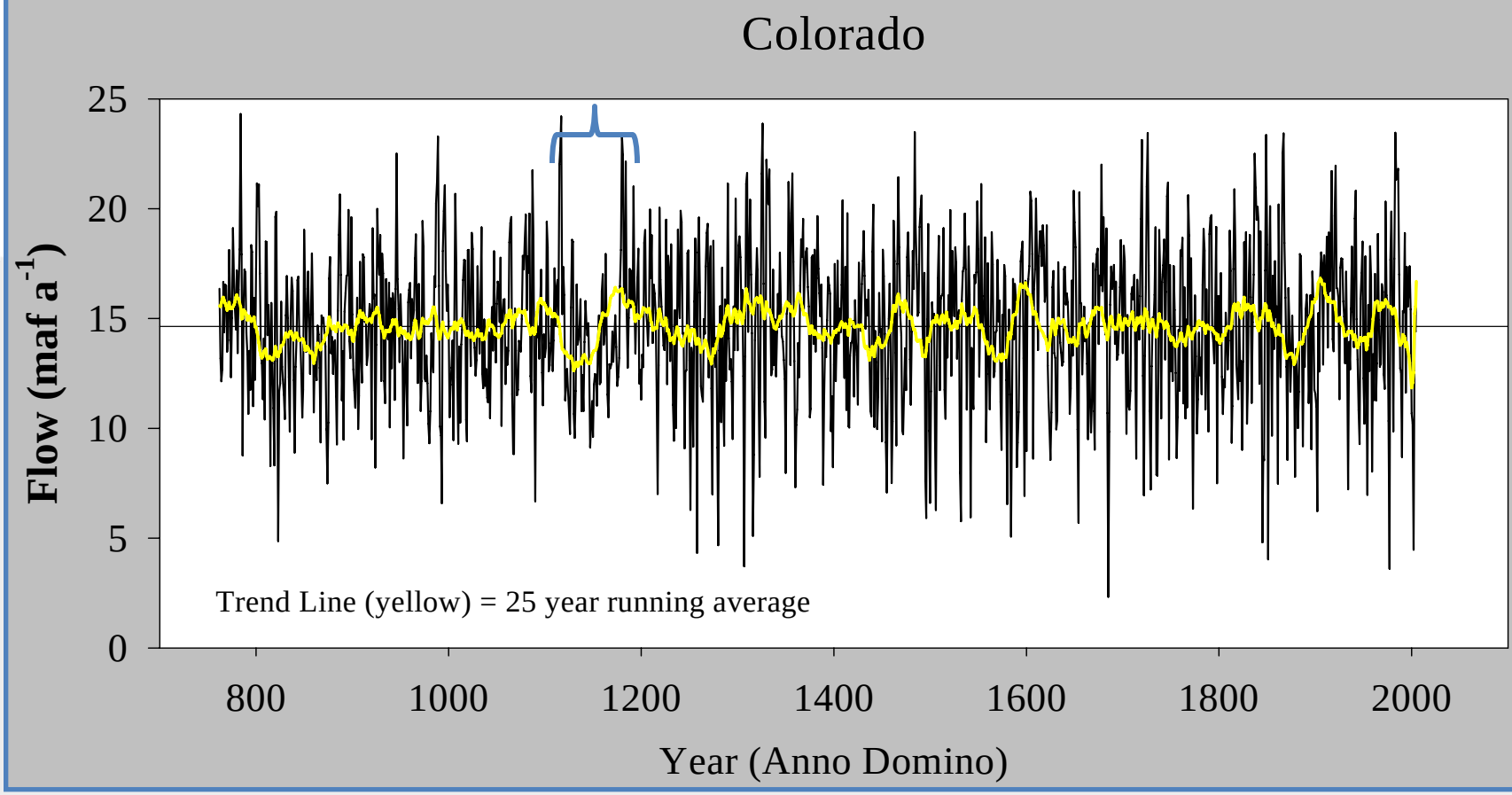
Salt-Verde-Tonto River Runoff

PI: D. Meko and K. Hirshboeck
URL: http://fp.arizona.edu/kkh/srp2.htm

