Institutional Assessment of the Transboundary Santa Cruz and San Pedro Aquifers on the United States-Mexico Border:
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ABSTRACT

Shared, transboundary aquifers along the U.S.-Mexico international boundary are subject to unsustainable levels of water use and water-quality degradation resulting from rapid urban growth as well as climate change and variability. The Upper Santa Cruz and Upper San Pedro alluvial aquifers, shared by the states of Arizona, U.S. and Sonora, Mexico are essential water sources for growing cities, communities, farms, and ecosystems on both sides of the border. The U.S.-Mexico Transboundary Aquifer Assessment Act, as authorized in the U.S. as Public Law 109-448, was signed in December 2006. Continuity of programmatic and funding support for transboundary aquifer assessment is essential to collaborative initiatives. Authorities in Mexico support this initiative to collaborate on scientific assessment; however, in Mexico no similar legislation has yet been passed, given that law-making follows its own process. In the U.S., a university – federal agency partnership leads aquifer assessment activities, and prioritizes aquifers on a case-by-case basis. By contrast, in Mexico, the procedure begins at the National Water Commission, which coordinates the activities of state agencies and municipal water utilities, with university researchers playing a support role. Additional institutional complexities include the varying roles of the U.S.-Mexico International Boundary and Water Commission; the U.S. Section works to facilitate coordination and the Mexican Section sets priorities and makes decisions. A specialized binational framework for coordination and data exchange has been developed and agreed upon specifically for the binational aquifer assessment. The investment made to establish this framework has resulted in the commitment to a long-term partnership, a better understanding of transboundary aquifers, and better management of shared aquifer resources.

Key Words: groundwater management, institutions, policy, asymmetry

1.1 Introduction

Growing demands for water along with climate change and variability are placing significant stresses on aquifers along the U.S.-Mexico boundary. Recognizing the associated challenges, the United States Congress passed the U.S.-Mexico Transboundary Aquifer Assessment Act (Public Law 109-448) in late 2006 to further the assessment of "priority" shared aquifers as specified in the Act. Four were designated by the Act for study on the U.S. side: the Mesilla and Hueco Bolson aquifers along the Texas-Chihuahua and New Mexico-Chihuahua borders, and at the Arizona-Sonora border, the Upper Santa Cruz and Upper San Pedro aquifers. Beginning in 2007, academics, federal agency representatives, and officials from Arizona, New Mexico, and Texas on the U.S. side and from Sonora and Chihuahua on the Mexican side have been working collaboratively. For the Arizona-Sonora border region, these collaborative efforts have resulted in designation of the Santa Cruz and San Pedro aquifers as priority aquifers for assessment by Mexico as well. Similar developments are underway between Texas, New Mexico, and Chihuahua.

Institutional factors have been important variables in the efforts to establish a truly binational, collaborative strategy to perform the assessments required and provide the information needed for sound management of these transboundary aquifers. This paper examines some key factors that have enabled the governmental and university partners to initiate significant, multi-year assessment activities despite limited funding.

1.2 The Setting

The location of the Santa Cruz and San Pedro aquifers are shown in Figures 1 and 2. The region known as Ambos Nogales (Nogales, Arizona, and Nogales, Sonora) is the center of economic activity and water use for the Santa Cruz aquifer. The centers of economic activity for the San Pedro Aquifers are located in Cananea on the Mexican side and in the Sierra Vista-Fort Huachuca area on the U.S. side, which are separated by about 60 kilometers. While water-use decision-making at the local level is based in these urban centers, it is important to recognize the influence exerted by institutions at the state, federal, and binational levels.

Figure 1. Location of the Santa Cruz and San Pedro Aquifers on the U.S.-Mexico Border

