

Executive Summary

Opportunities, Costs, Benefits, and Unintended Consequences: Secure and Sustainable Water by 2020

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INTRODUCTION

Water has emerged as a first-tier issue between the United States and Mexico, a situation that has potentially serious implications for the whole of the bilateral relationship. Border Institute IV, held in Rio Rico, Arizona, from May 6–8, 2002, successfully initiated another level of binational dialogue on border water issues, a necessary first step toward long-term planning and regional sharing of water and water-related resources.

Water management in many ways exemplifies the challenge of sustainable development. As population explodes in the border region, the demand for clean water increases. This increased demand intensifies competition among water users, including the economy, communities, and the environment itself. The challenge is to balance the needs of natural resources—which represent the future—with current demands from the two nations' economies and citizens.

Because border rivers and aquifers are inherently binational and because the institutional capacity to address groundwater issues is lacking, the Institute participants generally agreed that the federal governments of the United States and Mexico should take more proactive roles in addressing border water issues. Even top-level decision makers recognize the need for long-term planning. As the *New York Times* reported on May 24, 2002: “President [Vicente] Fox says Mexico has spent decades squandering what it has ‘without planning, without sense.’” Similarly, water use and distribution are less-than-optimally distributed in the United States because water policy is based more upon precedent than principle.

Some efforts by the federal governments to implement river basin planning have been successful at integrating various components of

overall environmental quality. The U.S.-Canadian International Joint Commission (IJC), for example, monitors and regulates water drawn from the Great Lakes. However, long-term planning to meet demand in the United States is confounded by states' rights over groundwater and some surface water, while in Mexico, water is wholly a federal matter. These institutional and jurisdictional "mismatches" clearly necessitate a carefully constructed, high-level resolution by the two nations.

OBJECTIVES AND FOCUS OF THE BORDER INSTITUTE SERIES

The Southwest Center for Environmental Research and Policy (SCERP) created the Border Institute series in 1998 because it recognized the need for a binational forum that would facilitate environmental policy discussions within the complex framework of Border XXI. SCERP foresaw the potential value of translating the results of scientific investigation into solid environmental policy. Hence, the purpose of the Border Institute series is to convene academics, policymakers, industry leaders, and other border stakeholders in a collegial yet highly work-intensive atmosphere to formulate policy recommendations and devise potential solutions to pressing environmental border problems. Participants are encouraged to focus on the region as a whole and on "the current year plus twenty" horizon, a conceptual two-decade window and landscape scale that foster the development of long-term policy recommendations.

Each Border Institute addresses the policy implications of selected border environmental issues. It must be emphasized, however, that the Institutes are not a series of isolated conferences. Rather, the thematic focus of the Institutes seeks to address border environmental policy problems in a programmatic way. Border Institutes I, II, and III investigated, respectively:

- Demographics and economic development asymmetry across the border
- Environmental infrastructure, natural capitalism, and environmental accounting
- Energy and its interdependencies in the border region

Recommendations from the Border Institutes, in the form of

executive summaries and this volume in the SCERP Monograph Series, are widely disseminated to decision-makers and other border stakeholders. Presentations from Border Institute IV are available online at www.scerp.org.

OVERVIEW OF WATER ISSUES

There is no more important issue than water. Few substances are as vital to the border's future as water and no subject has dominated the past decades' headlines as the scarcity of water and its human dimensions. Furthermore, water capital on the border to the year 2020 is shaped by two fundamental factors: first, the variable supply of naturally occurring water, and second, the steadily rising water demand. The sources of conflict stem from competition among user groups, as summarized in Figure 1.

Figure 1. Competition among Water User Groups

Upstream Users	–	Downstream Users
Surface Sources	–	Ground Sources
Urban Inhabitants	–	Rural Inhabitants
Economic	–	Environment and Ecology
Agriculture	–	Cities and Industry
Drought Years	–	Normal Years

Source: Author

Other users—including tribal nations, ecological resources, and rural communities—now compete for water of which they were once the sole user. Water is becoming such a major international issue that many foresee serious conflicts emerging from worsening tensions and disputes over this resource.

WATER ALONG THE INTERNATIONAL BOUNDARY

Although water in the arid U.S.-Mexican border region has a long history of negotiation and engineering, it remains a highly contentious issue. Water is locked up by treaties, pipes, and channels. The 1944 Treaty for Utilization of Waters of the Colorado and Tijuana Rivers and the Rio Grande still serves as the principal point of reference for the two nations on questions of boundary waters, although many consider it to be too limited in today's context of demographic growth and drastically shrinking supply.

