

Local IWRM organizations for groundwater regulation: The experiences of the Aquifer Management Councils (COTAS) in Guanajuato, Mexico

Philippus Wester, Jaime Hoogesteger and Linden Vincent

Abstract

Evidence of groundwater management by aquifer users emerging under Integrated Water Resources Management (IWRM) initiatives is presented, by analyzing the Consejos Técnicos de Aguas (COTAS; Technical Water Councils or Aquifer Management Councils) in the state of Guanajuato, Mexico, established between 1998 and 2000 by the Guanajuato State Water Commission (CEAG). Two contrasting models influenced this attempt to promote user self-regulation of groundwater extractions: locally autonomous aquifer organizations with powers to regulate groundwater extractions versus aquifer organizations with advisory powers only. The COTAS were conceived as locally autonomous IWRM organizations consisting of all aquifer users that would work together to reduce groundwater over-extraction and stabilize aquifer levels, at a later stage. CEAG followed an expedient IWRM approach to develop the COTAS, setting achievable targets for their development and explicitly focusing on active stakeholder participation. The article shows that, due to struggles between the state and federal levels, the COTAS have become advisory bodies that have not led to reductions in groundwater extractions. It concludes that achieving user self-regulation of groundwater extractions requires a fuller delegation of responsibilities to the COTAS which would not be possible without addressing the institutional struggles over water governance at the state and federal levels.

Keywords: Groundwater management; Water governance; IWRM; User self-regulation; Aquifer management councils; COTAS; Guanajuato, Mexico.

1. Introduction

A growing international consensus exists regarding the need for Integrated Water Resources Management (IWRM) (Allan, 2006; Mollinga, 2006; Kidd and Shaw, 2007; Molle, 2008), defined as “a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (GWP, 2000: 22). However, “normative” IWRM (Lankford *et al.*, 2007; Merrey, 2008) has been increasingly criticized for being a “nirvana” concept (Molle, 2008) that is very difficult to implement (Biswas, 2004), while glossing over the political nature of water management (Allan, 2006;

Molle *et al.*, 2007; Mollinga *et al.*, 2007; Swatuk, 2005; Warner *et al.*, 2008) and not focusing sufficiently on poverty reduction and livelihoods (Merrey *et al.*, 2005). Jeffrey and Gearey go so far as to state “IWRM remains (i) a theory about, (ii) an argument for, and (iii) at best a set of principles for, a certain approach to water resources management. Empirical evidence which unambiguously demonstrates the benefits of IWRM is either missing or very poorly reported” (Jeffrey and Gearey, 2006: 4).

To move forward, Lankford *et al.* (2007) and Merrey (2008) recommend adopting an adaptive and expedient approach to water management that focuses on identifying and implementing practical solutions, while explicitly recognizing the political and (re-) distributive dimensions of water governance. Groundwater management is a field where this is urgently needed since aquifer depletion is becoming increasingly serious in many areas, such as India, the Western USA, the North China Plain, Spain, Iran, the Middle East and Northern Africa and Mexico (Shah *et al.*, 2007). The regulation of groundwater pumping in these areas, which account for some 80% of the world’s groundwater irrigated area (FAO, 2005) is proving very difficult even though groundwater is of critical importance to their economies.

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It is well established that very few examples of sustainable groundwater management regimes exist in areas of intensive groundwater use (Knegt and Vincent, 2001; Shah *et al.*, 2007). Hence, the collective management of groundwater by water users — self-regulation or local-level governance — is increasingly advocated as an alternative or a complement to state regulation (Blomquist, 1992; Steenbergen and Shah, 2003; Lopez-Gunn and Cortina, 2006; Steenbergen, 2006; Schlager, 2007). Recently, the World Bank recommended frameworks to promote the development of aquifer management organizations as an integral component of IWRM (World Bank GW-MATE, 2006a, b). However, within these guidelines, the question of what powers should be held by an aquifer management organization versus higher-level river basin organizations and government agencies is not explicitly addressed. And, the political interaction between national water agencies and emergent aquifer-level organizations is glossed over. This article shows how contested and difficult the development of local-level groundwater governance can be, especially concerning the linkages with government agencies.

