

# RECLAMATION

*Managing Water in the West*

**Effects of Climate Uncertainty**

on the

**Development and Evaluation**

of

**Adaptation Strategies**

**Michael Tansey – Bureau of Reclamation**

**California Water Board Symposium**

**June 20, 2018**



U.S. Department of the Interior  
Bureau of Reclamation

# Acknowledgements

## ➤ Reclamation

- Katharine Dahm (Co-author) & Amanda Erath – Policy Office Program Manager
- Arlan Nickel – MP Basin Study Program Manager

## ➤ CH2M Hill

- Brian Van Lienden & Derya Sumer – CVP/SWP operations, WMA analysis
- Tapash Das & Armin Munevar – Climate Projections and GHG emissions

# Central Valley System

## ➤ Water Supplies

- Managed inflows ~ 25 MAF/yr (10 – 55)
- Groundwater ~ 2 – 5 MAF/yr

## ➤ Water Demands

- Agricultural ~ 18 - 27 MAF/yr
- Municipal ~ 2.2 MAF/yr
- Environmental ~ 1.2 MAF/yr
- Out-of-Basin ~ 1 - 2 MAF/yr

## ➤ Infrastructure

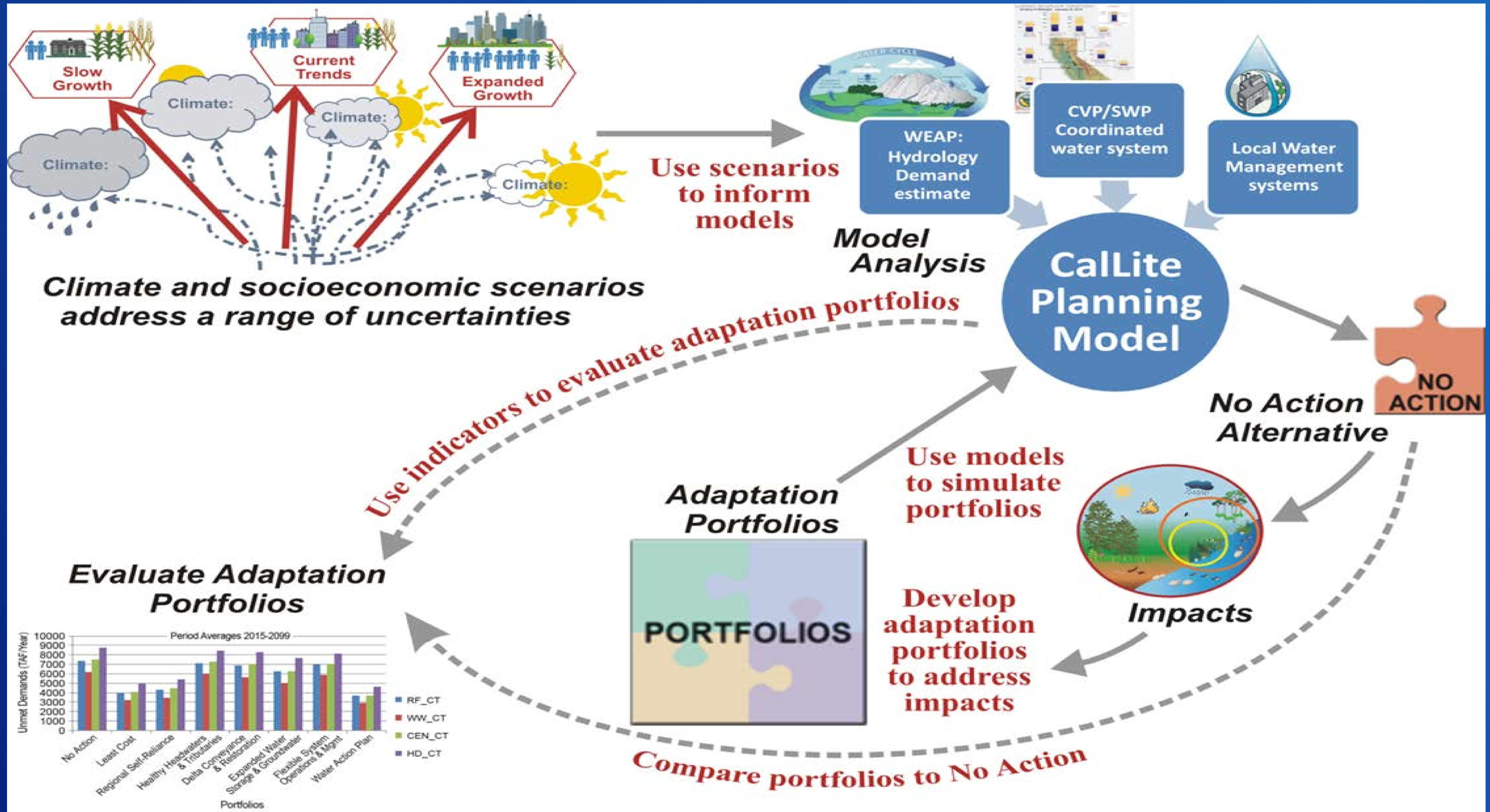
- Major Reservoirs ~ 25 (CVP/SWP/COE/Others)
- Canals & pipelines ~ 1200 miles (CVP/SWP)
- Hydropower generation plants ~ 20 CVP/SWP
- Major pumping facilities ~ 15 (CVP/SWP)

## ➤ Operations

- CVP/SWP Coordinated
- Biological Opinions – Multiple ESA species
- Water quality – Temperature & salinity
- Instream flows
- Water rights
- Flood control

