BUREAU OF RECLAMATION

Lower Santa Cruz River Basin Study Catch-up Presentation

Adaptation Strategy Workshop #2

February 22nd, 2021

Eve Halper, Reclamation

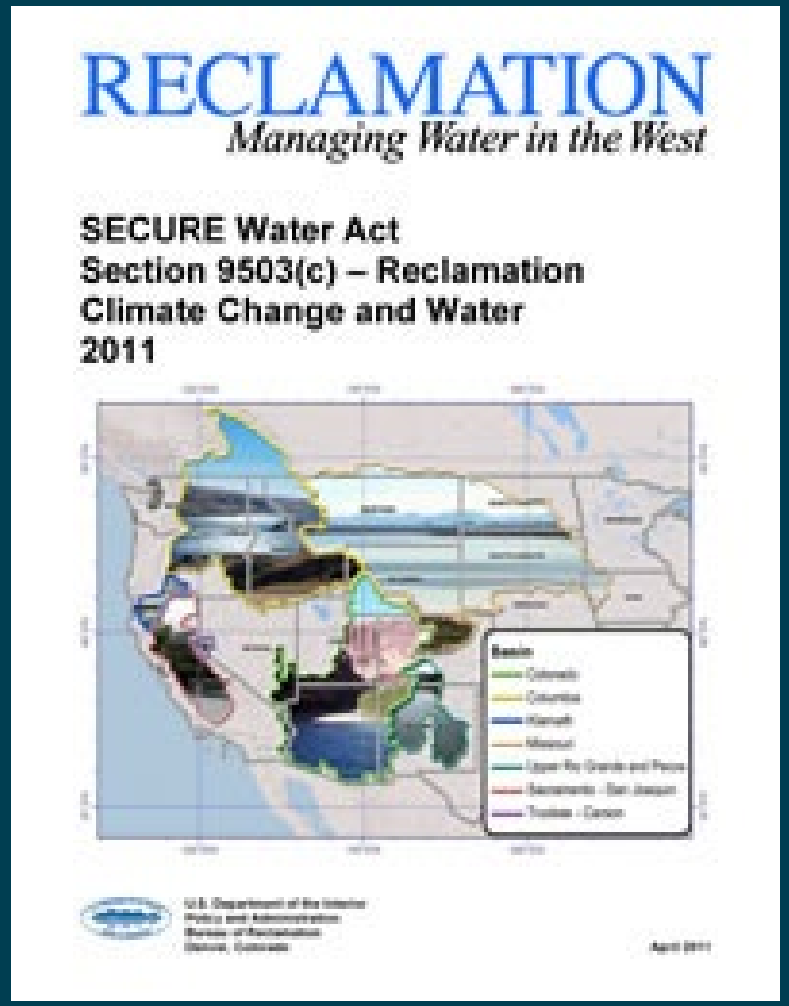
Kathy Chavez, Pima County

Presentation Outline

- ❖Basin Study Program Background
- ❖Study Objectives and Cost Share Partners
- ❖Step 1 – Project Supply-Demand Imbalances
  - Scenario Development
  - Climate Change Analysis
  - Surface Hydrology Analysis
  - Demand Modeling Analysis
- ❖Step 2 – Reliability
- ❖Step 3 – Adaptation Strategies
- ❖Step 4 – Trade-Off Analysis
- ❖Outreach Activities

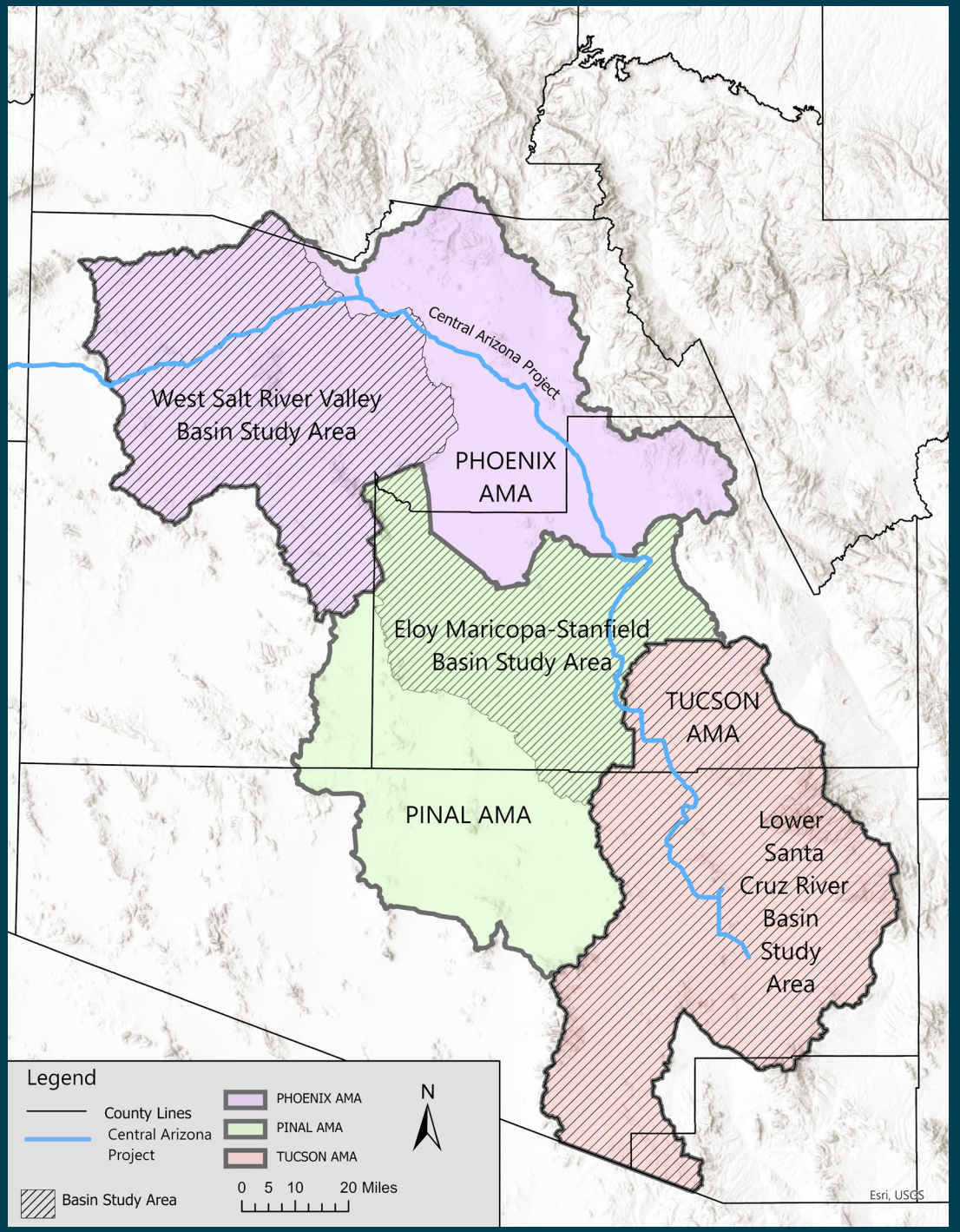
SECURE Water Act of 2009

- Directs the Secretary of the Interior to establish a climate change adaptation program to:
  - ➢Assess risks to water supply
  - ➢Analyze the impacts of changes in water supply on a variety of demands
  - ➢Develop adaptation strategies in consultation with non-Federal participants



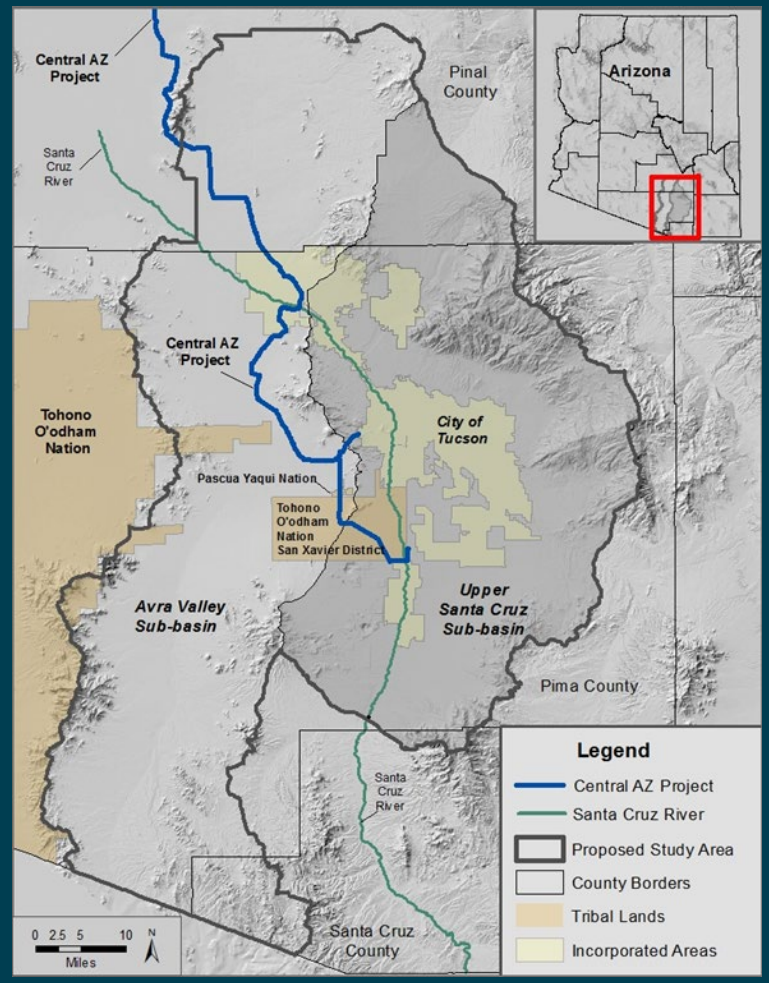
Reclamation Basin Studies in Arizona

1. West Salt River Basin Study
2. Lower Santa Cruz River Basin Study
3. Eloy Maricopa-Stanfield Basin Study

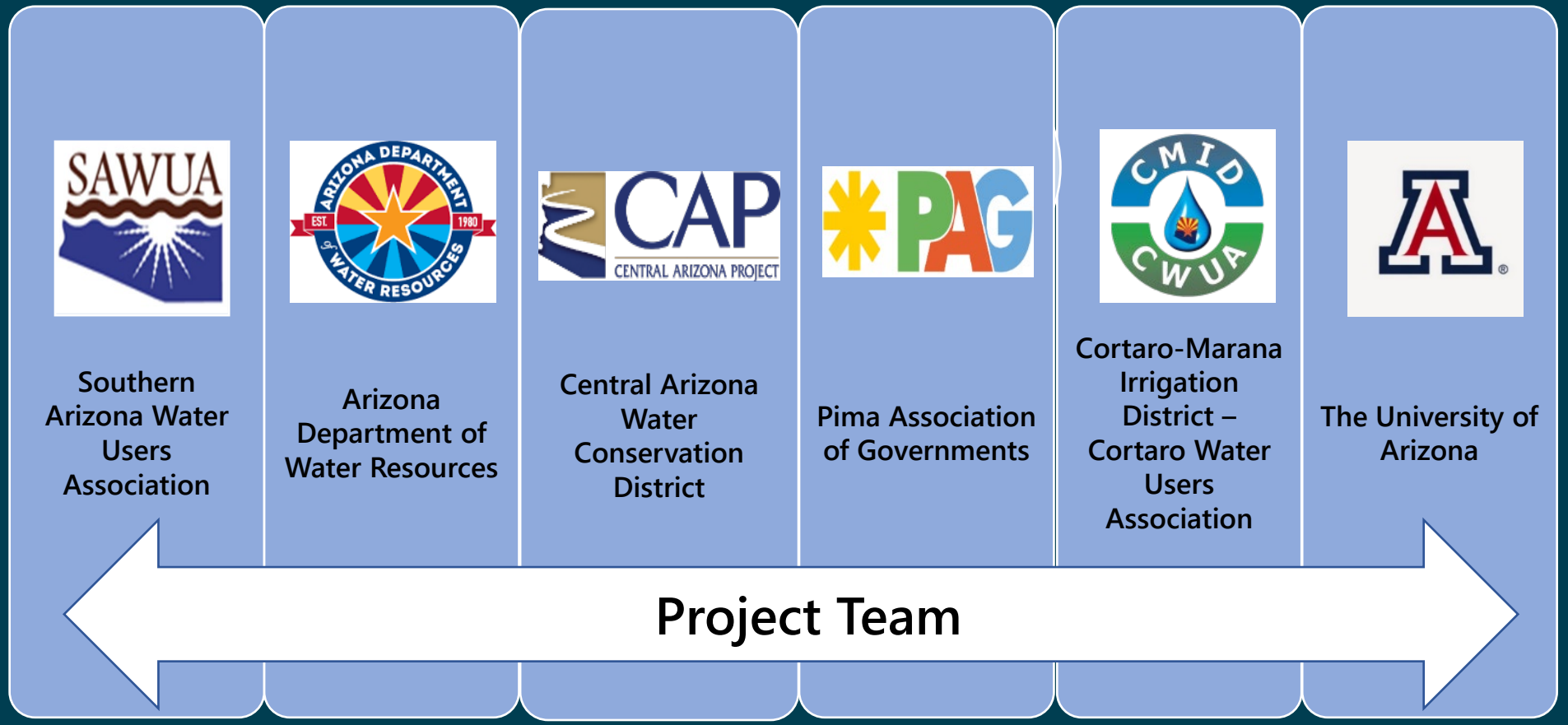


Lower Santa Cruz River Basin Study Key Details

- Five-year study period: 2016 - 2021
- Planning horizon: today through 2060
- $2,065,750 partnership
- 50/50 In-kind Cost Share
- Study Area – Tucson Active Management Area (TAMA)

