

Water and the Future of the San Joaquin Valley

OVERVIEW



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Introduction

The San Joaquin Valley—California’s largest agricultural region and an important contributor to the nation’s food supply—is in a time of great change. The valley produces more than half of the state’s agricultural output. Irrigated farming is the region’s main economic driver and predominant water user.

Like many agriculturally dependent regions, the valley faces significant socioeconomic challenges, including a high rate of unemployment and pockets of extreme rural poverty. These challenges increase when the farm economy suffers.

Stress on the valley’s water system is growing. Local water supplies are limited, particularly in the southern half of the region. To irrigate their crops, many farmers use water imported from Northern California through the Sacramento–San Joaquin Delta. But in many places farmers have also relied on groundwater overdraft—pumping groundwater in excess of the rate at which it is replenished. Worsening droughts, increasing regulations to protect endangered native fishes, and growing demand for Delta imports in Southern California have compounded surface water scarcity. While overdraft has been a challenge for many decades, the pace of groundwater pumping has accelerated, especially during the 2012–16 drought (Figure 1).

Addressing long-term declines in groundwater reserves and adapting to worsening droughts are essential steps toward a more prosperous future. A chronic decline in groundwater levels is making drinking water and irrigation wells go dry, increasing the amount of energy required to pump water, harming ecosystems, and reducing reserves to cope with future droughts. It also causes land to sink, which damages major regional infrastructure, including canals that deliver water across the state.

These problems spurred the enactment in Fall 2014 of the Sustainable Groundwater Management Act (SGMA), which requires local water users to bring groundwater use to sustainable levels by the early 2040s. With the largest groundwater overdraft in the state, the valley is ground zero for implementing this law. SGMA will have a broad impact on valley agriculture in coming years—and will likely entail some permanent idling of farmland.

In addition to water shortages, the valley must respond to a variety of water quality problems. The region is a hot spot for unsafe drinking water: more than 100 rural communities have contaminated tap water. Long-term remedies to unsafe drinking water are urgently needed. And valley farmers must address new requirements to protect groundwater quality from the buildup of nitrogen and salts, alongside SGMA’s requirement to balance water supplies and demands.

In these changing times, land and water management present complex challenges for the region. Today, much of the valley floor is managed for intensive crop production and many native species are in decline. Land and water management are often constrained by endangered species

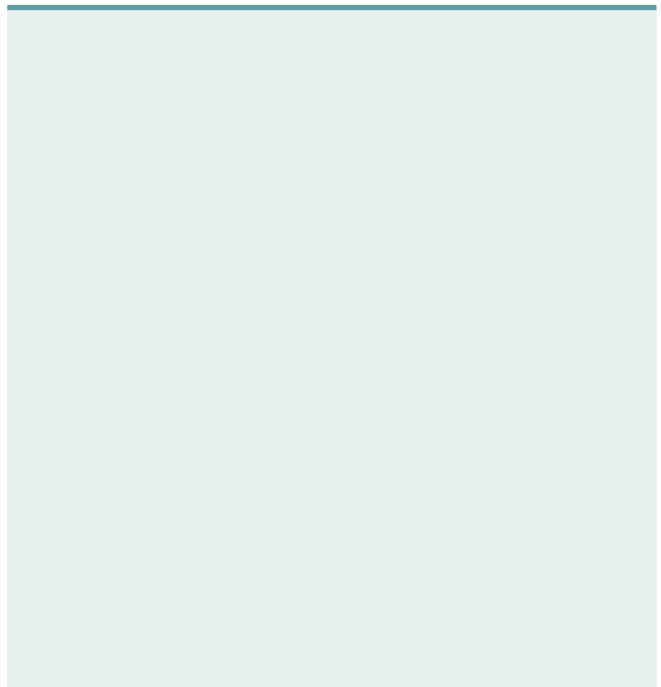
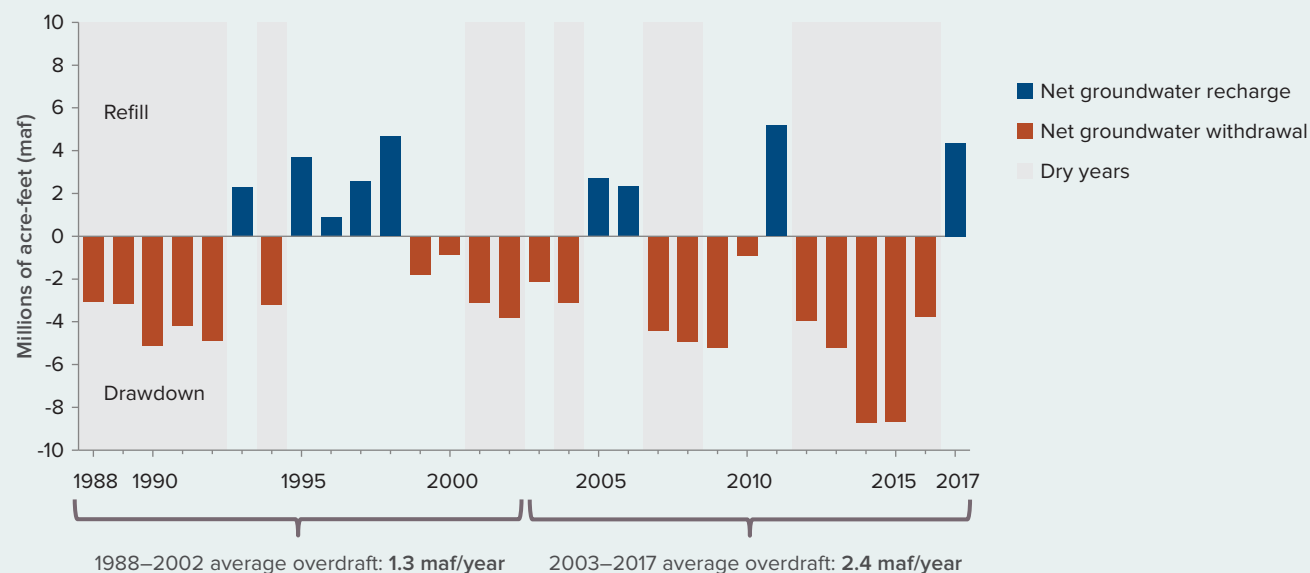


