

Groundwater Governance in the U.S.

Summary of Initial Survey Results

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May 2013



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AGRICULTURE
& LIFE SCIENCES



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EXECUTIVE SUMMARY

In fall 2012, the Water Resources Research Center and the Udall Center for Studies in Public Policy at the University of Arizona initiated the project “Groundwater Governance in the U.S.” The effort aims to better understand the scope of groundwater governance across the United States today. As a first step, the project launched a national-scale survey of state agency officials in the U.S. The objective of the initial survey was to acquire baseline information regarding state-level groundwater governance practices. For the survey, a respondent was recruited from each of the 50 states and the District of Columbia. The online survey, which was conducted between November 2012 and February 2013, was designed to take approximately 15 minutes. Agency officials were identified through online research and consulting members of the National Institutes of Water Resources, a network of federally-authorized water resource research institutes at universities across the U.S. This report presents major findings from the initial survey and focuses on analyzing survey results. Depending on available funding, future efforts will expand upon this research and include a broader set of survey participants.

We find great diversity in terms of the scope and extent of groundwater use across the states. In some states, as little as 3% of human water demands are met by groundwater supplies. In others, as much as 95% of human demands are met by groundwater supplies. The survey results also suggest great variation of groundwater use *within* states. About three-quarters (78%) of survey respondents report that reliance on groundwater use varies by region within their state in terms of relative reliance on groundwater to supply human demands. Similarly, 88% of respondents report that the proportion of groundwater use by each major groundwater-using water sector varies *by region* across their states.

Despite this diversity by state in terms of reliance on groundwater, the vast majority of states – some 96% – report the presence of formal groundwater laws regulations, including widespread adoption of state laws addressing groundwater quality and water conservation. Most states also encourage the use of voluntary measures for addressing groundwater issues. Authority for groundwater oversight and enforcement resides largely in state agencies (98%) along with some shared authority with local agencies (64%).

However, survey respondents highlight a great diversity in terms of the users of groundwater subject to state groundwater regulations. States rely on diverse tools and strategies to manage groundwater use and quantity and groundwater governance priorities vary by state. We observe less consistency across states in addressing international, interstate or Native American groundwater issues. And the role of the courts varies as well. In addition, there is significant variance in terms of the role of state law in recognizing the connection between surface and groundwater, and consideration of the water needs of groundwater dependent ecosystems. Finally, survey respondents report differences in terms of agency capacity to carry out policies and responsibilities, and the public accessibility of groundwater information.

This report is posted at <http://wrrc.arizona.edu/groundwater>.

INTRODUCTION

Groundwater is a critical component of the water supplies for agriculture, cities, industry, and ecosystems around the world. In the U.S., groundwater is the nation's principal reserve of freshwater and represents much of our potential future water supply.¹ Approximately 20% of total national water withdrawals come from groundwater sources; more than 27 trillion gallons (about 106 billion cubic meters) of water are pumped from underground sources annually.²

As population growth, economic development, changing land-use patterns, and climate change stress existing water supplies, it is essential to identify ways to improve the ways we govern and manage groundwater.

Yet, despite the acknowledged importance of groundwater to communities in the U.S. and across the globe, *governance* of this resource has been relatively neglected.

In practice, groundwater governance is the complex and overarching framework that determines the management of groundwater resources and the use of aquifers. The local, regional, or national governance framework establishes "who" participates in formulating strategies and is responsible for their execution and "how" the different actors (governmental, public sector, nongovernmental, private sector, and civil society) interact.

In the U.S., water management is largely decentralized, with each state maintaining significant authority and autonomy when addressing groundwater regulation and governance. For this reason, it is not possible to paint a picture of groundwater governance in one brushstroke. Rather, it is necessary to look at state practices and approaches to groundwater management.

Yet, no compendium of information on and analysis of current groundwater governance and management practices in the U.S. exists. This report begins to address this gap. It documents the findings from a national-scale survey of state agency officials in the U.S. involved in groundwater governance. The survey was designed to acquire first-hand knowledge

"Groundwater governance is the process by which groundwater is managed through the application of responsibility, participation, information availability, transparency, custom, and rule of law. It is the art of coordinating administrative actions and decision-making between and among different jurisdictional levels."

Varady et al., 2013. *Groundwater Governance: A Global Framework for Country Action*. Rome: UNESCO, p. 7.

¹ Reilly, Thomas E., Kevin F. Dennehy, William M. Alley, and William L. Cunningham. 2008. *Ground-Water Availability in the United States*. U.S. Geological Survey Circular 1323. Washington, DC: USGS.

² Kenny, J.F., N.L. Barber, S.S. Hutson, K.S. Linsey, J.K. Lovelace, and M.A. Maupin. 2009. *Estimated use of water in the United States in 2005*. U.S. Geological Survey Circular 1344. Washington, DC: USGS.

regarding state-level groundwater governance practices.

This initial survey is seen as the first component of a larger effort to (1) inventory current trends in U.S. groundwater governance, and (2) provide information in support of policy strategies and technical use in understanding and improving groundwater governance. This report and subsequent analyses can be found on the web site of the University of Arizona Water Resources Research Center at <http://wrrc.arizona.edu/groundwater>

METHODOLOGY

Survey questionnaire

The first section of the survey asked state agency officials about the extent and scope of state groundwater use. The second section surveyed state groundwater laws and regulations. The final section polled state agency officials about groundwater tools and strategies. *The survey is included as Appendix A to this report.*

Survey participants

One state agency representative per state was surveyed. State agency officials were identified through a network of federally-authorized U.S. Water Resource Research institutes at universities across the U.S. In some cases, where state agency officials could not be identified through this process, we conducted research online (through “Google” searches) to identify groundwater officials or water-related program offices within state agencies.³ The majority of state agency officials participating in the survey identified themselves as managers (50%) and mid-level administrators (21%).

Data collection and analysis

The online survey was conducted through Survey Monkey and occurred between November 2012 and February 2013. We achieved a response rate of 100%, with all 50 states and the District of Columbia participating.

³ For the state of Virginia, a representative from the Virginia Water Resources Research Center at Virginia Polytechnic Institute and State University participated in the survey project.