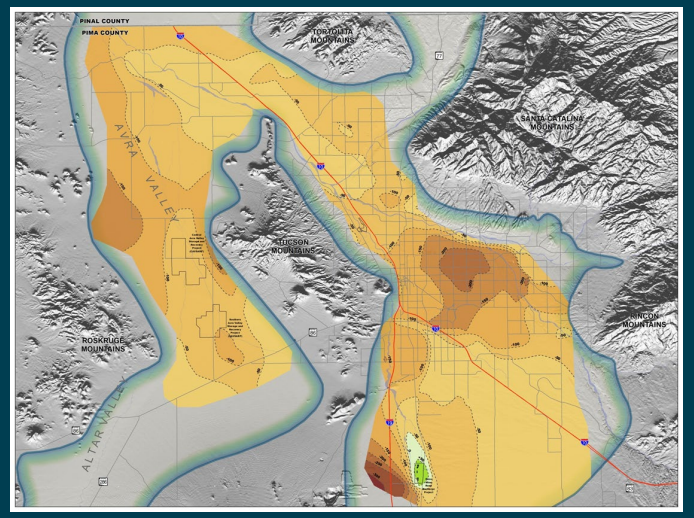


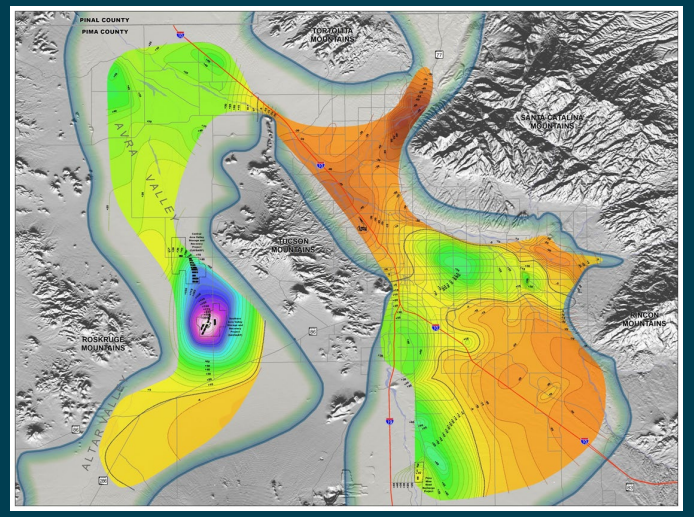
Cost-Share Partners



SAWUA Members

Tucson Basin Water Level Changes



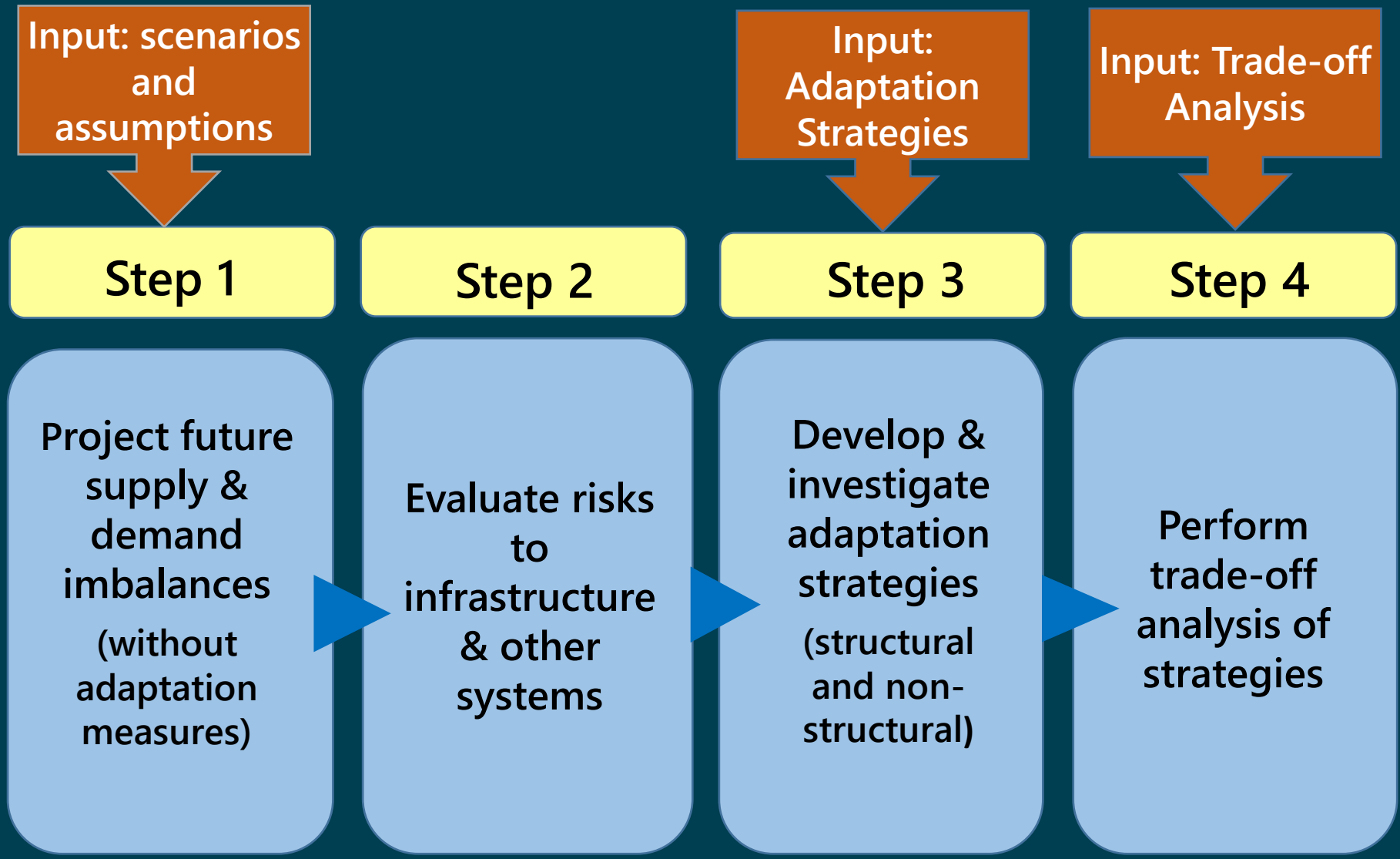


2000 - 2014

LSCR Basin Study Objectives

1) Identify Where Physical Water Resources are Needed to Mitigate Supply-Demand Imbalances

2) Develop Strategies to Improve Water Reliability for Municipal, Industrial, Agricultural and Environmental Sectors


Input: scenarios and assumptions
Input: Adaptation Strategies
Input: Trade-off Analysis
Step 1
Step 2
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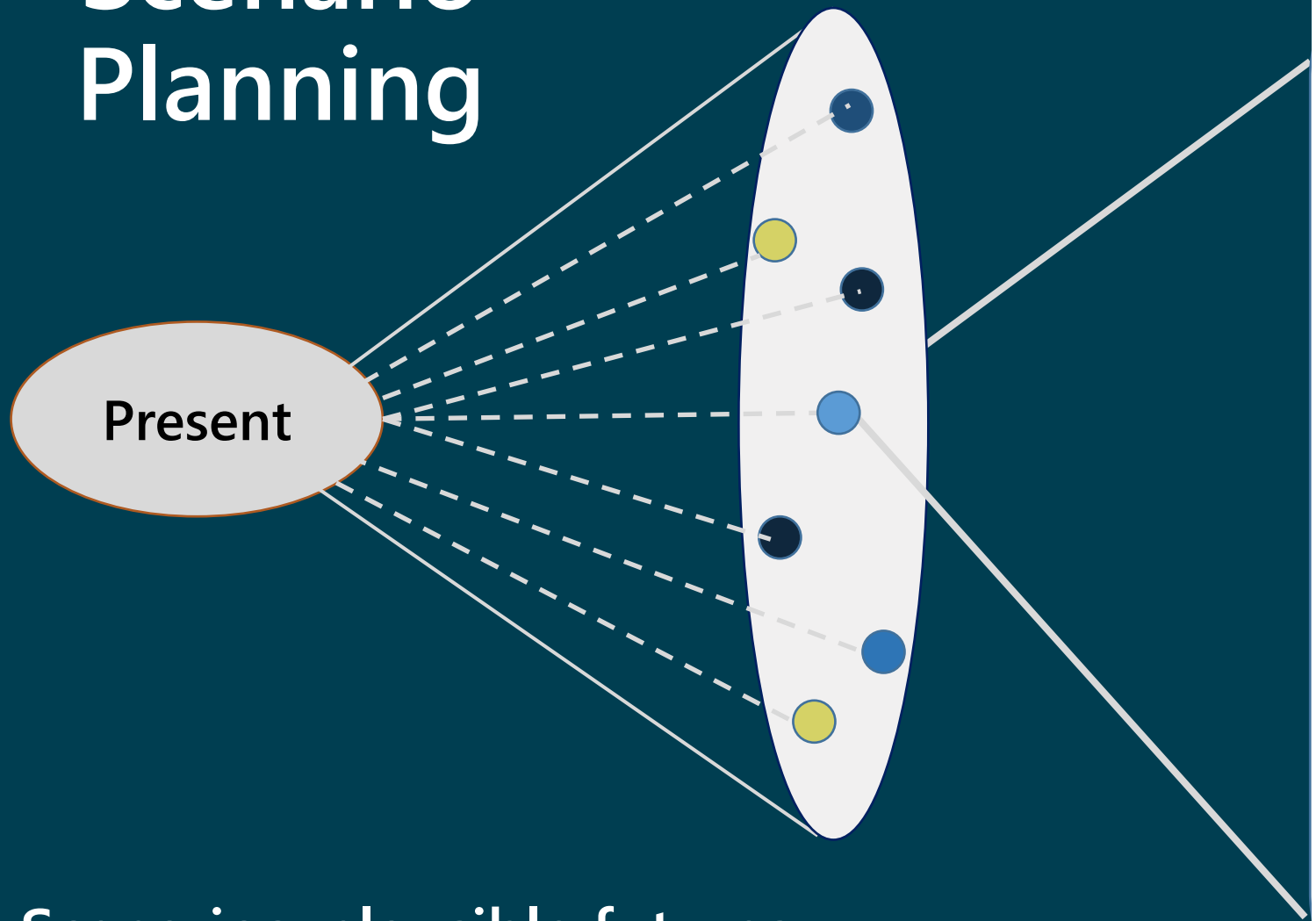
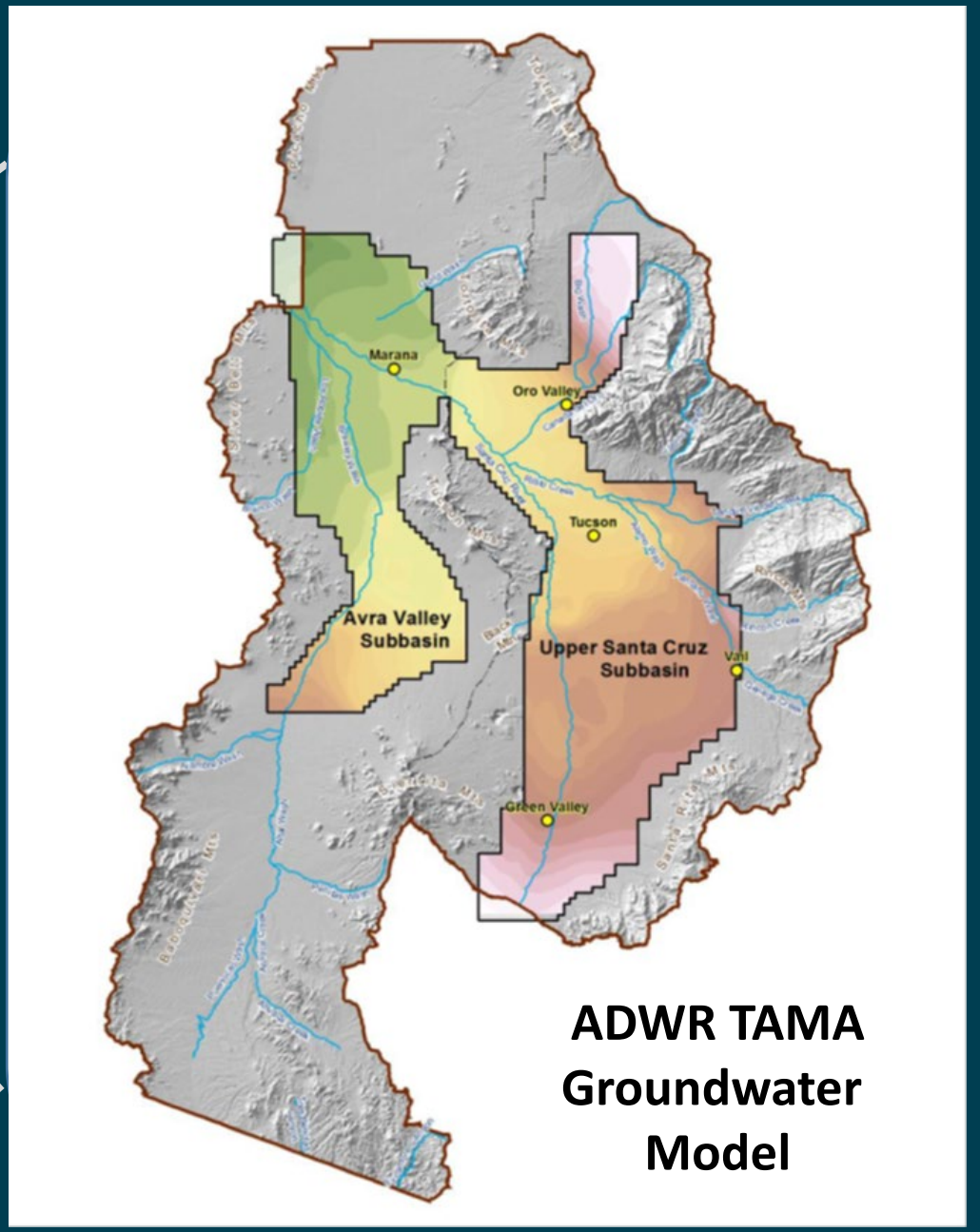
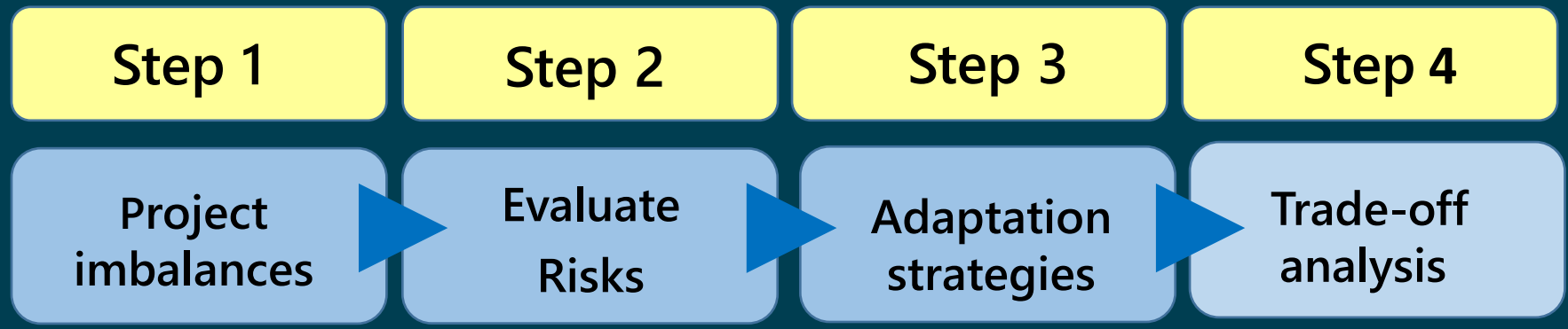
Project future supply & demand imbalances (without adaptation measures)
Evaluate risks to infrastructure & other systems
Develop & investigate adaptation strategies (structural and non-structural)
Perform trade-off analysis of strategies