Figure 1. Groundwater overdraft in the San Joaquin Valley has accelerated in recent years



protection and actions required to help species recover. Water supplies for the region’s fresh-water ecosystems can be managed more efficiently and effectively. And land fallowed to achieve groundwater balance will need to be thoughtfully managed. Reducing dust and weeds to protect air quality and neighboring farmland is imperative. At the same time, there is potential for using fallowed lands to achieve other benefits, such as groundwater recharge and improved soil and ecosystem health.

Valley farmers and residents have a history of creatively adapting to difficult and changing conditions. Although major challenges lie ahead, constructive solutions are in reach. This will require a major ramp-up in cooperation and coordination among a growing circle of stakeholders within the region, as well as state and federal support. Pursuing solutions that deliver multiple benefits will boost the chances of success overall. The entire region, and California as a whole, stand to gain from cost-effective approaches that support the valley’s economy while improving public health and the natural environment.

Balancing Water Supplies and Demands

To close the groundwater deficit, groundwater sustainability agencies (GSAs) in the valley’s overdrafted basins will have to augment their supplies, reduce their demands, or use some combination of these two approaches. A range of options are under consideration, but they are not likely to be equally effective or practical. Our analysis highlights the most promising approaches.

Expanding Supplies

Developing new supplies is limited by a variety of factors, including cost. We find that most valley farmers will not be willing to pay more than \$300–\$500/acre-feet for new long-term water supplies. The best options:

