WATER SECURITY IN THE AGE OF SGMA

AQUAOSO

A New Normal

Climate change unearths new challenges that humanity must face. Adapting to a new normal means securing natural resources that we all rely on. As we learn what the changing landscape means to each of our industries, we know that variability and extremes in climate conditions will increase. Reliance on the status-quo way of managing water and making decisions can no longer operate in this new normal.

California's approach to groundwater regulation is an experiment in local, state, federal, and landowner cooperation. Due to the waning health of groundwater basins throughout California, the government created the Sustainable Groundwater Management Act (SGMA). SGMA's presence is already impacting how agricultural farming, lending, real estate, and management operations think about the future of their organization. The inevitable land fallowing and groundwater pumping restrictions will change California agriculture forever. How will SGMA impact you?

This book will provide perspective on SGMA's reach across the agricultural business landscape and the communities that depend on a vibrant ag economy. This book does not give opinion on policies or regulations. We shed light on what is coming down the pipe backed by research and analysis. More importantly, this book is a call to action. Take responsibility by increasing your water security and start your journey to identify, understand, monitor, and mitigate water risk. That journey begins today!

Chapter 1: Background

In 2014, California became the last state in the U.S. to formally regulate groundwater. Groundwater regulation had various forms before 2014. Prior to SGMA, California saw groundwater adjudications that brought competing interests together for a court-supervised negotiation and settlement over groundwater rights in a basin. California also created voluntary groundwater regulation through AB 3030 and other programs in the 1990s that encouraged but did not mandate aggressive groundwater regulation and management. These efforts had positive impacts in specific areas in California but did not address the statewide crisis of over drafted groundwater basins.

What is SGMA?

After years of debilitating drought, the state of California enacted SGMA to ensure sustainable annual withdrawals by measuring sustainability metrics in groundwater basins. Local agencies, known as Groundwater Sustainability Agencies (GSAs) were given authority to regulate groundwater subject to stakeholder input. GSAs are mandated to develop a Groundwater Sustainability Plan (GSP) for approval by the California Department of Water Resources (DWR).

The goals of SGMA are to:

1. Develop regulations to revise groundwater basin boundaries
2. Adopt regulations for evaluating and implementing GSPs
3. Identify basins subject to critical conditions and overdraft
4. Identify water available for groundwater replenishment
5. Publish best management practices for the sustainable management of groundwater

Under SGMA, groundwater users will be required to report their water use, which may be unwelcome by some water users. A balancing act is at play between data collection, groundwater management and the burden of providing data to local and state governments.

Groundwater Sustainability Agencies

GSAs possess broad authority to regulate groundwater to reach sustainable yield for their designated groundwater basin, including the ability to regulate exchanges of water and the health of a groundwater basin. They are also responsible for preventing further harm, referred to as “undesirable results,” in the groundwater basins that are currently over drafted and labeled as “high” or “medium” priority.

Undesirable results include:

- chronic lowering of the groundwater levels within a basin
- significant and unreasonable reduction of groundwater storage
- seawater intrusion
- degraded water quality
- land subsidence that substantially interferes with surface land uses
- depletions of interconnected surface water that have significant and unreason-able adverse impacts on beneficial uses of the surface water

The GSA may implement fees to achieve the sustainable yield objective required by SGMA and combat these undesirable results. The powers are broad, but SGMA requires a GSA to

Chapter 1: Background

issue a Groundwater Sustainability Plan by 2020 for basins in over-draft, and 2022 for medium and high priority basins.

Groundwater Sustainability Plans

The GSP is meant to clarify how the GSA intends to wield their powers. GSA's must consult with water right holders, agricultural operations, and relevant stakeholders as part of the GSP creation process. Failure of the GSA to engage all stakeholders will likely result in a rejection of the GSP by DWR until proper stakeholder input is gathered. The powers granted to GSAs allow them to restrict groundwater pumping and impose new fees on groundwater extraction.

Currently, the broad powers afforded to GSAs create uncertainty for the Ag Community. An opportunity exists to shape the outcomes in the GSP by educating GSA decision makers through accurate data collection and information sharing. Though GSPs are under review for critically over drafted basins, there are many GSAs that are high and medium priority areas that are engaging in stake-holder outreach throughout California. There is still time to shape policies and regulations impacting agricultural groundwater.

A GSA's lack of land use authority for future water and agricultural development impacts the agricultural community. Depending on how local government is participating in the GSA, there is potential conflict on land use restrictions. Existing general plans, potential developments, and zoning modifications may conflict with a GSP. GSPs for critically over drafted basins have addressed relevant general plan elements and sections that relate to a GSP as a starting point for identifying potential issues. Without reliable data sources or mutual agreement on development practices, conflicts may result in costly, lengthy battles between local agencies and agricultural stakeholders.

Uncertainty as the New Norm

The most significant impact of SGMA on water users and related industries is uncertainty. GSA's are a new concept in California. Until the GSP's are in place for a few years, there are many layers of unknown issues that may arise. Litigation is certain; new partnerships are needed.

Yet, the best counter to an uncertain future is preparation. Prepare for uncertainty by:

- Organizing your data, because you can't measure what you don't track
- Understanding the context of your data and how global, regional, and local events impact your portfolio and organization
- Building relationships with other stakeholders and local government staff to share your insights from both data and broader perspective on how water regulation impacts your organization and the broader community
- Creating a water security strategy based on data and identify a few key indicators for water that best represent water risk to your operations

With these basic steps you can begin to reduce the noise of uncertainty and boost the signal of actionable steps to mitigate water risk and enhance overall water security.

Chapter 2: Impacts on Farming and Lending

Questions on how water factors into agricultural lending decisions are bubbling to the top as water scarcity takes center stage in the agricultural economy. Increasing uncertainty in the near future is the Sustainable Groundwater Management Act (SGMA). The uncertainty lies in the fact that regulation on this scale is untested in California, and the Groundwater Sustainability Plans (GSPs) are just beginning to unfold. The groundwater management paradigm shift that SGMA represents means understanding both surface and groundwater are essential to ensure water security in your portfolio.

Uncertain water security leads financial institutions to limit lending to growers due to limited or missing data. That potentially leaves money on the table in one transaction only to watch money burn in another transaction that proved riskier than expected. When a portfolio of investments sits in a higher water risk situation unknown to lending and financial institutions, that portfolio is at risk. If the risk is known, lender action can move assets and resources to a less risky area or work with the grower on mitigation strategies to lessen both the grower's and the financial institution's risk. The path to water security and sound management is data and knowledge.

Agricultural lenders and investors can mitigate risk by reducing uncertainties through understanding water risk on a given parcel or over an entire portfolio. Possession of actionable data to implement macro- and micro-level knowledge is key to intelligent decision-making that unlocks investment to fuel agricultural growth and help ensure critical water supplies in arid states like California. Understanding SGMA and its implications is one way to better understand both statewide, macro-conditions while also applying a micro-view of local GSA and conditions on a specific parcel of land.

The Groundwater Safety Blanket Has an SGMA-Sized Hole

For decades, surface water supplies and weather conditions in California followed a fluctuating but steady pattern. More recently, the snow pack in Sierra Nevada mountain range and general precipitation exhibits a boom and bust pattern. The one constant historically relied upon by agricultural operations and those financing them was groundwater as a supplemental supply. Entire operations may have relied 100 percent on groundwater, a practice that was not considered a high-risk endeavor. As subsidence, extraction expense, and water quality issues reared their ugly heads, the state decided to take action on groundwater regulation through SGMA.

Forged by a coalition of lobbyists, community groups, businesses, environmental organizations, and farmers, SGMA rolled off the assembly line.

Chapter 2: Impacts on Farming and Lending

Groundwater regulation is the way of the future. Dreams of unlimited pumping and ignoring the detrimental impacts are over. Change is never easy – unless you are prepared.

Understanding the Sustainable Yield

SGMA redefines groundwater management through the idea of a "sustainable yield," which is the maximum amount of groundwater that may be withdrawn from a basin without causing an "undesirable result." There are six undesirable results:

- Chronic lowering of groundwater levels.
- Significant and unreasonable reductions in groundwater storage.
- Significant and unreasonable seawater intrusion.
- Significant and unreasonable degradation of water quality.
- Significant and unreasonable land subsidence.
- Surface water depletions that have significant and unreasonable adverse impacts on beneficial uses.

There is a gray area in defining the sustainable yield for each groundwater basin. What is chronic, significant, or reasonable will mainly be up to the GSAs. The GSPs will reveal how the GSAs handle sustainable yield. Even the most recent GSPs released for critically over drafted basins will demand adjustments to the sustainable yields over the next few years, requiring stakeholders to track potential changes to that number.

Below is an example of a method for organizing GSA data that AQUAOSO Technologies implements:

Metrics	
Sustainable Yield AF/YR	249,700 (projected after all projects and management actions have been implemented)
Sustainable Yield AF / Acre	1.7
Current Water Budget Normal	Average annual (1989 - 2014): -122,490
Current Water Budget Dry	Below normal: -203,800 Dri: -192,520 Critical: -220,600
Current Water Budget Wet	Above normal: -72,980 Wet: 24,650

Chapter 2: Impacts on Farming and Lending

AQUAOSO does the heavy lifting of tracking and organizing data to save organizations time. GSAs are required to submit annual reports to the Department of Water Resources to update the data provided in the GSP. Once you commit to tracking key metrics related to SGMA and the GSPs, you can better understand how decisions made at the state level will impact the water security of parcels in your portfolio.

Preparation is Key

SGMA required GSPs in place for critically over drafted groundwater basins by January 31, 2020. Currently, GSAs inside of critically over drafted basins are working on actual implementations, while the rest of the GSAs are working with stakeholders through public outreach. Despite a lack of clarity on how each GSA will achieve sustainable yields, understanding the availability of surface water supplies, ability to transfer water to a property, and whether the soil conditions lend themselves to prime groundwater storage can combat the unknowns surrounding groundwater pumping. At AQUAOSO, we developed a water security research platform that gathers pertinent data to assist lenders, investors, and growers in making tough decisions by illuminating the strengths and weaknesses of their water portfolio.

By reading the above options, you already have the knowledge needed to ask the right questions and raise awareness surrounding water risk and SGMA. Be prepared. Take action with your newfound knowledge by forming the plans and partnerships needed before SGMA takes full effect.

Chapter 3: Impacts to Water Management

SGMA is disrupting those professions tasked with managing water and the risk surrounding water-business decisions. Businesses and professions that work in and around water-dependent industries must assess the water risk of their operation. Identifying the risks stemming from SGMA can create strategic opportunities to weather future water supply volatility. Water security is increased by a diverse and flexible management strategy that is informed by the right data in the appropriate context.

Supply and Demand

At its core, water economics relies on a market participant's ability to move water, make use of that water, and incentivize conservation practices to increase efficient use of water. SGMA allows Groundwater Sustainability Agencies to create and enforce a GSP that may introduce new fees and restrictions on groundwater pumping based on the estimated capacity of the underlying groundwater basin. GSPs are designed to reach a sustainable yield for the basin and avoid the six undesirable results.

Historically, California has allowed unrestricted groundwater pumping. SGMA will cap that, and in areas like the Central Valley where groundwater offered an alternative source to drought-reduced surface supplies, available pumped groundwater will plummet. The rules promulgated by the GSAs will create risks and opportunities for all industries in the GSA and the broader region. The following are water management strategies to consider both through direct implementation by organizations and growers, and through input to local, regional, and state government actors.