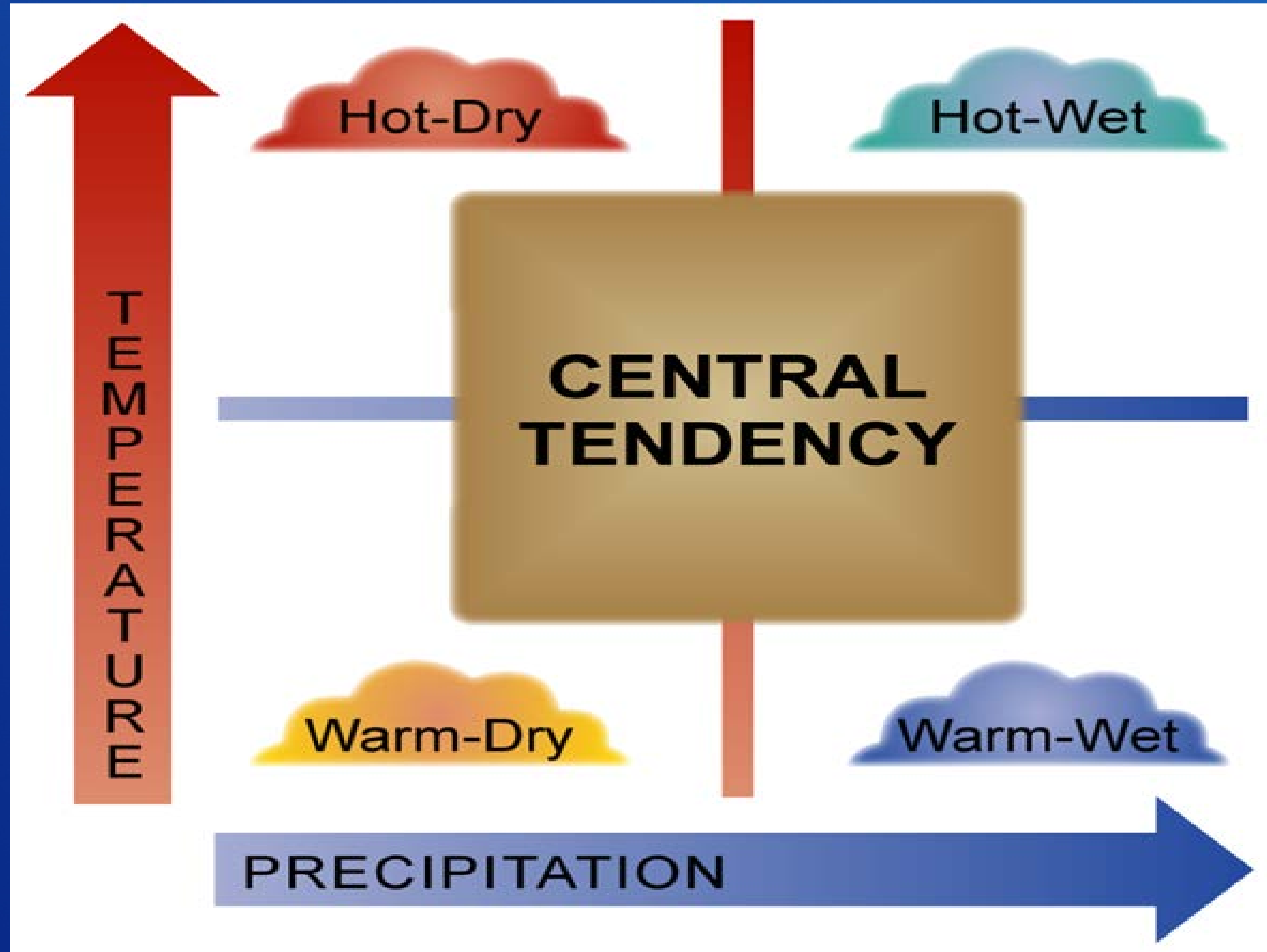


# Technical Approach



# Climate & Sea Level Rise Scenarios

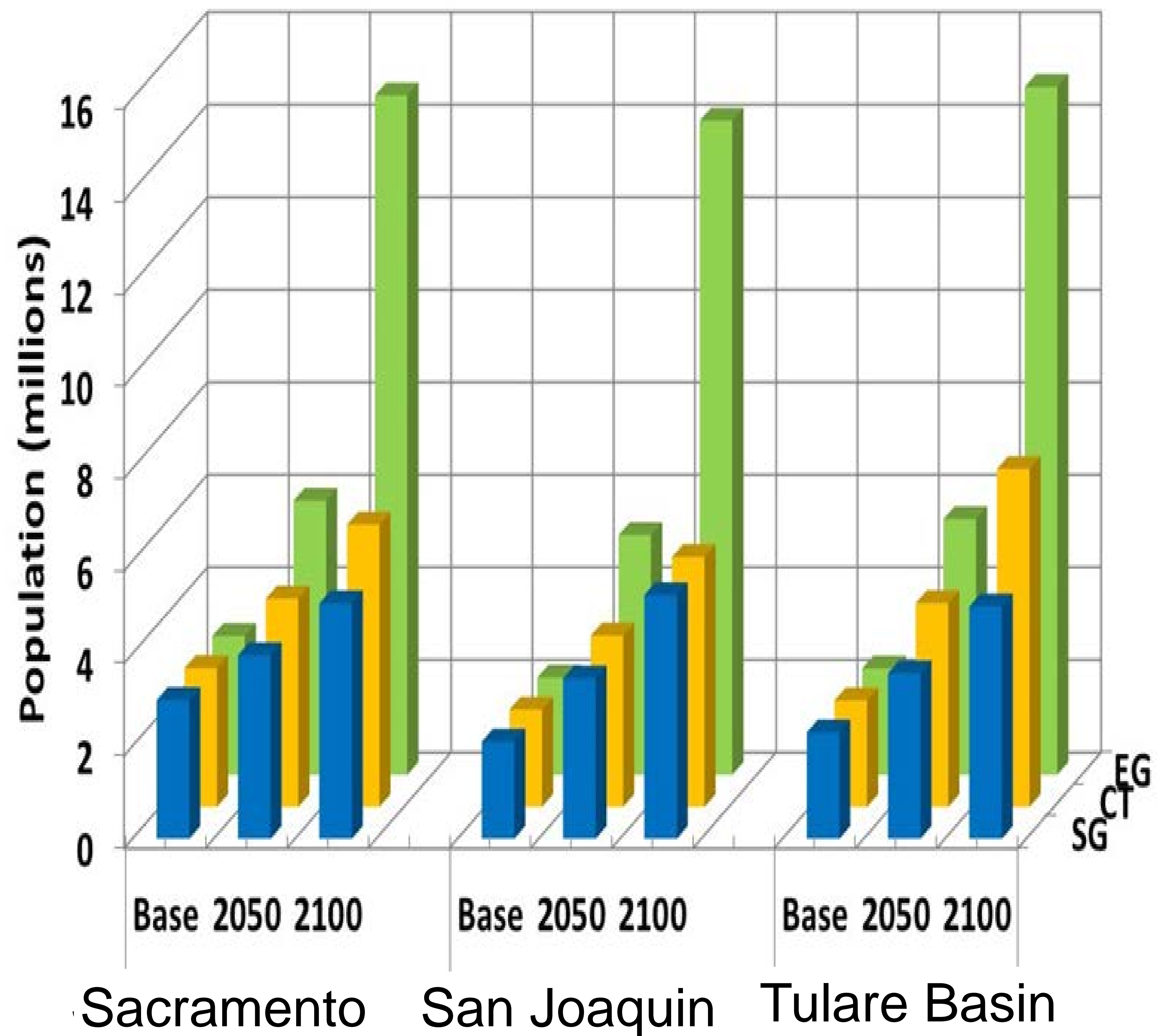
Five climate and sea level rise scenarios developed from 175 CMIP5 GCM simulations of the 21<sup>st</sup> century