Scenario Planning



Scenarios: plausible futures, based on consistent assumptions





Today's GW Modeling Results:
Future without Additional Adaptation

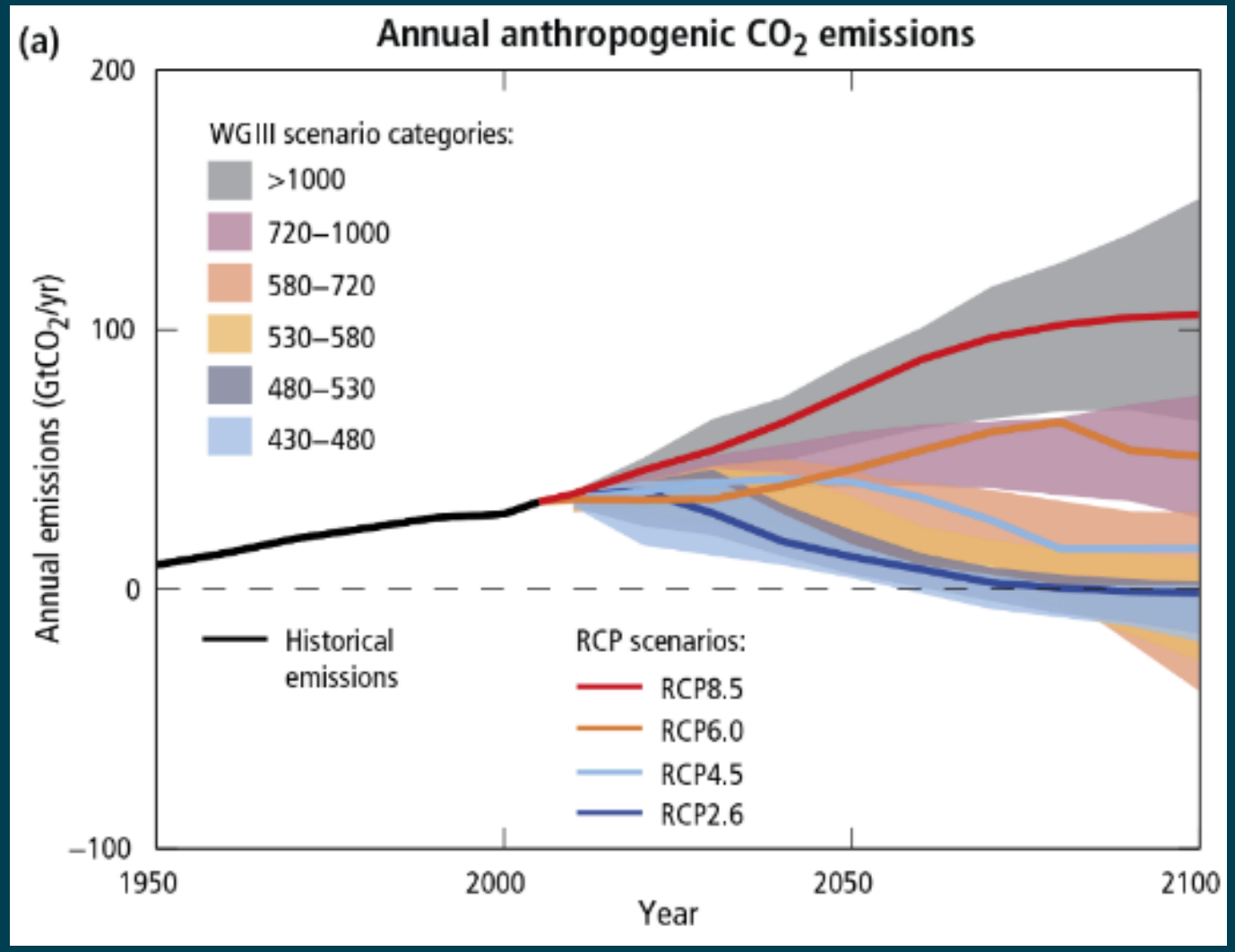
Future with Additional Adaptation

Benefits and Costs

Study Process and Scenario Planning

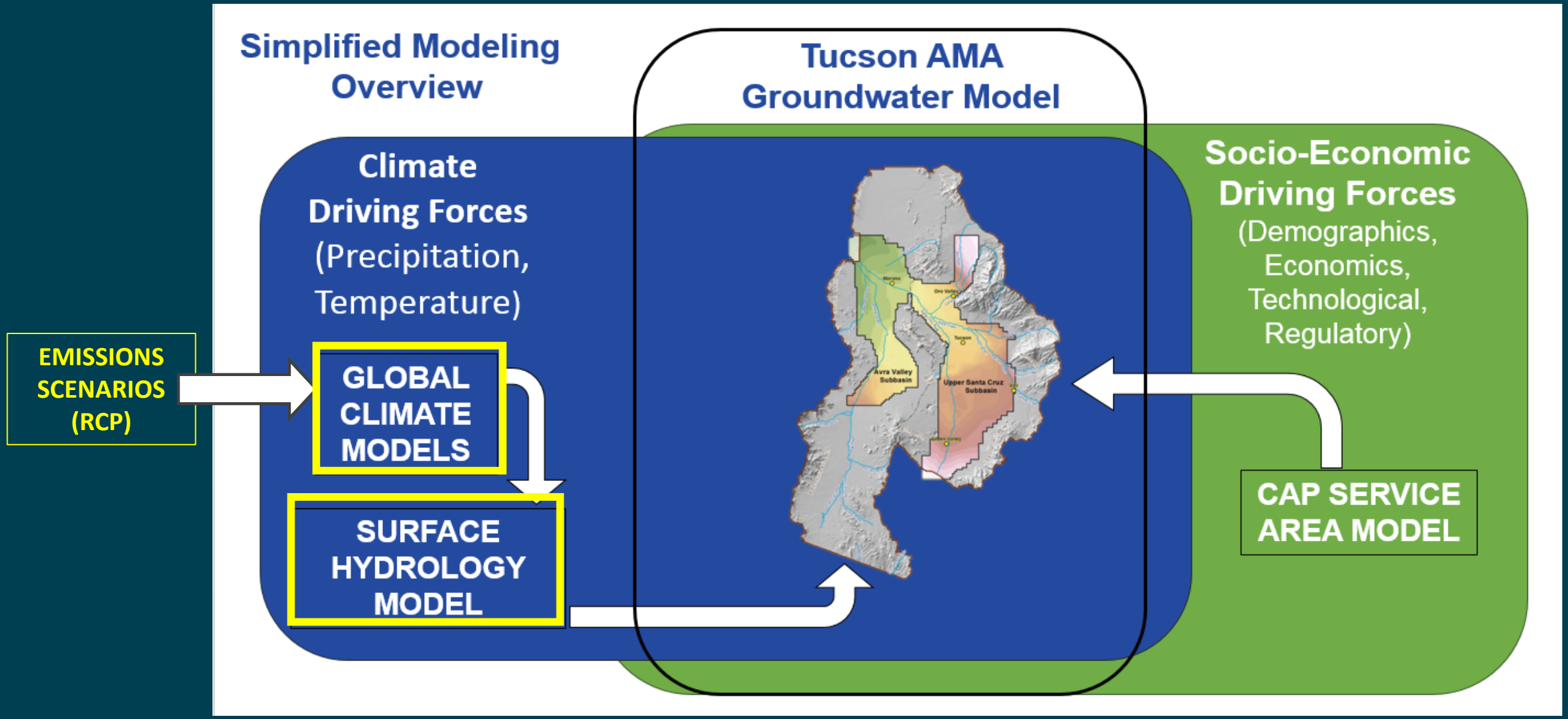
Representative Concentration Pathways (RCPs)

- Scenarios that include a time series of emissions and concentrations of the full suite of greenhouse gases.... •
- Used to compare results of climate models in an "apples to apples" manner



worse

best


Simplified Modeling Overview
Tucson AMA Groundwater Model
Climate Driving Forces (Precipitation, Temperature)
Socio-Economic Driving Forces (Demographics, Economics, Technological, Regulatory)
EMISSIONS SCENARIOS (RCP)
GLOBAL CLIMATE MODELS
SURFACE HYDROLOGY MODEL
CAP SERVICE AREA MODEL
Avra Valley Subbasin
Upper Santa Cruz Subbasin

Modeling Enhancements to address:

- Variability – Intra and Interannual
- Downscaling Issues
- Seasonality

Interannual Variability – Future Climate Analysis Periods

Historical: 1970-1999

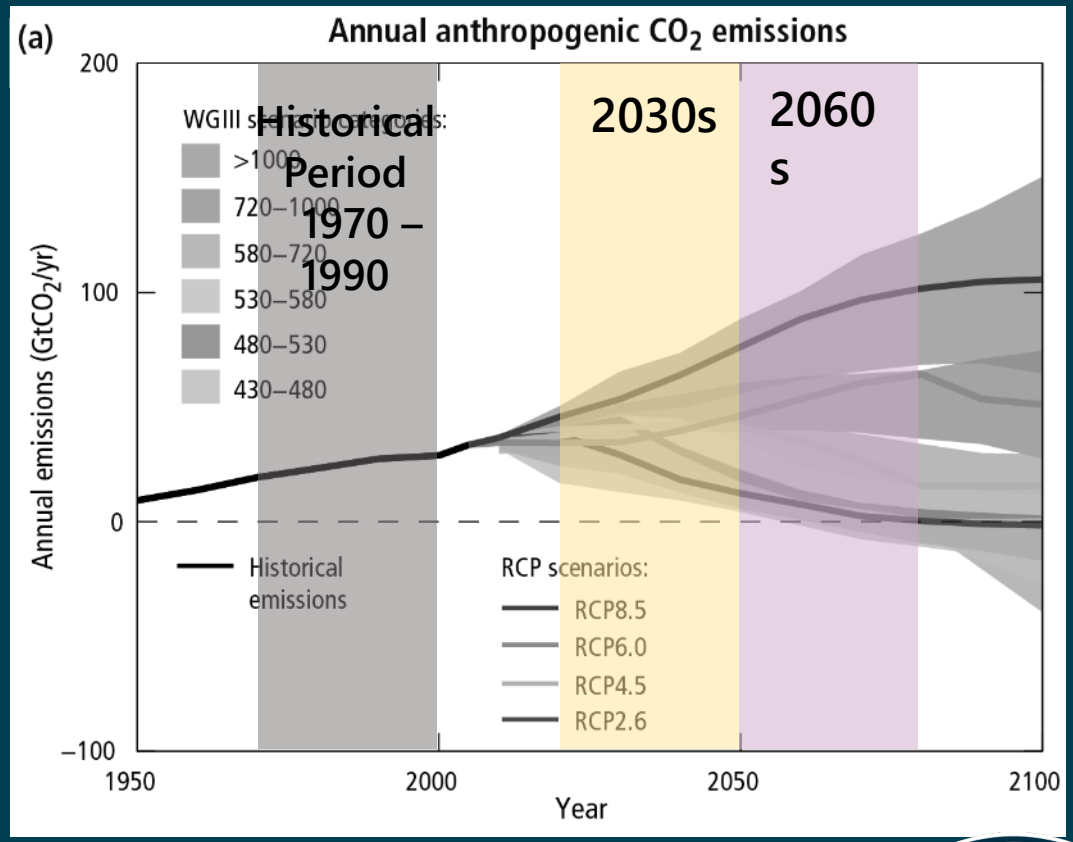
- SAC-SMA calibration period
- Prior to 2006 start of GCM "Futures"