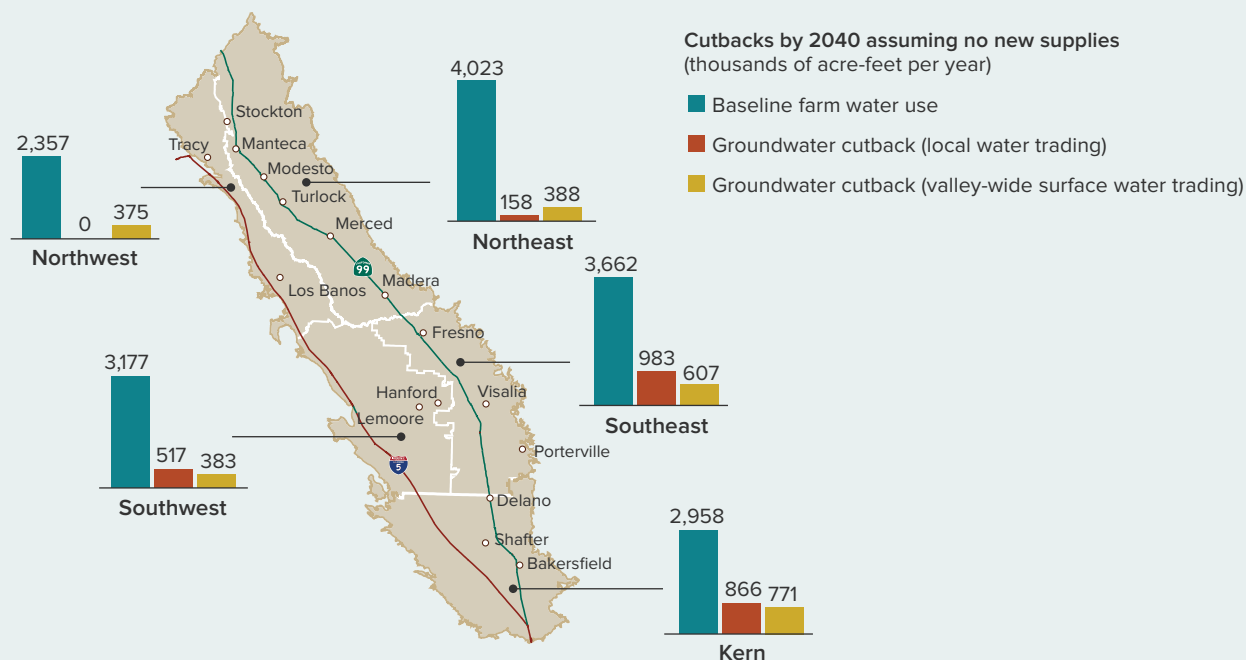
- **Capture more local runoff.** Capturing and storing additional water from big storms has the most potential. In particular, recharging groundwater could deliver significant new supplies at a cost farmers can afford. Coordinating management of surface and groundwater storage can help boost overall water storage capacity. Although building the proposed Temperance Flat Reservoir could also help, it appears to cost more than what most farmers would be willing to pay.
- **Manage the system differently to increase water imports.** Big investments to increase imports have limited potential to help valley agriculture. Most water from California WaterFix and proposed surface storage expansion would go to the Bay Area and Southern California. These options are also relatively expensive for valley farmers. Without federal or state support, expanding Shasta Reservoir—which would principally benefit valley farmers—is also likely to cost too much. Instead of relying on such projects, engaging in more coordinated management of the entire Central Valley network of surface and groundwater reservoirs appears to be a better option. This strategy would significantly increase capacity, yielding nearly half as much new water as building a new reservoir at Temperance Flat, at a much lower cost.
- **Use urban conservation to support population growth.** New state laws require cities and suburbs to reduce per capita water use. These savings can support population growth—thereby reducing competition with valley agriculture for scarce water supplies. However, farmers should not expect significant additional urban water savings to be available for valley agriculture.

Managing Demand

New water supplies available to valley agriculture can address only about one-quarter of the region’s long-term groundwater imbalance. At 1.8 million acre-feet per year, that deficit is substantial. This means that reductions in agricultural water use will have to cover most of the groundwater deficit. The best options:

- **Reduce agricultural water use.** Switching to crops that use less water and idling cropland are the best ways to reduce water use. In contrast, greater irrigation efficiency (e.g., switching from flood to drip irrigation) generally reduces how much water is applied to the land, but not overall water use. This is because most irrigation water not consumed by plants returns to rivers or recharges aquifers where it can be used again. Investments in irrigation efficiency will remain worthwhile for other reasons—including to protect water quality.
- **Expand water trading.** By giving farmers more flexibility, water trading can reduce the costs of transitioning to sustainable groundwater use. If farmers have no flexibility to trade water or adapt crop choices, ending overdraft without new supplies requires fallowing 780,000 acres and causes crop revenue losses of about \$3.5 billion per year. In the more likely scenario where farmers can make flexible crop choices and trade surface and groundwater within local groundwater basins, ending overdraft requires fallowing 750,000 acres and causes crop revenue losses of about \$2 billion per year. If broader, valley-wide surface water trading is an option, farmers in the south would buy some water from the north, where it is more abundant (Figure 2). This would further reduce the need to fallow the most profitable fruit, nut, and vegetable crops. The net result would be much lower crop revenue losses. Overall, the drop in regional GDP and employment would be about a third lower with valley-wide surface water trading than without it.

Figure 2. Valley-wide surface water trading would reduce groundwater cutbacks in the southern valley



NOTES: Because farmers need to apply more irrigation water to their fields than the amount crops consume, ending the long-term overdraft of 1.8 maf/year will require a pumping cutback of 2.5 maf/year. Subregional groundwater cutbacks with inflexible local water use would be the same as with local water trading.

The Optimal Portfolio

A portfolio approach to balancing water supplies and demands—combining cost-effective supply strategies and water trading to help farmers manage demands—is most promising. This combined approach would decrease the need for land fallowing by more than a quarter, from 750,000 acres to 535,000 acres. Annual regional GDP losses in crops and related activities (dairy, meat, and food processing) would decline—to \$1.3 billion from \$2.1 billion (37% lower). Annual job losses would also decline—to 13,000 from 21,000 (40% lower). With this portfolio, GDP and job losses equal roughly 4 percent of today’s agricultural economy, and less than 1 percent of the total regional economy.

