How Is Demand Management Developing in SGMA Groundwater Sustainability Plans?

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Demand management will play a critical role in both reaching groundwater sustainability under SGMA and determining the economic costs of groundwater regulation. Here, we provide an update on the approval process of 116 submitted groundwater sustainability plans. We detail demand management proposals and compare how these differ between plans that have been approved and those deemed incomplete or inadequate.

Almost a decade after the passage of the Sustainable Groundwater Management Act (SGMA), the law's implementation is now well underway. Prior to SGMA, groundwater extraction was almost entirely unregulated in most of California, with overlying landowners generally being free to pump as much water as they could put to beneficial use. Persistent drawdown of aquifer levels and its corresponding costs, including seawater intrusion and land subsidence, meant new rules were necessary to ensure the sustainability of California's groundwater resources. SGMA seeks to provide those rules in a decentralized manner, vesting the power to develop rules and regulations for groundwater pumping in local agencies with existing ties to land and water management.

A previous *ARE Update* article by Wardle, Griggs, and Bruno detailed how these new local agencies, called Groundwater Sustainability Agencies (GSAs), were developed and who filled their boards. The next step of SGMA implementation was to develop a Groundwater Sustainability Plan (GSP). Today, the deadline to submit GSPs has passed, and the plans are available to view on the Department of Water Resources' (DWR) SGMA portal. Here, we describe, for the first time, the role that demand management plays in the full set of submitted GSPs.

What GSPs Do and Do Not Tell Us

Many GSPs include over 1,000 pages, reflecting the long list of criteria they are required to satisfy. Among these pages are discussions of hydrogeologic features of the relevant groundwater subbasin, projections of future water demands and supplies, water budgets, and other information necessary for the development of an effective management plan. Only one small section of the plans, usually taking up only about a dozen pages, explains the management actions GSAs are proposing to achieve sustainability.

Even in those short sections, not all proposed management actions involve demand management, by which we mean new rules that alter the incentives facing groundwater pumpers when considering how much to pump. In fact, most proposed actions seek to augment supply through means like stormwater recharge. While supply augmentation has a definite role to play in achieving groundwater sustainability throughout California, there is only so much available water with which to augment groundwater resources. A study by the Public Policy Institute of California has shown that much of the proposed supply augmentation is infeasible. Demand management will be needed to achieve sustainability targets in many basins.

Beyond the simple unavailability of adequate surface water to make up for groundwater deficits, demand management is also important for its ability to influence the costs of reducing groundwater use. The fundamental problem that led to existing drawdown is that individual pumpers making a private choice about how much to pump do not personally face the full cost of their own pumping; while they do pay for the electricity to operate the pump, they do not bear the cost of lower groundwater levels for everyone else.

Fixing this problem purely through supply augmentation risks cascading expenses, as pumpers are free to simply extract whatever recharge the GSA provides. Demand management strategies resolve this "leaky bucket" problem. But not all demand management strategies are created equal—the type of demand-side strategy and the degree to which demand is limited will have implications for how agriculture and surrounding communities are impacted.

GSPs are an imperfect guide to what will actually happen as GSAs implement SGMA. The plans laid out in GSPs are not final; they are often subject to future votes of the GSA board, regulatory approval from other agencies, or successful contract negotiations with private parties. Plus, they may be conditional on the ability to raise funding. However, DWR is currently reviewing GSPs to ensure the plans can plausibly achieve the groundwater sustainability goals set by SGMA. For most GSAs, their submitted GSP is the best publicly available evidence of what steps they plan to take in meeting their SGMA obligations.

The GSP Review Process

Though all GSP submission deadlines have passed, the GSP review process is still ongoing. For every GSP submitted, DWR must assess whether the plan is in 'substantial compliance' with the SGMA law. Though the law broadly requires GSPs to include components of both monitoring and managing overdraft, as well as more specific consequences like land subsidence and groundwater quality degradation, the statute is fairly unspecific on the details. Instead, it directs GSPs to define their own measurable objectives and milestones using the best available science, then demonstrate that the plan's proposals will be adequate to achieve those goals.