The development of IWRM for groundwater use has received scant attention, with exceptions from the USA and Australia (White and Kromm, 1996; Donahue, 1998; Blomquist *et al.*, 2001; Peck, 2007; Turrall and Fullager, 2007). While the Mexican experience with aquifer management councils strongly influenced the World Bank's recommendations on groundwater governance (Foster *et al.*, 2004), there has been scant analysis of the political and institutional questions raised and struggles experienced. As stressed by Schlager (2007: 149) “the shape and form of productive and complementary relations among resource users and different organizations and governments is not well understood and requires substantial investigation.” This article explores both the management scope and the struggle for emergence, of two models of aquifer management organization that distil the crux of such relations: between organizations that have local representation but advisory powers only, and autonomous organizations allowed real control over groundwater use. The article analyzes the challenges that can emerge in developing local IWRM organizations for groundwater management based on the experiences with aquifer management councils in Guanajuato, Mexico. Through this it aims to bring a better understanding of how regional and national governments can encourage and support local-level groundwater governance.

Mexico was an early adopter of IWRM, initiating water reforms from the late 1980s onwards (Mestre, 1997; Wester *et al.*, 2003; Rap *et al.*, 2004; Scott and Banister, 2008; Wester, 2008). This included the creation of a federal water agency, the *Comisión Nacional de Agua* (CNA, National Water Commission). In line with water reforms at the national level, the state of Guanajuato, located in central Mexico, started implementing a political and institutional program in the mid-1990s to achieve IWRM within the state for both surface and groundwater. This program consisted

of strengthening the Guanajuato State Water Commission (*Comisión Estatal del Agua de Guanajuato*, CEAG) and the creation of 14 *Consejos Técnicos de Aguas* (COTAS; Technical Water Councils or Aquifer Management Councils) by CEAG from 1998 onwards. The COTAS were conceived as local IWRM organizations consisting of all the water users of an aquifer (an estimated 10,000 users in 14 aquifers) that would work together to regulate groundwater extractions. CEAG intended that the COTAS would contribute to reducing the level of groundwater over-extraction through user self-regulation and at a latter stage to stabilizing aquifer levels (declining by 2 m per year on average). Technically and financially the state government supported these user-based organizations.

This article first analyzes the emergence of the COTAS up to 2000. It details the political and institutional struggles that the state of Guanajuato had to engage in with the federal government to establish the aquifer management councils, showing that how IWRM is articulated at the local level is strongly linked to political processes and struggles between levels of government. The second part describes the development and achievements of the COTAS after 2000, showing that the COTAS have become advisory bodies instead of user organizations that regulate groundwater extractions and develop agreements on mechanisms to reduce groundwater use through consensus building amongst users. The article argues that there has been no delegation of authority to COTAS from the federal government to control water allocations. Moreover these institutions have not been able to establish mechanisms that bring about significant changes in groundwater use patterns. These realities bring into question the frameworks of current groundwater policy models on how aquifer councils can extend control over groundwater management locally.

The material presented in this article is based on research conducted over a ten year period, with intensive field work in 1999, 2000 and 2003, supplemented with a follow up study in 2006 and 2007. The research consisted of around 30 in-depth interviews with CEAG and CNA officials, COTAS board members, managers and water users, participant observation at events organized by CEAG to establish the COTAS in 1999 and 2000, and several workshops with COTAS in 2000 and 2007 to discuss research findings. Preliminary results were published in Marañón and Wester (2000), Hoogesteger (2004) and Wester (2008).

2. The emergence of COTAS in Guanajuato

Reaching sustainable groundwater extraction levels is the most critical issue in Guanajuato's water management. All its 18 aquifers are overexploited, with annual extractions around 1,200 million cubic meters (hm^3) more than recharge (CEAG, 2006). Total groundwater extractions fluctuate around 4,100 hm^3 while recharge is around 2,900 hm^3 for the whole state (CEAG, 2001), and thus the level of