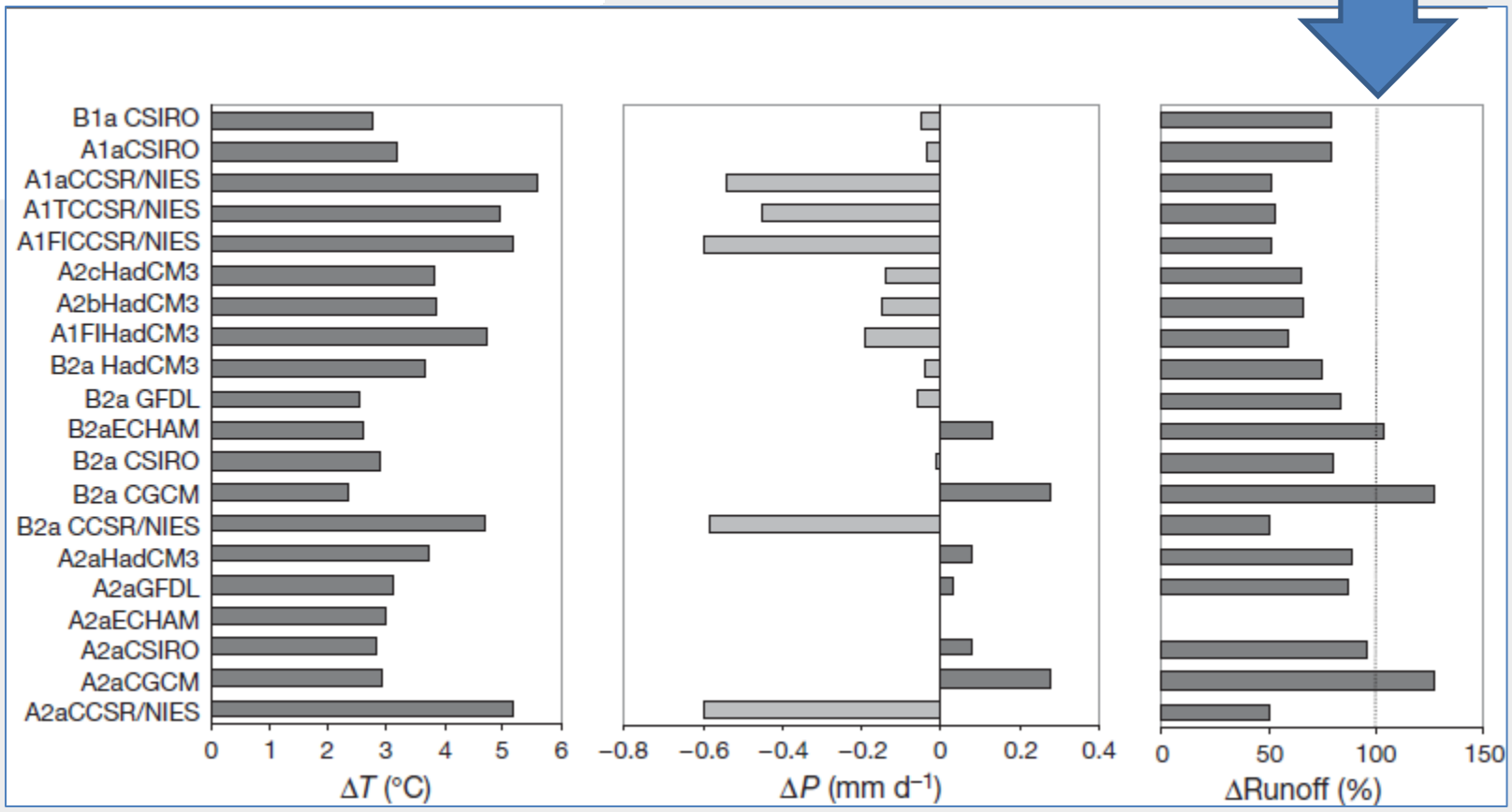


Colorado River Runoff

PI: D. Meko et al. 2007
URL: http://treeflow.info/upco/index.html

