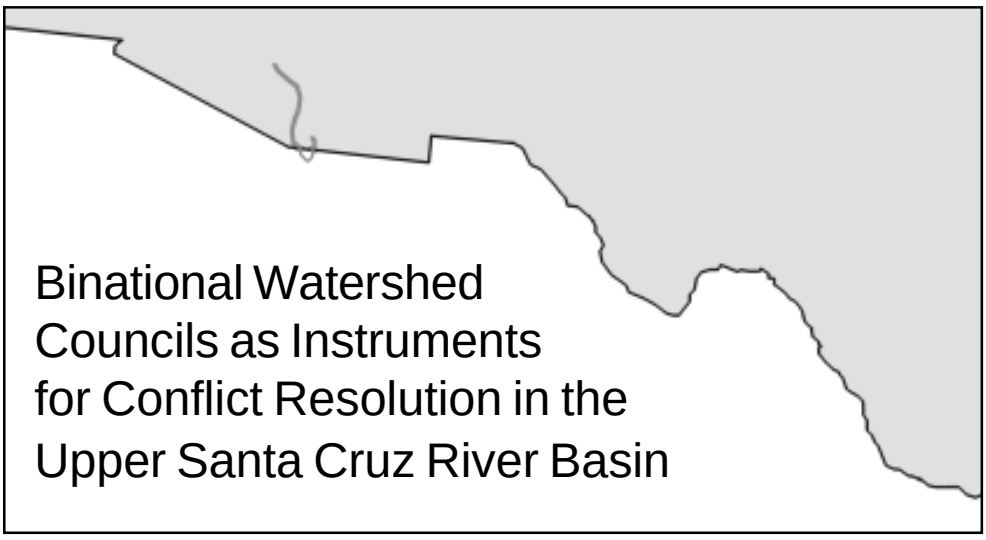

Binational Watershed Councils as Instruments for Conflict Resolution in the Upper Santa Cruz River Basin

by Christopher Brown

2000 Ford Foundation/Udall Center Fellow
in Environmental Conflict Resolution
on the U.S.-Mexico Border

Udall Center for studies in public policy
The University of Arizona

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BINATIONAL WATERSHED COUNCILS AS INSTRUMENTS FOR CONFLICT RESOLUTION IN THE UPPER SANTA CRUZ RIVER BASIN

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General Scope and Context of Research

Water resources along the U.S.-Mexico border are key ingredients in regional economic development and essential to the quality of human health and the environment in the area (Metzner 1989; Brown 1993). The seasonal patterns and limited quantities of regional precipitation in the region also make this a scarce resource that is approaching full allocation among existing users (Eaton and Anderson 1987; Gonzalez 1997). The increasing industrialization, urbanization, and population growth on the border in recent years that has occurred as a result of the North American Free Trade Agreement (NAFTA) and programs that led to NAFTA, greatly complicate water-resource management. Some of the most serious challenges facing the border include adequate management of water supplies and wastewater. According to the United States Environmental Protection Agency (USEPA), "water pollution is one of the principal environmental and public health problems facing the border area" (USEPA 1996).

In addition to asymmetric patterns of development, the distribution of raw and finished water resources along and across the border is uneven (Eaton and Anderson 1987), negatively impacting the quality of life among the residents of twin cities in both the United States and Mexico (Mungaray 1993; USEPA 1996). Given the scarcity of this resource, its importance to the region's viability, and the manner by which asymmetrical regional urbanization patterns are impacting water quality, the existence of water- resource-based conflict comes as no surprise to residents of the border and to researchers who examine these issues (DeWyze 1988; Sánchez 1990; Altomare 1991; Varady and Mack 1995). Variable allocations of water resources, the spatial variability of surface-water quality as a result of uneven urbanization patterns, and the manner by which the political role of the border influences regional water-quality issues are all important sources of regional conflict along the U.S.-Mexico border (Dedina 1991).

Regional and bioregional approaches to resource-quality issues and the conflicts involved have a rich history in geographic and resource-management literature (Mitchell 1989, 1990), and these approaches have also been advanced by the USEPA in examining domestic and binational resource-management issues (Gallant et al. 1989; USEPA 1996). Watershed approaches that offer the river basin or catchment as both a spatial framework and context within which resource management issues may be addressed have been extremely useful in resolving water-resource-based conflict and advancing holistic management of basin-wide water resources (White 1963, 1977; Downs et al. 1991; Montgomery et al. 1995; Milich and Varady 1999).

In this paper, I explore opportunities for watershed approaches to water-resource problems in the Upper Santa Cruz River Basin along the U.S.-Mexico border and the utility such approaches may offer in resolving cross-border water conflicts. After an introduction to the Upper Santa Cruz River Basin, I discuss binational watershed councils (*consejos de las cuencas*) as a potential tool for use in water-related conflicts. I then examine a range of significant water-resource issues in the region and identify the key stakeholders and institutions, and both pose and examine specific research questions concerning barriers to the use of these tools. In the latter part of the paper I seek to collect the above elements into a cohesive regional framework that may help advance policy efforts towards resolution of water-resource-based conflict in the U.S.-Mexico border region.

[1]Ford Foundation/Udall Center Fellow in Environmental Conflict Resolution in the U.S.-Mexico Border Region, 2000.

Study Area

The Upper Santa Cruz River Basin is a transboundary watershed[2] located in Sonora and Arizona, within which the binational twinned cities of Ambos Nogales (Nogales, Sonora and Nogales, Arizona) and the large urban area of Tucson lie. Ambos Nogales have a population of about 200,000 people (INEGI 2001), or between 1/3 and 1/2 the size of Tucson and an urban region of increasing importance for regional water-resource management (Figure 1).

The Santa Cruz River originates in the San Rafael Valley of Arizona and flows in a southerly direction crossing the border into Mexico just east of Lochiel, Arizona. In its Mexican reaches, the Santa Cruz flows in a u-shaped configuration primarily through *ejido*[3] agricultural lands and *ranchos* until reaching an area in which a major wellfield has been established to provide water for Nogales, Sonora.

The river then flows northward into Arizona through a region of mixed land use Santa Cruz County in which ranching, farming, and small scale settlements exist. Streamflow north of the Nogales International Wastewater Treatment Plant (NIWTP) near Rio Rico is effluent-dominated due to the discharge of treated effluent at the plant. As it crosses into Pima County, the river flows to the northwest through the Canoa Ranch, a historical land-grant ranch comprising approximately 6,500 acres, and an adjacent major region of pecan production.

Although the streambed continues northward towards Tucson, surface flows diminish due to the underlying hydrogeology of the area with intermittent flows only after precipitation events. As the course of the river nears Tucson, it crosses the San Xavier District of the Tohono O'odham Nation, a Native American tribe that has lived in the Sonoran Desert for centuries. From this point north, the river is partially channelized for flood-control purposes as its course moves through the predominantly urban reaches of Tucson, Arizona. The river channel proceeds northward until its confluence with the Gila River, a tributary of the Colorado River.

The river basin is essential in providing a vital source of water in various reaches, both in the United States and in Mexico. The climate of the region is characterized as arid to semi-arid, with annual amounts of precipitation ranging from approximately 300 millimeters (mm) in the lower elevations to 700 mm in the mountainous areas. This precipitation falls in a bimodal temporal pattern, with heavy summer monsoon rains accounting for approximately 60 percent of annual levels and winter cyclonic events accounting for approximately 20 percent. The driest months of the year tend to be April, May, and June, and the cyclical nature of the precipitation in the region results in minimum stream flow during the higher demand times of the year when increasing irrigation needs combine with the municipal demand generated in urban areas (Liverman et al. 1997).

Water uses in the Upper Santa Cruz River Basin produce a complex set of challenges. These uses include extraction of groundwater to meet agricultural and urban demands, groundwater recharge of regional aquifers, in-stream uses in support of wildlife, and the use of the river as a disposal site for treated wastewater. Upstream in the San Rafael Valley, the river is used as a watering source for stock grazing in the valley, and groundwater is mined through irrigation wells in the valley to support limited irrigated farming (Sharp 1999). In the Mexican portions of the basin from the border to the region near El Cajon, fairly extensive irrigated agriculture places demands on regional water resources as it does near Miguel Hidalgo and Mascareñas as well (Murrieta and Briggs 1999; Halpenny 2001). Regional population in the Mexican reaches from the border to Mascareñas is approximately 1500 people, which exerts additional pressure on regional water resources.