Priorities for Action

Assess infrastructure needs and modernize operations. Expanding local and regional infrastructure for water conveyance may be necessary to facilitate recharge and take full advantage of water trading opportunities. Land subsidence—sinking—from excess groundwater pumping has reduced the capacity of two of the valley’s critical conveyance arteries: the Friant-Kern Canal and the California Aqueduct. These reductions limit the ability to move water from the wetter northern part of the valley to the drier south. Investments in new east-west conveyance may also be warranted, along the lines of Kern County’s Cross-Valley Canal. There is also a need to rethink infrastructure operations to maximize the potential of surface and groundwater storage as a system. Analysis of new surface storage opportunities should be considered in this light. Dam operations need to be updated to work with advanced weather forecasting technology

and account for a changing climate. State and federal agencies will be essential partners in these efforts, but regional and local entities that own and operate storage and conveyance infrastructure should play an important role in assessing system capacity issues and potential.

Incentivize recharge on farmlands. One of the least costly ways to expand recharge is by spreading water on suitable fields when excess flood flows are available. This strategy has great potential, but it is still in early stages of adoption. Farmers could be incentivized to recharge on their lands in exchange for a “SGMA credit”—for example, the ability to pump some of this recharged water in the future. GSAs should develop crediting systems in water or cash. This action will require the establishment of more formal, standardized water accounting systems and groundwater budgets.

Develop local trading rules. Local water districts and GSAs will need to develop a healthy trading culture, with rules that ensure transparency and fairness. For local groundwater trading within basins—a new opportunity with SGMA—formal accounting and groundwater allocations for individual users will also be essential.

Clarify how much water is available for recharge. The State Water Board should develop a straightforward, expeditious process to enable water users to capture high-flow surface water when it is available. Beyond the legal aspects of establishing new rights for recharged water, the state should also develop a simple, rapid way to determine when flows on local rivers exceed water required for the environment and downstream users.

Facilitate approvals for trading and banking projects. Limitations in conveyance infrastructure are compounded by difficulties in securing state and federal permits for surface water trades and groundwater banking. While it is important to ensure that trading and banking do not harm other water users or the environment, it is difficult to receive approvals for these activities in a timely manner. New administrative approaches are needed to simplify the approval process—such as programmatic environmental reviews and preapprovals of some types of trades.

Coordinate to maximize benefits. To reap the most benefits from recharge, trading, and other tools, local entities will need to collaborate both within and across basins. This will require overcoming fragmentation: the valley now has more than 120 GSAs for its 15 groundwater basins. Collaborative efforts to bank groundwater with other parties will enable recharge to occur in the most suitable areas and can help districts with poor local recharge conditions balance their groundwater accounts. The process generally requires the parties to have a physical connection through a shared aquifer or conveyance.



GETTY IMAGES

Water trading and supply investments would increase acreage of almonds and other high-revenue

Addressing Groundwater Quality Challenges

Poor groundwater quality impairs drinking water supplies in disadvantaged rural communities, reduces long-term agricultural prosperity, and degrades ecosystems. California has been a national leader in seeking to address these problems, with a suite of new regulations adopted over the past decade. SGMA also requires GSAs to protect water quality while balancing groundwater supplies and demands.

Parties will need to manage water quantity and quality together to take advantage of synergies and avoid unintended consequences. The necessary coordination will be challenging because the various programs are carried out by numerous local and regional entities, whose lines of responsibility and geographic boundaries do not neatly align.

Providing Safe and Reliable Drinking Water

Common drinking water contaminants in the valley include nitrate—mainly from farming—and several other pollutants—such as arsenic, which occurs naturally. Larger communities have mostly been able to provide safe drinking water. But many small, disadvantaged rural communities lack the financial, technical, and managerial capacity to address their water quality problems. The solutions—especially treatment—are often unaffordable for smaller communities. Some valley residents who depend on shallow domestic or community wells also experience drinking water shortages, because these wells are prone to drying up as groundwater levels decline. The problem is worse during droughts, when farmers pump more groundwater.

Fast Fact

The valley has more than half of all public water systems that are out of water-quality compliance in California, even though it has only 10% of the state's population.

Priorities for Action

Support solutions to the safe drinking water crisis. Providing economies of scale to small water systems shows the most promise. This includes consolidation with larger systems—or making other institutional arrangements to aggregate smaller systems and promote sharing of technical, financial, and managerial resources. New regulations will require agricultural and urban dischargers to provide safe drinking water solutions in areas most affected by nitrate. Counties, urban water systems, and local nonprofits will also need to collaborate with affected rural communities and contribute technical and managerial expertise.

