The Nevada Water Initiative

Advancing the Science and Understanding of Nevada's Groundwater Systems

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Nevada Water Resources Association
Annual Conference, 2024

STATE ENGINEER STATE OF NEVADA USGS science for a changing world DRI Desert Research Institute

The Nevada Water Initiative

Ongoing activities

- As a first stage to a larger and long-term effort, DRI is developing data and providing guidance to make systematic statewide updates:
  - Agricultural consumptive use inventory and pumping database
  - Groundwater discharge area and ET volumes
  - Meteorological monitoring and ET intercomparisons

Railroad Valley

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The Nevada Water Initiative

Ongoing activities

- Support USGS in developing
  - statewide pumping database (agricultural consumptive use)
  - input datasets and methods for recharge estimation
- Assess GCM projections of hydrologic states and fluxes
- Apply techniques and datasets in Demonstration Basins

Sandy Valley

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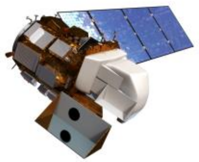
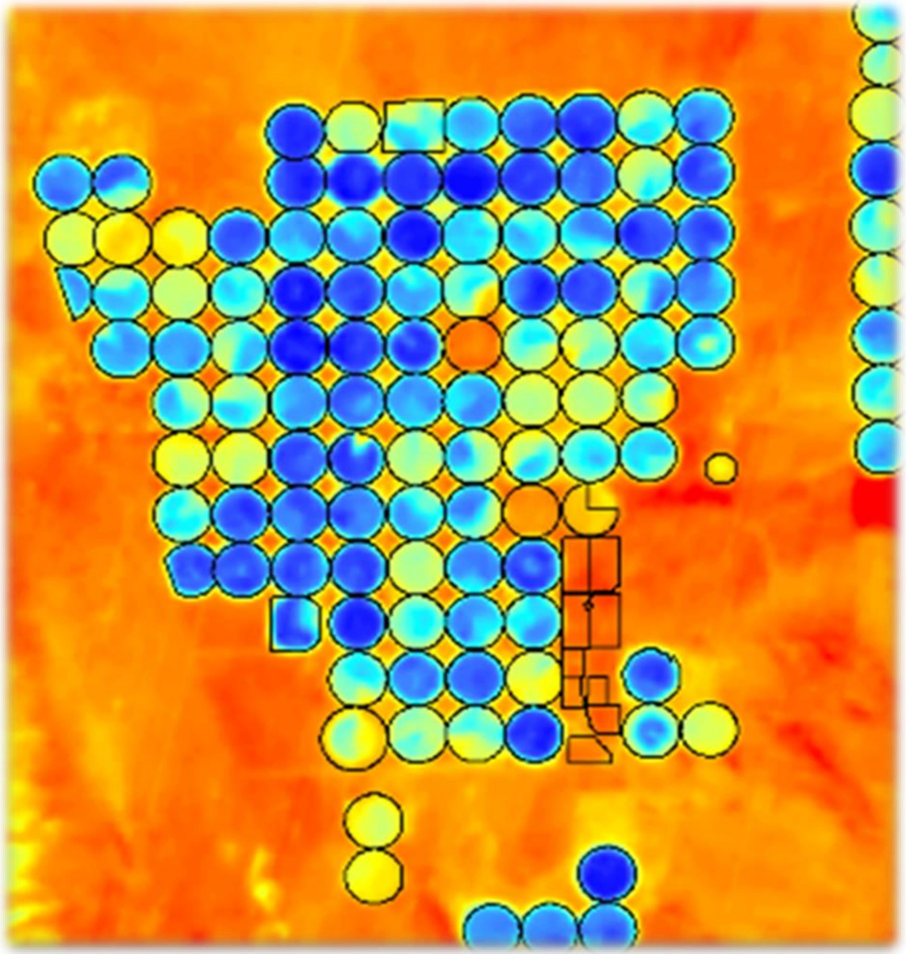
Consumptive Use Inventory & Database



- Actual crop ET a function of water supply, evaporative demand, crop type, and management practices
- Actual crop ET is commonly lower than potential crop ET due to water shortage, stress, non-uniform application, other factors
- Landsat satellite data is optimal for estimating historical crop ET and is used in this work



Blue = High ET
Based on OpenET
Landsat,1985-current

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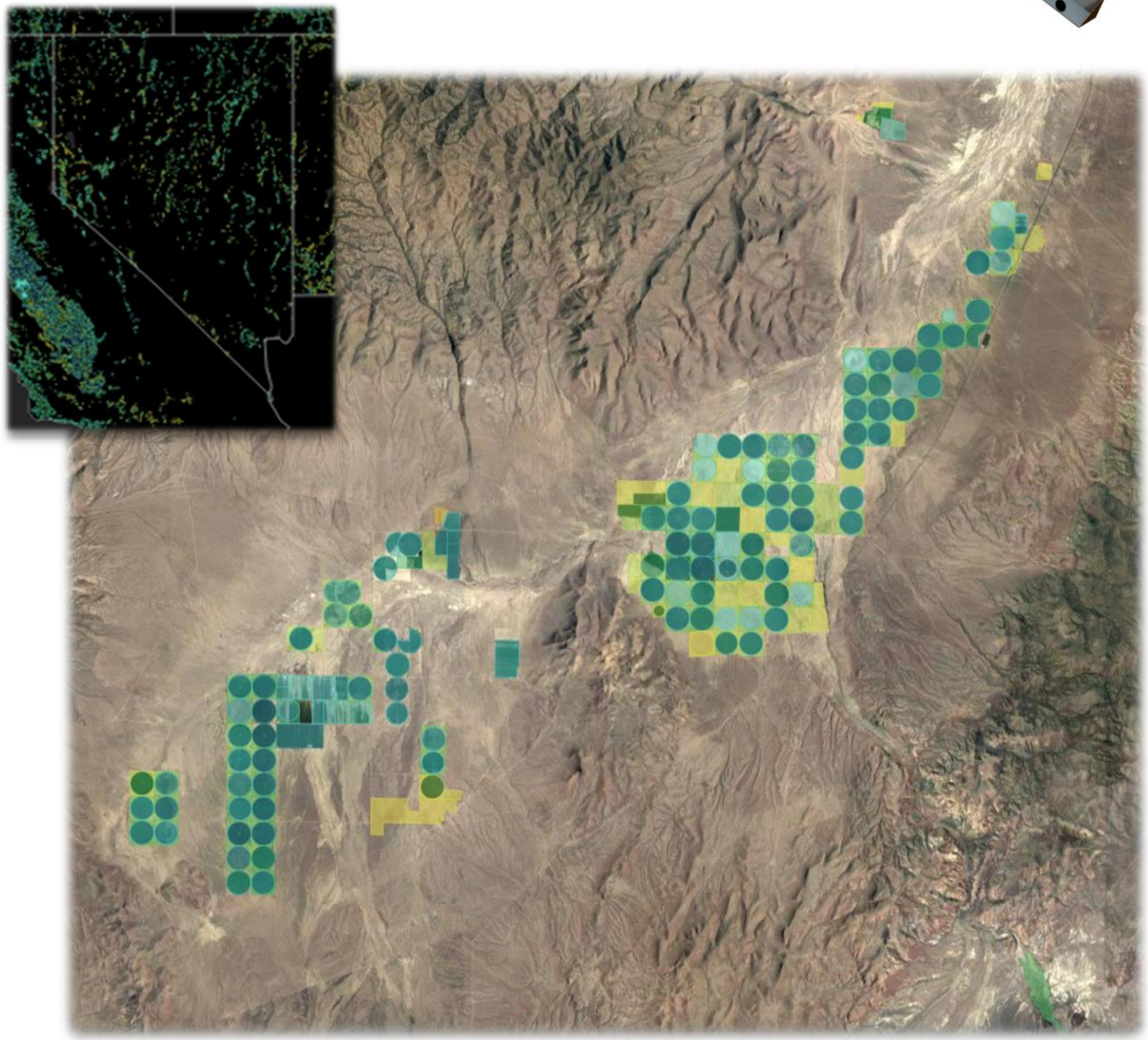
Consumptive Use Inventory & Database

- Preliminary database is 90% complete and being reviewed and refined
  - Developed field-scale ET through time (Landsat archive 1985-2023) (OpenET)
  - Developed field boundaries (24,000+ unique features) w/ attributes of:
    - Spatially averaged OpenET ensemble (6 models)
    - Crop type (USDA)
    - Irrigation status (IrrMapper)
    - Irrigation system type (5 types)
    - Irrigation efficiencies (5 values & ranges)
    - Water source (GW, SW, both)
    - Net ET estimation (ET less effective PPT)
    - Application rate estimation (Net ET / irrigation efficiency)
  - Developed initial comparisons to quality meter data
  - Developed initial basin volumes comparisons w/ committed rights and perennial yield