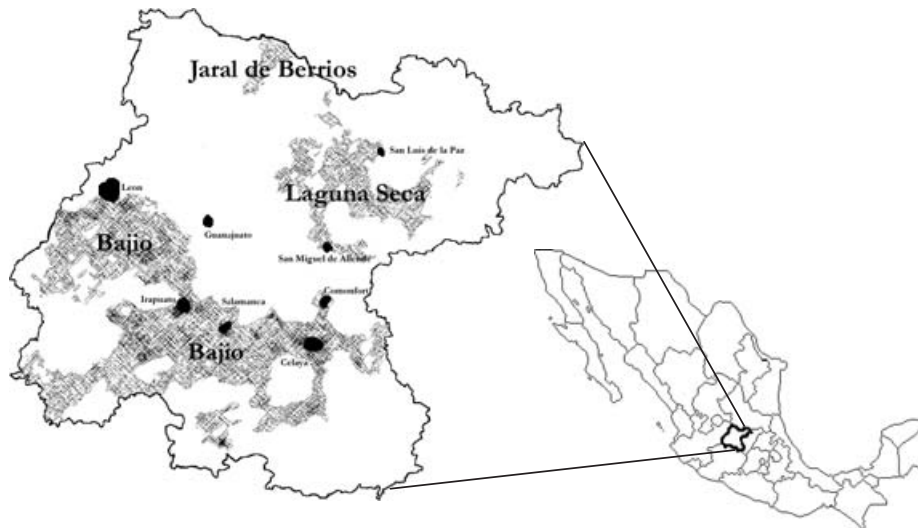


Figure 1. Areas of intensive groundwater use in Guanajuato
Source: Adapted from Hoogesteger (2004).

overexploitation is around 40% of recharge. Surface water in the state is also over-committed leading to severe competition for water between the states in the Lerma-Chapala basin (Wester *et al.*, 2008). The areas where most of the groundwater is extracted are the central Bajío region and the Laguna Seca region in the northeast of the state (see Fig. 1). The Bajío contains most of the large cities and industries of the state and is characterized by intensive irrigated agriculture, while in Laguna Seca groundwater is used primarily for the production of export vegetables and fodder crops. Although irrigation accounts for some 83% of groundwater extractions in Guanajuato, groundwater is also critically important for industrial and urban water use.

The main consequence of groundwater overexploitation in Guanajuato has been a sustained drop in groundwater levels and a cessation of base flow from the aquifers to the rivers. Analysis of measured static water levels of the last 30 years indicate an average decline of Guanajuato's aquifers of 2.06 m/year between 1976 and 1994 (Scott and Garcés-Restrepo, 2001) and 2.03 m/year between 1995 and 2000, with up to 3.5 m/year near cities (CEAG, 2001). Static groundwater levels in 2004 varied from 28 to 175 m below the surface in the north of the state, from 27 to 185 m in the center, from 30 to 140 m in the southwest and from 10 to 225 m in the southeast of the state (Acevedo-Torres, 2004: 4). At present, well depths between 200 and 400 m are common, while depths of 500 to 1,000 m have been reported (Chávez, 1998).

Long before user self-regulation, attempts were made to regulate and reduce groundwater use in Guanajuato. Since the 1950s, areas of intensive groundwater use in the state were placed under a drilling ban (termed a *veda* in Mexico). In the past 15 years, compulsory pump registration, subsidies for irrigation modernization, and the reform of electricity subsidies have been used by the federal government to reduce groundwater use, with meager results (Scott and

Shah, 2004; CEAG, 2006; Wester, 2008). Although the rate of increase in groundwater abstractions has slowed since the 1990s, new wells continue to be drilled and the water table continues to decline unabated.

2.1. Initial attempts by the National Water Commission to form COTAS

The first experiences with the creation of COTAS developed in the neighbouring state of Querétaro, also part of the Bajío, where the National Water Commission (CNA) closely interacted with industrial users, the city of Querétaro and farmers in developing an aquifer user committee in the early 1990s. This initiative was based on the recognition that the old, top-down regulatory approach of declaring *vedas* had not worked. This led to the formulation of the rules and regulations for the Querétaro aquifer in January 1997, which contained a paragraph on the establishment of a COTAS. The CNA was to be the president of the COTAS, with a long list of government agencies, municipalities, and user representatives as members (CNA, 1997). The tasks of the COTAS were listed as collaborating with the CNA in applying the aquifer rules and regulations, reporting any infractions of the regulations to the CNA, and receiving requests, denunciations and complaints from groundwater users and making these known to the CNA, but without any enforcement powers (CNA, 1997). In February 1998, the Querétaro COTAS was formally constituted along these lines.

As no specific mention of COTAS was made in the national water law of 1992, there was much ambiguity about their characteristics, mandate and structure. Between 1995 and 2000, the CNA did not publish a policy document outlining the structure and tasks of the COTAS or how they should be formed. However, during this period it became clear that the CNA intended the COTAS to be consultative bodies without a legal status or decision-making power, in which

aquifer users, government water agencies and organized groups from civil society would interact concerning groundwater management, under the auspices of the CNA. It appears that the CNA was very reluctant to design aquifer management organizations with any real clout in groundwater management (Palacios and Martínez, 1999).