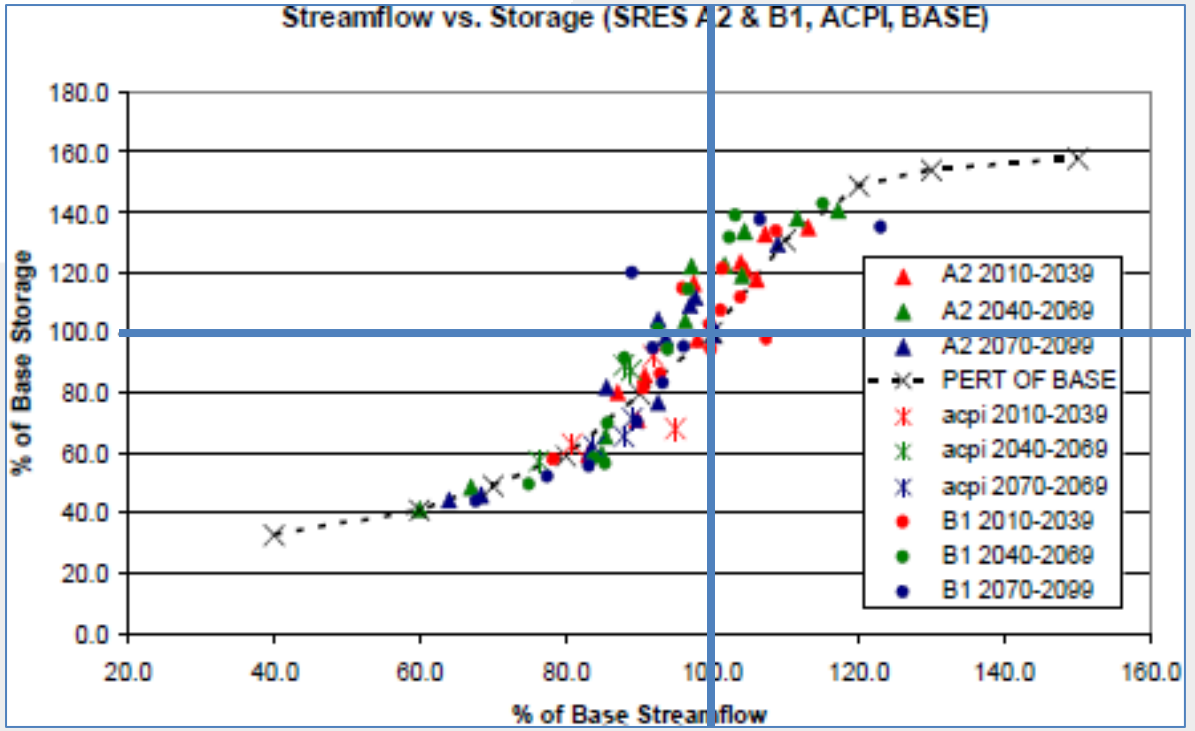


GCM downscaling- Salt-Verde-Tonto River Watershed

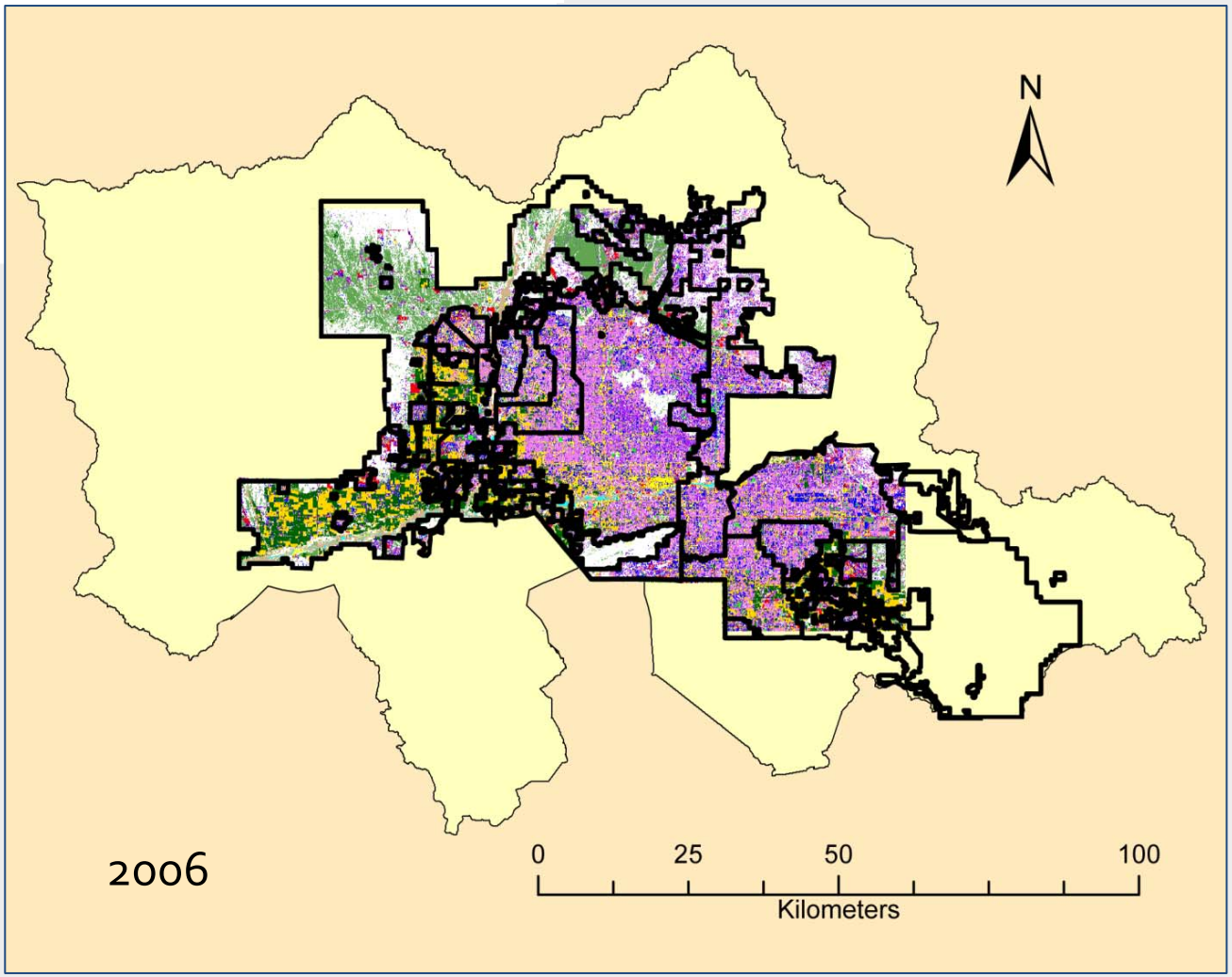


