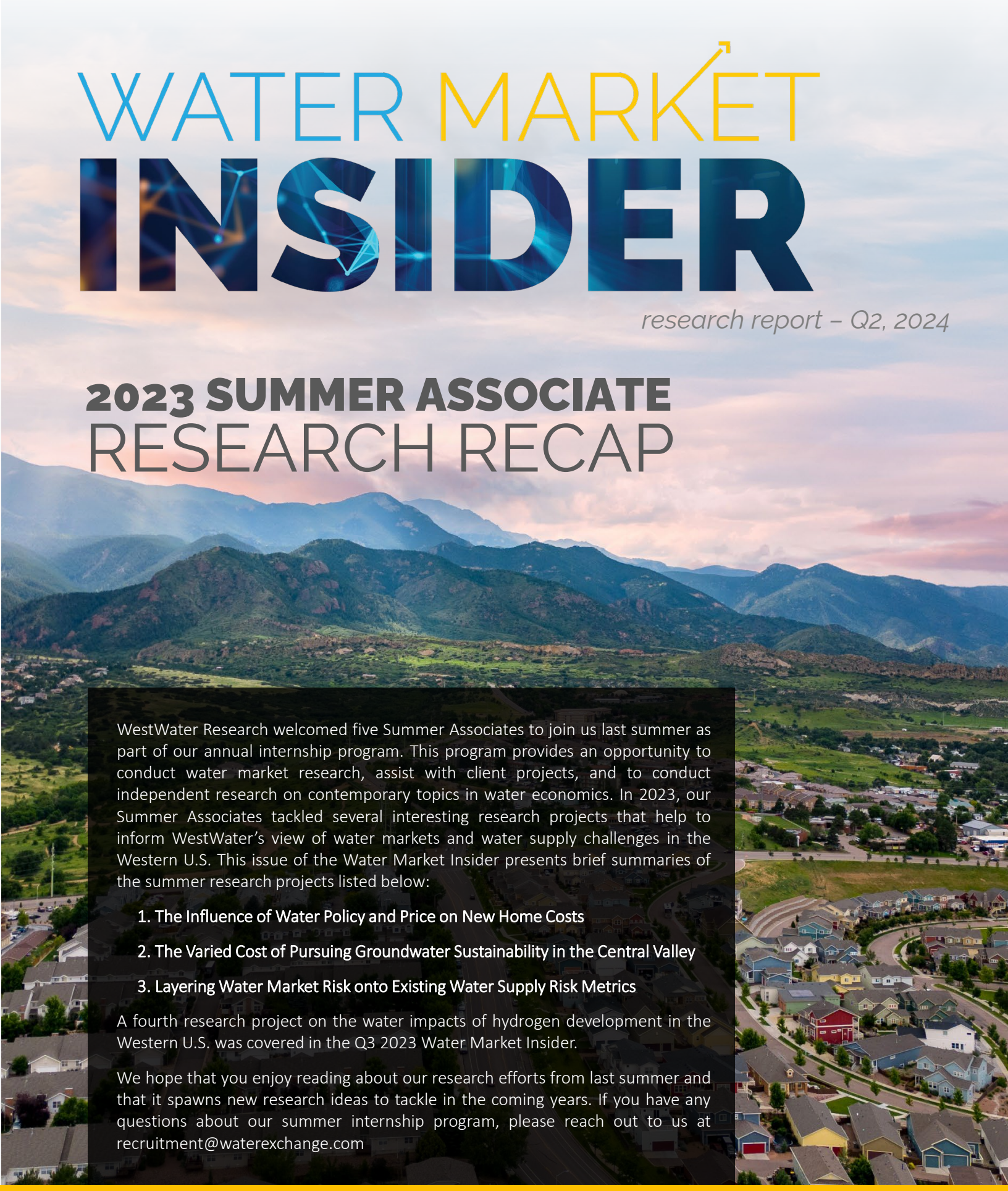
WATER MARKET INSIDER

research report – Q2, 2024

2023 SUMMER ASSOCIATE RESEARCH RECAP



WestWater Research welcomed five Summer Associates to join us last summer as part of our annual internship program. This program provides an opportunity to conduct water market research, assist with client projects, and to conduct independent research on contemporary topics in water economics. In 2023, our Summer Associates tackled several interesting research projects that help to inform WestWater's view of water markets and water supply challenges in the Western U.S. This issue of the Water Market Insider presents brief summaries of the summer research projects listed below:

