# The Dance Between Water Use and Residential Density

Ray Quay
Director of Engagement
Research Professional
Decision Center for a Desert City
Arizona State University

# Residential Density and Water Use

- Commonly held perception:

  Per capita water use declines as residential density increases.

- Emerging research:

  More complex and not as certain.

# Water Research Foundation Project 4633:
# Urban landscape water use research evaluation

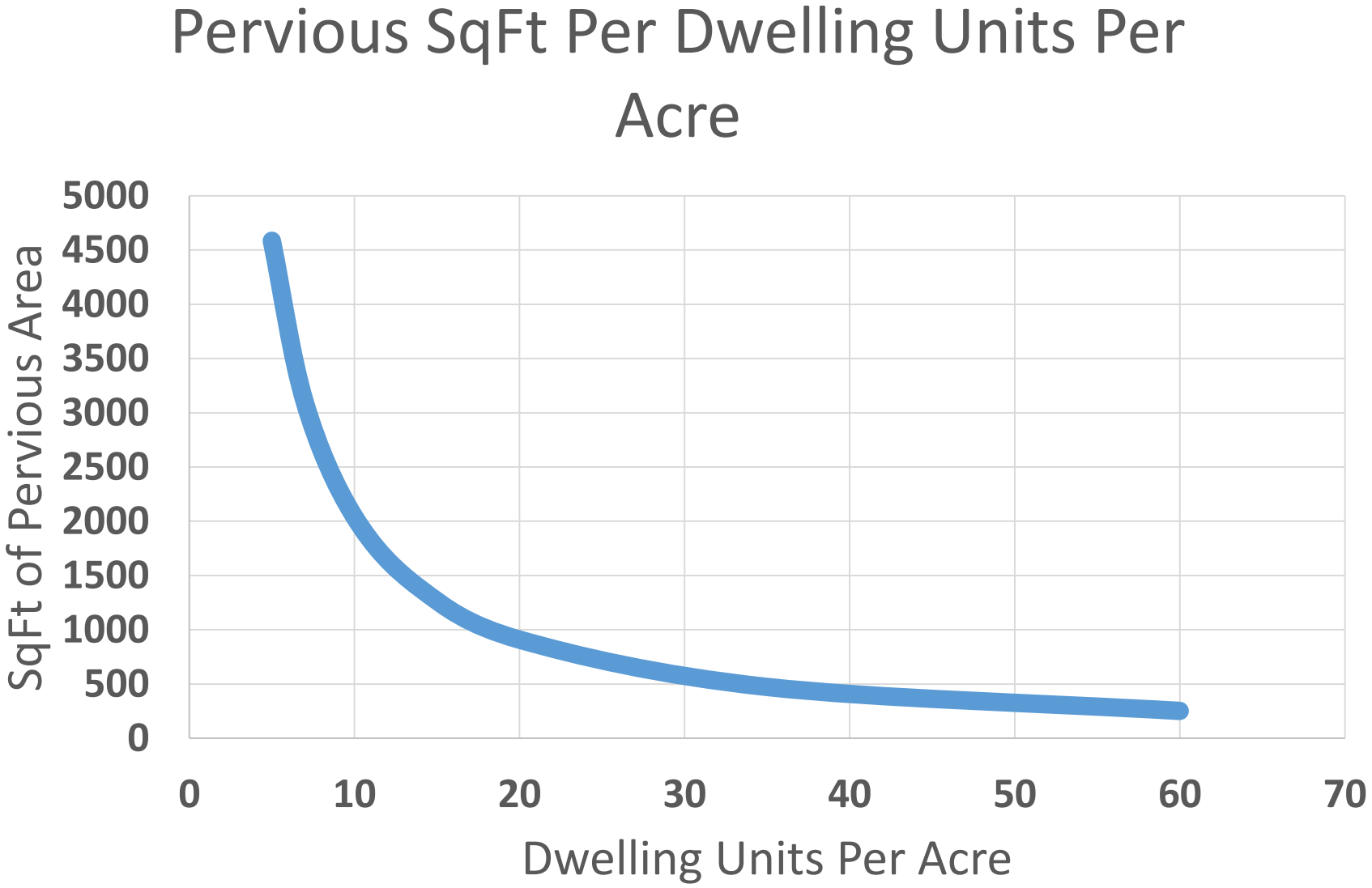
- In Portland and Phoenix, negative correlation between zoning and building area (Shandas & Parandvash, 2010, Ouyang et al. 2014).
- Portland, outdoor water responsive to building density, Phoenix it was vegetation (Breyer 2012).
- Phoenix socioeconomic factor spatial patterns negatively related to water use (Randall 2014).
- Tucson reduced landscaping/water use related to the distance to natural amenities (Halper 2011).
- Tucson presence of a pool most significant factor in models of MFoutdoor water use (Agthe, Billings and Bruce 2002).
- Austin though lot and house size correlated with water use, effect was small (Tinker et al. 2005).
- Central California climate accounts for 80% of difference between similar density and lot size located in different regions (Hanak and Davis 2006).
- Salt Lake City commercial more frequently over watered compared to residential (Farag et al. 2011).
- Businesses value lush landscapes more than residential to attract customers while residential values how it is used (Endter-Wada et al. 2008).

