



Summary Notes from Groundwater Data Workshop #3: Tools to Support decision-making

Workshop Date: June 3, 2016

Introduction

The following are summary notes from a one-day workshop focusing on potential management actions that local agencies may undertake to meet their sustainability goals under the Sustainable Groundwater Management Act (SGMA), and tools or processes to support their implementation. This workshop was the third in a four-part workshop series convened by Stanford University's Water in the West program and the Gould Center for Conflict Resolution, in partnership with California State University's Center for Collaborative Policy.

Held on June 3, 2016 the workshop brought together a select group of groundwater managers, county and state representatives, and technical and water policy experts to understand the challenges and opportunities that local, state, and federal agencies are likely to face when developing and implementing their Groundwater Sustainability Plans (GSPs) under SGMA.

The workshop included a mix of presentations and discussion, which are summarized in the following notes. These notes intend to capture broad themes and specific workshop goals, including (1) the joint development of list of potential management actions (divided into three categories, supply side, demand reduction and water quality) that water managers may undertake to meet their sustainability goals under SGMA; (2) identifying potential tools, approaches, or processes from water management and other natural resource management practices to support and communicate decisions (i.e., decisions to prioritize, implement, monitor, and communicate management actions) at the local level; and (3) identifying key areas of data uncertainty that could hinder the implementation of management actions under SGMA and potential tools to address them.

A workshop agenda and participant list can be found at the end of the summary notes. Additional information on the [groundwater data workshop series](#) or about Water in the West's [Sustainable Groundwater](#) program can be found at the links above or by visiting waterinthewest.stanford.edu.

1. Broad Themes

Discussions throughout the workshop were wide-ranging and covered a suite of social, legal, technical, and environmental issues related to SGMA and water management in California. The following are key themes discussed at the workshop.

1. **Data:** Meeting participants discussed several topics related to data and tools used for decision-making.
 - a. The Department of Water Resources (DWR) estimates that only 17 percent of basins in California were covered by compliant groundwater management plans at the time of the workshop. As a result, the lack of information required to make informed groundwater management decisions remains poor. Questions about how to bring all

groundwater sustainability agencies (GSAs) up to the data collection, monitoring and reporting standards required under SGMA were threaded throughout meeting discussions. Discussions highlighted the difficulty in meet these requirements given diversity of preparedness, data availability, funding, technical and/or legal expertise, and community buy-in observed throughout the state.

- b. Data uncertainty and a lack of data may hinder agencies' ability to manage groundwater effectively.
 - i. Key areas of data uncertainty include land use, groundwater extraction information, groundwater recharge location and potential, sustainable yield, and groundwater-surface water interactions.
 - ii. Agencies should identify areas of data uncertainty and work to fill data gaps, prioritizing areas or datasets where uncertainty is most likely to affect their decision-making ability.
 - iii. Agencies need to develop robust data monitoring networks and protocols to ensure that new and existing data are useable (i.e., in a readable format with necessary documentation and metadata) and shareable.
 - iv. Developing reliable groundwater models and decision support tools requires long-term, high-quality, consistent monitoring networks.
- c. Local, state, and federal agencies need to maintain existing water monitoring networks and work to develop additional water monitoring networks to support sustainable water management.
- d. Discussions also highlighted the need for standardized data structures and statewide data or tool sharing mechanisms to foster better interbasin and interagency communication.
 - i. The USGS was noted as a "model" agency with established data protocols and systems for collecting, storing, and providing high-quality data with appropriate documentation.

2. **Community outreach, stakeholder engagement, and communication tools:** Meeting participants discussed how crucial meaningful community engagement is for successful SGMA implementation. Tools to improve outreach and communication with community members were of particular interest to workshop attendees. There was additional discussion about how best to communicate the development of technical tools, models, and other applications to non-technical water users. Key findings on this topic include:

- a. There is a lot of diversity in public knowledge of and interest in SGMA. Tools to foster outreach and expand public/community understanding of SGMA would be helpful.
- b. There are social and political barriers that may hinder the successful implementation of SGMA.
 - i. While many basins are considering social and political barriers on an ad hoc basis, there would be value in a comprehensive study to better understand the barriers and potential opportunities to address them.
 - ii. Relationships and trust-building are crucial elements for successful water management. Building these relationships and the trust that underlies them takes time and long-term concerted effort.
 - iii. There is a need for bottom-up stakeholder engagement incorporating landowners into decision making throughout the SGMA process.

