The Nevada Water Resources Initiative

Advancing the Science and Understanding of Nevada's Groundwater Systems

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Nevada Water Resources Association
Annual Conference
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STATE ENGINEER STATE OF NEVADA

USGS science for a changing world

DRI Desert Research Institute

The Nevada Water Resources Initiative

Proposed activities

- As a first stage to a larger and long-term effort, DRI will provide data and guidance designed to make systematic statewide updates to…
  - Agricultural Consumptive Use Inventory
  - Groundwater Discharge Area and ET Updates
  - Meteorological Monitoring and ET Intercomparisons

Eagle Valley

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The Nevada Water Resources Initiative

Proposed activities

- Support USGS in developing the statewide pumping database (agricultural consumptive use)
- Collaborate with USGS on development of input datasets and methods for recharge estimation
- Assess GCM projections in precipitation, evaporative demand, and hydrologic states and fluxes
- Refine and apply techniques and datasets in “Demonstration Basins”

Snake Valley

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Consumptive Use Inventory & Database

- Comprehensive database
  - Through time (Landsat archive)

Diamond Valley - Photo: Daniel Rothberg/Nevada Independent

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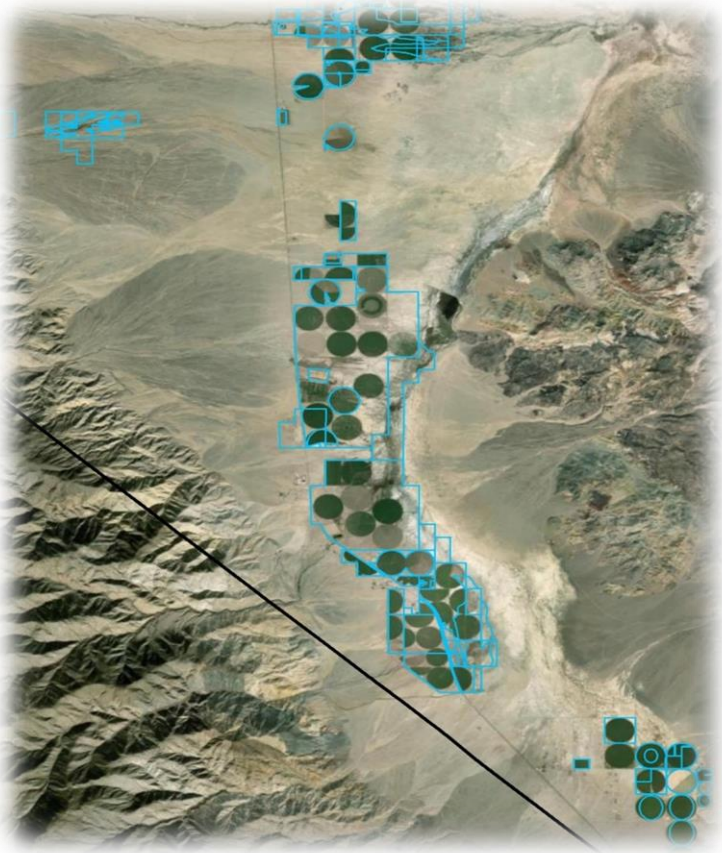
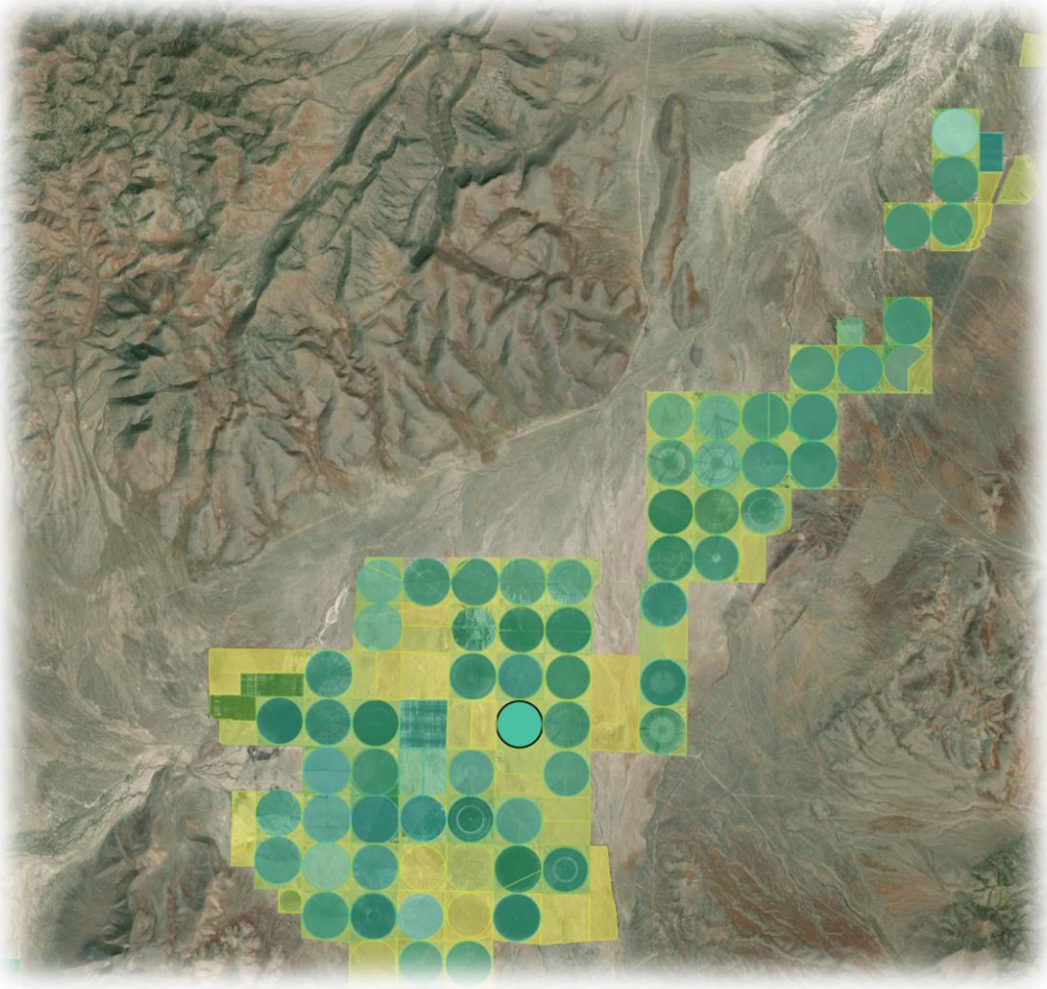
Consumptive Use Inventory & Database