RECLAMATION

# Socioeconomic Scenarios

## Population Changes by Region



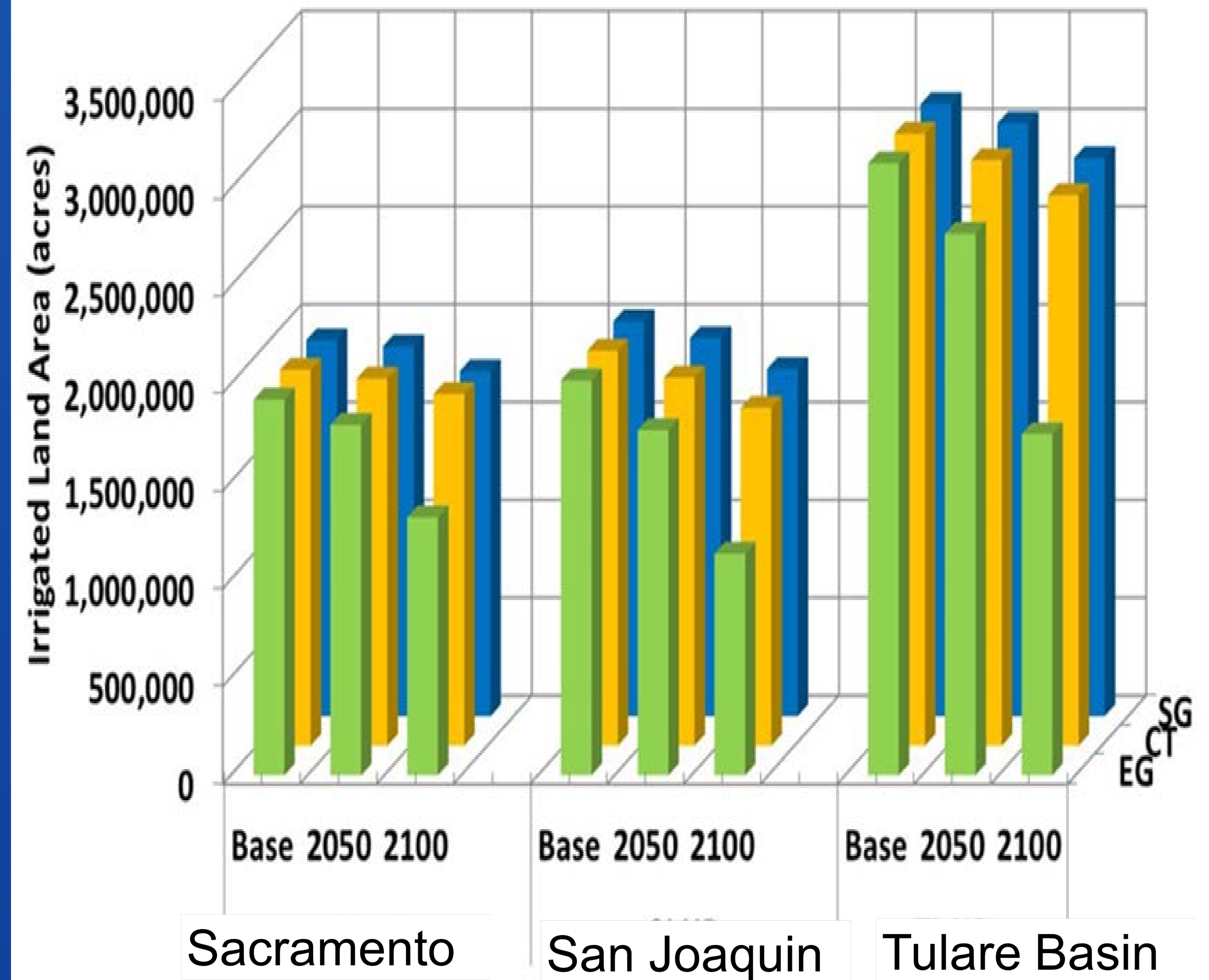
## Scenarios

**Expansive Growth (EG)**

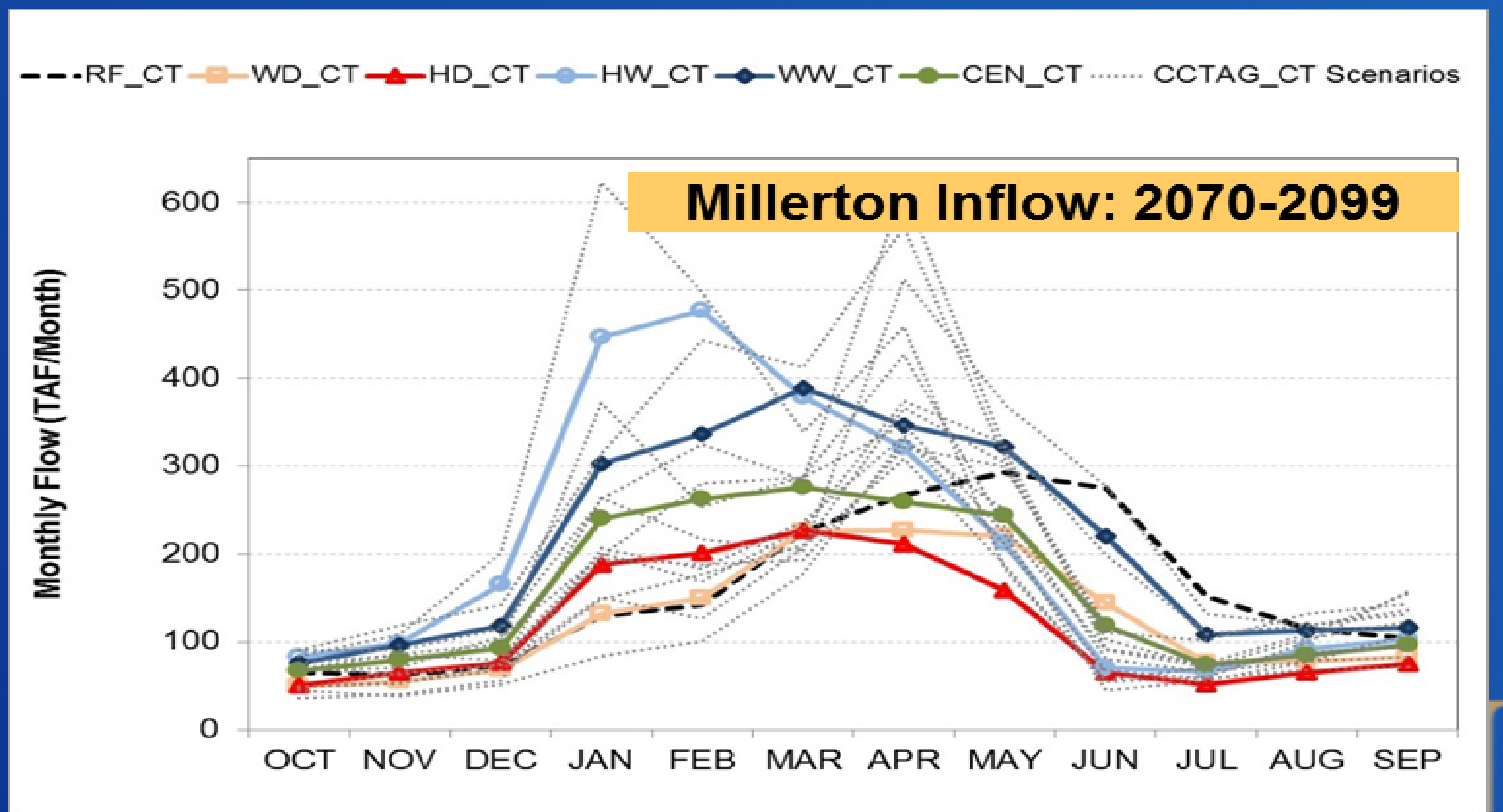
