



Putting Adaptive Management into Practice

Incorporating Quantitative Metrics into Sustainable Groundwater Management

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By Esther Conrad, Tara Moran, Ilana Crankshaw, William Blomquist, Janet Martinez and Leon Szeptycki

Groundwater is a critical resource in California, serving as a reserve during droughts that are expected to be increasingly frequent and severe as climate change progresses. Adaptive management – revising management practices based on monitoring of progress toward pre-established quantitative metrics of performance – is widely viewed as an effective approach to managing water and other natural resources under conditions of uncertainty. However, linking performance metrics effectively with decision-making processes is often challenging, requiring careful consideration of institutional factors that may limit an agency’s ability to act based on new information. Governance arrangements that enable adaptive management must balance the need for flexibility as conditions change with a preference among water users for stable rules.

SGMA incorporates many elements of adaptive management, including requirements to manage groundwater according to quantitative metrics of performance. Under regulations guiding the development of Groundwater Sustainability Plans (GSPs) newly formed Groundwater Sustainability Agencies (GSAs) must define measurable objectives, minimum thresholds and interim milestones to eliminate six “undesirable results” by 2040 or 2042, depending upon the basin. Yet, the creation

of these metrics alone will be insufficient to achieve sustainable management of California’s groundwater; institutional arrangements must support their use to guide management actions.

To provide insight into the design and use of metrics as guides to decision-making, this report draws upon the experiences of four special act districts that had authority to manage groundwater prior to SGMA. These include two primarily urban water agencies, Santa Clara Valley Water District (SCVWD) and Water Agency (Zone 7), and two agencies with significant pumping for agricultural use, Fox Canyon Groundwater Management Agency (FCGMA) and Pajaro Valley Water Management Agency (PVWMA). This report analyzes how these agencies used quantitative metrics in their groundwater management plans prior to SGMA and identifies institutional factors that constrained or enabled the adjustment of management actions in response to changing conditions during the 2012-2016 drought. Although the metrics employed by these agencies differ from those required under GSP regulations, these agencies’ experiences still offer important insights for GSAs seeking to develop metrics and integrate them into decision-making.



Designing Effective Metrics

The metrics these four agencies used to guide groundwater management efforts prior to SGMA took various forms, including: meeting a certain percentage of well-specific basin management objectives (FCGMA); outcome measures based on end-of-year projections of groundwater in storage (SCVWD); targets to meet a certain percentage of retailer needs while maintaining groundwater levels above historic lows and meeting salt management goals (Zone 7); and eliminating overdraft and halting seawater intrusion within a particular time period, with interim targets to ensure adequate progress (PVWMA).

A review of these agencies' experiences suggests the following lessons regarding the effective design of quantitative metrics:

- Metrics should be as simple as possible while remaining technically robust.
- Developing useful metrics requires considerable analysis and commitment from agency staff and stakeholders.
- Metrics related to factors over which the agency does not have full control need to be designed carefully, but can still be useful.
- Metrics should be clearly linked with a decision-making process.

- It is important to establish deadlines for achieving metrics, including a buffer when possible and clear consequences if deadlines are not met.
- To continue to be effective, metrics need to be revised over time.

Institutional Factors Affecting Implementation of Adaptive Management

The 2012-2016 drought impacted groundwater conditions within all four agencies. We analyzed their responses to these changing conditions, including whether management decisions were actually updated when thresholds were crossed. Several factors constrained or enabled their ability to adjust management actions.

Constraining factors included:

- Pressure to maintain rule stability.
- Political resistance that turned adaptive management into an excuse for delay.
- Lack of trust in data gathered to assess performance.
- Limits on authority to implement necessary management strategies.



Enabling factors included:

- Contingency plans with pre-defined actions to be taken when thresholds were crossed.
- Strong, trusting relationships with partner agencies.
- Access to financial and personnel resources to provide rebates and other incentives.
- Mechanisms that promote flexibility, such as trading and drought water pricing.

Recommendations for the GSP Process

Our analysis suggests important lessons for GSAs as they work to develop and implement GSPs. The regulations guiding GSP development incorporate many elements of adaptive management, including requirements to establish quantitative metrics of performance, submit annual reports and review plans every five years. However, the adoption and review of such metrics does not guarantee their effective implementation; institutional factors may constrain a GSA's ability to adjust their management actions in response to new information. Based upon our findings, we offer the following recommendations for GSAs as they develop GSPs:

- Establish a robust process for engaging agency staff and stakeholders in decisions to establish metrics and to review performance over time.
- Keep metrics as simple as possible while remaining technically robust.
- Agree in advance upon how metrics will be linked with action, including clear deadlines and steps to take if deadlines are not met.
- Balance flexibility against the need for stable rules and expectations.
- Consider including a drought contingency plan as part of the GSP.
- Take an adaptive approach to defining the metrics themselves.

waterinthewest.stanford.edu
waterinthewest@stanford.edu

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