- Comprehensive database
  - Through time (Landsat archive)
  - Field boundaries



Fish Lake Valley



Middle Reese River

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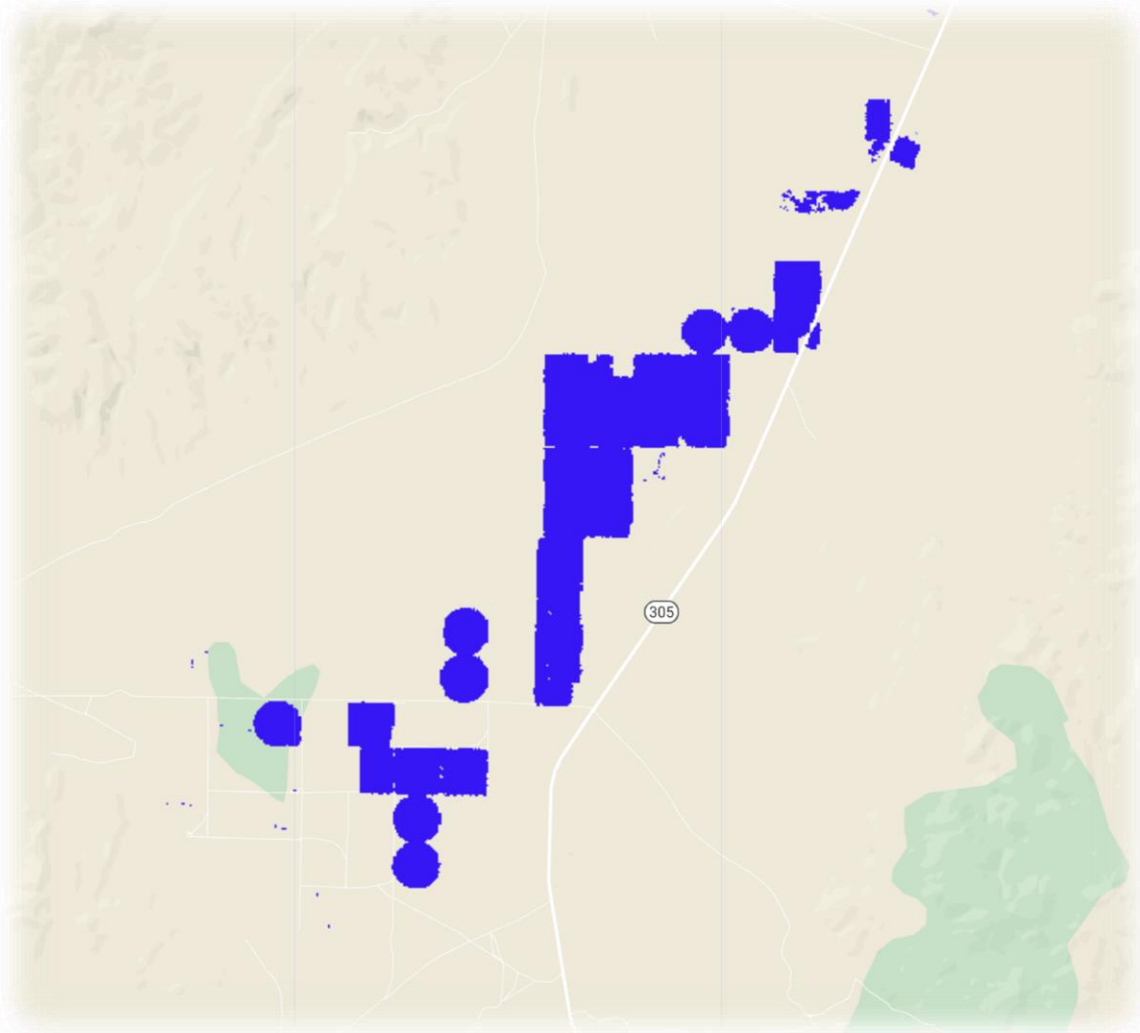
Consumptive Use Inventory & Database

- Comprehensive database
  - Through time (Landsat archive)
  - Field boundaries
  - Irrigation status mapping



Middle Reese River 2020 & 1990

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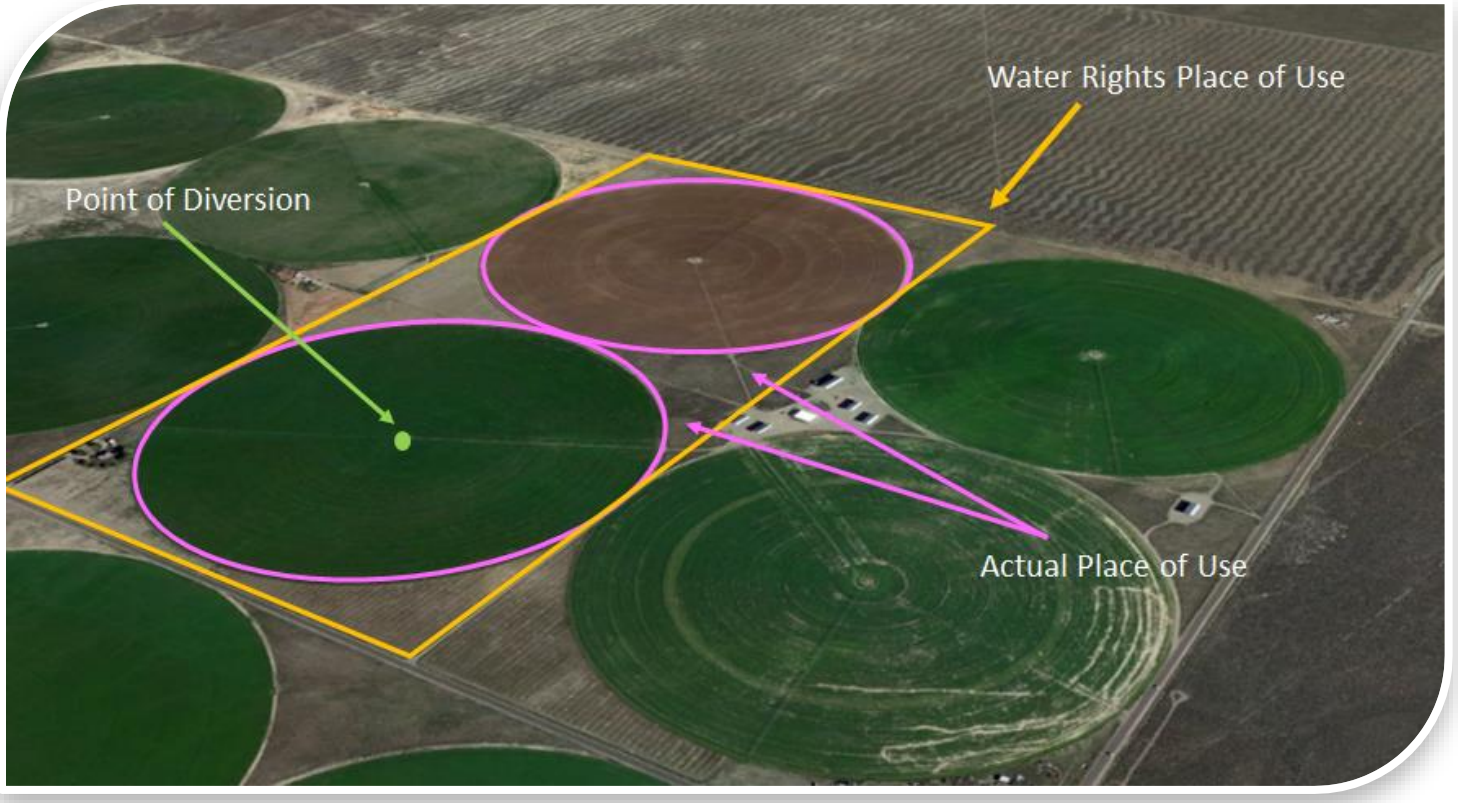
Consumptive Use Inventory & Database