Mitigate dry wells. To ease the burdens on the regional economy, most GSAs are likely to implement SGMA by making gradual reductions in excess pumping until 2040. As a result, continued lowering of the water table is likely. Flexible rules that allow more pumping during droughts could also benefit the regional economy, but would cause groundwater levels to fall further. Rural communities with shallow wells and households with domestic wells will be the most affected. GSAs should develop plans to anticipate these problems, map wells most likely to be affected, and employ strategies to ensure that rural communities do not lose drinking water supplies. State and county agencies should support this planning effort.

Ensure funding for safe drinking water. Funds for capital investments are available from several state and federal programs. But a key challenge for communities without safe drinking water is the lack of funding to support ongoing operations and maintenance of their water

systems, especially when they need new treatment plants. Several bills have been proposed in the California Legislature to fill this gap, but an enduring solution has remained elusive. State leadership is needed to establish a reliable funding source.

Managing Long-term Pollutants

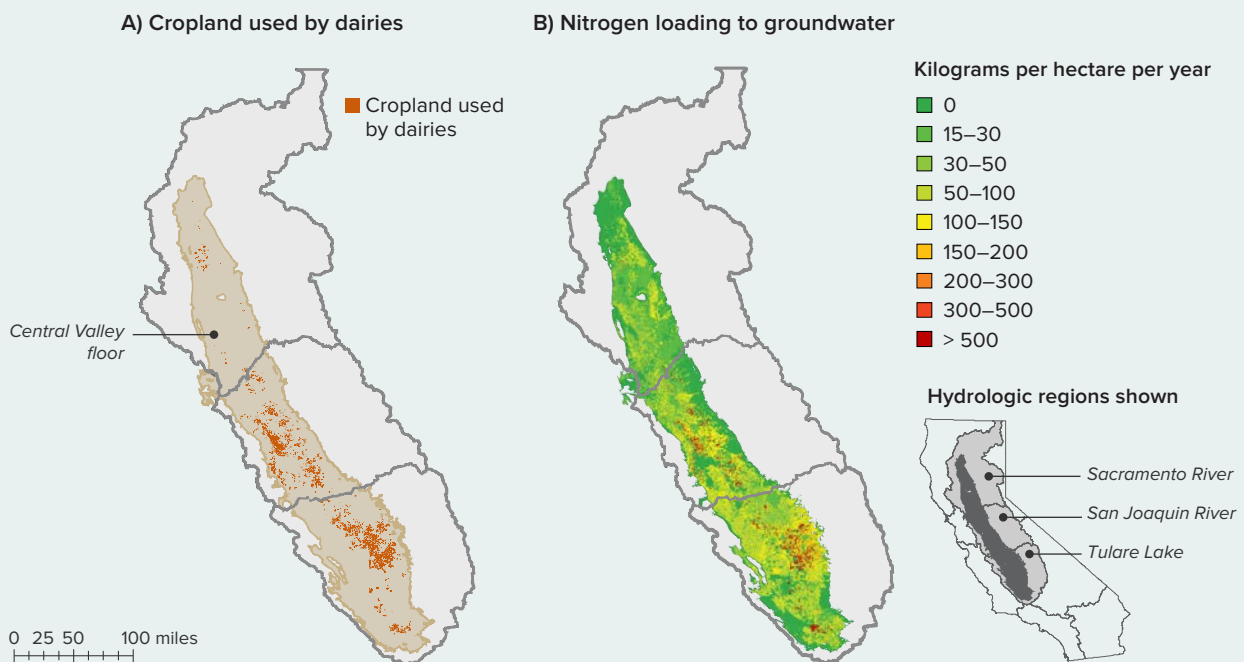
Ongoing contamination from nitrate and salts is a big challenge for the valley. Nitrate in drinking water is a major public health concern, and agricultural productivity is threatened by the accumulation of salts in groundwater and soils. Yet managing these contaminants is costly. A balance must be found between protecting water and land resources for the long run and maintaining the viability of agricultural production in the present, while also ensuring safe drinking water solutions.

Nitrate: Drinking water quality is under particular threat from nitrate, which mainly stems from decades of cropland fertilization with inorganic nitrogen fertilizers and dairy manure. Changes in farming practices can reduce the continued contribution (loading) of nitrogen to soils and groundwater. But this will rarely clean up today’s contaminated wells, because much of today’s nitrate contamination is a legacy of past farming activity. The central policy issue is balancing the costs and benefits of reducing further degradation. For dairy farms—which use large volumes of manure, especially on corn—solutions have been difficult and expensive (Figure 3). If the costs of pollution prevention are higher than the broad societal benefits, regulators have some flexibility to allow practices that continue to degrade water quality. In this agricultural region, it may be preferable to continue aiming to limit new nitrogen loading while

Fast Fact

Valley dairies account for just 6% of all lands, but 88% of lands with the highest contribution of nitrogen to groundwater.

