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An Internet for Water: Connecting Texas Water Data

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Foreword by Editor Robert E. Mace: As a hydrogeologist in Texas, I have been spoiled. At my fingertips, for as long as I can remember, was the Texas Water Development Board's (Board) groundwater database. At first, I had to visit the Board in person to access its data via a terminal. Then the data was available through the internet. As a researcher, the database allowed me to quickly access information to efficiently advance my understanding of our state's aquifers. The database also allowed others to quickly assess meeting their groundwater needs, understanding the implications of contamination events, and determining long-term groundwater availability trends. Most states do not have such a treasure trove of data. Phil Nordstrom, Janie Hopkins, and Bryan Anderson—keepers of this data for the past 30 plus years—are true heroes of data availability and accessibility.

Unfortunately, unlike the Board's groundwater database, all water data isn't FAIR: Findable, Accessible, Interoperable, and Reusable (and even here, the Board's groundwater database could use enhancements in interoperability). Today's world moves fast; accordingly, it demands fast answers. And fast answers require accessible data. This paper by Rosen and others presents the outcomes from a workshop on creating a Texas water hub where digital water data is freely available and easily accessible. Attendees agreed that there's a need for a Texas water hub and many reasons to have one—for example, see the massive data needs for the emergency response to Hurricane Harvey.

Fortunately, work on developing a Texas water hub will continue. The Meadows Center for Water and the Environment, with support from the Mitchell Foundation, is working with stakeholders to address the recommendations of this workshop included in this paper. As Director Kathleen Jackson of the Texas Water Development Board, a keynote speaker at the workshop, astutely noted: "The better the data, the better the science. And the better the science, the better the policy."

It's time for all of us to get on board—and get our data online.

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Abstract: The Connecting Texas Water Data Workshop brought together experts representative of Texas' water sectors to engage in the identification of critical water data needs and to discuss the design of a data system that facilitates access to and the use of public water data in Texas. Workshop participants identified "use cases" that list data gaps, needs, and uses for water data and answered questions on who needs data, what data do they need, in what form do they need the data, and what decisions need to be made about water in Texas. They described desires for future water data management and access practices and articulated key attributes of a comprehensive, open access, public water data information system. Next, steps were described to include a subset of workshop participants meeting regularly to further define the goals of a Texas public water data hub, develop a straw-man of the hub's structure, characterize several use cases, and facilitate development of pilot projects that demonstrate the value of connected public water data for improved decision making.

Keywords: public water data, Texas water, internet of water, water management, water data management

Terms used in paper

Acronyms	Descriptive name
GAM	groundwater availability model
WAM	water availability model
TACC	Texas Advanced Computing Center
TWDB	Texas Water Development Board

INTRODUCTION

In many areas of Texas where the human population is growing rapidly, major water-related concerns are growing as well. Water availability and use are affected by frequent droughts in some areas, flooding in others, and multiple human-caused events such as the introduction of pollutants. The consequences of these events can limit overall economic growth, business development, agricultural productivity, ecosystem health, and the stability of communities. Pressure is placed on public officials to protect against adverse consequences and on water managers to limit the pollution of our waterways and ensure continued access to dependable supplies of safe water. While several public agencies collect vast amounts of data to support decision-making around our water resources, too often that data is either inaccessible or unusable. This leaves Texas' decision-makers, industries, landowners, and communities with significant amounts of data of limited use to support real-time decision-making, development of opportunities for water security, or for modeling an accurate picture of Texas' water future. Making better decisions about water will require more data, better data, better access to data, and data that can be universally used (interoperable) through open and transparent public data systems, where data are presented in ways that are relevant to the needs of decision-makers and the public.