As shown in Table 1, at the time of this publication, there are 38 incomplete or inadequate GSPs, 24 approved GSPs, and 54 GSPs still under review, which gives a total of 116 submitted GSPs across California. All the GSPs that have already undergone review (and whose status is therefore either approved, incomplete, or inadequate) cover "high- and medium-priority" basins. This is due to the fact that basins classified as high- and medium-priority were required to submit plans by January 2020 or January 2022, with the subset of those facing conditions of "critical overdraft" on the faster 2020 timeline. On the other hand, the GSAs managing low- and very low-priority basins are not required, but encouraged, by DWR to submit a GSP.

Table 1. Number of GSPs by 2019 Priority Level and Review Status

Status	Priority Level	GSP Count
Approved	High	14
	Medium	10
Inadequate	High	23
Incomplete	High	15
Review in Progress	High	15
	Medium	31
	Low	1
	Very Low	7

Source: The SGMA Demand Management Action Database (DMAD). Available at: https://sgma-dmad.com.

Among the GSPs deemed incomplete by DWR, commonly cited issues include lack of coordination among GSPs (because some basins have multiple GSPs), data inconsistencies, and incorrect or inconsistent methodology. Other GSPs have not been approved because they fail to address the GSP's impacts on undesirable results in detail, for example by not being specific enough in setting minimum thresholds (e.g., for land subsidence or water quality), lacking quantification of infrastructure threatened by land subsidence, or lacking a plan to fill identified data gaps.

GSPs deemed incomplete by DWR have 180 days to issue corrections or else risk intervention by the State Water Board. Intervention aims to provoke the GSA to take corrective measures and subsequently resume local authority. This year, six basins have been transitioned to the State Water Board for state intervention.

Since the review process does not explicitly focus on the types of management actions implemented in the GSPs, a GSP that includes no demand management can still be approved, in principle. DWR's issued rejections of GSPs have not focused on inadequacies in the management actions section. Nonetheless, our collected data shows that the proportion of approved GSPs that include demand management actions is significantly larger than that of the incomplete or inadequate GSPs.

Differences in demand management actions between approved and not approved GSPs also correlate with the timing of GSP submission. Recall that only GSAs in critically overdrafted basins faced the earlier GSP submission deadline. Basins submitting under the later deadline were not critically overdrafted, and therefore, more likely to be able to achieve sustainability targets without implementing demand management.

The Demand Management Strategies Pursued in GSPs

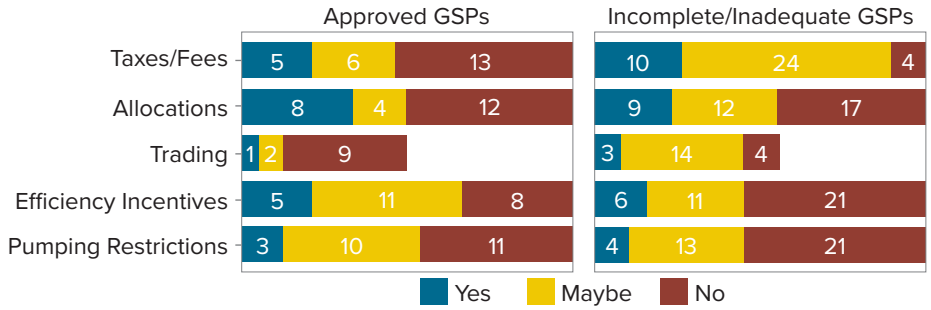
In evaluating the role of demand management in submitted GSPs, we've categorized demand management actions into a few broad categories, each with a good deal of variation within them. Below, we discuss the role of groundwater allocations and trading, taxes or fees, incentives for efficiency improvements, and outright pumping restrictions.