- Comprehensive database
  - Through time (Landsat archive)
  - Field boundaries
  - Irrigation status mapping
  - Irrigation system type
  - Water source mapping



Diamond Valley

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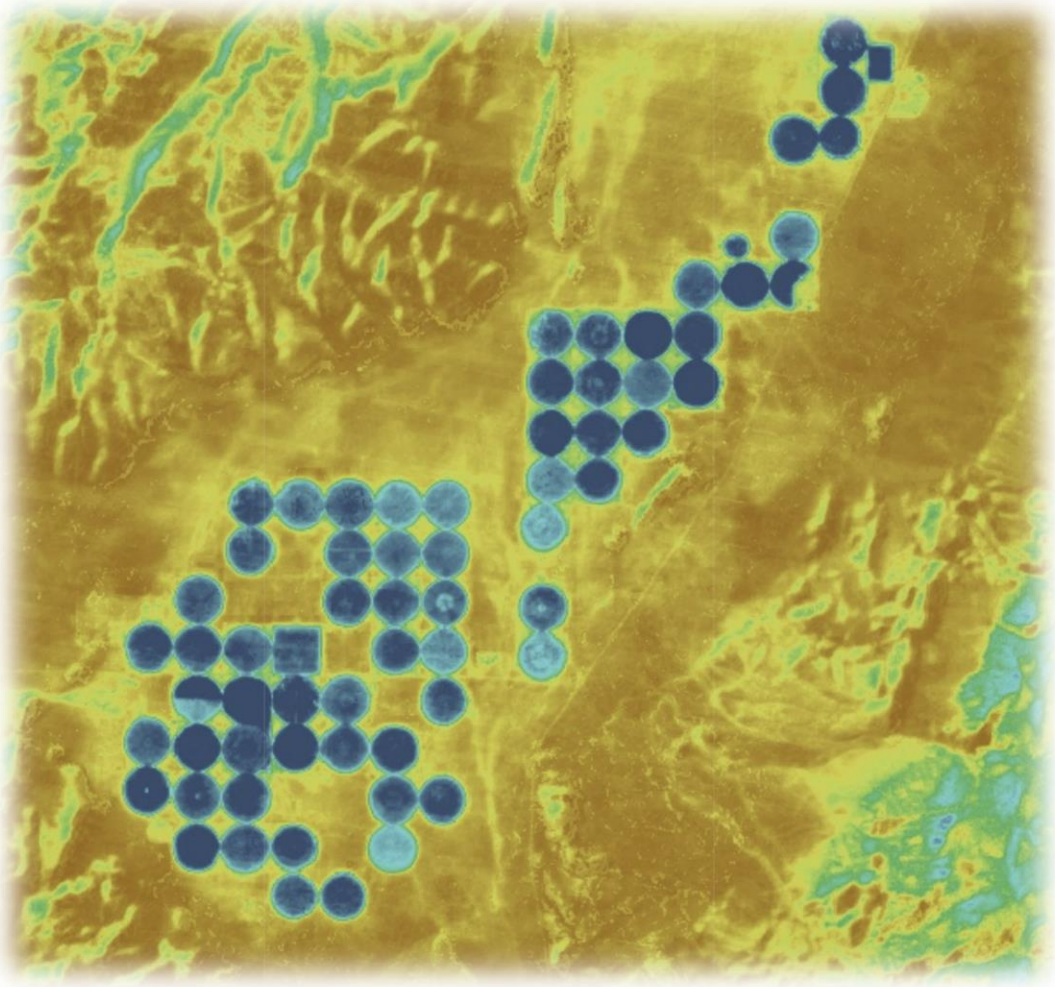
Consumptive Use Inventory & Database

- Comprehensive database
  - Through time (Landsat archive)
  - Field boundaries
  - Irrigation status mapping
  - Irrigation system type
  - Water source mapping
  - Net ET mapping



Middle Reese River 2020

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Consumptive Use Inventory & Database

- Comprehensive database
  - Through time (Landsat archive)
  - Field boundaries
  - Irrigation status mapping
  - Irrigation system type
  - Water source mapping
  - Net ET mapping
  - Application rate estimation (withdrawals)
  - Comparison to meter data
- A very big task…*we have a head start*
  - *Approaches well-defined*
  - *Data sources well-defined*
  - *Many datasets already developed and published*

Diamond Valley

Joined Fields	Pumping Data	Unique Fields
AoI ID	Application Number	Field ID
0	['43270', '43268', '43836']	['NV_8705', 'NV_8673']
1	['21930']	['NV_8734']
2	['35012']	['NV_683']
3	['22194']	['NV_8636']
4	['21428']	['NV_8749']
5	['33670', '33671']	['NV_5012']
6	['46505']	['NV_8756']
7	['23739', '41884', '23711', '41883', '23738']	['NV_13343', 'NV_13342']

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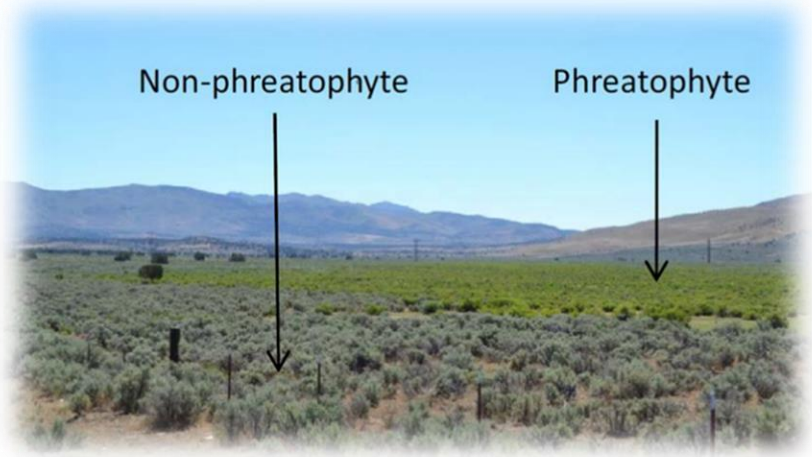
Groundwater Discharge Database

- Comprehensive database
  - State-wide



Dry Valley

ground water

Guest Editorial/

It Is the Discharge

by John Bredehoeft

We all know the mantra *Keep It Simple*—the principle KISS. I have been thinking of another mantra for ground water—*It Is the Discharge*. Let me explain: In a recent conversation with one of my distinguished colleagues, he bemoaned our lack of understanding of ground water recharge. I keep thinking about that conversation. In a broad sense as hydrogeologists, we are hoping to understand how aquifer systems function, more particularly how much water is flowing through a particular system—the focus on recharge is simply one facet of the larger task. In studying the system, there are at least three aspects that we can focus

"There is a reason why hydrogeologists in Nevada still use the Maxey-Eakin method to estimate recharge, a method published in 1949—no one has come up with an improved procedure to estimate recharge even given 50+ years of further investigation. ***On the other hand, the methods of measuring phreatophyte discharge are greatly improved***."