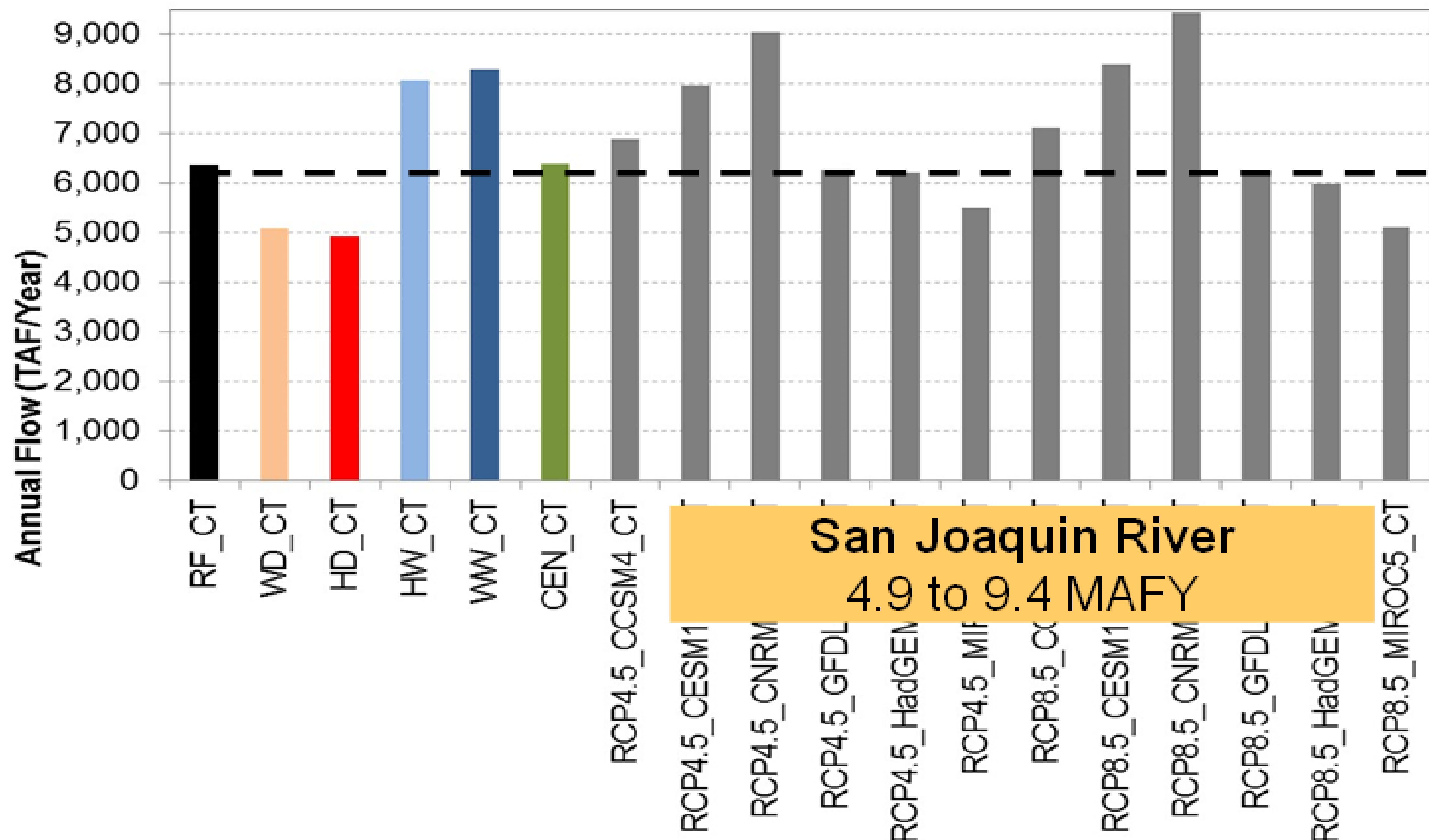
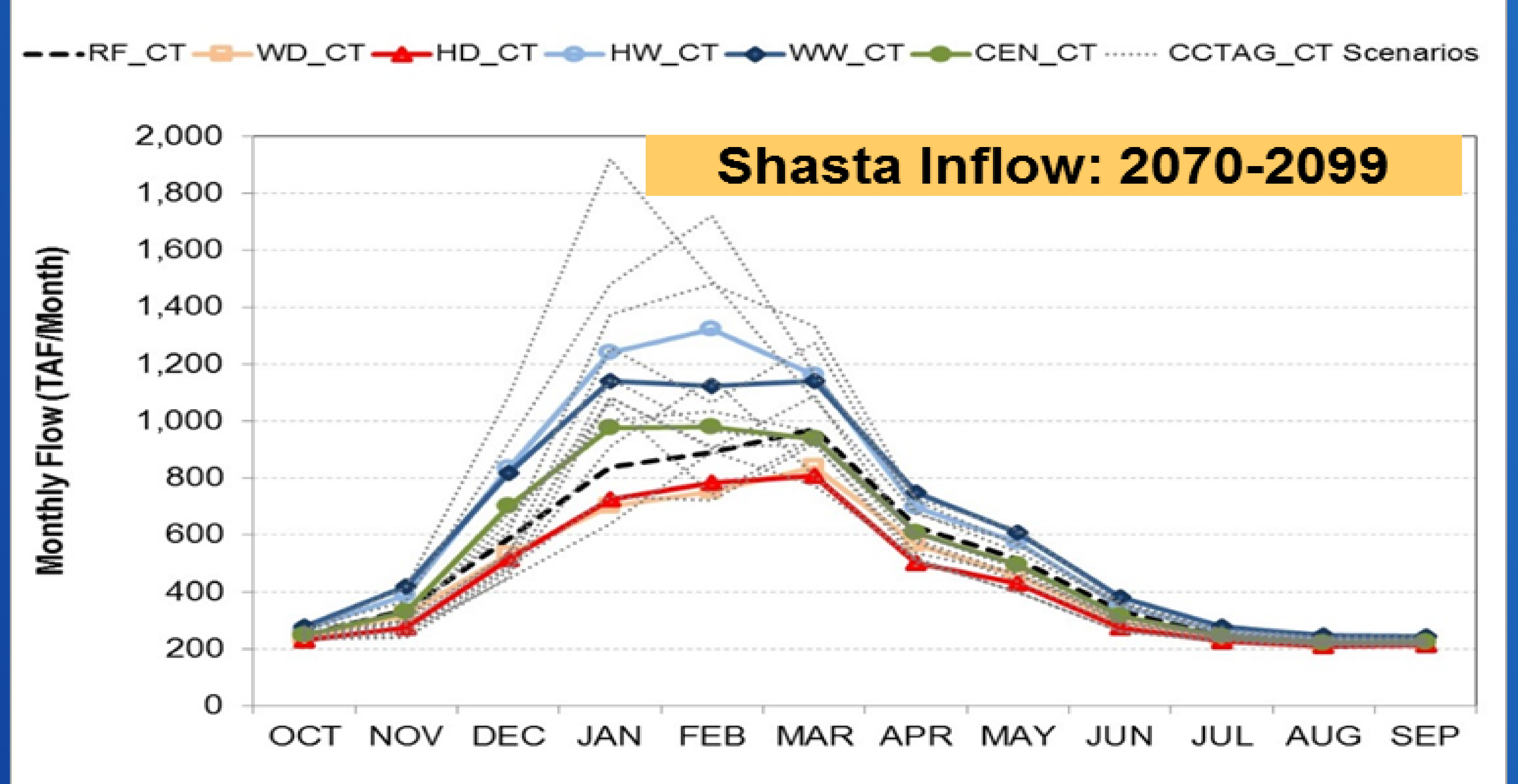
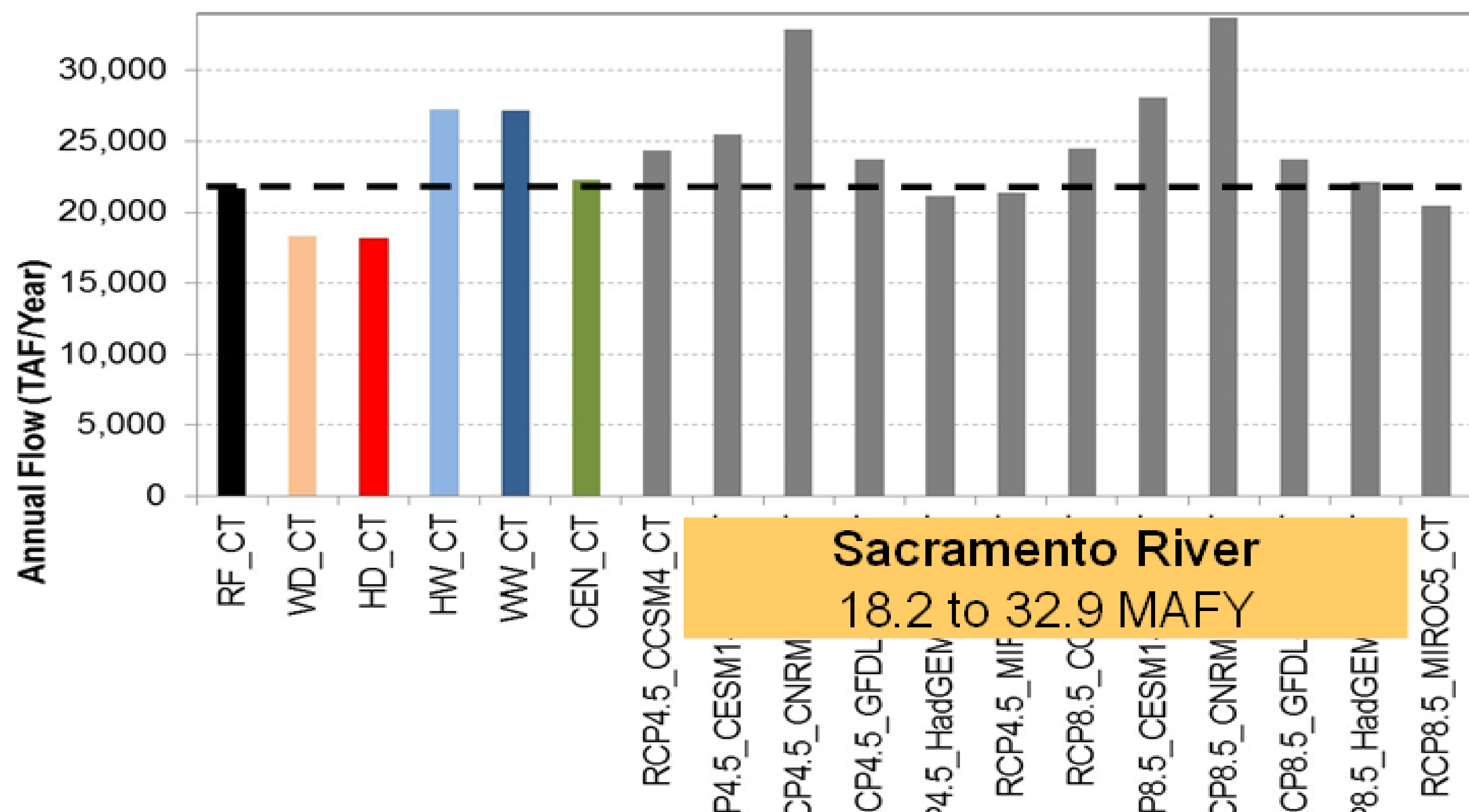
**Current Trends (CT)**