The current binational appropriation structure is a hopeless anachronism. While all recognize the difficulty of changing the treaty, most also realize that it has greater flexibility than many realize and can be used to deal with current and emerging problems.

For water planning purposes, the border region can be divided into three subregions (Figure 2): the western region, which is dominated by the Colorado River watershed (the Californias, western Arizona, and western Sonora); the central region, dominated by no large or single river system (Sonora, Arizona, New Mexico, and western Texas); and the Rio Grande/Río Bravo drainage (eastern New Mexico, Texas, and the four eastern Mexican border states).

It is important to remember that many tribal nations are also in the border region and that they face important water issues. For example, the very existence of the Cocopah or "People of the River," who once had flourishing communities along the lower Colorado River and delta, is now threatened because of decreasing river flows.

INTERDEPENDENCIES AND DISCONTINUITIES

Water is connected to nearly all measures of quality of life (human health, environmental processes, ecological integrity, and economic vitality), yet is subject to control by disparate agencies and competing interests. Water quality cannot be divorced even slightly from water quantity, nor can groundwater issues be separated from surface water concerns. Flows of water underneath the border, for example, not only replenish aquifers but can also transport contaminants. Additionally, water is intimately linked with energy, air quality, and economic development issues.

Figure 2. U.S.-Mexican Border

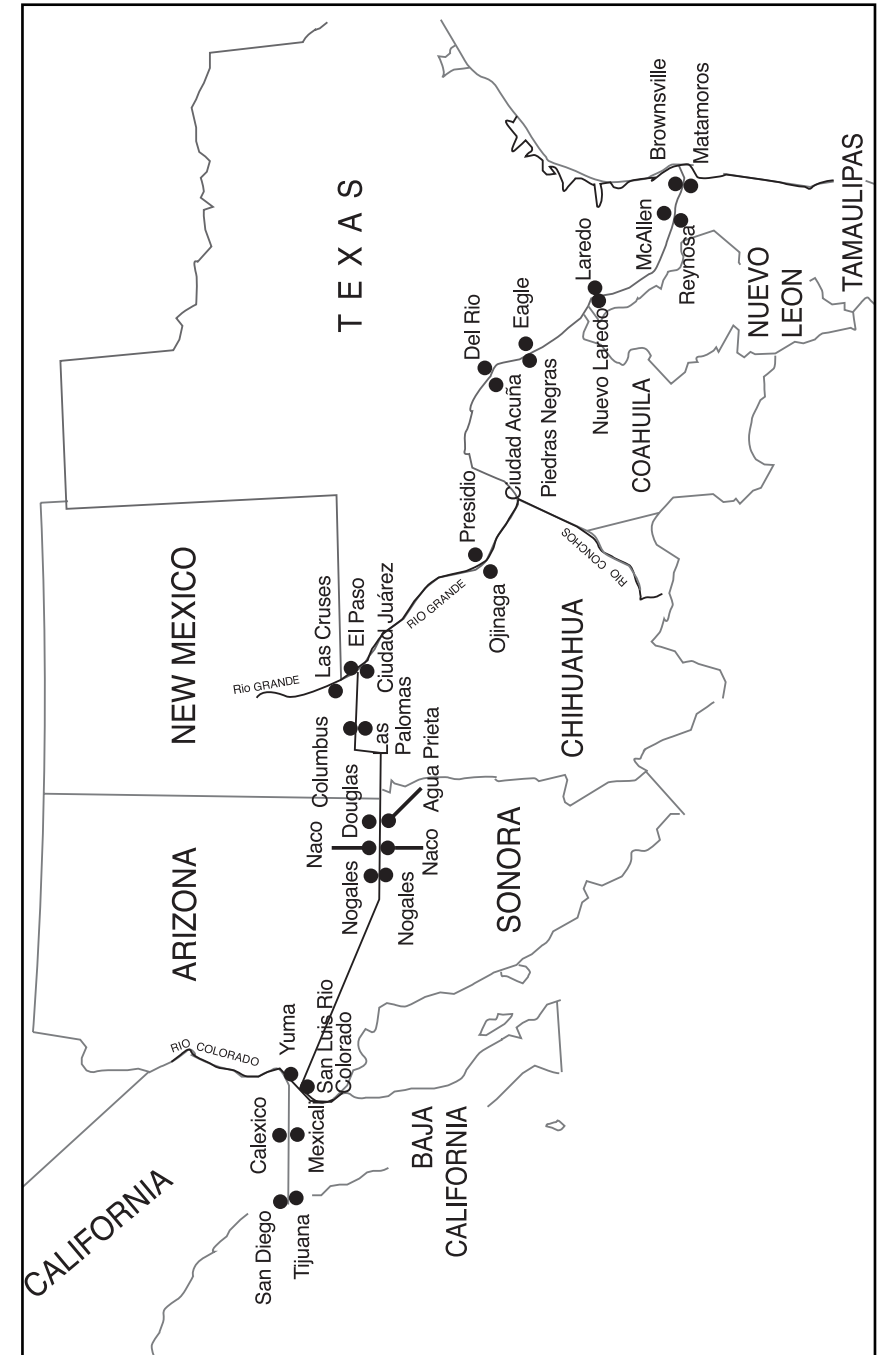


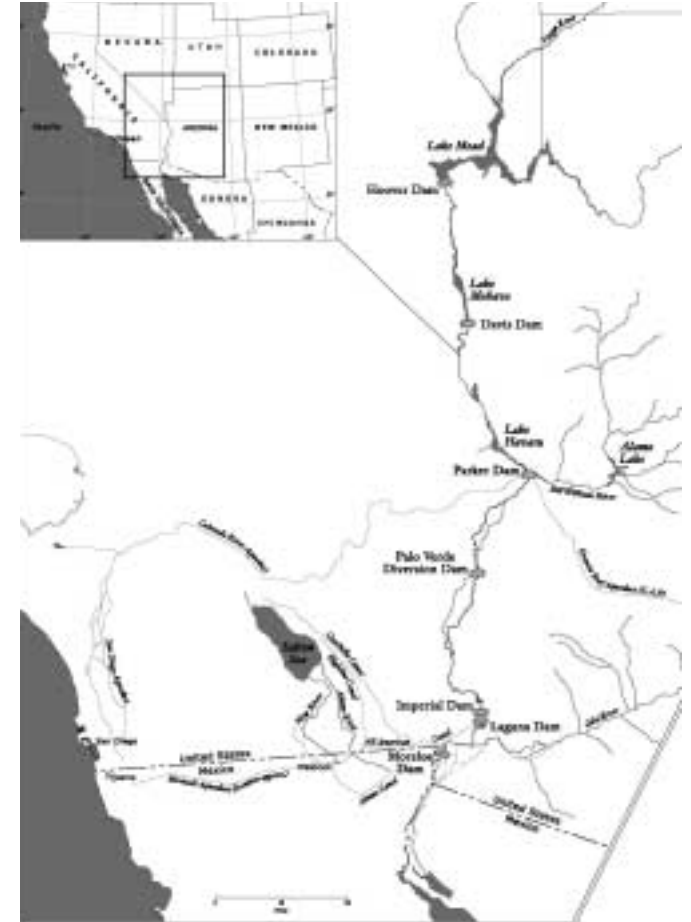
Table 1. Principal Events in the Evolution of Water Management between the United States and Mexico

Year	Event	Objectives