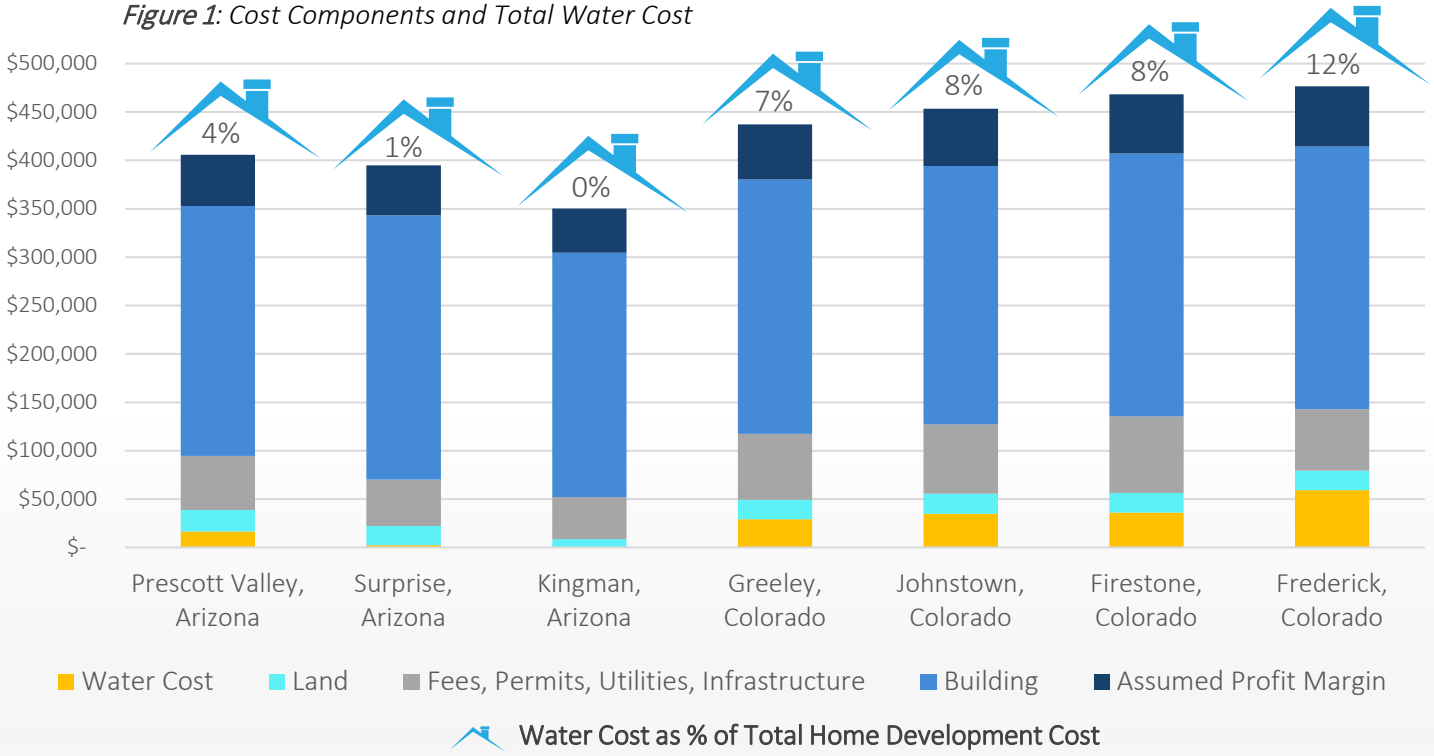
1. The Influence of Water Policy and Price on New Home Costs
2. The Varied Cost of Pursuing Groundwater Sustainability in the Central Valley
3. Layering Water Market Risk onto Existing Water Supply Risk Metrics

A fourth research project on the water impacts of hydrogen development in the Western U.S. was covered in the Q3 2023 Water Market Insider.

We hope that you enjoy reading about our research efforts from last summer and that it spawns new research ideas to tackle in the coming years. If you have any questions about our summer internship program, please reach out to us at recruitment@waterexchange.com

RESEARCH REPORT 1:
THE INFLUENCE OF WATER POLICY AND PRICE ON NEW HOME COSTS

Figure 1: Cost Components and Total Water Cost



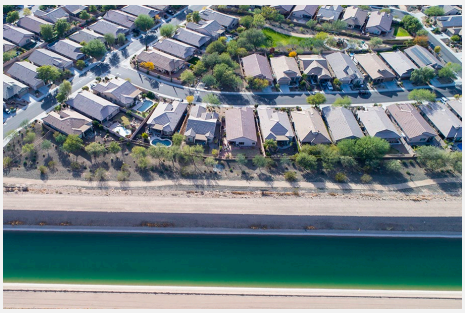
Housing costs in the Western U.S. have increased in step with population growth and the increased demand for available housing. In nominal dollars, median home prices have doubled over the past 8 years across the region. While demand for housing is driving home price appreciation, development costs have also been a factor. Many regions of the Western U.S. have also experienced rising levels of water stress and increasing market prices for water rights required to support new home construction. We estimated the major cost components of typical single-family home construction across seven communities in Arizona and Colorado to better understand the relationship between upfront water right costs and home building costs.