2.2. *The first COTAS in Guanajuato*

While the CNA was setting up COTAS in Querétaro and other parts of Mexico in late 1996, Guanajuato's *Secretaría de Desarrollo Agropecuario y Rural* (SDAyR; Secretariat of Agricultural and Rural Development) started the formation of COTAS in the Celaya and Laguna Seca aquifers. The CNA was not involved in this initiative, which was a new development in Mexico as until then the CNA had been in firm control of water management (Wester, 2008). However, much larger political processes were at work in attempts at reforming water management, of which the COTAS formed only one component.

On 28 May 1995, Vicente Fox of the *Partido Acción Nacional* (PAN; National Action Party)¹ was elected governor of Guanajuato. This was a momentous change, as it was the first time that a non PRI² political party won the elections in Guanajuato in more than six decades. From the day Fox took office he set out to do things differently from the PRI, and in particular to challenge the federal PRI government. A central component of Fox's political project was water, over which he wanted to wrest control from the federal government. To develop his political project concerning water, Fox focused on strengthening CEAG and SDAyR, so that these state institutions could stand up to the CNA.

In this political context, the SDAyR started the formation of two COTAS in late 1996 for the Laguna Seca and Celaya aquifers. The aim of this initiative was to stimulate the participation of the aquifer users in reaching a consensus on how to reduce groundwater extractions. As there was no established procedure for creating COTAS, and it was not clear what their attributes would be, SDAyR embarked on an open-ended process to form the COTAS.

In SDAyR's perspective, the formation of the COTAS was to be a "bottom-up" process in which the aquifer users would gain a clear understanding of the gravity of groundwater depletion. Based on this understanding, they

would collectively discuss ways to resolve this problem. In contrast to the Querétaro COTAS, where the CNA was the president, SDAyR wanted the COTAS to be more autonomous, with the users electing the representatives and the president. After nearly a year of deliberations, the two COTAS were formally constituted on 28 November 1997. The efforts by SDAyR to bring together many different stakeholders in the COTAS, without the CNA being in the lead, had shown that the federal government could be challenged. In late 1996 the COTAS were an uncertain gamble, and their formation was not yet a serious part of Fox's political project. However, by late 1997 they had become a vehicle through which control over water could be wrested from the federal government. However, the two COTAS had not yet started work on finding ways to reduce groundwater extractions, and their attributes and legal standing remained unclear. How this changed between 1998 and 2000 is analyzed below.

2.3. *Towards a new water agency at the state level*

In early 1998, the responsibility for the formation and supervision of the COTAS was transferred from SDAyR to the CEAG.³ The move to CEAG formed part of the new federalism policy initiated during President Zedillo's administration (1994–2000), which consisted of decentralizing government responsibilities, programs and resources from the federal to the state level. In the water sector this entailed that the State Water Commissions would receive more responsibilities in water management. Formed in 1991 by the state legislature to provide potable water, sewage and sanitation services, until 1996 CEAG primarily functioned as a financial mediator between the federal government and municipalities, mainly for domestic water supply projects, and was largely bypassed by CNA in all other spheres of water management.

As part of his political project, Fox seized on the opportunity to strengthen the CEAG and to broaden its mandate from domestic water and sanitation to all aspects of water management. He decided that it was to become the main water agency in the state that would promote comprehensive water management. From 1996 to 1998, the organizational structure of the CEAG was changed to reflect its new mandate, and a large number of water professionals were hired. Two new General Directorates were formed, one for planning and the other for social participation. The social participation directorate focused on forming the COTAS and promoting user participation, while the planning directorate set to work on formulating the state water plan (*Plan Estatal Hidráulico 2000–2025*), published in 2000.

¹ The PAN was formed in 1939 as a conservative and pro-business catholic party by disgruntled PRI (*Partido Revolucionario Institucional*; Revolutionary Institutional Party) elites who opposed the populist policies of President Cárdenas (1934–1940). Until 1988, it secured on average 13% of the vote for Congress and served as a pressure group within the corporatist PRI regime. In the 1980s it evolved into a strong opposition party through the influx of industrialists, businessmen, commercial farmers and neo-liberal politicians, called "neo-Panistas", that fled the PRI after the 1982 crisis. (Camp, 1999)

² The PRI arose from the Mexican revolution of 1910 to 1920 and ruled the country and most of Mexico's states uninterrupted between the 1920s and the 1990s.

³ The *Comisión Estatal del Agua y Saneamiento de Guanajuato* (Guanajuato State Water and Sanitation Commission, CEASG) was created in 1992. In 2000 it was renamed as "*Comisión Estatal del Agua de Guanajuato*" to express the widened scope of CEAG's mandate, namely to implement integrated water resources management within the state. This article uses CEAG throughout for sake of consistency.