Middle Reese River

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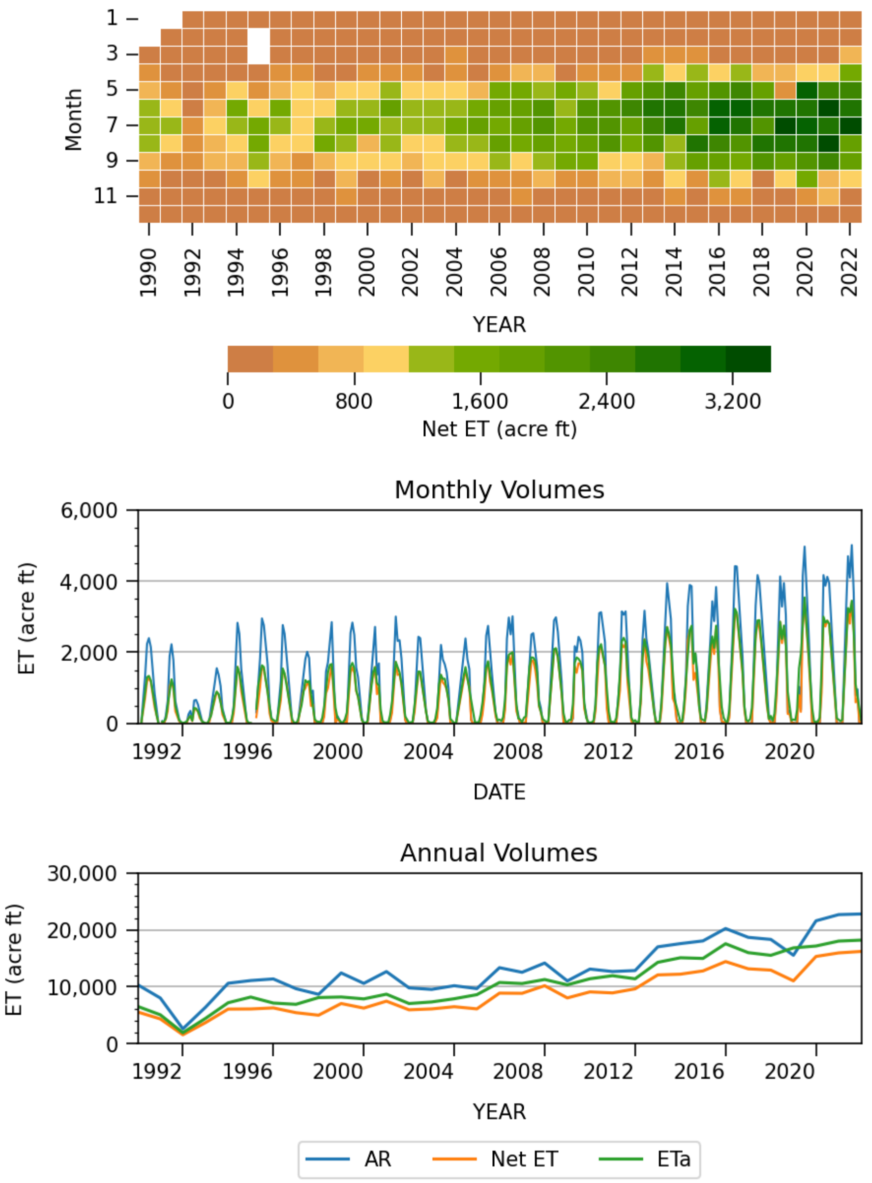
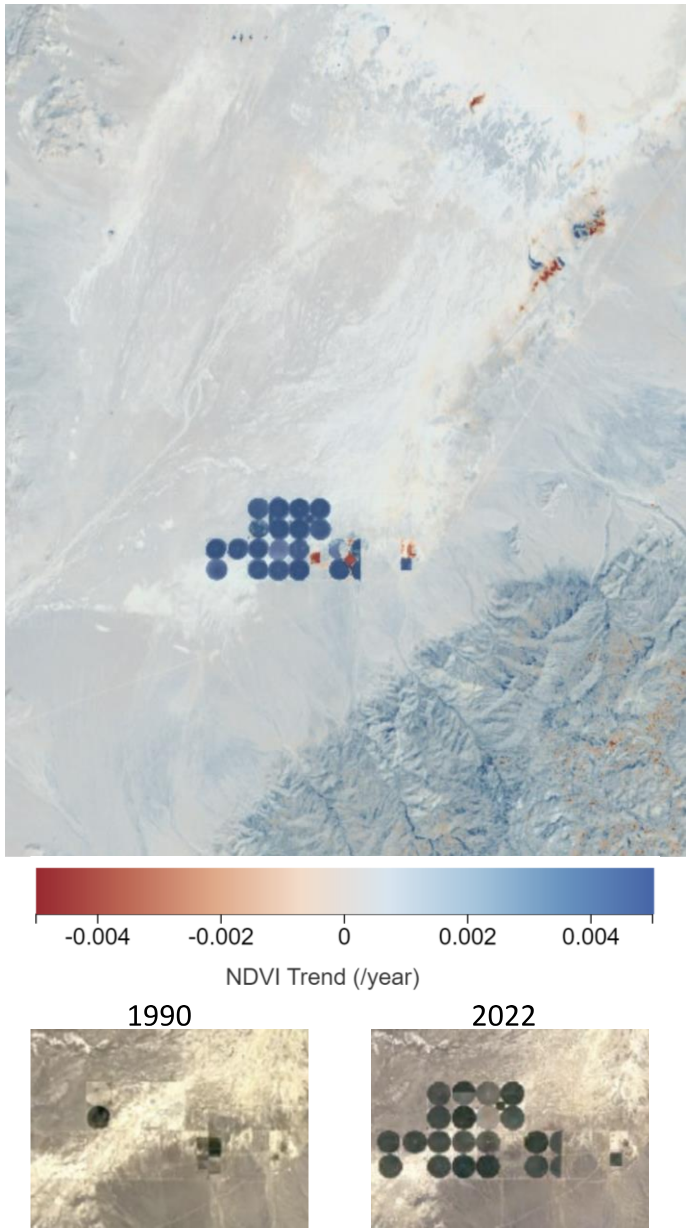
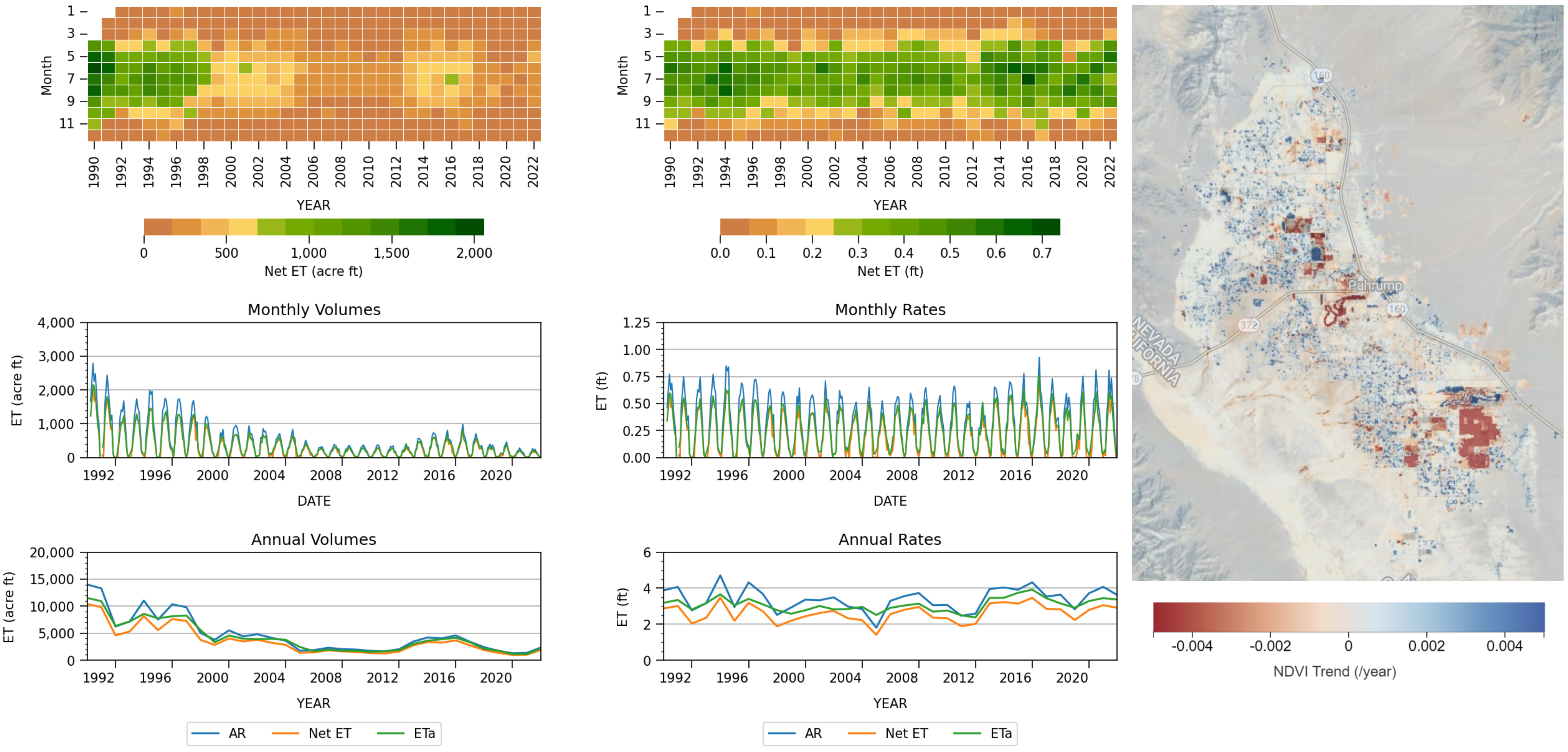
Railroad Valley (173B)





