

# RECLAMATION

*Managing Water in the West*

## **West Wide Climate Risk Assessments – Irrigation Demand and Reservoir Evaporation Projections**

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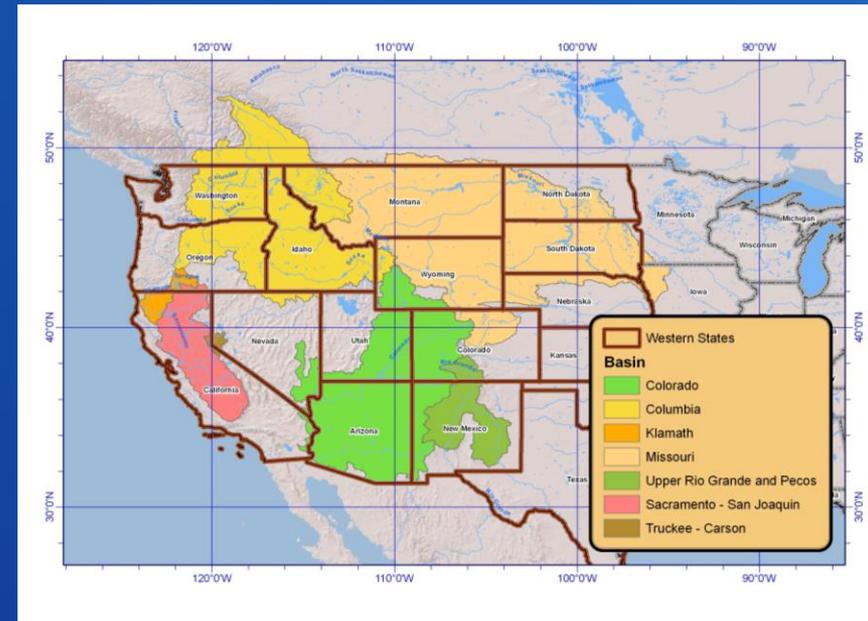
**Advisory Committee on Water Information Meeting, February 26, Webinar**



**U.S. Department of the Interior  
Bureau of Reclamation**

# Background

- Public Law 111-11, Subtitle F (SECURE Water Act, **SWA, 2009**) § 9503.
- Climate change risks for water and environmental resources in “**major Reclamation river basins.**”
- Reclamation’s WaterSMART (**S**ustain and **M**anage **A**merica’s **R**esources for **T**omorrow) Basin Studies Program
  1. West-Wide Climate Risk Assessments (**WWCRAs**)
  2. Basin Studies
  3. Landscape Conservation Cooperatives (**LCCs**)