"….***discharge is of much more pragmatic concern than recharge."***

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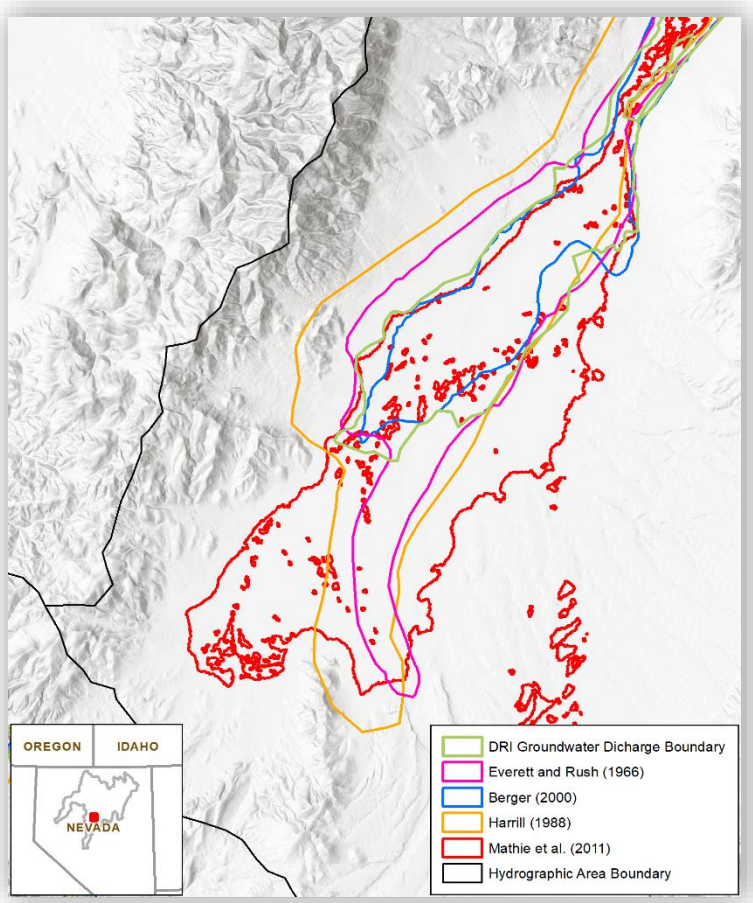
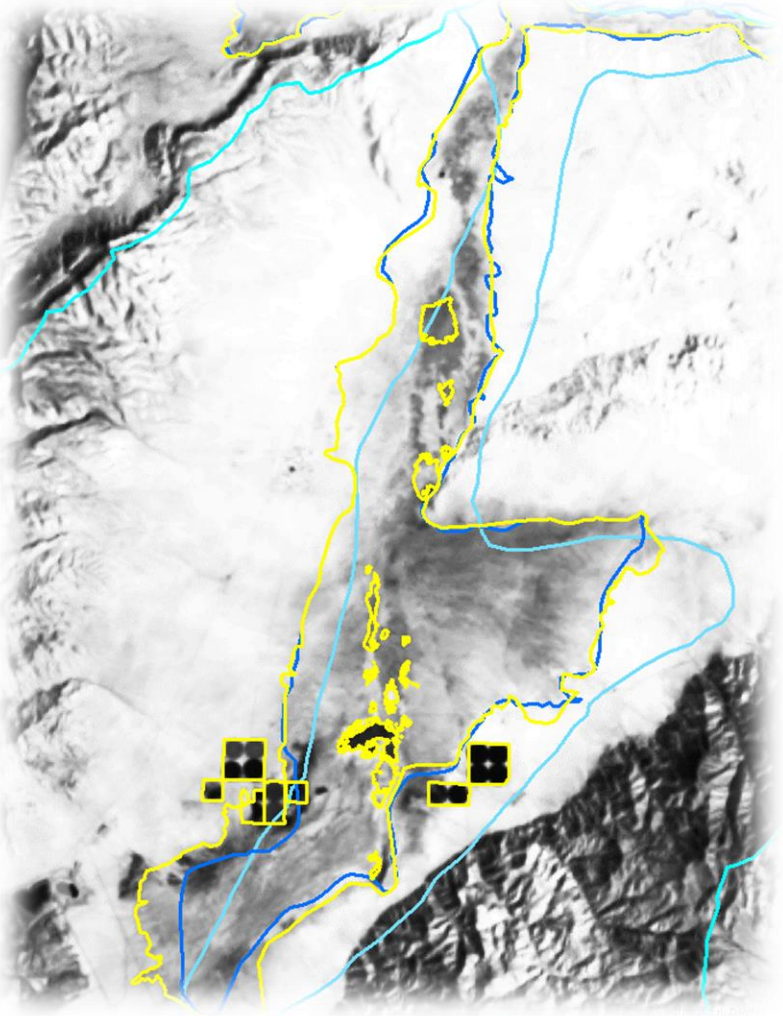
Groundwater Discharge Database

- Comprehensive database
  - State-wide
  - Potential areas of groundwater discharge



Carico Lake Valley



Crescent Valley

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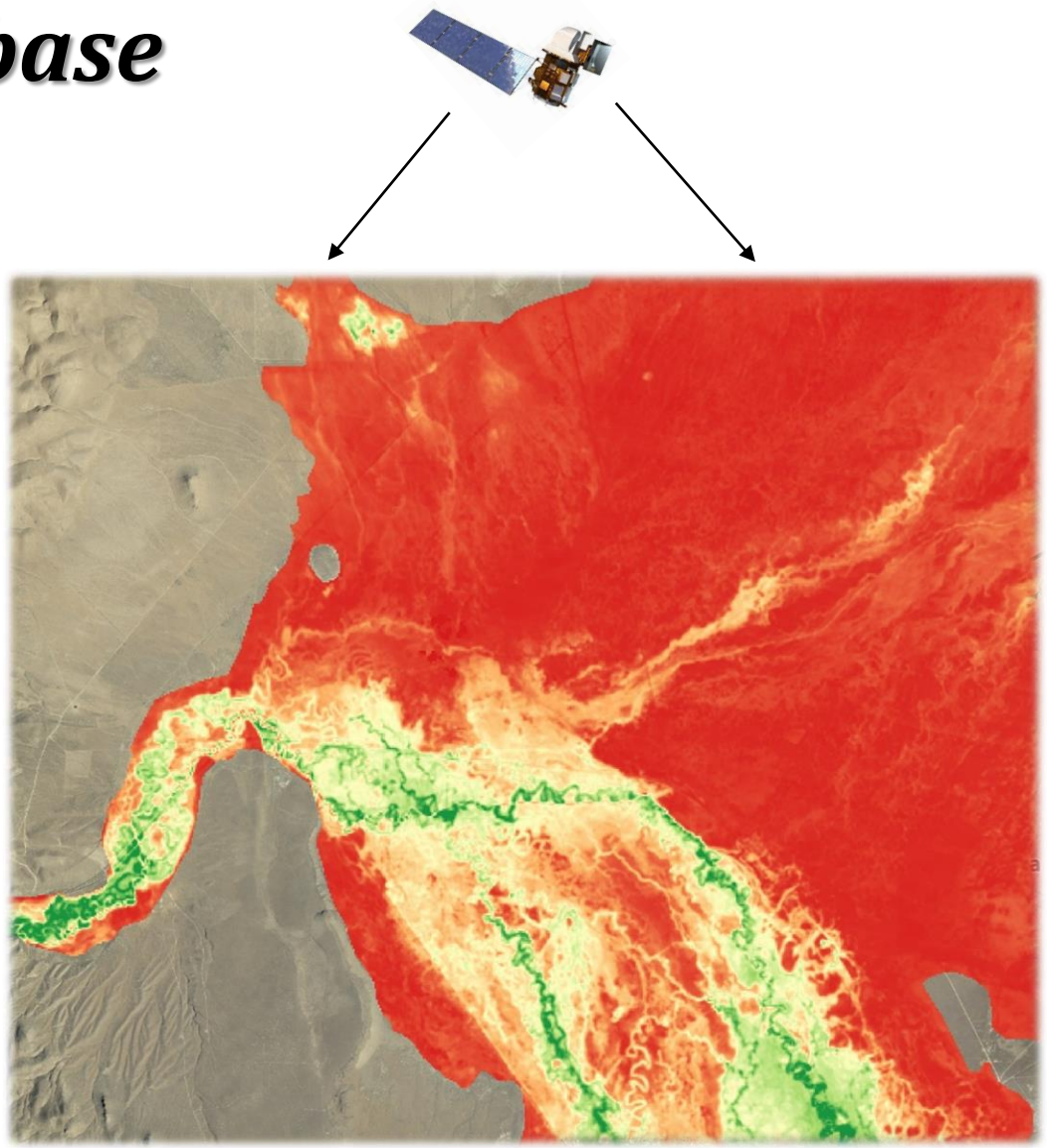
Groundwater Discharge Database