Near Mascareñas and at the pumping gallery at Paredes, wells for the Municipio of Nogales, Sonora, extract water for municipal needs from a very shallow aquifer that is hydrologically linked to river flows (ASU

[2]A transboundary river system is one that flows across borders, thereby creating upstream and downstream riparians (Milich and Varady 1999). This spatial orientation of elements also affords the opportunity for cross-boundary conflict and disputes related to water quality and quantity, providing an added level of challenge in addressing these conflicts.

[3]Ejidos lands are commonly held agricultural lands that are administered through a collective management regime. This arrangement has existed historically in Mexico since at least the mid-1800s, but ejidos increased in importance early in the 20th century as part of land reform efforts arising from the Mexican Revolution whereby large land holdings were broken up into these collectively managed ejidos (Meyer, Sherman, and Deeds 1999).

and COLEF 1995); the impact of this pumping may have fairly immediate impacts on river flows (Halpenny 2001). Conversely, wells to the northwest of this area in the United States extract groundwater for Nogales, Arizona, from much deeper aquifers. The impact of this pumping is minimal on river flows, but it does reduce the water table in groundwater aquifers (Halpenny 2001). As regional groundwater is used in the urban areas of Ambos Nogales, major amounts of wastewater are generated; adequate collection, treatment, and disposal of this wastewater pose further water-quality challenges to the region.

Through joint efforts of the U.S. and Mexican sections of the International Boundary and Water Commission (IBWC; CILA in Mexico)[4], the Nogales International Wastewater Treatment Plant (NIWTP) was constructed near Rio Rico, Arizona, in 1972 with an initial design capacity of 8.2-million gallons per day (mgd). After the plant's expansion in the early 1990s, the present design capacity of the plant is 17.2 mgd (IBWC 1999). The plant treats a mix of municipal wastewater from both Nogales, Arizona, and Nogales, Sonora; 9.9 mgd of this treatment capacity is allocated to Nogales, Sonora, and the balance of 7.3 mgd is owned by Nogales, Arizona (Camp Dresser & McKee 1999). Wastewater is collected in both municipalities and pumped to the plant, and the treated effluent is then discharged into the reaches of the Santa Cruz River.

The discharge of this effluent is an important water resource to downstream reaches in the basin. Perhaps the most important aspect of this discharged effluent is the support it provides for a major effluent-dominated riparian gallery. With respect to regional water balances, the effluent recharges the river system and allows regular surface flows in the river. Accordingly, water-quality issues related to effluent quality and the reliability of these effluent discharges are of major importance to water-resource managers and the general public.

[4]The International Boundary and Water Commission (IBWC) is a joint U.S.-Mexican federal agency with formal responsibility to deal with boundary and water- resource issues along the U.S.-Mexico border. Branches formally known as Sections, exist within the U.S. Department of State and the Mexican Foreign Ministry, these being the IBWC in the United States and La Comisión Internacional de Limites y Agua (CILA) in Mexico (IBWC 1981).

Use of water resources in these downstream reaches can best be examined by looking at uses in two separate management sub-regions of the basin that extend from the U.S.-Mexico border to Tucson: the Santa Cruz Active Management Area (SCAMA) and the Tucson Active Management Area (TAMA). Active management areas were established under terms of the 1980 Arizona Groundwater Management Code as subregions within which groundwater resources were experiencing major overdraft; specific management goals were developed for each active management area (AMA), with the overall goal being that of achieving safe yield for areas relying heavily on groundwater resources.

A 100-year assured water supply requirement for future development is one way in which the goal of safe yield of groundwater resources is pursued. The Groundwater Management Code established the TAMA as the area that lies roughly from the U.S.-Mexico border to the Tucson urban area. However, in 1994, the Arizona legislature recognized the hydrogeological differences between the northern and southern portions of the TAMA and split the AMA into a northern TAMA and a southern SCAMA (ADWR 1998, 1999a). Specifically, the SCAMA has an excess of surface-water flows at the Canoa Ranch; therefore the goal in the SCAMA is maintenance of safe yield, whereas the TAMA seeks to achieve a safe yield.

Within the SCAMA, approximately 33 percent of total water demand of 46.3-million cubic meters (Mm3) is used in irrigated agriculture and ranching operations; 18 percent is used by the municipalities of Nogales, Rio Rico, and smaller towns in the area; four percent is used in industry; and the balance of water resources is lost as evapotranspiration through riparian vegetation (Liverman et al. 1997). Currently, the SCAMA meets a safe yield criteria, yet future trends of increasing urbanization and population growth could see urban demands approximately doubling by 2025, putting increasing pressures on the regional water resources and raising questions concerning the ability to meet the safe yield criteria (ADWR 1999a).

Within the TAMA, total water use in 1994 was 386.2 million cubic meters, with 47 percent used by residential and service sectors, 31 percent used by agriculture, and 20 percent used by industry. Groundwater meets 90 percent of this demand for water supply. However, with only 50 percent of this quantity of water projected

to be replenished in the long run, serious overdraft is a major concern to the region (Liverman et al. 1997). In order to meet a safe yield criteria in the future, a variety of water-resource management practices including water conservation, groundwater recharge, and augmentation with imported Central Arizona Project water will need to be implemented (ADWR 1998).

Watershed Councils

Watershed approaches have been advanced by the USEPA for both domestic and binational work. Domestic basin councils in the United States have been successful in coordinating a wide range of watershed-management issues and resolving the inherent environmental conflict among multiple users of watershed resources. The Colorado River Compact and the Ohio River Sanitary Commission offer two instructive examples of this type of watershed council demonstrated in a U.S. domestic context (National Academy of Sciences 1968; Cleary 1967). In the binational arena, the 1997 Border XXI Implementation Plans call for integrated watershed planning and management along the border, yet these plans also acknowledge that no federal funding exists to support this work (USEPA 1997).

Concurrent with these U.S. domestic efforts supported by the USEPA, the federal government in Mexico mandates that *consejos de las cuencas,* or watershed councils, be developed to serve the many users of the hydraulic resources, establish hydraulic infrastructure, and preserve the water resources in the targeted basins (Estados Unidos Mexicanos, Articulo IV, La Ley de Aguas Nacionales - National Water Law 1992 and 1997). As such, these consejos have great potential to advance a discourse among a wide range of water users with competing interests, promote the understanding of different perspectives, and facilitate the resolution of the conflicts that these competing uses may generate. Although La Ley de Aguas Nacionales (the federal law of national waters in Mexico) calls solely for domestic basin councils in Mexico, considerable potential exists for constitutional reform within Article XXVII of the National Constitution of Mexico and for interpretation of the National Water Law that would allow the scope and scale of these basins to be binational in nature (Espinoza 1998). Given the utility that such an approach has demonstrated in the San Diego/Tijuana region (Brown and Mumme 2000), what potential does this tool have for addressing water-resource issues in the Upper Santa Cruz River Basin?

Research Approach and Questions

To what degree and in what manner could watershed councils be advanced along the border in different binational basins as a bioregional approach to the water-resource challenges of flood control, wastewater management, and potable water supply? Numerous environmental conflicts are associated with these issues in the border region—upstream versus downstream perspectives of water quality, junior versus senior appropriative water rights, and conflicts between the United States and Mexico over the groundwater seepage from American surface canals that is pumped as groundwater by Mexico. How might a watershed approach to these types of issues that utilizes a watershed council promote understanding among different perspectives and aid in resolution of these conflicts?

The United States Department of the Interior developed a new definition of the border region that provides considerable insight into the issues surrounding this area; this new regionalization is solely defined by a series of interconnected border river basins, the sum of which yields a unique and holistic redefinition of the border and watershed framework for applied research (Woodard and Durrall 1996). This regionalization provides a blueprint by which watershed councils may be explored in border watersheds.

Research on the role of consejos de cuencas in the Upper Santa Cruz River Basin (which contains Ambos Nogales) can provide the foundation for a comparative analysis of consejos along the entire border. Additionally, this research pursues more applied results. The Upper Santa Cruz River Basin has major regional importance to water-resource management as it contains two very different and important active management areas lie. As described above, the TAMA is a large alluvial basin within which massive volumes of groundwater have been extracted in the last 70 years to meet regional water demand, resulting in the potential for severe groundwater overdraft and related conflicts among water users. In contrast, the SCAMA is a surface-water system that lies adjacent to the international border with Mexico and accordingly faces a range of international challenges, including how to manage surface flows that

cross the border and how to jointly manage regional wastewater. This research aims to explore how water resource challenges may be addressed within a regional framework based on watershed dynamics.