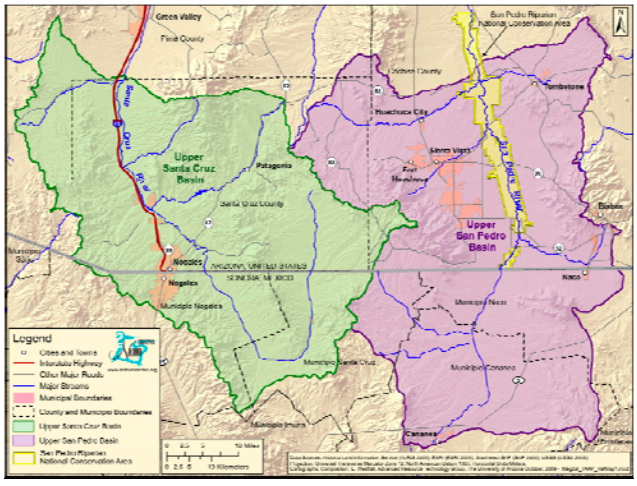

Figure 2. Detailed Map of the Santa Cruz and San Pedro Aquifers

Figure 2 shows the aquifer regions in more detail. The course of the Santa Cruz River is unusual in that it originates in Arizona, flows south into Sonora, and then flows back north into Arizona, where it meanders, dissipates, and ultimately its waters join the Gila River in Central Arizona. This Gila is also joined by the San Pedro, and ultimately flows to the Colorado River, emptying into the Sea of Cortez. The flows of the Santa Cruz River in the border area are ephemeral, occurring in direct response to precipitation events, with significant flooding events posing risks for human populations, property, and ecosystems (Norman et al., 2010). The other major and more constant source of flow is the Nogales International Wastewater Treatment Plant (NIWTP), which is located 16 km north of the border and is operated by the U.S. Section of the International Boundary and Water Commission (IBWC). Nogales, Sonora, is a much larger community than Nogales, Arizona, and so wastewater from the Mexican side accounts for approximately two-thirds of influent received by the NIWTP. Discharge from the plant, equaling approximately 17.3 MCM (million cubic meter) per year flows northward creating an "effluent-dominated" reach of the Santa Cruz River for approximately 20 km downstream (NIWTP, 2005). The economy of Nogales, Sonora, relies on maquiladoras (foreign-owned manufacturing plants) and general commerce. The border is a busy crossing for trucks with fresh produce and maquiladora-produced components.

The San Pedro River, some 100 km to the east of the Santa Cruz River, flows north from Sonora into Arizona. The Mexican town of Cananea, at the source, is the site of one of the largest copper mines in North America, which from 2007 to 2010 was idled due to a strike. The economic activity of the Sierra Vista-Fort Huachuca area centers on Fort Huachuca, a major U.S. Army base, as well as ecotourism. Sierra Vista's picturesque and climatically favorable location is also popular among retirees. The San Pedro River supports a rich riparian habitat that on the U.S. side is a National Conservation Area. The river is a key to the area's identity, and to help preserve it, members of governmental, environmental, and business organizations created the Upper San Pedro Partnership (USPP), a regional watershed association. The USPP has been tasked by the U.S. government to achieve sustainable yield of the regional aquifer by 2011.

Over the past two decades both regions have experienced population growth and expansion of economic activity, which are placing additional strains on the respective aquifers. Water management in the Santa Cruz aquifer is challenged by the existence of shallow "microbasins" in some of the most heavily used portions of the aquifer, which experience annual water levels fluctuations of up to 15 m, thereby limiting groundwater storage capacity. Climate change and variability only add to the complexities of water management for both aquifer regions, which are predicted to become hotter. Precipitation projections vary among climate models (and for the same model, according to different carbon emissions scenarios. This is partly due to uncertainty with the behavior of the North American Monsoon that strongly influences the pattern of precipitation. There is general agreement that better information and analysis are essential to developing water management strategies for these transboundary aquifers. As core members of the Arizona-Sonora group leading the effort to establish the institutional mechanisms necessary for conducting binational investigations and analyses, we have developed what we think is an effective framework for making significant progress, provided sufficient funding is available.

1.3 Institutional Asymmetries and the Roles of the Federal Agencies

The U.S. Geological Survey (USGS) is the lead U.S. federal government agency to carry out provisions of the U.S.-Mexico Transboundary Aquifer Assessment Act in the U.S. portions of the

binational aquifers identified for assessment. Mexico, for its part, relies on the National Water Commission (CONAGUA, by its Spanish acronym), part of the federal executive branch charged with authority over, and administrative responsibility for, the nation's waters, to lead the scientific and technical activities associated with binational aquifer assessment. The law stipulates that the USGS work in partnership with federally recognized water centers located at public universities in each of the participating U.S. states,[1] with appropriated funding divided equally between the USGS and the university partners. The university water centers may distribute their funding to collaborators, including partners in Mexico, and the Act specified that the International Boundary and Water Commission would be consulted "as appropriate".

The partners have had to work through two major asymmetries associated with the federal legislation. First, the legislation itself pertains only to the United States. Though the Act specified four priority aquifers, the U.S. Congress could not require concurrence from Mexico regarding priority aquifers for binational assessment, nor could it mandate Mexican financial participation. It did include a requirement that any U.S funding expended in Mexico required a one-to-one match from Mexican partners, with either cash or in-kind services being an acceptable match.

The other major asymmetry relates to the roles of the federal water agencies, particularly the IBWC U.S. Section and the Mexican Section of the same binational commission, known by its name in Spanish, the Comisión Internacional de Límites y Aguas (CILA). In the U.S., water management is highly decentralized. U.S. federal water agencies have less oversight of regional water volumes and pumping than do the states, particularly in terms of groundwater, even though federal authorities regulate water quality. Additionally, the IBWC U.S. Section has had limited involvement in transboundary groundwater matters. USGS, the designated federal participant in this Act, is not a regulatory agency, but a scientific agency of the U.S. Department of the Interior. It has long-term experience researching groundwater occurrence and quality, and working with university personnel across the country. In Mexico, on the other hand, water regulation is highly centralized. CONAGUA, part of the Ministry of the Environment and Natural Resources, coordinates the activities of state agencies and municipal water utilities and conducts or coordinates water-related research throughout the country. CILA has major federal responsibilities for groundwater and surface water at the border, and only at the border. Priority-setting and decision-making for the Mexican elements of transboundary aquifer assessment have been vested in CILA. CILA, which is a branch of the Mexican ministry of foreign affairs, has requested that all transboundary aquifer assessment activities be coordinated through the diplomatic channels usually employed for IBWC-CILA water matters. The legislation clearly established the Department of Interior as the lead federal department for the U.S., with the IBWC U.S. Section playing a consultative role. However, the primary role assigned to CILA Mexican Section by the Mexican government regarding transboundary waters, along with diplomatic considerations, has put the IBWC U.S. Section in a central coordinating position.