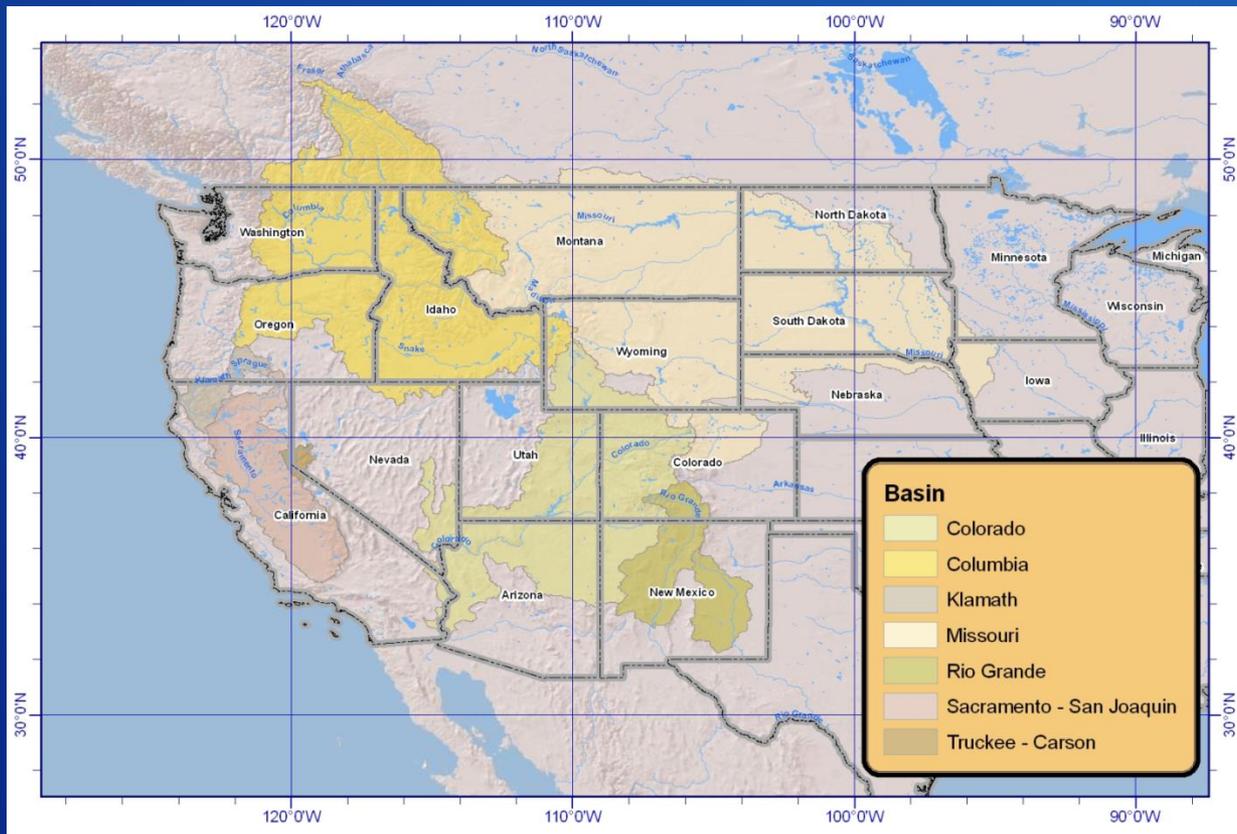


**8 major Reclamation River Basin**

SECURE – Science and Engineering to Comprehensively Understand and Responsibly Enhance

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# WEST WIDE CLIMATE RISK ASSESSMENTS

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# Funded Basin Studies

22 Basin Studies funded since 2009

2009

- Colorado River Basin
- Milk/St. Mary River Basins
- Yakima River Basin

2010

- Niobrara River Basin
- Truckee River Basin
- Santa Ana River Basin
- Henrys Fork of Snake River
- S.E. California Regional Basin

2011

- Lower Rio Grande River Basin
- Santa Fe Basin
- Klamath River Basin
- Hood River Basin

2012

- Upper Washita River Basin
- Sacramento-San Joaquin Rivers
- Republican River Basin
- Pecos River Basin
- L.A. Basin

2013

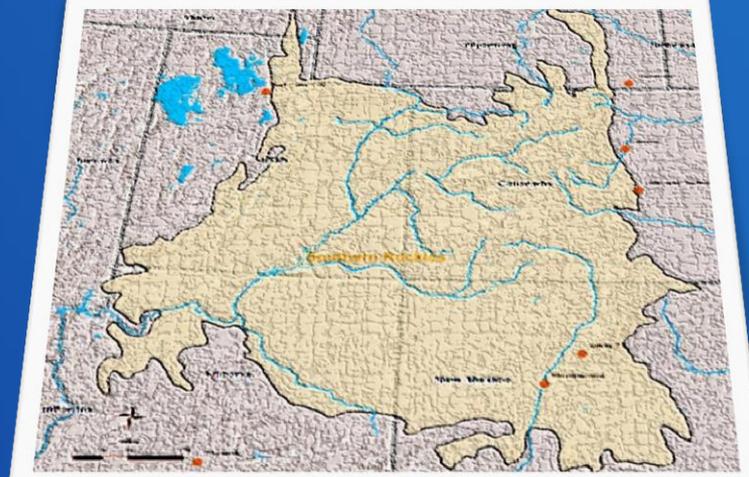
- San Diego Watershed
- West Salt River Valley