In my research, I contacted a wide array of shareholders within the Upper Santa Cruz River Basin who have a heightened interest in the basin's water resources and who have explored the possibilities of developing a binational watershed council for the Santa Cruz River. Questions posed in this research include:

1) What are the specific water-resource issues that each stakeholder faces in the basin? Who are the key stakeholders, and what institutions do they represent in examining these issues?

2) How may the existing institutional capacity to form watershed councils be enhanced along this section of the border? This capacity building may be in the form of:

- *functional enhancement:* augmentation of the resource management and policy functions of existing agencies to advance holistic solutions to problems in a watershed context (Mumme 1992 and 1993),
- *enhanced geographic sphere of influence:* increases to the geographic scope of agencies or organizations to advance a watershed context (Brown 1998), or
- *creation of a new institution:* exploration of the possibilities for a newly formed organization or institution to emerge as a truly binational watershed council.

3) What socio-cultural, economic, and political/legal impediments to a watershed council exist within the institutional framework that the above agencies and organizations comprise? How can these impediments be lessened or eliminated? Potential impediments that may exist include:

- constitutional limitations that impair organizations or agencies from expanding their spatial or functional sphere of influence,
- funding and budget limitations of needed financial resources,
- inter-agency friction or cross-sectoral conflict that may exist among stakeholders within the basin and reflect different priorities of resource use, or
- lack of active stakeholders within certain sectors of the institutional structure in the basin.

4) How can the answers to these research questions be brought together in a cohesive structural model of the hydropolitique (the politics and policy of water-resource management) of the basin and serve as a tool to promote an understanding of potentially conflicting uses?

5) To what degree may a model be developed that deals with the above questions and that may be useful in other binational basins depicted in the map by Woodard and Durrall (1996)?

Data and Methods of Investigation

The first step in my research was to conduct extensive archival research within key agencies and organizations identified in preliminary research of the Ambos Nogales region to uncover both resource-specific areas of investigation as well as specific water-resource issues of concern. I then reviewed the relevant literature to identify the main water-resource problems in the basin. I also explored the existing legal, political, and institutional structures for functional enhancement that could advance a watershed organization and reduce the attendant barriers to this enhancement.

Next, I interviewed the stakeholders identified above through a series of semi-structured queries. While I previously used this type of questionnaire in fieldwork conducted in the Tijuana River Basin (Brown 1998), my work in the Ambos Nogales region extends this research to seek location specific differences in the *hydropolitique* and to look for new potential vehicles through which a watershed council could be implemented as a conflict resolution tool. This latter point is of particular significance in that my work in the Upper Santa Cruz River Basin uncovered some previously unexplored tools that offer possibilities for regional approaches to water-resource management.

I explored both the impediments to a watershed council and potential means of reducing these obstacles in a manner similar to the way in which environmental impact statements approach barriers posed to significant environmental impacts of public works projects. Traditional positivist approaches to analyzing and ex-

tracting data from my interviews and archival research are not available; accordingly, I used a range of subjective analysis techniques and qualitative research methods for this work (Denzin and Lincoln 1994). Relevant data collected from my interviews and archival work concern the players and institutions involved in regional water resource issues; their positions on various policy options; the degree of political power they may possess; the manner in which they wield it; and the entire set of socio-cultural, economic, and political processes involved in policy development and implementation.

Discussion and Results

Stakeholders, Institutions, and Major Issues

In the early stages of this work, I compiled a preliminary catalog of stakeholders in the basin that could be active in the formation and implementation of a consejo de la cuenca del Rio Santa Cruz for water-resource-based conflict resolution. From July-December 1999, I contacted these stakeholders as well as people and institutions to whom they referred me, and I conducted interviews both to identify the major land-use and water-resource issues in the region and to explore possibilities for a consejo regional. These stakeholders included governmental agencies and staff, nongovernmental organizations, and a range of private citizens involved in water- and land-resource issues both collectively and individually. Considering these issues in conjunction with a map of the basin indicates a strong connection between a specific stakeholder or voice in the basin, the region within which this stakeholder exists, and the specific land-use and/or water-resource management issue(s) involved. Figure 2 details the spheres of influence of the major stakeholders in the Upper Santa Cruz River Basin and provides a useful visual tool to study this regional framework. These subregions, or spheres of influence, are discussed below, along with the major issue relative to each area.

San Rafael Valley. The San Rafael Valley is predominantly an agricultural region within which the headwaters of the Santa Cruz River originate. Approximately 120,000 acres of the area used for agricultural activities, 90,000 acres are publicly held and worked via lease arrangements, and 30,000 acres were privately held until the San Rafael Cattle Company holdings were sold to The Nature Conservancy (TNC) in 1998 (Sharp 1999; TNC 2000). This valley is a very rich riparian region within which a "special diversity of plants and animals exists, including rare and sensitive grassland and riparian species" (TNC 2000). The valley is also extremely well-suited to short prairie grasses indigenous to this region, making the area a prime area for ranching and related agricultural activities. For most of the last 50 years, much of the valley was worked in a holistic manner and the region functioned in a stable and sustainable manner. In a 1999 trinational research expedition to the valley, I found both conservationists and ranchers on the trip, with much experience in working and protecting grassland areas like this, who were impressed with the stability and health of this ecosystem.

However, in the early 1990s, the first significant subdivision of major land holdings occurred, splitting a large integral parcel into smaller parcels more suitable for "ranchette development." Residents perceived this subdivision as a grave risk to the integrity of the valley, and various conservation efforts were explored within the San Rafael Valley Association and the San Rafael Valley Land Trust. The coupling of development pressures and conservation efforts brings to light a major land-use management issue in the region: the fragmentation of rural land holdings caused by pressure for residential and "ranchette" development. The outcome of these pressures in the valley was the sale of the San Rafael Ranch holdings to TNC. Since the original sale of the ranch, TNC has developed a series of conservation easements and arranged for a private party to purchase these holdings with the goal of working the land and providing stewardship of the resources that exist on the ranch (TNC 2000). Of particular note is how the San Rafael Valley both illustrates the type of land-fragmentation risk that portions of the Upper Santa Cruz River Basin face and lends insight into the value that regional approaches to resource management can provide.

Mexican Reaches of the Basin. As the river flows south of the U.S.-Mexico border, it enters an agricultural region that differs somewhat from the San Rafael Valley, particularly concerning the land-tenure regime and population distribution. In the Mexican reaches of the basin, agricultural lands are held primarily as *ejidos*, yet some private *ranchos* also exist. Natural resources similar to those in the San Rafael Valley exist in this portion of the basin, yet they are managed differently and are under a greater and more immediate set of pres-

sures. Substantial irrigated acreage exists in the vicinity of the town of Santa Cruz, Sonora, which has been an important settlement for centuries. Major land-use and water-resource management issues in this region include : 1) maintaining the viability of agricultural activities given limited water resources and financial and human capital; 2) coping with water deficits due to climate variation and extensive grazing of livestock; 3) addressing the threat of urban encroachment on agricultural lands in regions near Nogales, Sonora; and 4) combating related threats to agricultural activities as urban water demand "crowds out" agricultural water use.

Ambos Nogales Region. Owing to its nature as a major urban area, the binational conurbation or "twin city" of Ambos Nogales faces a much different set of water-resource management issues. The earliest preliminary population data from the 2000 census indicate that the current population in Ambos Nogales exceeds 200,000 (INEGI 2001) generating a significant water need in the municipal and industrial sectors, and a range of related water-quality issues. Water-resource management issues in Ambos Nogales include provision of water supply to sectors of society with competing needs; development of the needed infrastructure and "plumbing" to deliver water to major sectors of Nogales, Sonora; facilitation of adequate wastewater collection and treatment; management of groundwater/surface-water interactions; and addressing a range of water-quality issues related to both groundwater and surface-water resources.

Groundwater is the major source of water for the region, and wells in both the U.S. and Mexican portions of the basin affect groundwater availability and surface-water flows in the river. Inherent in this discussion of groundwater resources is an important subtlety concerning the source of subsurface water: approximately 50 percent of the water for Nogales, Arizona, and 60 percent of the water for Nogales, Sonora, is pumped from deep groundwater resources in the Portero and Los Alisos wellfields respectively, and the balance of the water for these urban areas is pumped from wells that are much more shallow than Portero and Los Alisos wellfields that are hydraulically linked to the river (Halpenny 2001). Increasing urban groundwater extraction is impacting long-standing agricultural use of groundwater in the basin, and urban uses are also negatively impacting surface-water flows in the river and raising questions concerning sustainable use of groundwater in the future. Groundwater resources are frequently extracted at a much greater rate than that of groundwater recharge, a rate that also impacts river flows, making extensive extraction of groundwater such as that found in the Ambos Nogales region highly problematic.