- c. Water managers often know what needs to be done, but struggle with how to implement actions without losing credibility by promoting or discussing more controversial and/or emerging tools.
 - i. Who provides information and in what format matters.
 - ii. Reductions are difficult and in many basins in California unprecedented. Without trust and credibility, community buy-in will be difficult.
 - d. Meeting participants discussed the need for community “buy-in” in developing solutions. Communicating management needs and potential solutions was discussed as a key means of improving management transparency and community support, as well as enabling community members to provide feedback on solution development. Where the subject matter is highly technical in nature, GSAs should consider using advisory committees with community members.
 - e. State agencies and GSAs need to work to clearly articulate the benefits of SGMA.
 - i. DWR and the State Board need to clearly present the importance of regulating groundwater use moving forward through building better relationships and establishing continuity in messaging and personnel throughout the state.
 - f. Collaborative models and frameworks for joint-decision making were discussed throughout the workshop. Some benefits of these tools included an improved understanding of basin setting; an improved ability to understand and quantify system drivers, and develop joint solutions to address concerns; and the use of a formal approach to collaboration that incorporates all voices. Some concerns about the use of decision support tools included the cost and technical resources required to run and operate the models, the best methods to communicate model findings to the public, and potential mistrust of model results in some communities.
3. **SGMA’s timeframe:** SGMA requires agencies to achieve sustainable management within 20 years of plan implementation. This timeframe is likely to require the development of both short-term and long-term tools, processes, or approaches.
- a. Short-term: Discussion of short-term management actions under GSP development highlighted the need for management actions, tools, processes, or approaches that can be readily implemented. Discussion also highlighted the need for more funding. Particularly during the initial phases of SGMA implementation where agencies are likely to struggle to raise funds.
 - b. Long-term: Long-term, tools, processes, or approaches are needed to ensure ongoing conservation and reduction of groundwater supplies. Long-term, large-scale projects (e.g., water recycling, recharge projects) are likely to be helpful long-term, but will require funding, community buy-in, and concerted, collaborative effort to be successful.
4. **Uncertainty:** Meeting participants discussed challenges of managing in the face of significant and wide ranging uncertainty. Of particular interest to workshop participants were the following areas:
- a. Data uncertainty, including
 - i. land use,
 - ii. groundwater extractions,
 - iii. groundwater recharge location and potential,
 - iv. sustainable yield, and

- v. groundwater-surface water interactions.
- b. Management uncertainty, including:
 - i. Commodity pricing and changing land use patterns
 - ii. How to adequately manage under a changing climate
 - iii. Uncertainty in jurisdiction and authority. Individual basins and water managers were particularly unclear about authority to enforce restrictions on pumping
 - iv. Commodity pricing
 - v. Changing social values
 - vi. Drought and contracted water delivery
 - vii. There was uncertainty expressed in the untried nature of many of the institutional systems currently being developed under SGMA

Given these many uncertainties, it may be valuable for decision-makers to draw upon decision analysis frameworks designed to incorporate uncertainty from the start. Such decent analytic approaches attempt to keep the focus of modeling and data collection to discriminate between decision options rather than improving precision of estimates for the sake of science. Approaches from the realm of “deep uncertainty” may be particularly relevant to groundwater management, as they focus on problems where values, models and probabilities are highly contested. Recent reviews of important concepts from the deep uncertainty sphere can be found in Herman et al (2015) and Maier et al (2016).

- 5. **Funding:** Agencies require long-term, consistent access to financial and technical resources.
 - a. The question of how to fund projects is a critical concern for water managers.
 - i. More guidance around securing and accessing relevant funding streams for conservation and reduction projects is needed.
 - i. Legal ambiguity (e.g, the role of Propostion 218) could slow down or hinder agencies development of funding for groundwater management.