2014

- Deschutes River Basin
- Upper Missouri River Basin
- Upper Red River Basin



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# LANDSCAPE CONSERVATION COOPERATIVES

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# SECURE Water Act Reporting

- Risks
  - Change in snowpack
  - Groundwater recharge and discharge
  - **Increases in water demand or reservoir evaporation as result of increasing temperature**
- Impacts
  - Ability to deliver water
  - Hydroelectric power generation
  - Recreation at Reclamation facilities
  - Fish and wildlife habitat
  - Endangered, threatened, candidate species
  - Water quality issues
  - Flow dependent ecological resiliency
  - Flood control management

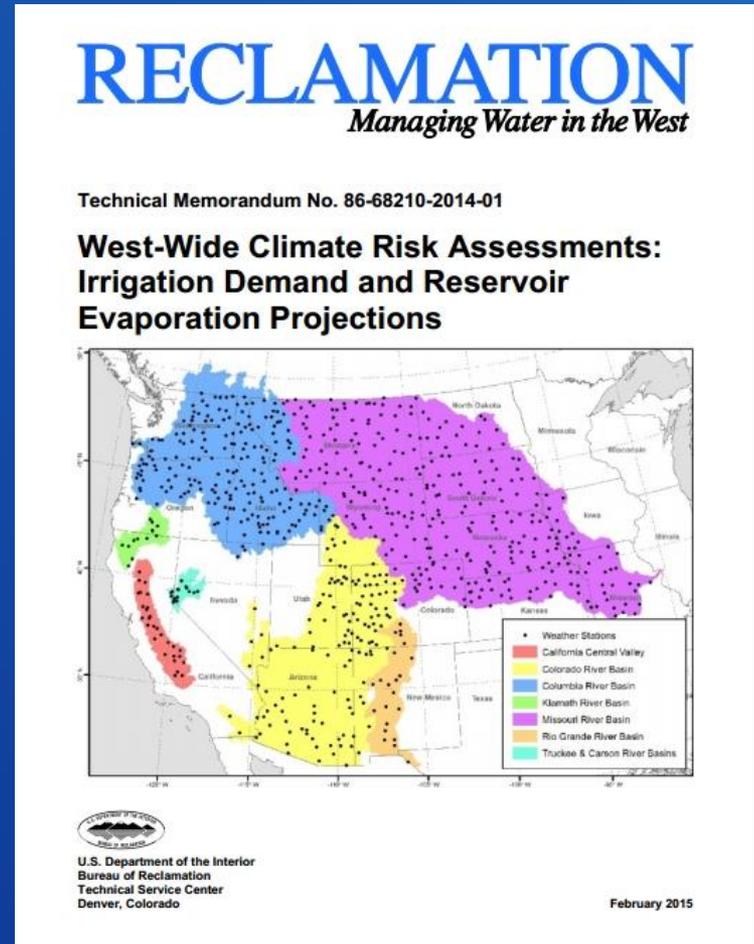


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# WWCRA – Irrigation Demand and Reservoir Evaporation Projections Report

<http://www.usbr.gov/WaterSMART/wcra>

- CMIP-3 climate projections BCSD
- Irrigation demand (NIWR) for each HUC-8 across the West
- 12-reservoirs across the West
- 2020s, 2050s, 2080s



# Hydroclimate Projections

[http://gdo-dcp.ucllnl.org/downscaled\\_cmip\\_projections/dcpInterface.html](http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html)



## Downscaled CMIP3 and CMIP5 Climate and Hydrology Projections

*This site is best viewed with [Chrome](#) (recommended) or [Firefox](#). Some features are unavailable when using Internet Explorer. Requires JavaScript to be enabled.*

- Welcome
- About
- Tutorials
- Projections: Subset Request
- Projections: Complete Archives
- Feedback
- Links

Downscaled CMIP5 climate and hydrology projections' documentation and release notes available [here](#).