Trading

Trading groundwater amongst overlying landowners is a common practice in many areas of the Western United States. However, it is prime for increased use in California. Typically, management practices in water follow a supply-side (surface water importing) or demand-side approach (exchanges and trading). Due to the increased severity of drought and the increased environmental concerns over climate change, a flexible demand-side approach can better handle water supply volatility when appropriate regulation reduces friction between trading participants. An oft-cited example is Australia, which utilizes demand-side solutions to bolster a 31 billion dollar agricultural products export industry, and a 93 percent domestic food supply, in spite of being the driest human-inhabited continent in the world. Flexibility can mitigate unexpected water shortages and thereby reduce long-term water risk.

Incentives

When water pricing is outside of the

Chapter 3: Impacts to Water Management

realities of supply and demand, there is a lack of motivation to manage it responsibly. Creating the right incentives for increasing water use efficiency while keeping costs down is a real challenge in the age of water scarcity in the West. However, investing in data to understand how people are using the water, how surface and groundwater use impact a region, and which actions can have the most significant impact to reduce waste is essential. Without reliable data, proper incentives are more challenging to create and implement. Circling back to supply and demand principles, how do you ensure water supply is adequate and understand the heightened demand for surface and imported water under SGMA? Data analysis that is quick and easy to absorb is necessary for applying appropriate incentives that work for agricultural operations and the broader local community.

Gaining and Losing Streams

Nearly 700,000 acre-feet of water is lost on the Kings River system, and about 2 million acre-feet is lost on the San Joaquin River system each year. SGMA calls out unreasonable impacts on surface water supplies as an undesirable result. Moving forward, it will be critical for water managers, investors, farm credits, banks, and related professionals to understand the importance of surface water/groundwater connections.

There are three categories of interactions between surface water systems and groundwater systems: "surface water bodies gain water from the inflow of groundwater through their bed, they lose water to groundwater by outflow through the bed, or they do both, gaining in some reaches and losing in other reaches." Groundwater pumping unchecked can turn a gaining stream into a losing stream which impacts surface water. SGMA requires addressing the surface water and groundwater interactions, and that connection requires a flexible approach to balancing competing priorities. Managing water trading and incentive-based programs will need to address the connection between surface and groundwater so that one is not harmed in favor of the other.

Recharge

A primary goal of SGMA is to maintain a balance between surface water and groundwater supplies to reach sustainable yield targets that are either in GSPs or will be in the next few years. However, many of the basins supporting crucial agricultural operations are in deficit. The solution: recharge.

Recharge describes the process of sending water back into the aquifer to replenish its stores. Recharge is accomplished through capturing high flows during wet seasons

Chapter 3: Impacts to Water Management

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and pumping or spreading that water to areas optimized for receiving the water into the underlying aquifer. One method in determining whether an area is suitable for recharge is using the Soil Agricultural Groundwater Banking Index (SAGBI) which incorporates multiple factors of soil and climate characteristics to give a rating on recharge capabilities. Additionally, understanding the Stories Index, soil classification, and the Federal Emergency Management Agency (FEMA) Flood Zone datasets provide a clearer picture on an area of land's capability as a water recharge site.

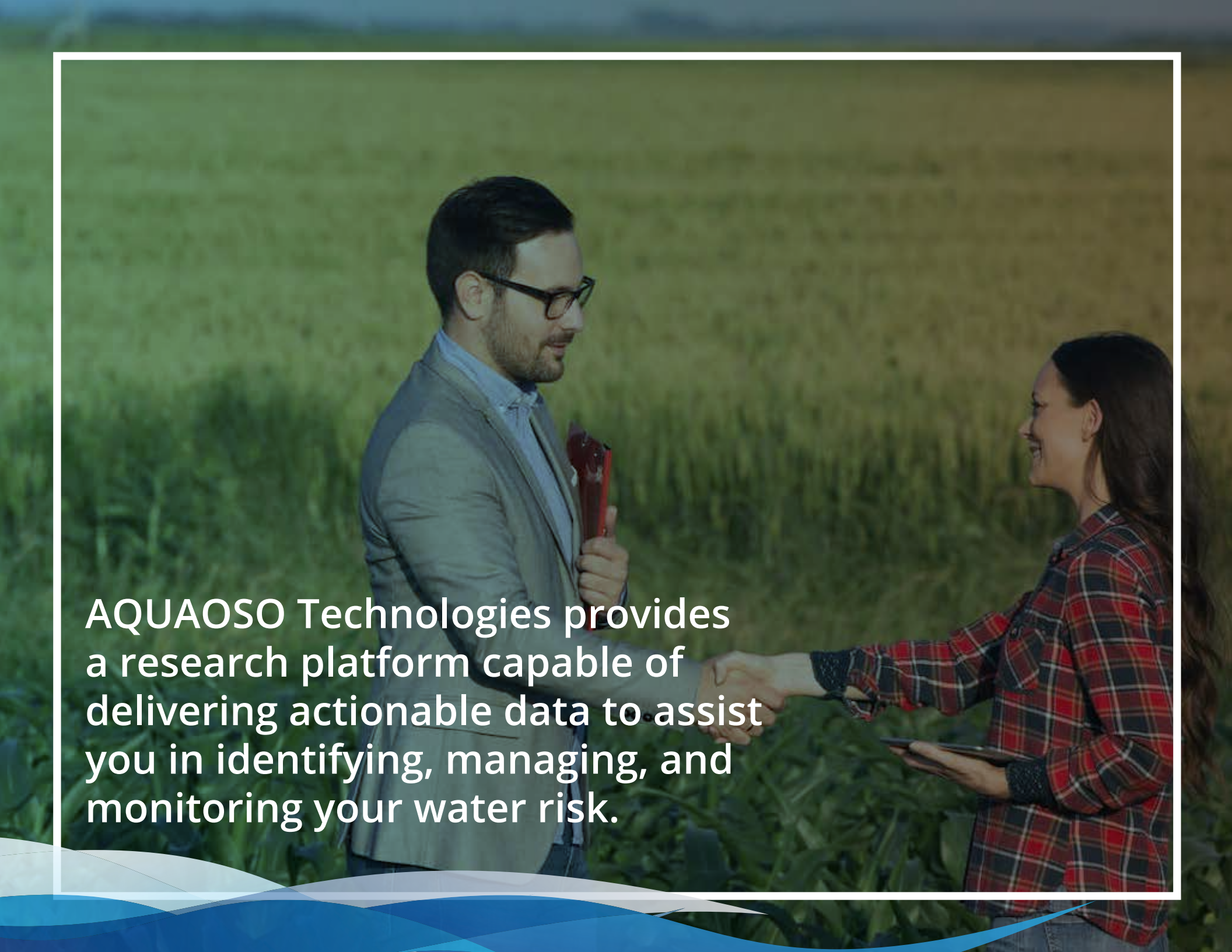
A growing trend in water management is the use of Flood Water for Managed Aquifer Recharge or "Flood-MAR." According to a 2018 White Paper by the Department of Water Resources, Flood-MAR is a management strategy that uses flood water from, or in anticipation of, rainfall or snow melt for groundwater recharge on agricultural lands. The benefits of Flood-Mar are an increase in water supply reliability as flood water is put to use instead of pushed out of the watershed. Another benefit is the ability to improve elastic subsidence, which is required by SGMA.

In 2017, California recharged approximately 6.5 million acre-feet. Additionally, with proper infrastructure and data, the amount of potential recharge water available could be up to twice that amount depending on regulatory actions and climate. The ability to replenish aquifers faster, thereby reaching a balanced water budget in the basin in a quicker manner, is essential to achieving SGMA sustainable yield targets.

Risk and Opportunity

Often the term water manager is associated with water, irrigation, and groundwater sustainability agencies. In reality, any business that touches water in some way needs to incorporate water management into their strategic thinking. At the core of water management is an assessment of water risk. As water supplies increase in volatility, understanding the water risk is essential to maintaining water security for your operation. While humans are working on solutions like groundwater recharge and demand-side market structures to mitigate risk, nature has a wicked curve that can throw us all off balance, unless you have done your research. Identify your water risk early, seek solutions to mitigate that risk, and take advantage of the strategic opportunities to position yourself for the future.

AQUAOSO Technologies provides a research platform capable of delivering actionable data to assist you in identifying, managing, and monitoring your water risk.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Chapter 4: Impacts to Real Estate

Real estate brokers and appraisers have a fiduciary duty to their client to represent all material facts related to a transaction truthfully. Additionally, appraisers must also take into account the environment and water availability when appraising agricultural property. In our new world of water scarcity, satisfying this duty becomes increasingly complex, especially for agricultural real estate. The Sustainable Groundwater Management Act (SGMA) only increases the complexity. As SGMA restricts a farmer's last reliable source of water, agricultural real estate transactions will be highly scrutinized based on the water resources available or not available to the property. SGMA not only impacts the valuation of the property but also what needs disclosure in order to avoid post-sale problems.

SGMA's Influence on Property Values

In this world of water scarcity, property value is viewed in a new way. Agricultural properties with subsidence issues, low precipitation, and a high reliance on groundwater look much less profitable because they present a higher risk than parcels with a secure source of water. On the flip side, properties that may be considered low value for many crop types may find rising values based on their water assets due to a less risky water position. Based on these and the myriad of other scenarios, a real estate professional should entertain new questions surrounding water risk:

- How easily can the property recharge groundwater?
- Is the property in a flood zone?
- Does the water district allow farmers to import, save, or transfer water?
- Under SGMA, how much groundwater can this property pump?
- Does the property have access to surface water?
- How reliable are the water sources to the property?

Easily identifying these complex property characteristics early on in the due diligence process prepare real estate and appraisal professionals for success and protect the Ag community against unforeseen water risk.

Mitigating Water Risk

SGMA causes uncertainty and increases water risk in an era defined by water scarcity. Real estate professionals have an opportunity to help their agricultural customers identify and understand water risk. SGMA mandates the creation of new local government agencies called Groundwater Sustainability Agencies (GSAs) to regulate groundwater pumping through Groundwater Sustainability Plans (GSPs). The GSPs are already in place for some critically over drafted basins and more will come out over the next couple of years, This is a perfect time to begin preparing for this significant shift in groundwater regulation!
There are five fundamental ways for real estate professionals to mitigate water risk:

- Research water rights
- Research potential water supplies available to the property
- Understand soil conditions on the property
- Keep tabs on the local GSA
- Understand how that property is situated compared to surrounding properties

The journey starts with research!

Chapter 4: Impacts to Real Estate

Water Rights Research

Wading into water research is no small feat. There are many times where data will be difficult to find or require multiple steps to piece the relevant data points together. Typically, you will need track down the following for a property:

- Application ID
- Right Holder
- Type of Water Right
- Priority Date
- Amount of Water

With the scenario to the right, you are missing some information, but what are we really looking at anyway?

- Application ID: Number assigned to each water right application and easy way to identify a water right
- Right Holder: The Legal entity in possession of the water application, permit, or license
- Type of Water Right: The main types are Riparian or Appropriative
- Priority Date: This is the date a water right application was submitted to the State Water Resources Control Board and may determine which right holder has a stronger claim to water
- Amount of Water: This is the amount of water the right holder is entitled to use if it is for the same type of purpose they listed on their water right application

As shown below, you may only know a right holder name like Owner 1 or maybe you only know the general area where you want to look for potential water rights. To understand the potential water risk and value of a property, you will need to do deeper research. For example, if Owner 2 has an appropriative right with an older priority date, they have a stronger water right which means when the State Water Resources Control Board reduces the amount of water available to that area, Owner 2 is likely less impacted than Owner 1. Owner 1 can continue to grow crops whereas Owner 2 will need to find new sources of water or potentially fallow land.

