Water Use Projections to Support Nevada State Water Plan Updates

July 22, 2026

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DRI

Outline

- Objectives
- General approach, methodology overview, and results by sector:
  - Agricultural (Justin & Peter)
  - Municipal, Industrial, Mining, Data Centers (Bea, Rachel, & Erik)
- Next Steps

Objectives

Update NDWR on spatially explicit projections of water demand for all 256 Nevada Hydrologic Areas (HAs) from 2025 through 2055.

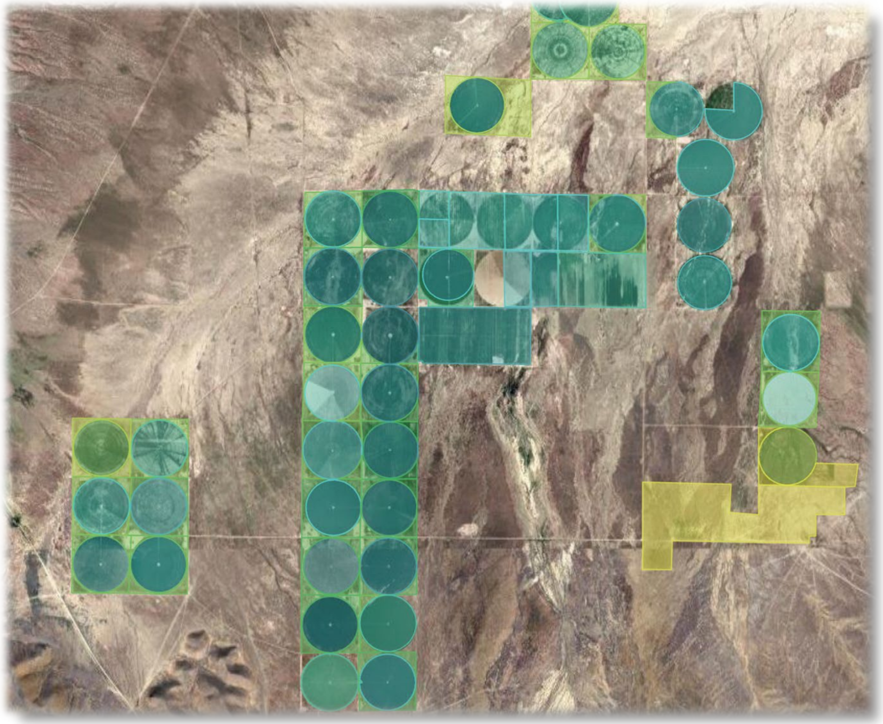
Annually resolved demand estimates at the basin level for multiple manners of use:

- Agricultural irrigation demand
- Municipal water demand
- Industrial
- Mining & Milling

AGRICULTURAL DEMAND

General Approach

Rely on historical satellite-based actual crop evapotranspiration (ET) and climate to inform future crop ET.

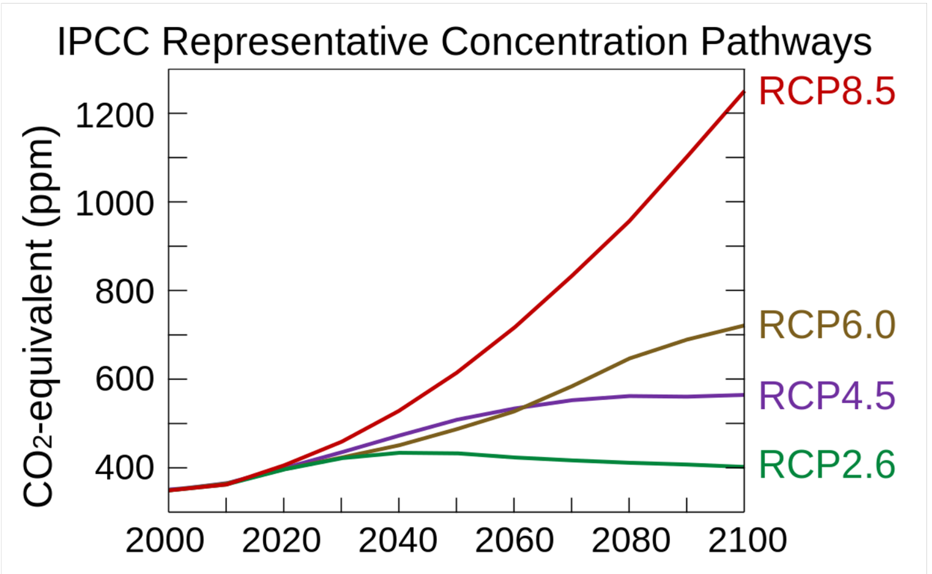


- Use historical actual crop ET from OpenET to develop HA-based statistical models, and predict basin-average crop coefficients (Kc)
  - Kc = ET / ETo, and ETo is the evaporative demand
  - Future climate used to predict future Kc and Net ET per HA
    - Net ET = ET less effective PPT (0.85 of annual PPT)
  - Percent change in future ET relative to 1991-2020 is used to perturb baseline GW pumping
  - NDWR Pumping Inventory information used as baseline GW pumping (2013, 2015, 2017, 2021)
  - Surface water use based on Net ET and field-level irrigation efficiency information

General Approach

Rely on future projections of solar radiation, temperature, humidity, wind speed and precipitation to compute evaporative demand (ETo) and standardized precipitation index (SPI).

- Global Climate Model (GCM) Projections
  - Sourced from Reclamation
  - Two future emissions scenarios
  - 20 GCMs * 2 scenarios = 20 model ensemble of future climate, daily time steps
  - Includes models chosen based on recommendations by California Department of Water Resources (CADWR) based on realistic historical climate simulations of Southwestern U.S. and California region water management relevant climate measures (CADWR-CCTAG, 2015)
  - Future Kc predicted from SPI and statistical model, and multiply future predicted Kc by future
    - Future ET = predicted Kc * future ETo



AGRICULTURAL DEMAND

Methodology Overview

Phase 1

Historical Data (1985–2024)

Field-level ET from OpenET, aggregated to basin scale. Separate SW/GW model workflows for ~24,000 field boundaries.

Phase 2

Model Development

Basin-specific multiple linear regression models: Kc = f(SPI + Kc monthly climatology for last 15 years).

SPI: Standardized Precipitation Index

Phase 3

Projections (2025–2055)

40 MACA climate scenarios (20 GCMs × 2 RCPs). Monthly Kc → Actual ET → Net ET → Applied Water (af) and Baseline GW change (af).

RCP: Representative Concentration Pathway (how much increase in warming due to carbon emissions)

Key Methodological Details

Water Source Classification

Separate SW and GW pipelines maintained. Mixed fields allocated dynamically: 20% SW when dry (low SPI) to 80% SW in wet years.

Active Field Identification

Baseline from temporal window analysis: fields classified as active if irrigated in ≥3 of last 5 years (2020–2024).