### Summary

This archive contains fine spatial resolution translations of climate projections over the contiguous United States (U.S.) developed using two downscaling techniques (monthly BCSD Figure 1, and daily BCCA Figure 2), CMIP3 hydrologic projections over the western U.S. (roughly the western U.S. Figure 3), and CMIP5 hydrology projections over the contiguous U.S. corresponding to monthly BCSD climate projections.

Archive content is based on global climate projections from the [World Climate Research Programme's](#) (WCRP's) [Coupled Model Intercomparison Project phase 3 \(CMIP3\)](#) multi-model dataset referenced in the Intergovernmental Panel on Climate Change Fourth Assessment Report, and the phase 5 (CMIP5) multi-model dataset that is informing the IPCC Fifth Assessment.

For information about downscaled climate and hydrology projections development, please see the [About](#) page.

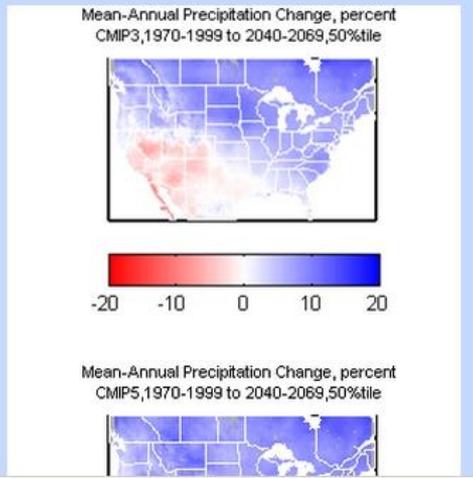
### Purpose

The archive is meant to provide access to climate and hydrologic projections at spatial and temporal scales relevant to some of the watershed and basin-scale decisions facing water and natural resource managers and planners dealing with climate change. Such access permits several types of analyses, including:

- assessment of potential climate change impacts on natural and social systems (e.g., watershed hydrology, ecosystems, water and energy demands).
- assessment of local to regional climate projection uncertainty.
- risk-based exploration of planning and policy responses framed by potential climate changes exemplified by these projections.

### Archive History

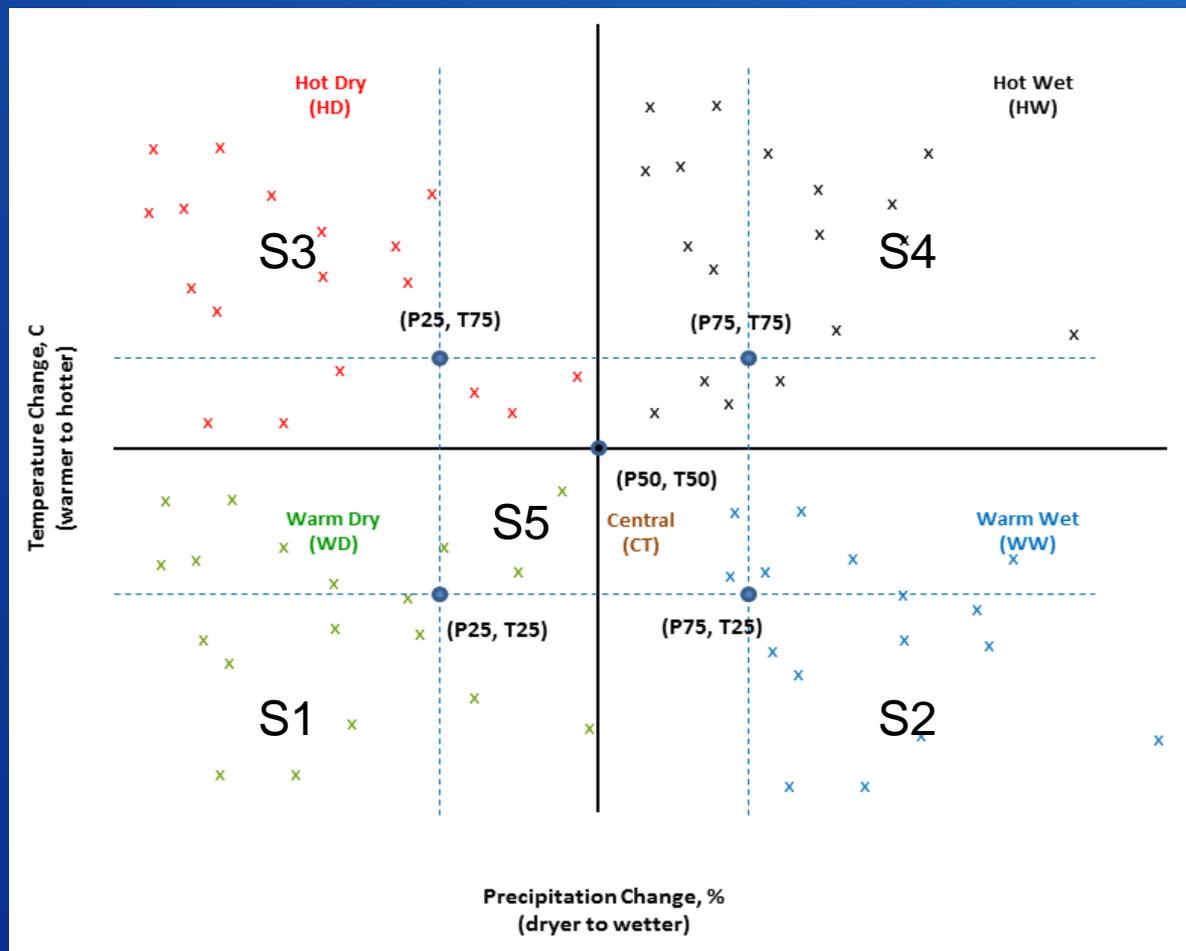
*Figure 1. Central Tendency Changes in Mean-Annual Precipitation over the contiguous U.S. from 1970-1999 to 2040-2069 for BCSD3, BCSD5, and Difference.*