**Slow Growth (SG)**

## Land Use Changes by Region



# Projected Water Supplies



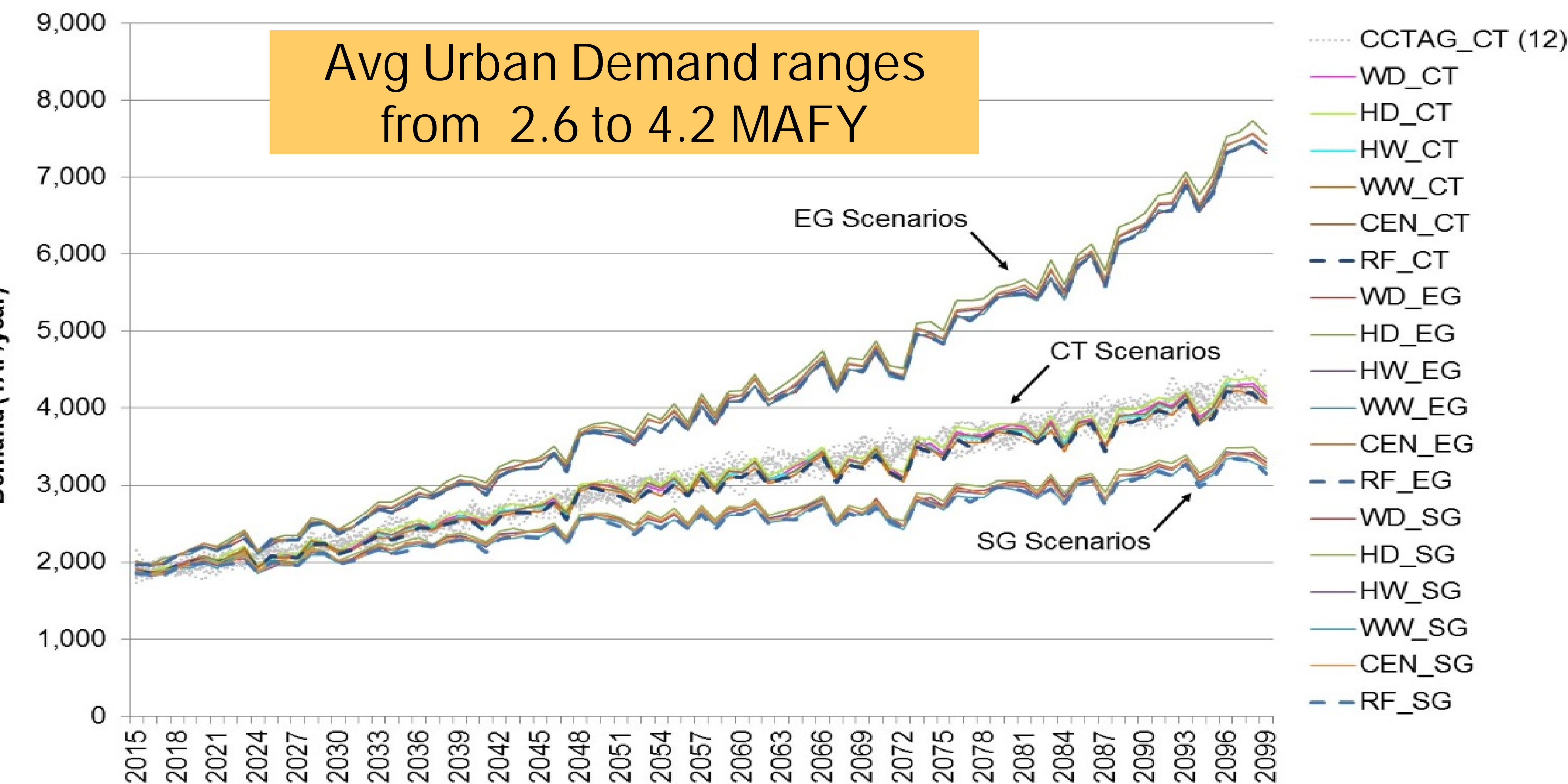
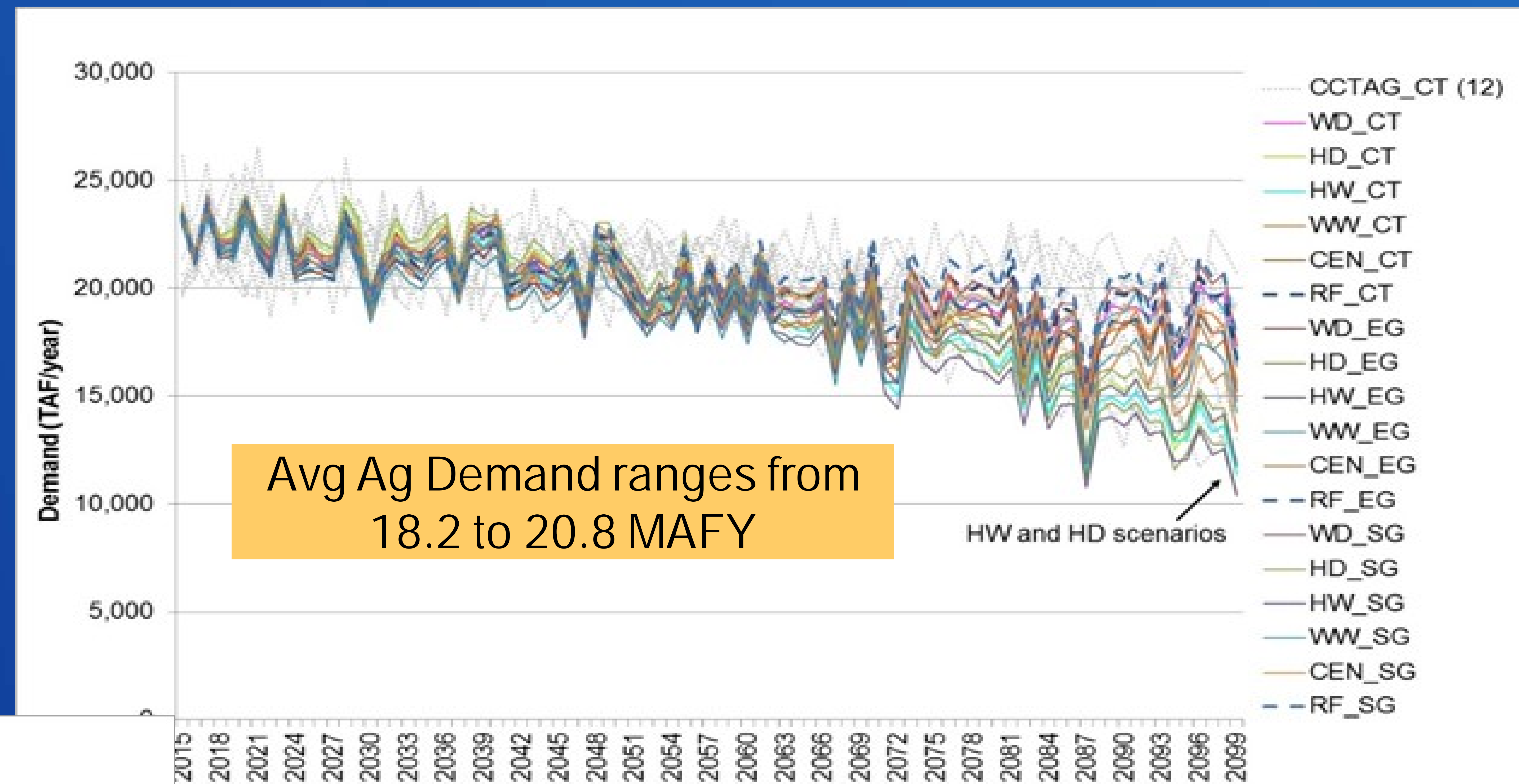
RECLAMATION