Texas water experts explored building an "internet" for Texas water data at the Connecting Texas Water Data Workshop held on April 17, 2018, at the Texas Advanced Computing Center (TACC) located at the University of Texas in Austin. While most states have one or more public agencies known for collecting and supplying water data, advancement of an internet of water acknowledges a need to gain open access to much larger amounts of water data currently inaccessible or in non-interoperable formats held by all public sources. What is meant by this term, "internet of water," is a water-information focused interconnected network and network of networks linking and providing access to devices holding water data by an array of electronic and wireless technologies. The workshop brought together almost 90 invited experts representative of Texas' government and water agencies, utilities, academia, businesses, industries, research institutes, water associations, and advocacy organizations. A comprehensive report of the workshop details the proceedings (Rosen and Roberts 2018). This program review presents a summary of the key findings.

METHODS

Workshop participants received background information about recent efforts on the internet of water (Patterson et al. 2017; Cantor et al. 2018) and Texas water data security (Rosen et al. 2017) in advance of the workshop. In addition to receiving advanced information, a portion of workshop participants met on the day immediately preceding the Connecting Texas Water Data Workshop in a roundtable discussion on the topic of "advancing the internet of water" in Texas. The roundtable was held by the Aspen Institute Dialogue Series on Sharing and Integrating Water Data for Sustainability.

On the following day all participants in the Connecting Texas Water Data Workshop met together and heard a series of plenary presentations on data access in Texas. They also worked in small groups in six concurrently held facilitated sessions and participated in plenary discussions. They worked together to address four predetermined objectives:

1. Identify specific "use cases" that list data gaps, needs, and uses for water data, and answer questions on (a) who needs data, (b) what data do they need, (c) what form do they need the data in, and (d) what decisions need to be made about water in Texas.
2. Describe desires for future water data management and access practices.
3. Articulate key attributes of a comprehensive, open access, public water data information system.
4. Inform next steps to further define, design, and build a public water data system for Texas.

A post-workshop survey allowed participants to enhance and add to information provided during the workshop.

Figure 1. Responses to the question "Who needs data?". Size of each word indicates the frequency of mention in the reporting of the workgroups.

RESULTS

Who needs what water data, in what form, to inform decisions

Participants provided over 60 different responses to the question, "who needs water data?". Answers ranged from "everyone" to specific water decision-makers, such as the "National Weather Service." The relative frequency of listing of who needs water data is described using a word cloud (Figure 1), where the size of words indicates the frequency of mention in the reporting by participant workgroups.

To help draw meaningful connections, we diagrammed how many workgroups mentioned users associated with major categories of use, such as for "agriculture," and also added specific user groups, such as "engineers" and "first responders" that workshop participants associated with those categories (Figure 2). The connection between all water users is indicated by the center circle, with different terms listed in the circle used by the six workgroups that point to "everyone." Note that the general technical professions, "resource managers, engineers, planners, and consultants," were mentioned as "who needs water data" in virtually every category of use.

Participants listed over 60 different "kinds of water data needed," with some kinds of data being subcategories of others (Figure 3). Several categories of needed data were mentioned repeatedly by the workgroups including "soil moisture, stream flow, water rights, water use, and water quality."

The next question to participants focused on the form of data needed. While there were over 50 descriptions of the form of data needed, two stood out. These were "raw data and metadata." The terms were mentioned most frequently, with many other terms used to describe various degrees of open data, accessible data, usable data, free data, and standardized data (Figure 4).

Figure 2. Responses to the question "Who needs data?" aggregated by users associated with each major use category. (Large circle noted by six workgroups, medium by three to four, and small by one to two workgroups.)

Participants were then asked to describe the purposes for which data are most needed. There were about 50 different responses with very little overlap. A wide diversity of interests of participants is not surprising given the wide variety of purposes for which data are needed and the situational, geographic, and temporal variability of water-related decisions. Responses ranged from general purposes, such as understanding how much water a person uses or how clean one's water is, to highly technical purposes, such as making flood risk determinations and updating water availability models. All recommendations are available for review in the workshop detailed summary (Rosen and Roberts 2018).