2. Management Actions

The management actions outlined below are the result of discussion on the existing or potential groundwater management actions agencies are likely to undertake for sustainable groundwater management.

Table 1. Potential management actions for sustainable groundwater management identified by workshop participants.

Category	Management Action
Supply side	
Recharge groundwater via	Natural Recharge
	Artificial Recharge
Improve local operational efficiency via	Conveyance
	Water transfers
	Improved communication/data sharing amongst water users
Land and resource management via	Integrated land use planning and water management
	Groundwater recharge zone mapping and protection
	Watershed management (including forest management)
	Ecosystem/habitat restoration
	Floodplain protection
	Sustainable agricultural practices

Category	Management Action
Develop alternative water sources via	Importation of water
	Recycling of water
	In-lieu water use
	Conjunctive use and groundwater storage
	Desalination
	Surface storage (local, state)
Demand Side	
Demand reduction and efficiency improvement via	<i>Urban water use</i>
	Plumbing retrofit incentives
	Water system audits
	Metering
	Water conservation education
	Turf replacement incentives
	Pricing or other economic incentives
	<i>Agricultural water use</i>
	Changing pumping locations and/or schedules
	On-farm irrigation improvements (systems, timing, etc.)
	Water conservation education
	Land fallowing or retirement programs
	Crop shifting or idling
	Improved access to recycled or irrigation-suitable waters
	Water transfers
	Canal lining to reduce seepage
	Unlined canals to increase groundwater recharge
	Automated canal-control structures
	Conjunctive use
	Water measurement and water use reporting
Pricing or other economic incentives	
Metering	
Water Quality	
Water quality improvement via	Surface water treatment and groundwater remediation
	Nutrient management programs and pollution prevention
	Matching water quality to use
	Salt and salinity management
	Urban runoff management
	Urban water treatment and distribution

3. Tools, approaches, and processes

The following table summarizes workshop discussion on existing or potential tools for groundwater management, barriers for implementation, and opportunities for improvement. It is important to note that some actions (e.g., resolving legal uncertainty) listed under the overcoming barriers heading are difficult to implement and will require long-term commitments to rectify. Limited resources (technical and financial), data uncertainty, and stakeholder buy-in were common concerns raised by workshop participants with respect to tool development and adoption.

Table 2. Tools, approaches or processes discussed at the workshop. GSA is Groundwater sustainability agency; USGS is U.S. Geological Survey; USDO I is U.S. Department of Interior.

Tools, approaches, or process	Examples of existing tools, approaches, or process	Factors affecting to tool, approaches, and processes for implementation	Overcoming barriers raised
Collaborative modeling tools or processes	1. Water Evaluation and Planning (WEAP) model; 2. Shared vision modeling (U.S. Army Corps)	1. Cost; 2. Distrust of models; 3. Confusion over model results; 4. Lack of integrated policy/social factors; 5. Time and effort	1. Provide clear analysis and from a trusted source; 2. Integrate policy and/or diverse social concerns in to results.
Conjunctive Use and Managed aquifer recharge (MAR)	1. Conjunctive water management and water import to dedicated recharge basins (e.g., Orange County Water District (OCWD), Kaweah Delta Conservation District, Sonoma County Water Agency); 2. Groundwater Recharge Assessment Tool from Sustainable Conservation.	1. Land suitability for recharge; 2. Insufficient or cost of water for recharge or conjunctive use.	1. Improve legal guidance; 2. Provide more explicit data for land suitability; 3. Better assesst and incorporate social and human impacts; 4. Provide information about the timing and availability of excess water; 5. Enhance decision-making support on costs and trade-offs.
Surface/ground water importation	1. In-basin transfers; 2. Interbasin transfers; 3. Interstate Transfers.	1. Legal restrictions prohibiting water import/export; 2. Technical and legal barriers hampering transfers; 3. Conveyance losses.	1. Develop of tools capable of identifying potential sources of excess ground/surface water for importation/exportation; 2. Provide publicly available data on water rights, water available for trade, and water pricing; 3. Expedite permits to capture flood flows.
Agricultural conservation measures	1. On farm fallowing; 2. Crop shifting; 3. Conservation outreach and education; 4. Irrigation improvements; 5. Pricing; 6. Enhanced access to recycled or irrigation-suitable water; 7. Automated canal control structures; 8. Infrastructure improvement (e.g. lined canals to reduce seepage losses).	1. Legal challenges to pricing (e.g., Prop 218); 2. Complexity in assessing the outcomes of conservation measures and infrastructure improvements; 3. Lack of information on groundwater extraction; 4. Fear of adjudication; 5. Lack of incentives.	1. Resolve legal uncertainties around groundwater and volumetric pricing; 2. Develop technical and economic tools to guide management decisions; 2. Incorporate ground up community engagement; 3. Fund more frequent land-use surveys; 4. Develop case studies and guidance documents from agencies that have successfully imposed groundwater pumping fees; 5. Develop models to predict long-term outcomes of conservation measures and infrasturcutre improvements.