# Meteorology and Climate

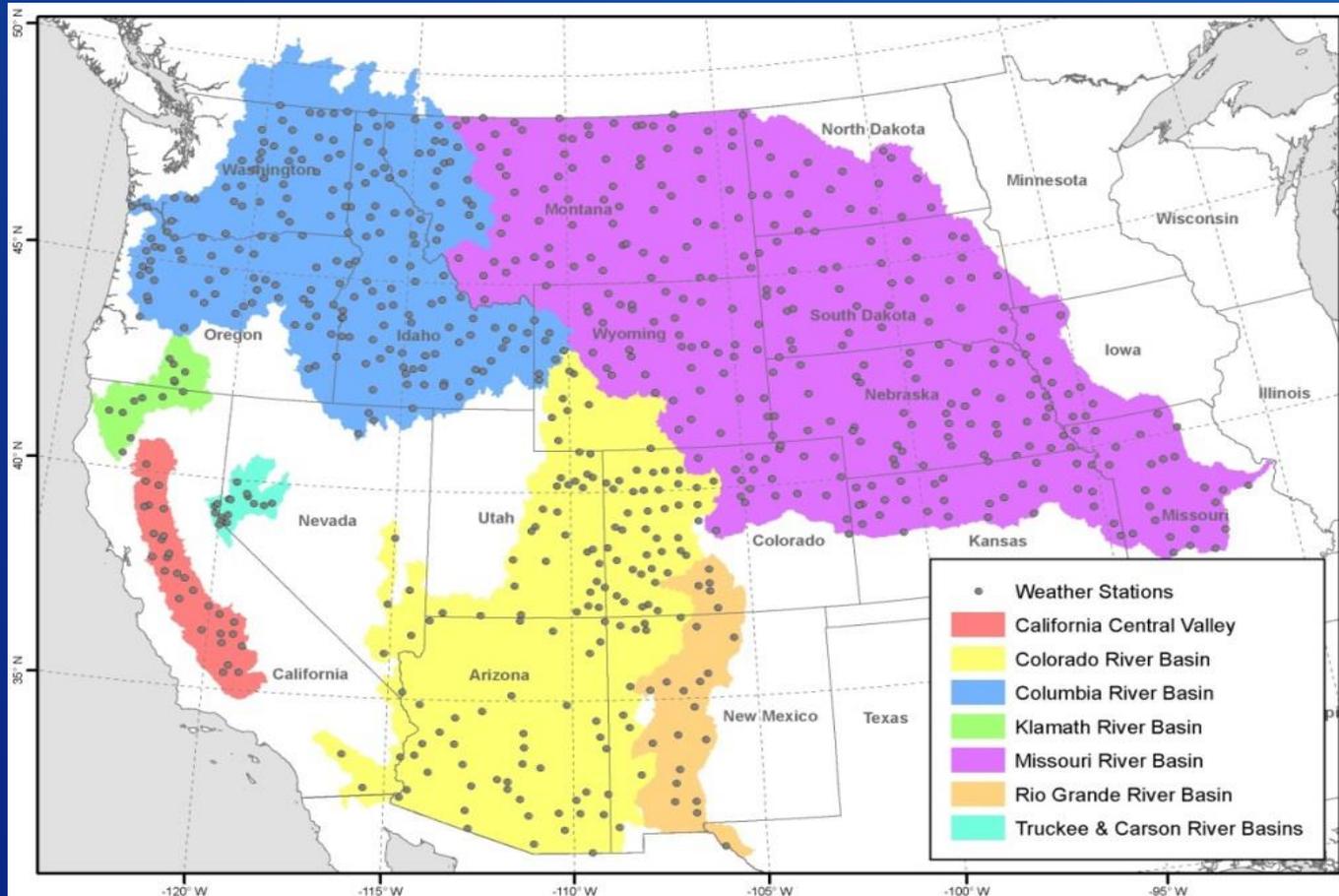
- 5 climate change scenarios utilizing ensemble informed hybrid delta (HDe) method for forcing crop ET model