1848	Treaty of Guadalupe Hidalgo	Definition of the international boundary
1889	Convention that created the International Boundary and Water Commission (IBWC)	Observance of the rules of the Boundary Treaties and the Convention in relation to the changes of course in the international rivers
1944	Treaty for Utilization of waters of the Colorado and Tijuana Rivers and of the Rio Grande	Allocated waters of the international rivers between the two countries and extended the functions of the IBWC
1983	Agreement for the Protection and Improvement of the Environment in the Border Area (La Paz Agreement)	Provided formal guidelines for the binational participation of various government levels in the design and implementation of transboundary environmental solutions by specific work groups
1992	Release of the Integrated Environmental Plan for the U.S.-Mexican Border Area (IBEP)	Strengthened enforcement of environmental laws, increased cooperative planning, completed the expansion of wastewater treatment facilities
1993	Creation of the Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADBank)	Assists communities on both sides of the border in coordinating and carrying out environmental infrastructure projects
1996	Release of Border XXI program	Promotes sustainable development in the border region

Source: Christopher Brown, Stephen Mumme, and Mark Spalding

There is a kaleidoscope of jurisdictions on the border. These include hydrological, jurisdictional, and competing sector discontinuities as well as mismatches between the two governments, among the levels of governments, and even within governments. For example, the water supply, water treatment, wastewater treatment, and public health agencies are often separate organizations with different organizational cultures operating in different locations. Institute participants concluded that strategic planning is necessary to get disconnected agencies to connect and march together.