Application ID	Right Holder	Type of Water Right	Priority Date	Amount of Water
A########	Owner 1	Appropriative	July 1, 1967	1000•AF/YR
B########	Owner 2	Appropriative	January 1, 1942	2000 AF/YR

Chapter 4: Impacts to Real Estate

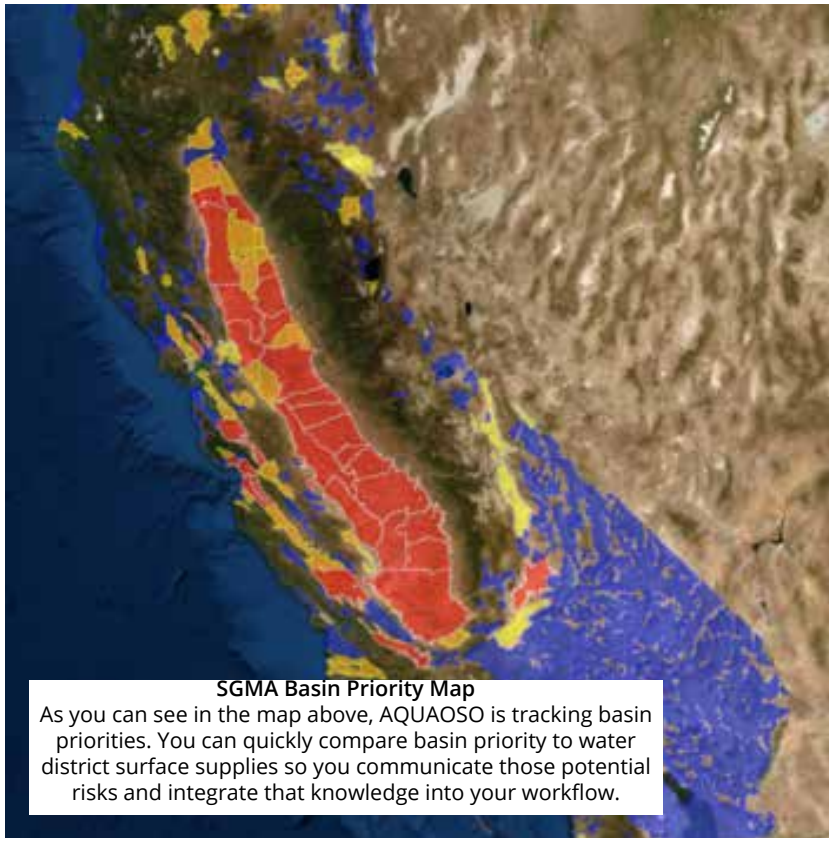
Water Supply

When researching a property, you will need to know if surface water supplies or groundwater supplies are available on the property. The mutual water company or water, including irrigation, district delivers surface water supplies. These are government agencies with varying budgets that charge water users a fee for water deliveries. If a property is not served by a water district, also known as a "white area" because it would be a blank-looking space on a service map, that means that property will have to make arrangements to get surface water or exclusively rely on pumping groundwater. Getting information on the cost of surface water, amounts available for purchase, and how water purchases are regulated requires figuring out which water district has jurisdiction and then contacting that water district for more information.

Pumping groundwater has long been a practice on agricultural parcels due to fluctuations in surface water supply. The groundwater safety net will be severely restricted in most of the high and medium priority groundwater basins, meaning a parcel that relies solely on groundwater pumping in a high priority basin is in a riskier position than a property that does not rely on groundwater or is outside of a high priority basin. You need to overlay the data on surface water you get from the water district with the understanding of SGMA's basin priorities to begin painting a property's water supply picture.

Soil is Critical

Soil provides nutrients to plants and regulates water flows. A standard like the Storie Index breaks soils into classes to make it easier to understand crop productivity on a property. Whether crops are viable on a piece of property is vital to understanding the value of the property and whether there is a financial risk in pursuing a specific agricultural operation. However, the soil, at the surface and below, offers its own potential risk.



SGMA Basin Priority Map
As you can see in the map above, AQUAOSO is tracking basin priorities. You can quickly compare basin priority to water district surface supplies so you communicate those potential risks and integrate that knowledge into your workflow.

Whether or not an agricultural property can bank water, which means storing water underground for later use or for recharging a groundwater basin, is essential due to the increased need for

Chapter 4: Impacts to Real Estate

maintaining groundwater basin health and developing alternate sources of water. The Soil Agricultural Groundwater Banking Index was developed by the University of California, Davis to indicate areas where farms could best participate in active recharge efforts. Depending on how the GSA regulates a basin, participating in recharge programs may be incentivized with groundwater credits for future use of groundwater supplies. High SAGBI rating and a favorable Storie Index rating on a property better prepare that property for future challenges. ***AQUAOSO allows you to combine both ratings on a property to know which properties have better or worse Storie Index and SAGBI ratings.***

Groundwater Sustainability Agency

GSAs are special districts that have jurisdiction within their defined boundaries to regulate groundwater pumping. GSA powers include creating a GSP, constructing groundwater allocation schemes, creating rules on groundwater trading, and charging fees for anything related to groundwater. Because GSPs are in early stage, non-public drafts, keeping up to date on who is involved with GSAs in areas where you tend to do business and how they are planning on regulating groundwater is key to knowing what the near-future holds for the agricultural community.

In the meantime, AQUAOSO has gathered GSA meeting highlights and a map of the GSA boundaries so you can know which GSAs to focus your attention on instead of the 200 plus across the state.

Comparing Apples to Apples

Many make it through a large portion of the water research journey after sifting through water rights records, water supply data, surveyed soil data, and emerging GSA documents. However, the water risk due diligence process is not quite finished. The next step is comparing properties in the same area or compare properties with similar characteristics located in different water districts and GSAs. Typically, you would need to go back to water rights and do the research circuit again, and again, and again.

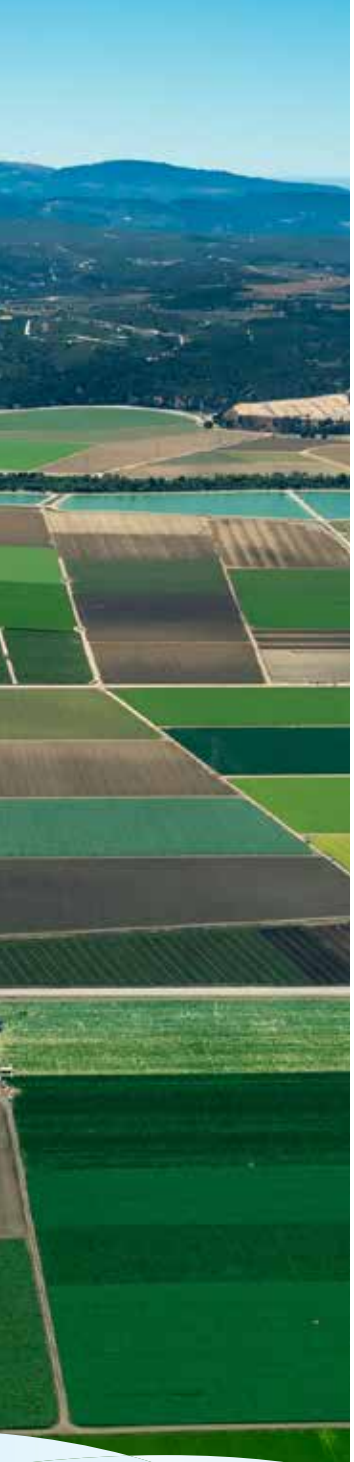
Additional due diligence requirements include:

- Physical inspection of buildings
- Deed restrictions, covenants, easements
- Financing,
- Land use restrictions
- Environmental hazards
- Other stacks of information that eat away time

There must be an easier way! AQUAOSO increases your ability to efficiently compare properties in an area with all the research you need to understand the water risk picture. Comparing parcel information, water, soil, and geographic location will cut your research time down exponentially as more properties enter the research mix!

Helping the Agricultural Community

Agricultural real estate professionals are part of a larger agricultural community that faces a one-two combo of Water Scarcity and SGMA. Check out our white paper entitled "Lending a Hand to California Agriculture" where we discuss the risks, realities, and rewards of assisting farmers in mitigating risk. In the end, helping your clients avoid water risk is also helping you avoid business risks by reducing your liability and attracting more clients as a trusted source of water risk information.



Chapter 5: Seven Steps that Could Save Your Organization

California has historically gone through periods of wet and dry years. State, federal and local water suppliers have all adjusted their deliveries over the years based on the weather conditions. Now, in an era defined by more frequent extreme weather events, farmers who have historically relied on groundwater to supplement their operations will soon be forced to limit their groundwater withdraws.

Farming in the age of SGMA requires new strategies to build water resiliency into the agricultural economy. Many of these strategies require collaborations, additional capital, and advanced planning. We will explore seven strategies to mitigate water risk in the age of SGMA, which include:

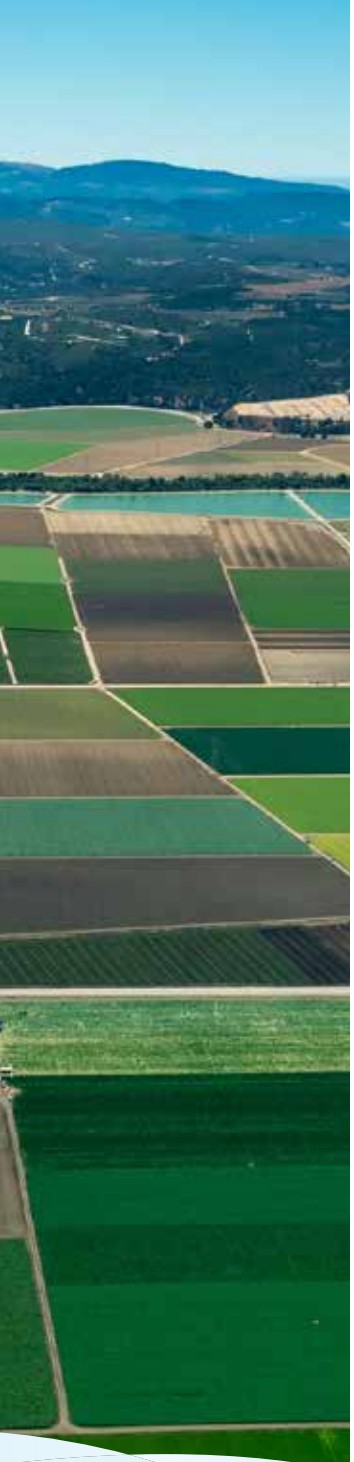
1. Innovative irrigation technology solutions,
2. Groundwater recharge
3. Groundwater banking
4. New water sources
5. Conjunctive uses
6. Water markets
7. Deep partnerships

1) Innovative Irrigation Technology Solutions

The reach of technology extends to all facets of agricultural life. From drones to desalination, farm efficiency aided by technological advancements creates new efficiencies and greater water security. Drones with an array of hyper-spectral, multi-spectral, or thermal sensors can identify crops that need more water over large areas. Early indications of poor crop health from drone observations can lead to crop saving actions that may have come too late without such advanced notice. Detecting irrigation issues is half the battle. Utilizing new technologies to provide additional water is the other major piece of the puzzle. Desalination in California's Central Valley allows for water with high concentration of salt to become usable for irrigating crops. For example, WaterFX created a project in Panoche Water and Drainage District that harnesses energy from the sun using solar power for desalination operation. The project produced 5,000 acre-feet a year of freshwater ready to deliver to 10,000 homes or 2,000 acres of cropland. While these solutions are perfect for understanding when and where to irrigate, and provide additional supplemental water supplies, more is needed to effectively manage water scarcity risks faced by Californian farmers and water managers. AQUAOSO provides analysis of water supply risks that compliment many on-farm technologies.