Source: Ellis et al. (2008)

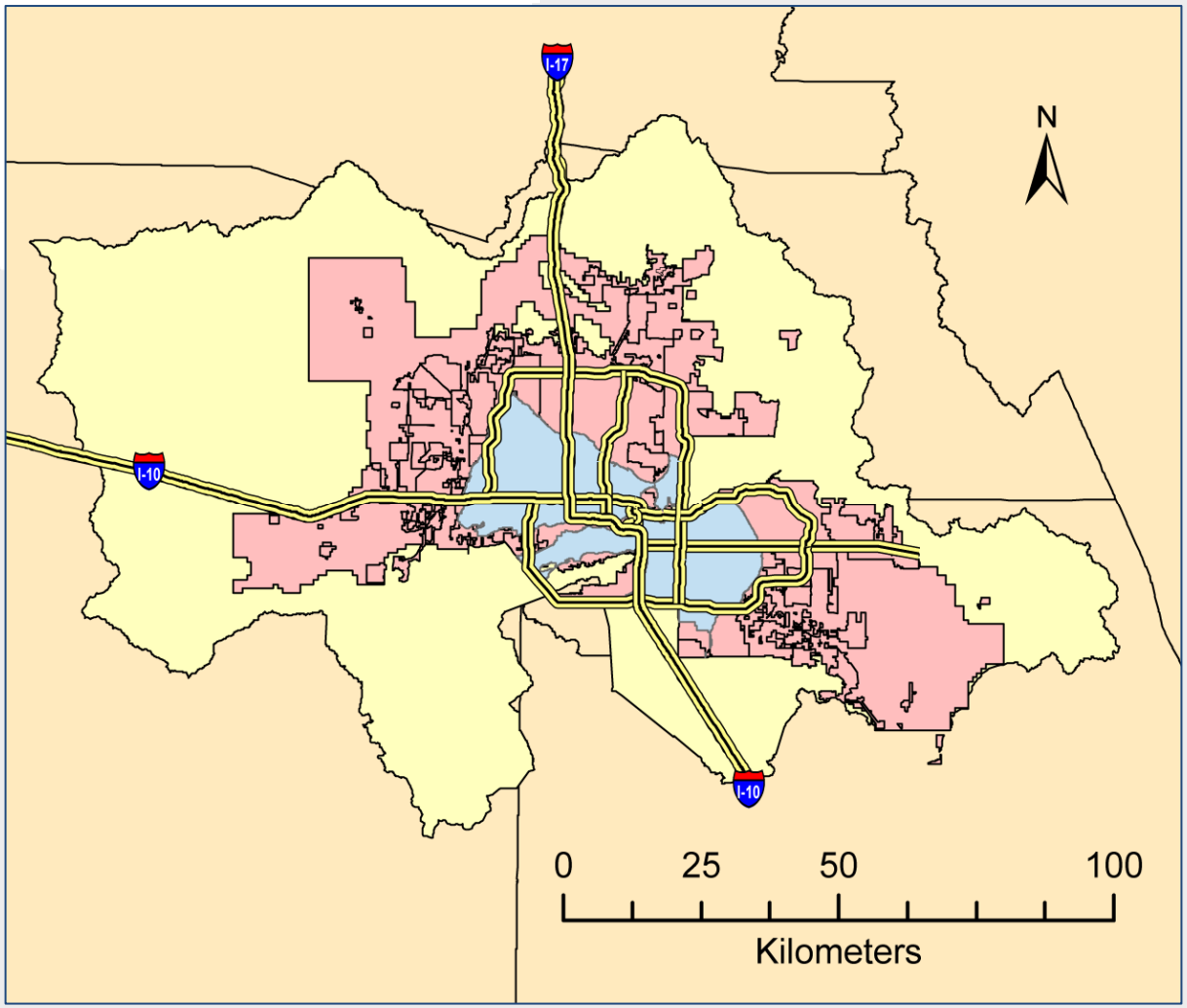
GCM downscaling- Colorado River Watershed



