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Stuck in the Mud: Groundwater Markets Struggle to Gain Traction Under SGMA

Liz Saunders and Ellen M. Bruno

Across critically overdrafted groundwater basins, groundwater market development has faced significant hurdles. These include challenges with determining allocations and resistance to trade due to fears of consolidation and the loss of small-scale farming. As a result, we find that there has been minimal progress, despite the fact that trading could substantially reduce the costs of SGMA compliance and maintain more land in agriculture.

California's Sustainable Groundwater Management Act (SGMA), which passed in 2014, opened the doors for groundwater markets and other demand-management strategies. Prior to SGMA, groundwater extraction in California was mostly unregulated. Overlying landowners were generally able to drill wells and pump as much groundwater as they wanted. But SGMA's sustainability mandates are now incentivizing local groundwater agencies to curb groundwater use. One strategy to meet SGMA's goals is the development of groundwater markets.

An *ARE Update* article by Friberg, Wardle, and Bruno in 2023 detailed the demand management strategies laid out in the full set of groundwater sustainability plans submitted to the state. Critically overdrafted basins were required to submit their initial plans to the Department of Water Resources (DWR) in 2020, with periodic reviews in five-year increments after that. Now that the five-year review deadline has passed, we can evaluate these plans to learn what developments have occurred since 2020 in critically overdrafted basins. We focus on groundwater markets, which have received more attention (and resistance) than other demand-side strategies.

Pros and Cons of Groundwater Markets

Creating a groundwater market involves determining an allocation of extraction rights or permits among users in a basin and setting rules to govern the trade of those permits. The flexibility enabled by the ability to trade is why economists often tout markets as a low-cost way to achieve sustainability goals. In fact, estimates by the Public Policy Institute of California (PPIC) suggest that allowing trade could reduce the costs of SGMA compliance by 33%–50%.

This is important because SGMA could cause large shifts in the agricultural landscape. The PPIC estimates that the San Joaquin Valley will face a 16% cutback in groundwater use, on average, due to SGMA. This cutback could cause the fallowing of 780,000 acres and crop revenue losses of about $3.5 billion per year. Policies that can reduce those costs should be taken seriously.

Simultaneously, community members have raised concerns about markets, fearing the ability of small farmers to participate on equal footing or the potential for unintended consequences for the environment and domestic wells. One major concern is that the ability to trade permits might lead to consolidation of pumping rights in the hands of a few powerful entities who could then exercise market power over small users. Groundwater trading could lead to consolidation as low-productivity firms exit and high-productivity firms acquire rights, reflecting increased resource use efficiency. If small farms are more likely to have low water productivity, this could lead

to the loss of small-scale farming and a change in the social fabric of local communities.

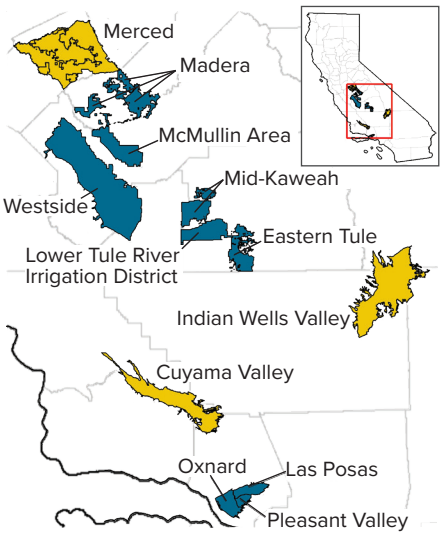
The high stakes and conflicting opinions about the effects of groundwater trading have sparked considerable interest in whether and how groundwater agencies are moving forward with groundwater markets.

Water Market Status in Key Areas

Our prior work showed that there was considerable interest in developing groundwater markets, but few agencies had made meaningful progress toward developing them in the initial years of SGMA implementation. To assemble a current and comprehensive picture of groundwater markets in California, we analyzed periodic (five-year) reviews, annual reviews, groundwater sustainability plans (GSPs), and groundwater sustainability agency (GSA) websites. We focused primarily on GSAs in basins that have released their first periodic review.

Our review suggests that progress toward developing groundwater markets has been rocky. GSAs have explored a range of approaches (e.g., simulations, pilot projects) to initiate markets, but various stumbling blocks have forced them to either discontinue their plans or, in at least one instance, proceed to a court adjudication.

Figure 1. SGMA Regions With Market or Allocation Progress



Source: Authors' calculations.

The map in Figure 1 highlights the regions that have shown interest or made some progress toward market development in blue and those that have established allocations (a precursor to markets) in yellow.

McMullin Area

McMullin Area, a GSA within the Kings Subbasin, is simultaneously planning allocations and trading systems, although there does not seem to be much progress on either front. McMullin Area has updated its GSP twice, in 2022 and 2025, since its original 2020 submission, but all three versions contain the same plans, status, and schedule for both allocations and trading systems. McMullin's allocations system still notes a need for more data and analysis. After allocations are assigned, water users will be subject to a ramp-down schedule to help them gradually reduce their groundwater use. Each iteration of the GSP says the GSA expects to begin working on the allocation policy within one year and complete it within three years.