2) Groundwater Recharge

Artificially recharging groundwater aquifers is not a beneficial use of water and requires a showing of an



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alternative beneficial use of water unless there is a water supply contract in place and the water provider has the right to artificially recharge a basin. If a permit is required, a temporary permit may be obtained after showing sufficient water accounting. Water accounting must quantify the beneficial use of water held in underground storage and will vary based on the size and complexity of the project, characteristics of the aquifer, and whether the groundwater storage and recharge occurs under a temporary or standard permit. This type of knowledge requires accurate water budget data.

3) Groundwater Banking

Groundwater banking is a method of storage that allows more control than pure reliance on snow pack from the Sierra Nevada Mountains and is less expensive to construct and maintain than surface water reservoirs. Water is stored in the empty space within an aquifer in wet years and withdrawn in dry years to supplement water supplies. Groundwater banking occurs through "in-lieu recharge" or "direct recharge" methods. In-lieu recharge utilizes surface water instead of pumping groundwater, while direct recharge stores water by allowing the water to flow into the groundwater basin naturally. For example, Semi-tropic Water Storage District sends surface water in wet years to farmers for irrigation instead of pumping water from the basin. Additionally, Semi-tropic water storage district will utilize direct recharge methods to ensure the health of the groundwater basin.

4) New Water

The concept of "New Water," also called developed water, can boggle the mind and conjure up visions of wizards and physicists fusing hydrogen and oxygen atoms out of thin air. New water is simply the product of regulatory language that describes clean water that was once wastewater that is treated by various technologies for a beneficial use, like irrigation. It is important to understand that water must be put to a beneficial use and actions taken with that water must never injure other water right holders that are entitled to that water. However, water developed from a technological process is often allowed to be reused many times over without as many restrictions as other water recycling efforts. The new water topic gets both technical and legal, requiring reasonable caution. However, arming yourself with water and soil data prior to asking questions can help determine whether developing new water is right for you.

5) Conjunctive Use

There is no question that a hydro-geological connection exists between groundwater and surface water. However, the legal system treats percolating

Chapter 5: Seven Steps that Could Save Your Organization

groundwater differently from surface water causing difficulties for a water manager who wishes to use groundwater and surface water interchangeably. Conjunctive use focuses on using surface water in the wet years and groundwater in the dry years to meet water demand. Conjunctive use includes the practice of pumping surface water into groundwater banks for later use.

Under California Water Code Section 1011.5(a), the state declares, "policy of this state to encourage conjunctive use of surface water and groundwater supplies and to make surface water available for other beneficial uses." Conjunctive use contemplates using water supplies only when needed, which made water right holders uneasy due to concerns over forfeiture or diminishment of their water rights for non-use. However, the legislature ensured that participants in conjunctive use programs would not forfeit or diminish their surface water rights by relying on stored groundwater.

Additionally, the legislature allowed saved water from a conjunctive use program to be sold, leased, exchanged, or transferred if it complies with laws governing transfers. As a management tool, it allows flexibility in utilizing surface and groundwater to meet users' needs and an inexpensive way to store groundwater or reserve surface water in a stream for various beneficial uses. However, data is required to make effective management decisions. Understanding this data can inform water managers and users on the best times to store or use surface or groundwater.

6) Water Markets

Water transfers are an effective and important tool for meeting water demands when water supplies are volatile. Due to a scarce water future, transfers are a necessary tool that requires an understanding of data to protect the soil, maintain agricultural viability, and serve the local community. Unlike trading baseball cards, water is difficult to characterize, quantify, or even identify ownership of because of the arcane system through which water rights are determined and managed. Water's unique properties and the clunky regulatory mechanisms seeking to control every molecule create a challenging water trading environment.

Regulation can stop trades from happening if the DWR or another responsible state agency perceives there is a negative impact on the environment or the economy. Complications with the pumping schedule in the politically contentious Sacramento-San Joaquin Delta, for example, can also prevent water trade from

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taking place. If you can navigate the state and federal regulations, you must also ensure county ordinances allow you to transfer water outside of county lines. With the advent of GSAs, groundwater transfers are subject to restrictions they may impose within the basin. There is a potential for conflict between GSAs and county governments over water transfers. A solid start to addressing these challenges, and even swaying the rule makers towards reform, begins with reliable water data.

Data is essential to water trades due to the myriad of restrictions on transfers and the lengthy process required for trades to successfully occur. If sellers knew how much they could trade at any given moment based on conditions statewide, or identify willing buyers, they would have the flexibility needed in this new, permanent state of water scarcity.

7) Deep Partnerships

Often technology is depicted as a robots, numbers, and complexity. However, its more about connecting people with tools, data, and partnerships. Managing something as complex as a farm or water district requires assistance, understanding your peers' problems, and sharing solutions. For example, water supply data collected at the regional level eventually makes it way to the state level, while the water districts and federal government collect water supply data. A deep partnership could exist if those datasets were housed in one location, utilizing one standard, and open to analysis. At AQUAOSO, our platform creates these conditions, in addition to working with our partners to increase the utility of the technology. We don't build technology for the sake of technology, we build tools for people to make intelligent water risk management decisions. A perfect partnership of people and technology for a resilient water future.

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Identifying water risk is crucial to ensuring protection for your organization from unexpected shifts in water supply, demand, quality, or cost. Threats to a water district, farmer, agricultural lender, appraiser, real estate broker, investor, and community member take many specific forms depending on what you do and where you operate.

However, some broader conditions and indicators impact everyone:

- Groundwater Basin Condition
- Available Surface Water Supply
- Water Demand

On the horizon, the Sustainable Groundwater Management Act (SGMA) will impact how we understand the above conditions, but focusing on the present can prepare us for the SGMA future. Understanding relationships between different risk indicators becomes difficult with the introduction of more indicators and variables. However, if you create a system that assists you in understanding the relationships and displays significant connections, you are better positioned to make use of the data. AQUAOSO decided to create a software platform that assists with the complex task of understanding water risk.

Making connections requires:

- data
- analysis
- communication

The tricky part about making these connections is obtaining enough data to generate the above figures and give a complete picture of a water risk scenario. Collecting data takes time and persistence. For example, to produce the above charts for Farm #1 on a real parcel of land requires obtaining data on:

- parcel boundaries
- ownership
- crops within those boundaries
- water district historical and current water delivery records and groundwater pumping information

Not only does each piece of information reside in a different place, but it is also often trapped in challenging-to-use formats for proper analysis. AQUAOSO knows because we already did this and continue to update our database daily.

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The analysis on one property using excel spreadsheets and making phone calls that may or may not be returned promptly was the typical method in gathering water data. Such 20th Century methods were necessary because technology was not cheap enough to deploy efficient and affordable solutions. Additionally, analysis used to require an expensive consultant to assist with understanding any of the data collected.

While there are times when experts are certainly needed, reviewing multiple properties in a portfolio for water risk indicators or setting a strategic plan for water risk does not require in-depth human analysis. We built a system that saves time for employees and saves money for any operation that is serious about water risk. Using advanced technologies like geospatial analysis and machine learning allows AQUAOSO to analyze data and make necessary connections right from your computer.

Advanced technology is great, but most people are not technological wizards or water experts. You need to be able to understand the complex analysis enough to communicate actionable recommendations for your organization and community. AQUAOSO provides reports that summarize the necessary analysis for a property resulting in a full picture of water risk for an agricultural parcel, set of parcels, or a comprehensive portfolio of properties spread throughout California. The best part is that it takes minutes instead of days and everyone can be on the same page, literally.

Though uncertainties exist, SGMA is a reality. Changes to agricultural lending, real estate, farming, and water management are imminent. Taking the time to review your organization's potential risks through identifying, understanding, monitoring, and mitigating water risk is critical. Leveraging trusted relationships, expertise, and technology will pay dividends for years to come. SGMA will have significant impacts, but you will be ready.

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SGMA requires GSAs to submit GSPs that include mandatory sections discussing how the GSA intends to bring the underlying groundwater basin into sustainable yield. For the agricultural sector, some of the biggest questions surrounding groundwater regulation are answered by the GSP including:

- What is the sustainable yield for the basin?
- Will there be restrictions to groundwater pumping for agricultural purposes? If so, what are those restrictions.
- Are there land use impacts due to overdraft?
- Are their groundwater quality concerns in the basin?
- Are their new fees?

While each GSP is designed and implemented at the local GSA level, there are requirements from the State regarding mandatory sections to include in the GSP. This guide is designed to assist you in understanding what might be included in each relevant section and what that means for agricultural lenders, investors, appraisers, and other professionals in the ag community. You will be prepared to review GSPs relevant to your portfolio or your client's properties.

The Introduction and Plan Area

The beginning of the GSP should include a discussion of the legal authority and cost associated with implementing a GSP. The cost section may be important to review because it could signal one-time or recurring fees related to the creation and implementation of the GSP. Some GSAs will also discuss grant funding received for technical assistance from the Department of Water Resources (DWR).

Another important part of the introduction of the GSP should include is how the GSA is organized. GSAs may be part of a group of GSAs or contain sub-areas within the GSA boundaries called Management Areas that may have different fees, restrictions, or benefits that are discussed later in the GSP.

Plan Area

The Plan Area and Basin Setting are designed as an overview of the important geographic and hydrological elements of a basin. The Plan Area is focused on the political boundaries and the Basin Setting on the hydrologic data. The Plan Area is important for agricultural community members primarily because it discusses further the multiple political jurisdictions that may exist within a GSA, the area the GSP covers, and current land use designations, such as land designated for agriculture. Below is an example of a GSA that has jurisdiction in multiple counties.

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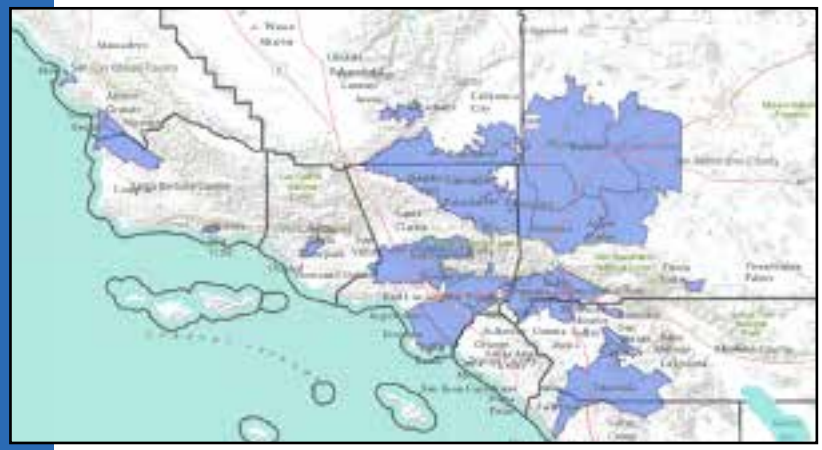
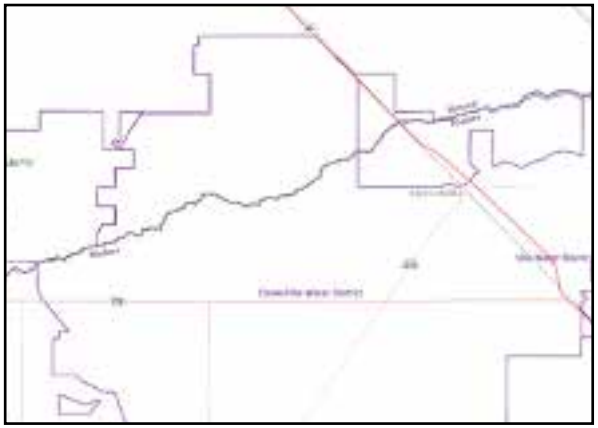
Adjudications

Understanding the area covered includes whether or not there is an area covered under a groundwater adjudication. A groundwater adjudication is a court supervised settlement for all stakeholders within the adjudicated area, a specific basin, which sets out the rules the parties to the settlement agree to follow. If a property is within an adjudicated basin, the property owner should refer to the settlement documents and contact the appointed watermaster regarding groundwater rules, which may be different than those contained in the GSP. Below is a map showing adjudications in the southern part of California.