RESEARCH REPORT 1:
THE INFLUENCE OF WATER POLICY AND PRICE ON NEW HOME COSTS

Overall, we found that water costs represent an average of 6% of the total new home costs, but there was significant variability in this value across the seven communities evaluated, ranging from 0% to 12%. The observed variability is attributed to the market prices of water assets in each state and the regulatory requirements dictating the water required for new housing projects.

In Colorado, competition among land developers and municipal water utilities for high-priority water supplies has driven up the market price for water and increased the cost of home-building. Further, some municipalities have established strict water dedication policies that create a high-level of demand for specific types of water rights that are uniquely accepted for serving new development. The municipal policies that require dedications of specific, high-priced water rights have influenced home-building costs and development activity in some areas.

In Arizona, the 1980 Groundwater Management Act was the driving force in establishing water supply requirements for new home developments in many parts of the state. Housing developments inside groundwater management areas are prohibited from relying solely on local groundwater sources and must secure alternative sources of water that can be costly. Outside of these management areas, there is much less regulation and often no need to secure additional water assets beyond the underlying groundwater to support new development. There is a clear regulatory influence on water costs for home construction between communities.



The seven example communities show that water policies and water market prices can have a significant influence on water costs of new home construction. In Colorado, water dedication policies and competition have already influenced the market for housing developments, whereas in Arizona, regulatory restrictions on physically available groundwater for new developments are a relatively new constraint driving developers to the market for new supplies. These policies and regulations will increasingly influence the location and extent of new residential growth. As water supply options become more limited, new home buyers may increasingly bear the costs of upfront water supply acquisitions. Looking forward, challenges in identifying and securing a viable source of water supply to support new home development may become a more significant constraint for housing developers than the costs presented in this analysis.

WestWater would like to thank Logan Barkley for his research efforts on how water entitlement costs impact the pricing of new homes in the West during his 2023 summer internship with us. Logan is currently serving as a research analyst at WestWater and is based in our Phoenix office.

RESEARCH REPORT 2:

THE VARIED COST OF PURSUING GROUNDWATER SUSTAINABILITY IN THE CENTRAL VALLEY

Passed in 2014, the Sustainable Groundwater Management Act (SGMA) aims to bring California's groundwater basins into a sustainable balance over the next two decades. SGMA places the burden of regulation on the shoulders of Groundwater Sustainability Agencies (GSAs) - local entities that often are associated with water or irrigation districts. Research was conducted on how GSAs are funding their operations and how those fees impact the costs to irrigate farmland in the Central Valley of California.

We compiled rates and fee structures for 66 GSAs in the Central Valley. Of the 66 GSAs, 25 have implemented at least one pricing mechanism to help fund SGMA implementation. These pricing mechanisms fall into two categories:

- Annual Fees: 16 GSAs had enacted annual fees charged on a per-acre basis. Fees ranged from $2.50 to $28.80 per acre with an average of $12.57 per acre.
- Extraction Rates: 13 GSAs had enacted groundwater extraction rates based on the volume of water pumped. Different rate structures were found including flat rates, tiered rates, and rates with penalty fees. Extraction rates are often paired with allocations of allowable pumping. Rates varied significantly with an average minimum rate of $168 per AF up to an average maximum rate of $345 per AF pumped.

What influences the types of pricing mechanisms that are being adopted?

Water supply risk and the magnitude of the groundwater overdraft problem were found to be the driving factors in GSA selection of a pricing mechanism for SGMA implementation. GSAs with medium to low risk of water supply shortages were found to have the highest adoption rates of pumping allocation programs and extraction rates based on pumping. High risk GSAs had the highest adoption rates of annual fees and the lowest adoption rates of allocations and extraction fees. High risk GSAs face a bigger problem with greater economic impact if they start to enact pumping allocations and extraction rates, and currently most high-risk GSAs are turning towards annual fees because they carry less immediate economic impact to landowners.