# Projected Future Water Demands

Agricultural

- Central Valley Applied Water Demands

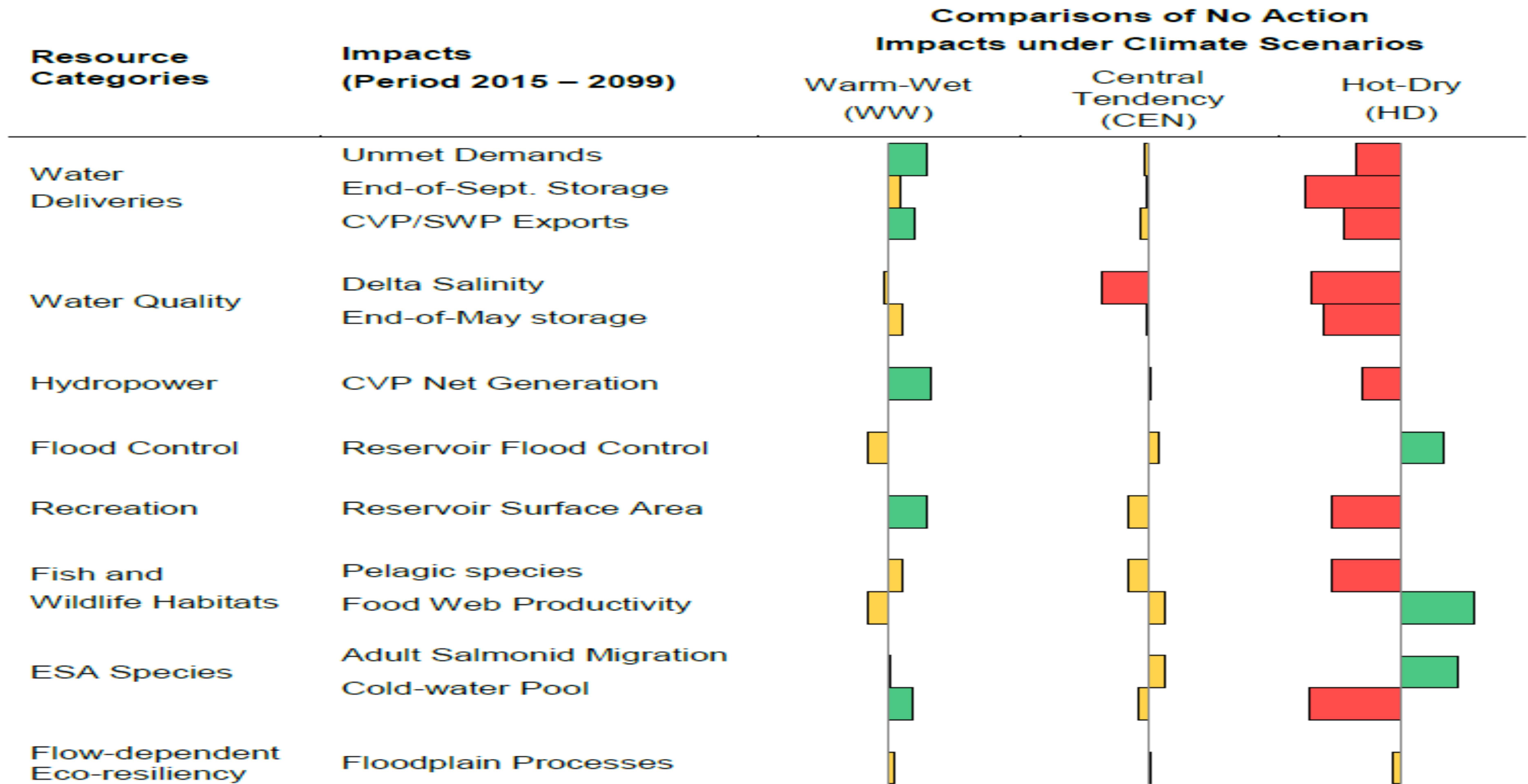
Urban



RECLAMATION



# System Risk and Reliability Analysis

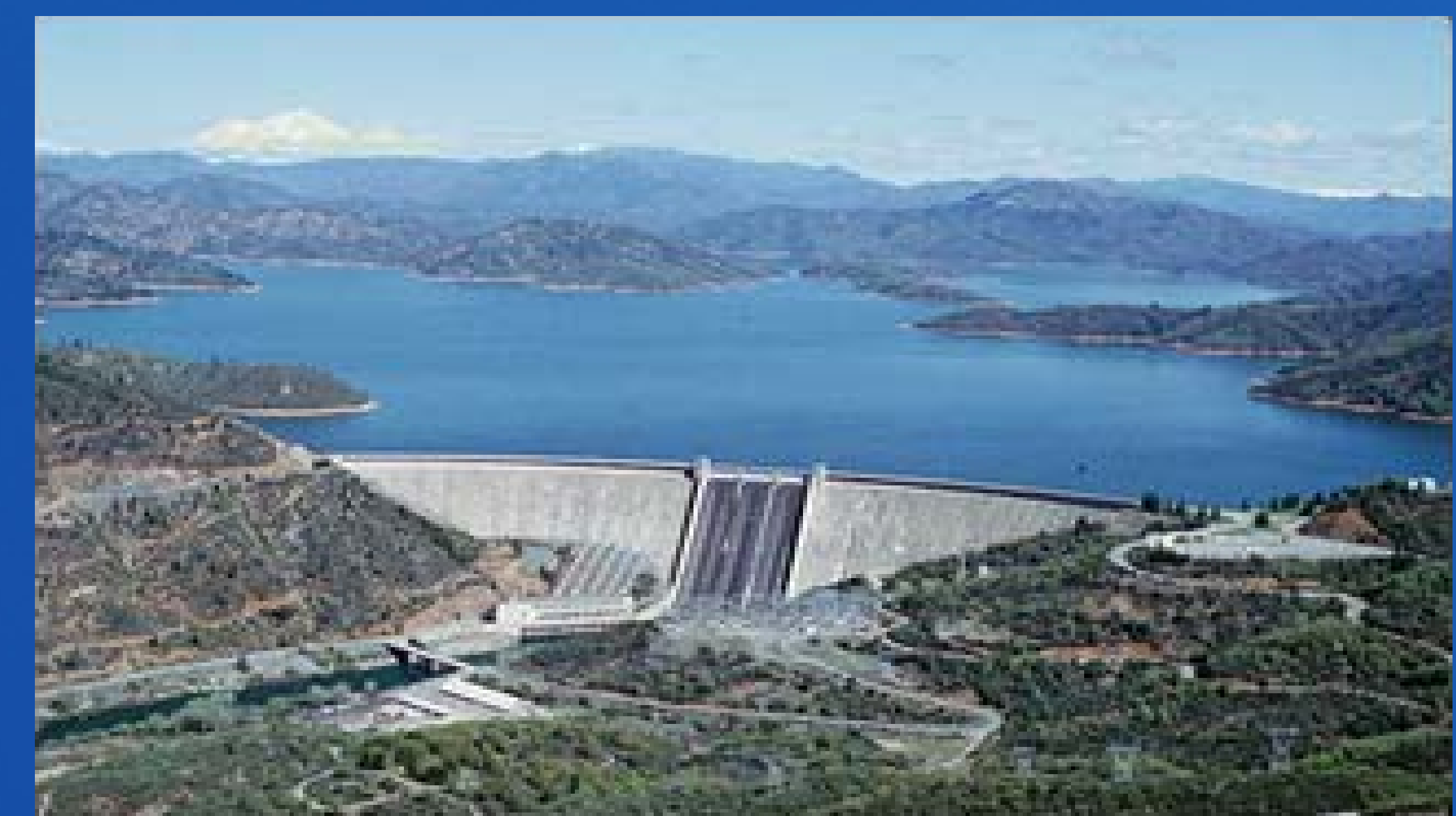


Analysis based on CT Socioeconomic Scenario

RECLAMATION

# Response Actions

- **Reduce Water Demand**
  - Increase agricultural water efficiency
  - Increase municipal & industrial water use efficiency
- **Increase Water Supply**
  - Increase regional reuse
  - Increase ocean desalination
  - Precipitation enhancement
  - Rainwater harvesting
- **Improve Operational Capabilities**
  - Conjunctive groundwater management
  - Enhance groundwater recharge
  - Improve salinity and nutrient management
  - Improve temperature management
  - Improve SWP/CVP operations
  - Improve tributary and environmental flows
  - Improve system and regional conveyance
  - Increase Sac, SJ, export area, and upper watershed storage
- **Improve Resource Stewardship**
  - Improve forest health
- **Improve Institutional Flexibility**
  - Improve regulatory flexibility and adaptability
- **Improve Data Management**