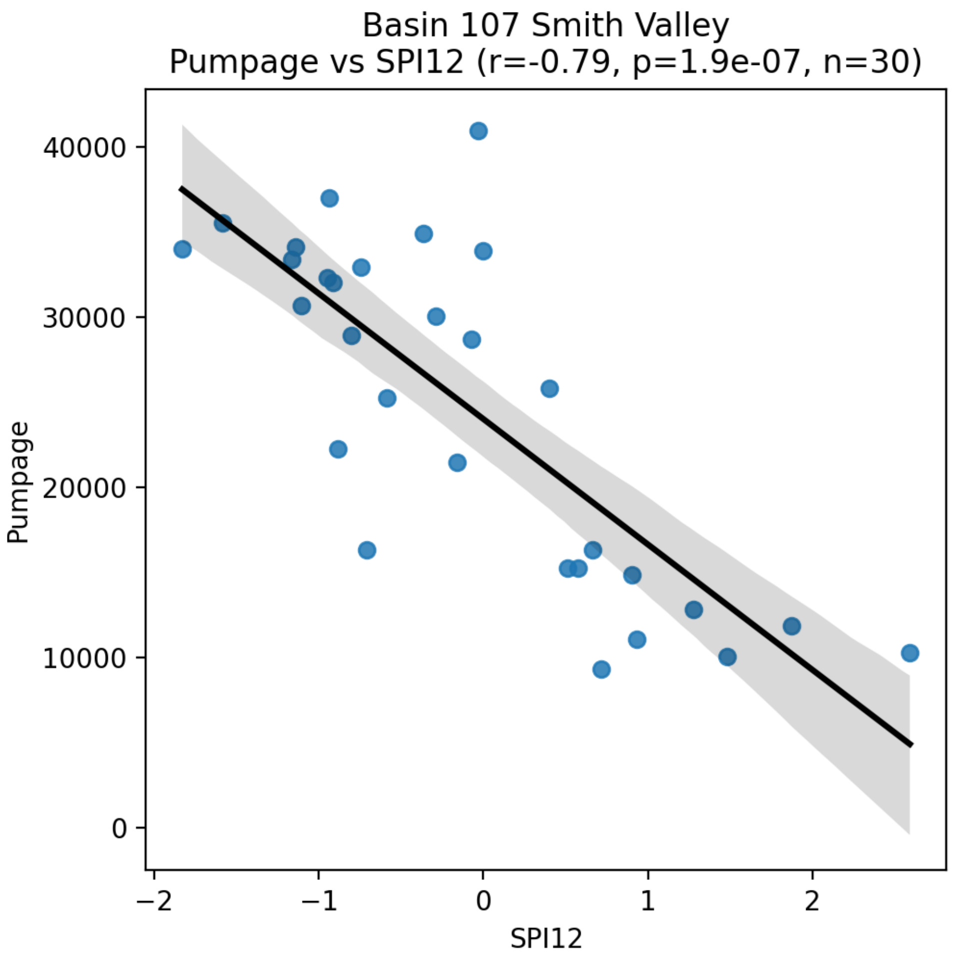
Statistical Models

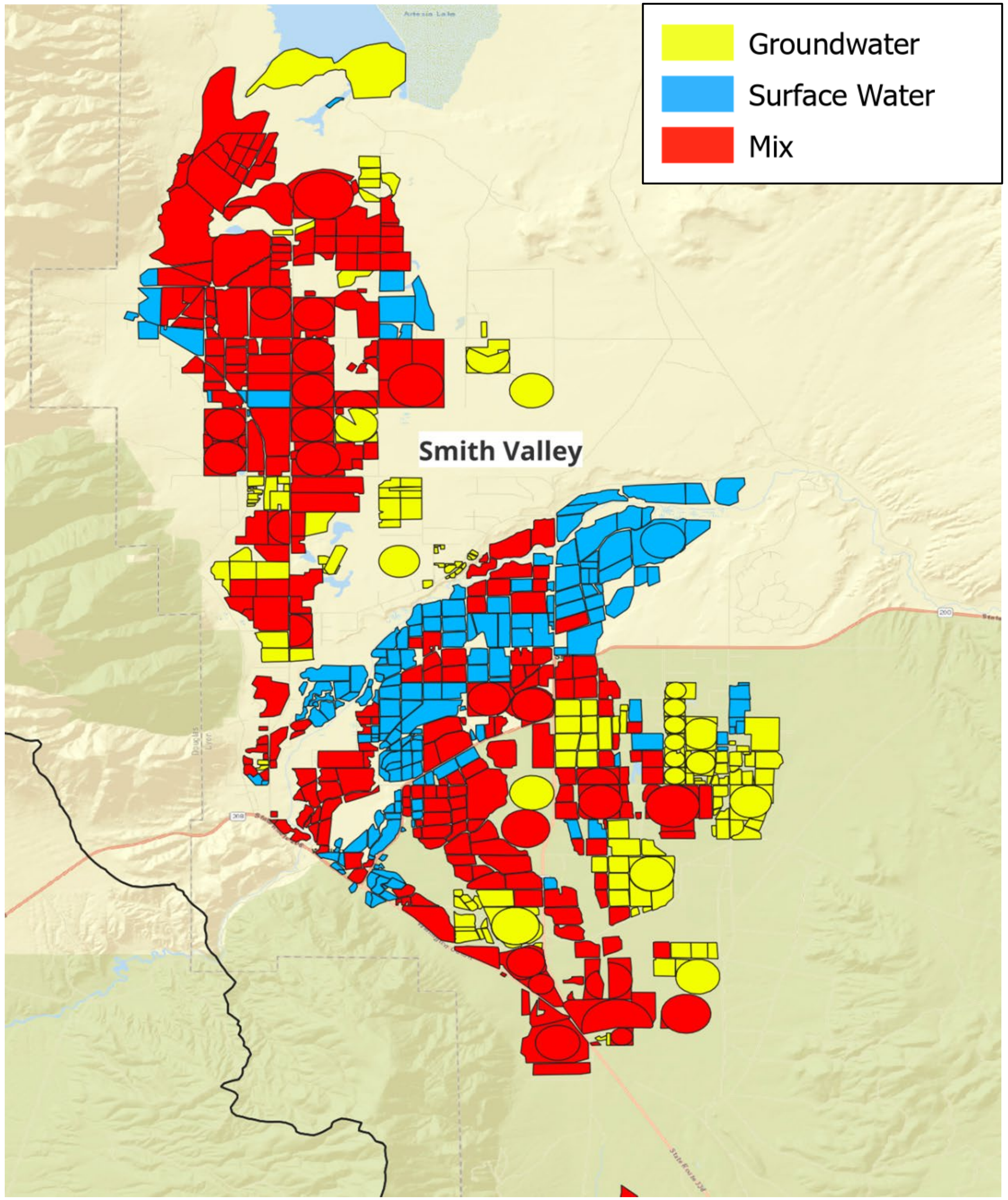
Multiple linear regression models trained per basin predict monthly Kc (ET/ETr) from drought indices, seasonal climatology, agriculture acreage, and irrigation fraction.

Key Assumptions

Irrigated acreage, efficiency, and crop mix held constant at 2020–2024 baseline. Isolates climate change effects on demand.

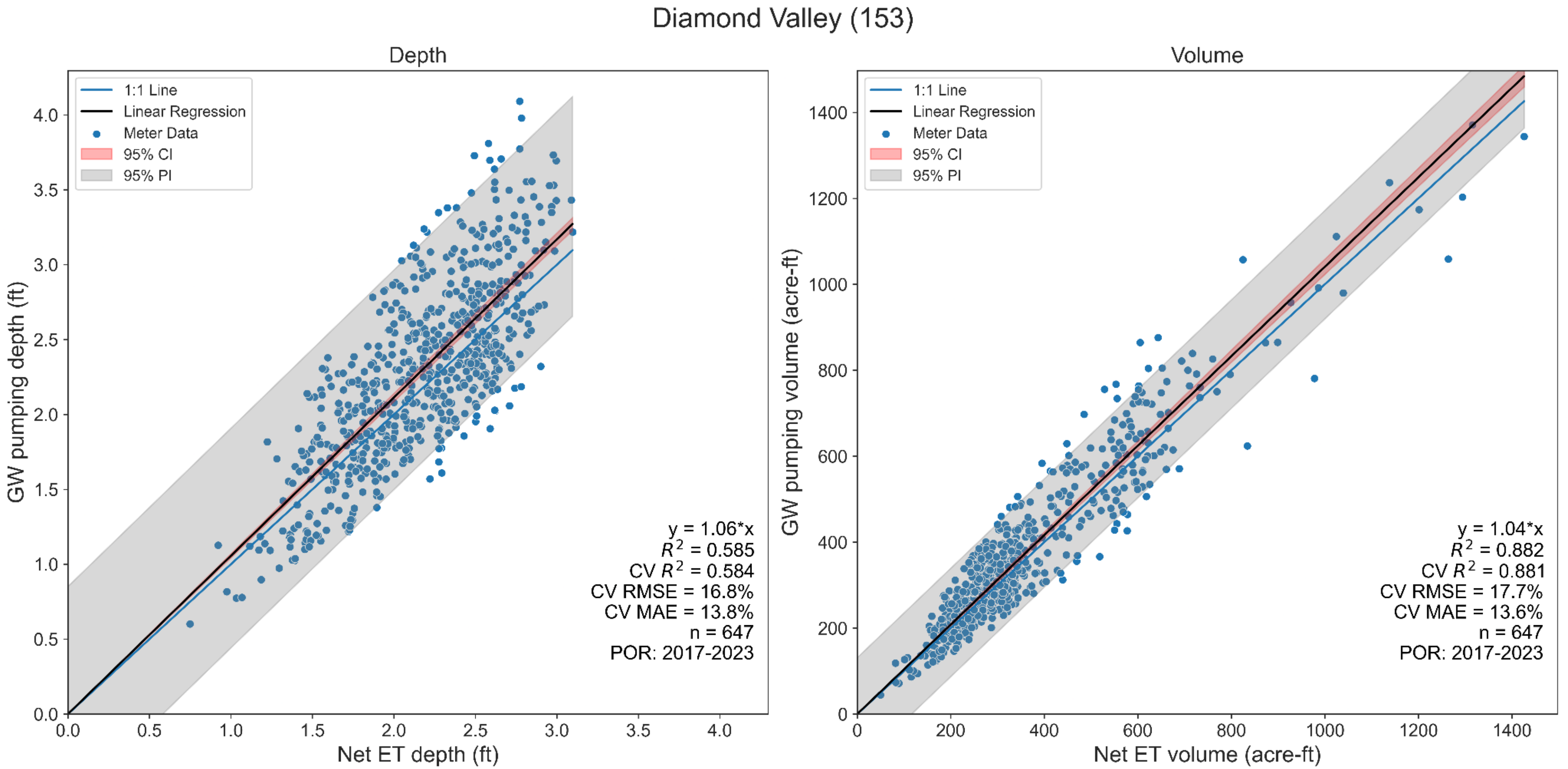
Partitioning of SW/GW - Supplemental Groundwater





OpenET pumpage validation using meter data

- **Join**: Follows the POU, meter data, and irrigated field joining from Ott et al. (2024).
- **Filter**: Applies the Ott et al. (2024)-derived lower and upper GW pumping / Net ET thresholds of 0.7 and 1.5 to remove outliers.
- **Regression**: Per basin, bootstrapped through-origin fit (slope + 95% CI) with 5-fold CV, in depth and volume space.