RESEARCH REPORT 2:
THE VARIED COST OF PURSUING GROUNDWATER SUSTAINABILITY IN THE CENTRAL VALLEY

Table 1: Example SGMA Costs for a farm: 300 acres, 4 AFY of applied water

Scenarios	GSA	Rates and Fees	SGMA Cost per Year	Unmet Water Demand
1: Allocation with Tiered Extraction Rate	Pixley Irrigation District GSA	1.33 AFY/acre Sustainable Yield, with a 2 AFY/acre transitional water costing $90/AF for the first AF and $180/AF for the second AF. No annual fees.	$81,000	201 AF
2: Allocation with Tiered Extraction Rates & Penalty Fee	Greater Kaweah GSA	0.83 AFY/acre Sustainable Yield, 0.83 AFY/acre Tier 1 at $60/AF, and a 1.04 AFY/acre Tier 2 at $120/AF, any extraction beyond this costs $500/AF. $10/acre annual fee.	$52,629 without penalties $247,629 with penalties	390 AF without penalties 0 AF with penalties
3: Per Acre Annual Fees	Merced Subbasin GSA	$3.50/acre SGMA Compliance Fee, $10.94/acre Phase 1 Fee	$4,332	0 AF
4: No Rates or Fees	County of Merced GSA	Only costs would be pumping costs which exist everywhere	$0	0 AF

What are the additional costs to irrigate due to SGMA?

Table 1 calculates the net cost to irrigate with only groundwater for an example 300-acre farm with an annual water demand of 4 AFY per acre or 1,200 AFY total. SGMA costs are estimated to meet this water demand under four example GSAs in the San Joaquin Valley.

- Pixley Irrigation District GSA has a tiered extraction rate based on its allocation program but no penalty fee. This keeps SGMA costs down but at the expense of not allowing pumping to meet the entire water demand. In this GSA, the landowner would need to source surface water or see if there is a groundwater trading program in place to buy allocations from another landowner.
- Greater Kaweah GSA has a similar allocation program to Pixley with the addition of a $500/AF penalty fee and a $10/acre annual fee. The penalty fee allows the landowner to meet their water needs without needing to source an additional supply. Depending on water prices, a penalty fee may be the cost-effective option.
- Merced Basin GSA and County of Merced GSA do not have allocation programs or extraction rates. In the Merced Basin GSA, the landowner pays an annual fee and has no limits or additional costs to use groundwater. In the County of Merced GSA, the landowner has no additional fees and restrictions due to SGMA. These two GSAs have low costs and do not limit groundwater extraction. However, these low costs are likely temporary and will likely rise as groundwater is depleted and supply augmentation projects and management actions are needed.

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THE VARIED COST OF PURSUING GROUNDWATER SUSTAINABILITY IN THE CENTRAL VALLEY

Conclusion

Since SGMA was passed in 2014, the adoption of fees and rate structures by GSAs to pay for SGMA implementation has been limited. Only 28% of the GSAs reviewed for this project have established pricing mechanisms to fund SGMA activities. Of the GSAs that have adopted fees and rates to fund SGMA, the costs to irrigators vary significantly. Current SGMA costs were found to vary from $0 to almost $250,000 per year for an example 300-acre farm in the Central Valley.

Over time, the successful implementation of SGMA will require each GSA to raise sufficient funding to implement management actions. Extraction rates and penalty fees raise the highest funds while also curbing overall groundwater pumping when paired with annual allocations. In comparison, annual fees raise much less funding but may be an advantageous policy in areas with limited direct groundwater extraction like cities. Over the next 5 years, many more GSAs are expected to evaluate and implement pricing mechanisms similar to those reviewed in order to fund necessary activities aimed at achieving the goals set out in SGMA.

WestWater would like to thank Helena Holmberg for her research efforts on groundwater sustainability during her 2023 summer internship with us. Helena is currently serving as a research analyst at WestWater and is based in our Sacramento office.

RESEARCH REPORT 3:
LAYERING WATER MARKET RISK ONTO EXISTING WATER SUPPLY RISK METRICS

The physical availability of water supply does not always match where demands are highest due to population density, agricultural intensity, and changes in supply. Given this imbalance between supply and demand on a global and regional scale, a series of geospatial datasets have been developed in recent years to quantify the risks to various human uses. For instance, international companies, such as Coca-Cola and Colgate-Palmolive, have used these models to understand risks related to physical (scarcity and quality), regulatory, reputational, and infrastructure. CDP's Global Water Report states that 79% of companies' water exposure are related to physical risks.

However, these existing water risk scores often do not factor in the market risk of securing new water supplies through acquisitions and transfers. Water market risk includes various factors such as price volatility, availability of supply, and regulatory factors. To explore the potential influence of market risk, we compared various water pricing metrics to existing water supply risk indices for seven areas with active water market activity in the Western U.S.