- Comprehensive database
  - State-wide
  - Potential areas of groundwater discharge
  - Groundwater ET rates and volumes



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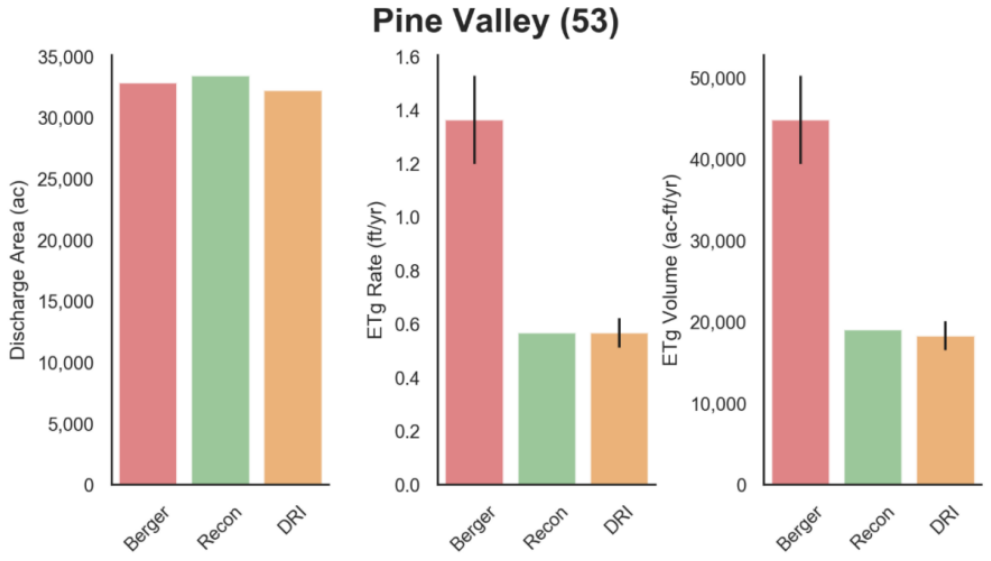
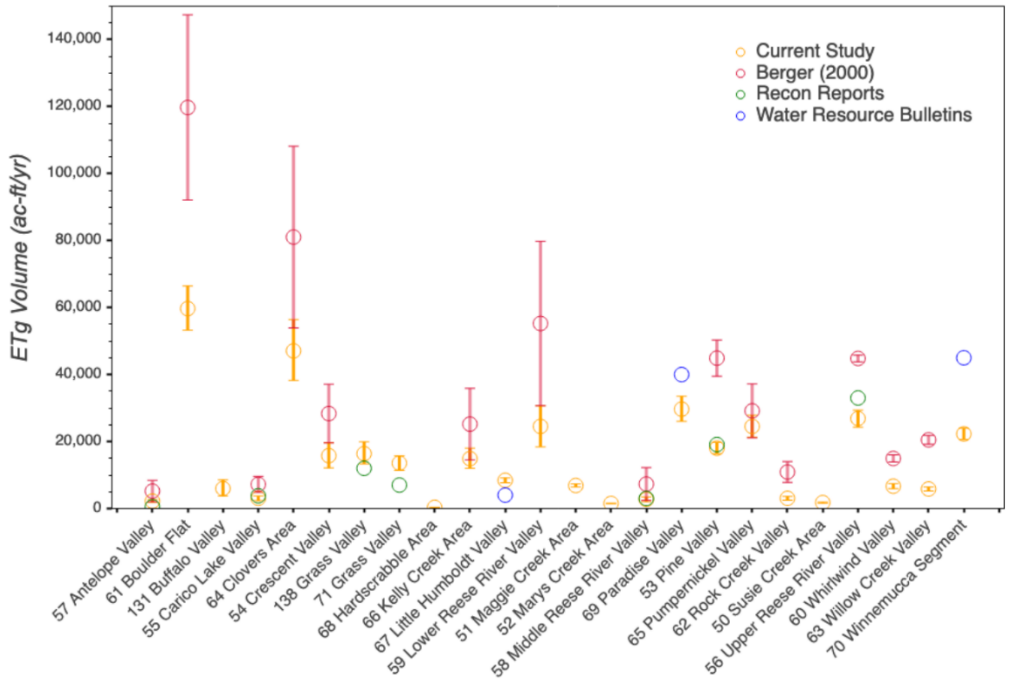
Groundwater Discharge Database

- Comprehensive database
  - State-wide
  - Potential areas of groundwater discharge
  - Groundwater ET rates and volumes
  - Comparison to micrometeorological data & previous estimates (phreatophyte & *playa discharge*)

- A very big task…*we have a head start*
  - *Humboldt River Basin*
  - *Many boundary datasets already developed and published (SNWA, BARCAS, Nichols)*





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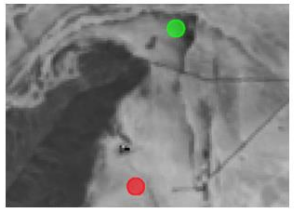
Meteorological Data and Monitoring

- Combining in-situ observation with satellite and climate data for estimating groundwater ET
  - Assessing and refining empirical relationships between satellite and groundwater ET data