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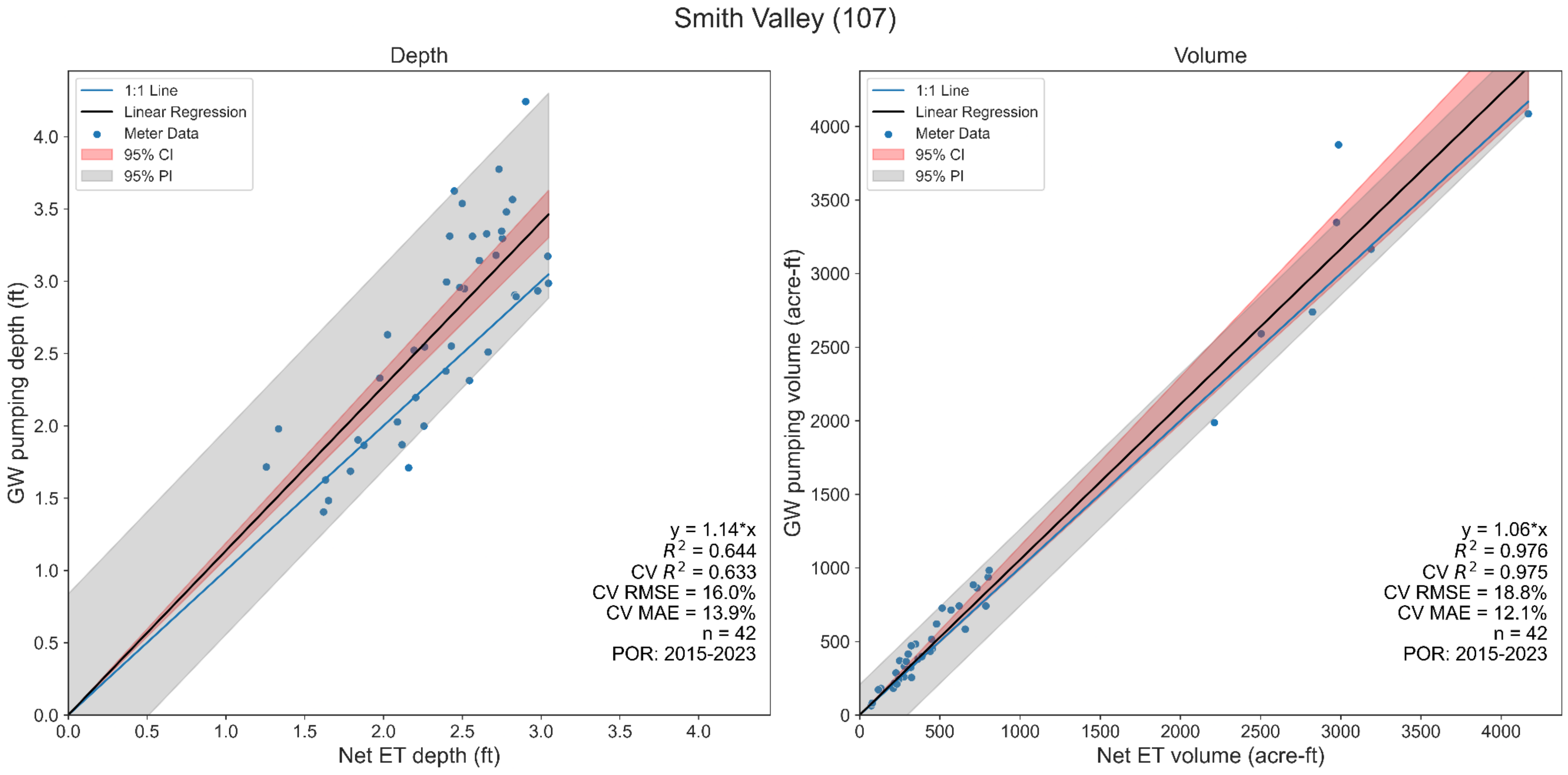
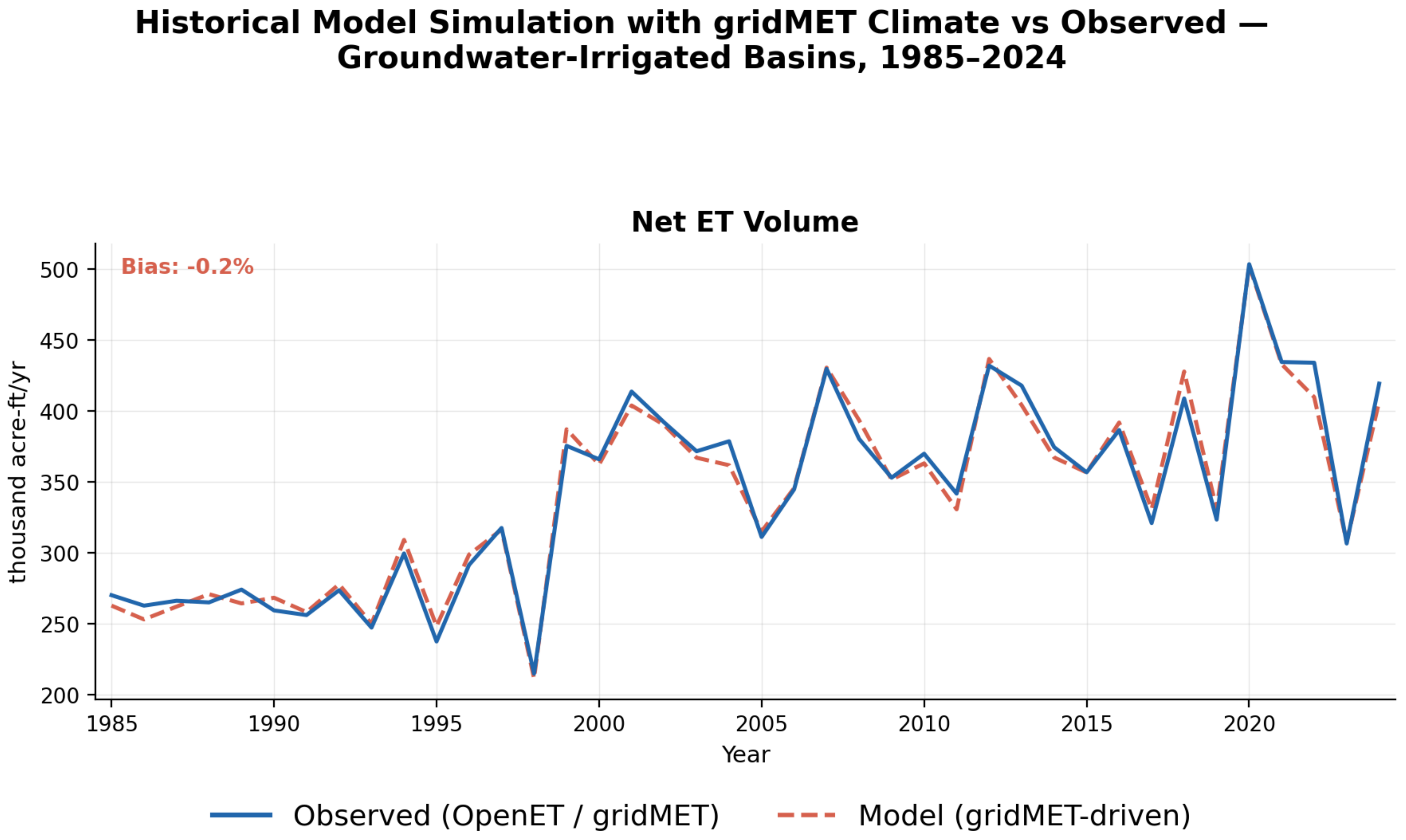
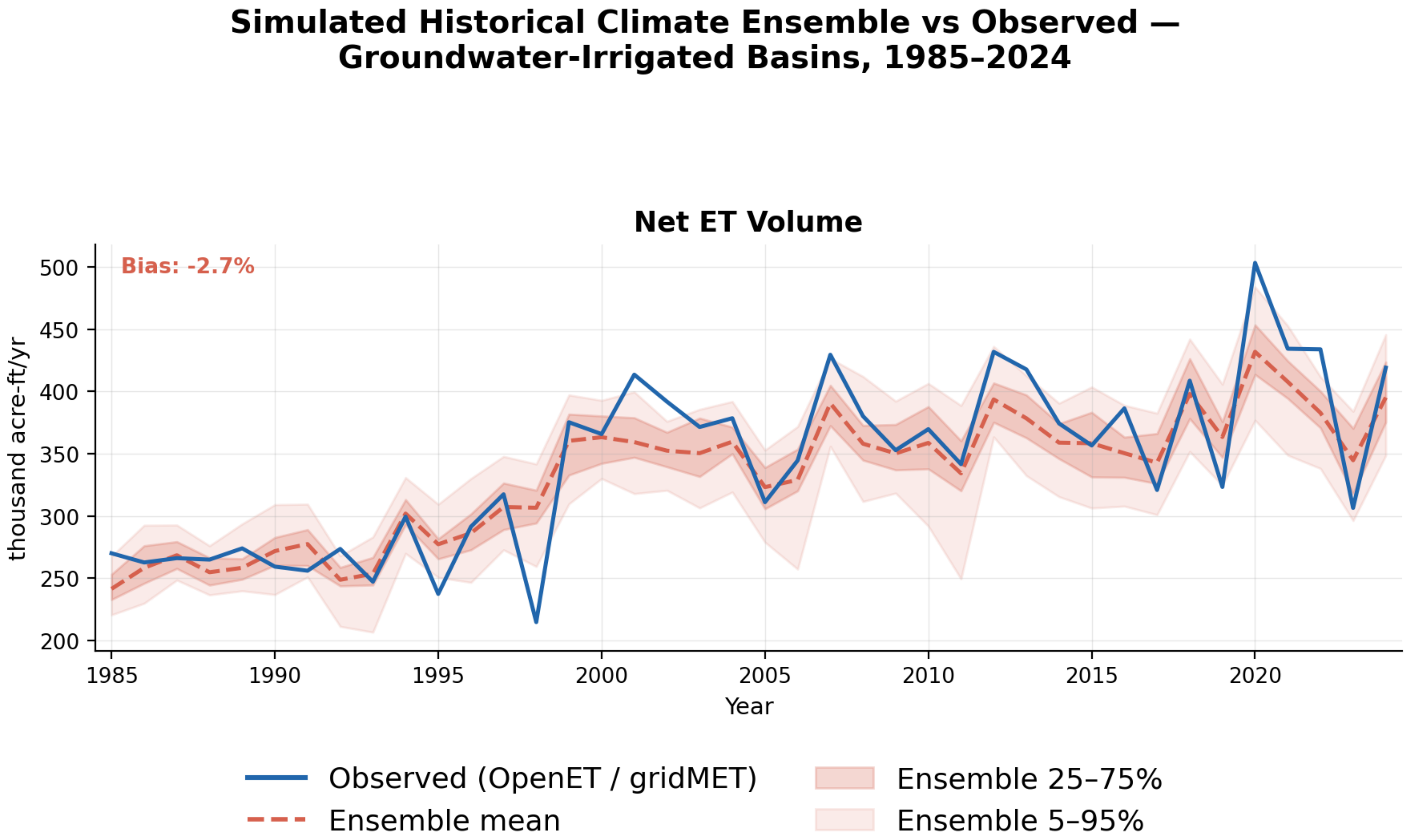


Model Validation



Model Validation



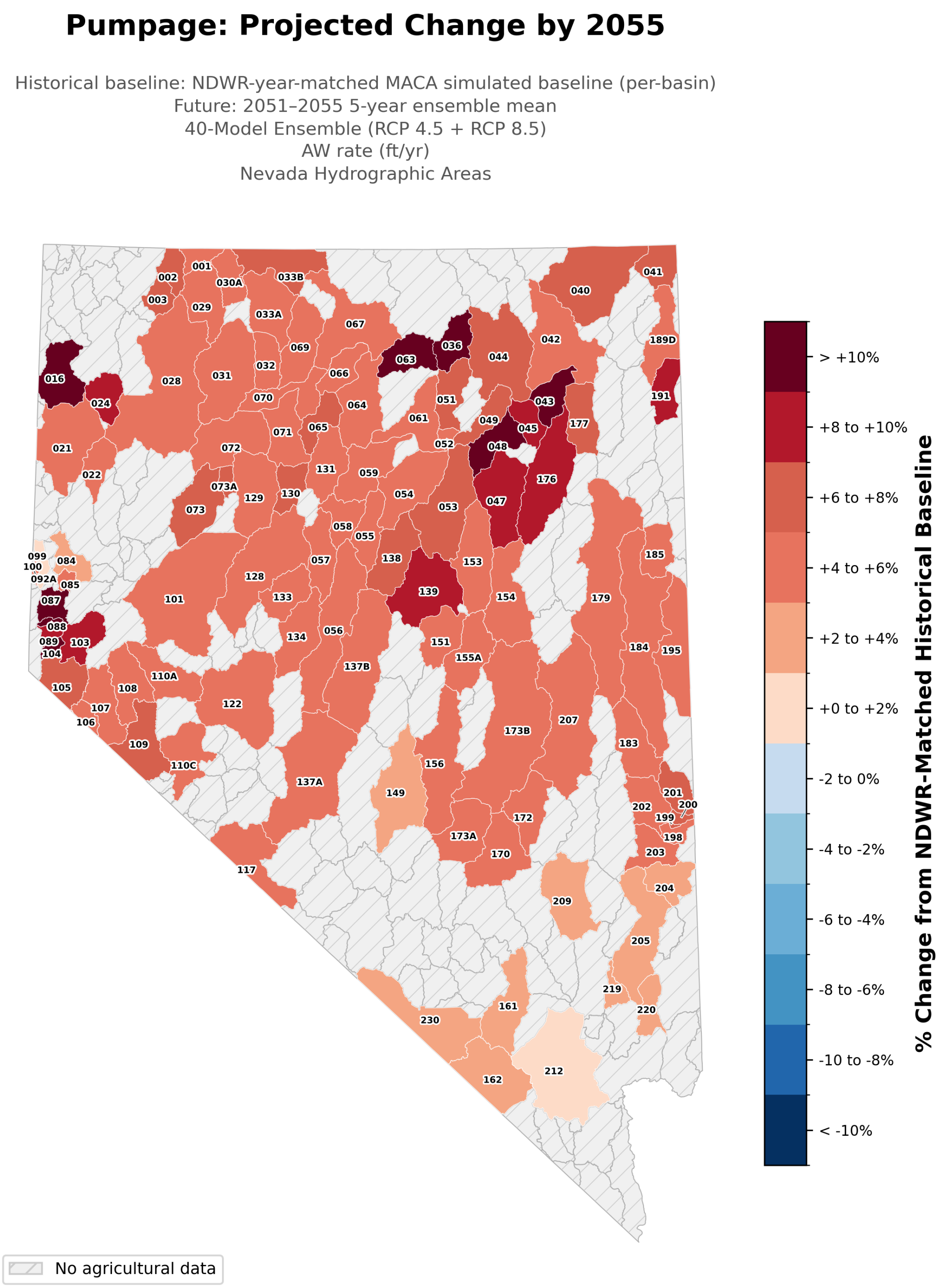
AGRICULTURAL DEMAND

Preliminary Findings

Modest increase in applied water demand
Rising temperatures and evaporative demand drive higher irrigation requirements.

2–4°F warming by 2055
Increasing ETo is the primary driver. Most agricultural basins show increases of 2–10%.

SW vs. GW differences
Similar trends but different magnitudes. Surface water systems are more sensitive to short-term drought.