Narrowing the questions still further, participants in the workgroups were asked to describe gaps in water data that need to be filled. Not all workgroups listed gaps, but the data gaps that were noted provide insight into where more data are needed both now and for the future. Data gaps described can be grouped into (1) access to and integration of data, (2) availability due to insufficient amounts of data or lack of any data at all, and (3) specific kinds of data. These categories are listed in Figure 5.

Use cases

Participants were asked to identify potential "use cases" that may serve as ready models to inform development of open data systems. A use case is a short summary organizing, in a concise and consistent format, the data gaps, needs, uses, users, regulatory requirements, and workflow for a particular objective (BerkeleyLaw 2017; See Appendix VIII, Rosen and Roberts 2018). Use cases serve as a tool for organizing and assessing stakeholder data needs and for communicating those needs to decision-makers.

Participants identified 35 potential use cases (Rosen and Roberts 2018). Several major categories of suggested use cases emerged. Major categories were (1) groundwater, (2) water rights, and (3) event planning, which included two subcategories: (a) drought planning and (b) flood planning (Figure 6).

Five of the six workgroups arrived at consensus on a single use case each to recommend for potential future development. All five of these use cases focus heavily on data needs for water use and management, including environmental management. Those use cases involve technical water database management

Figure 3. Responses to the question "What kind of data are needed?".

as well as socio-economic and policy challenges. Those five use cases are:

1. water utility reporting to the Texas Water Development Board (TWDB);
2. environmental flow transactions;
3. flood water management in ephemeral streams;
4. integration and updating of the Texas water availability models (WAM) and groundwater availability models (GAM); and
5. risk management of the probability of reservoir water supplies falling below target criteria at three, six, nine, and 12 months.

CONCLUSIONS AND RECOMMENDATIONS

The ideal data system

The ideal public water data system was described by participants as a series of integrated data hubs or nodes—with more added over time—specialized by water sector and application (i.e., ranging from expert to general water stakeholders), with incentives for adding data into the hubs. Participants concluded that the most critical data to be included in an open data system are (1) raw data or data as close to raw data as possible, and (2) metadata. Such data may also be among the most difficult to access in general without an open system due to the likelihood of such data being proprietary or difficulties in readily accessing the data due to matters of interoperability or quantity.

Data needed by the full diversity of users must be easily accessible and interoperable to serve a wide variety of user needs. This includes needs for data at various geographic, spatial, and temporal scales, and in formats that conform to standards generally employed by the various users of data. Participants also identified qualities of data essential to ensuring data usefulness, such as data being findable, accessible, universally usable, and reusable. They suggested these qualities must exist in the ideal water data system.

Following the workshop, participants were asked to refine their recommendations for open public data hubs by responding to a survey question asking them to describe the ideal hosting option for such hubs. Respondents were almost evenly split in recommending as host (1) a Texas state agency, (2) a consortium of Texas state agencies and universities, and (3) a consortium of Texas state agencies, universities, and the private sector.

Imagine the future

Participants described a vision for the ideal public water data system for Texas as one with open access that includes an ability to obtain available water data, including raw data, metadata, and legacy data, in a digitized form. The data system should be user-friendly and robust, and provide real-time information using web services with source information and built-in visualization tools that allow experts and non-experts alike to use the system. Data and information should be free, and should be created and kept in consistent reporting formats so that data can "talk to each other" as users search and gain access. The ideal form of public data system is envisioned as consisting of several integrated data hubs specialized by water sector, with incentives for people to add new data and share existing data through the hubs. There should be adequate funding to sustain the data system over time.

