



Measuring the  
**SUSTAINABILITY**  
of Western  
**WATER SYSTEMS**

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### Introduction

Our water systems in the American West are old-fashioned hybrids. Combinations of natural and engineered systems, they are largely the products of archaic political and institutional structures, some dating back centuries, late nineteenth-century scientific assumptions, and mid-twentieth-century engineering technologies. All of these foundational fixtures of the West's water system are showing severe signs of obsolescing rapidly.

Few water managers, moreover, are able to think beyond their basins or operate with a regional or watershed-wide mandate. The West's astonishingly fragmented water management systems—numbering more than 1,100 water districts, as well as hundreds of mutual water companies and other entities—have never been well articulated and are now approaching intolerable incoherence. Entrenched jurisdictional deadlocks chronically frustrate attempts to allocate and manage water efficiently and price it rationally. Everywhere challenges arise from the age-old competition among agricultural and urban users, but also from new threats like aging water infrastructure, soaring population growth, intra-regional population shifts, growing local and global demand for food, unanticipated climate change, and the increasingly compelling claims of aquatic ecosystems.

Policy makers desperately seek new water sources, even as they struggle with inadequate tools for assessing risk and uncertainty, surprising ignorance of one another's practices, lack of public or even scientific consensus regarding health and safety standards, scant understanding of how to put a value on “natural capital” or “ecosystem services” to balance human and environmental water needs, and virtually no

capacity to integrate the management of groundwater and surface water. Few, if any problems are more important to the future of the West than solving this formidable accumulation of water problems.

### Background

To gain a better understanding of the water challenges facing the West and how a major western research university might best contribute to solving them, the Joint Program on Water in the West at Stanford University held four major dialogues in 2008 and 2009. The Program is a collaboration between the Bill Lane Center for the American West, the Woods Institute for the Environment at Stanford, and numerous other researchers, government agencies, water purveyors, and nongovernmental organizations. The dialogues engaged private and public leaders and academics from both Stanford and other major western research institutions to identify the principal challenges and potential solutions.

Based on these dialogues and other consultations with public and private decision makers and experts, we concluded that our research could best contribute to improving the sustainability of western water resources by focusing initially on three major opportunities to achieve dramatic, immediate, and measurable improvements in water management in the West:

1. Through better management of groundwater, including groundwater banking, and of integrated management of surface and groundwater interactions;
2. Through development of metrics and performance measurement systems or “dashboards” needed to effectively guide efforts to move toward more sustainable water systems in the West; and

3. Through developing methods to expand and improve water reuse, including use of reclaimed water for irrigation and watershed restoration.

Participants in our dialogues consistently identified these three challenges as among the most important facing the western United States, so the Joint Program on Water in the West is now embarking on a five-year program of research, technology development, and policy initiatives focused on these three areas. The Program will not only engage in research and development, but will also test solutions and approaches at a variety of scales (from the level of a single building to the level of a campus, farm, or small community, to the level of municipal systems and water districts, and finally states and regions), and work with private and public decision makers to disseminate and implement the solutions and approaches.

Figure 1 details the conceptual model of our approach. (See page 21).

The goal of the Joint Program on Water in the West is to address and help overcome the major challenges facing western water and to help create water systems in the western United States that are sustainable from economic, ecological, political, institutional, and equitable perspectives.

The Program's work has particularly important implications for water management in agriculture, which accounts for about 80 percent of water withdrawn for human use throughout the region. In California alone, agriculture is a \$30 billion-a-year enterprise. But studies suggest that the state's agricultural sector can continue to thrive only if aggressive

steps are taken to increase water-use efficiency. The Program’s research on water reuse and monitoring, and managing contaminants of emerging concern will help ensure the safety, reliability, and public understanding of water reuse for irrigation of food crops. The Program’s research on groundwater recharge and storage will improve technology for sustainably managing aquifers as irrigation reservoirs and preventing saltwater intrusion in coastal farmlands. The Program’s evaluation of water banking practices will provide economic and policy decision-support tools for smoothing supply, moderating price fluctuations, putting water to its highest and best use, and implementing water transfers within and beyond irrigation districts. The Program’s assessment of best institutional practices for groundwater management will identify obstacles to the creation of local groundwater authorities and recommend politically viable solutions for groundwater regulation, which is a key to sustainable water management in places like California’s Central Valley.

Five principles guide the work of the Joint Program on Water in the West:

- Only a holistic, integrated approach is likely to yield solutions commensurate with the variety, complexity, and urgency of the challenges facing the West. The Program systematically integrates “institutional” analyses of the historical, legal, political, and

economic dimensions of western water issues with cutting-edge science, engineering, and the development, promotion, and transfer of innovative technologies to water managers.

- Water challenges are best examined by thinking about the region as a whole. Many challenges cannot be solved by individual states or locales alone. By thinking integrally about the entire region, researchers and practitioners in one area can help inform their colleagues in other areas.
- Solutions require not only sound science but also pilot projects that test and demonstrate the technical feasibility, efficacy, cost, and political viability of solutions on both small and large scales.
- Even the best solutions will not be effective if they are confined to academic journals. The Program will engage strategically with both public and private sector decision makers to ensure that its work is responsive to their needs and actively contributes to implementing solutions.
- Measuring results is crucial for success, but few metrics exist for improving the sustainability of water management systems. As noted above, we will develop

metrics to measure the success of our own work and broadly promote the development and use of reliable metrics for sustainable water systems in the West.

### Measuring the Success of Reform Efforts and Sustainable Water Systems

In the coming years, major investments must be made in reforming the West’s rapidly obsolescing water systems. This presents an historic challenge and opportunity to create an adaptable dashboard of metrics that can inform, help drive, and measure the success of water reform efforts and the sustainability of water systems in the West. This performance measurement system will draw from best practices around the region, and even overseas, particularly in other arid regions such as Australia, and in other sectors, particularly business.