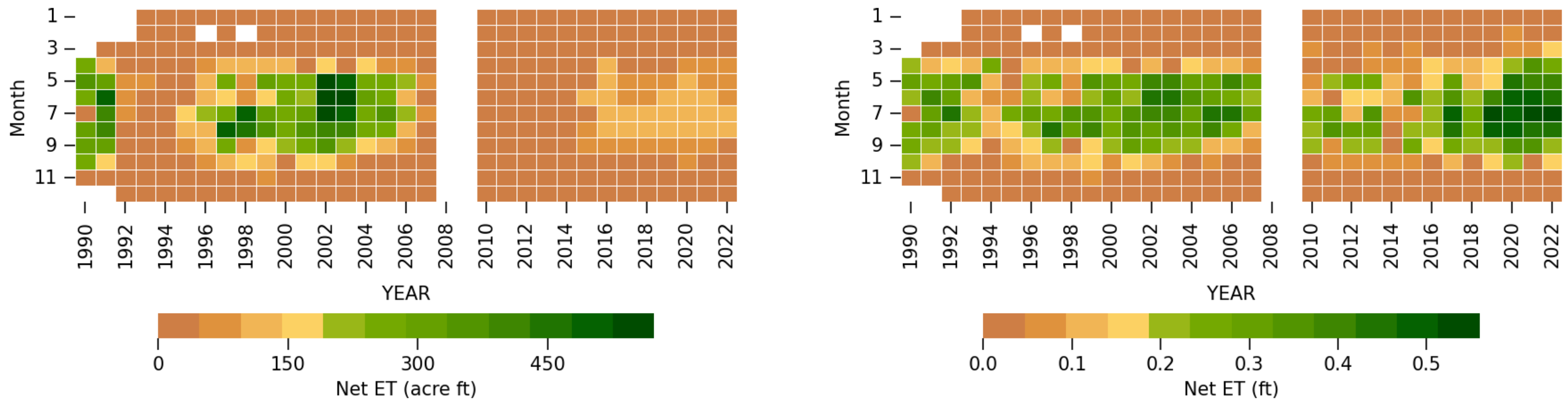
Preliminary Results

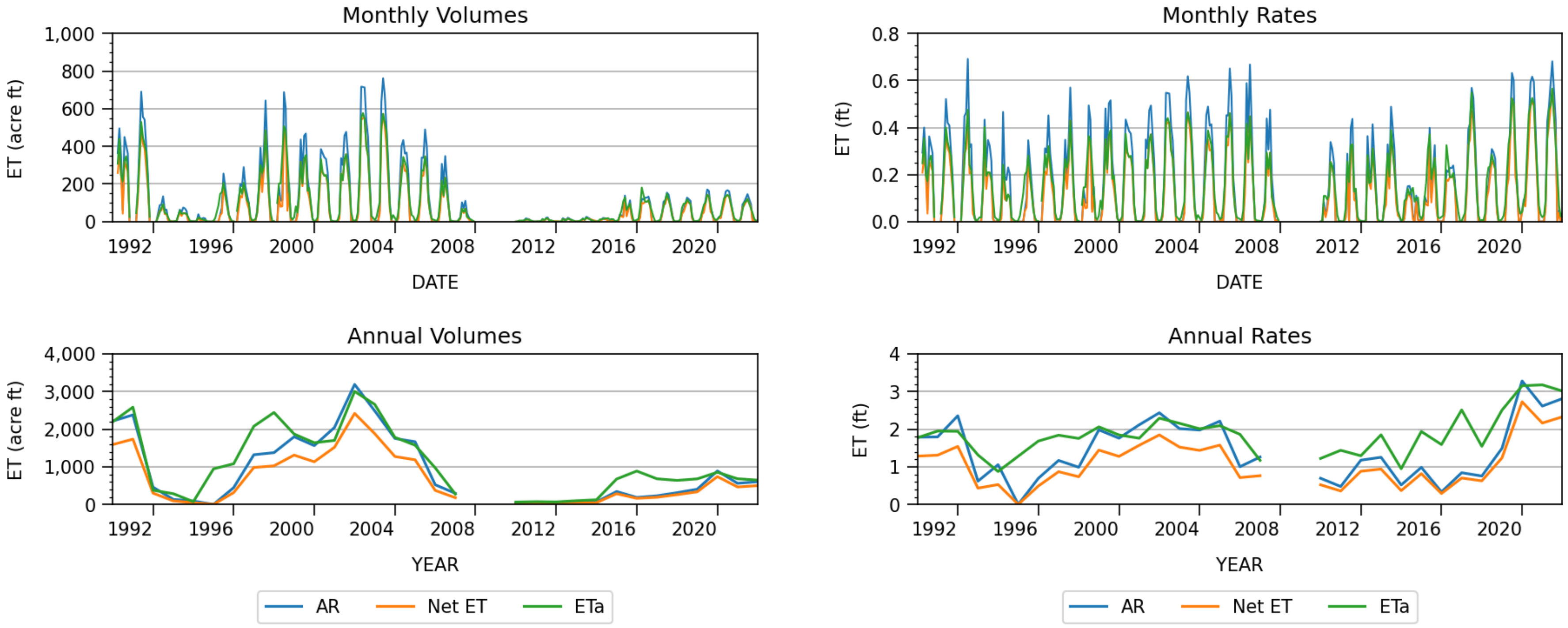
Pahrump Valley (162)

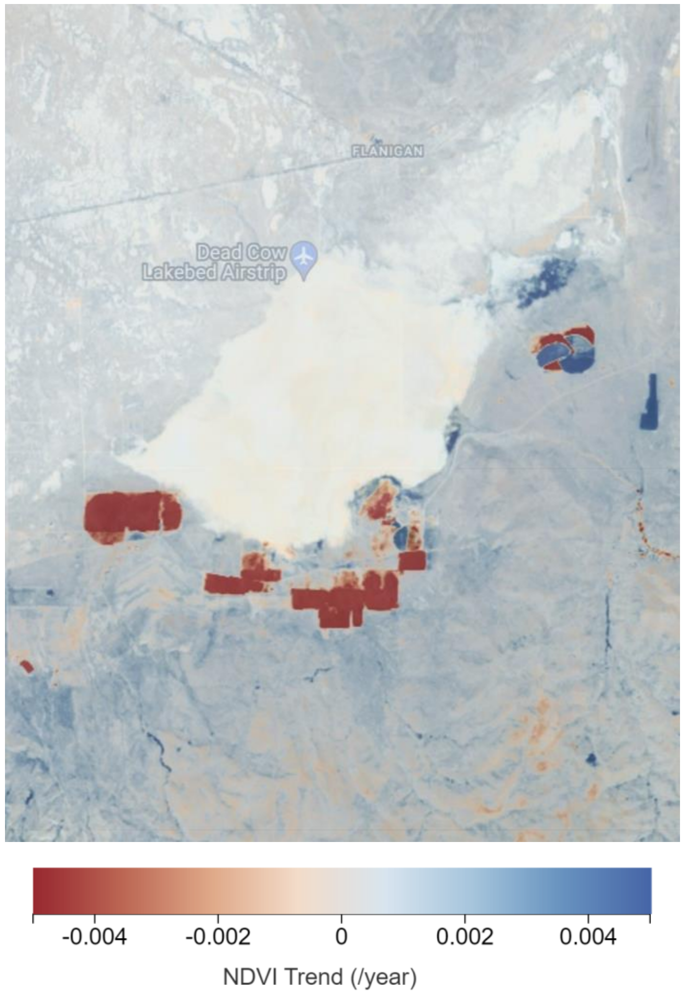


Preliminary Results

Honey Lake Valley (097)



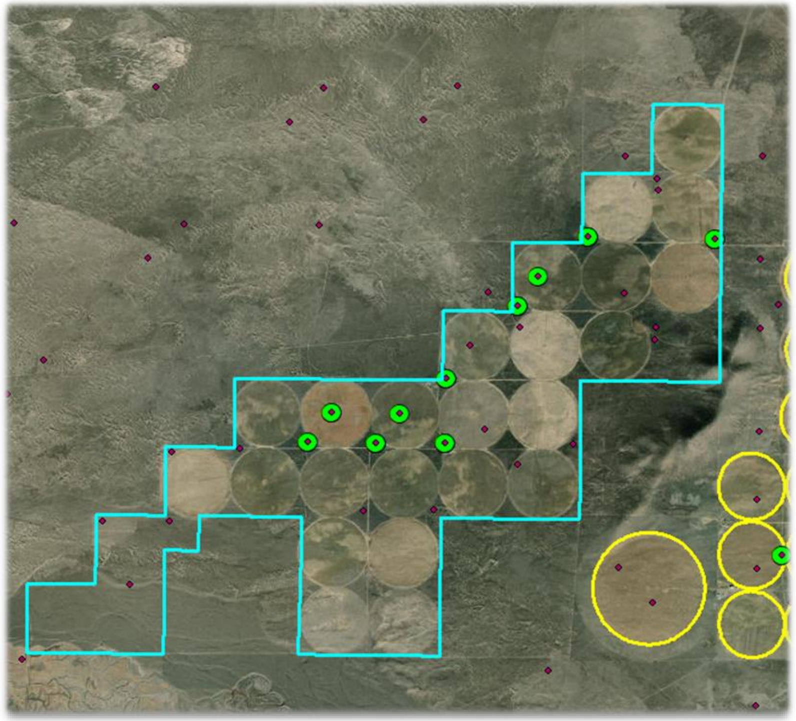




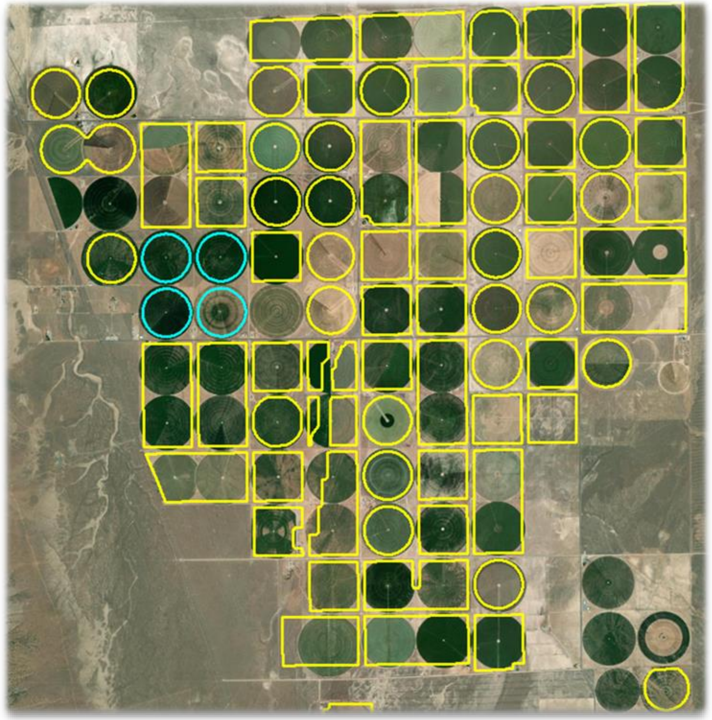
Preliminary Results

Consumptive Use Inventory & Database

- Next Steps
  - Review and revise initial results
  - Relate Net ET and Application Rates to points of diversion and attribute with screen depths
  - Refine source water mapping (SW, GW, both)
  - Compare high quality metered withdrawals to ET at field and aggregated scales
- End Product
  - Agricultural consumptive use database as a primary input for the pumping database