SURVEY RESULTS

PART I: GROUNDWATER USE

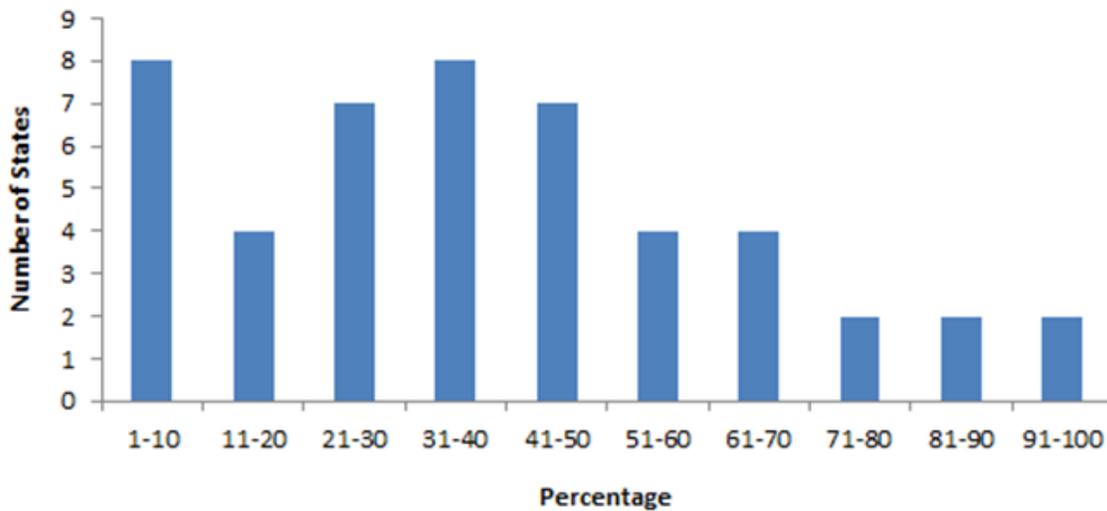
Part I of the survey was designed to explore the scope and extent of groundwater use in states.

The overall findings suggest:

- There is great variation in groundwater use both across and within states.

In an average year, we find that the approximate percentage of total human demands (i.e., domestic, commercial, industrial, and agricultural) met through use of groundwater varies considerably across states. In some states, most notably West Virginia and South Carolina, as little as 3% of human water demands are met by groundwater supplies. By contrast, in other states such as Florida and Hawaii, as much as 95% of human demands is met by groundwater supplies. Figure 1 below shows the percentage of human demands met by groundwater across the 50 states and the District of Columbia.

FIGURE 1: PERCENTAGE OF HUMAN DEMANDS MET BY GROUNDWATER



We can see that there is great variation of groundwater use within states as well. Some two-thirds (or 78%) of survey respondents report that reliance on groundwater use varies by region within their state in terms of relative reliance on groundwater to supply human demands. Similarly, 88% of respondents report that the proportion of groundwater use by each major groundwater-using water sector varies by region across their states. Figures 2 and 3 below illustrate the variability of groundwater reliance by region and sector.

FIGURE 2: VARIABILITY OF GROUNDWATER

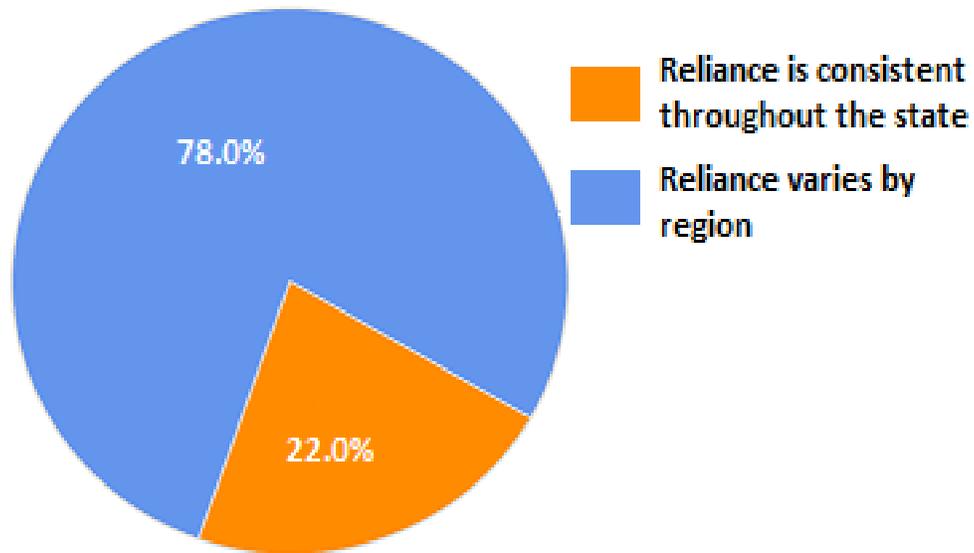
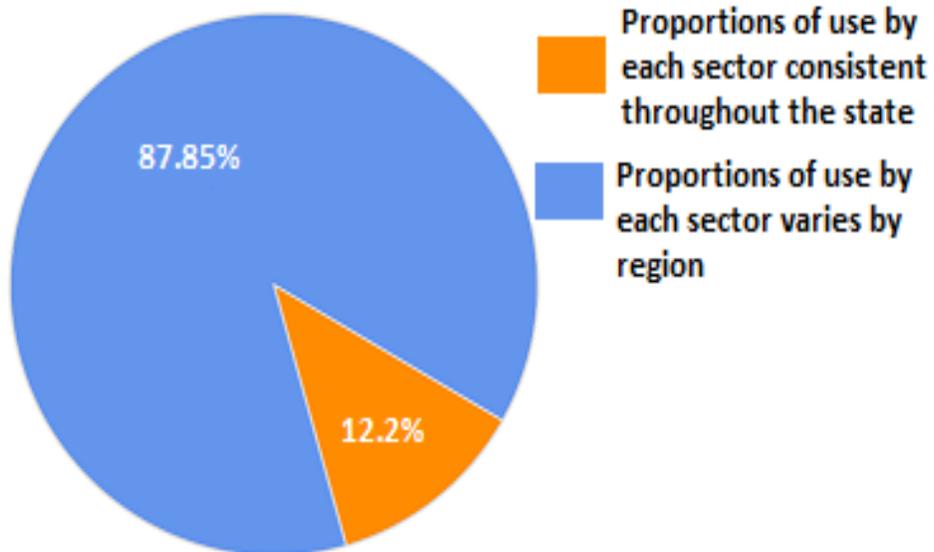


FIGURE 3: VARIABILITY OF GROUNDWATER RELIANCE BY REGION USE BY SECTOR



PART II: GROUNDWATER LAWS AND REGULATIONS

Part II of the survey was designed to explore the scope of state groundwater laws and regulations.