- Warm, Dry (S1)
- Warm, Wet (S2)
- Hot, Dry (S3)
- Hot, Wet (S4)
- Central Tendency (S5)



# Meteorology and Climate

- Valley / agricultural NWS/COOP Met Nodes (>700) were used for calibrating the irrigation demands and reservoir evaporation models
- Met Node calibrations were assigned to respective HUC8s (1 - 2 Met Nodes for each HUC8)



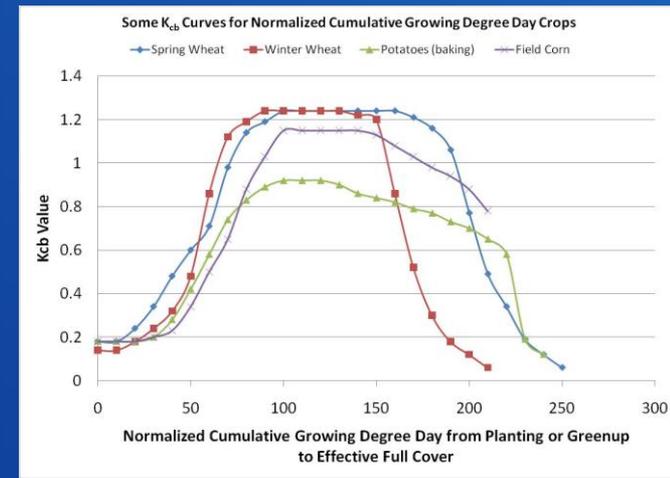
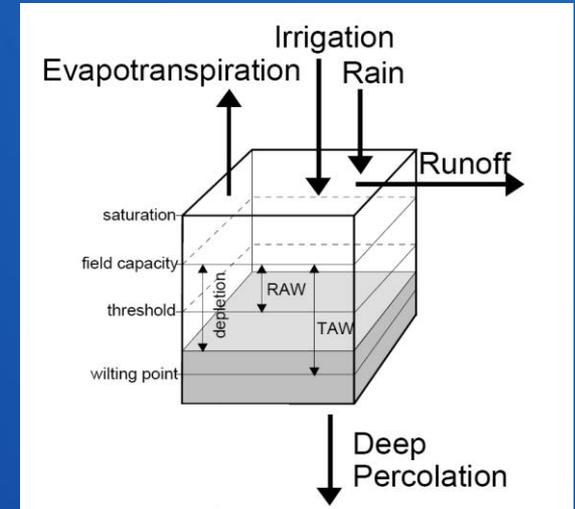
# Agricultural Cropping