Other Jurisdictions

GSAs do not exist in a political vacuum. There are still multiple other government agencies with various mandates and jurisdictional boundaries within the GSP Plan Area. The below image depicts a GSA that has boundaries in two different counties.



Federal, State, County, municipal and special district boundaries are discussed as part of the Plan Area. Putting the GSP in context of other governmental regulations assists stakeholders in understanding their responsibilities. For example, water quality regulations come from federal, state, and regional governmental entities. However, a GSP must also address impacts to water quality within the framework of existing law. AQUAOSO provides political boundary information on the GIS map allowing you to see the various jurisdictions impacting a property.

Water Plans and Monitoring

Another important Plan Area topic is a description of water monitoring. A GSP should list regional water plans, Agricultural

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Water Management Plans, Urban Water Management Plans, and other water plans that are part of the Plan Area. Additionally, monitoring programs implemented by federal, state, and local entities belong in this section. Understanding the monitoring programs already in existence provides added context for potential additional groundwater monitoring requirements as part of the GSP.

Conjunctive Use Programs

If a water district or other governmental agency participates or administers a conjunctive use program, that should be included in the Plan Area portion of the GSP. Conjunctive use policies encourage the use of surface water when available to reduce groundwater pumping and increase groundwater recharge. This is essential information when analyzing how use of surface water to support basin health through groundwater recharge programs. Conjunctive use programs may also identify use of recycled wastewater and storm water.

Land Use

Land use in the Plan Area looks at existing general plans and other land use plans that list crops, agricultural land acreages, urban acreages, and other land use statistics. Understanding the typical types of crops and how much of a basin's overlying land is dedicated to agricultural use can assist in estimating impacts to the community and key stakeholders. For example, if a basin is made up of primarily agricultural land and that land is largely permanent crops, the impacts of reduced groundwater pumping may be more severe than in a more urban, less permanent cropped basin. Additionally, this section would cover permitting processes, such as well permits, that agencies other than the GSA have authority over.

Basin Setting

Basin setting refers to hydrogeological models, current and historical groundwater conditions, water budget information, and whether there are designated management areas within the basin boundaries. The following highlight key points to pull from the Basin Setting section.

Recharge

Soils with higher permeability and infiltration rates increase the potential for

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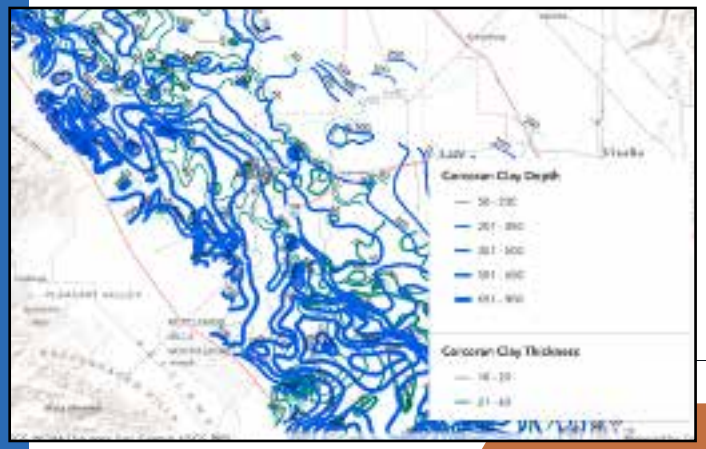
surface water to reach groundwater for water recharge purposes. This could also indicate areas suitable for groundwater recharge activities. Many of the GSPs will likely use the Soil Agricultural Groundwater Banking Index (SAGBI) to assist in determining crucial areas for recharge. ***AQUAOSO includes SAGBI as a GIS layer as part of our research tool to better assist customers in locating potential recharge opportunities.***

Clay Layer

Indication of weather large deposits of clay, like the Corcoran Clay layer, may present issues with groundwater quality, perched aquifers, and groundwater supply depending on the depth and thickness of the clay layer. Many GSAs will treat the upper and lower aquifers, with the clay layer in-between, as separate for sustainable yield goals. ***AQUAOSO provides two Corcoran Clay GIS layers, depth and thickness, to better assist customers with identifying potential issues resulting from the clay layer.***



Surface Water Sources: Local and Imported Supplies

Local and imported water supplies. Important for understanding additional sources of water potentially available to a parcel within the basin. AQUAOSO also provides information on surface water sources for water districts allowing you read and view on our GIS map for comparison purposes.

Current and Historical Groundwater Conditions

GSPs include historical groundwater data based on past studies and reports. GSPs will update every five years and evolve as groundwater monitoring continues to increase in frequency. Below are some key points to pull out of the Groundwater Conditions section of a GSP.

Groundwater Elevation

Groundwater elevation provides evidence of groundwater extraction, difficulty of extraction, and an indicator of potential overdraft issues. Also, if there are different parts of the aquifer, such as lower and upper, that have different characteristics, this section will account for those elevations separately. ***AQUAOSO provides publicly available groundwater depth data in an easy-to-view GIS map layer allowing a glimpse into recent groundwater depth readings for your area of interest.***

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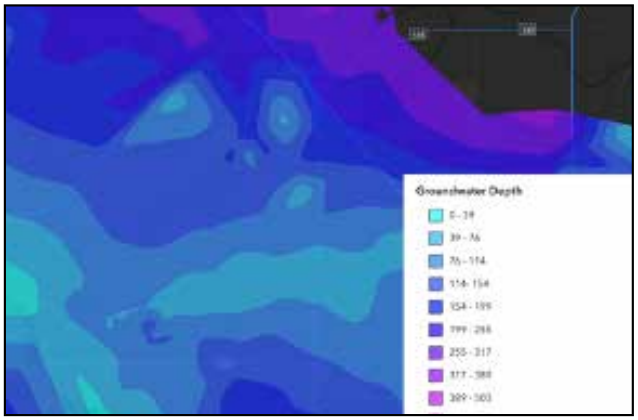

Groundwater Hydrographs

Hydrographs can illustrate trends in groundwater depth over long periods of time. The GSP will provide those graphs and explain the trends in more detail. A trend in declining groundwater levels indicates a net loss of groundwater for the basin which may lead to subsidence, expensive groundwater extraction, and a likelihood of stricter restrictions on future pumping.

Groundwater Storage

The Groundwater storage section of the GSP provides insight into the total amount of groundwater stored in a sub-basin and the specific yield estimates. Specific yield assists in understanding the actual porosity, or how much space is available for the water to infiltrate, of a sub-basin. Additionally, the change in groundwater storage is mentioned in a GSP. The change in storage indicates whether or not there is a consistent decline in groundwater in the sub-basin. Knowing there is a consistent decline indicates a higher likelihood of groundwater pumping restrictions to ensure the sub-basin reaches sustainable yield. Owning a property in an area with consistent decline in groundwater storage may present problems in relying on groundwater as a source of water for crops.

Water Quality

The amount of groundwater is important, but equally as important is the quality of the available groundwater. Contaminants such as nitrate and arsenic, as well as water salinity, can impact crop yields and soil health. The GSP will look at whether the specific contaminants analyzed, such as nitrate, exceeds the Maximum Contaminant Load (MCL) over a defined period of time. Such analysis is useful in understanding the water quality trends for the basin and planning appropriate measures to protect land and crops from high levels of contamination.

Land Subsidence

GSPs will also comment on land subsidence within a basin. GSPs will likely rely on various past subsidence studies showing historical trends in subsidence. Subsidence impacts groundwater quality, drainage, infrastructure, and other important agricultural assets. State and Federal government programs are analyzing subsidence with greater detail and more recent data should be forthcoming over the next few years.

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Water Budget Information

The GSP water budget section will explain the methodology used to determine the water budget and then present the results. Water budget components are largely dictated by regulation. Interesting information coming from the water budget analysis includes groundwater extraction by water use sectors, inflows and outflows based on local surfaces water sources and canals, and impacts on changes to water storage. Finally, the water budget section of the GSP will describe whether there are overdraft conditions are present.

Subbasin Sustainable Yield

GSP Regulations require the water budget to quantify the sustainable yield for the subbasin. Sustainable yield is defined as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the subbasin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result" (CWC Section 10721(w)). The sustainable yield will be a basis for groundwater pumping restrictions, fees, and other GSA rules governing a subbasin. The GSP will also cover available water and programs for groundwater recharge which can assist with mitigating impacts resulting from groundwater pumping.

Management Areas

Within a GSA, there may certain areas that require specific management practices due to political or environmental reasons. These management areas typically report back to the GSA and abide by the GSP. Potential differences in fees and severity of pumping restrictions may depend on which management area a property is located within.

Sustainable Management Criteria

The sustainable management criteria section of the GSP is designed to utilize the data provided in the previous sections to characterize what the undesirable results are for the basin, measures used to ensure basin operates within its sustainable yield, and how the GSA plans to reach the sustainability goal in 20 years.

Sustainability Goals and Sustainability Indicators

Sustainability goals are tied to sustainability indicators. There are six sustainability indicators that become undesirable results if there are significant and unreasonable impacts to the sustainability indicator.

- Chronic lowering of groundwater levels indicating a significant unreasonable depletion of supply if continued over the planning implementation horizon.
- Significant and unreasonable reduction of groundwater storage

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- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies
- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

These indicators are specific to a point, but it is up to the GSP to further define how to measure and determine the significance and unreasonableness. The quantitative indicators will inform important decisions impacting agriculture like groundwater pumping restrictions and pesticide usage. There are, importantly, milestones that are measured in increments of 5, 10, 15, and 20 years allowing for a baseline to make adjustments to GSA pumping restrictions and other regulations.

Minimum Thresholds and Metrics

Important metrics to review include: hydrographs, subsidence areas, and supply well information. Wells will typically be chosen to monitor for a broader area and are representative of that area. What is one of the more interesting measurements to note is groundwater elevation.

"Groundwater elevation may be used as a proxy for any of the minimum thresholds for the sustainability indicators if the GSP demonstrates a correlation between groundwater levels and any of the other metrics." (see 23 CCR §§ 354.30(d), 354.36(b))

Sustainability	Metrics Required by SGMA
Lowered Groundwater Levels	Groundwater Elevation
Reduction of Storage	Total Volume
Seawater Intrusion	Chloride Concentration isocontour
Degraded Water Quality	Migrations of Plumes, Number of Supply Wells, Volume, Location of isocontour
Land Subsidence	Rate and Extent of Land Subsidence
Surface Water Depletion	Volume or Rate of Surface Water Depletion

In addition to the minimum thresholds for the GSA, the GSP requires observance of adjacent GSAs' minimum thresholds due to the natural movement of water, and potentially contaminants, from one GSA service area to another.