Little Humboldt Valley



Diamond Valley

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Groundwater Discharge Database

- Preliminary database is 50% complete
  - State-wide potential areas of groundwater discharge
    - Imagery, water levels, soils, field work, past studies
  - Updated groundwater ET rates and volumes
    - Based on in-situ micrometeorological data of ET, ETg, ETo, and PPT paired with satellite-based vegetation indices
    - Comparison to previous studies and independent micrometeorological data

Railroad Valley

"….*<u>discharge is of much more pragmatic concern than recharge."</u>* – John Bredehoeft

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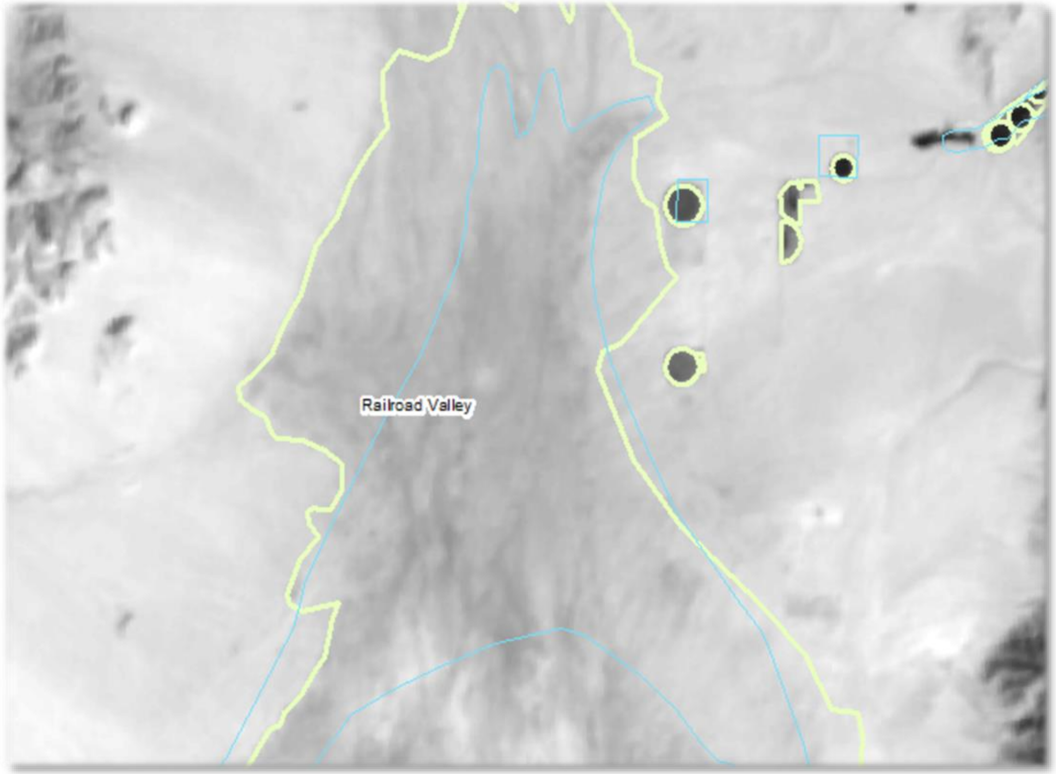
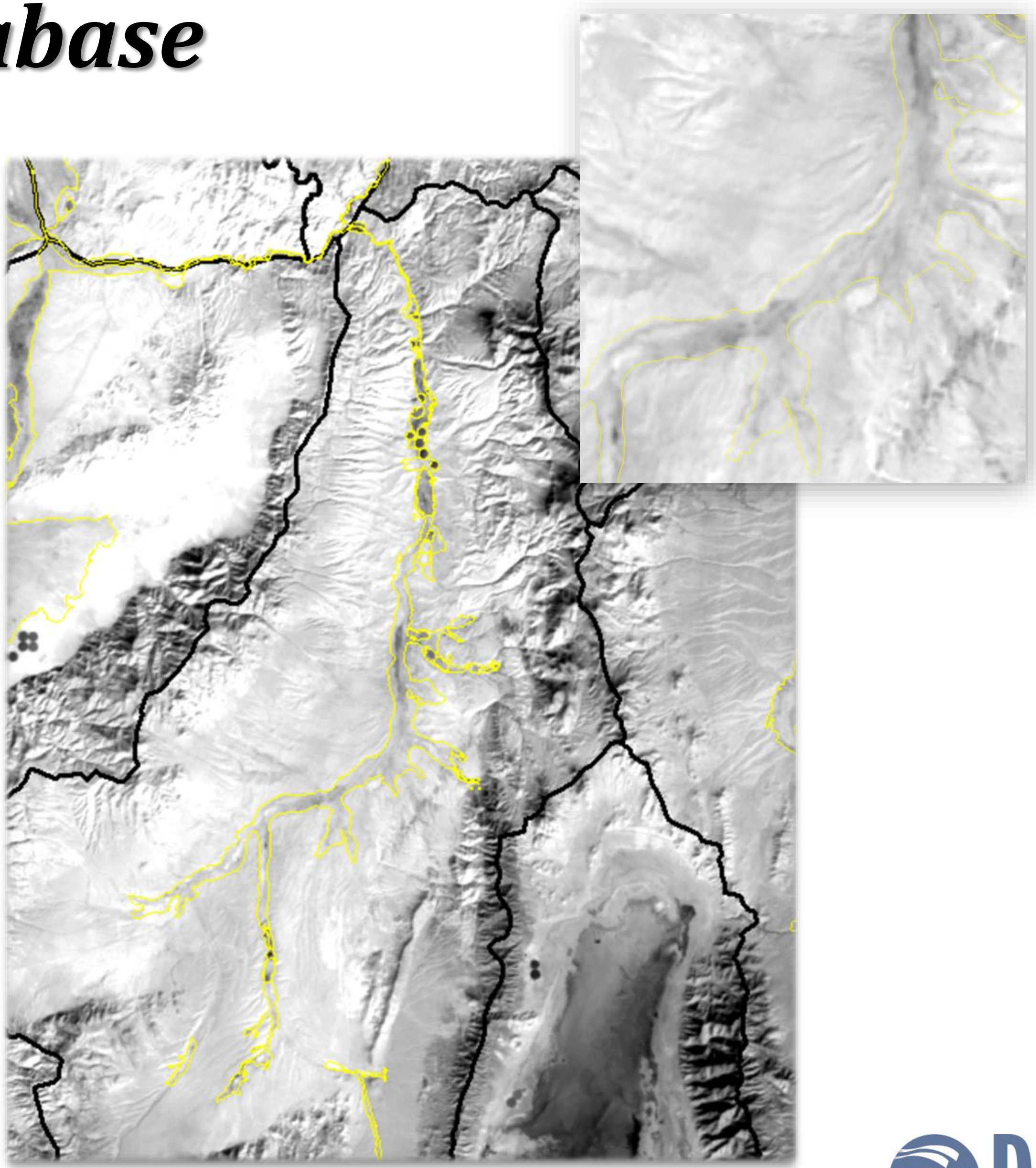
Groundwater Discharge Database

- Landsat surface temperature and very useful for refining boundaries due to evaporative cooling effect



Railroad Valley



Pine Valley

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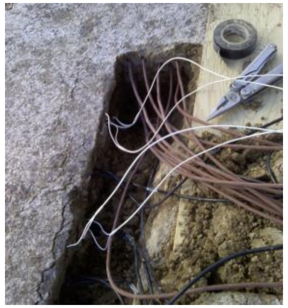
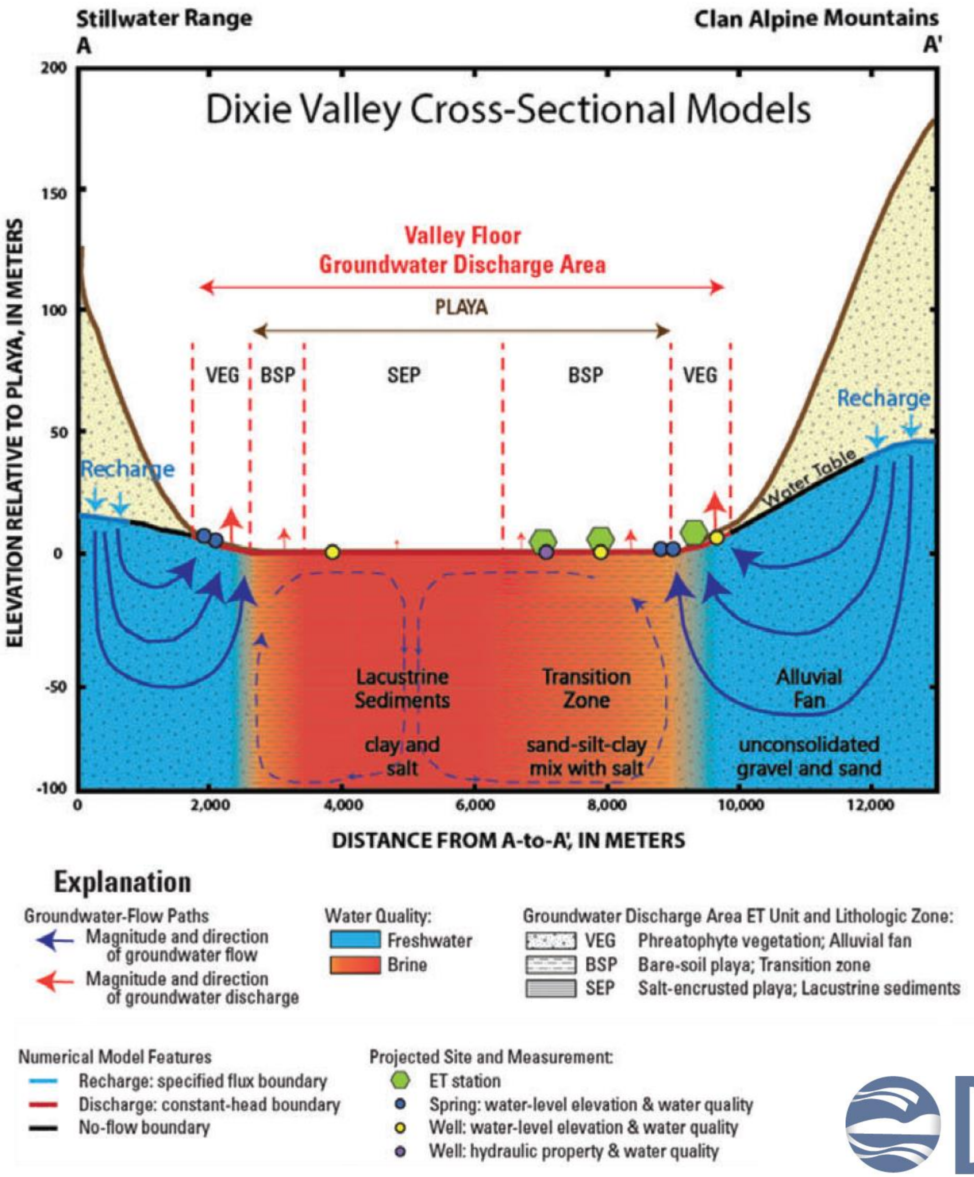
Groundwater Discharge Database