Crop types and acreages for each basin were developed from the following sources and assumed static for future demand estimates:

<b>Basin</b>	<b>Crop Source</b>
San Joaquin	Cropland Data Layer
Sacramento	Cropland Data Layer
Colorado	Ag Statistics Service Census of Agriculture Cropland Data Layer
Klamath	Irrigation Project Data Cropland Data Layer
Missouri	Great Plains Regional Database
Rio Grande	Cropland Data Layer
Truckee	Cropland Data Layer
Columbia	Cropland Data Layer

# Crop ET – ET Demands Model

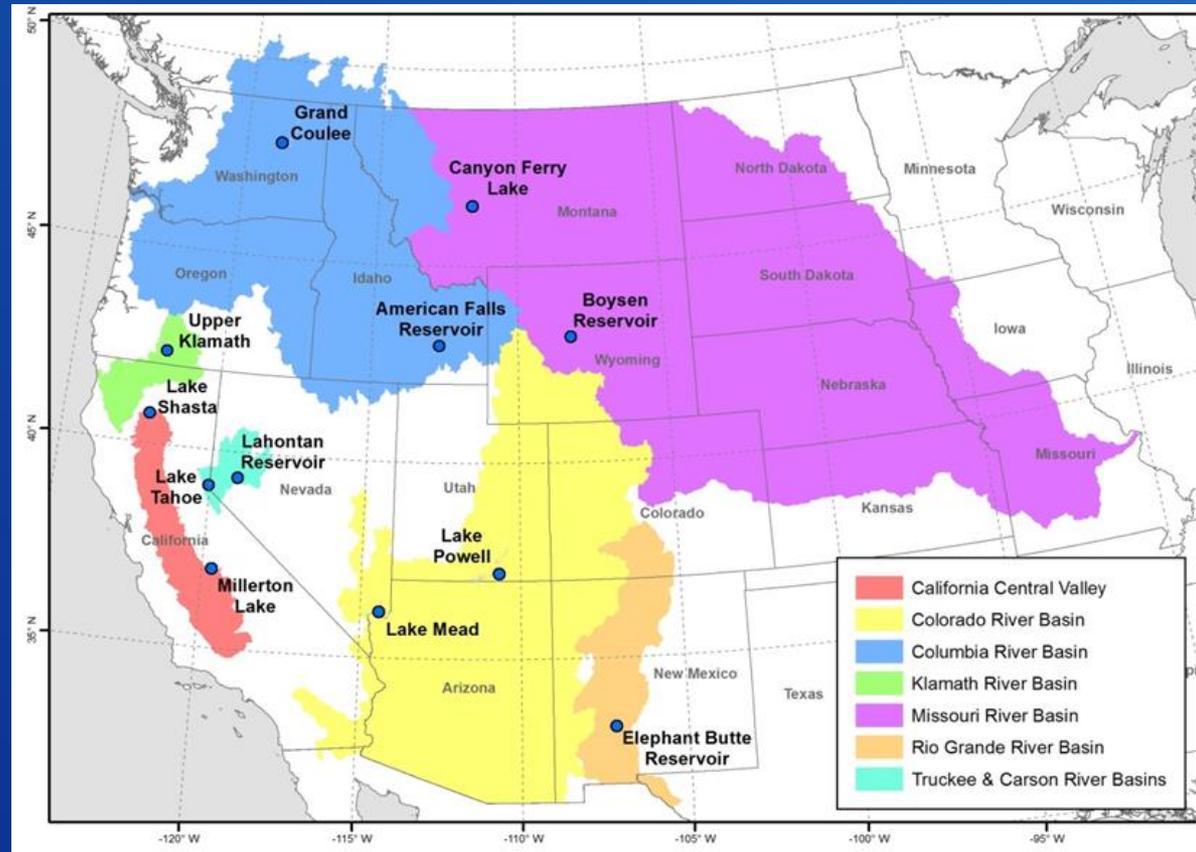
- ET Demands model is a ASCE-PM reference ET and dual crop coefficient model (Allen and Robison, 2009; Huntington and Allen, 2010)
- Used to compute crop ET and net irrigation water requirements
  - Considers variable growing season lengths based on 30 day average temperature, growing degree days (GDD), and killing frost temperatures
  - T30 and GDD thresholds control planting, greenup, development and harvest were calibrated for a crop specific to that basin
  - Growing **and non-growing** season estimation of daily ET
  - Maintains daily soil root zone water balance to simulate irrigation events, estimate effective precipitation, and ultimately the Net Irrigation Water Requirement (NIWR)
    - $NIWR = \text{Crop ET} - (\text{PPT} - \text{runoff} - \text{deep perc.})$