Figure 3. Nitrogen loading is particularly high on croplands fertilized with dairy manure



NOTE: The San Joaquin Valley is the southern part of the Central Valley, including the San Joaquin River and Tulare Lake hydrologic regions.

also ensuring safe drinking water solutions through other pathways, including treatment or tapping alternative water sources.

Salts: Farmers and regulators will also face a balancing act to manage salts in groundwater and soils, which come from a variety of sources, including relatively saline Delta imports. Salts reduce crop yields and can ultimately make land unsuitable for farming. Cost-effective approaches are key. One set of solutions includes adapting agricultural activity to increases in salt buildup in groundwater and soils (e.g., adopting farming practices that minimize harm to crops, tolerating continued reductions in crop yield and choice in high-salt areas, and retiring some lands). Another set of solutions includes making investments to reduce salt buildup (e.g., reducing salt imports, sequestering salts in certain parts of the valley, or exporting them out of the valley through expensive desalination and drainage). Both approaches reduce farm profitability.

Given the high costs of removing salt from the valley, adaptation actions—including eventual retirement of salt-impaired lands—may be the preferred option for many growers.

Fast Fact

Roughly 250,000 acres of valley farmland have already been retired due to salinity accumulation in soils, and another 1.5 million acres are considered salt-impaired.

Managing for Quality and Quantity

Managing water quality and quantity can converge, but they can also be in conflict. One example of potential synergy is fallowing land to achieve groundwater balance, which can also help manage salt-impacted lands.

Fast Fact

About half of valley cropland is suitable for on-farm recharge. About a quarter of suitable land is planted with “clean crops” that use little or no nitrogen fertilizer. Another half of suitable land would require careful fertilizer management.

The tool with the most promise for augmenting water supplies—recharge—poses some potential tradeoffs with water quality goals if not managed properly. Under certain conditions, recharge can accelerate the migration of chemicals in the soil (especially nitrate) and impair drinking water quality, at least for a time. Yet recharging with high-quality water—such as flood flows from Sierra rivers—also offers some potential to improve ground-

water quality. An effective recharge approach, therefore, must not only identify the most suitable lands for recharge but also consider other factors that could affect water quality.

Priorities for Action

Coordinate water quality and quantity management. To avoid harming water quality, GSAs must consult with various entities responsible for groundwater quality. Early coordination with key partners could help GSAs develop recharge projects that minimize harm—and even improve water quality near vulnerable local communities. There is also potential to coordinate land retirement to reduce water use and to manage salinity.

Implement new technologies to manage pollutants, especially for dairies. Valley agriculture will need continued improvements in technologies and practices to manage nitrogen and salts. Dairies—a large economic sector—face major challenges in managing manure, which causes air pollution and greenhouse gas emissions in addition to nitrate in groundwater. The valley’s dairies

produce enough manure to fertilize a significant share of the state’s cropland, but manure is heavy to transport and difficult to apply precisely. Advances are needed to improve the efficiency of manure fertilization on dairy cropland, and to develop environmentally safe, cost-effective manure-based fertilizer products that can be marketed to other farms.

Provide regulatory flexibility. To facilitate recharge and maintain the viability of valley agriculture, state and federal water quality regulators should allow for some continued nitrogen and salt loading as long as impacts on rural community drinking water supplies are mitigated. This approach is consistent with the new regional regulatory plan.

Fostering Beneficial Water and Land Use Transitions

Effectively addressing water scarcity and the resulting land use changes in the San Joaquin Valley offers opportunities to put lands coming out of production to good use—and gain “more pop per drop” from limited water resources.

Multiple-benefit approaches to water and land management can enhance groundwater recharge and improve air and water quality. They can also promote healthier soils, new recreational opportunities, additional flood protection, improved habitat, and new revenue streams for private landowners engaging in conservation-oriented management.

An approach called “reconciliation ecology” offers opportunities to improve the natural environment while managing changes coming to the valley. Rather than focusing solely on protecting or restoring natural areas, reconciliation ecology emphasizes strategies that increase the habitat value for native plants and animals living outside of traditional protected areas. It also holds promise for reducing conflict over the use of water and land for ecosystems and species.