RECLAMATION

# Water Management Action Screening Criteria

Action Name	Cost	Quantity of Yield	Timing	Technical Feasibility	Permitting	Legal	Policy	Implementation Risk	Long-term Viability Risk	Operational Flexibility	Energy Needs
Agricultural Water Use Efficiency	A	A	B	B	B	B	A	B	C	E	A
M&I Water Use Efficiency	A	A	C	A	A	A	B	B	B	B	A
M&I Water Reuse	B	A	C	B	C	C	B	B	C	D	D
Ocean Desalination	D	B	C	C	C	C	C	B	C	D	D
Precipitation Enhancement	A	C	A	C	B	C	C	B	D	B	C
Rainwater Harvesting	E	D	A	A	A	A	B	A	B	A	A
Conjunctive Management	C	B	C	B	C	C	A	B	C	D	B
Enhance Groundwater Recharge	C	B	C	B	B	B	A	B	B	E	A
Improve Tributary and Delta Environmental Flows	A	E	B	A	C	B	D	B	B	B	C
Improve System Conveyance	E	C	C	B	D	C	C	C	C	D	D
Improve CVP/SWP Operations	A	D	B	A	D	C	C	B	B	B	C
Improve Regional/Local Conveyance	A	D	B	A	B	B	B	A	B	C	C
Increase Sacramento Valley Surface Storage	A	C	C	B	D	C	B	C	B	D	C
Increase San Joaquin Valley Surface Storage	C	D	C	B	D	C	B	C	B	D	C
Increase Export Area Surface Storage	B	C	C	B	D	C	B	C	B	D	C
Increase Upper Watershed Surface Storage	B	D	C	B	D	C	B	C	B	D	B
Improve Forest Health	A	B	C	D	C	C	E	D	D	E	C
Improve Regulatory Flexibility and Adaptability	A	D	B	A	D	D	B	C	B	A	A
Improve River Temperature Management	E	E	B	A	B	C	B	C	D	C	C
Improve Salinity and Nutrient Management	E	E	D	B	C	D	B	D	C	D	B

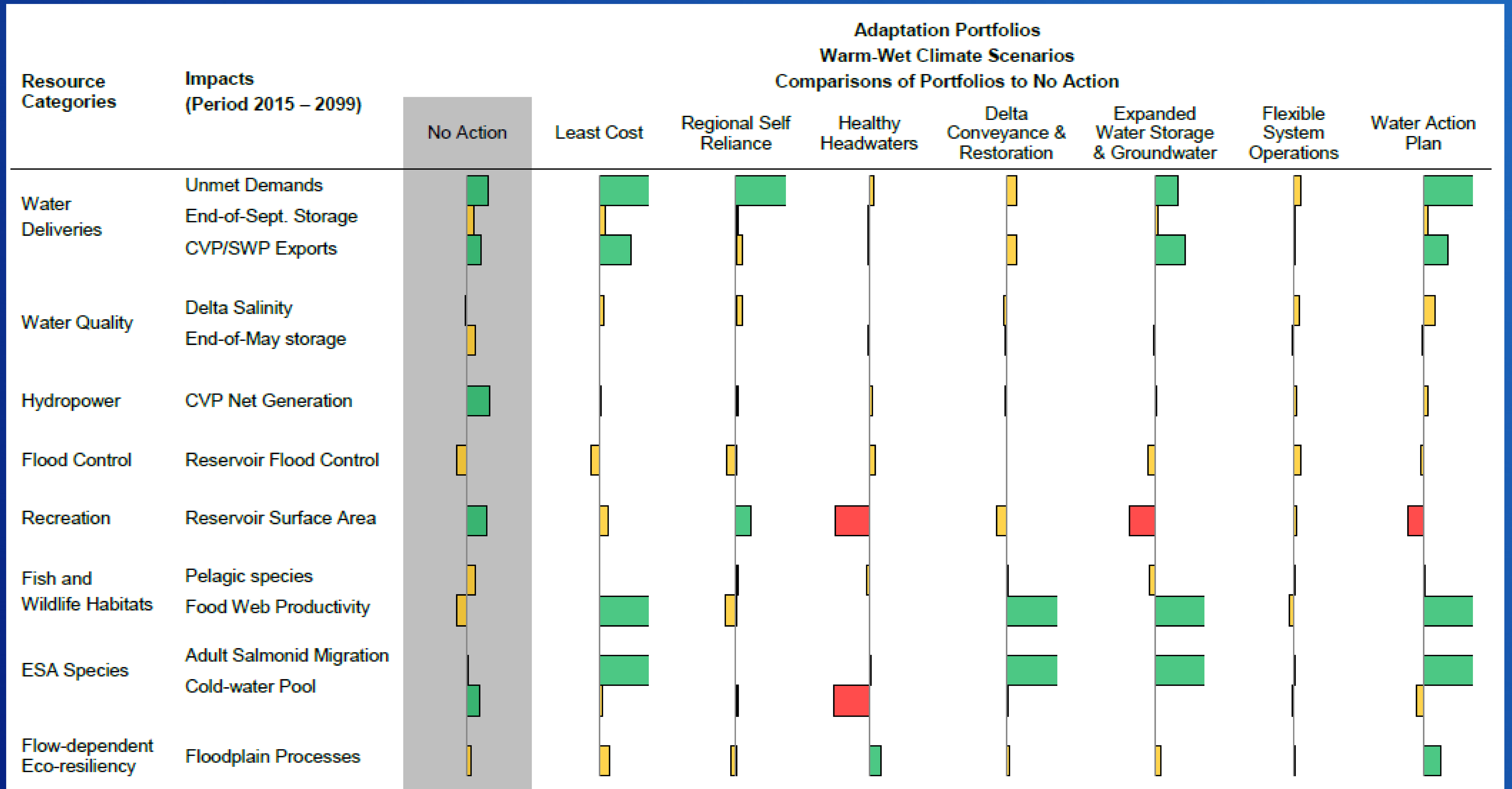
# Management Portfolios

Water Management Action	Least Cost	Regional Self-Reliance	Healthy Headwaters and Tributaries	Delta Conveyance and Restoration	Expanded Water Storage	Flexible System Operations	Water Action Plan
Increase Agricultural Water Use Efficiency	Reduce Demand	Reduce Demand					Reduce Demand
Increase Urban Water Use Efficiency	Reduce Demand	Reduce Demand					Reduce Demand
Increase Regional Reuse		Increase Supply					Increase Supply
Increase Ocean Desalination		Increase Supply					Increase Supply
Precipitation Enhancement	Increase Supply	Increase Supply					Increase Supply
Rainwater Harvesting		Increase Supply					Increase Supply
Conjunctive Groundwater Management		Operations			Operations	Operations	Operations
Enhance Groundwater Recharge		Operations			Operations	Operations	Operations
Improve Tributary Environmental Flows			Operations				Operations
Improve System Conveyance	Operations			Operations	Operations		Operations
Increase Sac Valley Surface Storage	Operations				Operations		Operations
Increase SJ Valley Surface Storage					Operations		Operations
Increase Export Area Surface Storage	Operations				Operations		Operations
Increase Upper Watershed Surface Storage					Operations		Operations
Improve Forest Health	Resource		Resource				Resource
Improve Regulatory Flexibility/Adaptability	Institutions					Institutions	Institutions