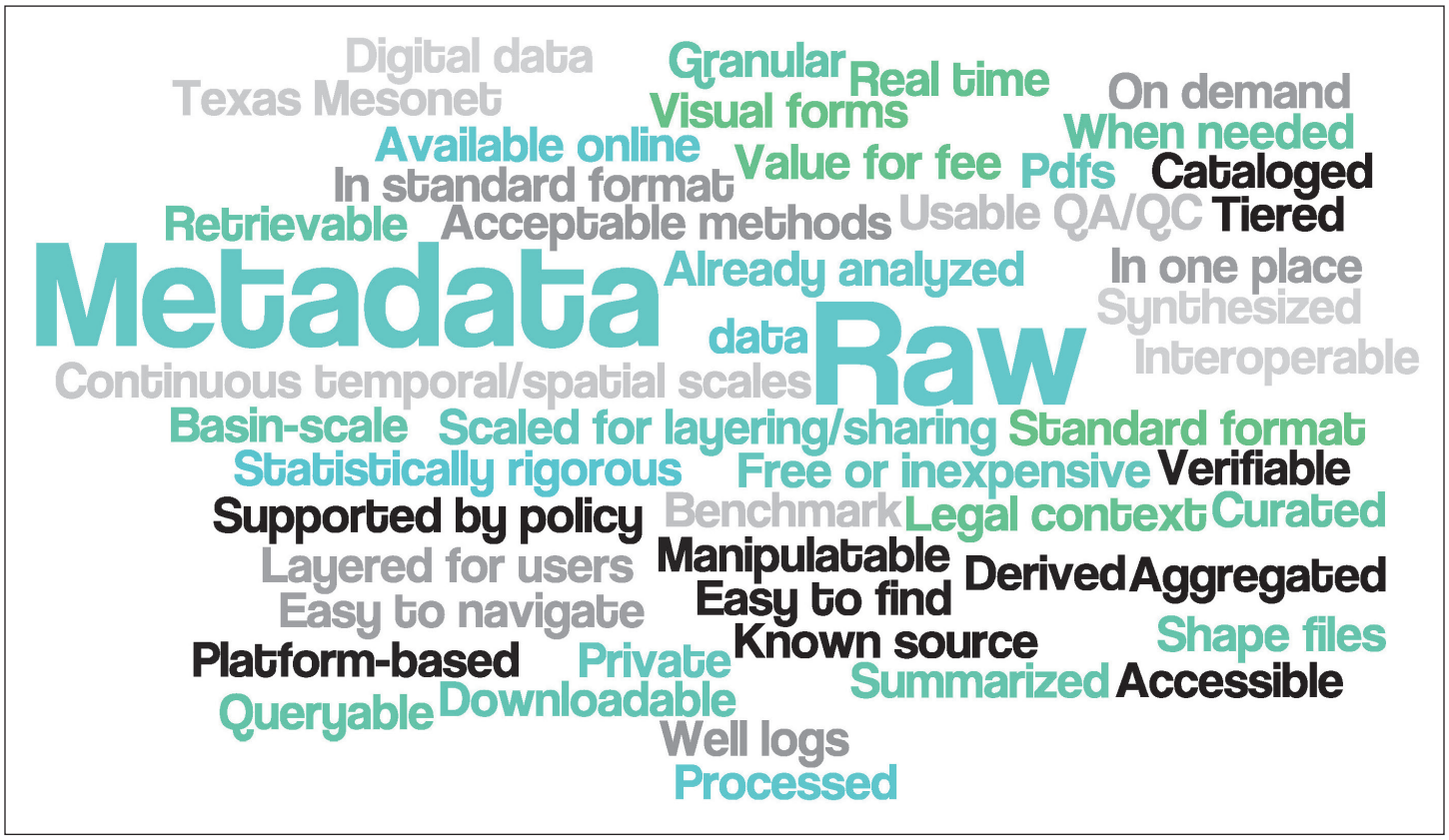

Figure 4. Responses to the question "What form of data is most needed?".