In addition, drinking water is a particularly pervasive and immediate need in Nogales, Sonora, which poses special challenges for regional approaches to water-resource planning. Estimates indicate that only 50 percent of Nogales, Sonora, residents have piped water or connections to a sanitary sewer system (Solis Garza 1999). Providing an enhanced delivery network, addressing major loss of water resources through leaks, and securing a raw water source with which to meet demand are three related and very important issues that face Nogales, Sonora. These needs have led to explorations of enhanced increase groundwater extraction in the areas upstream from the city near Mascareñas, Santa Barbara, and Parades (Barcenas 1999). Towards resolution of these water-supply issues, the region has undertaken a major facilities-planning process (FPP) to enhance the wastewater collection and treatment facilities in the Ambos Nogales region, and to provide future supplies of potable water to Nogales, Sonora (Barcenas 1999; IBWC 1995).

This FPP is a binational planning effort that extends technical support to regional water-resource planning agencies with the aim of obtaining USEPA funds to construct needed wastewater- management infrastructure (IBWC 1995). Within this FPP, the U.S. and Mexican sections of the International Boundary and Water Commission (IBWC/CILA); the Sonoran Commission for Water Supply and Sewage (CoAPAES); the City of Nogales, Arizona; the Arizona Department of Water Resources, and a range of private sector consultants have cooperated over the last few years on a regional water-infrastructure effort. Both a technical working group and a policy group have collaborated on and explored various configurations of enhanced water-resources infrastructure (Barcenas 1999).

As a result of this process, an alternative was approved that provided for increased treatment capacity, upgraded treatment processes, and replacement of outfall facilities. Specifically, the treatment capacity at the international treatment plant will be increased from 17.2 mgd to 22 mgd, an amount projected to meet future de-

mands of both Nogales, Arizona, and Nogales, Sonora. Wastewater-treatment processes will be upgraded to increase nitrogen removal. These treatment processes will allow effluent treated in the plant to meet USEPA and State of Arizona regulations, and will address water-quality concerns advanced by residents downstream from the plant. Replacement of the outfall that brings sewage from the border to the plant will provide additional transmission capacity needed to convey larger flows in the future and will also eliminate extraneous flows into the outfall that were due to infiltration of baseflow into these outflowing waters (Camp Dresser & McKee 2000).

In addition, both wastewater-treatment and potable water-treatment facilities are to be built in Sonora. A small wastewater-treatment plant (4-5 mgd) employing an advanced ponding system will be built at Los Alisos in Nogales, Sonora, and a lift station will be built to convey wastewater to this new plant. Also, the existing wastewater collection network in Nogales, Sonora, will be upgraded in an effort to reduce infiltration similar to that posing problems with the outfall discussed above. (USEPA 2000). At the request of CoAPAES in Sonora, Mexico, a potable water component for Nogales, Sonora, is being planned, and this related potable water project has complicated the final design of the wastewater treatment plant and related funding issues. These complications were largely resolved in early 2001, and current plans are for approximately $8.5-million from the Border Environmental Infrastructure Fund to support the potable water component of the project (Sprouse 2001; Wachtel 2001).

Downstream From Ambos Nogales. The discharge of treated effluent from the international plant also has a major impact on surface-water and groundwater dynamics within the downstream reaches of the river, approximately from Rio Rico to Amado. The regular discharge of this effluent is the largest source of groundwater recharge in the region; over time, this effluent has become the largest contribution to regional groundwater balances. Specifically, Mexican effluent that is discharged after treatment at the NIWTP recharges downstream groundwater aquifers and provides for year-round flows in the downstream reaches of the river; an effluent-dominated ecosystem has evolved downstream that depends wholly on this discharge for its existence. One noteworthy facet of the facilities-planning negotiations has been the desire on the part of downstream riparians and of the Arizona Department of Water Resources to ensure that adequate amounts of Mexican wastewater will be diverted over the long run to insure viable levels of recharge to groundwater aquifers. This guarantee is of primary importance to the possible formation of a groundwater-replenishment district (Barcenas 1999).

Several key stakeholders have been involved in examining these water quality and quantity issues in these downstream reaches. The Friends of the Santa Cruz River (FoSCR) is a relatively long-standing nongovernmental organization representing downstream riparians and property owners in this area of the basin. Formed in 1991, FoSCR seeks to "protect and enhance the flow and water quality of the river" (Friends of the Santa Cruz River 1999a). Activities advanced by FoSCR since its inception include the Friends' RiverWatch Program, which conducts regular water-quality monitoring, environment, and watershed- education programs with local schoolchildren on both sides of the border. This project also provides input to local land development projects. FoSCR also was active in providing citizen input to government agencies working with the Mexican government towards a minimum flow guarantee for effluent discharges into the river at the NIWTP (Friends of the Santa Cruz River 1998).

Two efforts have developed in conjunction with the Santa Cruz Active Management Area that are relevant to the water-resource management issues in the reaches of the river downstream and to the north of Ambos Nogales: the SCAMA Groundwater Users Advisory Council (GUAC) and the SCAMA Settlement Group. The Groundwater Users Advisory Council, established under the Arizona Groundwater Management Code of 1980, is a governmental effort whereby private citizens who are active users of water resources regularly meet with SCAMA staff in an effort to discuss water-resource issues in the region and various means available to manage these resources more effectively. Recent Council discussion topics include the status of water rights adjudication in the region, awards of ADWR grants to study groundwater resources, results of the Statewide Safe Yield Task Force, adjustment of pumping fees for groundwater users, and the status of a SCAMA surface-water model (SCAMA GUAC 1999). Of particular note is the open manner by which these meetings are conducted. Not only are members of the Council and SCAMA staff welcome to actively participate, in-

terested members of the general public are also welcome to attend and contribute to the discussions. If openness and participation are deemed valuable to regional approaches to water-resource management, then the efforts of this Council can provide important lessons learned for future efforts in other regions along the border.

Somewhat related to the Groundwater Users Advisory Council is a less formal effort known as the SCAMA Settlement Group. The Settlement Group is composed of private citizens who own water rights within SCAMA and attorneys representing the legal interests of large water-rights holders in the region. Although ADWR staff members are not formal members of the Settlement Group, staff from both the Phoenix and the SCAMA offices regularly participates in Settlement Group meetings to provide technical support, and meetings take place in ADWR offices. The aim of the Settlement Group is to work towards resolution of water rights adjudication in the SCAMA as an alternate mechanism to the lengthy legal processes that have unfolded concerning this adjudication and that have shown little progress to date (SCAMA Settlement Group 1999). As with FoSCR, the Settlement Group functions in an open and participatory manner, which is not surprising given the membership of the group and the open manner by which SCAMA staff conduct business.

An example of this openness came in late 1999 and early 2000, when the Settlement Group worked with ADWR staff to develop and implement a pilot project whereby water-rights holders were surveyed concerning land ownership and water rights. The project's first step was the delineation of the study area, and ADWR staff presented a sophisticated computer- generated map identifying what staff thought was a reasonable area. Immediately, local water-rights holders noticed several potential problems with the delineations, including areas with limited water uses where a survey may lack utility and other locations where an uninvited visit from ADWR staff could actually pose a risk to the staff involved. To the credit of ADWR staff present, this local knowledge was actively welcomed into the debate. After more discussion, the study area was modified to take into account the hydrologic science that ADWR staff brought to the table as well as the valuable local knowledge that ranchers and other water-rights holders possessed. Given the political climate of rural southern Arizona, considerable tensions exist among water- rights holders and ADWR staff, and the cooperation evident in this meeting was essential to implementing this project.

In addition to water-quantity issues that SCAMA efforts are addressing, both water quality of the treated effluent discharged by the NIWTP and water quality of contaminated surface flows within Nogales Wash that originate in Nogales, Sonora are of particular significance. Monitoring of effluent quality and surface flows downstream from the plant has revealed elevated levels of ammonia and nitrate/nitrates (Friends of the Santa Cruz River 1999b). These levels raise water-quality concerns that have been directly communicated to USEPA staff involved in the upgrade of the NIWTP (Valentine 1999). As the primary operator of the NIWTP, the IBWC has failed to meet National Pollution Discharge Elimination System, and these water quality concerns have been a good part of the impetus for enhancements to the rigor of the treatment processes at the plant (Holub 1999).