- Reflecting on Fundamentals
  - Transmissivity and groundwater density contrasts force freshwater recharge to the surface around valley floor and playa areas
  - Groundwater ET is typically highest around on outer edges of valley floor areas
  - Playa salt crusts limit evaporation
  - Playa discharge is minimal





Dixie Valley



Jackson et al. (2018) - Groundwater

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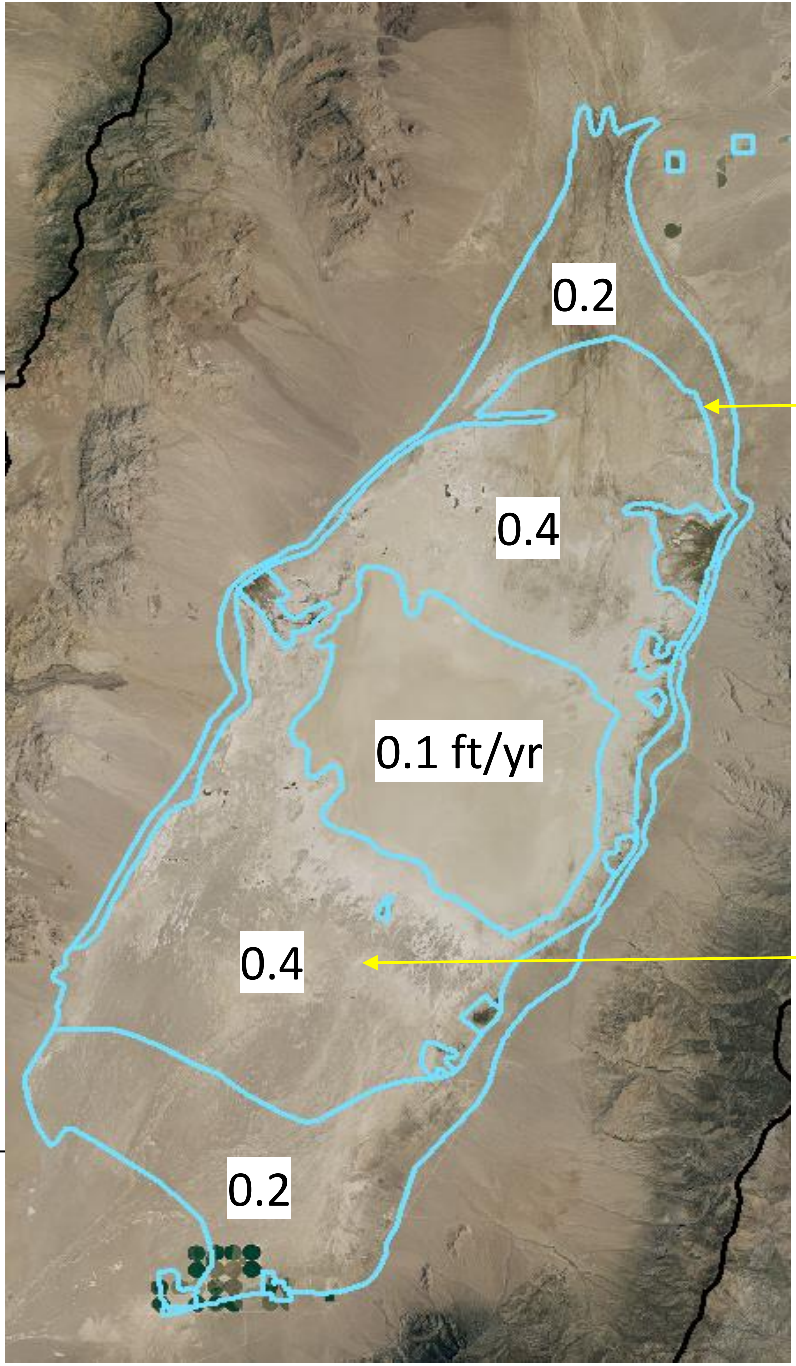
Discharge Update: Railroad Valley

Railroad Valley Recon Report 60

Table 8.--Estimated average annual ground-water evapotranspiration[1/]

Type of water loss	Area (acres)	Depth to water (feet)	Evapotranspiration Feet per year	Evapotranspiration Acre-feet per year
NORTHERN RAILROAD VALLEY				
Playa (bare soil)	38,000	0-10	0.1	3,800
Greasewood, rabbitbrush, saltbush, moderately dense to scattered	68,000	10-50	0.2	14,000
Saltgrass, with or without above phreatophytes, moderately dense to scattered	110,000	1-10	0.4	44,000
Meadowgrass, tules, willow, and other wet-area phreatophytes (includes areas of meadowgrass irrigated mostly with springflow)	12,000	0-5	1.5	18,000
Free-water surface	400	--	4	1,600
Total (rounded)	227,000	--	--	80,000