"2030's" Future: 2020-2049

- Near future

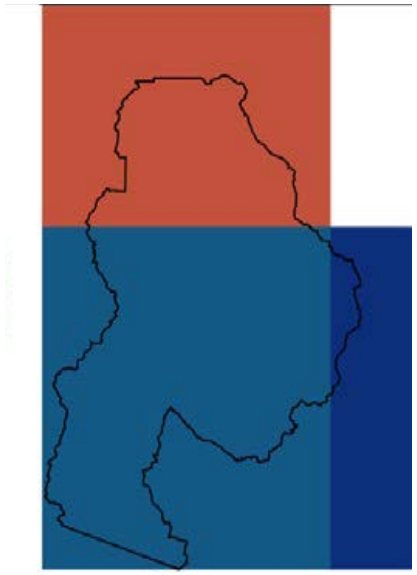
"2060's" Future: 2050-2079

- Far future
- Lower Santa Cruz study through 2060
- Aligns with Colorado River Basin Study analysis through 2060



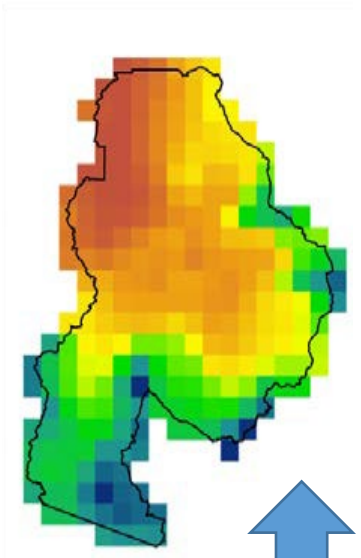
Study Uses Dynamically and Statistically Downscaled Climate Projections

Dynamical Downscaling uses GCM projection as input to a Regional Climate Model



Global Climate Model Projection

Regional Climate Model



Downscaled Climate Model Projection

Statistical Downscaling uses correlations between the GCM projection and historical observations

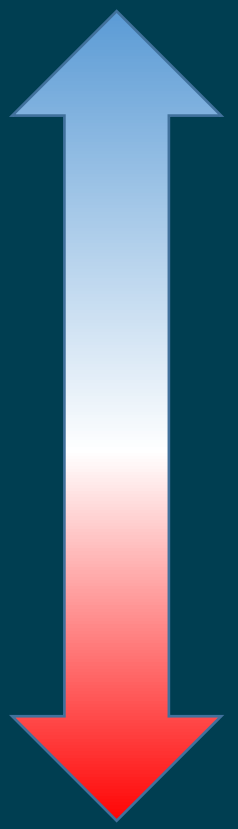
Climate Scenarios

Best Case:

- MPI Model using emissions scenario RCP 4.5
- Statistical Downscaling Type
- Downscaled Method: Localized Constructed Analogs (http://loca.ucsd.edu/)

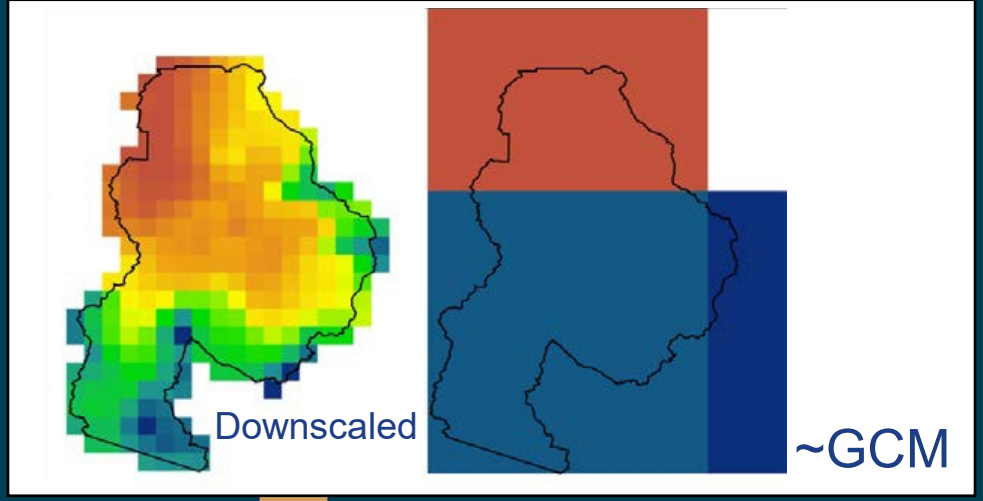
Worse Case:

- MPI Model using emissions scenario RCP 8.5
- Dynamical Downscaling Type
- Downscaled Method: Weather Research and Forecasting Model (https://www.mmm.ucar.edu/weather-research-and-forecasting-model)

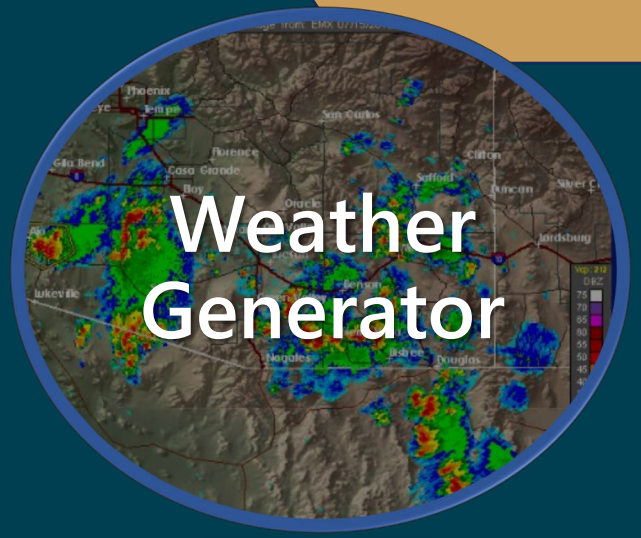


Modeling Configuration

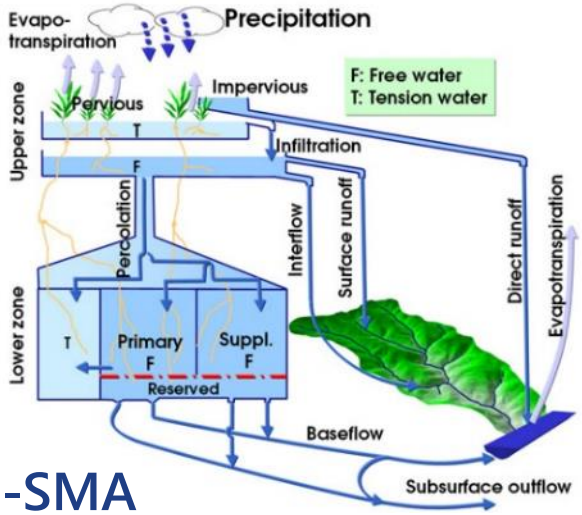
1. Climate Model



Precipitation & Temperature



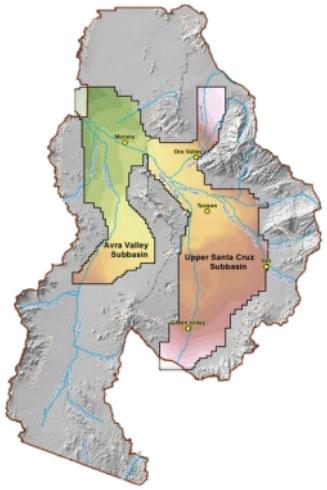
2. Surface Water Model



SAC-SMA

RECHARGE

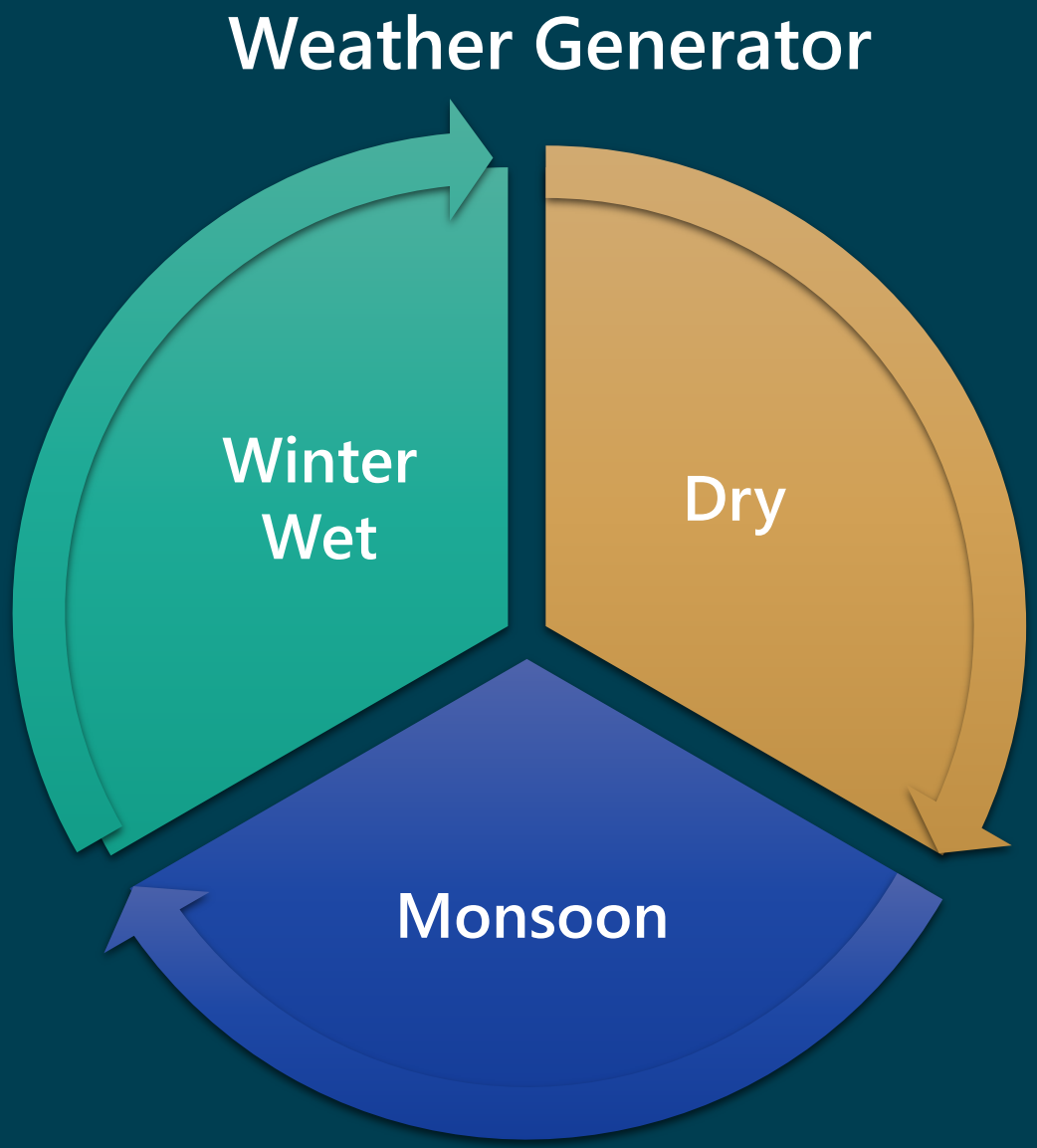
3. Groundwater Model



TAMA

Seasonality Variability

- Variability is a defining characteristic of local precipitation patterns
- Climate model projections do not reproduce this variability
- *Weather Generator* - technique to generate many plausible time series while preserving statistical properties of a distribution
- Weather Generator produces a probability distribution of future streamflow discharges