Thus, the CEAG went from an organization with very focused functions in 1995, to a water agency that would defend the state's water interests and act as a valid interlocutor with federal agencies by 2000.

The formation of the COTAS was a crucial component of CEAG's institutional project, namely to become the main water agency in Guanajuato, at the expense of the CNA and SDAyR. As part of his political calculations, Fox believed that it would be better to strengthen CEAG instead of SDAyR as the central water management institution in the state. However, the removal of SDAyR from the formation of the COTAS was to have consequences because CEAG was urban in its outlook, and did not initially have strong connections with irrigation farmers, the largest water use sector.

2.4. *The COTAS according to CEAG*

The move to CEAG led to several changes in the structure of the COTAS. The most salient difference was that CEAG decided to form councils with only water user representatives on the COTAS board. These councils were to consist of all water users that would work together to achieve IWRM in their aquifer, focusing on both surface and groundwater, and on quantity as well as quality aspects. A consultative group consisting of government agencies was to provide advice to the COTAS board. Also, the COTAS were to have a technical office run by a manager paid for by CEAG, to support the board. What remained the same was the problematic relationship with the CNA, which was not involved in the formation process.

In the CEAG model, the membership of the COTAS was to consist of all the water users of an aquifer, defined as those with a concession title to extract groundwater for agricultural, industrial or commercial use, while urban inhabitants would be represented in the COTAS through the municipal water supply utilities (Guerrero-Reynoso, 2000). CEAG intended that the COTAS would be legally recognized local water management organizations that would focus on regulating and conserving water. Most importantly, the COTAS were to reverse aquifer overexploitation and recover groundwater levels by reaching agreements on aquifer management and agreeing on actions to regulate, conserve and efficiently use water (Guerrero-Reynoso, 2000). To achieve these goals it was foreseen that the COTAS would:

- Propose aquifer rules and regulations for the sustainable use of aquifers;
- Propose a local hydraulic plan and participate in the State Hydraulic Plan;
- Participate in the granting of water concessions; and
- Monitor the aquifer rules and regulations and the volumes of water extracted.

CEAG did not intend that the COTAS would become water agencies with full user control over the aquifers and it also did not specify which powers the COTAS would have to

execute the activities listed above. However, it clearly did not have a consultative body in mind, which was the model CNA was pursuing. In the CNA model, the COTAS were a mixed organization of government agencies and user representatives focusing on groundwater only, whose main task was to collaborate with the CNA in formulating the rules and regulations of an aquifer. However, the COTAS would not participate in the granting of groundwater concessions and could only make suggestions to the CNA. A final important difference between the two models was that CEAG intended the COTAS to be financially and administratively independent, after an initial period of support, and fully managed by water users.

2.5. *The formation of the COTAS in Guanajuato*

Besides changes in the structure and objectives of the COTAS, the move to CEAG also changed their formation process. The process followed by SDAyR was replaced by a much quicker approach focused on showing results. By the end of 1998, CEAG had constituted six COTAS in addition to the two already formed in Celaya and Laguna Seca. The remaining six were formed in 1999, bringing the total number of COTAS in Guanajuato to fourteen, to cover all 18 aquifers in the state (the COTAS boundaries did not exactly follow aquifer boundaries). The COTAS were formed as civil associations, to ensure that they were legally recognized.

CEAG defined three phases for the establishment of COTAS in Guanajuato: legal constitution, establishment of aquifer regulations and organizational development. It aimed to finish the first two phases by the end of 2000, and succeeded in completing the first phase by the end of 1999. The participation of aquifer users, especially farmers, in the formation of the COTAS was restricted as CEAG wanted to establish the COTAS before the Mexican presidential elections of July 2000. Thus, CEAG did not opt for a large-scale convocation of aquifer users but only invited the leaders of diverse organizations to participate in the formation process of the COTAS. In the majority of cases, the representatives of the agriculture sector in the COTAS were commercial farmers or agroindustrialists and the peasant sector (*ejidos*) was largely bypassed (Marañón and Wester, 2000). Besides the three agriculture representatives on the COTAS board, three representatives each for the industrial, potable water, and services sectors were selected. Thus, although agriculture used around 80% of groundwater, it only had 25% weight in the COTAS board. This misbalance in the composition of the COTAS, while bringing together all the water use sectors, was to have a marked effect on their development. In particular, the large industries, commercial farmers, and municipal water companies all claimed that they were already using water very efficiently, and that it was the agrarian producers, or small farmers, that were to blame for groundwater overexploitation.