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Understanding where your organizations portfolio or client's land is in relation to neighboring GSAs can assist in assessing whether a neighboring GSA's GSP creates a negative impact.

Undesirable Results

An "undesirable result" occurs when there is a significant and unreasonable condition measured by any of the six sustainability indicators explained in the above section. However, one exceedance at one monitoring well is not sufficient to be an undesirable result. Also, undesirable results may differ depending on management area or region of a GSA. It is important to identify where exactly in the GSA a portfolio or single property is located to understand the criteria for undesirable results.

Remember, remedying the undesirable result is a marathon, not a race. GSAs have 20 years to correct the undesirable result. While there are annual reporting requirements and milestones every 5 years, there is an expectation of SGMA regulations that this process will take some time. Keeping an eye on changes to the GSP and the annual reports will provide an understanding of the general direction of the GSA and how likely an increase or decrease in groundwater pumping regulation will impact your organization.

Summary

The following are key takeaways for understanding GSP Sustainable Management Criteria and Metrics:

- There are 6 indicators for determining whether a basin has reached sustainability
- There are various metrics to measure the 6 indicators, of which groundwater levels may be used as a proxy as long as it is correlated with measurement of the indicator
- Exceedance of an indicator creates an undesirable result
- Undesirable results must be corrected at the end of the 20 year period that the GSP covers
- Understanding how the metrics and indicators impact your organization is critical

Next Steps

The GSPs are the tip of the groundwater data iceberg as more public information is available on level, quality, and availability of groundwater. Keeping track of the data is not an easy task. Making sense of it and applying that to actionable steps for your organization is an even more challenging task.

At AQUAOSO Technologies, we work on these hard problems every day so you don't have to. Visit us at our website to learn more about identifying, understanding, monitoring, and mitigating water risk.

Chapter 8: Putting Data into Context and Taking Action

Water security is a global problem. The World Bank estimates a massive population boom, requiring a 70 percent increase in agricultural production. Because of this increase, the World Bank predicts an increase of future water demand of 25 to 40 percent. Meanwhile, climate change makes it difficult to meet these new water demands due to an increase in major disruptive climate events like “Megadroughts” that are already impacting the Western United States.

- How do we understand the water risk associated with an increased need for water agriculture and the climate change impacts to water supplies?
- How do I apply water risk analysis to a smaller scoped task such as an agricultural loan portfolio or property transaction?
- A water risk analysis provides a system to answer these questions. In this two-part series we will explain: The different scopes for water risk analysis
- The benefits and limitations of each, and how they can work together to create a more complete look at a group of parcels

Scoping Analysis

Assessing water risk stems from a business aim of whether there is enough water for an area to safely meet water demand. The most important follow up question in taking on a water risk analysis is then what is the geographic scope.

What is the Geographic Scope?

If you must assess multiple jurisdictions, such as the western United States or even a few counties, you will quickly find increased complexities as compared to two parcels in the same jurisdiction. The geographic area can include both the physical geography such as a groundwater subbasin, or a political boundary such as a water district service territory or parcel boundary. You should include both physical and political boundaries in your research scope to better understand how Mother Nature and regulation may impact risk analysis.

What is the Thing to be Analyzed?

Second, ask what the type of thing is you are analyzing. If it is a loan application for acquiring agricultural property, then the thing is a parcel or parcels of land. If it is for something more complex, such as a food supply chain, then the thing is an understanding of where the growers are, what is being grown, how and when is it harvested and processed, and possibly regulatory analysis.

What are the Most Important Variables?

When assessing a group of properties in several water districts, you would want to clarify what is most important to answering: “is there enough water to meet the water demand?” The variables for this assessment may include data on soil, water, climate, ecology, and economics.

However, not all variables are required. You are seeking to find the strongest signal and ignore the background noise. Also, your

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task may not have the budget or time allotted to track down every single potential variable. Incorporate the data that has the largest impact on water supply and demand into your analysis.

Hypothetical Project

Say you are tasked with assessing the potential water risk of a group of properties owned by AgriHarvest Farmhands LLC, a group your organization is interested in lending money to.

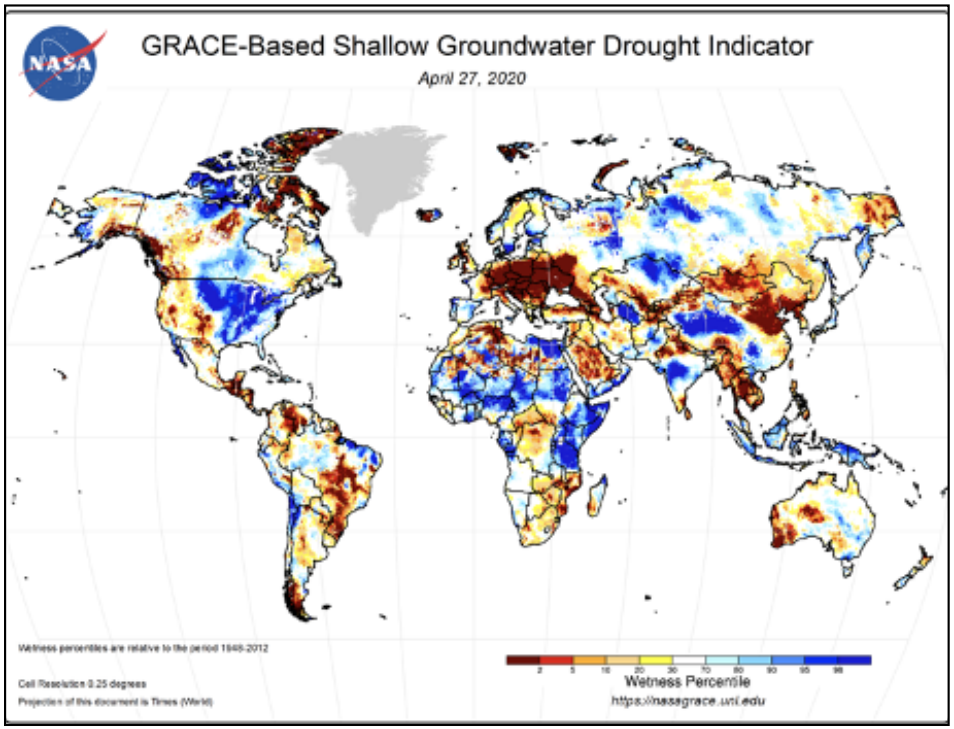
1. Geographic Scope: You locate the properties in California, in a single county, spread out in two different water districts.
2. What is the Thing to be Analyzed: You are looking at agricultural properties that you learned are primarily almonds.
3. Most Important Variables:
    - You are assessing agricultural properties in different water districts so the ability of each water district to deliver water consistently, and with sufficient water supply to meet almond orchard water demand.
    - Also, this is in California so the Groundwater Sustainability Agencies may have additional affects to water availability, and the typical amount of water needed to support almond trees will also be important.

Looks like you have an excellent start on scoping your analysis.

Let's get to the data!

The Global Macro View: NASA Satellite Data

NASA GRACE-FO, a satellite data collection program, in cooperation with the German Research Centre for Geosciences, completed work on mapping the globes groundwater supplies and providing groundwater drought indication on a global scale.



For more information on the project and the data, click here. A dataset that is massive requires laser focus on a few variables over the entire planet. For many this may be illuminating, but a bit too removed from the scope for our hypothetical analysis.

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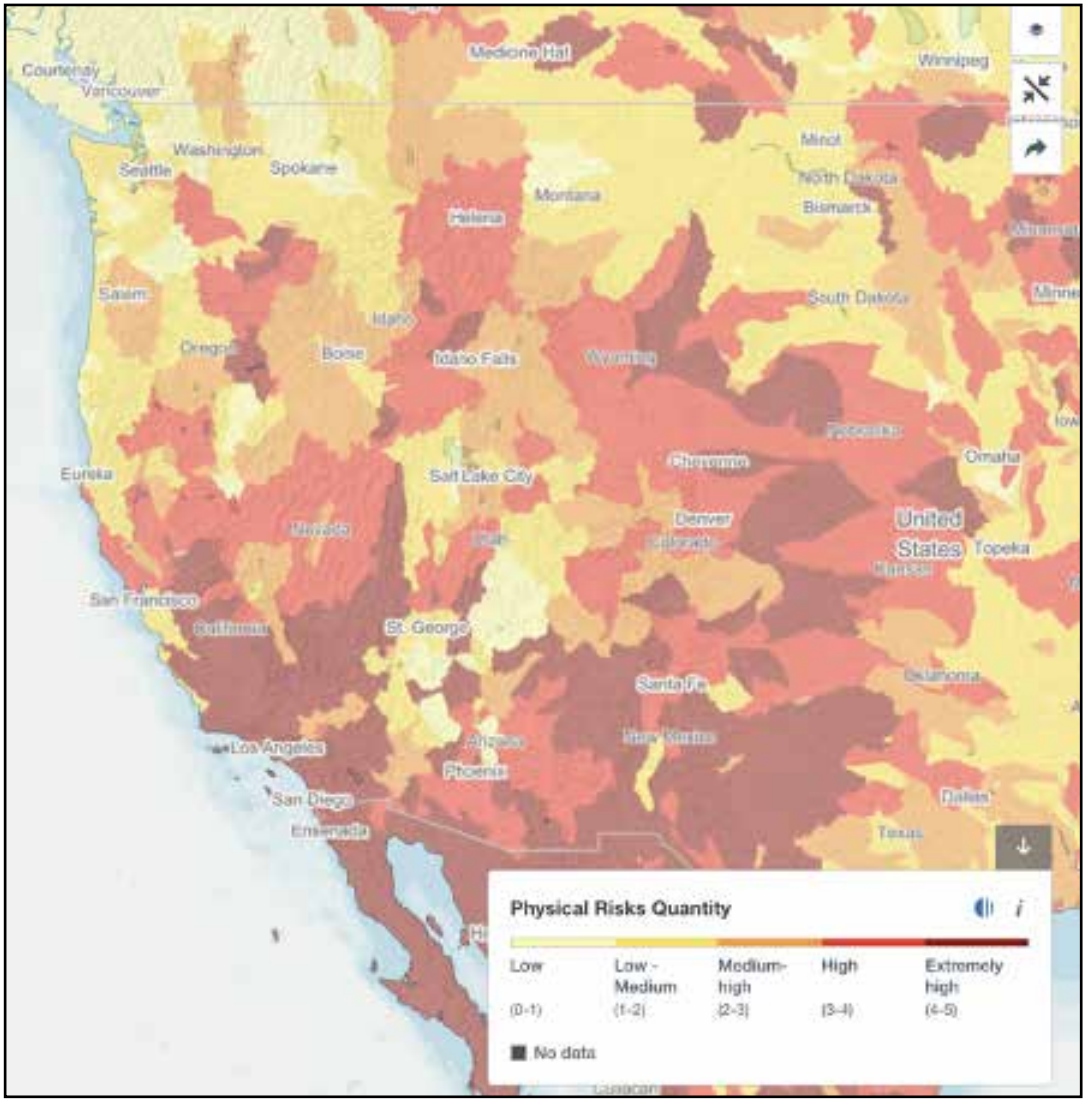
Zooming In: The Regional Macro View

Based on work with customers with varying water risk analysis objectives, there are some common concerns among those relying on water for their operations. Frequently asked: "what are the risks of not having enough water for what is planted in an area?" The folks at the World Resources Institute (WRI) created the Aqueduct Mapping Tool that provides a look at water risk using more variables than NASA's project and the ability to look a bit closer at water risk for a region. To the right is a look at Physical Agricultural Water Risk with a focus on the Western United States using the Aqueduct Mapping tool.