Figure 3. Lower Colorado River System Average Water Budget 1977-1999



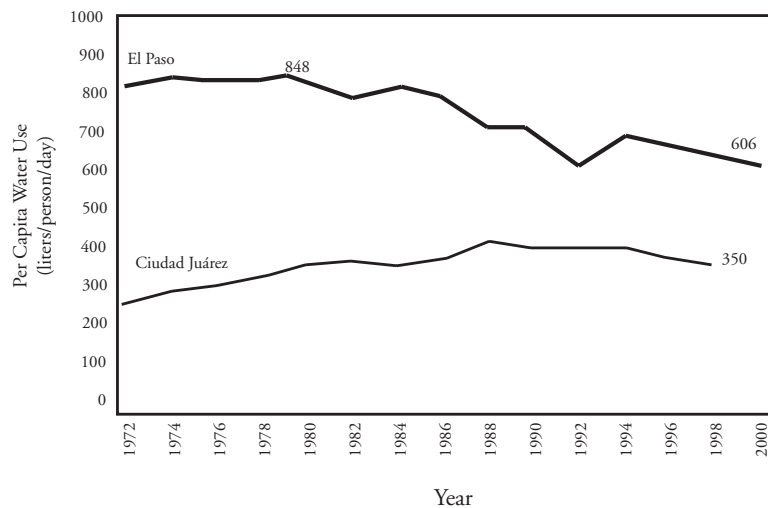
Sources: Jessica Swartz Amezcua and Harry Johnson

There are also unnecessary and potentially damaging links in the 1944 treaty addressing border water issues. The Colorado River and Rio Grande, for example, are linked by mention in the same treaty, yet each possesses different issues and has diverse mechanisms to resolve problems. Furthermore, groundwater is not included in the bilateral treaties between Mexico and the United States.

PAST, PRESENT, AND FUTURE TRENDS

While the region has been water-scarce for decades, extreme shortages and higher costs are looming. Historic and current usage patterns reflect the asymmetry in water availability and price. Agricultural use is relatively constant, using between 60% and more than 80% of surface waters while municipal withdrawals range from 10% to 30%, depending on location. However, increased demand for water is being driven by urban growth. Per capita use is higher in the U.S. border cities than Mexican border cities (Figure 4; Figure 5). Likewise, information quality, institutional capacity, and budget size is better on the U.S. side.

Figure 4. Per Capita Water Use Trends in El Paso and Ciudad Juárez



Source: Edwin Hamlyn

Although Ciudad Juárez relies almost solely on groundwater, the allocation of 74 million cubic meters per year ($Mm^3/year$) of surface waters from the Rio Grande is especially critical. Water demands in Ciudad Juárez are increasing and its source of groundwater, the Hueco Bolsón aquifer, is over-extracted and declining in quality. The impact of increasing water shortages on many dimensions of quality of life will be felt on both sides of the border.

Of course, all water availability is threatened by global climate change. Already, the warmer temperatures have caused greater evapotranspiration and there is some indication that less precipitation occurs regionally in the border zone.

CURRENT SOLUTIONS

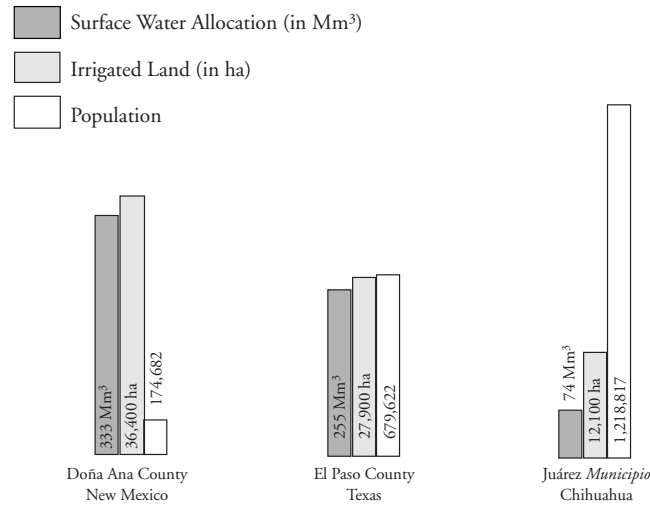
Many engineering and technology solutions to water crises exist. Satellite or decentralized facilities, for example, save money by more effectively addressing local needs, replacing extensive lengths of pipes with less expensive systems, and reducing flow rate fluctuation. Another scenario involves reuse of water within a single community. This option entails re-treating water within a twin-city pair, rather than transferring water over long distances, which often involves high energy and infrastructure costs.