CEAG chose first to form the COTAS, and then to expand user participation. However, by neglecting to bring together all the aquifer users at the start, and to arrive at a shared understanding of the problems facing the aquifer and the possible solutions, the COTAS were not designed and owned by the water users. Later on, this proved to be an obstacle for their consolidation. The lack of an adequate representation of all the groundwater users in the COTAS made it difficult to reach consensus on reductions in groundwater extractions, and many users did not see the COTAS as user organizations, but as an extension of the state government. Thus, the approach followed in forming the COTAS, namely sticking to timelines without giving sufficient space to reaching agreement between users, restricted their effectiveness. By late 1999, the whole state of Guanajuato fell under COTAS, under the supervision of CEAG, that would work to achieve IWRM in their respective aquifers. To our knowledge this is the first time that an IWRM approach based on aquifers as the spatial unit, rather than river basins, was attempted in the world.

The creation of COTAS by CEAG was a direct affront to the CNA, which viewed itself as the principal water authority in the country and strongly believed it was responsible for forming COTAS. While SDAyR had reluctantly involved the CNA, CEAG developed a more adversarial role in its relationship with the CNA and excluded the CNA and all other government agencies from the COTAS general assembly and board. On the other hand, the CNA was very reluctant to provide information to the COTAS, especially concerning the number and location of groundwater pumps and their owners. It also tried to stall the formation of COTAS in Guanajuato, based on the legal argument that the CNA should be in charge of this process as the representative of the federal government. In particular, the CNA did not permit the COTAS to play a role, even in an advisory capacity, in the granting of new groundwater concessions or the regularization of existing wells.

2.6. Summary remarks

This section has analyzed the formation of COTAS in Guanajuato from 1996 to 2000. Although they were successfully created, their objective to reduce groundwater overexploitation through user self-regulation did not receive much attention. Rather, the analysis shows that they formed part of a political and institutional project of the state government to gain larger control over water management in Guanajuato. In this, CEAG was only partly successful, as the CNA remained in control of groundwater concessions and largely ignored the COTAS. Also, the move from SDAyR to CEAG restricted the effectiveness of the COTAS. The SDAyR intended that the COTAS would become responsible for monitoring and regulating groundwater concession titles and that agricultural water users would have the largest vote in the COTAS. When the COTAS moved to CEAG many large commercial farmers lost interest, as

it was clear that the COTAS would not have any real influence in issuing groundwater concession titles. Thus, the struggles between levels of government and government agencies significantly reduced the prospects of the COTAS.

3. Working on groundwater regulation by users at the local level

The formation of 14 COTAS by 2000 covering all of Guanajuato's aquifers, and the election of Vicente Fox as President of Mexico on 2 July 2000, raised high hopes for the coming years. It was anticipated that the COTAS would take off as an innovative institutional model and that their consolidation would lead to sustained reductions in groundwater extractions. It was also hoped that the rivalry with the CNA would lessen and that Fox would seriously delegate responsibilities and resources to the state level. However, the consolidation of the COTAS between 2000 and 2006 did not translate into concerted efforts to reduce groundwater use. The rivalry with the CNA continued and the COTAS were not delegated the authority to manage their aquifers.

The development of the 14 COTAS in Guanajuato from 2000 to 2006 strongly depended on the continued support of CEAG, who continued to pay for their office costs, staff, vehicles, and computers. CEAG's efforts to strengthen the COTAS during this period focused on increasing user participation and formulating a groundwater management model. While the original aim had been to formulate aquifer rules and regulations by 2000, the focus on reducing groundwater extractions moved to the background. Rather, the COTAS were recast as "consensus-building spaces where integrated water management models and programs are to be implemented" (Sandoval, 2004: 9–10). This change of focus was related to the lack of a real delegation of authority to CEAG and the COTAS, and thus the COTAS could not play a more active role in reducing groundwater extractions. However, behind this vague formulation a strategy was developed by CEAG to achieve both autonomous user organizations and reductions in groundwater extractions. This consisted of developing a "groundwater management model" that built on the aquifer studies supervised and updated by CEAG and the ongoing activities with the COTAS. In the words of the then executive secretary of the CEAG;