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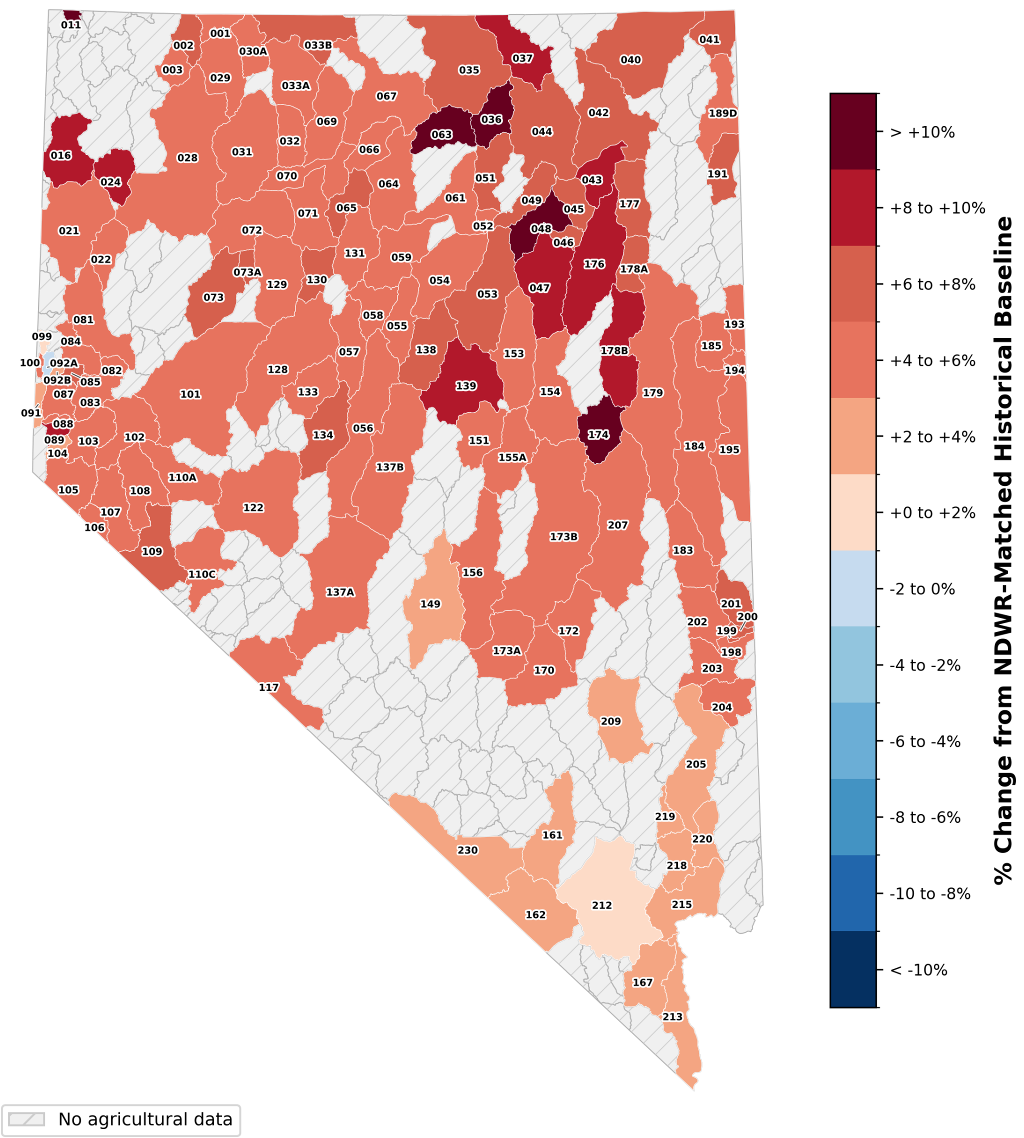
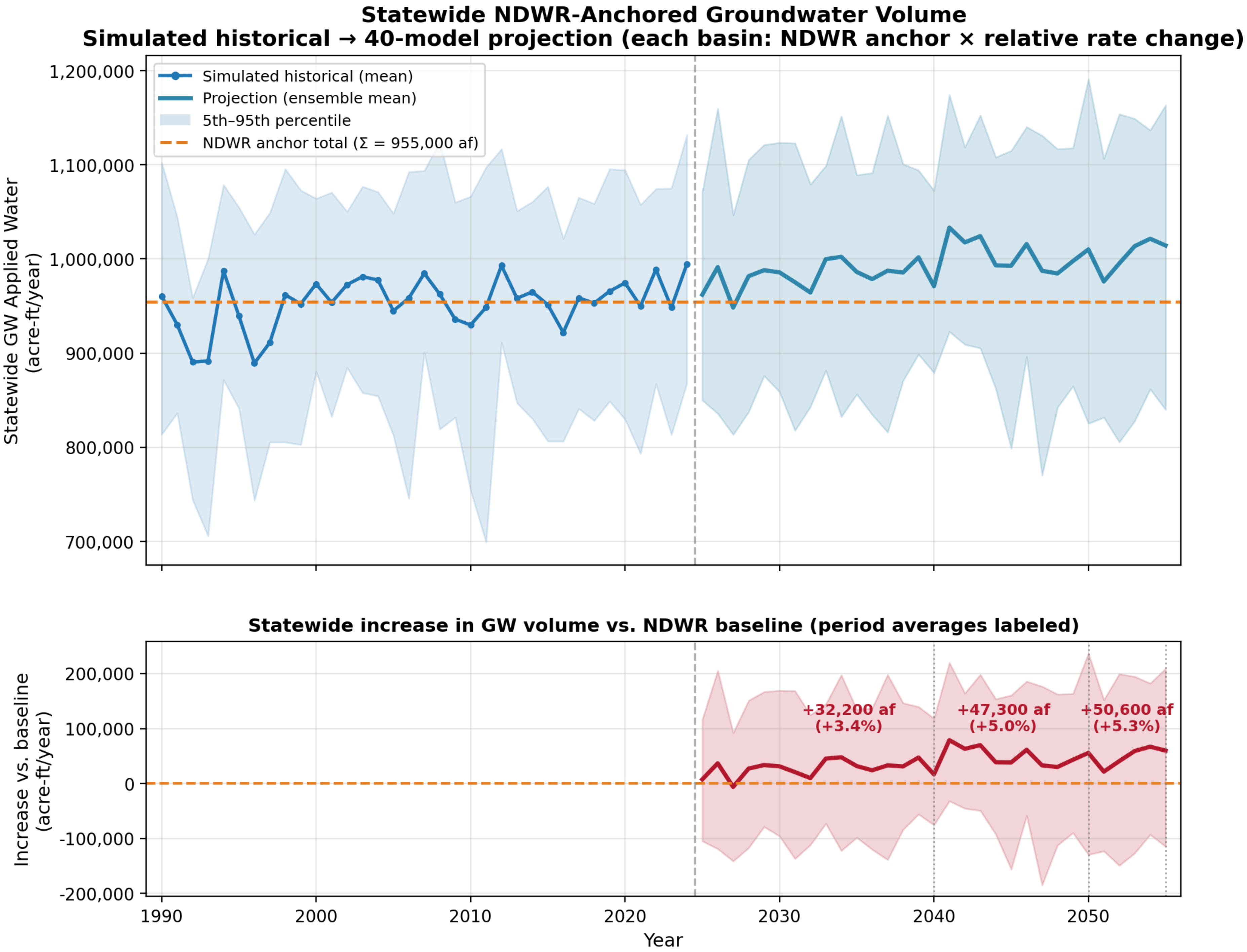
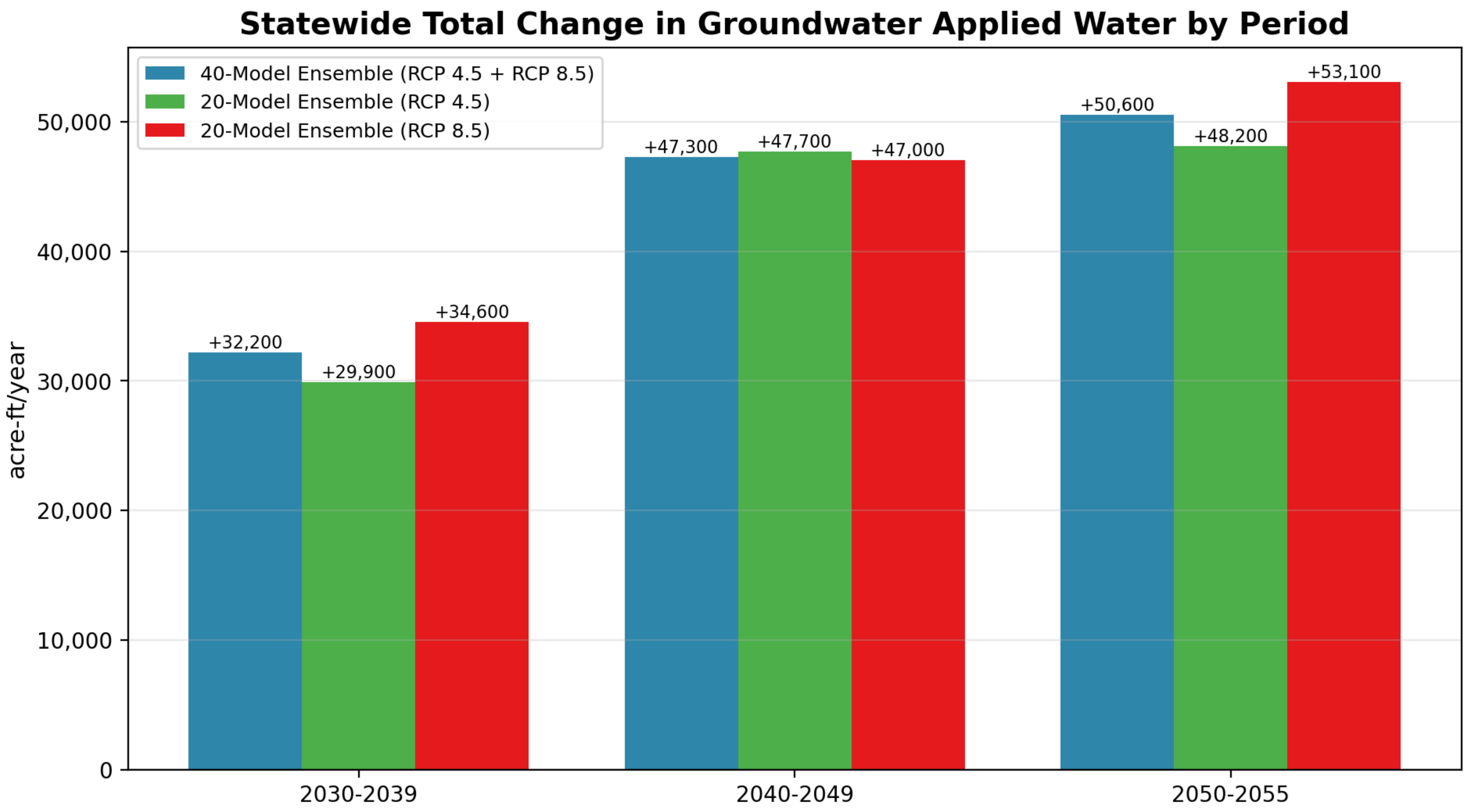
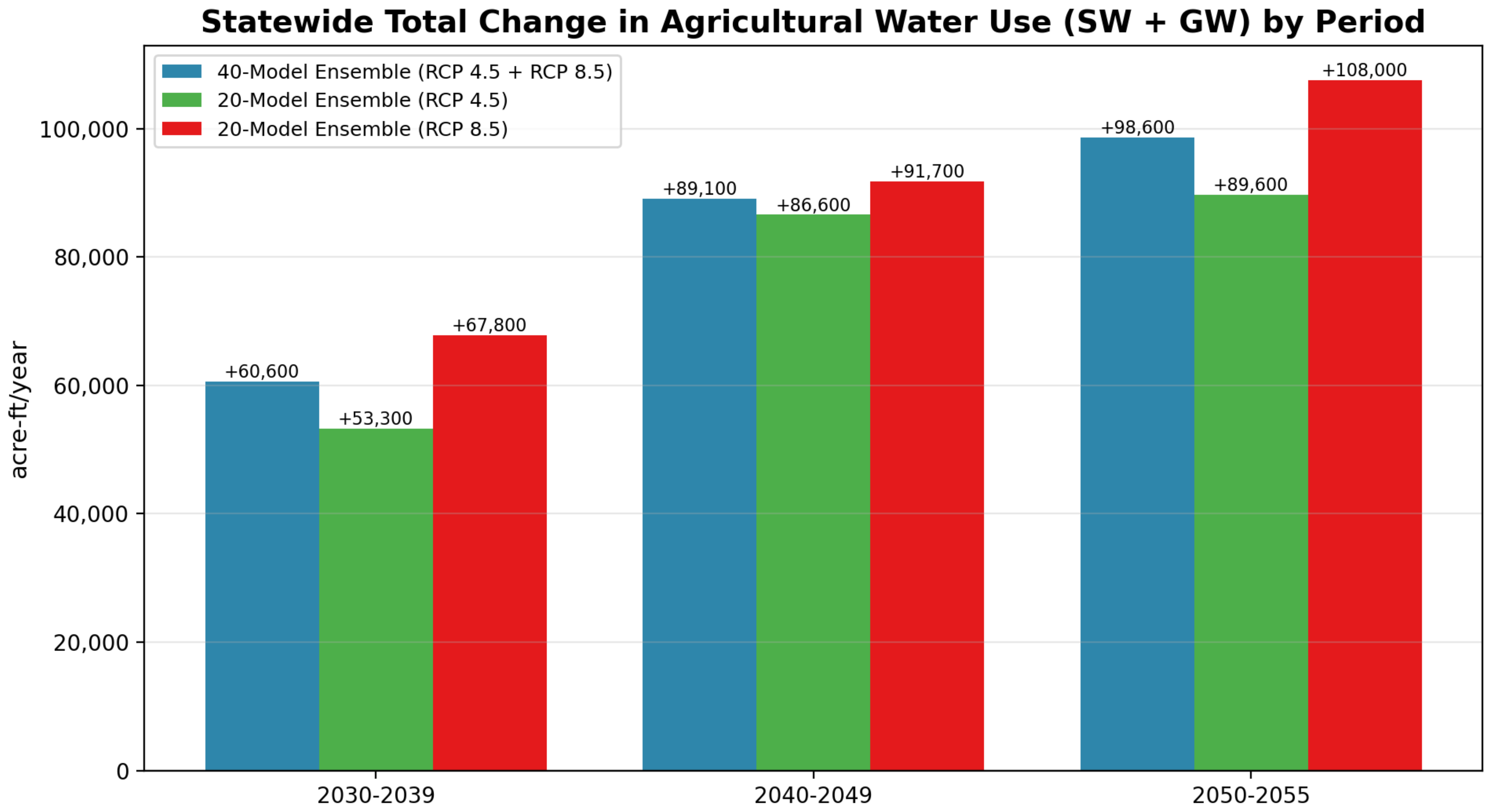
Total Agricultural Water Use (SW + GW): Projected Change by 2055