The overall findings suggest:

- Survey responses indicate the presence of formal groundwater laws and regulations, including widespread adoption of state laws addressing groundwater quality and water conservation.
- Authority for groundwater oversight and enforcement resides with both state and local agencies for the majority of states. The activities of groundwater management agencies are funded predominately by the state general fund and user fees.
- In most states, groundwater regulations apply to a broad set of users although regulations differ based on the type of water user. Most states encourage the use of voluntary measures for addressing groundwater issues.
- The top three state groundwater governance priorities include: water quality/contamination; conflicts between water users; and declining groundwater levels.

Groundwater law

Some 96% of survey respondents report that there *are* formal groundwater policies, rules, or regulations in their state. *See Appendix B for a complete listing of reported formal groundwater policies, rules or regulations for each state.*

A majority of states also highlight change in groundwater law and regulation. When asked if they have observed substantial changes in how groundwater is managed in the state over the past few decades, some 70% of respondents suggest that there has been substantial change in their state. These changes include the following:

- the passage of new legislation
- changes in permitting procedures
- aquifer modeling
- aquifer storage and recovery systems
- more integrated approaches to managing surface and groundwater resources

Survey respondents highlighted the following changes underway in terms of groundwater governance in their state:

“With the passing of the Clean Water Act, Groundwater Protection Act and the Water Resources Protection and Management Act, GW management has been greatly improved over the past 30 years.”

“Evidenced by the rules that have been promulgated over the past 30 years for groundwater protection and remediation; and the rules and policies reflecting increased awareness of water supply issues in the state.”

“Metering of wells required, annual water use reports required (fines for late reports), increased penalties for recurring overpumpers. Most of the major aquifers are modeled. And more conservation planning occurring.”

“More control of agricultural withdrawals.”

“Greater legislative interest in regulating it.”

“Addition of water withdrawal regulations, changes in groundwater quality standards for discharges and clean ups, and drinking water.”

“More interest in preventing contamination from impacting the resource.”

“Through permit decisions, court cases, and laws and regulations, over the past few decades, our state has moved toward fully recognizing and managing surface and groundwater as a single resource.”

“In response to demand for water for oil field industrial use (fracking), the State Engineer has developed policies to allow more timely and efficient distribution of water. Policies include issuance of temporary permits from surface water bodies (predominantly ponds and sloughs) and temporary conversion of irrigation use permits to industrial use permits.”

“Increased use of and reliance on groundwater is starting to cause conflicts between users and impacts on natural resources. Political emphasis on groundwater regulation is increasing, particularly during times of drought.”

See Appendix B for a complete listing of reported changes across all states.

Somewhat more than half (57%) of respondents indicate that there exist programs or settlements addressing international, interstate, or Native American groundwater issues in their states. Respondents point to compacts and agreements as well tribal settlements and

consultations. *See Appendix B for a complete listing of reported programs.* Only 29% of respondents indicate that there are programs or settlements specifically addressing Native American groundwater issues in their states.

Only 49% of respondents indicate that courts are active in groundwater issues in their state. *See Appendix B for a complete listing of court rulings.*

A majority of states (51%) have state laws that explicitly recognize or address the connection between surface water and groundwater. In some states, state law requires the state water plan to recognize the connection between surface and groundwater. In other states, the connection between surface and groundwater applies only for new applications for groundwater rights. Integrated practices are not always statewide, as some states report integrated management in select areas and basins. *See Appendix B for a complete listing of reported state laws recognizing the connection between surface and groundwater.*

Survey results indicate that a significant majority of states, or 90% of state laws, explicitly address groundwater quality. They do so through water-quality and groundwater-quality standards and rules. But a significant majority (71%) of state respondents report that separate agencies deal with water quantity and water quality. *See Appendix B for a complete listing of reported state laws.*

Some 75% of state respondents indicate that there are water conservation regulations applicable to groundwater use in the state law. Fifty-four percent of respondents note that state law considers the water needs of groundwater dependent ecosystems. *See Appendix B for a complete listing of reported state laws.*

Groundwater administration

Most states report that report that groundwater oversight and enforcement resides within both state and local agencies. Some 98% of state respondents report that groundwater oversight and enforcement resides within *state* agencies. At the state level, this primarily involves state environmental and natural resource agencies and departments, water resource boards and departments, and health departments.

In addition, some 67% of respondents indicate that groundwater oversight and enforcement resides with *local* agencies. This primarily involves health and environmental departments, and municipal and county governments.