# Complexity and Uncertainty

- Water use results from the needs of complex and adaptive systems – Social, Economic, and Environmental.
- Can we predict the future?  Not really!
- Think about it in terms of complexity and uncertainty.

# Residential Water Demand: Complex

- Indoor Water Demand
  - Human Consumption, Sanitary (Flushing, Bathing, Cleaning),
    Washing ( Clothes, Dishes)
  - A function of people and their personal needs
- Outdoor Water Demand: Everything else
  - Irrigating Landscaping, Pools, Washing, Cooling Towers
  - A function of what? A mix of factors: Square Feet, Units – people
- Many related factors within complex systems

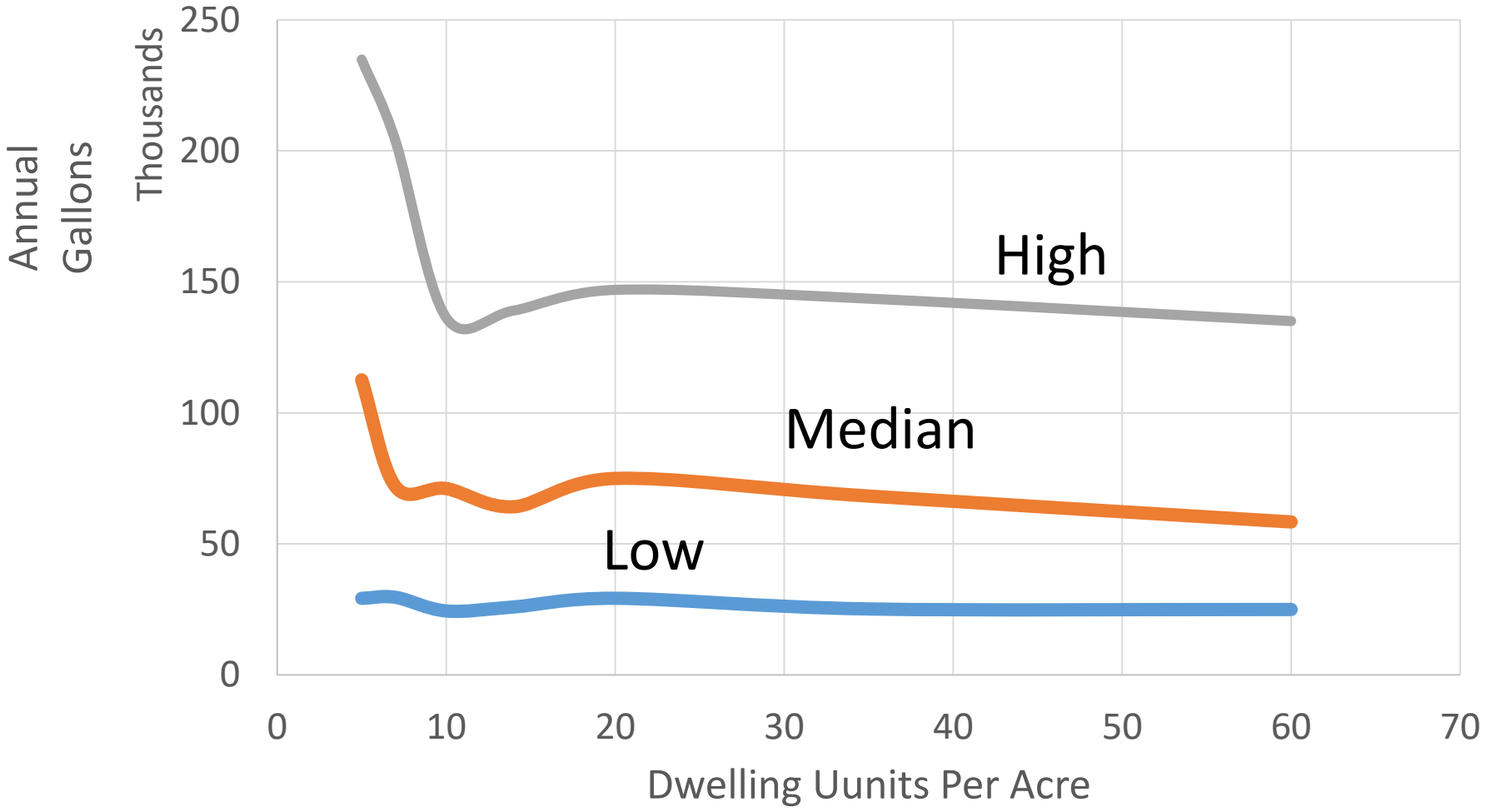



Source of Data: Denver Water 2016

# Residential Water Demand: Uncertain

- Indoor Water Demand
  - People – Factors that affect personal water needs
    - Income, Culture, Age, Politics (Environmental)
  - Infrastructure – Factors that affect efficiency
    - Toilet, Showerhead, clothes washer, treatment
  - Range:25 GPCD to 150 Gallons Per Capita per Day
- Outdoor Water Demand
  - Personal Choice : Factors that affect landscape irrigation needs
    - Housing choices and Landscape area size
    - Plant choices
    - Maintenance and Infrastructure Choices
  - External : Factors that affect irrigation needs
    - Climate: Hotter / drier or wetter
    - Regulation: Development review and enforcement
  - Range : 2 to 300 Gallons Per Square Foot Per Year.