Tools, approaches, or process	Examples of existing tools, approaches, or process	Potential barriers to tool, approaches, and processes for implementation	Opportunities for improvement
Urban conservation measures	1. Pricing structures (e.g. uniform and tiered rates); 2. Appliance efficiency; 3. Education; 4. Water system audits; 5. Plumbing retrofit incentives; 6. Turf replacement incentives.	1. Legal barriers challenging implementation of management fees, tiered pricing (e.g., Prop 218); 2. Lack of community buy-in.	1. Resolve legal uncertainty; 2. Develop legal guidance around legislative challenges to pricing; 3. Create models to guide pricing strategies; 3. Develop case studies and guidance documents from agencies that have successfully imposed tiered pricing structures.
Metering	1. Metering of wells	1. Distrust by many water users about data use.	1. Better articulate value of metering data for management; 2. Promote the use of estimates from remote sensing technology to assess water use. Use of these technologies could incentivize meter use over time; 3. Provide water users with the initial choice to opt out of metering and rely on remote sensing-derived values.
Water recycling and desalination	1. Water recycling facilities (e.g., Pajaro Valley Water Management Agency, OCWD); 2. Desalination plants.	1. Cost of desalination facilities; 2. Long-term horizons for project scoping, permitting, and construction; 3. Environmental regulation (e.g. lack of baseline data or study, potential overlap with endangered species, etc.)	1. Provide documents outlining considerations of facility construction; 2. Provide funding for construction; 3. Streamline permitting for water recycling.
Land use planning	1. Individual or basin specific tools for land use planning (e.g. Kaweah Delta Water Conservation District); 2. Land use surveys.	1. Overly general or overly specific tools; 2. Inconsistency between water plans and general plans; 3. Inconsistent management boundaries; 4. Inconsistent or outdated land use data.	1. Provide consistent state-level funding for land use survey; 2. Set up workshops/forums to understand common challenges in integrating land-use and water planning; 3. Develop standard population projections and land use projections that can be used by water and land use planners; 4. Develop case studies highlighting areas with tightly linked land-use practices with water management.
Land subsidence monitoring	1. Interferometric synthetic aperture radar (InSAR); 2. Continuous GPS; 3. GPS surveying; 4. Spirit-level surveying; 5. Extensometers.	1. Cost of monitoring; 2. Poorly understood state and local monitoring needs; 3. Remote sensing techniques for monitoring are still not widely available.	1. Provide consistent state-level baseline subsidence data and funding to support long-term monitoring efforts; 2. Develop a technical advisory committee to advise state and local data agencies on data collection techniques and their limitations.
Water quality	1. Irrigated lands program; 2. Nutrient and salt management programs; 3. Local water quality programs, 4. Clean Water Act.	1. Lack of clarity on existing water quality programs integration with GSPs; 2. Variable data availability and format; 3. Cost of monitoring and modeling; 4. Difficulty of identifying non-point source pollutants.	1. Develop a list of existing water quality programs and their objectives and authorities; 2. Develop standard data collection protocols; 3. Provide grants and funding for construction, use, and long-term monitoring of dedicated monitoring wells; and 4. Prioritize water quality programs in agricultural areas where legacy issues may be a problem and in disadvantaged communities.