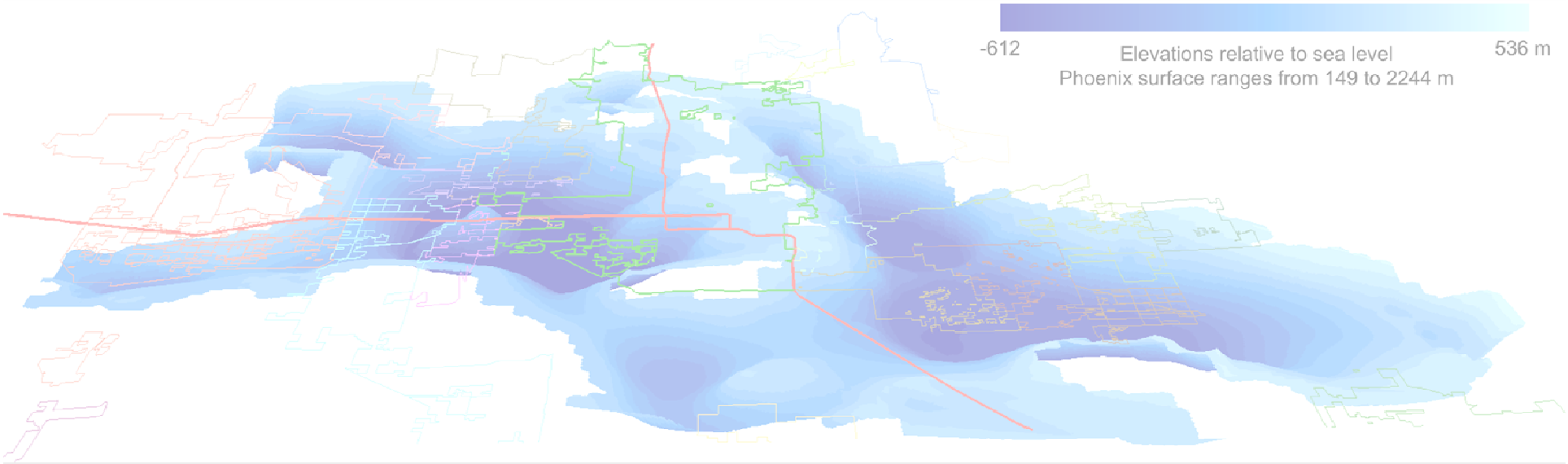
Land Cover from Landsat Thematic Mapper



Salt River Project member lands, water providers, and the Phoenix AMA



SRV Groundwater model



Lower Alluvial Unit