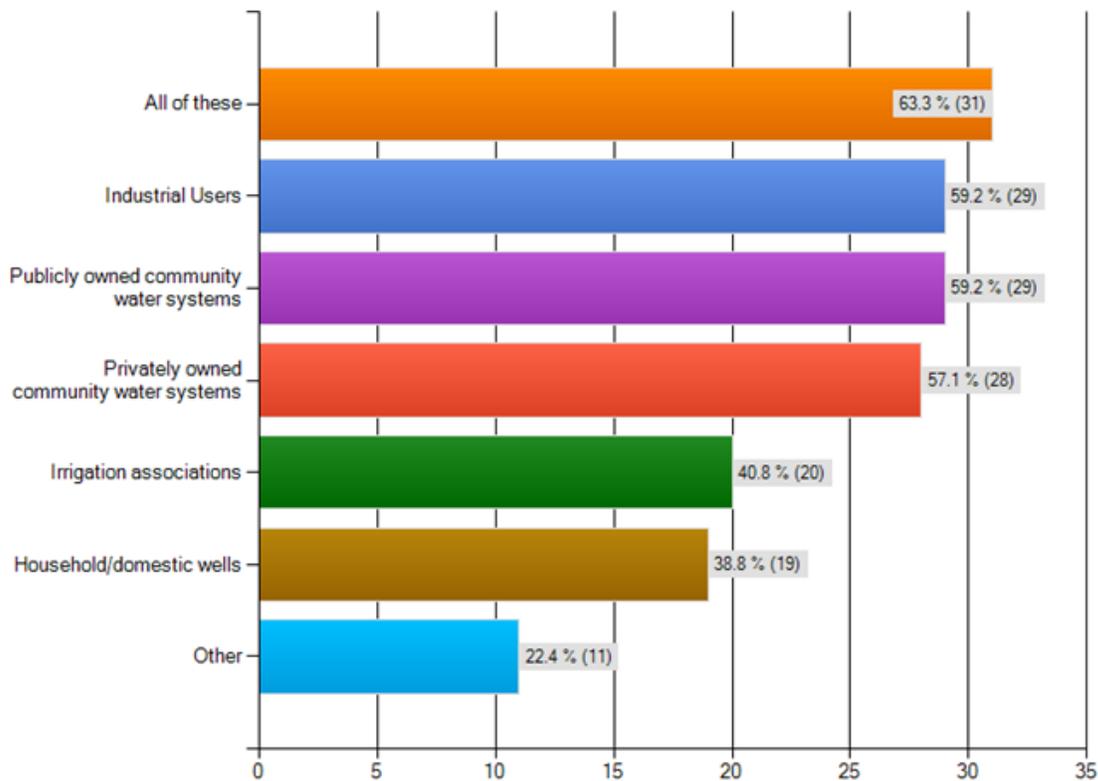
In terms of enforcement authority, just over half (52%) of respondents report that enforcement agencies have sufficient capacity to carry out policies and responsibilities. Of the 48% of respondents who note insufficient capacity to carry out policies and responsibilities, several respondents (10 out of 48, or 21%) point to recent budget cuts and reductions in personnel that have hindered enforcement abilities. Others highlight prioritization practices related to enforcement within their state.

The activities of groundwater management agencies (e.g., permit reviews, monitoring) are funded predominately by the state general fund (86%) and user fees (63%).

Groundwater regulations

In regard to groundwater regulations, survey respondents report that groundwater regulations apply to a broad set of users. These include: household/domestic wells; industrial users; privately owned community water systems (57%); publicly owned community water systems (59%); and irrigation associations. Sixty-three percent of respondents report that all users are subject to regulations.

FIGURE 4: STATES APPLYING GROUNDWATER REGULATIONS TO KEY USER GROUPS



But regulations differ based on the type of water user, according to 76% of our survey respondents. Some users are exempt (e.g., domestic household use). Some users have fewer restrictions (e.g., agriculture). Others face more stringent regulations (e.g., industrial, public drinking water).

Survey respondents highlighted some of the following ways groundwater regulations differ based on type of water user:

“Primarily, our regulatory interest is in aquifer protection, with a strong interest in well registration and management, both for industrial, agricultural, and public supply; not much difference in terms of regulation.”

“Water quality regulations differ among the various water user types. Regulations regarding groundwater withdrawals apply only to large users in certain areas of the State.”

“In regard to water quality, public water supply sources are more tightly regulated than that of private domestic wells.”

“Overall groundwater quality and quantity regulations are consistent for all users, construction standards intended to protect groundwater differ somewhat between potable and non-potable wells.”

“Potable water supply is provided the highest priority of use. State policy allows for the permitting of different volumes depending on specified beneficial use.”

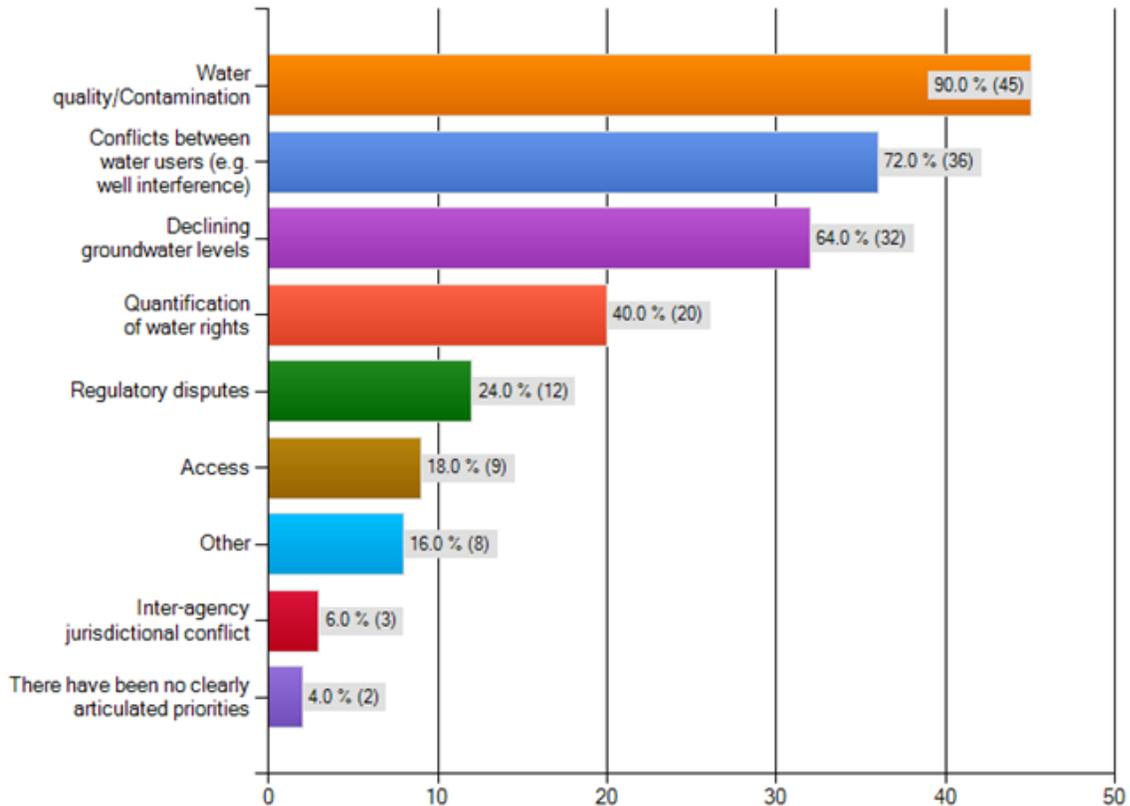
“Only bottled water withdrawals are effectively regulated. Large industrial withdrawals may be regulated if they are associated with a Site Location of Development permit.”