Historical baseline: NDWR-year-matched MACA simulated baseline (per-basin)
Future: 2051–2055 5-year ensemble mean
40-Model Ensemble (RCP 4.5 + RCP 8.5)
AW rate (ft/yr)
Nevada Hydrographic Areas




Statewide NDWR-Anchored Groundwater Volume
Simulated historical → 40-model projection (each basin: NDWR anchor × relative rate change)
Simulated historical (mean)
Projection (ensemble mean)
5th–95th percentile
NDWR anchor total (Σ = 955,000 af)
Statewide GW Applied Water (acre-ft/year)
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
Statewide increase in GW volume vs. NDWR baseline (period averages labeled)
+32,200 af (+3.4%)
+47,300 af (+5.0%)
+50,600 af (+5.3%)
Increase vs. baseline (acre-ft/year)
200,000
100,000
0
-100,000
-200,000
1990
2000
2010
2020
2030
2040
2050
Year


Statewide Total Change in Groundwater Applied Water by Period
40-Model Ensemble (RCP 4.5 + RCP 8.5)
20-Model Ensemble (RCP 4.5)
20-Model Ensemble (RCP 8.5)
acre-ft/year
0
10,000
20,000
30,000
40,000
50,000
+32,200
+29,900
+34,600
+47,300
+47,700
+47,000
+50,600
+48,200
+53,100
2030-2039
2040-2049
2050-2055


Statewide Total Change in Agricultural Water Use (SW + GW) by Period
40-Model Ensemble (RCP 4.5 + RCP 8.5)
20-Model Ensemble (RCP 4.5)
20-Model Ensemble (RCP 8.5)
acre-ft/year
0
20,000
40,000
60,000
80,000
100,000
2030-2039
2040-2049
2050-2055
+60,600
+53,300
+67,800
+89,100
+86,600
+91,700
+98,600
+89,600
+108,000

Methodology Overview

Phase 1

Per Capita Water Demand (1985–2010)

USGS water-use records for every county to obtain a per-capita water demand rate. Data used to establish trends in per capita water demand for 25 pooled groups (EPA Level I ecoregion ×population class).

Phase 2

Model Development

Applied the Pickard et al. (2017) model relating per-capita water demand to time. Obtained Nevada Department of Taxation projected county-level population estimates and used linear extrapolation to project through 2055.

Phase 3

Projections (2025–2055)

Applied the projected per-capita rate to the projected population to estimate annual municipal demand. Future minimum and maximum per capita estimates used to define the envelope of potential demand.

Key Methodological Details

Grouped Estimation, Not Per-County

Per-capita trends are fit for ecoregion × population-size groups, not individual counties. Rural counties have short, volatile records; pooling borrows strength across hydrologically similar counties.

Declining Per-Capita Use

Per-capita use declines across all three Desert population classes. Attributed to 1992 Energy Policy Act. Consistent with USGS reports of public-supply per-capita use falling from 100 → 89 → 82 gpcd between 2005 and 2015 (Dieter et al., 2018).

Dasymetric Disaggregation

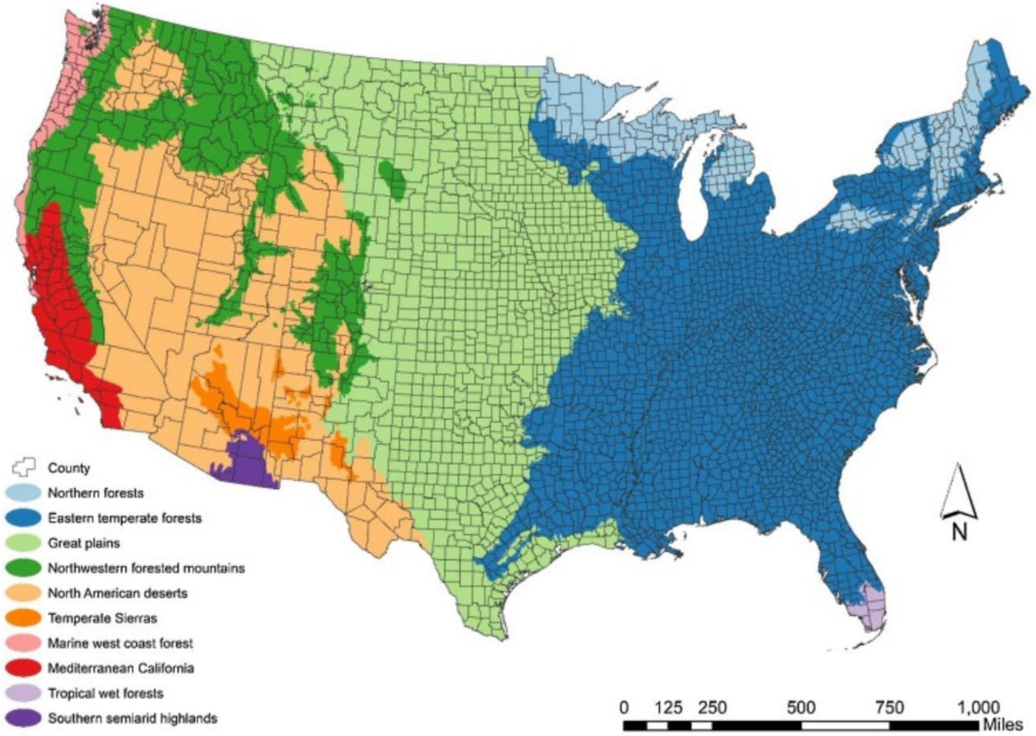
County-level demand is split across hydrographic basins using 2020 Census block populations. Demand is distributed to basins in proportion to where people live (2020 Census blocks), not by land area.

Key Assumptions

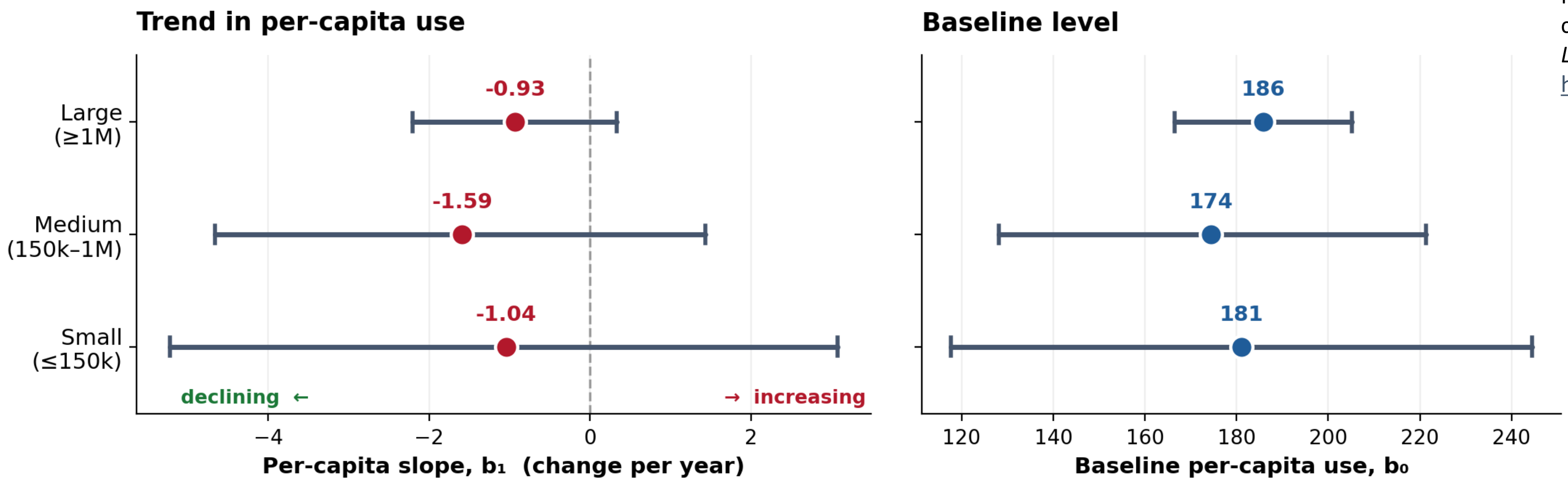
Grouped estimations capture local conditions, which may vary and could introduce uncertainty. Population distribution within counties stays proportional to the 2020 Census. The maximum and minimum per capita estimates capture the floor and ceiling.