Recon Recharge ~ 55,000 – 60,000 ac-ft

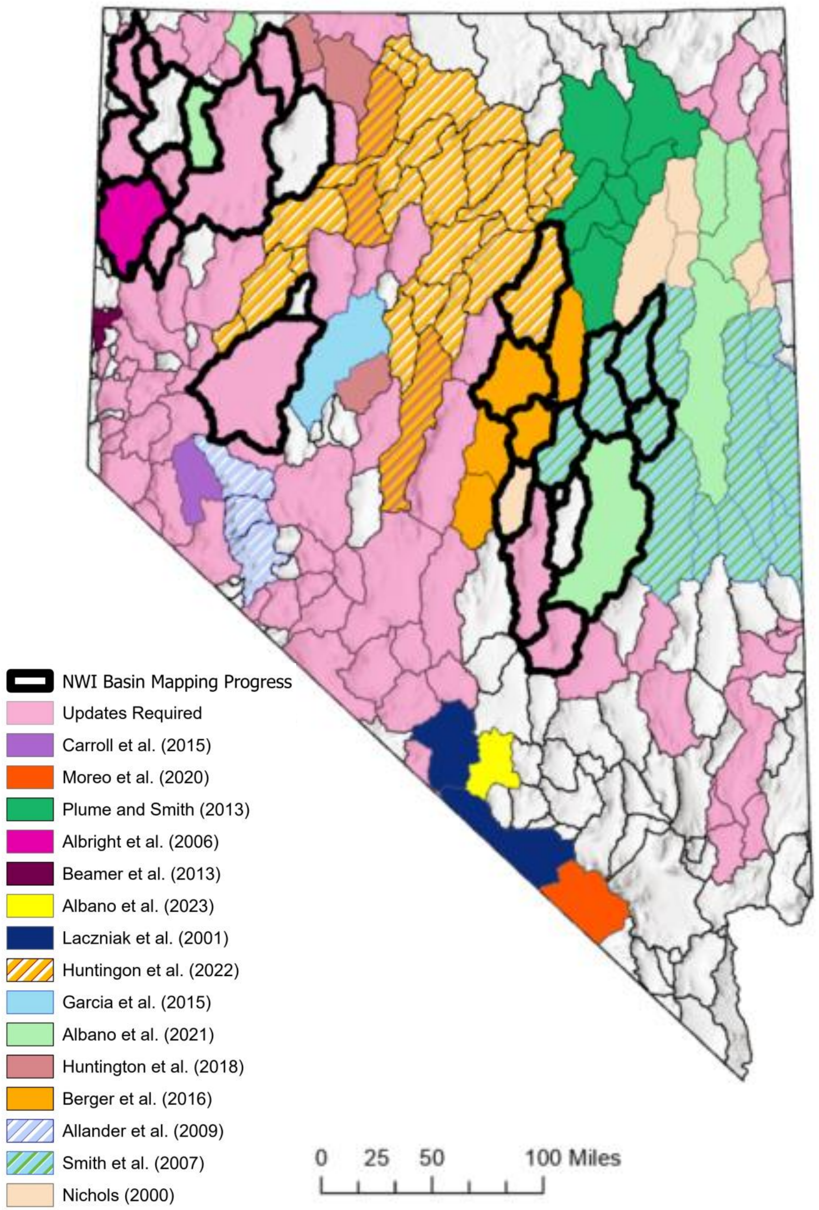


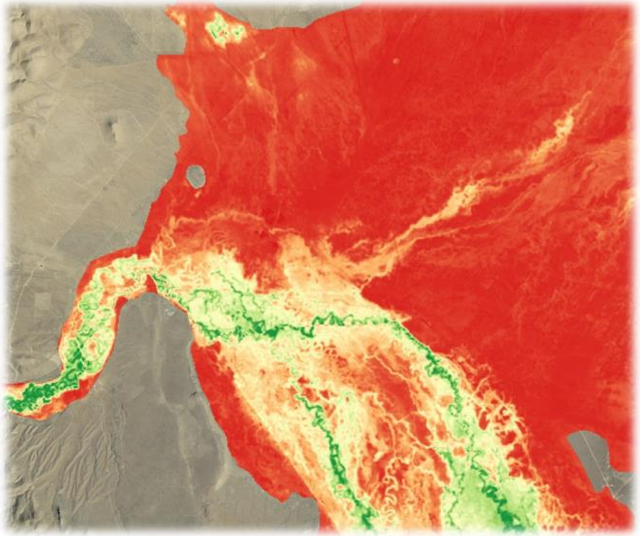
Van Denburgh & Rush, 1974

Railroad Valley

Groundwater Discharge Database

- Next Steps
  - Finish compiling previous study information
  - Perform remaining field investigations this spring/summer
  - Reassess satellite – station ET relationships, including other models
  - Develop ET Units within discharge boundaries
  - Develop preliminary discharge estimates and integrate into recharge and water budget assessments
- End Product
  - Revised discharge rates and volumes, with summaries and comparisons across all HAs and ET Units





Middle Humboldt

Meteorological Data and Monitoring

- Installed 2 eddy-covariance ET stations – Diamond Valley & Railroad Valley
  - Providing real-time data to farmers
  - Combing station with satellite data for OpenET comparisons
  - Installing 1 EC station in S. Railroad Valley phreatophyte area this spring
- Upgrading Nevada Integrated Climate & Evapotranspiration Network (NICE Net) – 18 stations in agriculture (nicenet.dri.edu)

Diamond Valley

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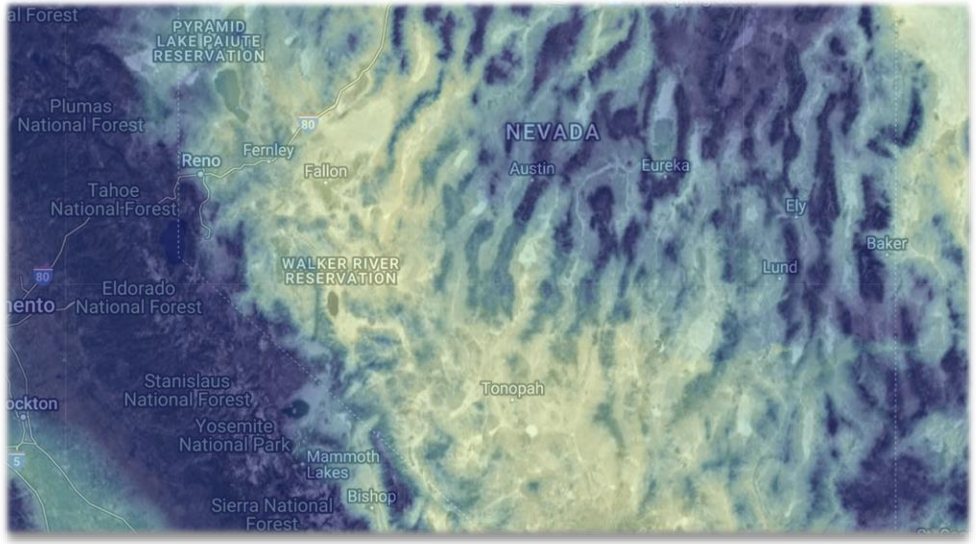
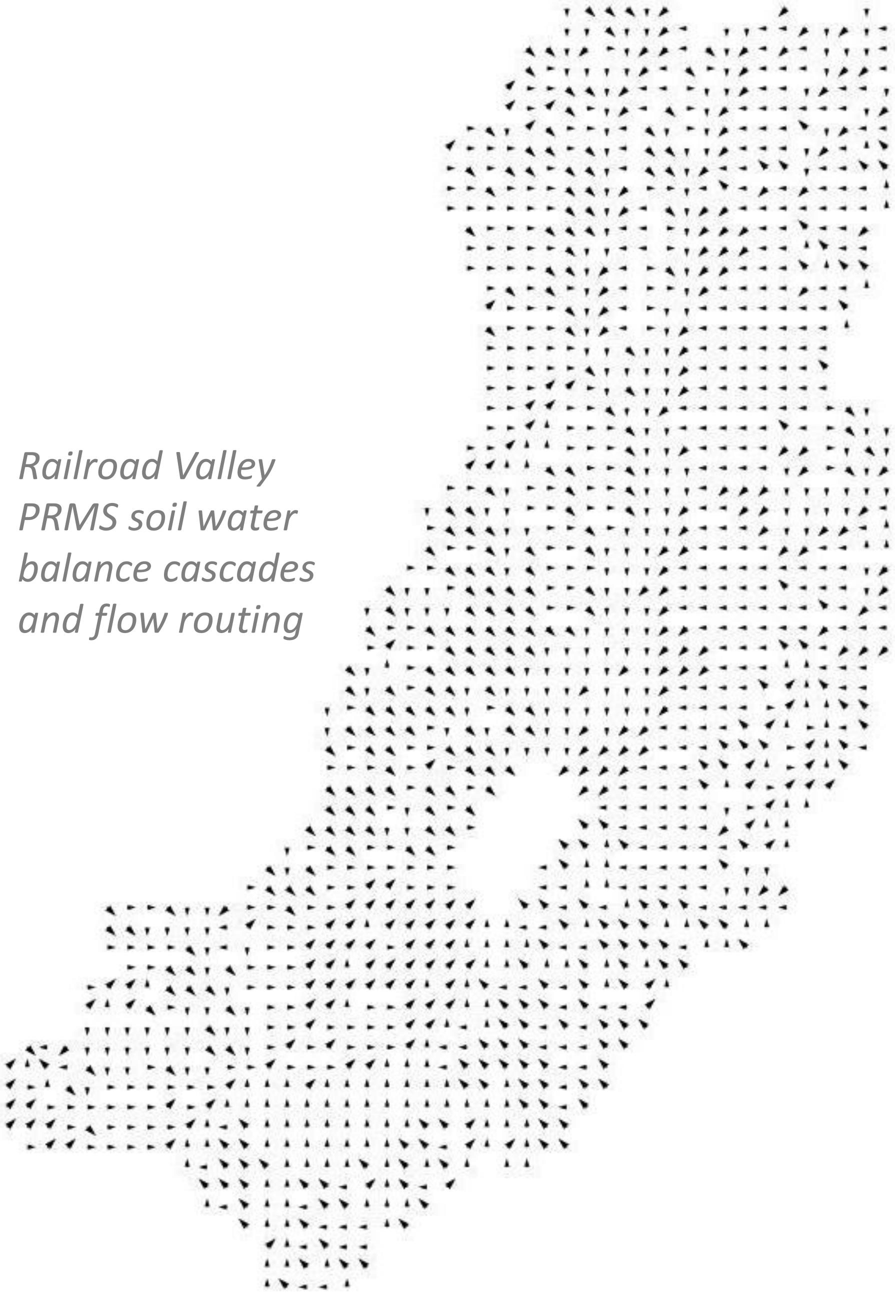
Water Resource Evaluations

- Supporting USGS in developing recharge, comparing to discharge, and providing geospatial data
  - Co-developing PRMS model for Railroad Valley
  - Exploring multiple climate, vegetation, soils, ET, recharge, and other spatial datasets, state-wide





Railroad Valley PRMS soil water balance cascades and flow routing

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Thanks to the Team

- USGS and NDWR Staff
- Groundwater Discharge *(Blake Minor, Murphy Gardner, Eugene Long)*
- Agricultural Consumptive Use Inventory *(Matt Bromley, Peter ReVelle, Blake Minor, Thomas Ott)*
- Agricultural Withdrawals *(Sayantan Majumdar, Thomas Ott, Matt Bromley)*
- Evapotranspiration and Climate Monitoring *(Richard Jasoni, Chris Pearson, John Volk)*
- GCM and Recharge *(John Volk, Murphy Gardner, Christine Albano, Mike Dettinger)*
- Water Resource Investigations *(John Volk, Murphy Gardner, Blake Minor, Eugene Long)*