Nearly nine of ten states (88% of respondents) note that their state encourages the use of voluntary measures for addressing groundwater issues. Some of these measures include programs for voluntary onsite contamination cleanup and remediation; planning and program implementation; technical guidance; information and education; water conservation efforts; and wellhead protection and monitoring. *See Appendix B for a complete listing of reported voluntary measures.*

Groundwater governance priorities

States suggest a broad array of groundwater governance priorities. The top three state groundwater governance priorities include: water quality/contamination (90%); conflicts between water users (e.g., well interference) (72%); and declining groundwater levels (64%).

FIGURE 5: STATES ADOPTING GROUNDWATER GOVERNANCE PRIORITIES



PART III: GROUNDWATER TOOLS AND STRATEGIES

Part III of the survey was designed to explore the scope of groundwater tools and strategies.

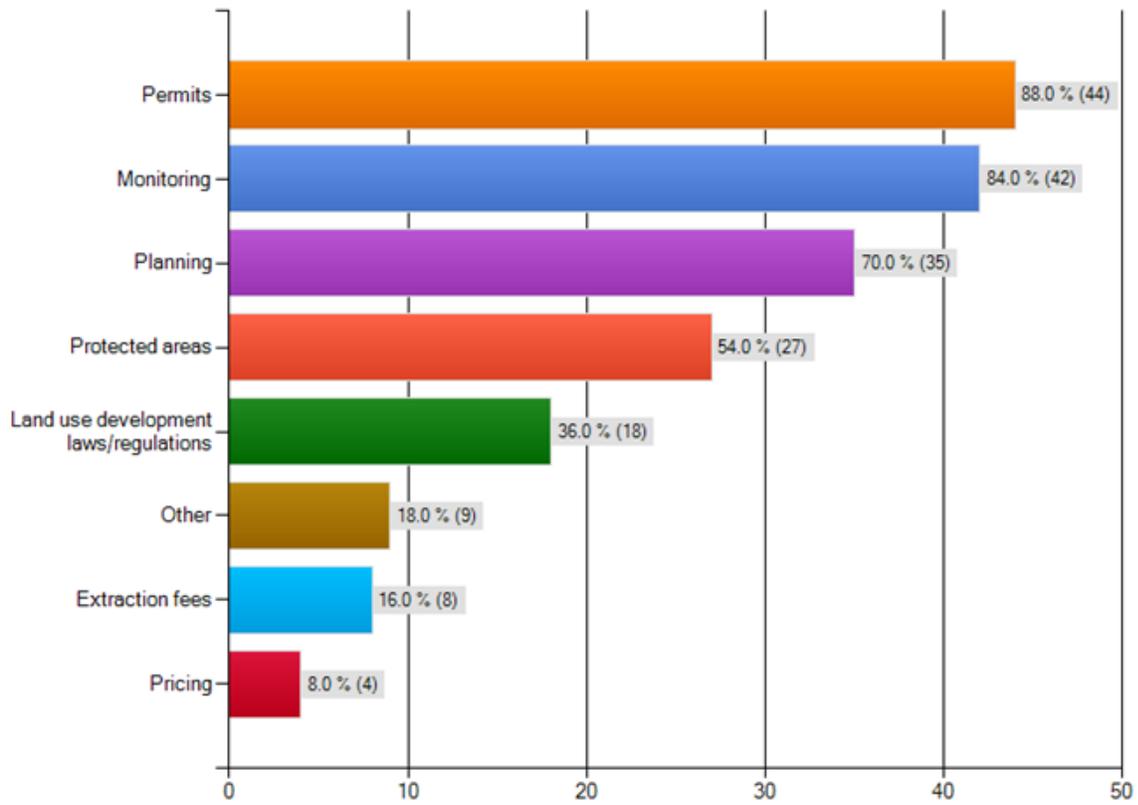
The overall findings suggest:

- Survey respondents indicate reliance on a broad set of tools to manage groundwater use/quantity as well as water quality, including monitoring; permits; planning; and protected areas.
- States report that groundwater use is metered or monitored across a diverse set of sectors, including municipal, industrial, and agricultural. Both groundwater levels and groundwater quality are monitored closely by states.
- States report a diversity of groundwater management strategies. Most notably, public education programs are utilized but states also rely on regional planning or management organizations to support groundwater management strategies.
- Information about water rights of all users is seen as publicly available and accessible in most states, including information about groundwater use and groundwater supplies.

Groundwater management tools

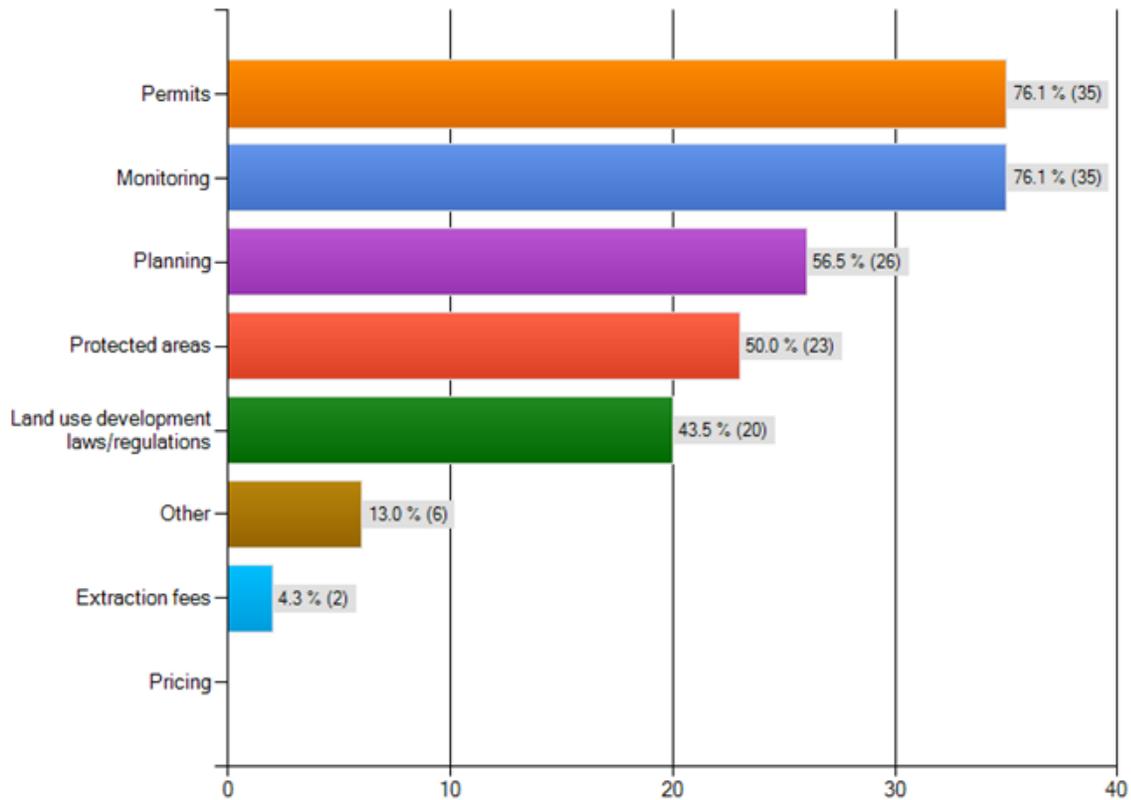
In terms of groundwater tools, most states report reliance on a variety of tools to manage groundwater use/quantity, including monitoring (84%); permits (88%); planning (70%); and protected areas (54%).