Canoa Ranch Region. North of the region where FoSCR has been working is the Canoa Ranch, an important historical area of Pima County that has been at the heart of a development-versus-preservation debate in Pima County since the mid 1990s. Initially established as a Spanish land grant in 1821, the commonly recognized modern grant occupies approximately 6,500 acres straddling Interstate 19 in the southernmost part of Pima County. Valuable cultural resources that exist on the ranch reflect early native Piman settlement, exploration and settlement by the Spanish, and a more modern period of ranching that occurred in the 20th century under the ownership of the Manning family (Mayro 1999).

In 1994, Fairfield Homes purchased the ranch and announced plans to build between 6,000 and 9,000 homes and supporting resort facilities, thereby extending the Green Valley area of development south towards Santa Cruz County (*Arizona Business Gazette* 1995). Owing to both the historical values of the ranch and the importance of the area as a critical riparian wildlife corridor, the development plans offered by Fairfield Homes generated a great deal of conflict. Amigos de Canoa, a local advocacy group, and the Canoa Heritage Foundation have worked to preserve these values. Conversely, Fairfield Homes has argued that the zoning be upgraded

to allow more extensive development. In March of 2001, after a great deal of debate and an extensive lawsuit filed by Fairfield Homes, the Pima County Board of Supervisors voted to accept a compromise plan that would preserve approximately 85 percent of the Ranch while also allowing Fairfield Homes to build approximately 2,200 homes and 150 acres of commercial shopping areas (*Associated Press State & Local Wire* 2001).

San Xavier District of the Tohono O'odham Nation. Located just south of Tucson is the San Xavier District, one of the four units of land that form the Tohono O'odham Nation. The District is also an independent reservation predating other Nation holdings. Within its approximate 70,000 acres, several interrelated land and water-management issues face the District as an independent entity and the Nation as a whole. The District leases large parcels of land to ASARCO, a major copper mining firm in the region; this constitutes the largest land-use activity in the San Xavier District. For several years, the District and ASARCO have been in conflict over the financial terms of the leases, rock waste and tailings disposal practices, and the extraction of groundwater by ASARCO through wells adjacent to District lands (Pierson 1999).

The San Xavier District Allottees Association was formed in the early 1990s to advance the cause of the 300 District members who held allotments and had signed lease agreements with ASARCO that allowed mining development to occur on this land without relinquishing ownership to ASARCO. In the past, ASARCO had not pursued mining activity related to the leases actively enough to produce the level of royalties that District allottees had desired. In 1971, the Nation initiated legal action against ASARCO that sought a guaranteed level of royalties, and this issue was settled later that year. Another dispute surrounded how ASARCO was disposing of mining tailings and waste rock. The District has long held that ASARCO should have been abiding by mining regulations that required a certain level of reclamation. ASARCO argued that because the 1959 leases predated the mining regulations, and consequently, it was not obligated to follow these more stringent regulations.

Groundwater mining of the regional aquifer by the City of Tucson, ASARCO, and the Farmers Investment Corporation (FICO) has been another resource-management conflict in the region, an expected result of extensive pumping by regional economic interests. Due to this pumping, the water table in District wells dropped dramatically, increasing pumping expenses precipitously and consequently making agriculture unprofitable for the cooperative farming operations in the District. Legal action initiated by the Nation and the District led to the Southern Arizona Water Rights Settlement Act, which provided 27,000 acre feet of water to the District directly and exchange rights to another 23,000 acre feet through indirect grants of water rights to the Nation.

The scope of land- and water-resource-management issues that have faced the San Xavier District reflect both competing interests for scarce water resources and conflicting viewpoints on how to best manage mining operations in a manner that balances return on investment for various parties with reclamation needs of District allottees. It is notable that the majority of these issues appear to be approaching resolution through a combination of stakeholder-driven legal actions on the part of various stakeholders and interpersonal communication among the various parties involved. During interviews, these stakeholders appeared genuine in their efforts to resolve these conflicts and were wary of intervention that could jeopardize resolution.

Urban Reaches Around Tucson. The subregion within the Upper Santa Cruz River Basin that contains those reaches of the river within the urban area of Tucson hosts a wide range of governmental and nongovernmental stakeholders who interact on a wide range of issues related to river restoration or rehabilitation. In fact, one of the more promising organizations that could lead to a broader watershed approach to water-resource management in the basin, the Santa Cruz River Alliance (SCRA), evolved from discussions concerning urban stream rehabilitation.

In October of 1997, the mayor and city council of Tucson approved the formation of a Santa Cruz Advisory Committee, whose goal was to explore opportunities for an urban river renewal project that would include active public participation (City of Tucson 1997). The Committee met for approximately one year to discuss various options, and these options were shared with a larger public audience in a Santa Cruz River Restoration Conference in November of 1998. Out of the Conference and related activities, interested members of the public came together in January 1999 to form the SCRA, a group aiming "to promote ecological restoration and

conservation of the natural and cultural resources of the Santa Cruz River and its watershed" (SCRA 1999).

Land- and water-resource management issues in this part of the basin reflect the impact of a large and growing urban area within an extremely arid region. Historically, the Tucson region has relied almost extensively on high quality groundwater resources for water supply. Currently, heavy pumping rates with extremely slow recharge are combining to threaten long-term supply of water for the region (ADWR 1998). Attention has turned to inter-basin transfers of surface-water resources brought to the region by the Colorado River via Cental Arizona Project (CAP). Although this imported water has the potential to significantly augment declining groundwater resources, the physical quality of these waters is problematic. Poorly implemented use of this surface water in the mid 1990s resulted in a firestorm of criticism from the public who found the taste and odor of the water offensive; in some cases considerable property damage resulted. The paradoxical outcome of this initial use of CAP water is that a large available source of water (approximately 150,000 acre feet) was not used to its potential in a highly arid region that relies to large degree on declining groundwater reserves (Jacobs 1999; ADWR 2001).

Groundwater recharge, where CAP water would be injected into regional aquifers at a much higher rate than would normally occur through infiltration of precipitation and surface runoff, is one way CAP has been examined as a means to increase regional water supply. Owing to the natural hydrology of the river, this portion of the basin has seen intermittent flows. Many stakeholders in this part of the basin would like to see flow return to the river, even if this were to occur through a manufactured method. Linking groundwater recharge with urban stream rehabilitation in the Santa Cruz River Basin could provide for flows in the river; while this possibility is a subject of some research, the concept has not been proven within a scientific arena. Furthermore, landfills and other toxic disposal sites within the recharge zones in the river floodplain pose considerable problems that would be extremely expensive to rectify (Jacobs 1999). Stakeholder opinion in the basin differs on the degree to which recharge can be linked to urban stream rehabilitation, making it an area of lively discourse in the urban reaches of the river.

Flood control is another issue related to rehabilitation efforts in this section of the river. "Soil cement," or the installation of concrete walls that mimic the soil surfaces of steep banks in urban areas, is one extensively used means of flood control, yet this practice is not without its critics. Certain stakeholders argue that this practice makes for a very barren and sterile river environment within which natural or transplanted vegetation cannot survive. In spring 2001, the Santa Cruz River Alliance convened a second Santa Cruz River Conference at which alternatives to this type of flood control were explored in an open and public manner.

Potential Vehicles to Advance Region Building and Regional Cooperation

International Boundary and Water Commission (IBWC/CILA). As stated in the 1944 Water Treaty and reaffirmed in the La Paz Agreement, the IBWC/CILA clearly have a pre-eminent role in binational water-resource management (United States of America and the United Mexican States, 1944 and 1983). What then is the potential role of IBWC/CILA in efforts towards region building and a watershed council? Previous research found that the IBWC/CILA could clearly play a crucial technical role in a wide range of border water-resource planning, yet its history of open and participatory engagement of the public is both problematic and inconsistent at best (Brown and Mumme 2000). Nonetheless, this agency clearly had an important role in the Border Water Council formed in San Diego/Tijuana, a role that emerged in conjunction with crucial work that was done by the Consul General of Mexico to the United States in this region.

The situation in Ambos Nogales is much different that that in the San Diego/Tijuana region, due both to the geography and the political culture of this part of the border. However, in clear contrast to the situation in San Diego and Tijuana in which IBWC and CILA staff advanced a regional approach, little if any efforts towards a regionally based approach that would take advantage of local and regional expertise have been advanced by CILA or IBWC staff in the region (dos Santos 2001).