# Open Water Evaporation Modeling

- The Complementary Relationship Lake Evaporation (CRLE) model (Morton et al., 1985) was utilized to simulate open water evaporation from 12 reservoirs / lakes

- Energy balance based approach
- Takes into account seasonal heat storage leading to the potential shift in seasonal evaporation
- Relies on commonly measured and estimated climate observations (air temp, solar radiation, dewpoint)
- Relatively insensitive to the contrasts between the open water and land environments



# West-Wide Summary

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- Precipitation projections are highly variable and basin dependent, with the ensemble median scenario (S5) showing both slight increases and decreases within most basins.
- Temperature shows a persistent increasing trend from the baseline level.
- Reference evapotranspiration is projected to increase in all basins.
- Crop evapotranspiration is projected to increase in areas where perennial crops are grown, and with smaller increases, and sometime slight decreases, in areas where annual crops are grown.
- Because the NIWR incorporates growing season and non-growing season soil moisture gains and losses from precipitation, bare soil evaporation, and crop ET, projections of NIWR are largely uncertain and heavily dependent on the precipitation scenario being considered.
- The ensemble median of annual reservoir evaporation and net evaporation is projected to increase in all basins.

# WWCRA – Irrigation Demand and Reservoir Evaporation Report

	Net Irrigation Water Demand (Change % vs. 1950-1999)	Net Reservoir Evaporation (Change % vs. 1950-1999)		
	2080	2080		
<b>Colorado River Basin (AZ, CA, CO, NM, NV, UT, WY)</b>				
Upper Colorado	22.86			
Lake Powell		7.1 (4.1 inches)		
Lower Colorado	8.31			
Lake Mead		10.1 (6.1 inches)		
Imperial Valley	1.39			
<b>Columbia River Basin (ID, MT, OR, WA)</b>	6.34			
American Falls Reservoir		6.0 (2.0 inches)		
Lake Roosevelt		5.4 (1.3 inches)		
<b>Klamath River Basin (OR, CA)</b>	14			
Upper Klamath Lake		8.2 (2.4 inches)		
<b>Missouri River Basin (CO, IA, KS, MN, MO, MT, ND, NE, SD, WY)</b>				
Western Missouri			13.55	
Boysen Reservoir				4.3 (1.3 inches)
Northern Missouri			3.61	
Canyon Ferry Reservoir				6.9 (1.7 inches)
Southeastern Missouri			-0.98	
<b>Rio Grande River Basin (CO, NM, TX)</b>			18.66	
Elephant Butte Reservoir				9.5 (4.2 inches)
<b>Sacramento and San Joaquin River Basins (CA)</b>			6.81	
Lake Shasta				14.7 (2.5 inches)
Millerton Lake				12.3 (5.0 inches)
<b>Truckee and Carson River Basins (CA, NV)</b>			14.59	
Lake Tahoe				14.4 (1.9 inches)
Lahontan Reservoir				7.1 (3.2 inches)

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# Questions?



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