FIGURE 6: STATES USING GROUNDWATER MANAGEMENT TOOLS



In terms of managing groundwater quality, states also employ a number of tools similar to those above. A majority of states rely on permits (76%), monitoring (76%), planning (57%), and protected areas (50%).

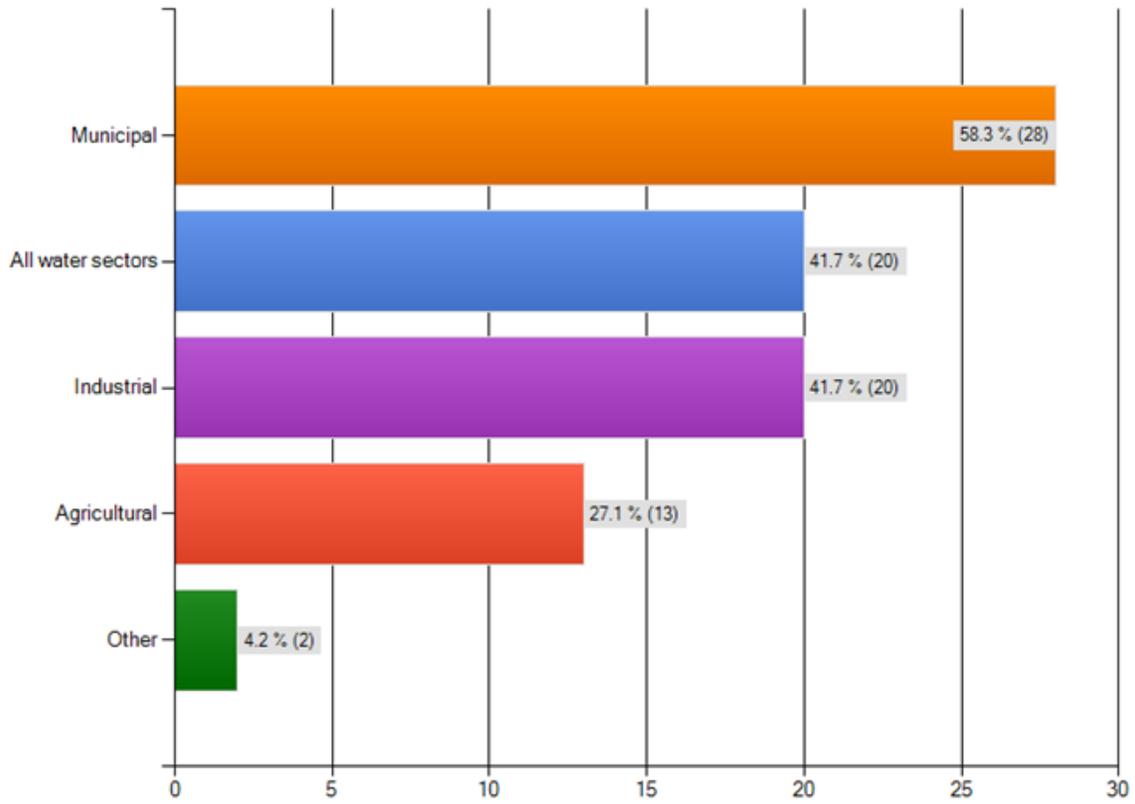
FIGURE 7: STATES EMPLOYING PARTICULAR GROUNDWATER QUALITY MANAGEMENT TOOLS



Groundwater monitoring

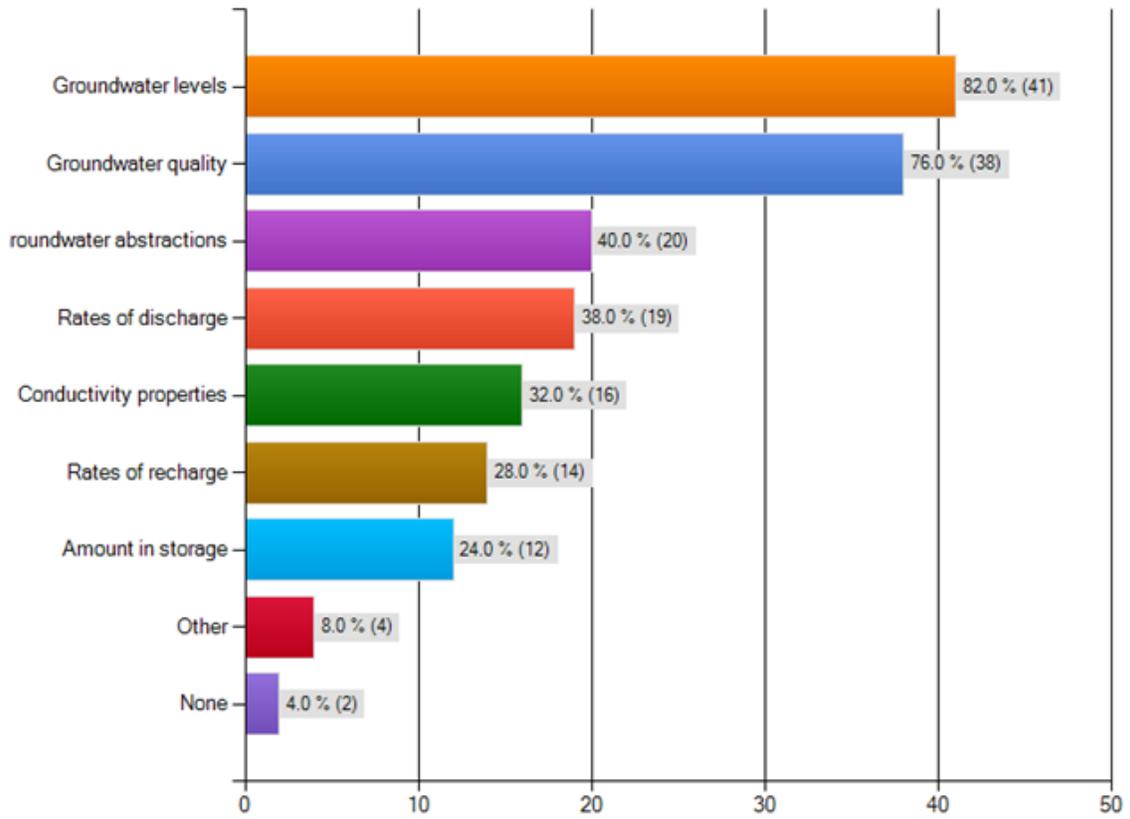
States also report that groundwater use is metered or monitored across a diverse set of sectors, including municipal, industrial, and agricultural. For 42% of respondents, all water sectors are metered or monitored.

FIGURE 8: STATES IN WHICH KEY WATER SECTORS ARE METERED OR MONITORED



States report that many aspects of groundwater are monitored. Groundwater levels and groundwater quality are monitored closely by states, with 82% and 76% of states reporting monitoring, respectively.

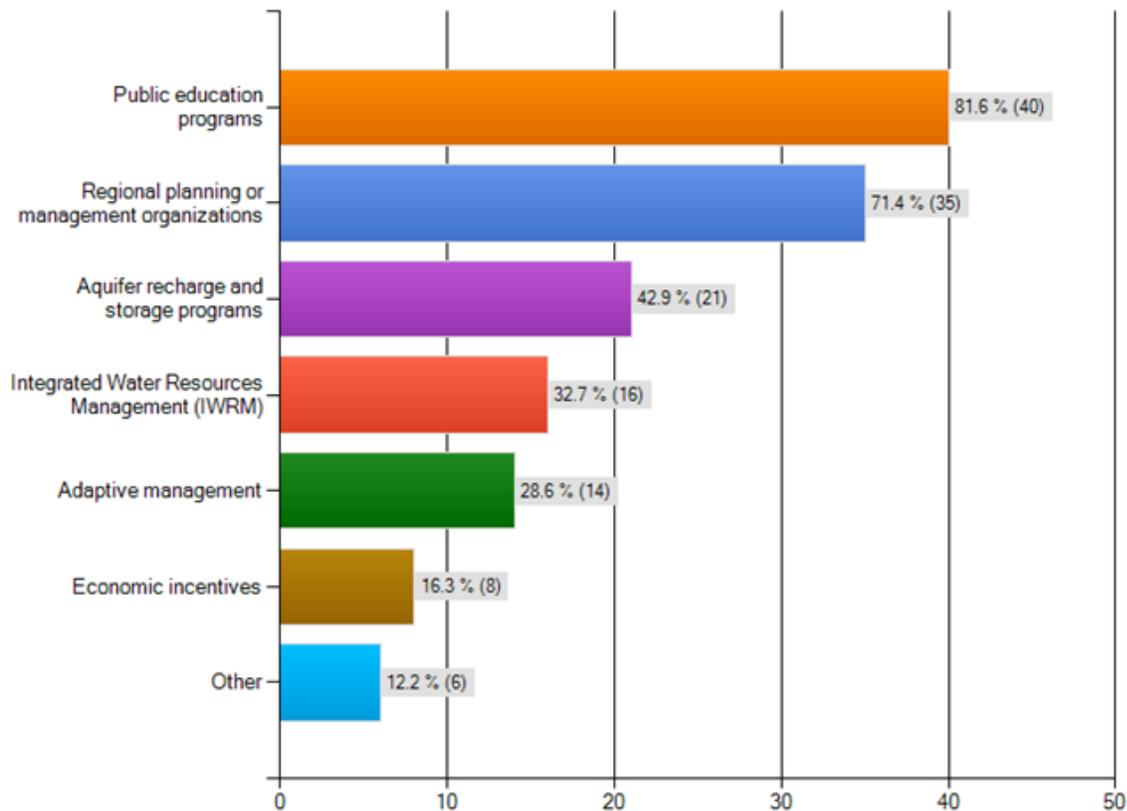
FIGURE 9: STATES MONITORING PARTICULAR GROUNDWATER ISSUES



Groundwater management strategies

Finally, states report a diversity of groundwater management strategies. Public education programs are most popular in terms of state management practices, present in 82% of states surveyed. Regional planning or management organizations are present in 71% of surveyed states.

FIGURE 10: STATES EMPLOYING PARTICULAR GROUNDWATER MANAGEMENT STRATEGIES



Public access to groundwater information

Information about water rights of all users is publicly available, according to 65% of states surveyed.

In terms of information about groundwater resources and rights, 94% of states report that information about groundwater use is publicly available. In addition, 90% of states report that information about groundwater supplies is publicly available.

According to 50% of survey respondents, public access to groundwater information is extremely publicly accessible. Another 50% suggest that groundwater information is somewhat publicly available.

FUTURE DIRECTIONS

The Initial Survey was undertaken to inform the international and national audiences involved in forums such as the GEF Groundwater Governance Project, the World Water Forum, UNESCO's Internationally Shared Aquifer Resources Management Programme, and the Organisation for Economic Co-operation and Development that a picture of water management in the U.S. cannot be painted by a broad brushstroke.