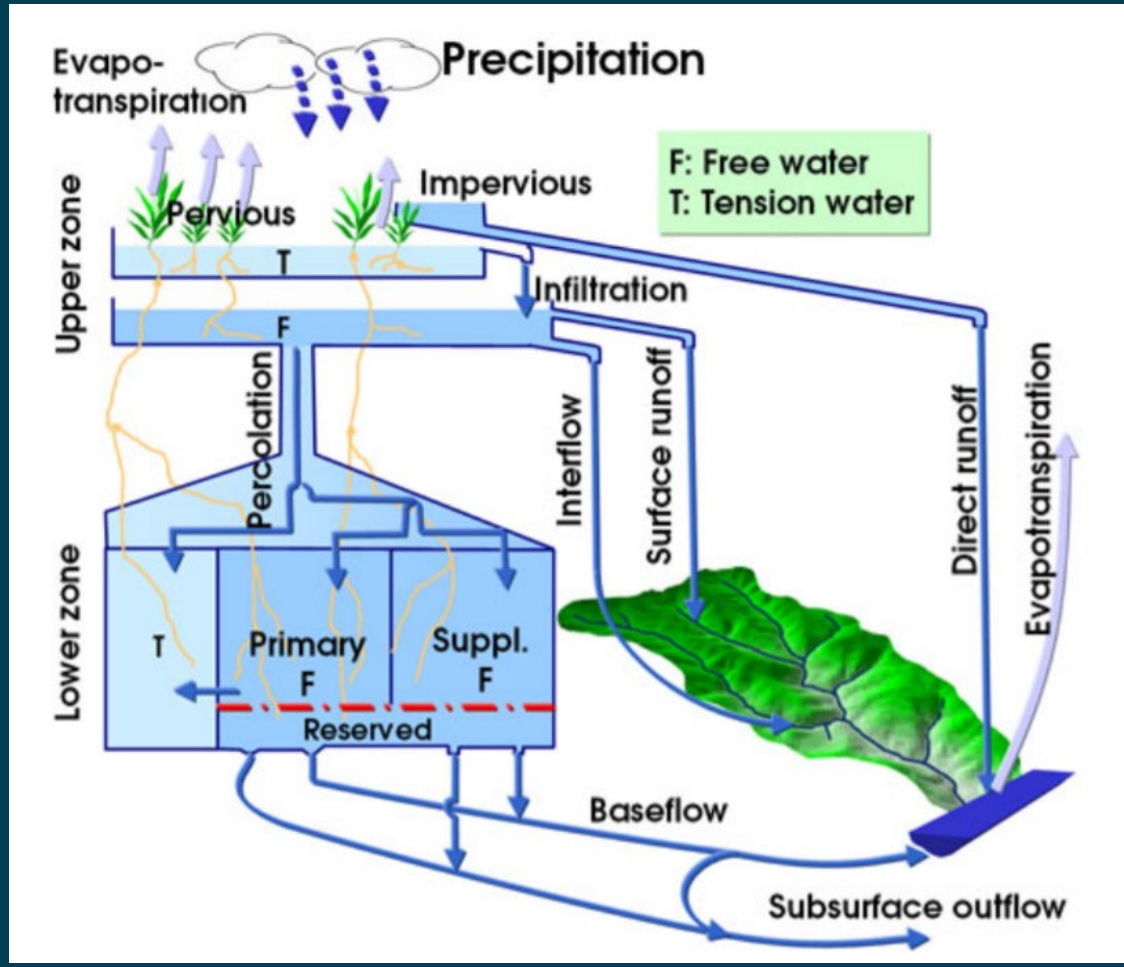
Climate Change Analysis Results - TAMA

Variable	Best Case – 2030's	Best Case – 2060's	Worse Case – 2030s	Worse Case – 2060s
Change in Annual Average Temperature	2.92^0 F	3.81^0 F	3.36^0 F	5.07^0 F
Change in Average Annual Precipitation	0.40 in.	-0.50 in.	-4.44 in.	-3.73 in.

Surface Water Basin Configuration

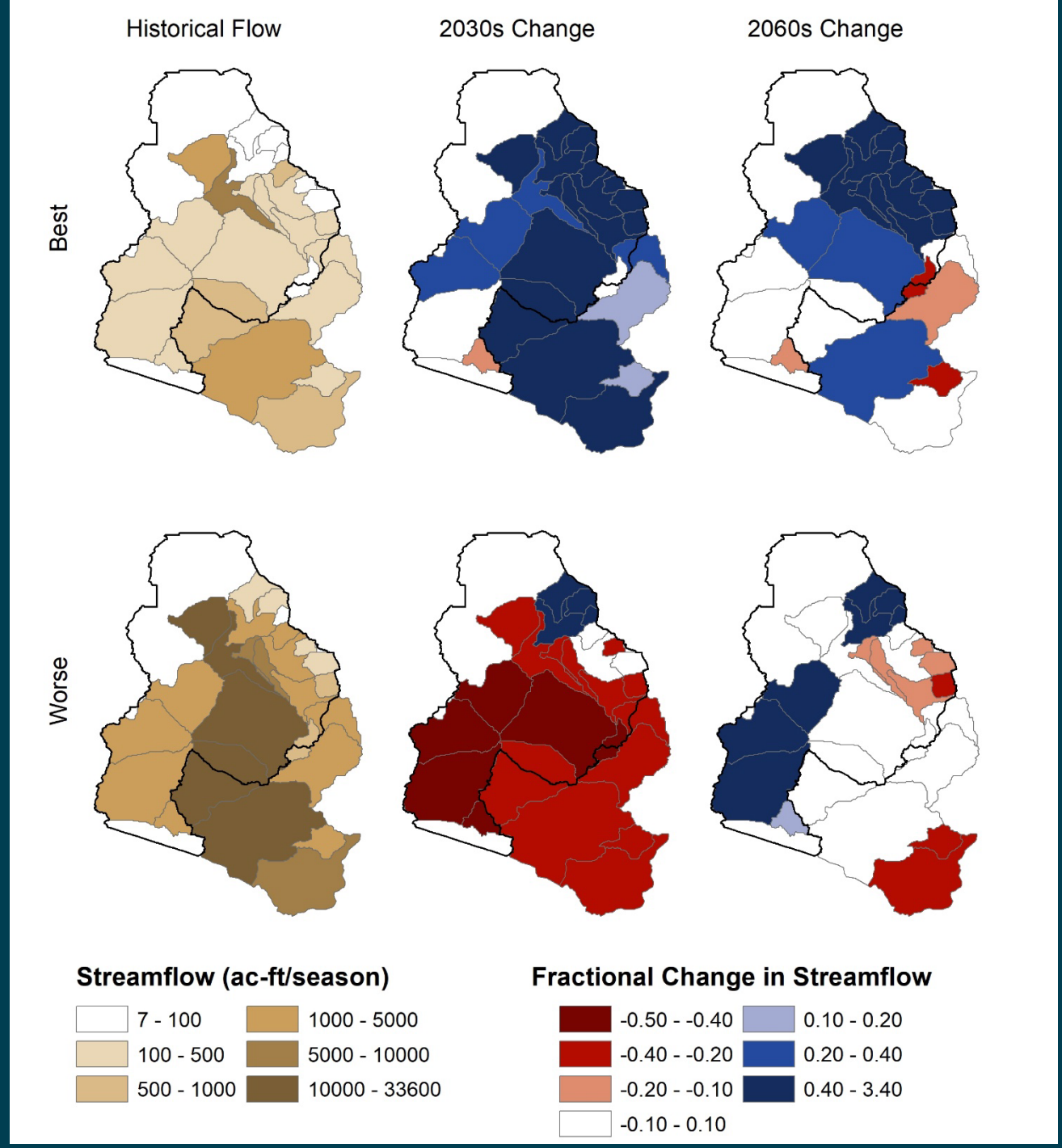
Surface Water Model

- SAC-SMA[1] model
- Simulates basin runoff and soil moisture
- Spatially Lumped based on mean basin inputs
  - Precipitation
  - Temperature
  - Potential evapotranspiration (ET) and outputs
  - Runoff
  - Base flow
  - Actual ET
- Daily & Continuous: has memory of previous soil moisture in system.



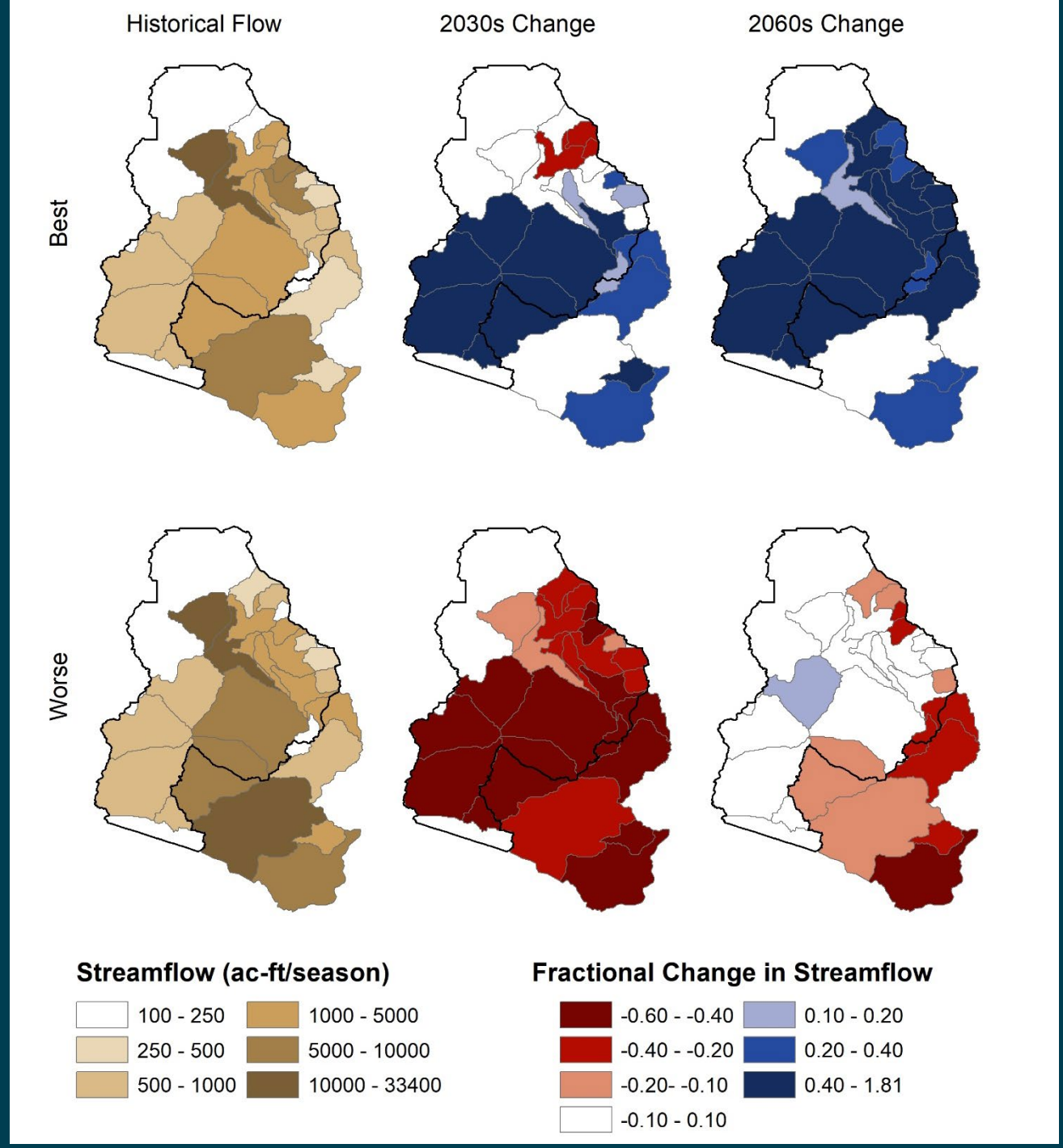
1. Colorado Basin River Forecast Center – SACramento Soil Moisture Accounting

Monsoon Season Spatial Streamflow Worse Case is drier



RECLAMATION

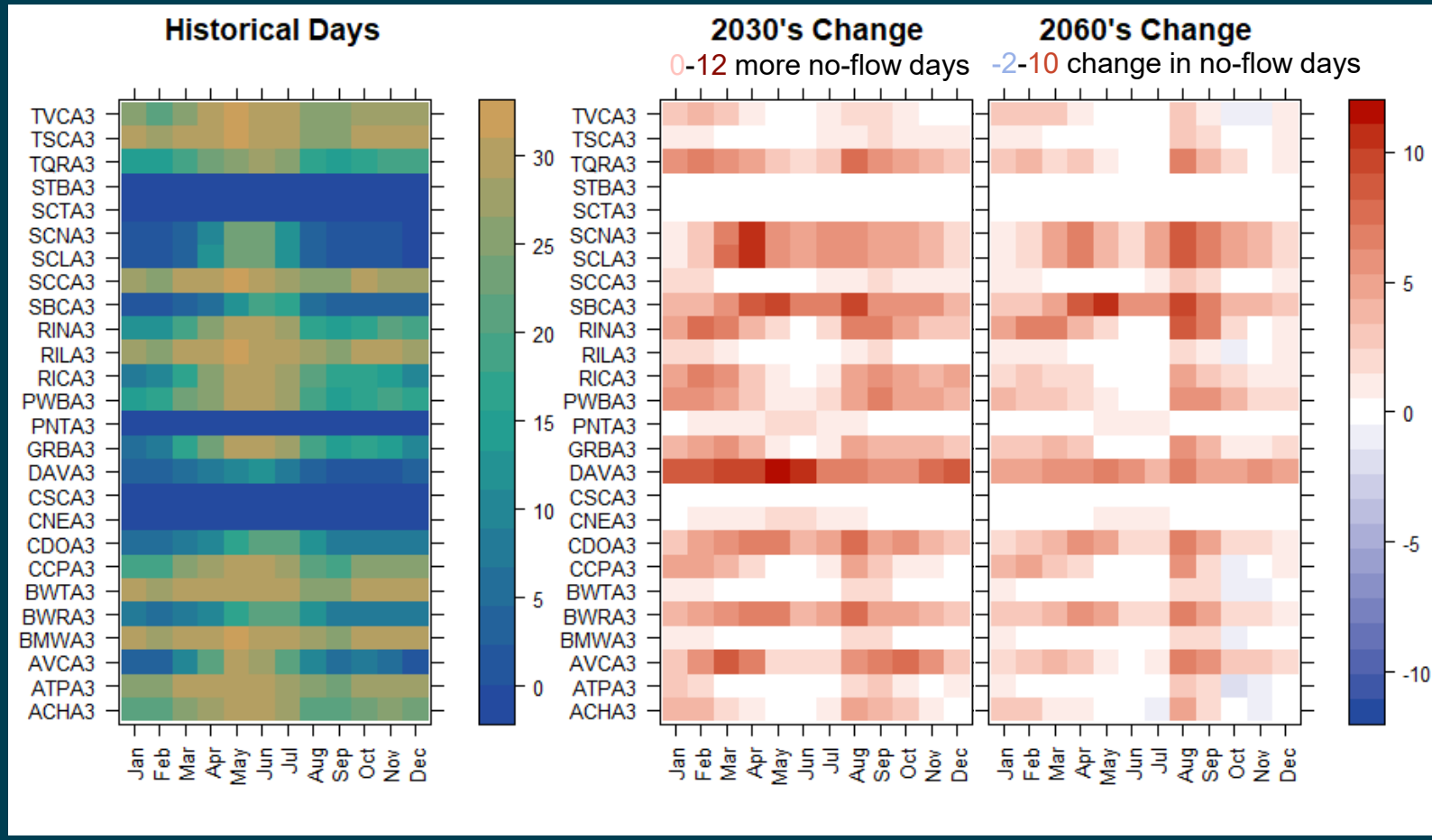
Winter Season Spatial Streamflow Worse Case is drier