Desert Valley

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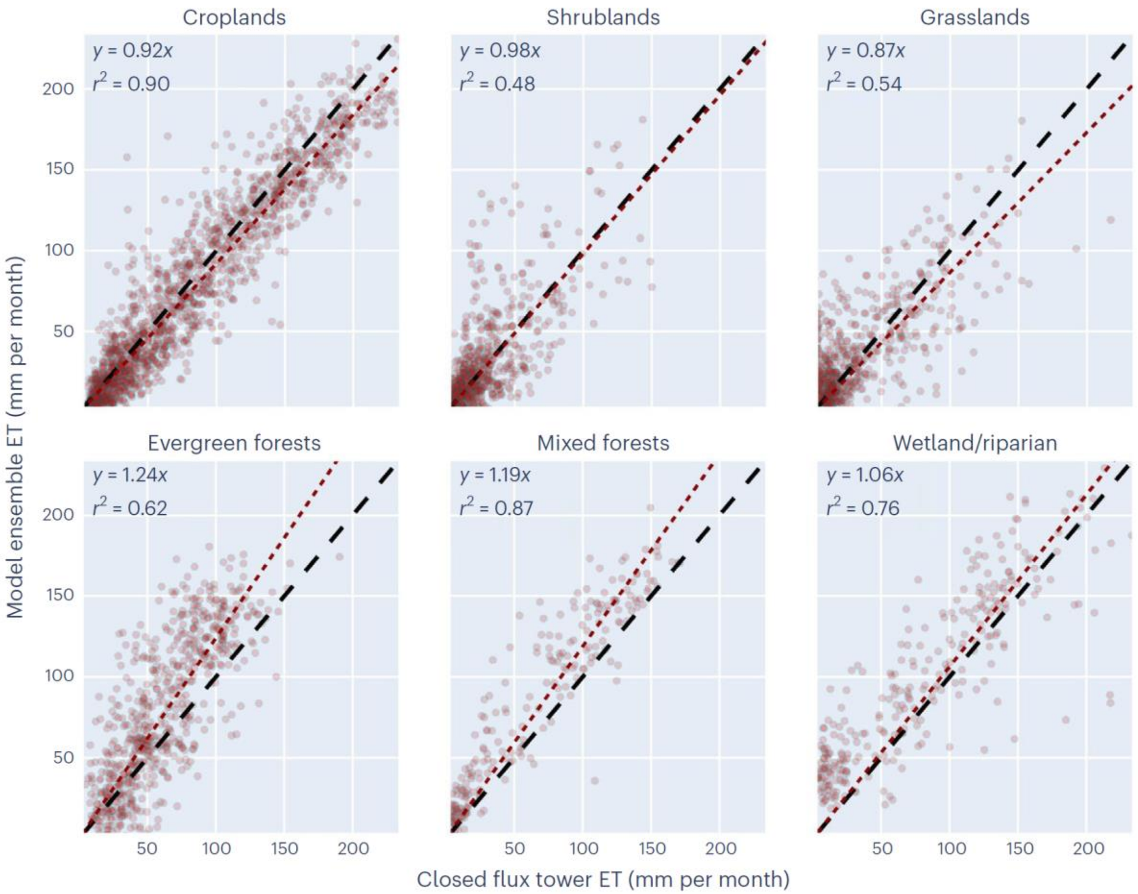
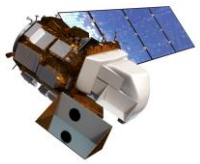
Consumptive Use Inventory & Database

- Accuracy good for croplands; Growing season Mean Absolute Error = 13%, 39 sites, n=177
- Accuracy no good for shrublands; Growing season Mean Absolute Error = 40%, 21 sites, n=88





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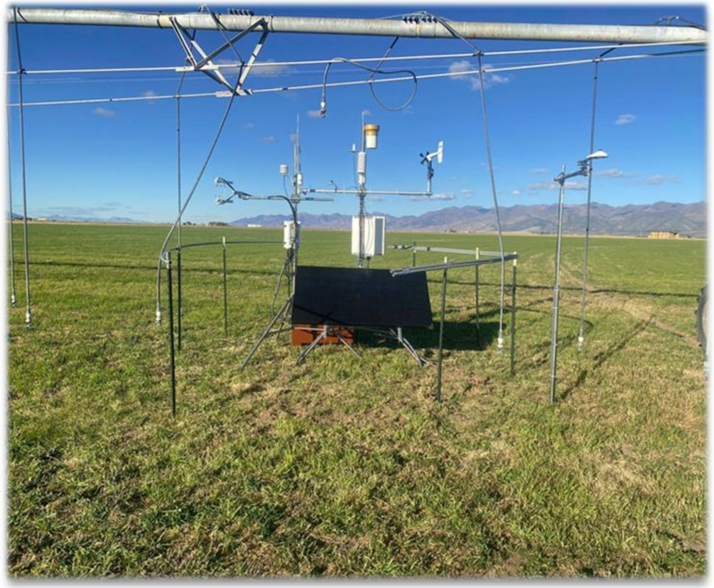
Assessing the accuracy of OpenET satellite-based evapotranspiration data to support water resource and land management applications

John M. Volk, Justin L. Huntington, Forrest S. Melton, Richard Allen, Martha Anderson, Joshua B. Fisher, Ayse Kilic, Anderson Ruhoff, Gabriel B. Senay, Blake Minor, Charles Morton, Thomas Ott, Lee Johnson, Bruno Comini de Andrade, Will Carrara,



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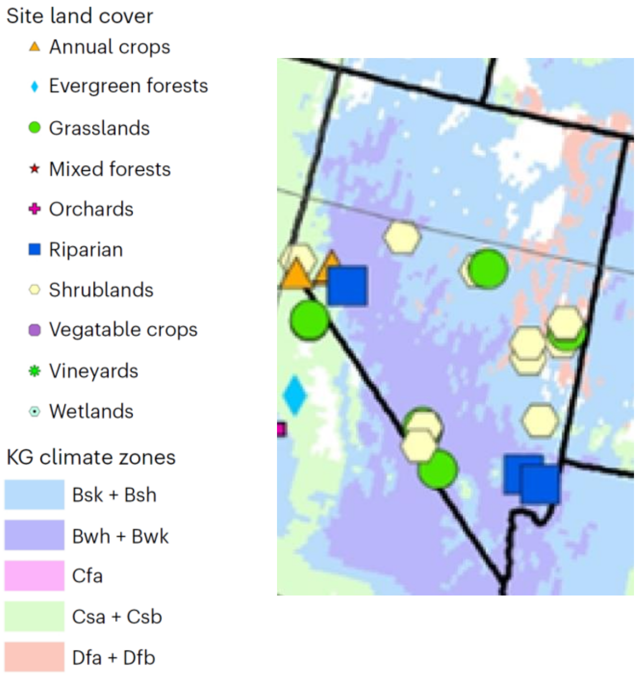
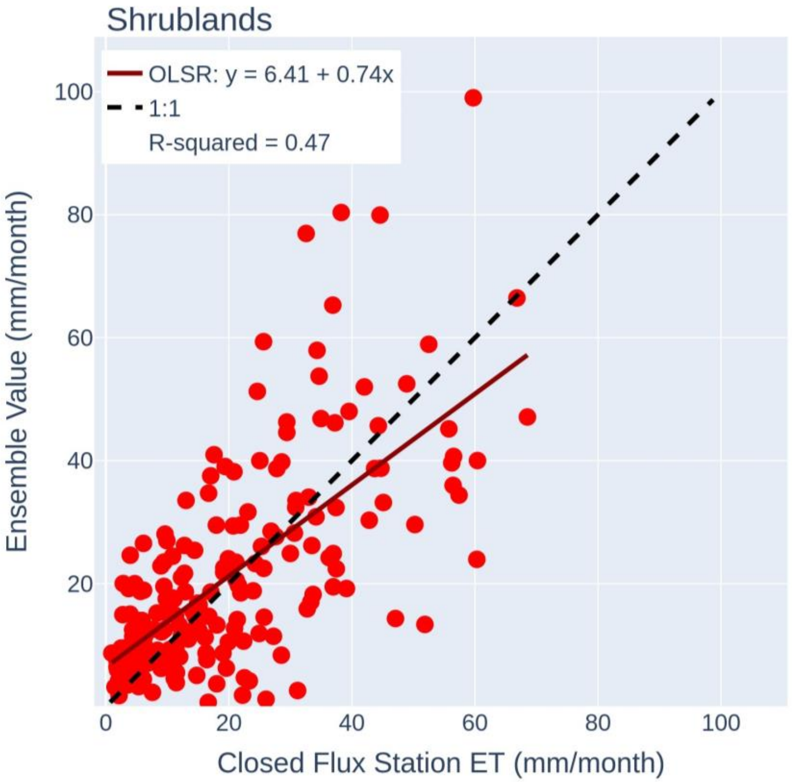
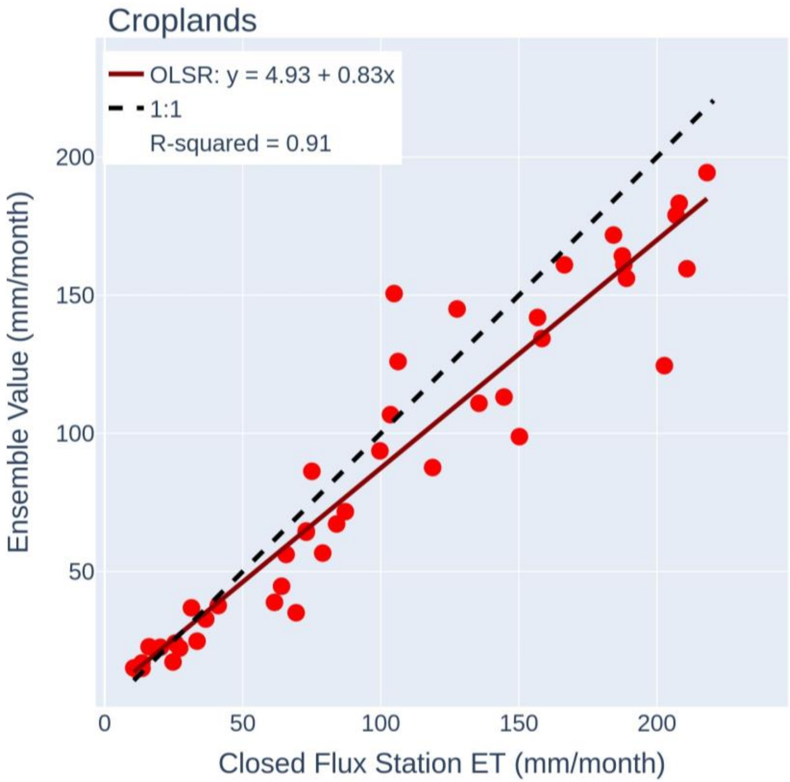
Nevada OpenET Intercomparisons (monthly)