"bearing in mind that all these activities [developed by the COTAS] can, in the end, result in the establishment of a local organization which is reliable and morally authoritative enough to perform effectively a set of concrete actions that will achieve results in terms of aquifer renovation. The groundwater management model was designed to be instrumental in reaching this goal." (Sandoval, 2004: 11–12)

CEAG developed the groundwater management model in 2002, in coordination with the COTAS, to focus on concrete

actions that would have a large impact on groundwater extractions and foster social participation. The model consisted of nine elements that together would lead to less groundwater extractions. The first two elements had already been developed between 1998 and 2002, and consisted of the extensive aquifer studies and the database developed by CEAG and the COTAS on the number and location of groundwater wells. As part of its aquifer studies, CEAG identified more than 15,700 groundwater wells (many of which were not registered by CNA), and these data were transferred to the COTAS who further extended and updated the groundwater wells database. The third element consisted of the monitoring of aquifer levels. Starting in 1998, CEAG set up a groundwater monitoring network that grew to 12 deep observation wells and 955 pilot wells, for which the COTAS collect the static level readings twice a year. Based on the aquifer studies, depletion cones were identified in the aquifers and one pilot zone covering between 50 to 100 km² and 100 to 300 users was established in each COTAS while 7 pilot zones were established in the Celaya COTAS.

Based on the wells database, the COTAS identified the groundwater users in the pilot zones, and initiated an intensive process of working with the users to identify and reach agreement on a list of measures to reduce groundwater extractions. This program mainly focused on agriculture, and sought to channel the various government support programs for irrigation modernization through the COTAS to these pilot zones. The intention was to produce the same or more crops with less water and energy, hence at a lower cost. Once the measures had been agreed on and funded, the users were requested to form aquifer monitoring committees, to monitor aquifer levels and evaluate the results of the interventions. They were also urged to install meters on their pumps and to carefully monitor pumping hours and electricity use. The long term objective was that the pilot zones would gradually be expanded, to cover the whole aquifer. Only then would the work start on drawing up the rules and regulations of the aquifers, as CEAG believed that groundwater users would only support and implement the regulations after investments had been made in social participation and water use efficiency.

As a result of the groundwater management model, the number of users that became members of the COTAS rose from 225 in 2000 to 8,610 in 2006 (of an estimated 18,000 groundwater users), and 20 aquifer monitoring committees were formed (CEAG, 2006). The COTAS were also very actively involved in training around 5,300 users in water issues, together with government agencies, and extensive information campaigns on the “new water culture” were held. Another important achievement of the COTAS is that each has updated and verified the database on groundwater wells, in the process identifying many irregular wells. Lastly, for many farmers the COTAS have become an important help desk or service window that supports them in their interactions with government agencies. Especially

concerning groundwater concession titles, the COTAS play an important role as intermediaries between farmers and the CNA and other state and federal agencies, for obtaining and renewing the titles (most titles are valid for ten years). The COTAS have also become intermediaries for users who through them can get support to access government programs aimed at more efficient water use, a role many farmers would like to see expanded.

Based on the strong support from CEAG, the COTAS matured between 2000 and 2006, and their position and tasks became clearer. The aquifer monitoring committees have led to enhanced awareness. At a political level, the COTAS have gained the recognition of the CNA, which has delegated several programs to them. And recently the CNA has given them a role in supporting the users in the required administrative procedures for renewal of water use permits that fall within each aquifer. However, they have not become full-fledged user organizations in which strategies for reducing groundwater overexploitation have been devised. The result is that they have not achieved significant reductions in groundwater extractions nor have they led to user self-regulation.

During interviews in 2006 and 2007, COTAS board members and CEAG officials frequently mentioned that for the COTAS to have an impact they needed to have more responsibilities and delegated authority. The WUAs in the transferred irrigation districts were frequently referred to as a promising model for groundwater management (cf. Kloezen, 2002; Rap, 2004; Wester, 2008). Thus, many of the groundwater actors in Guanajuato want to convert the COTAS into groundwater management districts with delegated responsibilities to regulate groundwater extractions. In this model, the groundwater districts would receive the delegated authority to advise on and approve the granting of groundwater concessions in collaboration with the CNA and the legal capacity to fine pumpers extracting more than their concessioned volume and to close illegal wells. To make this possible, the mandate of the COTAS would need to be expanded, so that they would share the responsibility for the registration and regularization of wells, the formulation and enforcement of aquifer rules and regulations and the monitoring of groundwater extractions together with the CNA and CEAG.