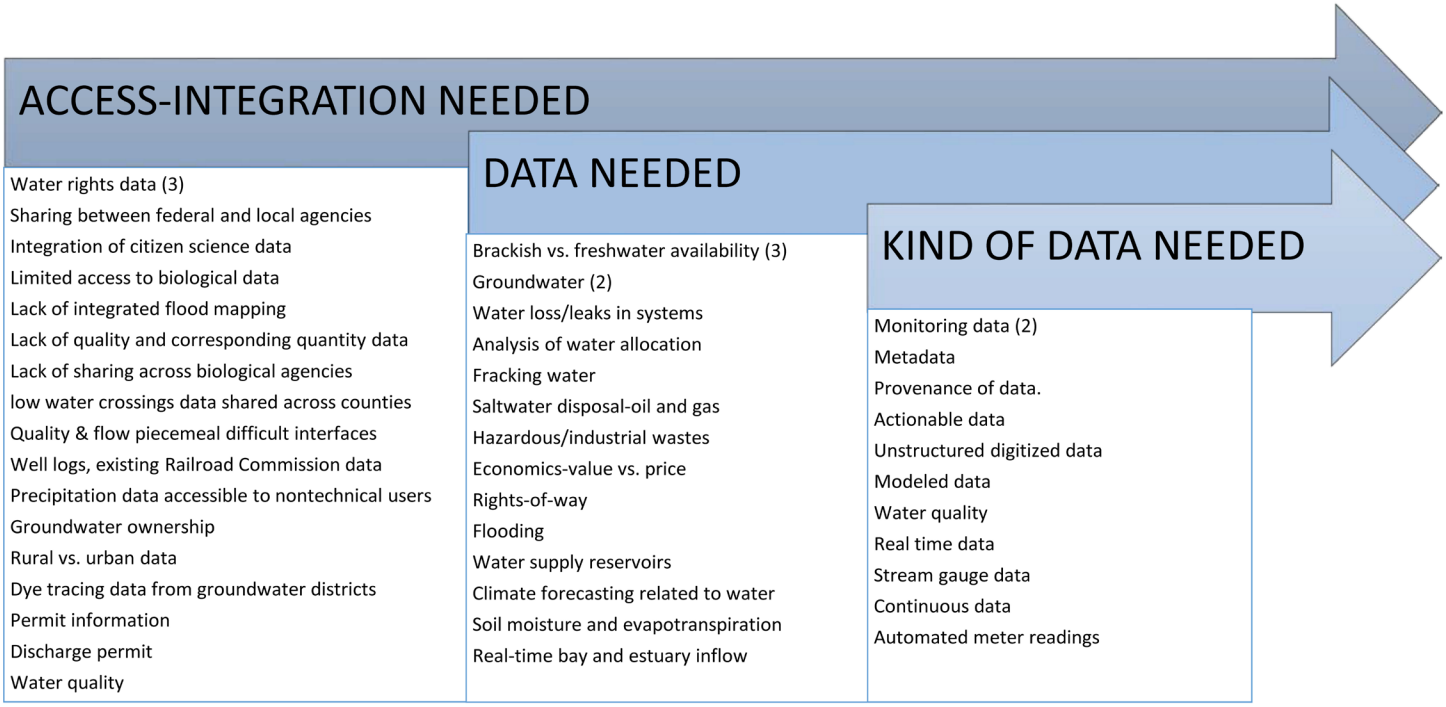

Figure 5. Data gaps arranged by category.