Official activities of CILA and IBWC surrounding the facilities-planning process discussed earlier illustrate how IBWC/CILA may view local participation in wa-

ter-resource management. This facilities-planning process was put in place by USEPA to more actively involve regional stakeholders in the planning of new water resource infrastructure in the Ambos Nogales region (Barcenas 1999). This overall planning effort was formally advanced under IBWC/CILA Minute No. 294, in which language included a public-information component. IBWC was the lead agency in the facilities-planning process, and a range of agencies at many levels of government and on both sides of the border were involved, as well as private sector technical consultants (IBWC/CILA 1995).

After extensive consultation within both a technical working group and a policy level group, the specific project alternative for enhanced treatment capability and expansion of the plant's capacity that was previously discussed was broadly shared with the public in a December 1999 steering committee meeting convened in the SCAMA office. The goal of this meeting was twofold: to share the technical details of the project with the public and, perhaps more important, to lay out a plan whereby members of the local community would "sign on" to this project and provide the needed public participation component of a forthcoming proposal to the Border Environment Cooperation Commission (BECC) for certification for NADB (North American Development Bank) and Border Environment Infrastructure Fund (BEIF) funding (Camp Dresser & McKee 2000). BECC, IBWC, and the private consultant involved in the project were striving to involve the public in this process, and the local community acknowledged and welcomed this increase in public participation.

However, the timing of this public involvement was problematic on many levels. The public participation process needed to be completed by March 23, 2000, to ensure access to the maximum amount of BEIF monies, yet the convening of the public participation meeting in early December left less than 120 days in which to hold two public meetings, allow 30-day and 45-day comment and review periods respectively, and compile a complex document with fairly stringent guidelines. Participants at this initial meeting reflected a willingness to work with the process and an appreciation for more public involvement within projects managed by IBWC/CILA. Yet participants' comments also manifested their frustration over being invited so late as to have little opportunity to impact the design and planning process. In addition, this delayed invitation was seen as an obstacle to completing the public participation process adequately and in the time allowed. Finally, concerns were also raised about the IBWC/CILA commitment to truly involve the public and regional players in this process, given the ill-timed public invitation.

These experiences concerning IBWC/CILA's manner in undertaking the regional outreach and public participation activities raise some questions about how to drive the formation of a binational watershed council in the Ambos Nogales region. It appears that an effort towards a binational watershed council is unlikely to be forthcoming from IBWC/CILA in this region of the border. This comment is not meant as an indictment of any of the people involved in the process; rather it is offered as a comment concerning the institutional inertia that the IBWCand CILA exercise in these types of project.

Mexico's National Water Commission (CNA). The National Water Commission of Mexico, Comisión Nacional del Agua (CNA), is the other agency essential to regional efforts to borrow the watershed council concept, based on language in la Ley de Aguas Nacionales. Previous research has indicated that this agency's regional offices may be more prone than national headquarters to engage in decentralization efforts conducive to a binational watershed council along the border (Brown 1998 and Brown and Mumme 2000). A key point to examine in the Upper Santa Cruz River Basin is how willing CNA regional staff (especially the Ambos Nogales region) might be to discuss the formation of a regional watershed council in the Ambos Nogales region.

Interviews with two CNA engineers illuminated numerous barriers to this type of regional participation (Rodriguez and Oros 1999). The preeminence of CILA as the lead Mexican federal agency in water resource matters concerning the United States was one of the most over-arching issues to emerge from these discussions, and the CNA staff interviewed unequivocally deferred to CILA in all matters relating to binational water issues or management options. In addition, CNA staff did not see a watershed council as advantageous to Mexican interests in the basin and instead offered an alternate treaty mechanism similar to the 1944 Water Treaty. Perhaps the most notable comment reflecting CNA's centralized manner suggested that the decen-

tralization that has occurred elsewhere in Mexico is not happening in the Upper Santa Cruz River Basin (Rodriguez 1997; Brown 1998; Mumme and Brown 2001).

Offices of the Consuls General. The last piece of the national/international institutional framework that would influence the formation of a watershed council in the Upper Santa Cruz River Basin is that of the Offices of the Consuls General that operate in twin cities along the border. The U.S. Consul General to Mexico that resides in Nogales, Sonora, and the Mexican Consul General to the U.S. that resides in Nogales, Arizona, operates respectively within the U.S. Department of State and Mexico's Secretaria de Relaciones Exteriores. Activities from the sister offices in the San Diego/Tijuana region eventually led to establishing the Border Water Council, and it is instructive to discuss how this framework in Ambos Nogales enters the calculus of binational water policy reform efforts.

The potential for the offices of Consuls General to facilitate regional discourse among a wide range of regional agencies in the Ambos Nogales region is clearly evident, as past activities of the U.S. and Mexican Consul General has demonstrated (Gray 1999). During the late 1990s, the U.S. and Mexican CGs in Ambos Nogales convened quarterly border liaison mechanism meetings involving agencies in the region that examined a wide range of issues. Y2K compliance, public safety issues related to immigration and immigration-control efforts, and social and economic development have been examined through border liaison mechanism meetings (Gray 1999; Rodriguez 1999)[5]. Such discussions clearly reflect the border liaison mechanism's usefulness in convening representatives from a wide range of local and regional agencies with invaluable local knowledge and the local Consul General in the Ambos Nogales region to facilitate these meetings.

Despite this success in region building on a wide range of efforts, the Ambos Nogales Consuls General have not been active in water-resource issues. A great deal of the momentum and leadership for binational water-resource management and planning in the region has come from IBWC/CILA through the facilities planning process discussed previously. To a large degree, the Consuls General have deferred to the traditional role of IBWC/CILA in water-resource issues (Rodriguez 1999). This may reflect regional sensitivities, a greater set of asymmetries across the border than is evident in San Diego/Tijuana, and a shorter period of time within which the border liaison mechanism has been exercised in Ambos Nogales (Rodriguez 1999). Further, it is possible that lack of activity within the border liaison mechanism framework in water-resource issues may also reflect IBWC/CILA's historically larger role in regional water-resource issues owing to their involvement and management of the international wastewater-treatment plant.

Very recent events in the Ambos Nogales region involving the Arizona Department of Environmental Quality (ADEQ) and the offices of the Consuls General reflect more innovative approaches to environmental issues within the border liaison mechanism framework. For the last few years, ADEQ's coordinator of border issues has been working with the Consuls General and a range of regional agencies in two areas: air quality and emergency response and preparedness. From this collaboration, two working groups, the Air Quality Working Group and the Border Emergency Planning Committee, have emerged as focused efforts within the Economic and Social Development subcommittee of the border liaison mechanism. These recent examples of cross-border collaboration within the border liaison mechanism on environmental quality issues highlight the promise that this framework has for a wider array of environmental issues. These efforts could include water-resource management loosely cast within a watershed council type of framework.

State and Regional Context. North of the border, the active management areas (AMA) framework of the Arizona Department of Water Resources (ADWR) offers useful insights into regional approaches that could support a watershed council or consejo effort. As detailed earlier, the Groundwater Management Code of 1980 established AMAs based on groundwater basin divides as subregions within which ADWR would conduct its management of water resources in Arizona (ADWR 1999a). Hence, both the Tucson AMA and the Santa Cruz AMA are subregionalizations consistent with a hydro-regionalization in which a watershed or basin approach is actively advanced (Jacobs 1999). In fact,

[4]The border liaison mechanism is a joint U.S.-Mexico federal initiative operating under the auspices of the U.S. Department of State and Mexico's Secretaria de Relaciones Exteriores (SRE - Mexico's Department of State) that provides a protocol for dealing with a range of binational issues at a regional level.

the recognition of the original TAMA's hydro-regional and institutional differences in its northern and southern portions led to revising this original AMA into the current TAMA to the north and SCAMA to the south (ADWR 1999b; Jacobs 1999). Examining each AMA individually provides further insight into how the AMA framework is consistent with the regional approach to water-resource management that a watershed council seeks to advance.

Within the TAMA, the ADWR manages a wide range of water-resource issues predominantly linked to groundwater resources or the management of imported CAP resources, activities that are carried out regionally and in a manner consistent with the establishment of the AMA boundary. However, there are various possibilities for TAMA to increase its functional sphere of influence consistent with a more holistic approach in the Tucson portion of the Upper Santa Cruz River Basin. Functional enhancement refers to the TAMA increasing its functional reach within the current TAMA region rather than expanding its spatial reach into the SCAMA or other regions.