Existing Water Risk Models

Two existing water supply risk models were reviewed: (1) Water Risk Atlas published by the World Resources Institute and (2) Water Risk Filter published by the World Wildlife Fund.

Both tools follow a similar hierarchical structure to quantify risks: indicators > risk types > overall score. Indicators common to both databases include:

- Baseline water stress
- Drought risk
- Water quality
- Biodiversity importance
- Media importance (reputational risk)

Within each hydrologic basin or political jurisdiction, one indicator may have more importance than another. These indicators can be weighted based on different use sectors, including agriculture, mining, food & beverage, or electric power generation. Scores for each indicator are then aggregated into an overall score.

Adding a Water Market Risk Indicator

The risk indicators applied in existing models focus on physical water supply risk and do not include water market risks. WestWater created an additional risk indicator to represent water price risk as one element of water market risk. Water price risk was evaluated from three metrics:

- Interannual price variability (water prices variation over the past 7 years, 2022-2016)
- Absolute price (average price of water in 2022)
- Price growth (how much water prices increased from 2016 to 2022)

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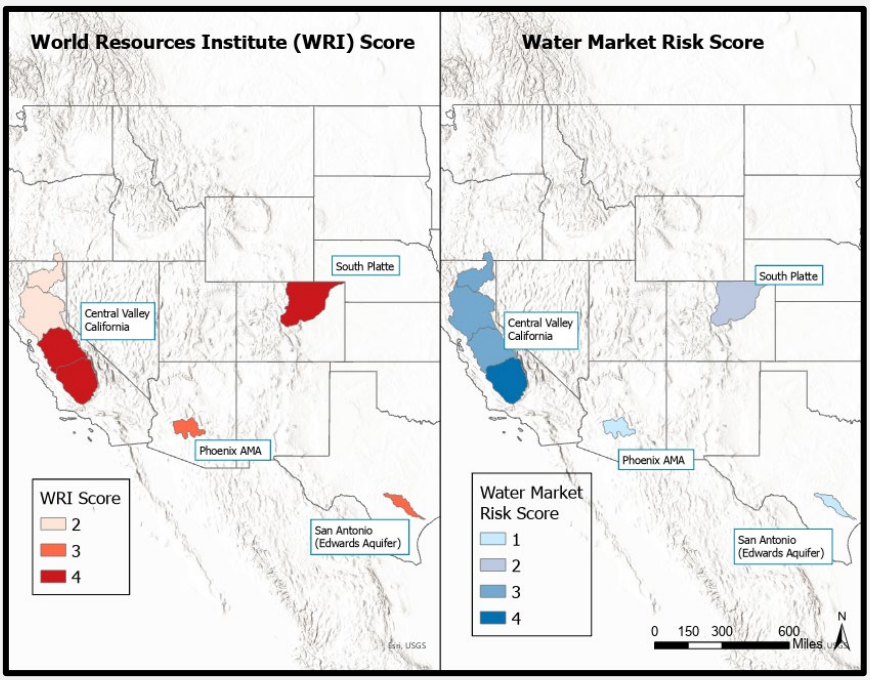
Summary of Findings

The three example areas in California were found to have the most water market risk across all three pricing metrics. This market risk is most notable for the agricultural sector in the Central Valley that often looks to the single-year spot market for supplemental water supply. Northern Colorado also had notable market risk due primarily to high water prices and high price appreciation resulting from continued housing development.

Most of the example market risk regions are also areas demonstrating physical stress, mainly due to scarcity. Variable hydrology and declining supplies provide price signals that impact the market risk scores. For instance, water supply prices in the three basins in California are highly sensitive to drought. The main risk factors in the regions of Phoenix and San Antonio are the high rates of extraction due to population growth, new industrial demand, and relatively low rates of recharge.

Water pricing information was taken from Waterlitix. This analysis was completed for seven specific water markets in the Western U.S. that are observed to have active water trading, as shown in Figure 2.

Figure 2. Water Supply Risk and Market Risk for Seven Example Areas in Western U.S.



Understanding water market risk is an important component of assessing supply and demand factors that can ultimately impact sustained economic growth and livable communities. Water markets generally represent the ability and cost to reallocate water resources among supplies and demands, which is an important mitigation strategy for physical water supply risks. This research started to develop the concept of incorporating water market risk (through pricing metrics) into existing physical water supply risk models. Further research could incorporate other water market risk metrics to more fully capture the ability and constraints around water supply reallocation.

WestWater would like to thank Ben Asperheim for his research efforts on water supply risk metrics during his 2023 summer internship with us. Ben is a senior at UC Santa Barbara where he is double majoring in economics and data science.