Tools, approaches, or process	Examples of existing tools, approaches, or process	Potential barriers to tool, approaches, and processes for implementation	Opportunities for improvement
Tools from DWR	<p>1. Interactive GIS Map; 2. California Statewide Groundwater Elevation Monitoring (CASGEM); 3. Water Data Library; 4. Reports and publications (e.g. Bulletin 118); 5. Online System for Well Completion Reports; 6. Water Management Planning Tool; 7. Integrated Water Flow Model; 8. Contour and Hydrograph Tools.</p>	<p>1. Variable data availability and format; 2. Lack of standardization in data collection and/or reporting; 3. Siloed data.</p>	<p>Potential to incentivize tool use by modifying or creating tools that are: 1. Scalable; 2. Standardized; 3. User friendly (e.g. logical interface, easy downloads, and query-able); 4. Capable of interagency sharing (e.g. compatible with USGS/USDOI data); 5. Equipped with analytical and visualization tools; and 6. Capable of in-platform data analysis and summary.</p>
Databases	<p>1. Individual basin level databases (e.g., Water Resources Management System from OCWD); 2. Statewide level database in development by the DWR to house SGMA-related data (AB1755).</p>	<p>1. Variable data availability and sharing capability; 2. Lack of standardization.</p>	<p>Databases need to: 1. Be user friendly with simple, intuitive user interface; 2. Be capable of data queries; 3. Be able to scale and evolve; 4. Include some data QA/QC capability; 5. Enable a variety of security settings (i.e., enable data to be variably accessed by different groups); 5. Facilitate sharing; 6. Produce reports required by SGMA. There is an economy of scale in developing a larger database that can be accessed and used for their own purposes by all GSAs. These systems are likely to be cloud-based, which will facilitate scalability.</p>

4. References

Herman, J. D., Reed, P. M., Zeff, H. B., & Characklis, G. W. (2015). How Should Robustness Be Defined for Water Systems Planning under Change? *Journal of Water Resources Planning and Management*, 141(10), 4015012. [http://doi.org/10.1061/\(ASCE\)WR.1943-5452.0000509](http://doi.org/10.1061/(ASCE)WR.1943-5452.0000509)

Maier, H. R., Guillaume, J. H. A., van Delden, H., Riddell, G. A., Haasnoot, M., & Kwakkel, J. H. (2016). An uncertain future, deep uncertainty, scenarios, robustness and adaptation: How do they fit together? *Environmental Modelling & Software*, 81, 154–164. <http://doi.org/10.1016/j.envsoft.2016.03.014>



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DECISION-MAKING IN THE SGMA CONTEXT: Tools to Support Sustainable Groundwater Management Decisions

June 3, 2016

Workshop Goals and Objectives:

This workshop is the third in a four-part series. Based on learning from the first two data workshops, it is clear that many groundwater basins across the state lack basic data or information to make effective management decisions. In addition, many basins that have adequate data lack the tools¹ necessary to access and integrate data from multiple sources and to communicate them in a way that is useful to decision makers (e.g., board members, the public). Using interactive scoping and plenary discussion, this workshop will identify the approaches or tools that groundwater managers need to make management decisions, even with limited data, under the Sustainable Groundwater Management Act (SGMA).

Workshop participants will:

1. In an interactive scoping exercise, develop a list of groundwater management actions that local agencies are likely to consider under SGMA, as well as the data or metrics that agencies may use to compare and prioritize these management actions, and the key uncertainties that may affect agencies' ability to compare and prioritize these actions.
2. Identify existing and potential approaches, data platforms, analytic tools and other technologies to support and communicate decision-making (i.e., decisions to prioritize, implement, monitor, and communicate management actions) at the local level.
3. Identify key areas of uncertainty that hinder groundwater management decisions under SGMA and possible ways to move forward under uncertainty.