In order to facilitate binational progress, after considerable negotiation in August 2009, the Principal Engineers for the two IBWC-CILA Sections adopted a Joint Report establishing a cooperative framework for transboundary aquifer assessment. The Joint Report calls for formation of a binational technical advisory committee to oversee the associated work efforts. Development and implementation of official binational work plans will be coordinated through IBWC-CILA, with U.S. funding flowing through both Sections. In addition, IBWC-CILA will be the official repository for the studies, which will be available in both English and Spanish.

[1] For Arizona, the Water Resources Research Center at the University of Arizona is the designated partner.

1.4 Carrying Out a Binational Work Plan

The joint cooperative framework sets out the conditions for pursuing the collaborative approach to establishing a binational work plan of the Arizona and Sonora program participants. From the start, representatives of the major partners in Arizona and Sonora have met regularly to identify priority activities. Field trips have been conducted and bilingual fact sheets were prepared by the University of Arizona team.[2] In November 2009, a binational workshop was held in Tucson, Arizona, to obtain stakeholder input into the work plans for the Santa Cruz and San Pedro aquifers. These work plans serve as the foundation for a long-term binational effort. The University of Arizona team has identified funding under the transboundary aquifer program for work to be conducted in Mexico by researchers at the University of Sonora. CONAGUA and CILA have identified funding to match the U.S. funding for assessment activities to be conducted in Mexico. Currently, scientists are working through detailed work scopes, intergovernmental/interagency agreements, and the terms of reference documents. There are institutional challenges to accomplishing the many steps along the way to binational work. The funding flow is complicated in that U.S. federal funding flows first to USGS, who then shares it with the University of Arizona through an annual grant agreement. The University of Arizona then channels the funding for Mexican work to the IBWC U.S. Section, who then transmits it to the CILA Mexican Section, who finally transfers it to the researchers doing the work in Mexico. In Mexico, CONAGUA funding is passed to CILA, who then contracts with the local scientific experts (the University of Sonora for the San Pedro and Santa Cruz shared aquifers). Each agency/participant has to follow its own protocol for funds transfer and have accountability mechanisms for financial expenditures. Developing agreement language between the agencies involved has entailed several iterations due to complications based on the asymmetries mentioned above, but also due to differing institutional mandates and administrative procedures. Nevertheless, financial resources were transferred from CONAGUA to CILA Mexican Section and this institution is independently in charge of taking necessary actions to handle project funds as required in the first phase of assessment studies. While the specific complexities we describe are unique to the U.S. and Mexico, similar asymmetries and institutional coordination challenges are likely to arise for other transboundary cases.

Significant effort has gone into developing the capacity to do work collaboratively at a foundational level. The effort acknowledges that developing a binational groundwater model is a multi-year process and that groundwater models are only as good as the data on which they rely. It further recognizes challenges of transboundary collaboration. Accordingly, transboundary aquifer assessments proceed on the basis of joint data development on both sides of the border. The scientists will synthesize and analyze existing as well as new data and reports to update the conceptual model of the hydrologic functioning and state of the aquifers (including water quantity and quality), and identify data gaps. Because cross-border hydrologic monitoring is essential and expensive; more than a few months of monitoring will be required to establish an adequate understanding of the average functioning of these aquifers on both seasonal and annual time scales. To understand annual variations, it is anticipated that a minimum of three years of monitoring will be necessary.

In addition to the hydrological studies, the parties expect to undertake socioeconomic and institutional studies as well. This will entail demographic growth projections, assessment of water use in different sectors, and characterization of organizational mandates and functions, as well as institutional and legal assessments related to groundwater management. The U.S. authorizing Act anticipated this to be a long-term investment by authorizing the U.S. program for 10 years.

[2] http://ag.arizona.edu/azwater/taap/index.html

1.5 Concluding Remarks

There are many challenges associated with transboundary aquifer assessment. This paper highlights the importance of recognizing and addressing institutional factors associated with a binational technical effort early in the process. Most binational efforts involve asymmetries in governmental functions and legal frameworks. The roles and the relative capacity and influence of non-governmental and academic institutions are likely to differ across borders. The Mexican and U.S. parties have established the foundation for genuinely collaborative, binational efforts to acquire, share and analyze data/information. Aquifer assessment will require time and financial resources, which have not yet been fully realized. The time taken to establish the cooperative framework required for the binational assessment efforts has resulted in a long-term commitment to a partnership that will result in better understanding of transboundary aquifers and thereby lead to better cross-border water management.

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