RECLAMATION

More No-Flow Days under Worse Case

Davidson Canyon (DAVA3)	May	12
Davidson Canyon (DAVA3)	June	11
Santa Cruz nr Nogales (SCNA3)	April	10
Santa Cruz nr Lochiel (SCLA3)	April	10
Sabino Creek (SBCA3)	May	10

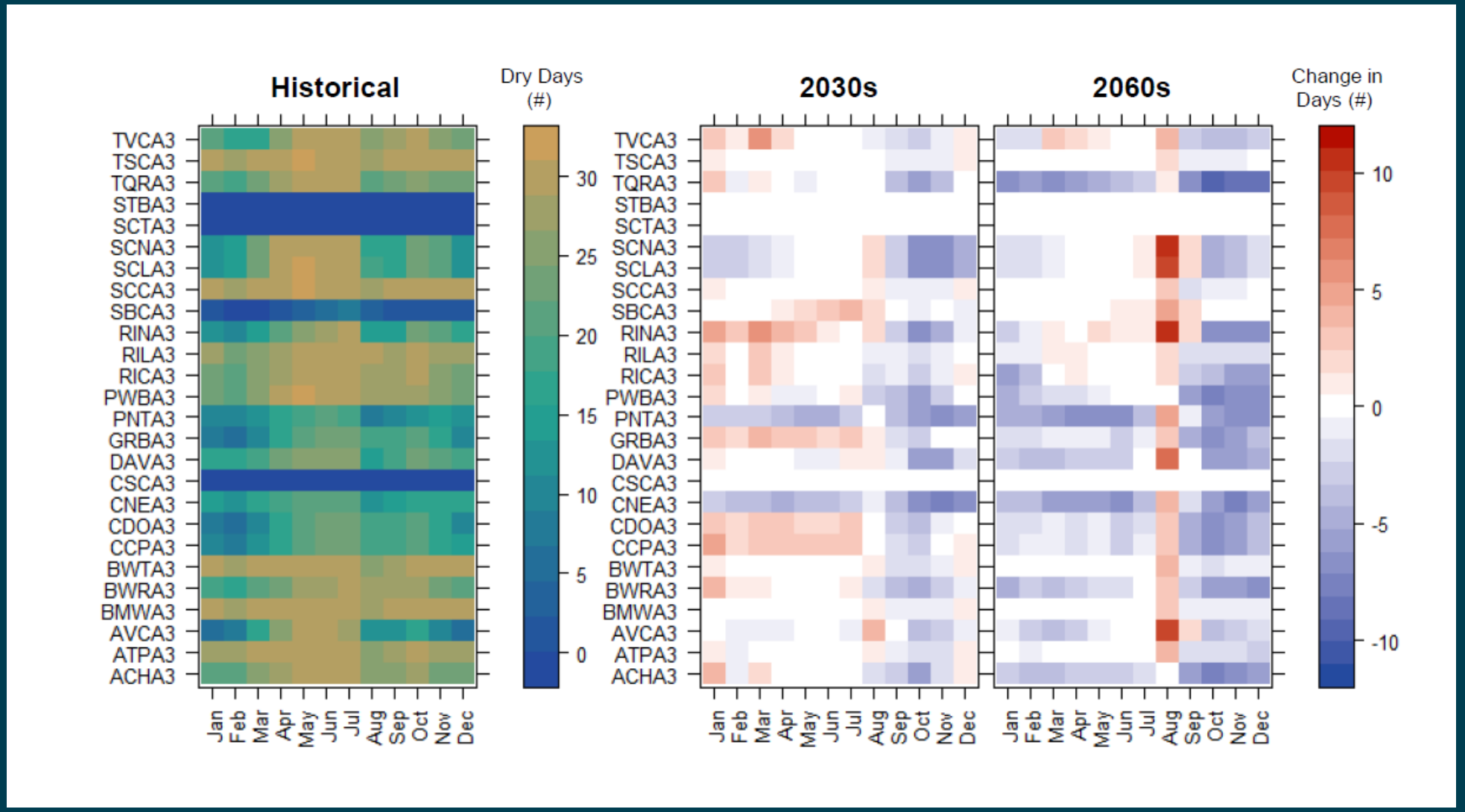


2030's - Top 5 increase in # of dry days

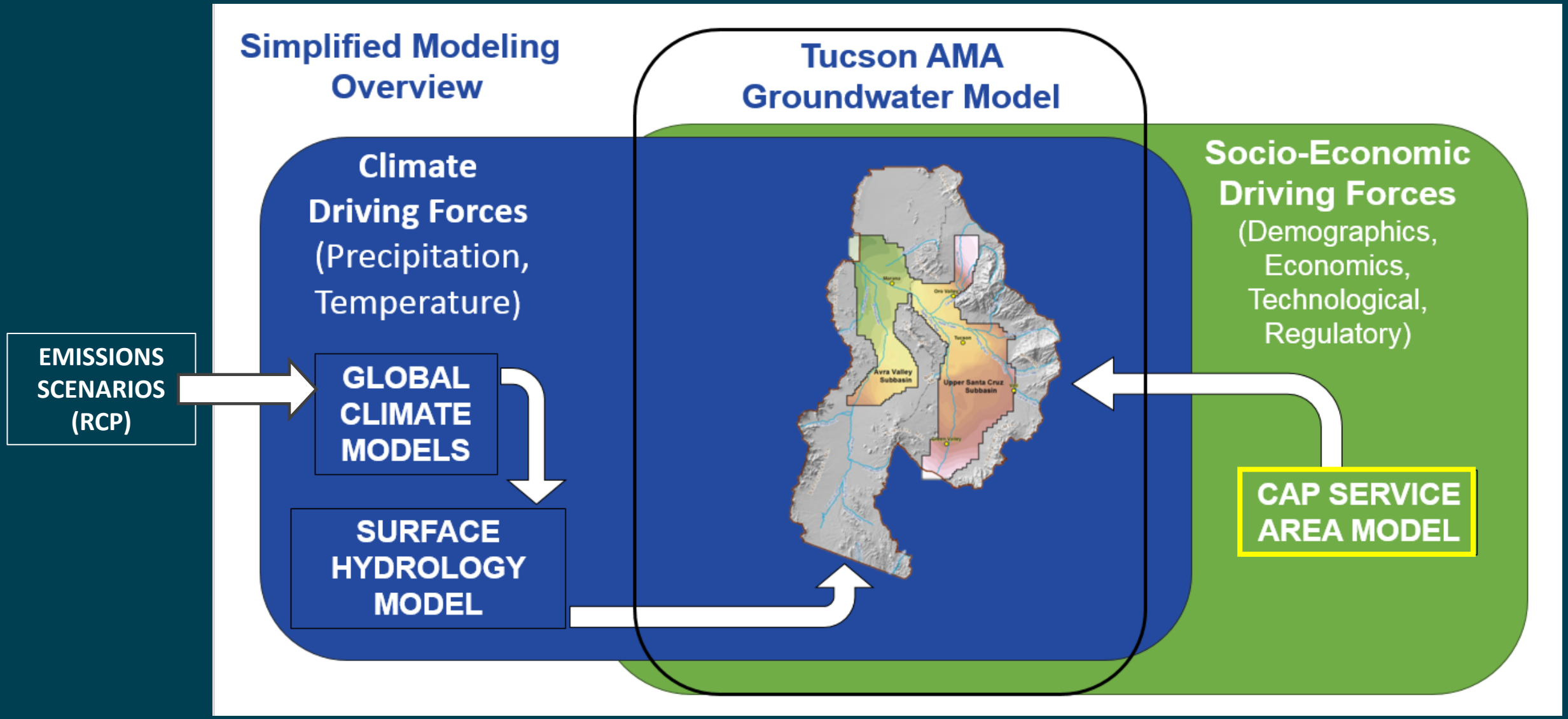
RECLAMATION

Change in No-Flow Days

Best Case



Simplified Modeling Overview



Socio-Economic Modeling

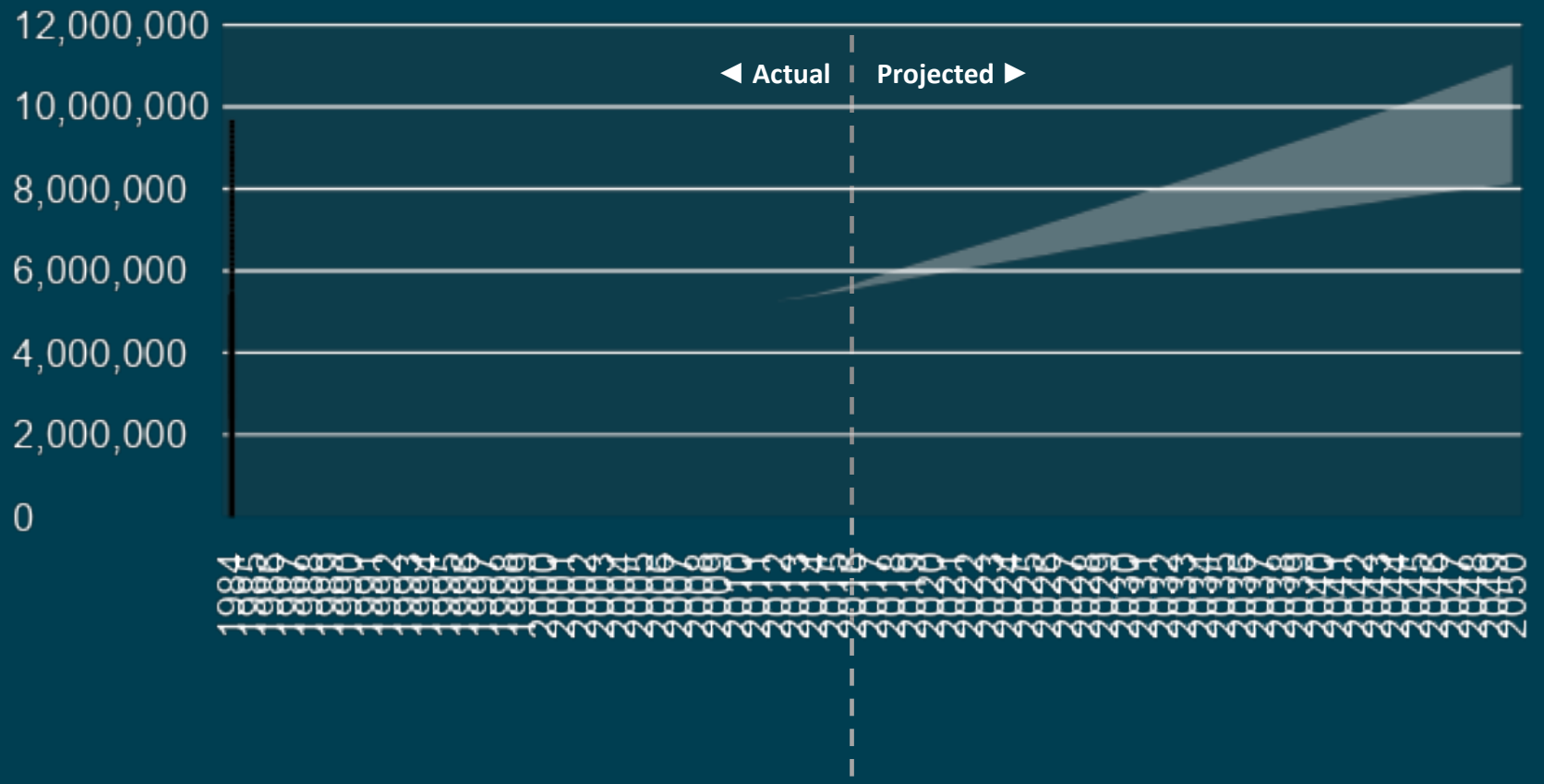
Factors that Affect Water Supply and Demand

- Population Growth
- CAP Shortages
- Climate
- Socioeconomics
- Sector Trends
- Policy Changes
- Behavioral Shifts

"Driving Forces"

Growth Rate

AZ Department of Administration (Low, Med, High Series)



3 Growth Scenarios

Official State Projections:

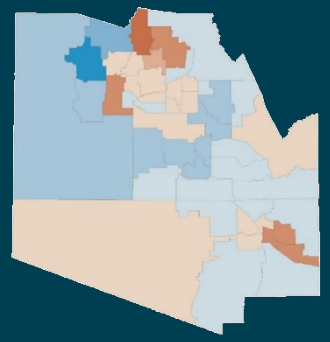
- Based on medium growth series
- Baseline growth pattern