# Range of Annual Per Unit Water Use By Dwelling Units Per Acre

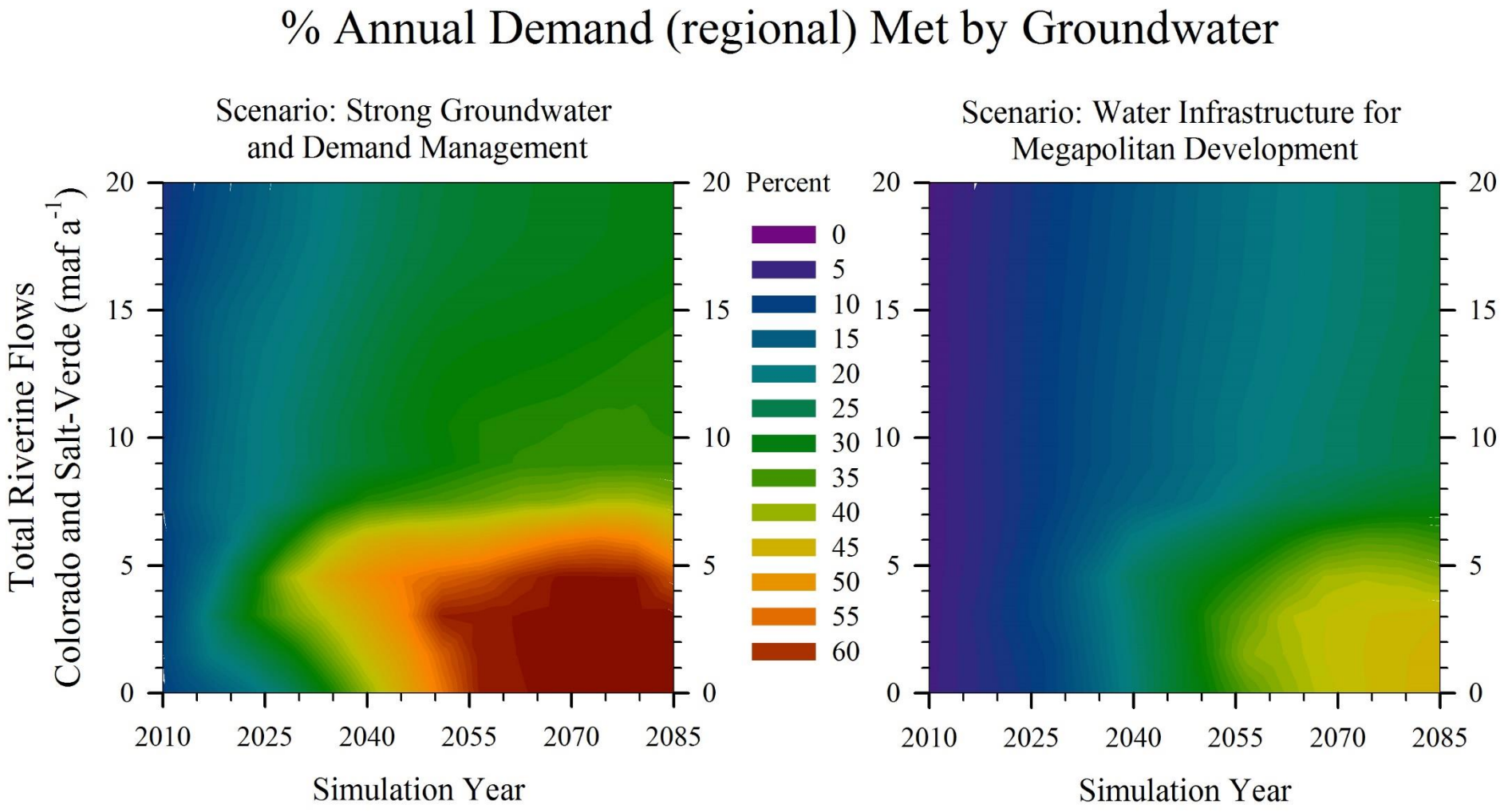



Source of Data: Denver Water 2016

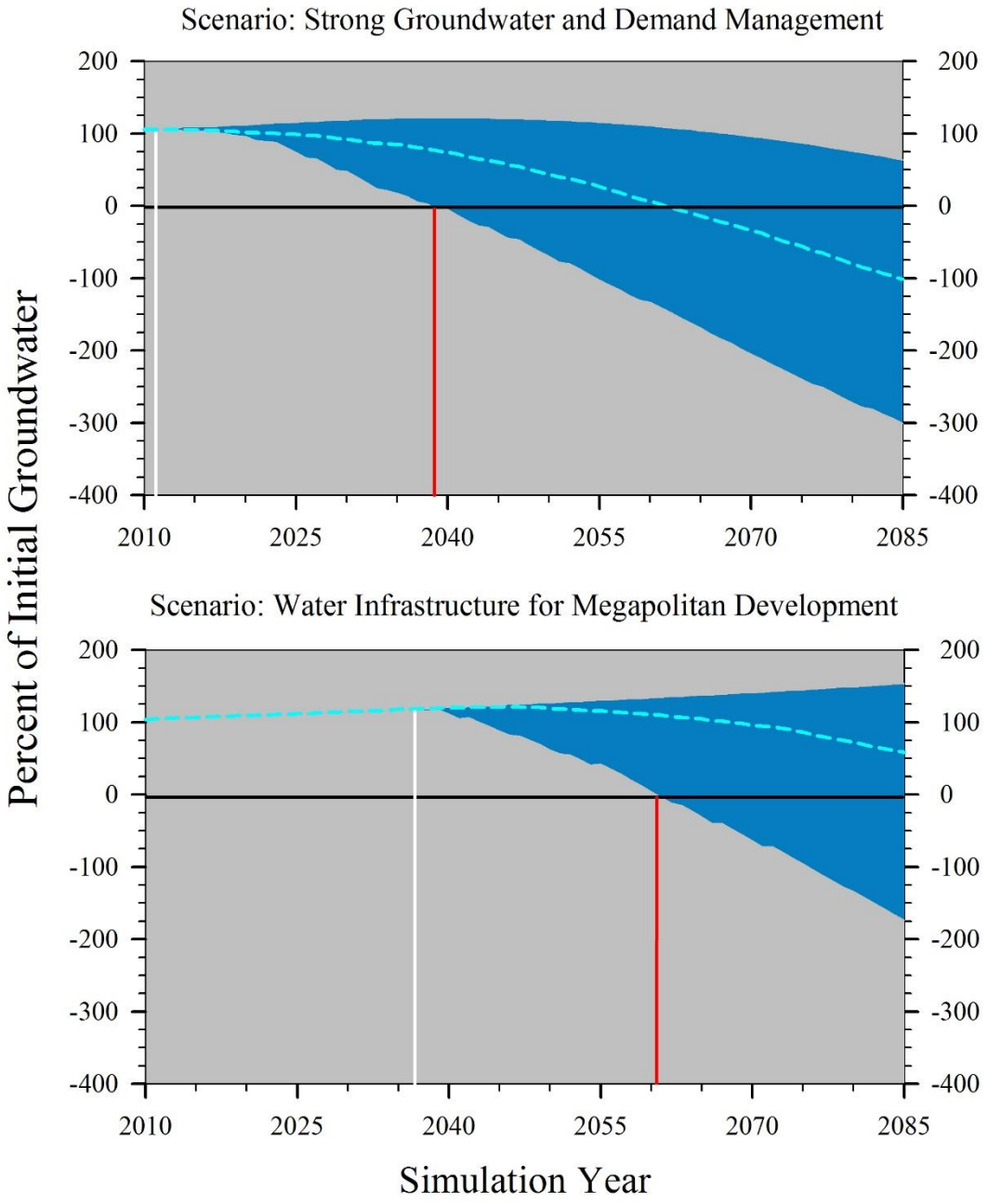
# Colorado Water and Growth Exploratory Scenario Analysis

- Looking for the strategic aspects of relationship between residential density and water use.
  - Using Denver's Residential Water Demand Model
  - Identify scenarios based on the variation and uncertainty of factors related to land use that affect water use
  - Create scenarios of different residential density.
  - Estimate water use across the factor and land use scenarios.
  - Look for patterns that suggest strategic insight.
- Strategic insights can be used by water managers and land use planner to plan for possible futures and influence key factors that impact water demand.

# WaterSim Results



# Case Example: Phoenix, Arizona



RAY.QUAY@ASU.EDU