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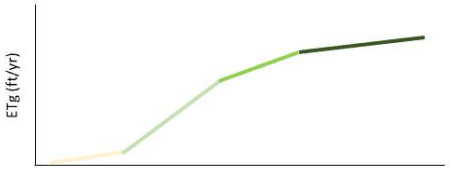
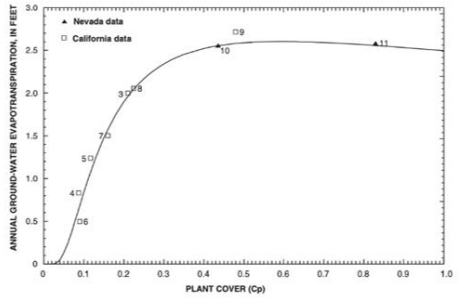
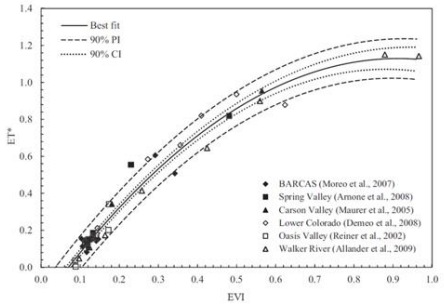


ET Unit approach



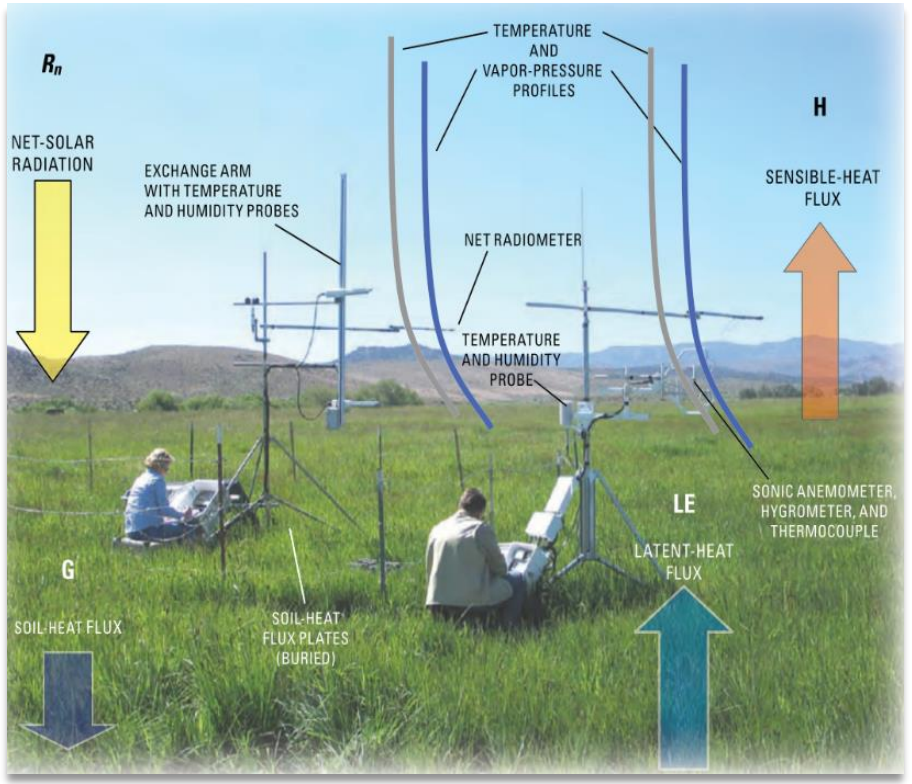
Nichols (2000)
Berger (2000)



Beamer and others (2013)

$$ET^* = \frac{ET - PPT}{ETo - PPT}$$

Maurer and others (2005)



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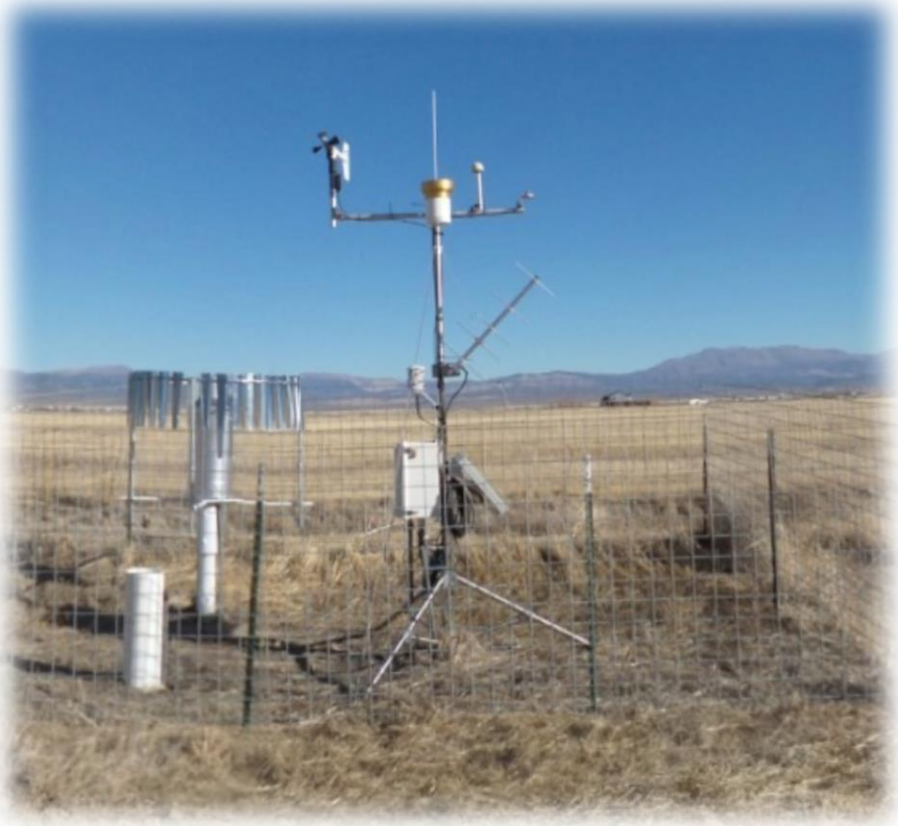
Meteorological Data and Monitoring

- Combining in-situ observation with satellite and climate data for estimating groundwater ET
  - Assess and refine empirical relationships between satellite and groundwater ET data
  - Upgrading Nevada Integrated Climate & Evapotranspiration Network (NICE Net)

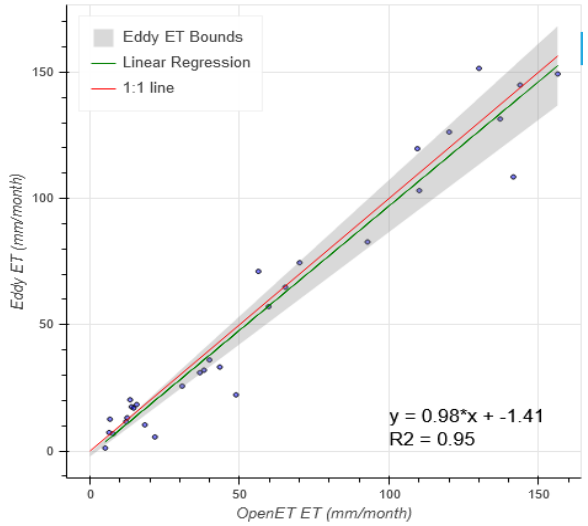


Carson Valley

Desert Research Institute

Meteorological Data and Monitoring

- Combining in-situ observation with satellite and climate data for estimating groundwater ET
  - Assess and refine empirical relationships between satellite and groundwater ET data
  - Upgrading Nevada Integrated Climate and Evapotranspiration Network (NICE Net)
  - Measuring ET within agricultural fields for intercomparison to satellite-based ET