Fast Fact

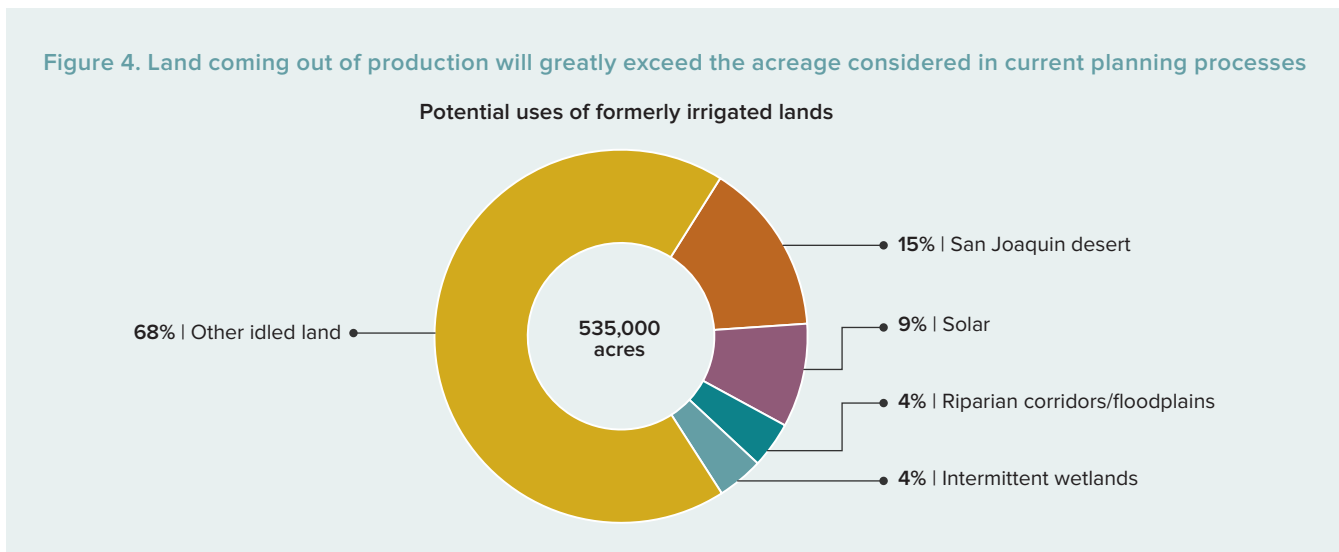
The San Joaquin Valley has one of the highest concentrations of endangered species in the US.

Adopting this approach will require valley stakeholders to engage in much broader and more comprehensive planning than ever before.

Potential Uses of Idled Land

Even with investments in new water supplies, achieving groundwater sustainability will require taking more than half a million acres of irrigated cropland out of production. By design, these lands will have little or no dedicated, ongoing water use. Potential land uses envisaged under current planning processes include solar energy and multi-benefit restoration of some of the valley’s historic riparian, wetland, and desert ecosystems. But even if these relatively ambitious targets are met over the next two decades, this would only account for one-third of all land likely to be idled (Figure 4). Managing this transition successfully will require expanding the planning effort to identify strategies that can yield the greatest benefits from all idled land.

Figure 4. Land coming out of production will greatly exceed the acreage considered in current planning processes



Here are our rough estimates of potential uses of idled lands:

- **Expand solar energy.** Perhaps as much as 50,000 acres in the San Joaquin Valley could be used for solar development, given the state’s new commitment to provide all electricity from carbon-free sources by 2045. However, not all new solar development will occur on retired cropland; some will likely use non-irrigated rangeland. Solar energy represents one of the few options for generating significant non-farm revenues on lands retired to save water. Recent efforts show that it is also possible to manage these lands in wildlife-friendly ways.
- **Reduce flood risk and expand riparian corridors and floodplains.** Some retired land—perhaps 20,000 acres—may be suitable for multiple-benefit projects that meet these goals. These lands would be intensively managed to restore habitat for fish and wildlife, similar to the existing restored floodplains along the San Joaquin River.
- **Create intermittent wetlands.** Efforts are underway to improve the reliability of water supply for the valley’s managed wetlands, but it is unlikely that their surface area will significantly increase. However, there are opportunities to expand dedicated recharge areas, similar to the Kern Water Bank, which can also serve as intermittent wetlands—perhaps 20,000 acres. Unlike recharge on active cropland, dedicated recharge areas reduce farm water use.
- **Recover the San Joaquin desert.** The recovery plan for this unique ecosystem envisages up to 80,000 acres for intensively managed habitat. This amount would allow for persistence, if not recovery, of endangered desert species. The plan is ambitious; to date only small patches of this habitat have been restored.



JONATHAN PARKER, KERN WATER BANK AUTHORITY

Intermittent wetlands at the Kern Water Bank.