Although there is a plenitude of data available on such questions as water supplies, use, and treatment, most western states have crucial data gaps on important questions such as groundwater supplies, groundwater-surface water interactions, and water quality. States, moreover, have spent little if any time addressing the fundamental question of what defines an efficacious water system. For example, is the percentage of endemic fish species on the federal endangered or threatened species lists a good measure of the ecological health of a water system?

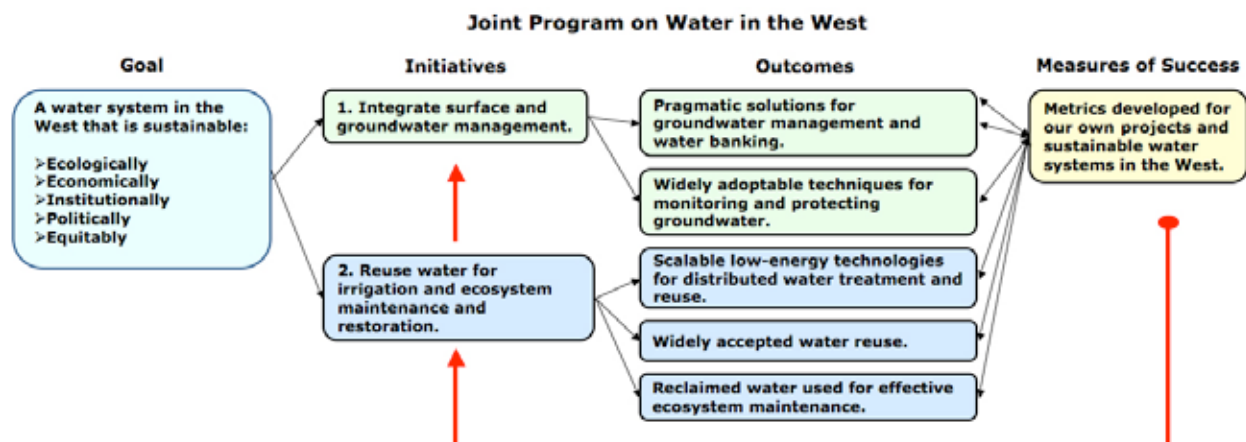


Figure 1. Conceptual Model of Joint Program on Water in the West.

Performance measurement in any field is a crucial challenge. Defining metrics for success can be particularly challenging in reform efforts that are necessarily tied to theories of change. Metrics and performance measurement systems must identify key actionable metrics that deserve the attention of decision makers and be adaptable as the environment for reform changes, successes change what needs to be measured, and people adapt their behavior to perform to measurement systems.

Defining performance metrics, however, is critical both to states seeking to evaluate the status of their water systems and to reform efforts wishing to evaluate their success. The Program is working to develop an improved set of metrics, along with recommendations on the type of information needed to implement the metrics, by bringing experts in the discipline of performance measurement together with experts in water law, biology, water institutions, political reform, databases, and data visualization.

Together, these experts are helping us identify the broad goals for sustainable water systems and define metrics that can serve as indicators for making progress toward those goals. The Program is working with visualization specialists to create a set of interrelated dashboards for measuring the success of efforts to reform California's water system. Key audiences may require different metrics, and the Program's work will reflect this key fact. Measurement of progress toward broad goals statewide, and specific goals on a local level, can help build public support for reform. But reform efforts will require metrics for measuring progress on intermediate goals, whether on groundwater management and water banking, for instance, or freshwater flows for ecosystem health, or even support for key legislation. Policy makers may require a different dashboard. In each case, important decisions will have to be made about conserving and focusing the attention of key audiences on the metrics that matter for success in driving reform.

The Program will also identify and work to fill data gaps and address information asymmetries that hamper reform efforts. Finally, the Program will practice what it preaches, defining metrics for its own success, measuring results, and sharing what we learn with collaborators.

### Conclusion

Since before the publication in 1879 of John Wesley Powell's "Report on the Lands of the Arid Region of the United States," water—or more precisely, its scarcity, has defined the identity and character of the American West. Coping with aridity deeply shaped the cultures of western indigenous peoples from the parched mid-continental prairies to the sere flats of the Great Basin and the dusty pueblos of the Sonora Desert and desiccated arroyos of coastal California. The novelty of the West's great thirst challenged and confounded the earliest American pioneers—and often broke them.

Powell was among the first to understand that the fabled "westward movement" could not proceed on the sunset side of the Hundredth Meridian as it had proceeded across the eastern half of the continent. Here the land was dry. Its settlement would depend crucially not just on the frontiersman's gumption and grit but on scientifically informed, daringly ambitious efforts to capture, store, move, manage, and allocate water on unprecedented scales.

Powell's recommendations led eventually to colossal dams on the Colorado, Columbia, and Sacramento River systems, as well as elaborate water management schemes like the Colorado River Compact, the Bonneville Power Authority, California's Central Valley Project, and the California State Water Project. Those epic engineering achievements are the stuff of legend. They literally made the desert bloom and caused cities to arise from the plains. In the decades after World War II, they transformed Powell's arid West into the nation's most populated, prosperous, and dynamic region.

But those achievements are no longer adequate to sustain the West's water needs. The West now faces an urgently mounting water crisis. In the years to come we must find new solutions through innovations in science, technology, policy, law, economics, institutions, and rigorously measuring our results as we move toward sustainable water systems in the West. ■

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### Additional Resources

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Joint Program on Water in the West, Bill Lane Center for the American West, Woods Institute for the Environment, Stanford University  
<http://west.stanford.edu/research/WiWindex.html>

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