Harney Basin, OR

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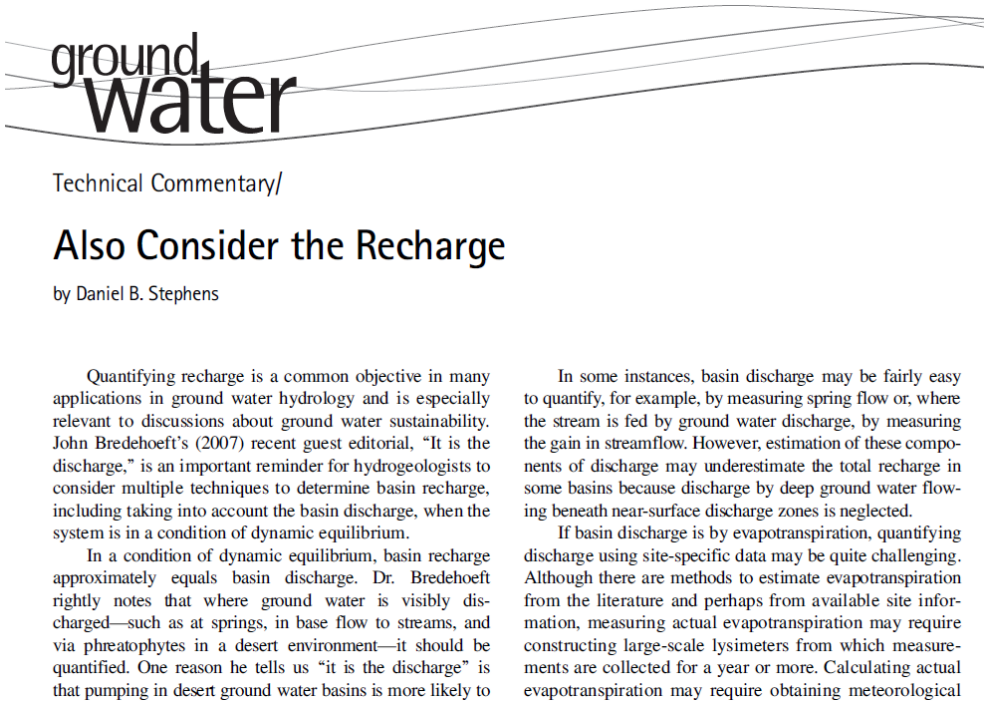
Water Resource Evaluations

- Supporting recharge datasets and methods, comparing to discharge, and assessing climate projection Information
  - Spatial ET (uplands), climate, vegetation, geology, soils, stream properties information



ground water

Technical Commentary/

Also Consider the Recharge

by Daniel B. Stephens

Quantifying recharge is a common objective in many applications in ground water hydrology and is especially relevant to discussions about ground water sustainability. John Bredehoeft's (2007) recent guest editorial, "It is the discharge," is an important reminder for hydrogeologists to consider multiple techniques to determine basin recharge, including taking into account the basin discharge, when the system is in a condition of dynamic equilibrium.

In a condition of dynamic equilibrium, basin recharge approximately equals basin discharge. Dr. Bredehoeft rightly notes that where ground water is visibly discharged—such as at springs, in base flow to streams, and via phreatophytes in a desert environment—it should be quantified. One reason he tells us "it is the discharge" is that pumping in desert ground water basins is more likely to

In some instances, basin discharge may be fairly easy to quantify, for example, by measuring spring flow or, where the stream is fed by ground water discharge, by measuring the gain in streamflow. However, estimation of these components of discharge may underestimate the total recharge in some basins because discharge by deep ground water flowing beneath near-surface discharge zones is neglected.

If basin discharge is by evapotranspiration, quantifying discharge using site-specific data may be quite challenging. Although there are methods to estimate evapotranspiration from the literature and perhaps from available site information, measuring actual evapotranspiration may require constructing large-scale lysimeters from which measurements are collected for a year or more. Calculating actual evapotranspiration may require obtaining meteorological

Stephens (2009)

"Even if the discharge is of greatest pragmatic importance, one should consider the recharge methods to bolster the calculated discharge."

"The spatial distribution of the recharge rate is often a key input requirement in numerical models of ground water systems. ***The total basin discharge per se tells us little about this flux and its spatial distribution***."

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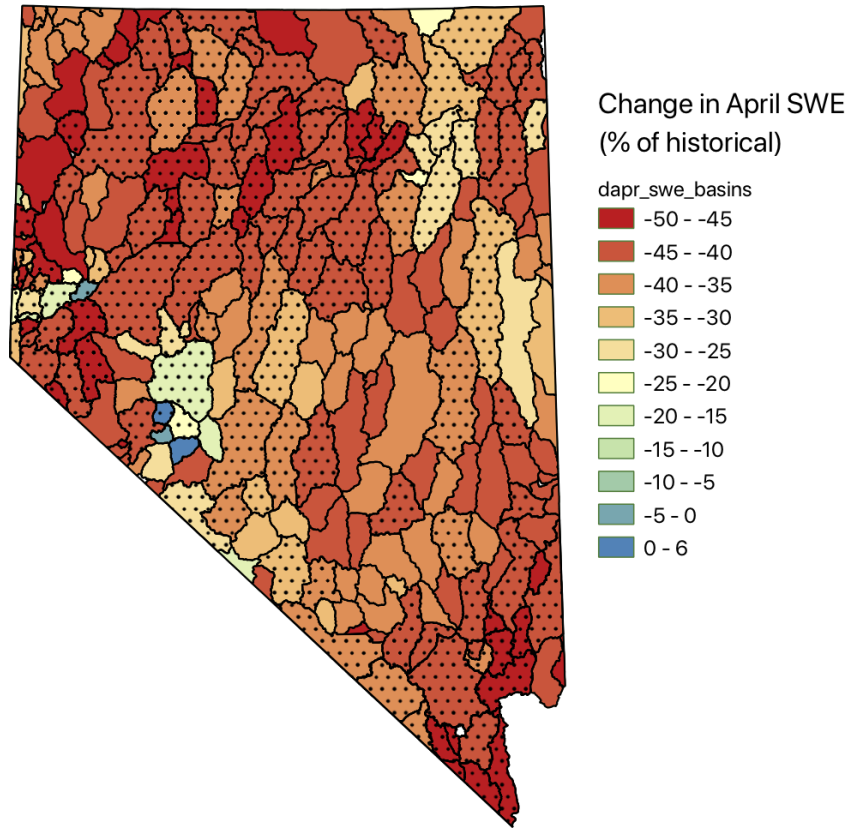
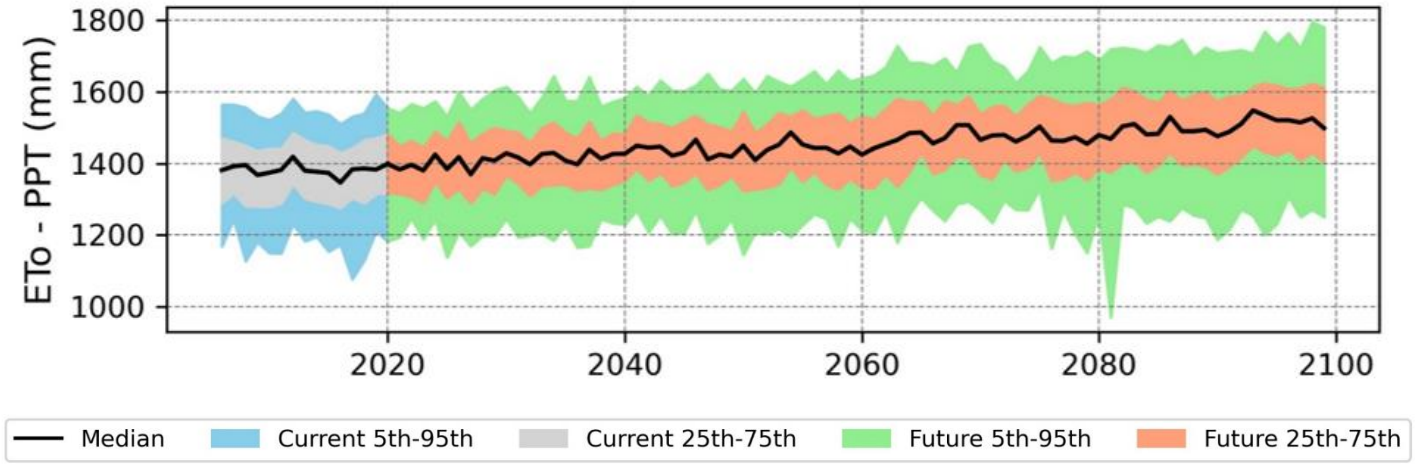
Water Resource Evaluations