- **Manage other idled land.** Most remaining land to be idled (365,000 acres or more) exceeds the scope of these energy and habitat restoration plans. Some of this acreage could accommodate new housing or industrial developments—if they rely on urban conservation to meet their water needs. But much could be fallowed with little consideration of the potential benefits or impacts for the valley, creating issues with dust, weeds, and pests. Proactive planning could minimize the negative impacts and provide benefits for soil health and carbon storage, as well as habitat if lands are managed as a system of wildlife corridors.

This mix of future land uses is not a foregone conclusion. The shape of the landscape—and the benefits from idled lands—will depend on how and where fallowing occurs. There will also be choices to make between permanently retiring croplands or fallowing them in rotation for shorter periods. Either way, achieving multiple benefits from these lands—in terms of water storage, public health, and the natural environment—will depend on the level of stewardship and coordination.

Minimizing management costs will be important, given the scale of this effort and the limited revenues available. The costs of land management are likely to increase with conservation-oriented approaches, including those that improve soil health or focus on restoring native species. But by providing an array of benefits, conservation-oriented approaches can also raise revenues from a variety of resource stewardship programs.

Stewarding the valley’s water and land resources to benefit people and nature will not need to start from scratch. But making it work well will require new ways of thinking, creative application of existing tools, and some regulatory changes.

Priorities for Action

Undertake comprehensive land use planning. For many key land use decisions, a broader planning effort than is currently underway will be essential. This means involving city and county planning departments, GSAs, farmers, business and community groups, environmental non-profits, and regulators. Coordinated planning at multiple levels—groundwater basins, counties, and the region—will be critical to protecting lands suitable for recharge and considering which lands can best protect groundwater quality. And since most ecological processes operate at a regional scale, restoration decisions are best done regionally. We recommend the establishment of a multi-county authority that covers the entire region and receives funding from both state and local sources for its activities.

Plan for and manage ecosystem water differently. Regional planning at the level of watersheds is also needed to more efficiently and effectively manage scarce water for the valley’s freshwater ecosystems. Granting ecosystems a water budget that is managed like a water right is a promising approach. The water in this budget could be flexibly managed, stored, and traded. It would allow environmental managers to prepare for drought and to have assets for response. The valley’s managed wetlands—which have a water allocation—provide a prototype for this approach. Negotiated settlements involving multiple stakeholders can be a good way to develop and implement this approach for local rivers and the Delta; they harness the potential for creative solutions that go beyond requirements from regulatory agencies.

Increase regulatory flexibility. To foster creative, beneficial management of water and land use transitions, parties need more flexibility for project design and implementation. State and federal agencies should encourage the adoption of broad planning processes such as habitat conservation plans, simplify the permitting of restoration projects, relax restrictions on the retirement of prime farmland, and encourage the use of “safe harbor agreements” to protect farmers engaged in habitat management from regulatory sanctions if their fallowed lands attract endangered species.

Provide incentives and funding. An array of funding sources could be used to support land and water conservation efforts, including fees on water, land, and energy use, as well as state and federal grants and tax credits. The new federal Farm Bill has significant potential in this regard. We propose the development of a new state-federal partnership to fund land retirement and restoration. Such programs can provide financial incentives to farmers to participate in coordinated efforts. Other local incentives—such as maintaining the water credit associated with the land—will also be important for many farmers.

Expand technical assistance and research support. There are many open questions about restoration at the scale predicted under SGMA. Technical assistance from third-party honest brokers such as resource conservation districts, environmental nonprofits, and state and federal advisors can be invaluable—but is currently underfunded. The state and federal governments should also support research on important questions to guide conservation and idled land management.

Managing Change for a Prosperous, Healthy Valley

San Joaquin Valley farmers and residents have demonstrated an ability and willingness to innovate and adapt to changing conditions in the past. Today’s challenge is to find practical ways to manage unavoidable water scarcity and quality problems to protect public health, maintain economic prosperity, and improve the natural environment. The local economy has been deeply dependent on irrigated agriculture for more than a century. To continue on a prosperous path for the next century will require balancing groundwater accounts, tackling water quality concerns, and taking advantage of opportunities to get multiple benefits for people and nature from limited water resources and the lands coming out of production.

Perhaps one of the region’s greatest challenges is developing new cooperative approaches to seize these opportunities. The solutions to the valley’s problems do not fall neatly into traditional political and institutional boundaries. The issues are complex, and many players will need to be involved in the solutions. Addressing the full range of challenges will require a well-planned, comprehensive response and an all-hands-on-deck level of cooperation and participation.

Although state and federal partners can help, the valley’s future is in the hands of its residents. A valley-wide conversation on the changes that lie ahead can help determine how to tackle the challenges outlined here and take the next steps for creating a better future. The stakes are high. So are the costs of inaction.

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