		Ensemble	geeSEBAL	PT-JPL	SSEBop	SIMS	eeMETRIC	DisALEXI	N sites	N data points
Shrublands	**Slope**	0.94	1.24	0.78	0.59		1.34	0.91	12	199
	MBE (mm)	1.68	9.66	-0.06	-8.45		12.12	0.98	12	199
	MAE (mm)	10.79	16.97	12.27	13.74		17.77	12.43	12	199
	RMSE (mm)	13.24	21.53	14.66	16.54		21.84	15.25	12	199
	R-squared	0.46	0.28	0.26	0.33		0.44	0.37	12	199
Croplands	**Slope**	0.86	0.85	0.8	0.82	0.88	0.95	0.8	3	45
	MBE (mm)	-12.31	-16	-14.64	-20.11	-6.24	-0.58	-21.74	3	45
	MAE (mm)	17.87	24.88	21.88	25.5	16.52	16.1	26.93	3	45
	RMSE (mm)	22.9	31.26	28.13	30.18	20.22	23.14	34.6	3	45
	R-squared	0.91	0.83	0.87	0.88	0.94	0.88	0.82	3	45

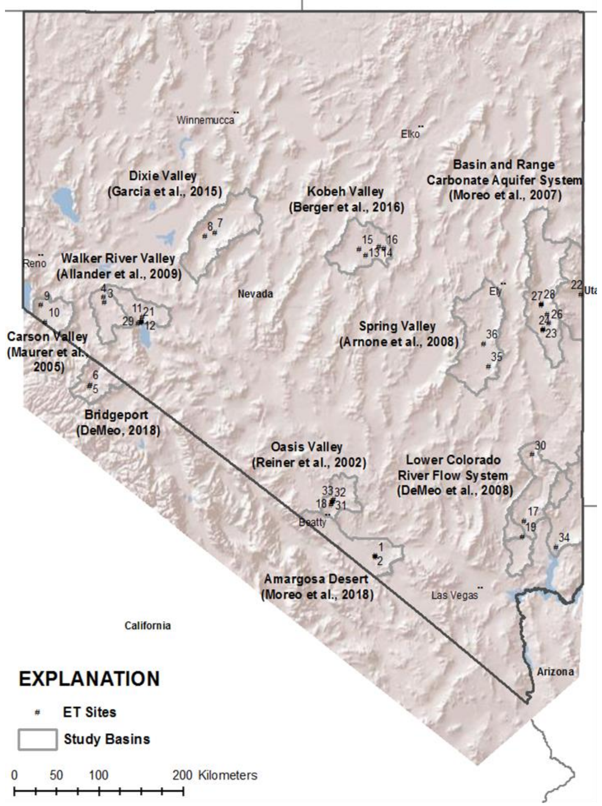


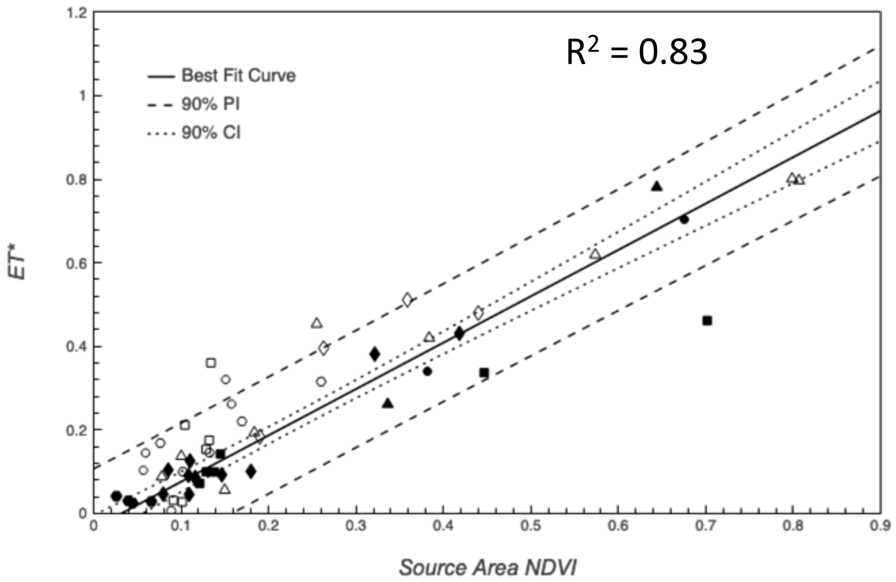




NDVI – ET Predictive Equation*

- Paired 54 site-year ET* values with respective mean NDVI values
- ET* = ET – PPT / ETo – PPT
- Water year time steps
- NDVI was chosen over other vegetation indices
  - NDVI is a popular standard measure, doesn't require soil parameter calibration, shown to outperform other indices for in sparse vegetation
  - Other indies were also used. Didn't really change the fit…
  - Taking another look at VI and ET relationships for existing and new datasets





Water Resource Evaluations

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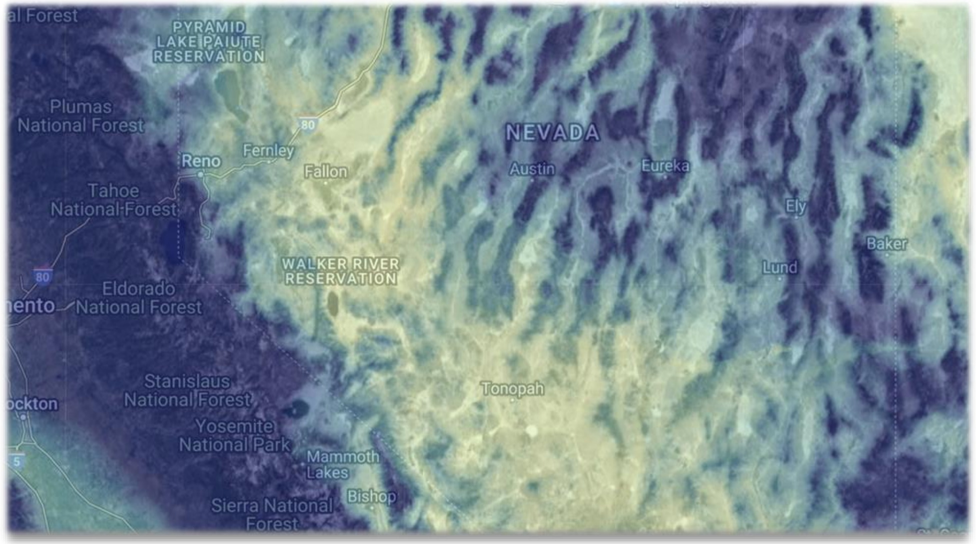
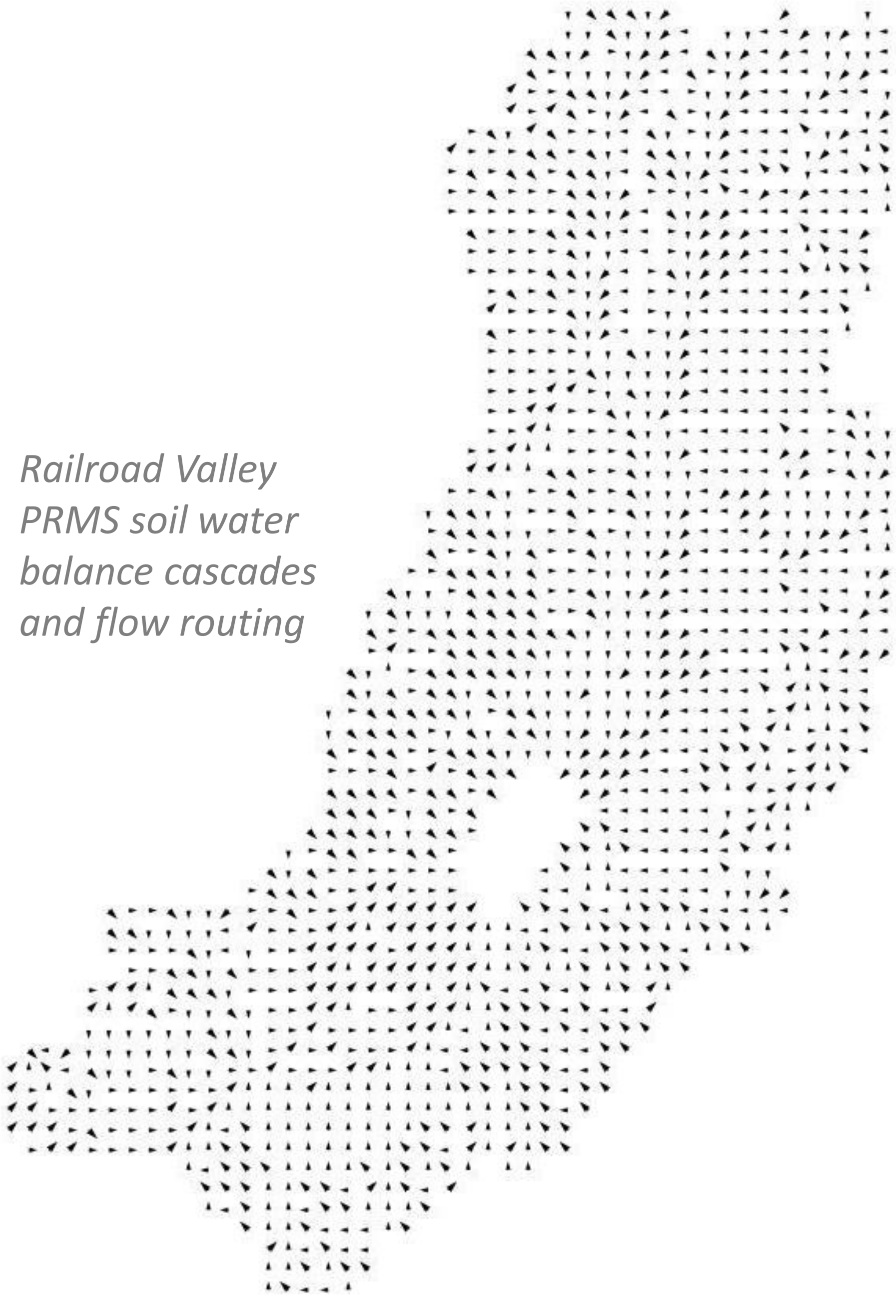


Railroad Valley PRMS soil water balance cascades and flow routing



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