Taxes and fees are sometimes placed directly on groundwater extraction but are sometimes placed on less direct measures of groundwater use, like the number of irrigated acres or total acres. In discussing groundwater allocations, we include a large set of GSPs that do not make explicit reference to the word "allocations"—likely due to legal restrictions on how private property rights for groundwater can be implemented—but that do create policies that mimic the basic functions of an allocation system. For example, a GSP may introduce a tiered tax on pumping that is nearly zero up to an individual-specific cap and then prohibitively expensive above that cap. Such a scheme is clearly intended to endow a pumper with what amounts to an allocation, especially when pumpers are further allowed to trade their caps within the basin. Still, there are important distinctions between this sort of "allocation" and formal private property rights over groundwater, such as in the ability to use the allocation to, for example, collateralize a loan.

In the next sections, we look at the differences in implementation of the

five mentioned demand management categories between approved and incomplete/inadequate GSPs. Results are summarized in Figure 1. We discuss the management actions in order from highest to lowest overall implementation frequency within the GSPs: 1) taxes or fees, 2) allocations, 3) efficiency incentives, and 4) pumping restrictions. We include discussion of trading in the section on allocations since having an allocation system is a prerequisite for having a trading system. Before going into detail with the demand management actions, it should be noted that GSPs' descriptions of demand management actions are often unspecific, creating uncertainty about their implementation in practice.

Figure 1. Demand Management Actions



Source: The SGMA Demand Management Action Database (DMAD). Available at: https://sgma-dmad.com.

Note: The figure shows the number of different types of demand management actions included in the GSPs that are approved (left) and either incomplete or inadequate (right). The 'trading' bar is shorter than the others to show that only GSPs with allocation plans can include trading as a demand management action.

Taxes or Fees

Among our demand management action categories, taxes are the most commonly included. GSPs consistently favor taxing groundwater extraction directly over the less direct alternative of taxing acreage, irrigated acreage, or other potential bases. This is encouraging, as taxes on groundwater extraction directly address the incentive problem that leads to unsustainable extraction. When an individual pumper privately weighs the costs and benefits of additional extraction, an appropriately set tax can adjust the "costs" side of that equation to better capture the full costs of additional pumping, inclusive of effects on other basin users.

Among the GSPs that specify the form their taxes will take, the preferred rate structure is tiered, where marginal tax rates increase after crossing certain pumping thresholds, as opposed to a flat tax rate that remains the same regardless of the amount extracted. This can help to maintain the correct incentives at the margin while avoiding massive tax bills. The preference for tiered tax rates also reflects the fact that, for many GSPs, the tax actually functions as a way to implement allocations.

Most GSPs do not include plans for the rates themselves, and many implement taxes primarily for the purposes of raising revenue to cover GSA operating costs rather than explicitly as a strategy for adjusting pumpers' incentives. It is unclear whether the tax rates that GSAs eventually implement will be set at a level that successfully aligns pumpers' behavior with sustainability targets.

Allocations and Trading

A fixed allocation of extraction rights distributed among basin users, when combined with the ability to trade, also provides a flexible way of meeting sustainability goals at minimized cost. Under an allocation and trading scheme, a private pumper deciding how much to extract will have to weigh the benefits of additional pumping against the price of extraction permits. If the overall allocation is set appropriately, the price of the permits will reflect the real scarcity of the underlying groundwater resource. Without trading, allocations still set a useful ceiling, preventing excessive pumping, but may leave people with inadequate allocations without a cost-effective route to secure more water. Less than half of the GSPs that include allocations also include trading of those allocations.

Though the economic benefits of trading can be achieved no matter how initial allocations are distributed, determining how initial allocations will be made is a major political question that comes with implications for equity. Allocations based on historical use can reward people who have overused groundwater in the past. We find a difference in the allocation base between approved and incomplete/inadequate GSPs. The approved GSPs with allocations all determine allocations based on historic pumping, whereas almost all of the incomplete/inadequate GSPs that include allocations use acreage as their allocation base. These two schemes would result in meaningfully different initial allocations in areas where the water intensity of land use is variable.