For more maps and an explanation of the data, checkout the WRI website. This analysis can help you understand the impacts of regional stressors to water and provides a starting point for regional forecasting. If your scope is based on a regional analysis, maybe for supply chain concern or targeting regional land acquisitions, then this is a significant starting point. However, most projects, including our hypothetical, will require more depth than what we depict here.



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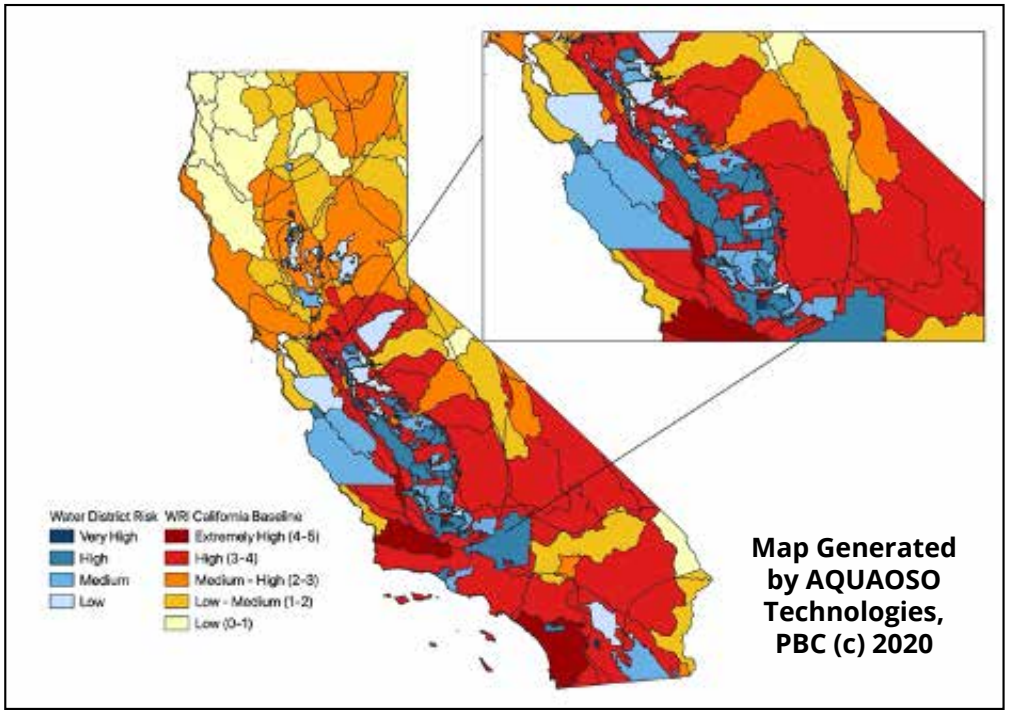
Micro Views: Water District Risk and Groundwater Sustainability Plans

We define Water District Risk as the potential for a deficit in available water supplies that are sufficient quality and quantity to meet average water demands within a water district's jurisdiction. Simply put: is there enough water to meet demands? If we return to our hypothetical situation, we are working with parcels in two different water districts (Water District A and B) for AgriHarvest Farmhands LLC. Upon further research you discover Water District A has a contract with the U.S. Bureau of Reclamation to receive Central Valley Project (CVP) Water and Water District B does not. There are multiple data points that you would need to assess relative riskiness of each water district including:

- Historical Water Delivery Data
- Present Allocation Percentages for agricultural water for that Water District's CVP contract(s)
- General water demand based on crops within the water districts irrigated acreage service territory
- Water delivery infrastructure
- Reliance on groundwater pumping to meet water demands

The map to the right represents the WRI Aqueduct 2.0 map with AQUAOSO's water district risk research overlaid on top. This provides a view of both macro-regional risk, but also the districts within risky regions that may have a stronger water supply than their neighbors.



Map Generated by AQUAOSO Technologies, PBC (c) 2020

After calling around and conducting online research, you discover that the relevant Groundwater Sustainability Agency (GSA) released a Groundwater Sustainability Plan (GSP). Reliance on groundwater requires a review and understanding of newly implemented GSP because it contains insights into the sustainable yield and proposed projects that could impact groundwater pumping for properties both within the GSA and Water Districts for the next 5 to 20 years. This step can take many focused hours mapping out a picture and comparing the strengths and weaknesses of Water District A and Water District B.

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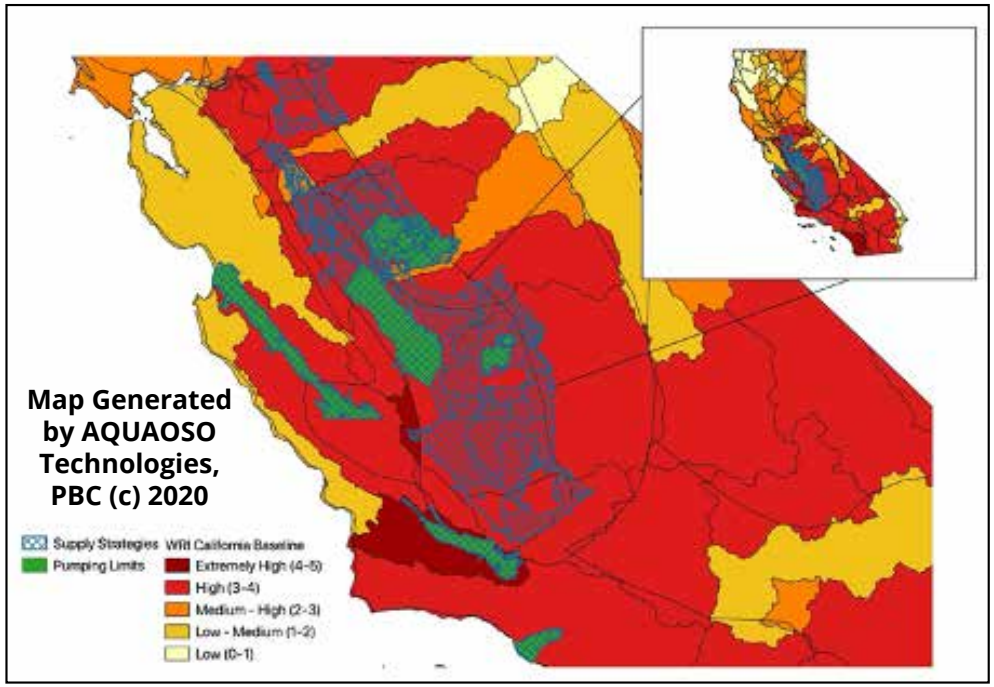
Below is a visual example of how data from reviewing GSPs can assist with understanding specific risks and actions for a region:



The map above shows areas where there was mention of pumping limits as a necessary management action to bring the subbasin into sustainability. The blue lattice areas show where there are general supply strategies for increasing the amount of water while also bringing the subbasin to sustainability.

Specific water management strategies and how they benefit or negatively impact AgriHarvest Farmhands LLC's properties provides a glimpse into the future of water supply reliability in light of local water management practices.

Combining visual representation of data like the maps above help provide context and frame your analysis.

A note about variables

The above list could easily expand into 20, 30, even 50 variables. However, it is important to understand which are the strongest datasets, signals, and what are weaker datasets, also called noise. AQUAOSO selects strong signals that show the potential for impacts to water supply availability to reduce the amount of noise for our customers. Data is helpful, too much data is not.

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Looking Closer: Parcel Level Water Risk Analysis

You have an understanding from NASA and WRI that there are global and regional factors that are causing water stress. AgriHarvest Farmhands LLC specifically has parcels in two different water districts in a water stressed region of California. Your research also uncovered potential restrictions on future groundwater pumping. Do we know is there enough water to meet demands on particular parcels?

The limitations of a water district analysis are that some water districts are large with varying topography, soil quality, and other localized concerns. You will need to complete the journey from satellites in space to the parcels in question using parcel-level data and analysis.

Again, we find that there are a multitude of variables that increase the noise and can drown out the signal. At AQUAOSO, we work with our customers on identifying the variables that matter most and the workflows to gather data for those variables. For example, we provide workflows for capturing more granular data that is helpful to assessing AgriHarvest's water risk:

- Land Ownership
- Endangered Species Habitat
- Soils
- Crop Water Demand
- Water Budget
- Groundwater Banking

The above, paired with your prior research, provides a more complete picture of each parcel. Also, AQUAOSO provides software that allows you to group parcels and assess the whole group as well as each individual parcel, something AgriHarvest Farmhands LLC and your organization would find interesting to review.

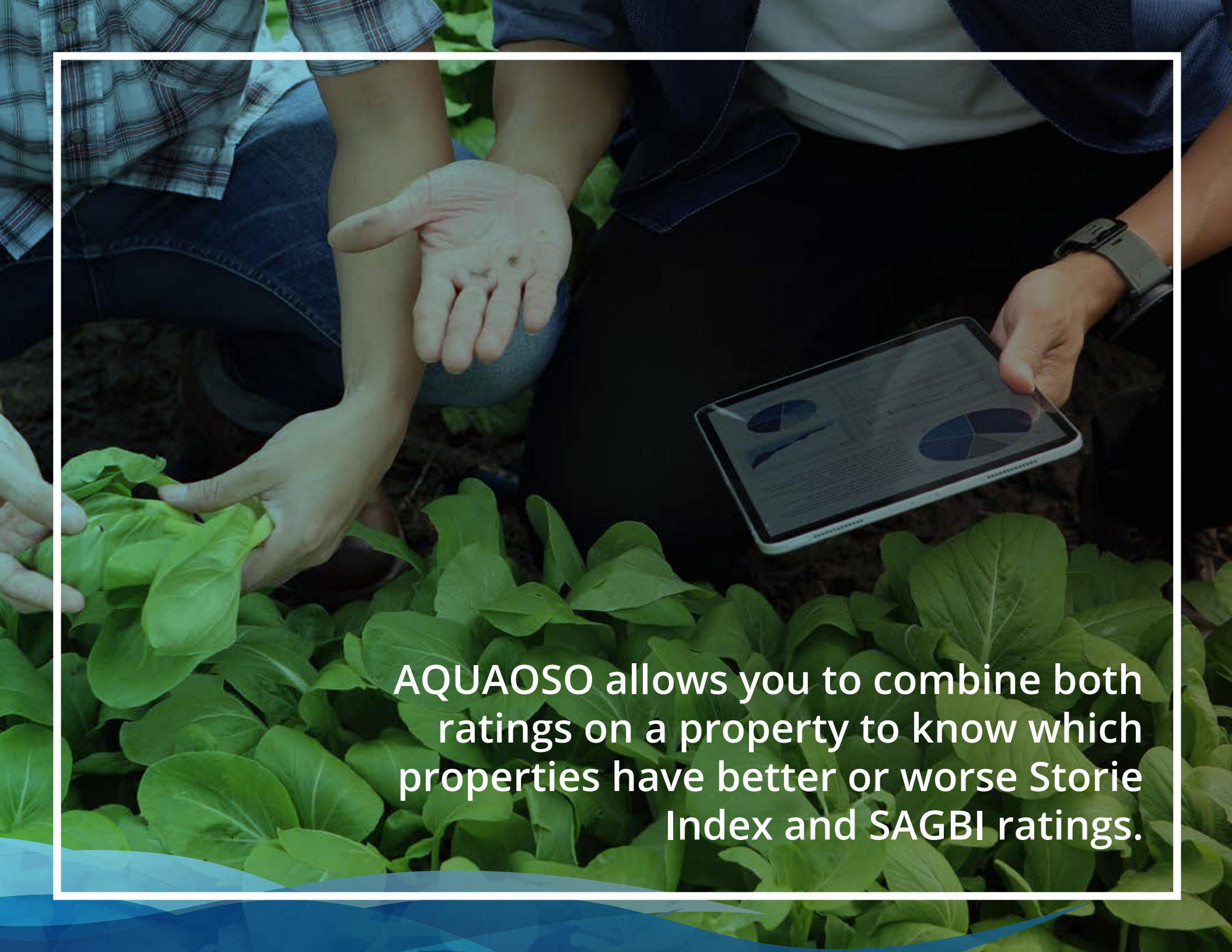
A Complete Picture

We explored the different levels of analysis that may be required when assessing water risk for a group of parcels. Not all levels are necessary for every assessment. Remember that a complete picture means you understand the context:

- Geographic Scope
- Type of Thing for Analysis
- Most Important Variables

Setting up your research process to understand both context and results will clear out the noise, isolate the most important signals for water risk, and provide a better decision making foundation for your organization.