The Safe Yield Task Force is an effort advanced within the TAMA framework that examines policies towards a balanced and sustainable use of groundwater resources, use that would provide a "safe yield." Recommendations of the Task Force include enhanced management of exempt wells, industrial and agricultural groundwater rights, enhanced use of CAP resources including a replenishment district, and exploration of better conservation practices (ADWR 1999b). One of the more innovative recommendations of the Task Force is a suggestion to explore options for sub-area management that could be implemented as "overlay zones" to be executed within an "overlay approach."

Overlay zones would focus on immediate local efforts, "looking within each AMA" for subregions within which specific management needs exist and developing appropriate management policies. Specific management needs that would be explored in overlay zones include subsidence mitigation, water-supply management, Indian rights management, water- quality management (a joint issue for ADWR to examine with input from ADEQ), and riparian enhancement and rehabilitation. This entire set of management objectives would also take into account the hydrologic connectivity of surface water and groundwater resources, a relationship that is not acknowledged in existing water resource regulation in Arizona. "Sustainable yield in this context would include a component to protect surface-water flows, not just groundwater balance" (ADWR 1999b).

What are the impediments to this logical extension of the regional approach to water- resource management in the TAMA? Stakeholders whose water use would be regulated may be resistant to policies advanced under overlay zones, as would individuals within overlay zones who are generally in opposition to government regulation. Arizona is well-known for a sense of rugged individualism that does not always welcome government intervention in natural resource management, and consequently, resistance to overlay districts is expected. In addition, the Groundwater Management Code does not allow AMAs to be broken into subregions (the 1994 split of the original TAMA into two smaller AMAs required Arizona Senate Bill 1380), providing a major legal barrier to this subregionalization.

How might these impediments be lowered or eliminated to allow overlay districts to proceed? From a legal and administrative perspective, a change to the Groundwater Management Code would be needed to allow the TAMA to be redrawn into functional subregions that would function as overlay zones. The AMA would not actually be divided into smaller AMAs; rather the AMA would remain intact, but different management policies could be applied within subregions (Jacobs 1999). Discussions with water-resource experts in the Upper Santa Cruz River Basin indicate that this type of change to the Groundwater Management Code is possible, provided the socio/cultural and economic dimensions to this change were handled properly. In this regard, the Tucson Active Management Area Safe Yield Task Force Issue Summaries outlining overlay zones provides excellent suggestions in this regard. "Equity concerns will be a major impediment unless there is a consensus that the selected approach is fair and reasonable" (ADWR 1999b). ADWR would need to work with affected stakeholders in the development of overlay zone policies, cost benefit analyses would be required to support these changes, and a review and appeals process would be essential to handle objections and changes in the physical conditions of the overlay zones.

Perhaps one of the more interesting insights gained from discussions of TAMA issues concerned the degree that the present regional approach of AMAs ap-

proximates the manner by which a watershed council would function. In response to a query concerning how a watershed council in the Upper Santa Cruz River Basin might be realized, a high level official with the ADWR responded that the ADWR is "already doing this type of work through the AMA approach" (Jacobs 1999).

Looking to the south in the Santa Cruz Active Management Area, similar opportunities for approaches to water-resource management that are consistent with a watershed council are evident. As noted earlier, two efforts advanced within the SCAMA offered particular promise in this regard: the SCAMA Groundwater Users Advisory Committee and the SCAMA Settlement Group. Both of these efforts are solidly based on a hydrologic, regional approach based on sound scientific work that actively includes local and regional knowledge and expertise. The success of these efforts to date reflects how important local participation is; this participation is particularly well-suited to watershed councils. In this AMA much of the work that watershed councils are suited to conduct is already being done within the SCAMA, reflecting the utility of regional approaches to water-resource issues.

One of SCAMA's most unique aspects is its location on the U.S.-Mexico border: ". . . the legislature recognized the international nature of water management issues facing the Upper Santa Cruz River Basin . . . and the desire of the water-using community to participate in binational coordinate efforts" (ADWR 1999b). As noted previously, one of the most difficult binational challenges facing the SCAMA is how to reconcile the confluence of issues related to binational wastewater in the Ambos Nogales region and the role of discharged treated effluent in regional water balances. This is exactly the type of binational water-resource management challenge that is suited to a watershed council approach.

Given the region's increasing rates of groundwater extraction and the daily generation of millions of gallons of treated effluent, what prospects exist for acknowledging the hydrologic connectivity of surface water and groundwater in the Ambos Nogales region? Various water-resource experts in the region have advanced the idea of a binational, regional, groundwater-replenishment district as a means of reconciling the needs of various interest groups and water users across the border in a regional framework that acknowledges both regional linkages and the value of regional and local knowledge (Holub 1999; Barcenas 1999; SCAMA GUAC 1999).

Presently, approximately 10-million gallons per day (mgd) of wastewater generated in Nogales, Sonora, are diverted to the Nogales International Wastewater Treatment Plant in the United States. At the plant, these flows and approximately 5mgd of wastewater from Nogales, Arizona, are treated and discharged into the Santa Cruz River. The cost to Mexico for treatment is approximately $300,000 per year, and this amount is paid by CILA. The NIWTP was built with U.S. federal monies, and the IBWC and the City of Nogales have jointly managed the plant.

Of note is that the Mexican government owns the wastewater generated in Mexico. As wastewater, it lacks immediate value; however, once it has undergone various levels of treatment, this wastewater can have value as reclaimed water for a variety of uses. Once the wastewater crosses the border and enters the plant on the U.S. side, it is owned by the IBWC or City of Nogales. (This ownership and related management duties have been shared to various degrees in the past). After the effluent is treated and discharged into the river, it becomes an appropriable water resource within the State of Arizona (Barcenas 1999).

This dynamic takes on additional importance when the impact of the treated effluent on downstream surface and groundwater balances is addressed. Treated effluent is the largest input of water supply into these water balances and is essential both to the riparian condition in downstream reaches and as a source of groundwater recharge to downstream aquifers. The reliability of wastewater input into this water balance is also important to the IBWC, USEPA, and BECC, as all plans for expanding wastewater-management infrastructure in the Ambos Nogales region require that minimum inflows of effluent arrive at the plant both to justify build-out of the plant and to insure efficient and effective plant operation.

Implicit in this situation is the need for a guaranteed minimum wastewater flow generated from Mexico; the conditions by which this guarantee are arranged form the pre-conditions for a binational groundwater replenishment and management district. One possibility for an entity (perhaps the City of Nogales) to as-

sume the $300,000 per year cost of operation and maintenance that Mexico is currently paying and to provide additional funds to buy or lease the rights to the wastewater involved in exchange for guaranteed minimum flows to the plant. A variation on this theme would see some U.S. entity provide treated potable water in exchange for the flow guarantee, perhaps at a 3:1 effluent to potable-water credit rate (Barcenas 1999). This minimum flow guarantee would then be credited by the ADWR as an assured water supply as well as a valid source of supply for future management options. The actual discharged effluent would continue to enter the hydrologic system in this portion of the basin as a source of groundwater recharge, which could then be appropriated by some form of water right or lease. Upon sale or lease of these rights, proceeds would fund the operation of the district and financial transfers of groundwater recharge to Mexico.

Although a complex matrix of water flows, ownership, and potential terms of exchange, the above arrangement of some form of "Ambos Nogales Binational Groundwater Replenishment and Management District" has considerable potential to meet regional water resource management needs well into the future. This arrangement could be viewed as a form of a watersjed council that would incorporate the value of local and regional knowledge in a spatial framework consistent with a subregion of the Upper Santa Cruz River Basin.

Although the above framework offers promise for innovation in binational water-resource management, it is not without considerable barriers. Foremost of these are the tendencies of the large federal and international agencies involved in border water-resource management to not openly and actively engage the public and regional players (Barcenas 1999; Holub 1999). In this regard, IBWC/CILA and the National Water Commission (CNA) of Mexico may obstruct this type of regional cooperation. As noted in the 1944 Water Treaty, IBWC/CILA have the preeminent right and responsibility to direct binational water resource management and planning (UMS and USA 1944), and past experiences have shown this joint agency reluctant to surrender political primacy. In addition, la Ley de Aguas Nacionales established CNA as the Mexican agency with absolute authority for management of federal water resources (CNA 1992 and 1997). It is clear that both the CNA and IBWC/CILA must be at the table for a replenishment district to emerge, and to date the needed participation and willingness to work with regional stakeholders has not been evident.