- Supporting recharge estimates, comparing to discharge, and assessing climate projection Information
  - Spatial ET (uplands), climate, vegetation, geology, soils, stream properties information
  - Global Climate Model (GCM) projection information to assess potential changes in precipitation, evaporative demand, and hydrologic states and fluxes



Dettinger (2020, NWRA Pres.)



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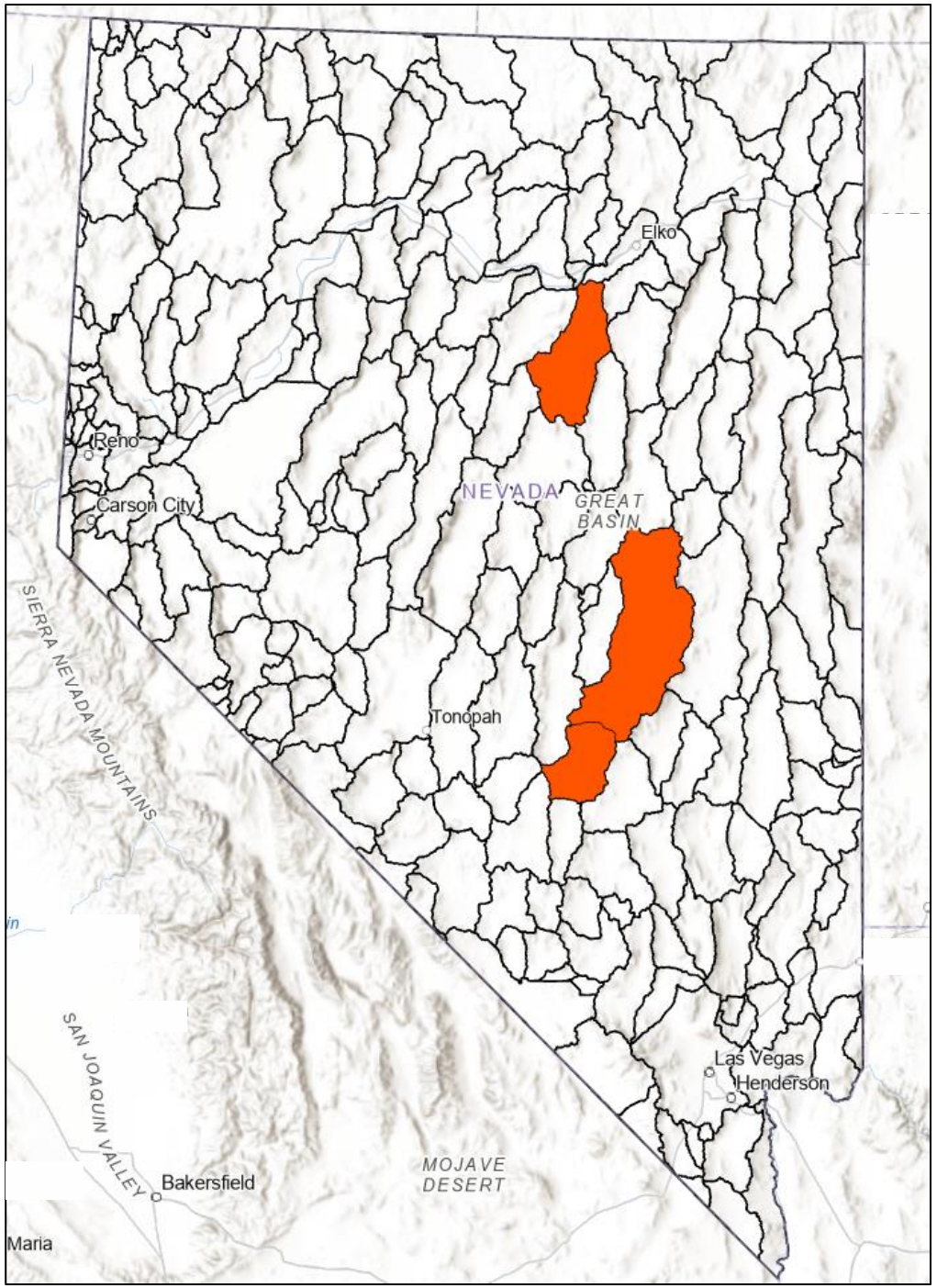
Demonstration Basins

- Pine Valley
  - Reconnaissance Series Report No. 2
    (Eakin, 1960)
- Railroad Valley
  - Reconnaissance Series Report No. 60
    (Van Denburgh & Rush, 1974)
- Reevaluate Conceptual Model
- Focus methods evaluation
  - Detailed agricultural, phreatophyte, playa ET estimates
  - Comparison to recharge and recharge efficiencies
  - GCM projections



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NWRI – DRI Activity Summary

- Support development of historical pumping database (Agricultural consumptive use inventory)
  - Agricultural water use methods → document toolbox
- Groundwater ET database
  - Groundwater ET methods → document toolbox
- Meteorological monitoring & data collection
- Water resource evaluations & GCM projections
- "Demonstration Basins"
  - Multiple teams, several projects
  - Timeline, Spring 2023 – CY2026