Slow Compact Growth:

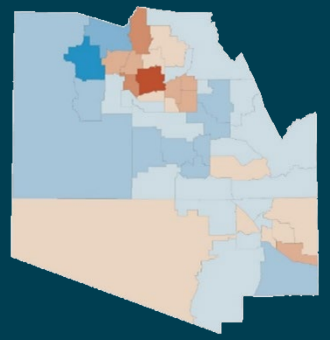
- Low growth series
- In-Fill/Redevelopment
- Water Providers with renewable water

Rapid Outward Growth:

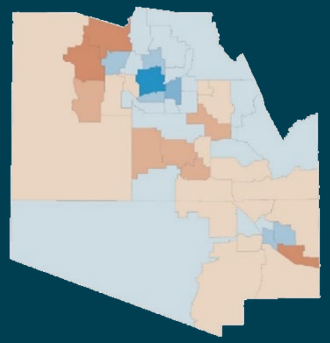
- High growth series
- Outward development
- Higher dependence on groundwater



Redevelopment

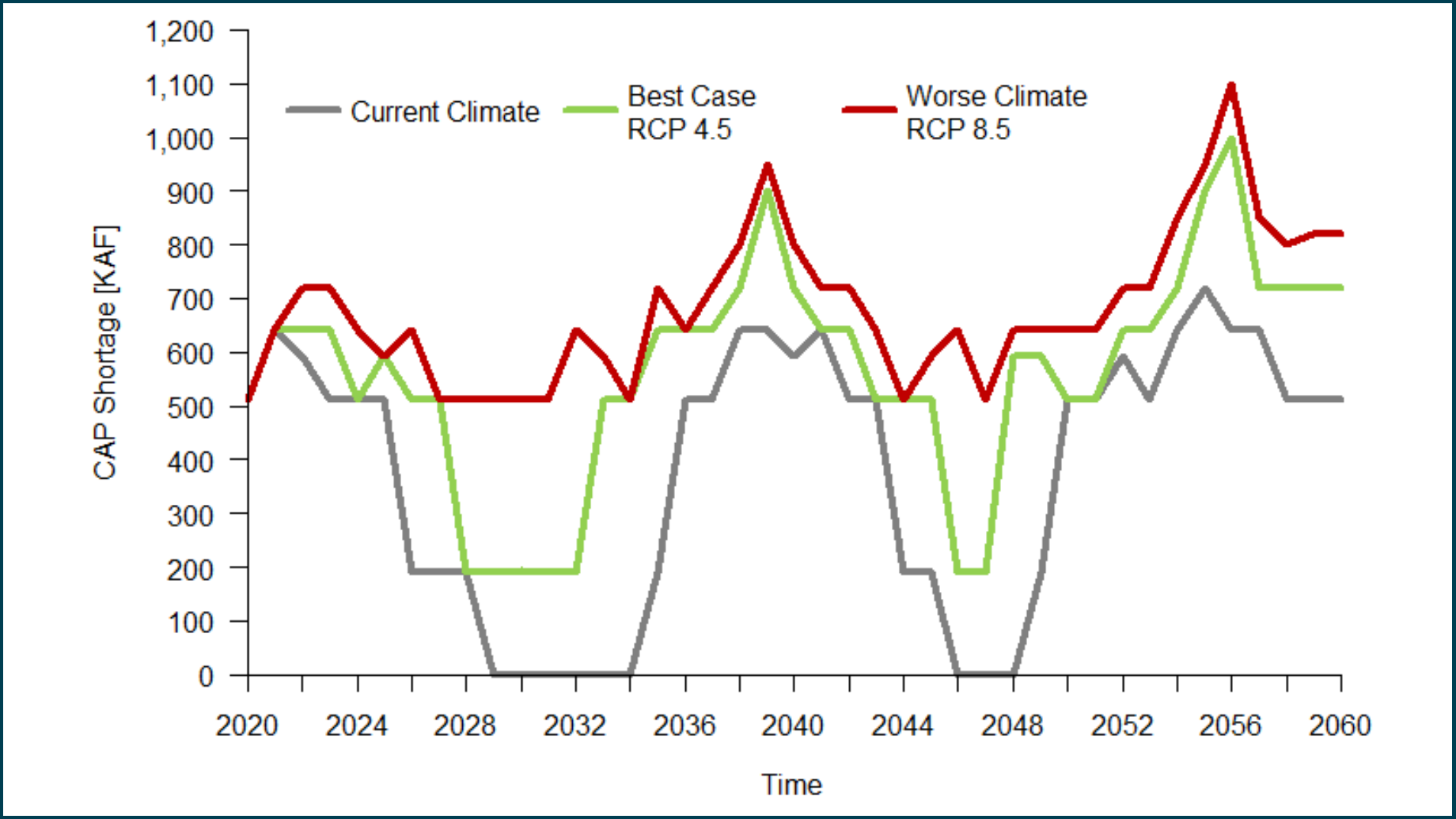


Infill



Outward Growth

Simulated CAP Shortages



"Synthetic" shortage sequences simulate periods of reduced supply and test system resilience

Six Scenarios

A. *Official Projections*: Medium, mixed-density growth and Current climate

B. Slow, compact growth and *Best Case* climate

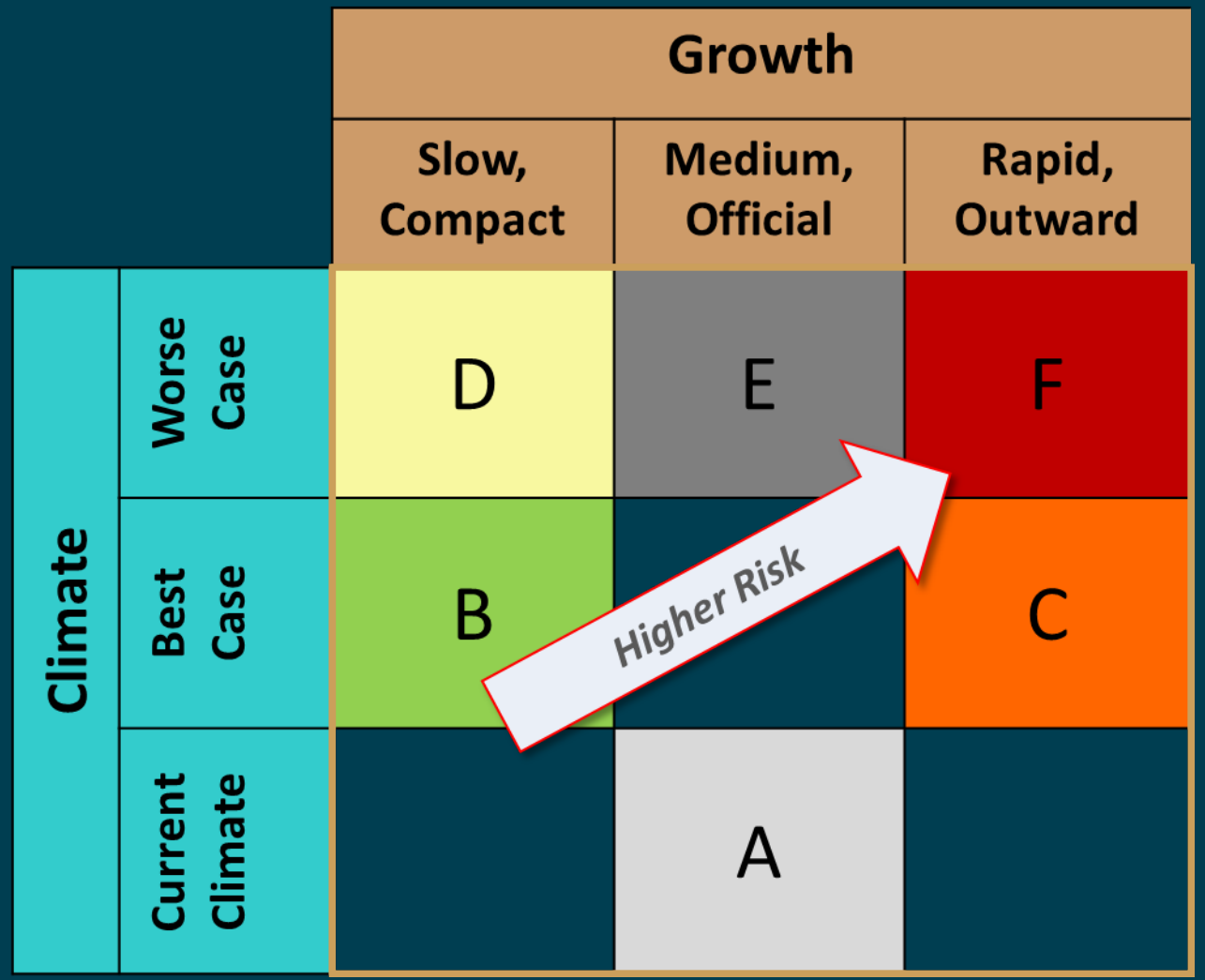
C. Rapid, outward growth and *Best Case* climate

D. Slow, compact growth and *Worse Case* climate

E. Official Projections and *Worse Case* climate

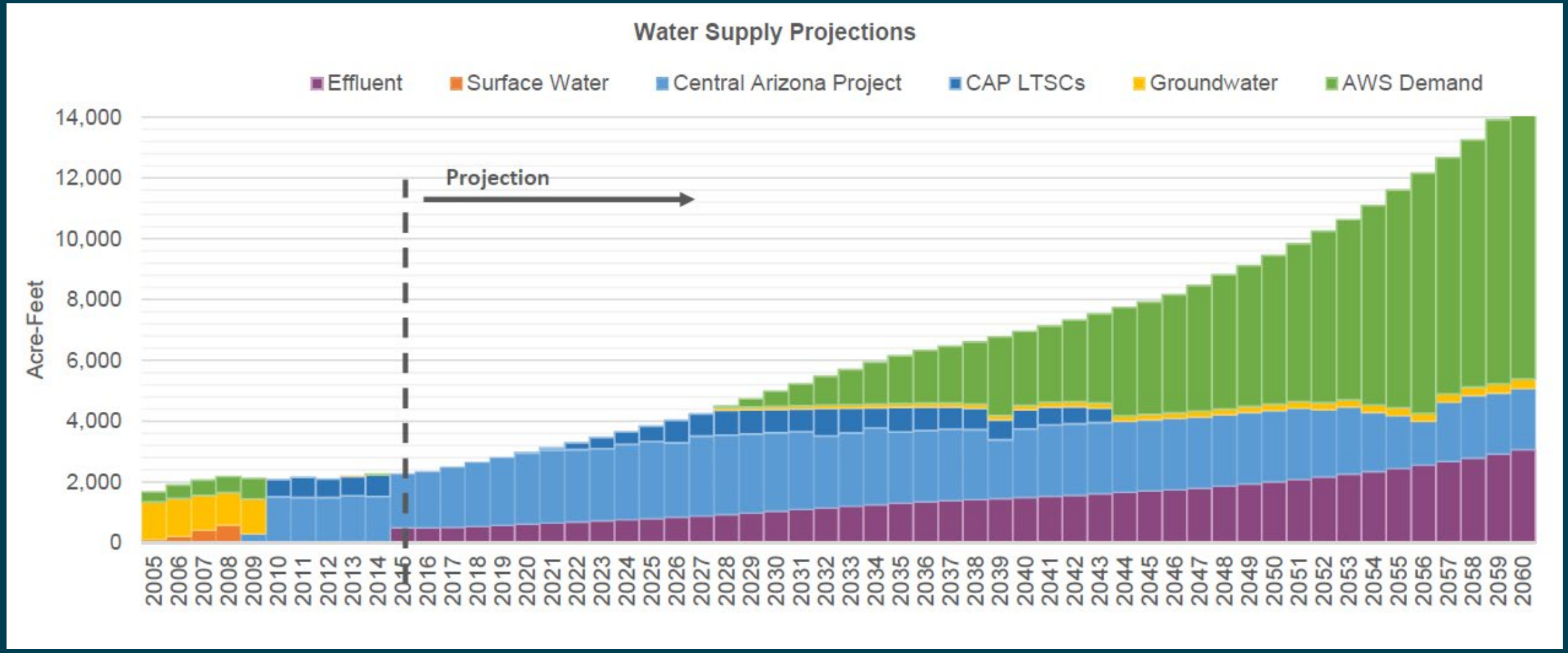
F. Rapid, outward growth and *Worse Case* climate

2018-05-08



CAP Service Area Model – CAP:SAM

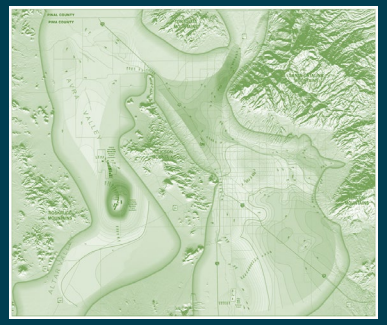
- Model Runs for six Climate-Growth Scenarios and 26 Water Providers



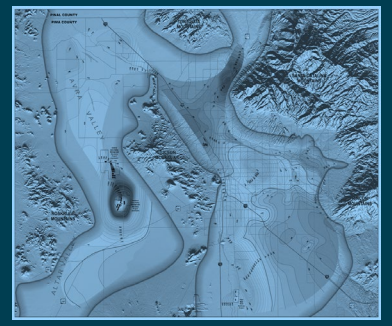
Project Supply/Demand Imbalances

- Surface Water Model Inputs
- CAP:SAM Inputs
- Run Groundwater Model under Six Scenarios
- Identify Where Imbalances Occur