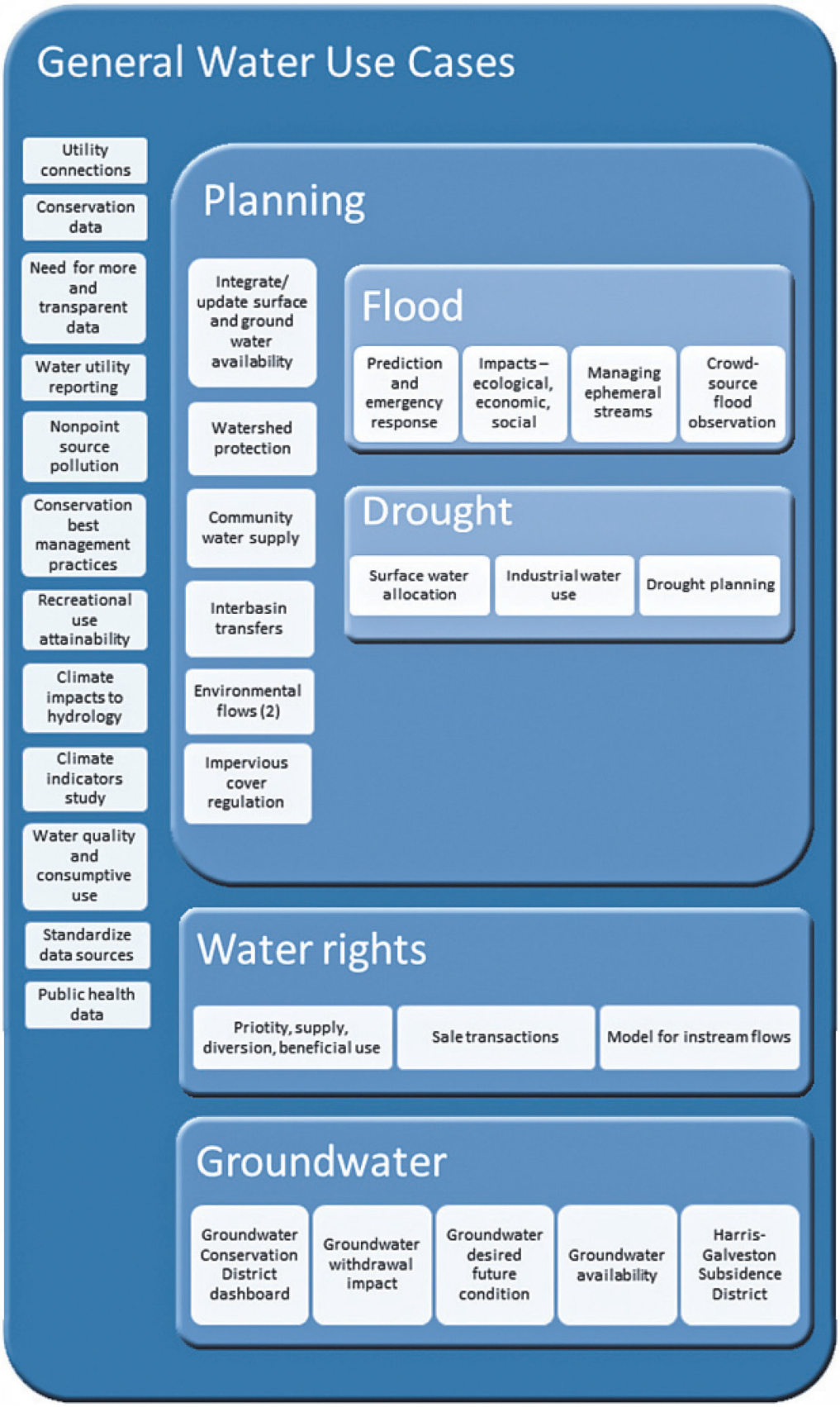

Figure 6. Use cases by categories and subcategories.

Next steps

Participants provided a list of next steps for connecting Texas data. There was considerable excitement among participants when developing this final—and perhaps most direct action-focused—part of the workshop. Key takeaways included strong support for and consensus around the need for and value of a Texas public water data hub to exist; deep commitment to the belief that Texas public water data should be FAIR: F – Findable, A – Accessible, I – Interoperable, and R – Reusable, and; continued engagement with water stakeholders in the development of a Texas public water data hub is needed.

Following from these conclusions, the group recommended that a subset of workshop participants meet regularly to further define the goals of a Texas public water data hub, develop a strawman of the hub's structure, characterize several use cases of primary interest to decision-makers and the public, and facilitate the development of pilot projects that demonstrate the value of connected water data for improved decision-making.

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