Possible Workshop Outputs:

1. A report or white paper mapping common data-related needs for groundwater management decisions to existing tools and technologies. The paper will also identify potential areas for data and/or tool development and potential entities to develop them.
2. One or more academic publications that will combine the findings from all four groundwater data workshops, as well as in the groundwater data survey.

Meeting Details:

When: June 3, 2016

Where: Y2E2 Room 299, Bechtel Conference Room, 473 Via Ortega, Stanford CA 94305

Hotel: Stanford Guest House, 2575 Sand Hill Road, Menlo Park, CA 94025

Meeting Contact: Tara Moran, 650-721-2421, tamoran@stanford.edu

Logistics Contact: Athena Serapio, 650-724-7609, athena3@stanford.edu

¹ In this workshop series, we use the term tool to capture a breadth of processes, methods or models designed for the purpose of prioritizing, measuring, consolidating, visualizing, and/or disseminating data or information for decision-making purposes. This term may include decision frameworks, visualization software, data integration platforms, decision support tools, databases, models, or other technologies.

AGENDA

8:00am **Breakfast**

8:30am **Welcome & Meeting Overview, Introductions (20 mins)**

Tara Moran, Program Lead, Sustainable Groundwater, Water in the West

Marci DuPraw, Managing Senior Facilitator and Mediator, California State University, Sacramento

8:50am **Session 1: Basin Management Decisions under SGMA (100 mins)**

Objective: To jointly develop a list of local management actions and the factors affecting them.

Presenter and Facilitator: Benjamin Bryant, Postdoctoral Fellow, Water in the West (15 mins)

- Example Basin One: Mark Larsen, Kaweah Delta Water Conservation District (15mins)
- Example Basin Two: Brian Lockwood, Pajaro Valley Water Management Agency (15 mins)

Plenary Discussion (45 mins)

10:30am **Break (20 mins)**

10:50am **Session 2: Case Studies with DWR: Tools to support decision-making under SGMA (100 mins)**

Objective: To learn about and provide feedback on tools being developed by DWR.

Moderator: Marci DuPraw, Managing Senior Facilitator, California State University, Sacramento

Dan McManus and Steven Springhorn, California Department of Water Resources

- Case Study One: Existing tool(s) (45 mins) – Groundwater Information Center
- Case Study Two: Future tool(s) (45 mins) – Guiding principles for tool development

12:30pm **Lunch (50 mins)**

1:20pm **Session 3: Process and Tool Visioning: Tools to support decision-making under SGMA**

Session 3a: Presentations and Sharing (75 mins)

Objective: To learn about new and existing tools used for groundwater management decisions.

Moderator: Marci DuPraw, Managing Senior Facilitator, California State University, Sacramento

Presentations:

- Example One: Adam Hutchinson, Orange County Water District (15 mins)
- Example Two: David Purkey, Stockholm Environment Institute and Tim O'Halloran, Yolo County Flood Control and Water Conservation District (20 mins)
- Example Three: Daniel Mountjoy, Sustainable Conservation (10 mins)

Sharing:

- Time to share experience on decision-making processes and tools in small groups (30 mins)

2:45pm **Break (15 mins)**

3:00pm **Session 3b: Plenary Discussion (60 mins)**

Objective: To identify local agency decision-making needs and tools to meet them.

Moderator: Amanda Cravens, Research Social Scientist, USGS, Fort Collins Science Center

Discussion questions:

- What would help you make decisions or prioritize management actions?
- Are there processes or tools that would that would be helpful? What would they look like?
- What opportunities do you see to support better decision-making under SGMA?

4:00pm **Session 4: Opportunities, Meeting Synthesis, Next Steps, Feedback**

Facilitated by: Janet Martinez, Director, Gould Center for Conflict Resolution

- How do we collectively ensure successful implementation of SGMA?

4:30pm **Adjourn** for a light reception



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June 3, 2016**

PARTICIPANT LIST

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Dave Ceppos, CSUS Center for Collaborative Policy
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Marcus Trotta, Sonoma County Water Agency
Derrick Williams, Hydrometrics