Future directions might entail more in-depth case study analyses to examine state groundwater laws and regulations more fully and to get behind the state-level single brushstroke. It will likely also involve surveying multiple parties from different water sectors in each state to gather perspectives on the performance of the groundwater governance framework to better understand what is working best.

ACKNOWLEDGMENTS

We thank the respondents to this initial survey and Alana T. Duong for legal research assistance. This work was supported by the Technology and Research Initiative Fund, through the University of Arizona Water Sustainability Program and Water Resources Research Center. We also acknowledge the federal Morris K. and Stewart L. Udall Foundation, whose ongoing commitment to the UA Udall Center helped support this effort.

APPENDIX A: SURVEY

U.S. Groundwater Governance Project

Introduction: This is a short questionnaire intended to acquire first-hand knowledge from state agency personnel about your state’s groundwater governance practices, including the institutions and laws involved.

The study aims to describe the state of the practice in the U.S. and produce a national-scale report identifying the range of approaches to groundwater governance.

This questionnaire should take approximately 15 minutes to complete.

Please note: Data or comments obtained in this survey project will not be attributed to particular individuals. Respondents may skip questions, as necessary.

1. Basic Information

State you represent: _____

Name of the agency you represent: _____

Part I: Groundwater Use

1. In an average year, what approximate percentage of total human demands (i.e. domestic, commercial, industrial, and agricultural) are met through use of groundwater supplies in this state?

% of all water withdrawn for human demands in the state that comes from groundwater:

2. Is the importance of groundwater use consistent throughout the state or does it vary by region in terms of relative reliance on groundwater to supply human demands? Check only one.

Reliance is consistent throughout the state

Reliance varies by region

3. Is the proportion of groundwater use by each major groundwater-using water sector consistent throughout the state or does it vary by region? Check only one.

Proportions of use by each sector consistent throughout the state

Proportions of use by each sector varies by region

Part II: Groundwater Laws and Regulations

1. Are there formal groundwater policies, rules, or regulations in the state?

_Yes

_No

Please provide names and dates of relevant statute/rule(s):

2. Have you observed substantial changes in how groundwater is managed in the state over the past few decades?

_Yes

_No

Please explain: _____

3. In what agencies do authorities for groundwater oversight/enforcement reside? Please list all.

Local agencies: _____

State agencies: _____

4. Do separate agencies deal with water quantity and water quality? Yes ___ No ___

5. What are the state's groundwater governance priorities? Check all that apply.

_Declining groundwater levels

_Conflicts between water users (e.g. well interference)

_Access

_Quantification of water rights

_Water quality/Contamination

_Regulatory disputes

_Inter-agency jurisdictional conflict

_There have been no clearly articulated priorities

_Other

6. Are there programs or settlements addressing international, interstate or Native American groundwater issues in the state?

_Yes

_No

Please explain: _____

7. Are there programs or settlements addressing Native American groundwater issues in the state?

_Yes

_No

Please explain: _____

8. Are there water conservation regulations applicable to groundwater use in the state law?

_Yes

_No

Please provide names and dates of relevant statute(s): _____

9. Does state law explicitly recognize or address the connection between surface water and groundwater?

_Yes

_No

If yes, how? Please provide names and dates of relevant statute(s):

10. Does state law explicitly address groundwater quality?

_Yes

_No

If yes, how? Please provide names and dates of relevant statute(s):

11. Does state law consider the water needs of groundwater dependent ecosystems?

_Yes

_No

If yes, how? Please provide names and dates of relevant statute(s):

12. Do enforcement agencies have sufficient capacity to carry out policies and responsibilities?

_Yes

_No

Comments: _____

13. Are the courts active in groundwater issues in the state?

_Yes

_No

Please list relevant court decisions: _____

14. To which of the following user groups do groundwater regulations apply? Check all that apply.

_Household/domestic wells

_Industrial Users

_Privately owned community water systems

_Publicly owned community water systems

_Irrigation associations

_All of these

_Other

15. Do regulations differ for each water user types listed above (e.g. municipal use vs. irrigation)?

_Yes

_No

If yes, please explain: _____

16. Does your state encourage the use of voluntary measures for addressing groundwater issues?

_Yes

_No

If yes, please explain: _____

Part III: Groundwater Tools and Strategies

1. Which tools do the state use to manage groundwater use/quantity? Check all that apply.

_Permits

_Planning

_Land use development laws/regulations

_Protected areas

_Pricing

_Extraction fees

Monitoring

Other

2. For which water sectors is groundwater use metered or monitored? Check all that apply.

All water sectors

Municipal

Industrial

Agricultural

Other

3. What aspects of groundwater are monitored? Check all that apply.

Groundwater levels

Groundwater abstractions

Amount in storage

Conductivity properties

Groundwater quality

Rates of recharge

Rates of discharge

Other

None

4. Which tools does the state use to manage groundwater quality? Check all that apply.

Permits

Planning

Land use development laws/regulations

Protected areas

Pricing

Extraction fees

Monitoring

Other

5. How are the activities of groundwater management agencies (e.g. permit reviews, monitoring) funded? Check all that apply.

User fees

- Taxes
- State general fund
- Mitigation fees
- Other

6. How widely is information about groundwater resources and rights reported? Check all that apply.

- Information about groundwater supplies is publicly available
- Information about groundwater use is publicly available
- Information about water rights of all users is publicly available
- Information about groundwater supplies is provided directly to water users
- Information about groundwater use is provided directly to water users
- Information about water rights of all users is provided directly to water users
- Information about groundwater resources and water rights including access to water rights registers is not reported

7. To what extent is groundwater information publicly accessible?

- Extremely accessible
- Somewhat accessible
- Not publicly accessible at all

8. In your state, are any of these groundwater management strategies in use? Check all that apply.

- Integrated Water Resources Management (IWRM)
- Aquifer recharge and storage programs
- Regional planning or management organizations
- Economic incentives
- Adaptive management
- Public education programs
- Other

Part IV: Future Research and Contacts

1. Contact information (optional)

Your name (optional) _____

Telephone (optional) _____

Email (optional) _____

2. May we contact you with additional questions in the future?

Yes__

No__

3. Please indicate which of the following categories best describes your professional title.

_Engineer

_Economist

_Planner

_Mid-level administrator

_Manager

_Political appointee/Director

_Researcher/Academic

_Lawyer

_Other (please specify)

Thank you for taking our survey!