MUNICIPAL DEMAND

Estimating Per Capita Water Demand



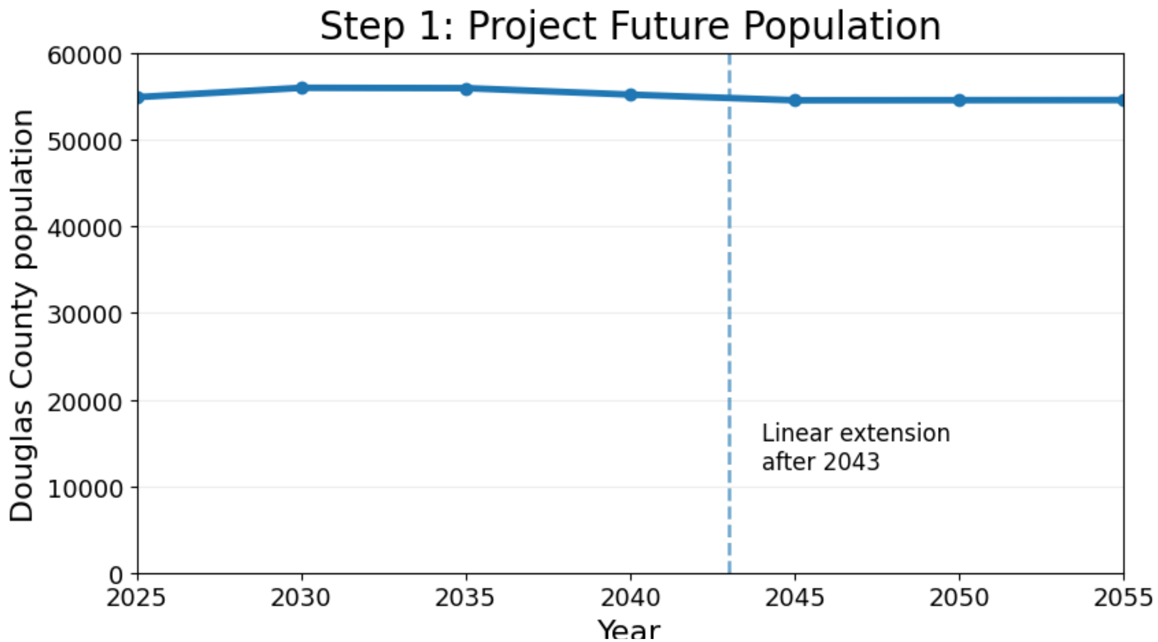
North American Deserts — Bayesian regression estimates by population class

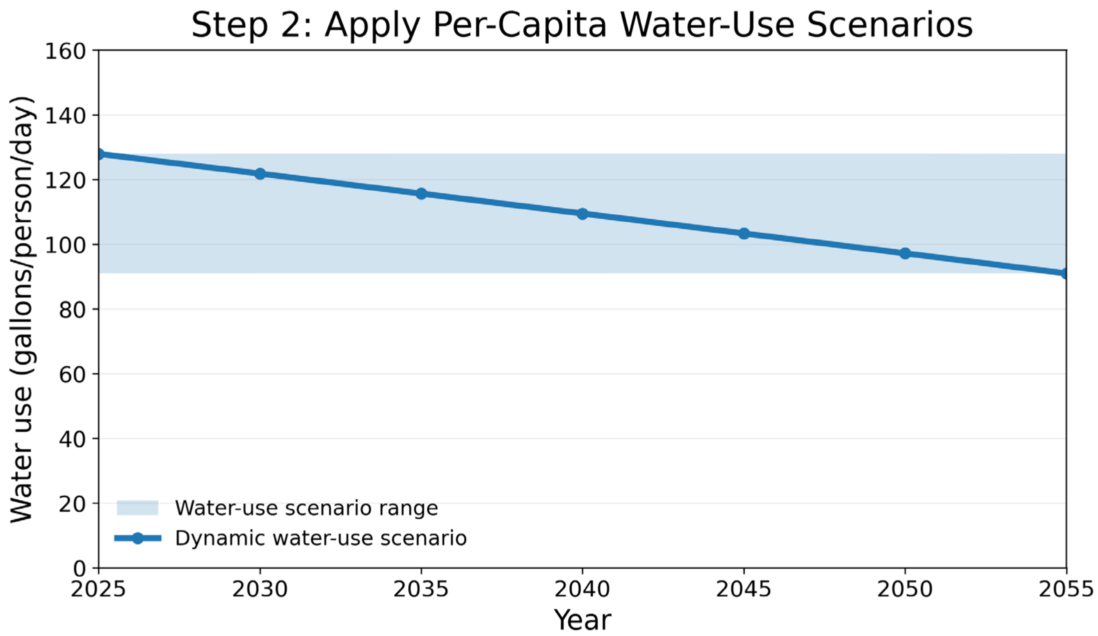


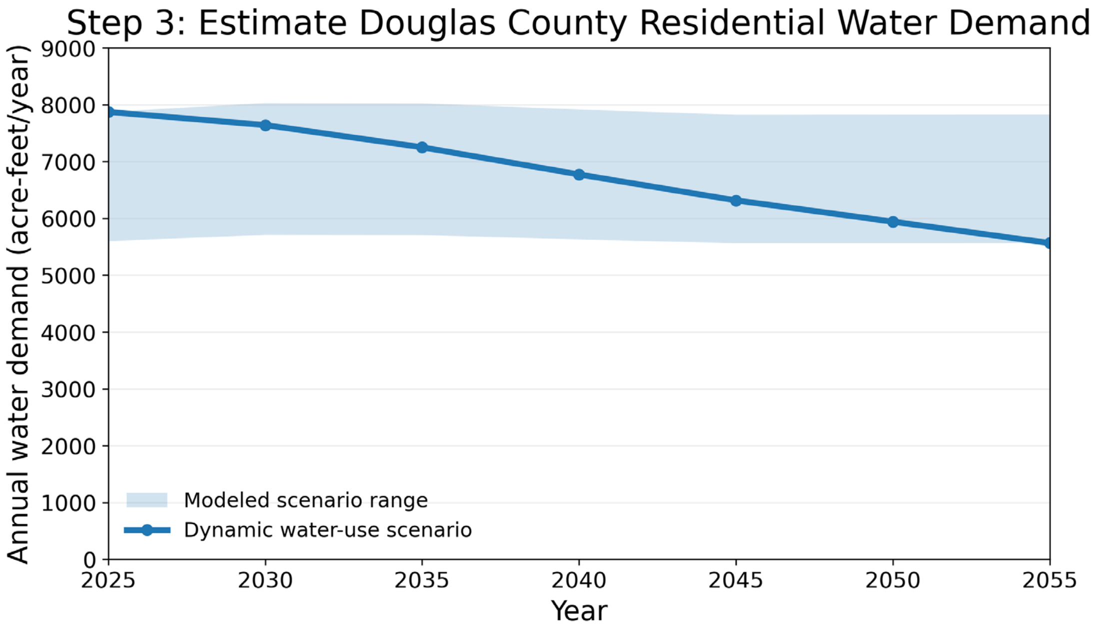
Points = posterior mean; bars = credible interval. All three slopes are negative, but each interval spans zero.
Source: Pickard et al. (2017), Table 1.

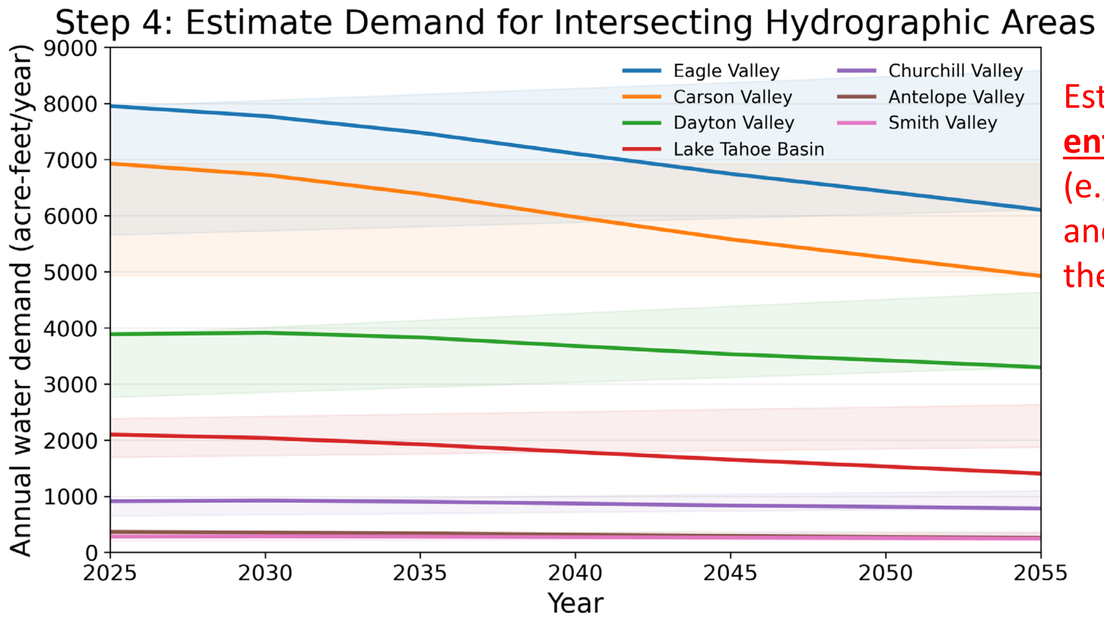
Pickard, B. R., Nash, M., Baynes, J., & Mehaffey, M. (2017). Planning for community resilience to future United States domestic water demand. *Landscape and Urban Planning, 158*, 75–86. https://doi.org/10.1016/j.landurbplan.2016.07.014

MUNICIPAL DEMAND



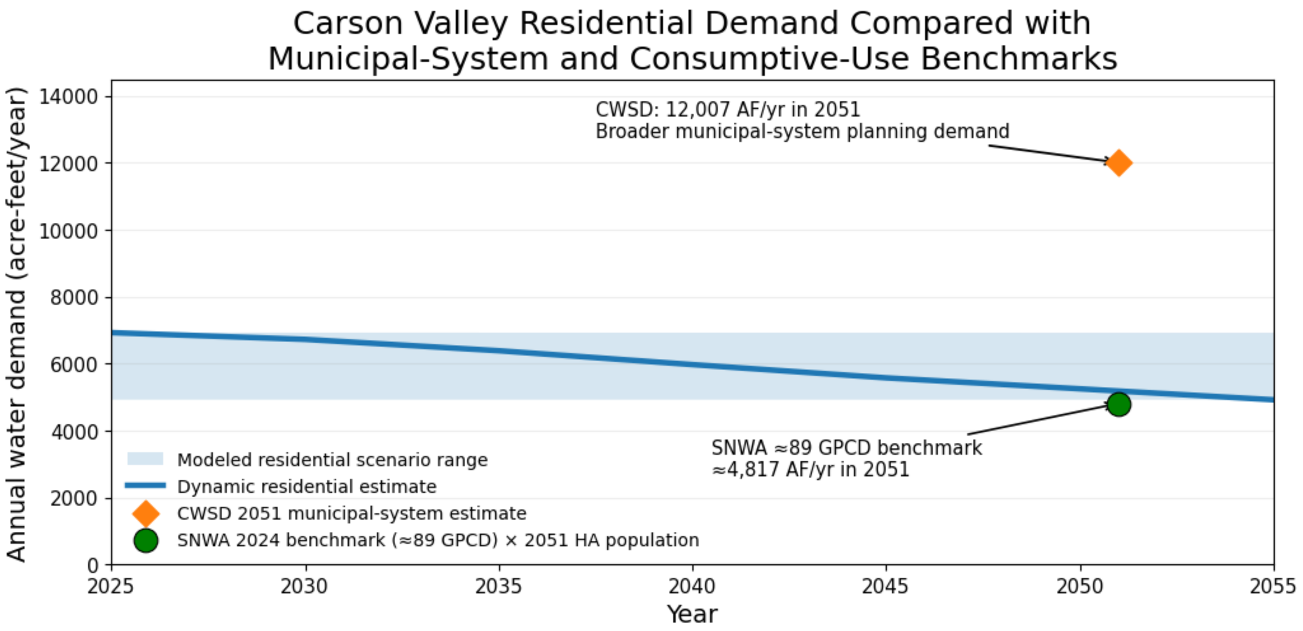






Estimates for **entire** HA (e.g., inside and outside the county)

Benchmarking Estimates – Douglas County



Notes: The CWSD point represents broader municipal-system planning demand. The SNWA point applies ≈89 GPCD to the estimated 2051 Carson Valley HA population as a contextual consumptive-use benchmark; it is not directly equivalent to modeled residential demand.