Looking to get started on your water research and need a partner? AQUAOSO's research and analytics software is the perfect companion! Contact us to learn more about how we can help you with your water risk research.



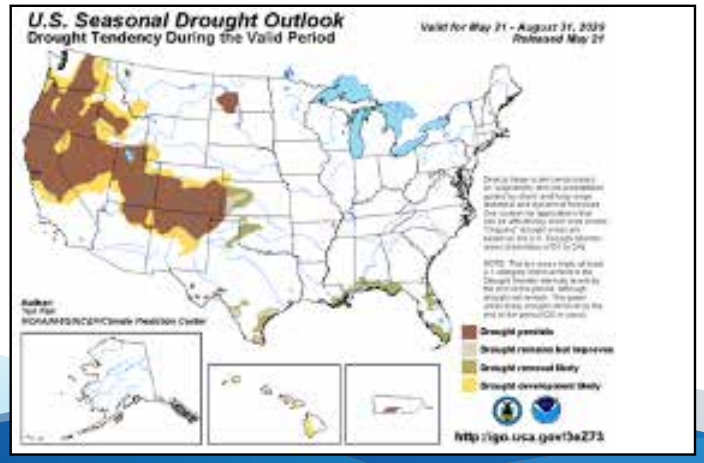
AQUAOSO allows you to combine both ratings on a property to know which properties have better or worse Storie Index and SAGBI ratings.

Chapter 9: Looking Forward

The future will present new challenges in climate variability and adaptation. Today we see new regulatory and management practices to comply with that require assessment of risks and a strategy to boost water security. The GSPs provide insight into risks associated with limits on groundwater pumping and some agricultural operations. However, there are also efforts to implement management practices and develop existing water supplies that may mitigate some of the risks.

You can't track what you don't measure. Many in the ag industry find themselves barely treading water when it comes to due diligence research that incorporates changes from both climate and regulation. Locating the right data to track changes in water risk is a key component to fulfilling modern due diligence research requirements and provides an opportunity to compare different regions. Without comparing the right trended datasets, due diligence becomes a dangerous guessing game.

SGMA and the Megadrought



Several scientific reports sent a warning to the western U.S. this past April: the megadrought has begun. Something that was often referenced as a potential future event has arrived and it is now a question of how do we adapt? But first, what is a "megadrought"?

Drought

No exact definition exists for megadrought, but a drought of this magnitude is one that lasts decades and had not occurred since the Middle Ages. An increase in megadrought conditions will magnify the negative consequences observed in California's most recent critically dry years that will lead to increases in subsidence, curtailment of surface water, and an unsustainable reliance on groundwater. SGMA attempts to mitigate some of the worst impacts from the continued dry conditions over the next 20 years.

As climate change increases the average temperatures, the odds we will roll a severe drought are consistently getting worse for agricultural operations. One expert, using the analogy of tossing dice, likened the future scenario to chances of rolling a drought will continue to increase.

With the enactment of the Sustainable Groundwater Management Act (SGMA), groundwater is no longer a reliable resource for the agricultural industry to count on without innovations in water management and data analysis.

Chapter 9: Looking Forward

SGMA and Curtailment

The State of California's response to unsustainable reliance on groundwater is manifested in the 2014 enaction of SGMA. As of 2020, we are at the very beginning of implementation. Groundwater Sustainability Agencies (GSAs) in critically overdrafted basins were required to submit Groundwater Sustainability Plans (GSPs) earlier this year.

The emphasis on groundwater is important but is not the only key component of water supply and conditions in California. For example, due to a pair of below-normal to dry water years, Westlands Water District faces a reduced allocation of 20 percent from the Central Valley Project and predicts 160,000 acres of farmland fallowed as of June 2020. While there was a good amount of storage to cover most operations this year, another below normal or worse year could cause additional curtailments and surface water supply reductions. Curtailments are not unheard of but act as the proverbial canary in the coal mine for extended drought. Conditions that include curtailments and dry years are similar to the lead up to the major drought years of 2014 and 2015. SGMA's implementation may be just in time for drought conditions water management tactics.

Fires

In 2017 and 2018, California set records destruction related to fire spending over $1.5 billion on fire suppression. In part, the fires were related to the change in water year patterns that feature increased extremes and volatility. In 2017, there was a very wet year which increased vegetation growth only to be followed by a rather dry year in 2018 that reduced the moisture in the vegetation turning it into fire fuel. The threat of fire may impact agricultural economies near fire risk areas and divert dollars away from important downstream water infrastructure projects that would mitigate water supply risk.

Ag Economy

Adding to the competition for water and financial resources are a host of additional impacts from a drying and volatile climate in California. The following is part of a list created by the National Drought Mitigation Center that sums it up nicely:

- Farmers may lose money if a drought destroys their crops.
- If a farmer's water supply is too low, the farmer may have to spend more money on irrigation or to drill new wells.
- Ranchers may have to spend more money on feed and water for their animals.
- Businesses that depend on farming, like companies that make tractors and food, may lose business when drought damages crops or livestock.
- Water companies may have to spend money on new or additional water supplies.
- Additionally, the impacts of subsidence on water conveyance infrastructure is already a known problem with very expensive solutions.

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As the severity of drought increases and the side-effects of climate change present risk of fire, flood, and economic loss, how does this relate to trends occurring on, and under, the ground in California?
Trends from Recently Released Groundwater Sustainability Plans

AQUAOSO has analyzed over 74 GSAs that recently released GSPs which are just one of many data sources needed for complete water risk due diligence, albiet one of the most complex sources. AQUAOSO put our analyses together to assess the various trends, water risks, and water security highlights in California's critically overdrafted basins. We took a sample size of 53 GSA analyses and here are the results:

Water Risk Trends

Assessing GSPs that applied to 53 GSAs in critically overdrafted basins we found:

- 33 out of the 38 distinct water budgets captured in our analysis demonstrate water budget deficits in at least one water year type (87%).
- The largest water budget deficit out of the plans analyzed is in the Kern Sub-basin, where estimated overdraft was equal to -2,225,366 acre-feet in 2015.
- The most common risk identified by GSPs is continued overdraft due to water budget deficits.

Water Security Trends

From the same sample of GSAs, we found the following trends in improvements to water security:

- 50% of GSAs plan to conduct or participate in some form of groundwater recharge in order to reach sustainability.
- 48% of GSPs that specify projects and management actions include a mention of supply augmentation as a strategy to meet sustainability. Supply augmentation projects include: water reuse and recycling, purchased and imported water, stormwater capture, reservoir reapportions etc. and does not include demand reductions or increases in water use efficiency.
- Only 33% of GSPs with reported projects and management actions mention groundwater pumping restrictions or groundwater allocation as a method to reach sustainability. GSPs tend to focus more on strategies to augment supply as compared to reducing pumping.

How Do the Trends Impact the Future?

The future is difficult to predict in these unprecedented times, but that does not mean data is unable to provide insight to mitigate risk. Important for researching water for due diligence and creating a mitigation strategy is to understand the context of the data you are reviewing to make proper comparisons and assessments, and to connect that data back to the parcel or group of parcels you are researching.

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Understanding Context

Data is plentiful in the 21st Century. The challenge is keying in on the data that is meaningful for the task at hand. Commonly referred to as noise, a large amount of irrelevant data can dilute the powerful insight hiding in all the bits and bytes. The signal, often used as a term to indicate the valuable data you seek within the noise, is more easily located when you understand the context of the data.

One example of the importance of context: determining if there is enough water in a specific part of a county that could support permanent crops over the next seven years. There are many variables and datasets that could be used to make a decision. A few of the datasets could be:

- Soil data
- Precipitation Forecasting
- U.S. Drought Monitor Data
- Mapping which water district(s) or GSA(s) have jurisdiction
- Surface water deliveries for current and past years
- Evapotranspiration for the permanent crops
- The challenge is that many of the datasets have extra information that is not relevant to the amount of water needed for the crops you are interested in, and other datasets may be missing information that make it difficult to find value in them when looked at on its own.

Don't look at data in isolation, the data must be connected to the other datasets and put in the context of location. If you are looking only at the average surface water delivery for an area you crucially miss the potential risks of the groundwater situation or that there is a new canal project that will serve part of the area you are researching. On the next page is a risk assessment on Madera County CVP contract water recipients from Spring 2020 that shows how decision making can benefit:

While the overall risk of some of the Federal Contractors, except Chowchilla Water District, is not of great concern, the water supply risk is higher than expected for water districts with federal contracts. A low risk to reliability and a medium to very-high risk of water supply indicates a heavy water demand, which may mean the water district will have a consistent issue in meeting crop water demand with surface water alone.

Placing the data in the context of location provides a foundation to make important connections between the data and arrive at better estimates.

Connecting Data to Parcels

Using location to put data into context is not new. GIS data has become a required component in properly executing the due diligence process. However, with the only constant being change, knowing how those changes impact a parcel of land is a necessary step in agriculture underwriting, appraisal, and investment.

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Water District Name	Supply Risk	Reliability Risk	Quality Risk	Land Risk	Overall
Central California Irrigation District	Medium	Medium	Low	Medium	Medium
Chowchilla Water District	Very High	Low	High	Medium	High
Columbia Canal Company	Medium	Low	Low	Low	Low
Gravelly Ford Water District	Very High	Low	Low	Medium	Medium
Madera Irrigation District	Very High	Low	Low	Medium	Medium

We are seeing a trend in organizations wanting to connect their data together so they are able to boost the signal, reduce the noise, and improve decision-making at the parcel level. Utilizing best practices in data management and implementing GIS technology is an important step in understanding trends and more importantly, what they mean for your due diligence research goals.

Benefit from the Macro and Micro Views

This is how you take action on the water trends. Look at both macro and micro views of water and land data to put that data into context, and then you can begin to draw conclusions and flag potential concerns.

To keep up on macro and micro trends happening in California and the western US visit our blog.

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