Instead of designing its own allocation system, McMullin Area GSA plans to collaborate on basin-wide allocations with the other six GSAs in the Kings Subbasin. North Fork Kings GSA, one of these six, is taking the lead on drafting the allocation methodology. A fully drafted, basin-wide methodology is expected to be completed in 2025 for the GSAs to discuss.

Once the GSA determines allocations, it plans to explore a trading system, although details still need to be hashed out. The GSP gives enormous leeway in the type of trading system that might be developed (e.g., auction, "smart market", brokerages). Trades could be short-term, long-term, or permanent, and may be subject to restrictions based on physical realities such as effects on surrounding wells. Each of the three GSP versions states that the development of a trading system is expected to begin within five years of GSP adoption, with the final plan being approved two years after that. Although the McMullin Area GSA expressed early interest in market development, it appears to have stalled in a coordination phase surrounding allocations.

Madera

The Madera Subbasin Joint GSP is a collaboration among three GSAs. However, only one of these GSAs stands out for its progress on allocations and trading. Madera County GSA has enforced allocations for irrigated acreage since 2022. It set a flat rate of acceptable groundwater use (in acre-feet, or AF, per irrigated acre), with rates differing by subbasin since the Madera County GSA covers the Madera, Chowchilla, and Delta-Mendota subbasins. Allocations follow a ramp-down schedule starting in 2021 and ending in 2025, where farmers decrease their groundwater use incrementally. Fees for overpumping started at $100 per AF in 2023 and increase by $100 per AF each year until the final fee of $500 per AF is reached. Farmers can select one of three water monitoring options, and in certain situations can earn recharge credits to pump more in the future than their allocation would otherwise allow.

The Madera County GSA's market development stalled after it conducted a virtual water market simulation from January to November 2021, which included 57 participants. The GSA's summary of the results concluded that implementing a water market would be challenging, although it has not completely ruled out the option to implement a water market in the future. Stated challenges included some participants' mistrust

of government motivations, unsold water once the algorithm had finished matching buyers with sellers, and the difficulty of predicting where groundwater pumping would increase.

The desire to predict post-trade outcomes presents a dilemma: A market's fundamental attractiveness lies in leveraging decentralized information to discover the efficient allocation (the "invisible hand"), precisely because regulators lack the knowledge required to predict it. Instead of trying to forecast trading hot spots to set rules ex-ante, GSA managers seeking to minimize negative unintended impacts could consider general rules that are based on outcomes. However, this would require clear thresholds and consequences for undesirable results combined with real-time monitoring and reaction.

Westside

Since 2023, landowners have been limited in their groundwater pumping by an allocation of 1.3 AF per acre. Westside's plan involves a ramp down where this allocation decreases by 0.1 AF per acre every year until 2030, at which point the sustainable yield of 0.6 AF per acre is reached.

The potential benefits of groundwater markets are clear in areas like Westside, where allocations are far below crop water needs. In the absence of trade, farmers who choose to stay in business would have to shrink irrigated acreage significantly. It is possible that some farmers can make up the difference with surface water supplies during wet years. Regardless, a groundwater market would allow some farmers to better maintain production (through purchasing groundwater) while others could generate revenue from selling their allocations.

Westside's policies do allow for trades to occur, although no formal market is in place. Users can negotiate among themselves and settle on a trade, subject to approval. It is not clear if any trades have been made.

Oxnard and Pleasant Valley

The Fox Canyon Groundwater Management Authority (FCGMA) covers the Oxnard and Pleasant Valley subbasins, among others. Since October 1, 2020, Oxnard and Pleasant Valley have been subject to the same groundwater allocation system (albeit with some small policy differences), replacing their old system. The new system set initial allocations using base-period extractions (a multi-year historical average) and fixed them by production well. They instituted a ramp-down schedule over 20 years to ease pumpers into their allocation. Anyone pumping more than their allocation faces a tiered surcharge rate.

In 2016, the FCGMA began planning and testing a groundwater market in a small portion of Oxnard—the first of any GSA under SGMA. A third party administered the water market, paid for by a 2% fee on both the buyer and seller of each trade. Buyers and sellers were matched using an algorithm and remained anonymous to one another. FCGMA originally expressed a desire to roll the market out to all agricultural groundwater users in Oxnard and Pleasant Valley. However, since then, Oxnard and Pleasant Valley have begun an adjudication process triggered by plaintiff concerns about groundwater allocations, so there are no plans to continue the water market at this time.

The fact that FCGMA's groundwater market led to the start of an adjudication is particularly notable since it was often held up as the poster child for how groundwater markets should be developed. Their process involved stakeholder engagement, and the market was designed with trading rules to prevent negative externalities.