Source: Southern Nevada Water Authority (SNWA), 2026 Water Resource Plan, Chapter 3, pp. 38–39.

Benchmarking Take Homes

Benchmarks: CWSD projected municipal-system demand through 2051; SNWA's 2024 89-GPCD benchmark applied to Carson Valley (HA 105) population.

CWSD: Carson Valley systems total ~12,000 AF/year, compared with ~5,200 AF/year under our dynamic residential scenario.

Key difference: Basin-wide population and dynamic residential per-capita use (ours) versus provider-specific growth applied to broader municipal-system demand (CWSD).

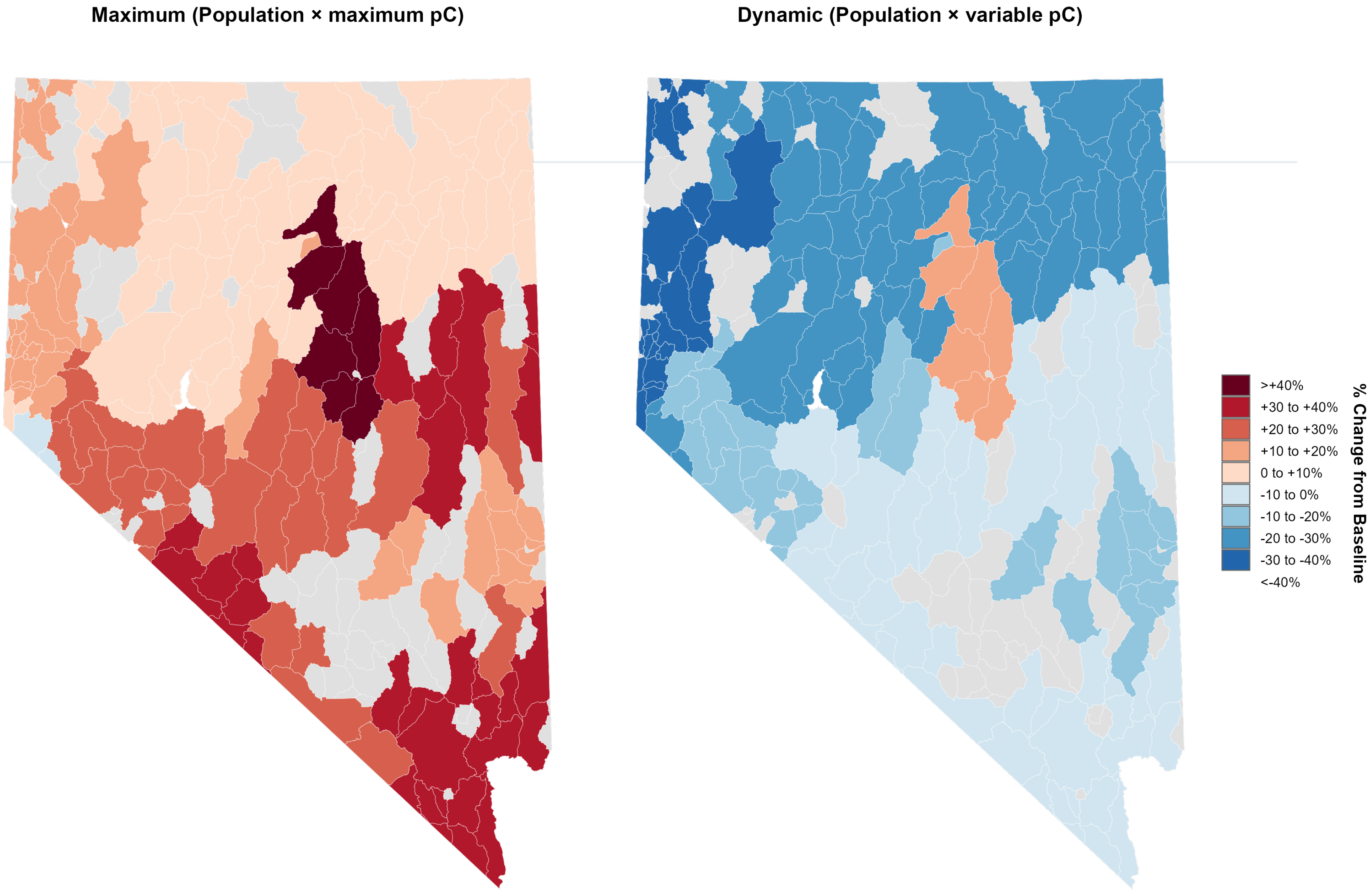
Preliminary Findings

Key Take Homes:
Statewide change by 2055: +142,599 af/yr (29.6%) under the maximum

-47,685 af/yr (-9.9%) under the dynamic

Dynamic demand declines despite population growth.

Concentrated increases in Central Nevada.



Methodology Overview

Phase 1

Baseline Pumpage per MOU (2013, 2015, 2017, 2021)

Current demand estimated as the average of NDWR pumpage records from 2013, 2015, 2017, and 2021 for each industrial manner of use, including mining and milling.

Phase 2

Documented Future Demand

County-by-county review of planning and permitting documents to identify new, expanded, or extended industrial water demands → assigned to each County & HA. Independently reviewed by at least 2 researchers for convergence and accuracy.

Phase 3

Projections (2025–2055)

Documented future project demand was added to the historical pumpage baseline according to source-reported timing, duration, and changes in water use. Projects were assigned to the HA(s) where water is sourced and/or used.

Industrial demand: Water used for mining and milling, power generation—including solar, thermoelectric, and geothermal—and other industrial activities. Data-center demand is evaluated separately.

INDUSTRIAL DEMAND

Key Methodological Details

Historical Baseline

Baseline demand calculated separately for each industrial manner of use as the average of NDWR-reported pumpage in 2013, 2015, 2017, and 2021.

Project Inclusion Criteria

Future industrial demand included only when a specific water-use estimate was supported by an attributable, publicly verifiable source. **Projects without sufficient documentation were not included.**

Independent Review

At least two researchers independently reviewed each county for new, expanded, or extended industrial activity. Findings were compared and reconciled into a single documented project inventory.

Spatial and Temporal Assignment

Project maps (if available) were compared with HA boundaries to identify where water is sourced and/or used. Source-reported timing, duration, end dates, and changes in demand were incorporated when available.

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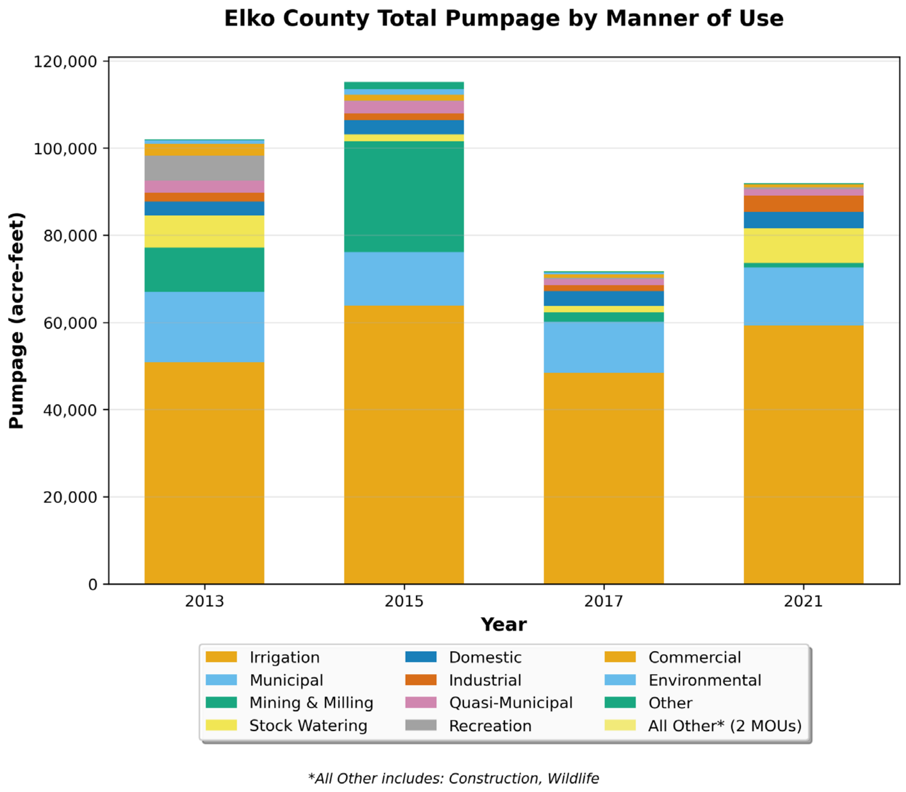
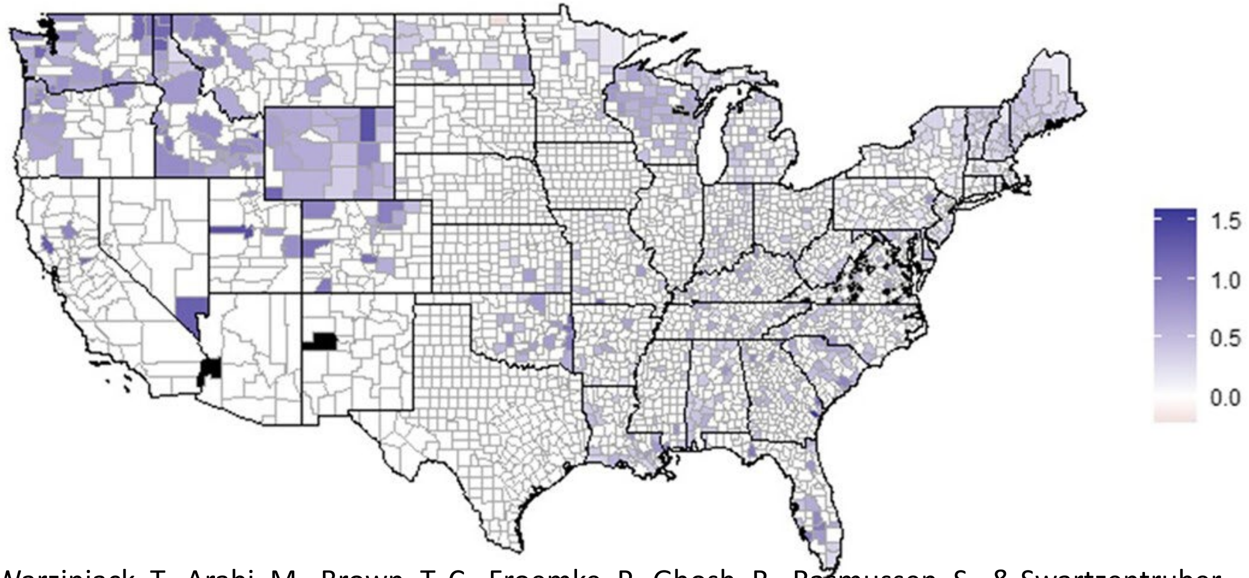
Why this approach?

Industrial water demand is historically substantial in many Nevada counties.