Some GSPs limit allocations to a certain time period (typically one year), meaning allocations cannot be carried over in time. The San Gabriel Valley GSP is one exception and explicitly allows a one-year carry-over in allocation trading, meaning that if a portion of a user's full allocation was not extracted in the previous period, the user may trade that portion in the current period. In consideration of the smallest groundwater users, several

GSPs mention that de-minimis users (mostly those relying on private wells for household use) are exempt from allocations. The Indian Wells GSP solves this problem with so-called Transient Pool Allocations, which are limited, single-use, and untradeable allocations targeted at current pumpers not receiving normal allocations.

Efficiency Incentives

Incentives to improve efficiency or limit groundwater use take many forms, each using a piecemeal approach to resolving the problem of over-extraction. Unlike a tax, which can align the incentives facing pumpers for all their pumping decisions, even in the best-case scenario, an efficiency incentive can only align incentives over the narrowly-defined, particular decisions targeted by the incentive (e.g., the single decision over whether or not to upgrade an irrigation system), while leaving other extraction decisions unchanged. On top of this, funding these programs introduces a budgetary issue, potentially requiring new or higher taxes. Setting the right prices, through either taxes on extraction or the trading of allocations, will create the needed incentives for groundwater sustainability and render something like a voluntary land fallowing program unnecessary.

Five out of the twenty-four approved GSPs include definite plans for efficiency incentives. Examples targeted to residential users include rebates for efficient fixtures and appliances, greywater reuse systems, stormwater capture and reuse, or turf removal. Other incentives target agricultural users, such as incentives for improvements to irrigation efficiency, voluntary land fallowing, crop rotation, or conversion to less water-intensive crop types.

Ad-Hoc Pumping Restrictions

Pumping restrictions prohibit pumpers from extracting water under certain conditions with little flexibility. Examples of ad-hoc pumping restrictions would be hard caps on extractions in drought years or bans on pumping in areas under immediate threat of seawater intrusion.

Overall, the descriptions of pumping restrictions are very vague. Some GSPs mention restrictions as part of their allocation scheme, and others simply state that extraction will be restricted to a certain amount without specifying how the restrictions will work in practice. The majority of GSPs that mention pumping restrictions reserve it as an intervention for worst-case scenarios of extreme drought or the failure of other projects and management actions to achieve sustainability and avoid undesirable results. No GSP relies primarily or even substantially on these ad-hoc pumping restrictions to achieve sustainability.

Our Data Are Publicly Available

To make these data readily available, we created the SGMA Demand Management Action Database (DMAD), where anyone can bulk download the data we collected and present here, or find a specific GSA on a map of California and see what demand management strategies that agency is proposing. The SGMA DMAD can be accessed at https://sgma-dmad.com.

Concluding Thoughts

While we are still in the early stages of SGMA implementation, a look at the proposed management strategies across the 116 submitted plans provides insight into how agencies will achieve sustainability. Demand management will play a critical role in both reaching sustainability and determining the economic costs of groundwater regulation.

Almost 20% of GSPs contain no mention of demand management and are instead depending exclusively on supply augmentation. Many of the others propose strategies with unnecessarily high costs.

Incentive-based strategies like pricing and trading have the potential to achieve sustainability goals at lower cost than allocations without trade or single-dimension efficiency programs. GSAs should take this into consideration, and keep tabs on the performance of their neighbors pursuing different strategies, as they continue to fine-tune their plans for achieving sustainability.

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For additional information, the authors recommend:

Wardle, Arthur R., Paige Griggs, and Ellen M. Bruno. 2021. "A Progress Report on California's Sustainable Groundwater Management Act." *ARE Update* 24(3): 1–4. Available at: https://bit.ly/2ZwDzaT.

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