Las Posas

FCGMA also covers Las Posas. Like Oxnard and Pleasant Valley, FCGMA switched Las Posas from its old allocation system to a new one on October 1, 2020. The 2023 Las Posas Adjudication Judgment formalized this allocation methodology and assumed legal authority, essentially adapting the existing FCGMA rules. The judgment establishes four types of allocations: agricultural, commercial, domestic, and mutual water company allocations. Users may carry over unused allocations, subject to certain restrictions.

While the sum of all current allocations exceeds the groundwater extraction goal, the GSA ramps them down over time. The extraction allocation system is generally consistent with that of Oxnard and Pleasant Valley, but allocations are assigned at the individual level rather than the well level. While no formal market exists, transfers and temporary assignments of extraction allocations are permitted subject to FCGMA approval.

Other Notable Regions

Mid-Kaweah is a critically overdrafted basin whose GSP has yet to be accepted by DWR. Despite this, the GSA actively piloted a water market in the summer of 2024, structuring trades as auctions. The GSA hosted two of these auctions, each spanning several days, in which groundwater users could sell up to 10 inches per acre of allocation. At this point, it is unclear whether Mid-Kaweah will implement this or a similar water market at scale.

In the Eastern Tule and Lower Tule River Irrigation District GSAs, groundwater allocations can be transferred between users, provided they meet certain criteria and receive approval from the relevant GSA.

Several GSAs collaborated with Environmental Science Associates, the

Environmental Defense Fund, the California Water Data Consortium, and the engineering and design firm Olsson to create an open-source water accounting and trading platform. Rosedale Rio-Bravo Water District participated in a pilot test of the trading system. The water district is currently using the platform, but does not seem to have allowed trading yet.

Areas With Allocations

A handful of regions have instituted allocations—a necessary precursor to trading—but have not made any documented progress on trading. Table 1 summarizes the allocation rules and status for these regions, as well as the previously mentioned areas that have made progress on market development.

Cuyama Valley has had allocations at the parcel level in place since 2023. Allocations were assigned based on baseline pumping levels, and groundwater pumpers were ordered to reduce their use by 5% in 2023 and 10% in 2024. The region will require pumpers to further reduce groundwater use until the sustainable yield is met in 2038. Landowners can challenge their allocations if they disagree, and they face tiered fees for overpumping.

Finally, the three Merced GSAs are working together on an integrated groundwater allocation framework in case they need to set a basin-wide allocation. For now, the Merced Irrigation-Urban GSA has set acreage-based allocations for farmers. The allocation for agricultural users is set at 1.4 AF per acre per year through 2031 and then 1.1 AF per acre per year until 2040. Similarly, in 2026, the Merced Subbasin GSA will enforce distinct sustainability zones with initial allowances of 23 acre-inches per acre. Every year for 10 years, the pumping allocation will decrease by 1 acre-inch per acre until it reaches the sustainable yield level of 13 acre-inches per acre.

Concluding Remarks

Enabling the trading of groundwater could put a big dent in the costs of SGMA, easing some of the burden from cutbacks to growers and local communities. In several regions, the proposed or implemented allocations are far below crop water needs. This is a huge challenge for farmers. Yet we aren't seeing widespread adoption of groundwater trading across California.

Why aren't markets gaining more traction, despite basically every economic model saying there are large gains from trade? Clearly, developing allocation schemes and trading frameworks is more easily said than done. Our review highlights some of the difficulties in getting markets off the ground. For one, determining allocations is challenging both politically and administratively. On top of that, GSAs must make a lot of decisions about market design. And finally, stakeholders are often mixed in their desire to see markets develop. It remains to be seen whether GSAs will successfully establish functional, well-governed systems for groundwater trading in California.

Table 1. Summary of Allocation Rules and Status

GSA(s)	Status	Initial Allocation Methodology	Ramp Down
Kings Subbasin GSAs	Drafting	NA	NA
Madera County	In place	Flat-rate allocation in acre-feet per acre that differs by subbasin.	Yes
Westside	In place	Flat allocation in acre-feet per acre.	Yes
Oxnard and Pleasant Valley	In place	Determined using multi-year historical average per production well.	Yes
Las Posas Valley	In place	Varies by type (e.g., agricultural, commercial, domestic, or municipal).	Yes
Mid-Kaweah	In place	Assigned annually as a flat rate of acre-feet per irrigated acre.	NA
Indian Wells Valley	In place	Assigned 51,000 acre-feet in allocations to individuals based on irrigated acreage during a designated base period.	Yes
Cuyama Basin (Cuyama Valley GSP)	In place	Assigned at the parcel level based on baseline levels of pumping.	Yes
Merced Subbasin GSAs	In place in one GSA, basin-wide allocations in development	Merced Irrigation-Urban GSA assigned acreage-based allocations. Merced Subbasin GSA plans to allow a set number of acre-inches per acre starting in 2026.	Yes

Source: Based on authors' synthesis of GSPs and periodic reviews submitted to DWR.

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For additional information, the authors recommend:

Hanak, Ellen, et al. 2023. "Managing Water and Farmland Transitions in the San Joaquin Valley." PPIC Report. Available at: https://tinyurl.com/munwfpy7.