At the state and regional levels, issues of management and control are also potential barriers. Were a replenishment district to emerge, who would manage and control the district: ADWR headquarters in Phoenix, the regional staff of the SCAMA, or local stakeholders operating outside of the formal ADWR framework? Historical management of the ADWR may argue for the former, while the degree of regional expertise and perspective would argue for the latter. An alternate arrangement to outright management by the ADWR would be an independent entity, and discussions of many facets of this possibility are presently occurring in the Settlement Group (Halpenny 2001). For the needed support within the legislature and executive branches of government to materialize this management issue would need to be resolved. Lastly, a lack of experience in managing traditional surface waters exists within the AMA framework, a framework that evolved primarily to manage groundwater resources.

How might these barriers be removed or lessened? At the federal level, participation of the Consuls General that serve the Ambos Nogales region through the border liaison mechanism may help to facilitate a willingness on the part of CILA and CNA to explore such a district. In addition, IBWC/CILA's recent tendency to employ a more participatory and open management style would advance proper linkages between IBWC/CILA's leadership and regional stakeholders to emerge. Ambos Nogales is a smaller urban region than many other twin cities along the border. These qualities are valuable to the success of an intra-regional effort. Long-term communication and lobbying at the state and nationals level will also increase the likelihood that individuals in key positions will be willing to help such an effort (Holub 1999).

Local and Regional Stakeholders. While there are promising areas of regional cooperation based on governmental efforts, what of the nongovernmental sector and members of the general public? The experiences of two such nongovernmental organizations (NGOs) offer insights regarding the potential contributions of NGOs to region building towards a watershed council.

The Friends of the Santa Cruz River (FoSCR) is the longest standing of the watershed organizations in

the basin, and has succeeded at a range of environmental monitoring and education efforts, as well as focused advocacy on behalf of protecting and enhancing the quality of riparian areas. The majority of these efforts have been narrowly focused on the reaches of the river downstream from Ambos Nogales to Amado, although other initiatives include outreach and environmental education involving Mexican school children. This limited geographical scope has allowed the FoSCR to be successful in its activities, yet it also limits the spatial sphere of its influence to this reach of the river. Limited financial resources and staff have also been factors preventing FoSCR from playing a larger regional role in the Upper Santa Cruz Basin.

The other watershed advocacy organization that has played an increasing role in the Upper Santa Cruz River Basin is the Santa Cruz River Alliance. The mission of the organization speaks to a wider geographical scope and also a wider set of issues intended– "to promote ecological restoration and conservation of the natural and cultural resources of the Santa Cruz River and its watershed." The Alliance has successfully engaged a wide range of individuals, other NGOs, and staff from many important public agencies involved in urban river rehabilitation as evidenced by the invited speakers at the Second Santa Cruz River Conference that took place from March 30-April 1, 2001 (SCRA 2001)[6]. Discussions with key members of the Alliance indicate that the entity would welcome opportunities to increase the spatial reach of their advocacy work and involve a wider range of people in an open and participatory manner. The fact that the group's name casts the entity as an "alliance" also speaks to the desire to involve a variety of people and other organizations under an umbrella of interested parties working to protect and enhance watershed resources.

The Alliance faces barrier to expanding their spatial and functional reach. Founded in 1999, this new organization is wrestling with the issues familiar to all new entities. Much of its early work focused on generating membership and providing opportunities for people to learn about relevant issues and to get to know one another. More recently, the Alliance has been able to refine the focus of its activities, evident in the group's upcoming conference on river rehabilitation projects in urban reaches of the basin (SCRA 2001). Despite its maturation, as a volunteer NGO, the group lacks a solid funding base that would support a dedicated staff; furthermore, while members are dedicated to the group, there are limits on their time and energy. Lastly, as an NGO, the group lacks the political role to directly influence the politics of water-resource management or specific management decisions. While numerous public agencies respect the work of the Alliance, its voice is advisory at best, and the group is unable to convene basin-wide activities on a formal basis.

Despite these barriers, the Alliance is well-positioned to contribute substantially to a watershed approach to water-resource issues in the Upper Santa Cruz River Basin. The Alliance's history as an entity offering a grass-roots response to pressing issues in the urban reaches of the river reflects the value of local knowledge and expertise of the members of the Alliance. The open and participatory manner by which the Alliance operates also bodes well for a regional approach to watershed management. The group's successes over the last two years reflect an organizational maturity essential for future efforts and a level of momentum to continue building upon.

Conclusions

What insights involving water-resource policy may be of use in other border regions? Perhaps the most evident conclusion concerns prospects for a binational watershed council, a basin-wide effort encompassing the entire Upper Santa Cruz River Basin, that is consistent with the intent of developing watershed councils and approaches that is stated clearly in U.S. and Mexican policy documents. Although la Ley de Aguas Nacionales calls for councils, or *consejos*, and USEPA argues the merits of watershed-based research, the barriers to a comprehensive watershed council in the Upper Santa Cruz River Basin appear to be considerable. Yet, the political realities of the stakeholders involved, the regional and hydrogeological nature of subregions within the basin, and the strong local and regional connection that people have for the places within which they work

[6]The entire focus of this conference was to bring a wide range of people from the public and private sectors together to discuss urban stream rehabilitation. Speakers included Ann Riley, a nationally recognized expert on stream rehabilitation, Lewis McAdams, Director of the Friends of the Los Angeles River, and John Drake, US Army Corp of Engineers staff person involved in Arizona-Nevada planning (SCRA 2001).

and live combine to make an overarching regional approach difficult, at best, to develop and implement.

Figure 2 illustrates some of these dimensions to a watershed-wide effort. Many of the basin's stakeholders work and live within subregions that they know better than those living and working elsewhere; good faith attempts by people outside the region to work towards resolution of problems may not be welcomed or successful. Furthermore, despite dramatic changes in the way people communicate and move information, no substitute exists for the day-to-day and face-to-face interaction that those people living in a region experience. To what degree is it feasible for people in Ambos Nogales to be active and effective in advancing urban river issues in Tucson? Given the unique connection to the land that the Tohono O'odham people have, how effective can others be at addressing the issues evident in the San Xavier District?

Although an overarching basin-wide effort may not be likely to emerge in the Upper Santa Cruz River Basin, there are numerous cases of successful regional approaches in this area that capitalize on the value of local and regional knowledge. The FoSCR has been very successful at the work it has conducted in the reach of the river downstream of Ambos Nogales, as has the Santa Cruz River Alliance with its work in the Tucson region. Due to the hard work done by members of the San Xavier District and other stakeholders with which the District interacts, resolution of a range of environmental conflicts appears promising. ADWR staff within both the Tucson and Santa Cruz active management areas have seen success in advancing regional approaches to water- resource management, as well as a great deal of potential for other regionally based innovations in the future.

Many other examples of successful environmental conflict resolution based on regional approaches exist in the Upper Santa Cruz River Basin. A gran consejo may not be the likely outcome of these efforts, yet the value of regional approaches that capitalize on the same elements on which watershed councils are based is clearly evident. Specifically, approaches that examine subbasins and related subregions, and capitalize on the community of shared hydrogeological resources, shared concerns, and the necessity to work together are useful in solving applied water-resource management issues.

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Acronyms

ADEQ: Arizona Department of Environmental Quality

ADWR: Arizona Department of Water Resources

AMA: Active Management Area

BECC: Border Environment Cooperation Commission

BEIF: Border Environment Infrastructure Fund

CAP: Central Arizona Project

CILA: Comisión Internationales de Limites y Agua

CNA: Comisión Nacional del Agua

CoAPAES: Comisión de Agua Potable y Alcantarillado del Estado de Sonora

FICO: Farmers Investment Corporation

FoSCR: Friends of the Santa Cruz River

FPP: facilities planning process

GUAC: SCAMA Groundwater Users Advisory Council

IBWC: International Boundary and Water Commission

INEGI: Instituto Nacional de Estadistica, Geografia y Informatica

IRSC: Institute for Regional Studies of the Californias

NADB: North American Development Bank

NAFTA: North American Free Trade Agreement

NIWTP: Nogales International Wastewater Treatment Plant

SCAMA: Santa Cruz Active Management Area

SCRA: Santa Cruz River Alliance

TAMA: Tucson Active Management Area

TNC: The Nature Conservancy

UMS: United Mexican States

USEPA: United States Environmental Protection Agency

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