Mean Percent Change in Industrial Water Use (Published Estimate)



Warziniack, T., Arabi, M., Brown, T. C., Froemke, P., Ghosh, R., Rasmussen, S., & Swartzentruber, R. (2022). Projections of freshwater use in the United States under climate change. *Earth's Future, 10*(2), e2021EF002222. https://doi.org/10.1029/2021EF002222

But it's challenging to capture in CONUS-scale future projections.

INDUSTRIAL DEMAND

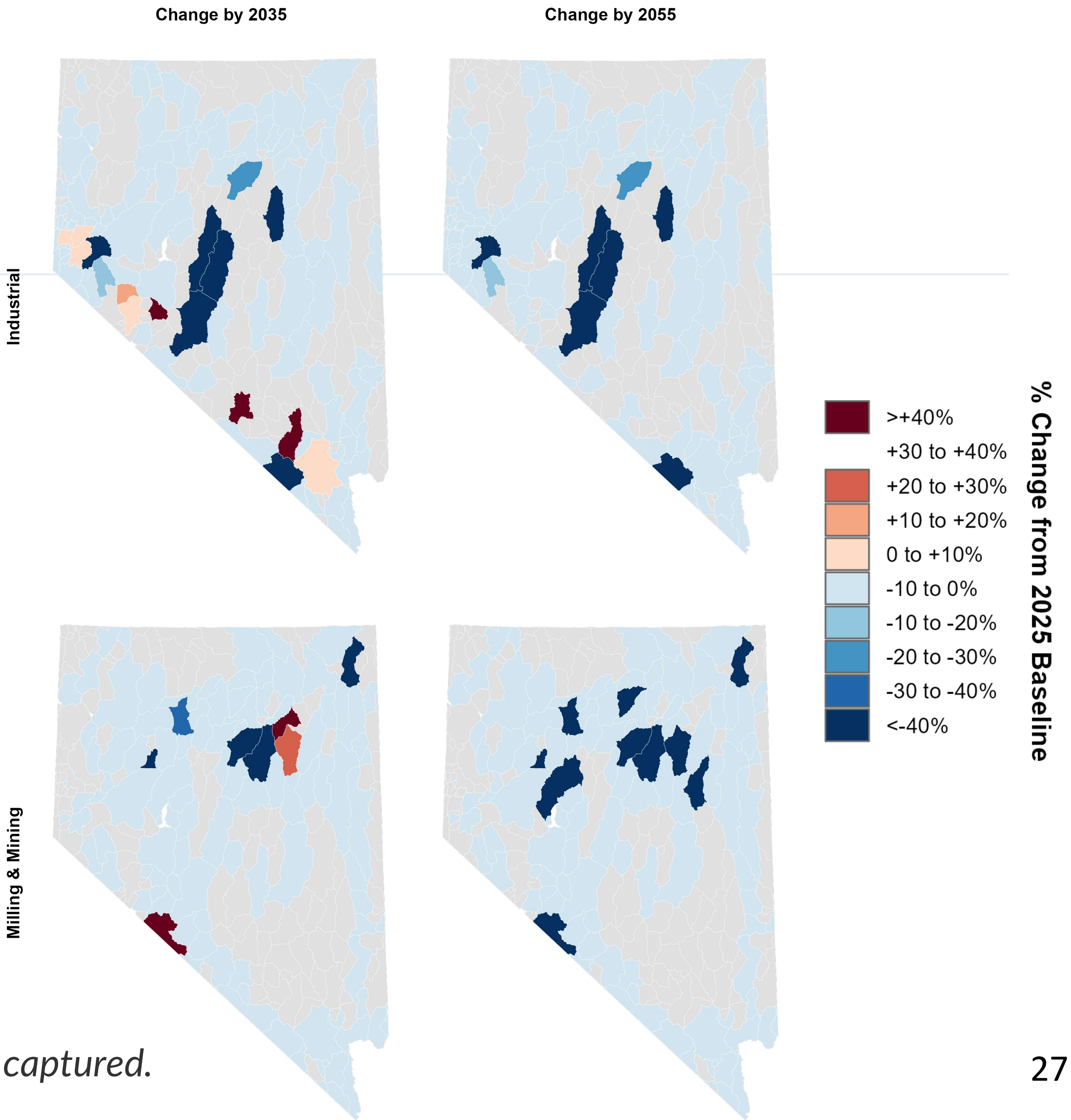
Preliminary Findings

By 2055, statewide industrial and mining & milling demand decreases by ~65,500 AF/year (27%) relative to 2025. Concentrated in Nye, Clark, Mineral, Esmeralda, and White Pine.

Industrial could decrease by 12,400 af/yr; mining and milling by 53,100 af/yr.*

Non-monotonic behavior driven by shorter horizons in the available documentation.

Does not account for data centers.



This assumes all new projects are currently captured.

Data

NV Energy 2024 IRP:

“These twelve [data center] customers represent 5,900 MW of requested capacity by 2033 and expected load growth of 957 GWh at Nevada Power and 24,633 GWh at Sierra” (Link to 2024 IRP)

NV Energy 2026 IRP:

“The 39 data center customers represent nearly 16,530 MW of requested capacity by 2036 and expected load growth of 13,200 GWh at Nevada Power and 30,554 GWh at Sierra” (Link to 2026 IRP)

DRI
Desert Research Institute

Data Center Water and Electricity Consumption in Nevada

Erik M. Henzl
Sean A. McKenna, PhD

January 2026

Publication No. 41311

Previous work based on 2024 IRP data
Link to Jan. 2026 report and storymap

Key Methodological Details

Capacity

The National Laboratory of the Rockies showed 713 MW of operational data center capacity in Nevada in 2025. NV Energy's 2024 IRP shows 5,900 MW of additional requested capacity while their 2026 IRP shows 16,530 MW.

Direct Water Use

Direct water use is the water consumed on-site for cooling. It is shaped by cooling technology and water usage effectiveness (WUE), which is assumed to be 0.15 L/kWh, reflecting trends in cooling efficiency.

Indirect Water Use

Indirect water use is the water consumed off-site for electricity generation. It is shaped by the generating resources in use and may fall with greater use of renewables. Indirect water use typically exceeds direct water use for data centers.

Key Assumptions

100% of data center load is assumed to materialize on time, though project completion rates remain uncertain. Load growth following initial buildout is assumed to follow the 2005-2020 average growth in U.S. electricity consumption, 0.1%.

Preliminary Findings

	2024			2026		
Year	**Capacity (MW)**	**Direct Water (AFY)**	**Indirect Water (AFY)**	**Capacity (MW)**	**Direct Water (AFY)**	**Indirect Water (AFY)**
2025	713	660	3,037	713	660	3,037
2030	3,004	2,783	12,802	3,073	2,846	13,092
2035	7,136	6,610	30,408	13,243	12,268	56,432
2040	7,172	6,643	30,560	17,809	16,497	75,886
2045	7,208	6,677	30,713	17,898	16,580	76,266
2050	7,244	6,710	30,867	17,988	16,663	76,648
2055	7,280	6,744	31,022	18,078	16,746	77,032

Direct water use

- Assumes 0.15 L/kWh WUE
- Estimates scale linearly with WUE
- 0.36 L/kWh industry average WUE in 2024

Indirect water use

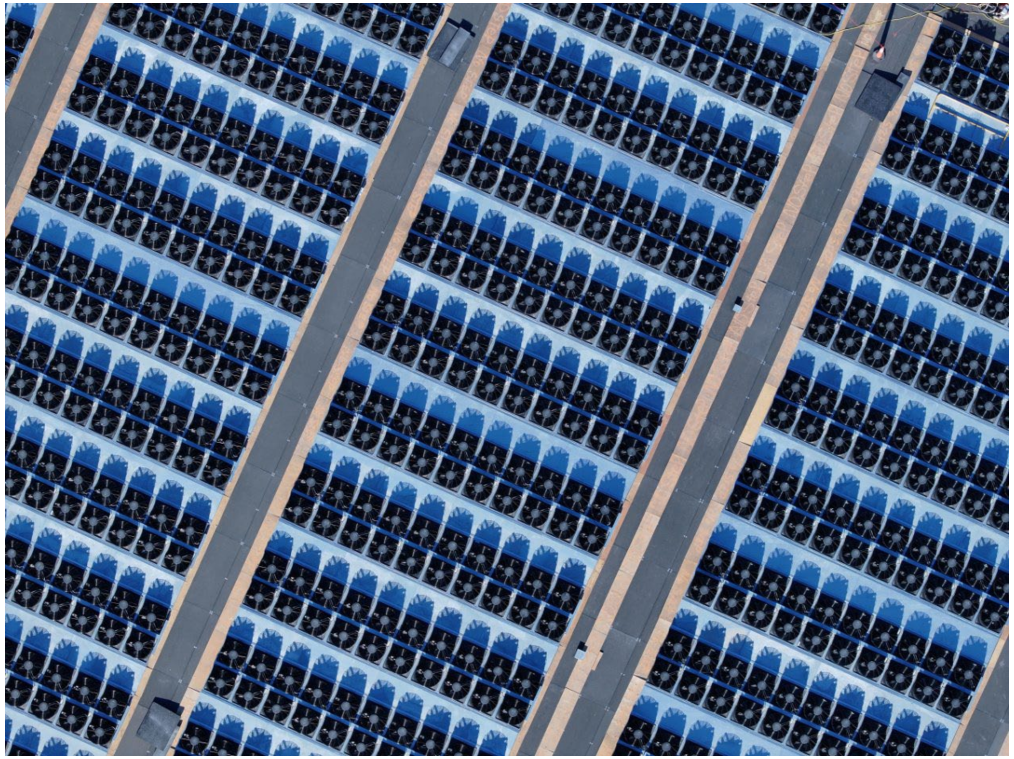
- Assumes 0.6 L/kWh (per NV Energy)
- May fall if renewables are increasingly utilized

MW Capacity

- 2024: 5,900 MW requested by 2033
- 2026: 16,530 MW requested by 2036

Key Data Center Takeaways

- Indirect water use exceeds direct water use
  - Water consumed via electricity generation is key
- Uncertainty concentrated in the next 10 years
  - Rapid 10-year buildout that shapes subsequent outcomes/impacts
- Several opportunities to offset demand and/or boost efficiency
  - Advanced cooling technologies and load flexibility
- There may be challenges
  - Data center clustering
  - Potentially increasing grid and water stress
- Uncertainties remain
  - Need for more data
  - Community preparedness



Aerial view of data center cooling tower fans (Temple, 2025)

Key Take Aways

Agricultural Demand

Increases in agricultural water use expected, primarily due to increases in evaporative demand. Increases in precipitation do not offset the increases in evaporative demand to reduce irrigation demands.

Municipal Demand

Continued trends in reduced per-capita water use ***could*** offset population growth if they persist into the future, resulting in stable or declining residential water demand across many hydrographic areas and counties.

Industrial Demand

Industrial demand is variable and concentrated in fewer counties and basins. New projects in the future not accounted for in our current inventory and data centers represent a source of uncertainty in future estimates.

Next Steps

Continue Iterative Process with Counties for I, M&M; Integrate Feedback

Continue iterative process between Bea Gordon and Rachel Kozloski with 8 counties to enhance existing database of mining and milling and industrial data. Integrate with County Water Plan to provide location data for future projects based on process.

Agricultural Finalization

Preliminary HA-level projections complete for all basins with active irrigated agriculture. Remaining work: county-weighted aggregations and deliverable CSV files matching the municipal output format.

Report Draft and Public Database

Finalize Draft report and peer review and develop publicly available database and documentation.

THANK YOU

DRI

Researching the human impact on the environment
and the environment’s impact on humans.