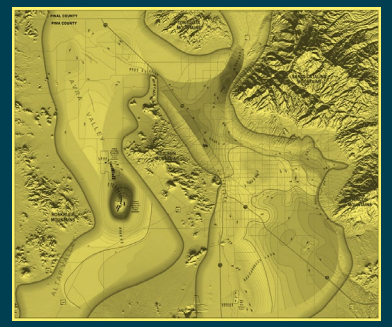
Scenario A



Scenario D

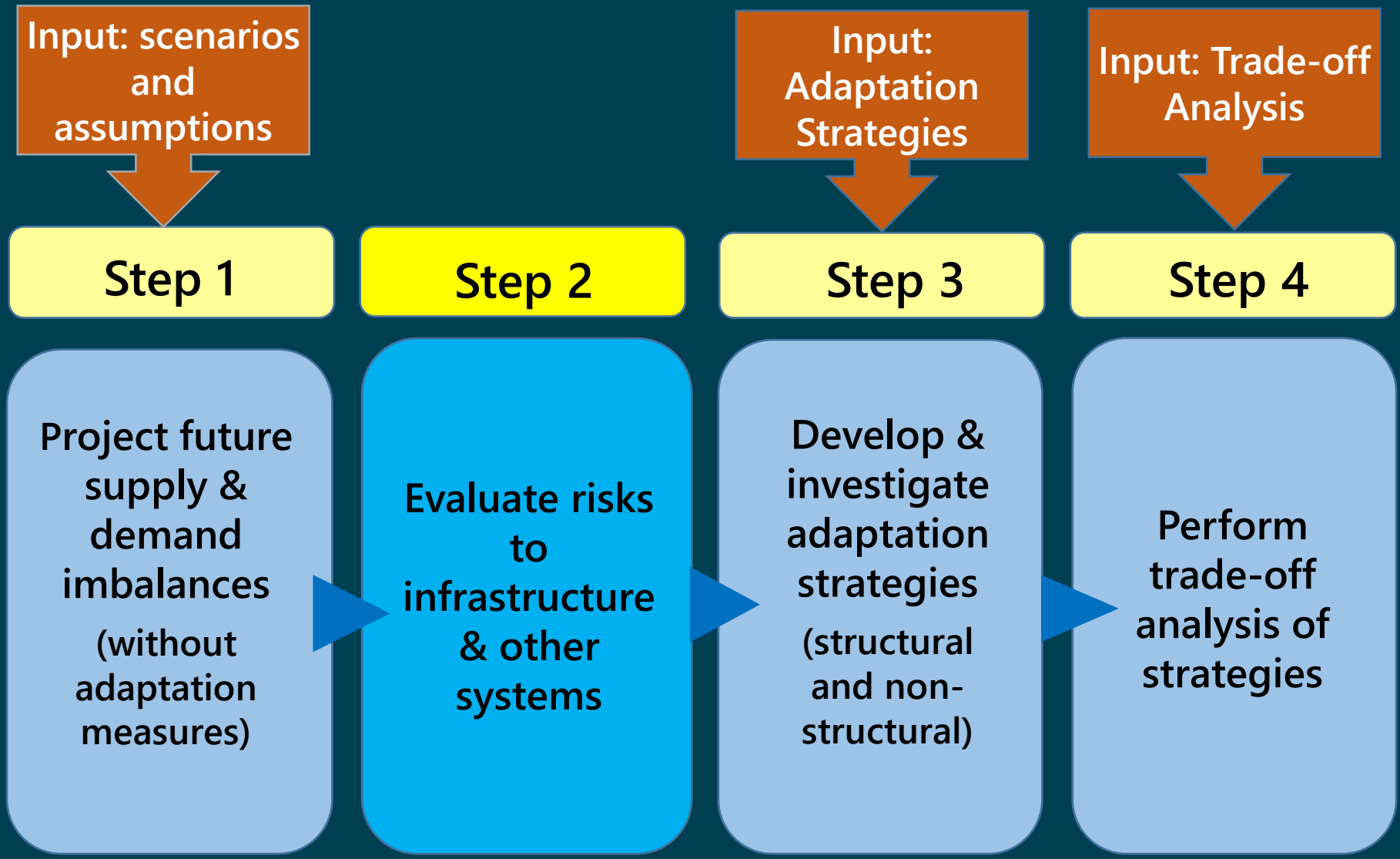


Scenario B



Scenario E

Scenario F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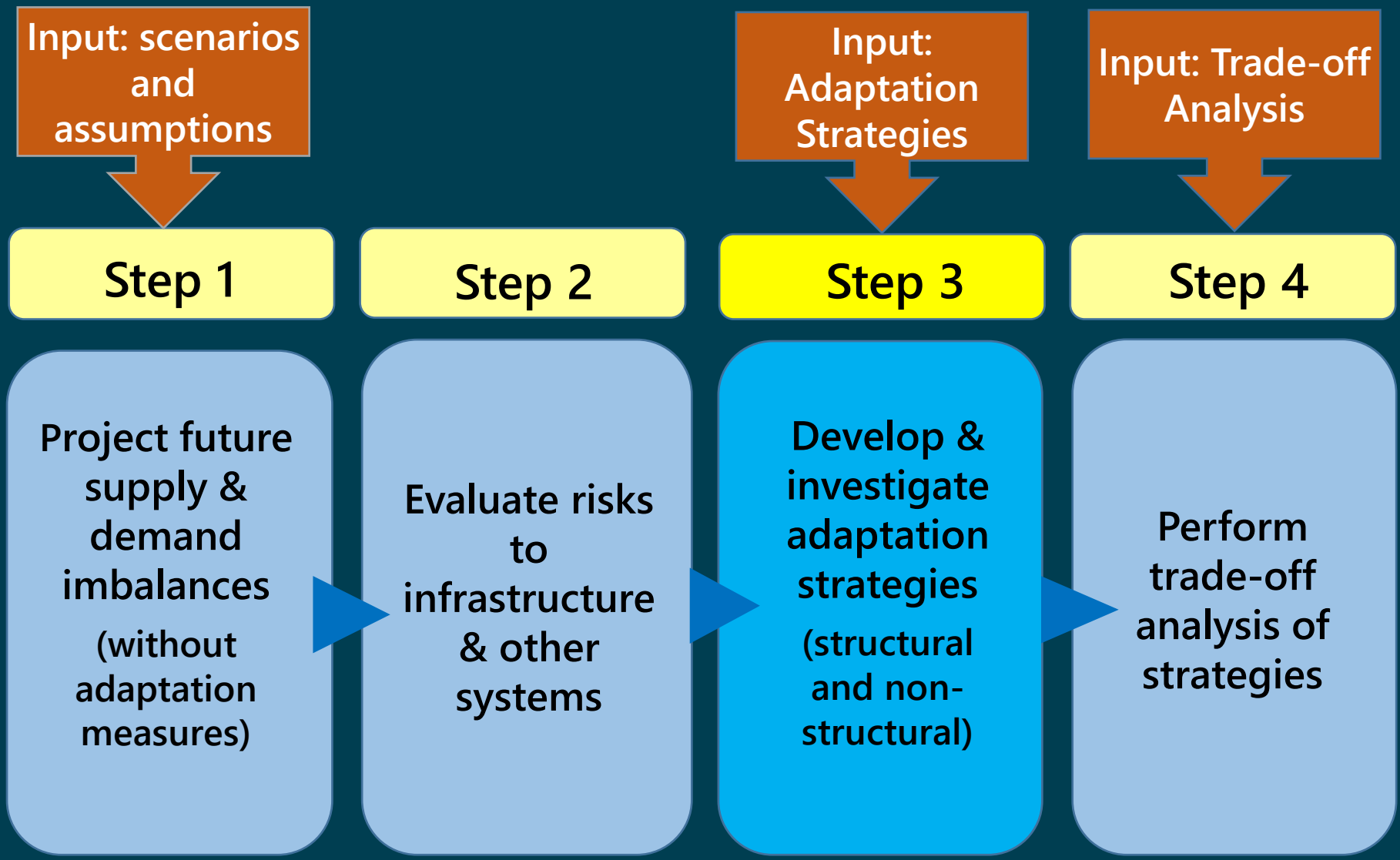
Reliability Analysis
Risk to Infrastructure and other Systems

- Identify Reliability Metrics
- Baseline Analysis
- Future Reliability
- Supply Risks for
  - Municipal
  - Industrial
  - Agricultural
  - Environmental
- Impacts to Safe Yield
- Infrastructure capacity
- Recovery of Stored Water
- Risk of pumping in areas prone to subsidence
- Risk to groundwater dependent ecosystems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Adaptation Strategies – Workshop 1

November 21, 2019

- Local cost share partners, technical sub-teams and stakeholder advisors
- Based on known areas vulnerable to declining groundwater
- To be applied to groundwater model to assess impact to water supply & demand imbalances

Categories

- Shallow Groundwater & Environmental
- Wastewater/Reclaimed Water
- CAP Water
- Agriculture & Landscape
- Infrastructure
- Policy
- Mountainous Regions
- Low Impact Development

Trade-off Analysis Process

- Brainstorm large number of alternatives
- If necessary, group into categories (e.g. conservation, groundwater storage, etc.)
- Develop screening criteria to narrow down to a few for detailed investigation
- Compare alternatives using previously agreed upon evaluation criteria
- Rate/Score alternatives if desired

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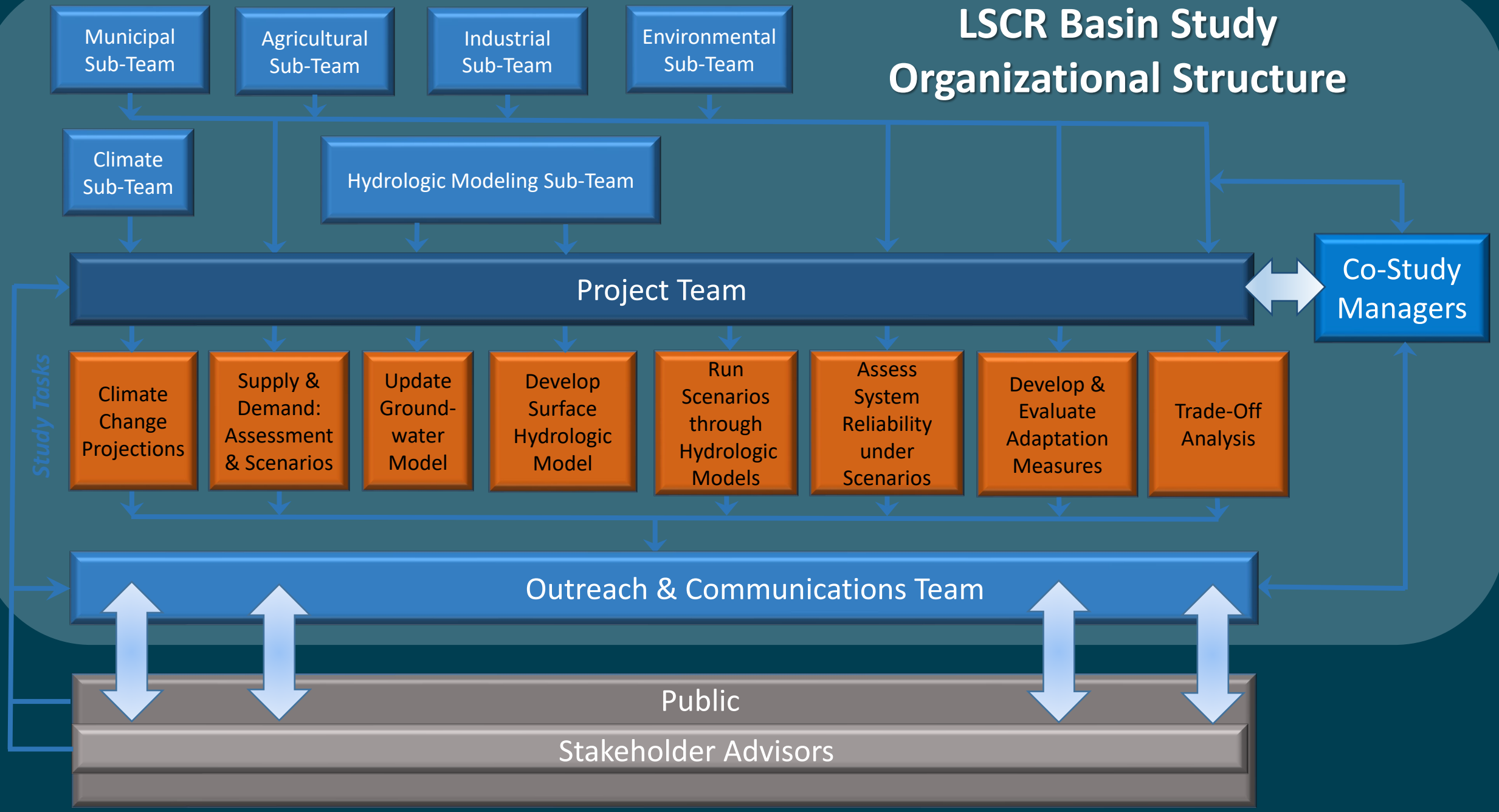
Organization

Outreach

Participation

LSCR Basin Study Organizational Structure



Project Website:

http://www.usbr.gov/lc/phoenix/programs/lscrbasin/LSCRBStudy.html or www.sawua.org

Project Email:

bor-pxa-lscrbs@usbr.gov