4. Conclusions

During the 1990s both the federal and the state governments agreed on the need for new institutions that would respond to the pressing groundwater problems present in Guanajuato. Both CNA's and the state governments' initiatives were based on the principles of IWRM and included stakeholder participation, integrated water resources planning, and water management based on hydrological boundaries. However, the ideas greatly differed about how the aquifer management organizations should be structured, how

responsibilities should be established, and how users, municipalities, the state government and the CNA would participate in these new institutions for water management.

The state government saw the creation of the COTAS as an opportunity to increase its role in water governance. At the same time, it firmly believed that giving aquifer users much more responsibility and voice in the management of their own resources would lead to user-defined goals for arresting aquifer depletion. The CNA also felt the need to work on water management at the local level through the involvement of users, municipalities and the state but wanted to keep a central role in these institutions, which would only support and advise the CNA.

Regardless of these discrepancies over how to structure the COTAS, Guanajuato was determined to create the COTAS before the end of 2000, without an active involvement of the CNA. This resulted in the creation of COTAS that had no legal mandate over water management and which were not recognized or supported by the CNA. This blighted the effectiveness and further development of the COTAS as instruments to reach agreements on reductions in groundwater use. The CNA retained its control over issuing groundwater permits and initially bypassed the COTAS. Slowly the COTAS have won recognition from the CNA, yet without any delegation of responsibilities to manage groundwater.

Although the COTAS have been hailed as a real example of user-based aquifer management organizations (World Bank GW-MATE, 2006a, b), they have not yet achieved sustained reductions in groundwater extractions. To move towards user self-regulation it is necessary that the COTAS receive delegated responsibilities to manage their aquifers, and that the high volume extractors actively participate in the COTAS. It is exactly this point that has been the most disputed, with much institutional struggle and little institutional coordination as promoted by emerging models of aquifer management organizations. Current discussions in the COTAS focus on ways to reduce groundwater pumping (e.g., by installing sprinkle and drip irrigation systems) and to increase aquifer recharge, but negotiations to reach agreement on reductions in groundwater extractions have not yet started. In addition, new pumps continue to be installed and regularized via legal loopholes. The reluctance of the federal government to impose strict pumping limits and the continued race to the pumphouse by farmers bodes ill for Guanajuato's aquifers.

Nonetheless, the COTAS form a platform for groundwater users to find solutions for the vexing problem of groundwater depletion. To move forward, groundwater users would need to devise aquifer agreements with substantially lower levels of groundwater extractions, either through an adjudication of pumping rights on the basis of mutual prescription (cf. Blomquist, 1992) or through a negotiated downward adjustment of groundwater concessions with the federal government. To do so, however, would require far-reaching changes in the institutional arrangements for water management that prevail in Mexico, with a strong reluctance

by the federal government to delegate responsibilities and mandates to the state and local level.

The COTAS are trapped by a social participation model where higher level central agencies retain power over groundwater regulation, and the dominant model remains that of aquifer management organizations with advisory powers only. Autonomous aquifer management organizations with real powers to regulate groundwater extraction have been squashed in institutional struggles around water control, and water as a tool in wider political power struggles. The state agencies have struggled to build expedient forms of IWRM where users have real representation and there is much more direct local control over groundwater use and management, but this autonomy has not been won yet.

The experience of the COTAS shows that the political and social arenas in which local IWRM is applied strongly circumscribes the possibilities of achieving user self-regulation. The main obstacles have been:

- Political struggles over water control between different administrative levels: The struggles between SDAyR, CEAG and CNA over groundwater control and the mandates of these institutions initially led to a polarization of efforts and inter-institutional struggles instead of an integration and coordination of efforts.
- User participation has remained low compared to initial expectations and has mainly been promoted by CEAG and not by aquifer users themselves.
- Failure of self-regulation: As a result of the first two obstacles farmers, cities and the industrial sector have not been willing or able to devise serious self-regulation mechanisms to curb groundwater overexploitation.

This article shows that moving towards local IWRM is fraught with difficulties. While IWRM principles sound good on paper, in practice an expedient approach is needed that explicitly recognizes both the political nature of water management and the complexities of water resource challenges, while retaining a focus on addressing specific problems in water management. In the case of the COTAS of Guanajuato, such an expedient approach should focus on creating functioning mechanisms for enforcing groundwater legislation, especially concerning well permits and pumped volumes, to create credible incentives for groundwater users to engage in self-regulation. Second, mechanisms are needed to ensure the legitimacy and accountability of user's representatives to both users and state agencies, so that COTAS do not become interest groups but actively strive to reduce groundwater extractions.

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