**Type of Action**

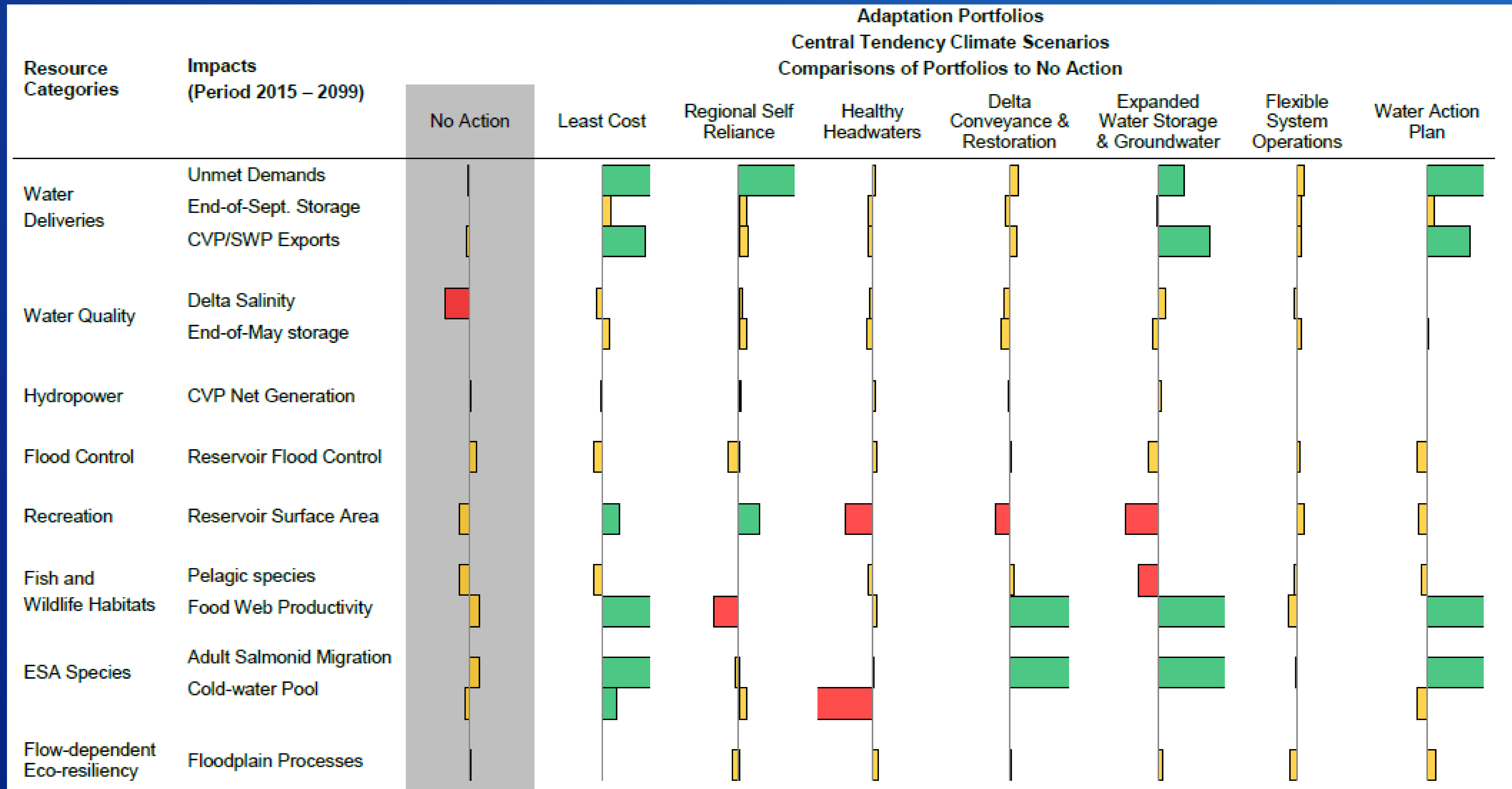
- Reduce Demand
- Increase Supply
- Operational Capabilities
- Resource Stewardship
- Institutional Flexibility

# Portfolio Performance & Tradeoffs



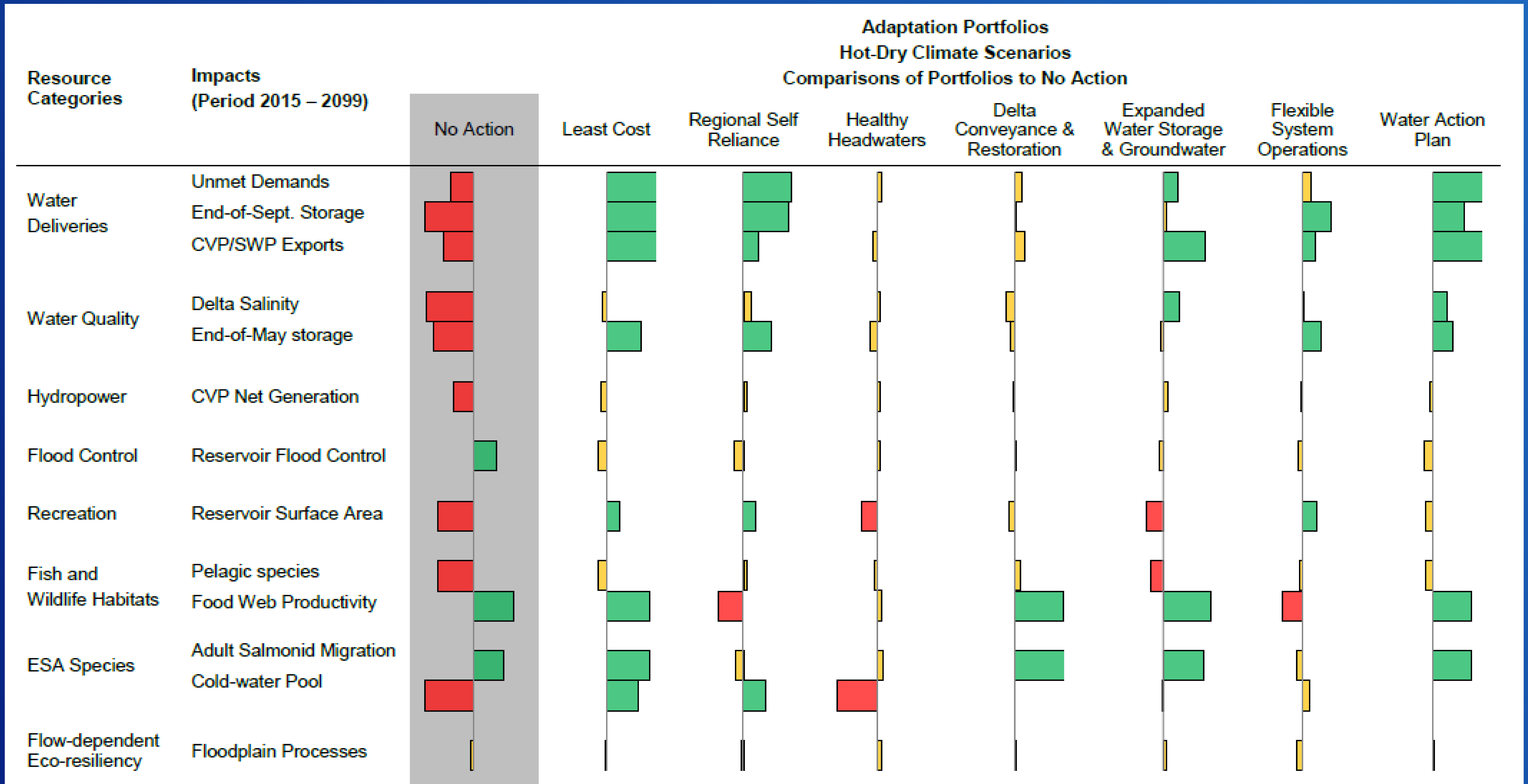
Warm Wet – Current Trends scenario

# Portfolio Performance & Tradeoffs



Central Tendency – Current Trends scenario

# Portfolio Performance & Tradeoffs



Hot Dry – Current Trends scenario

# Summary of Management Challenges

- Resource category risks are highly sensitive to potential climate uncertainties.
  - For example, Delta salinity was only slightly increased in Warm-Wet climate but increased significantly in Hot-Dry climate.
- Portfolios generally perform consistently across the wide range of climate uncertainties studied.
  - For example, the Least Cost portfolio provides positive water delivery benefits for all climate scenarios studied.
- Effectiveness of the portfolios is quite variable across the range of resource categories.
  - For example, water deliveries varied considerably between portfolios
- Addressing risks in a specific resource category by implementing a particular portfolio of actions results in varying degrees of improvement / deterioration in other resource categories. The extent of these tradeoffs depends on specific climate conditions.



# Discussion

**Basin Study website: <https://www.usbr.gov/watersmart/bsp/>**

Contact Information:

Michael Tansey  
916-978-5197  
[mtansey@usbr.gov](mailto:mtansey@usbr.gov)

RECLAMATION