Additionally, current water loss could be reduced on the order of 50% if efficient irrigation practices were applied. Low efficiency in agricultural water management results primarily from the use of gravity irrigation systems, where evaporation and infiltration losses occur through open and unlined channels. The main challenge for the region is to increase irrigation efficiency. The solution is in the introduction of high technology irrigation infrastructure and practices coupled to rational management of water resources under sustainability criteria.

Yet another point of view recognizes that demand for water is absolute and growing, water availability is flexible but shrinking, water prices are variable but related to supply, and water use must be prioritized according to grades, ultimately providing potentially more and sometimes cheaper water to various users. Currently, partial, traditional, and additional treatment of wastewater makes it available for use for groundwater recharge, industry, agriculture, landscaping, and parks. Soon, wastewater will probably be used for cooling new power plants. Any number of grades of water can safe-

ly and economically be used for additional purposes. For example, brackish groundwater may soon be used directly to irrigate some salt-tolerant crops; it may also be treated less expensively than ocean water for general irrigation purposes.

Figure 5. Surface Water Allocation



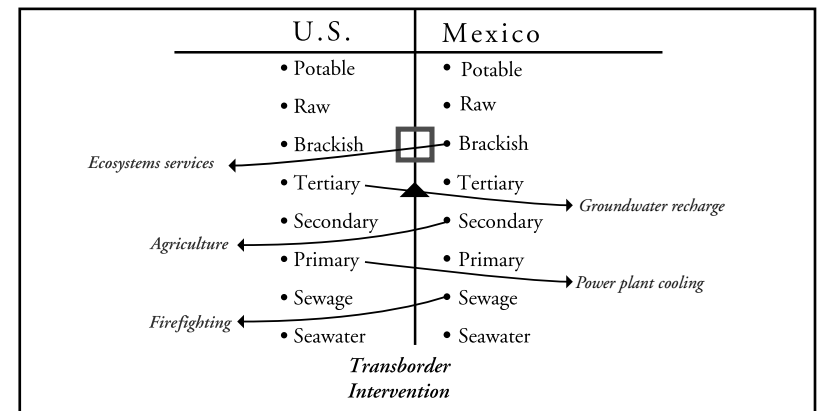
Source: Edwin Hamlyn

It is clear that the opportunity to match and trade across the border exists. The challenge is to motivate current users to make the different grades available for trade. For example, a Mexican farmer should be compensated for saving water (or perhaps temporarily fallowing) and “delivering” the saved water to a broker. The broker, in turn, could sell the water to a farmer in Texas, or to a government agency that wants to restore a habitat (Figure 6). In the year 2000, for example, agencies paid \$61 million for just over 397Mm³ of water for habitat restoration. Clearly the possibilities of moving water across the border are many and wasted, reclaimed water can be engineered to serve either side without topographical hindrances and associated costs.

Ideally, wastewater treatment for agriculture should be primary—or no more than secondary—treated wastewater, as this maximizes the fertilizer content while minimizing the concentration of salts.

However, the water should be applied through a drip irrigation system for maximum safety. Although the farmer should bear some of the costs because drip irrigation alone will increase yields, this is a cost that should not be borne by the farmer alone. The current situation should actually be reversed. Instead of the farmer first receiving and using the water, which then gets treated and passed on to the city, clean water from rivers or aquifers should be run through the city, partially treated, and then applied to farmland. Currently, shared aquifer storage and reuse of recycled water represent largely untapped, yet valuable, options. Through injection of aquifers—which are accessible from both sides of the border—recycled water could overcome some of the transport barriers caused by urban development.

Figure 6. Examples of Potential Binational Water Exchanges



Source: SCERP

Since three existing wastewater treatment plants and four future plants in the San Diego-Tijuana region are potential sources of recycled water, several alternatives may emerge for large-scale aquifer storage and reuse. One possibility is to combine plants for conjunctive use resulting in transboundary sharing and multiple benefits. Conjunctive use is the coordinated management of surface, reclaimed, and groundwater supplies. In addition to trades of agricultural drainage and fresh, brackish, ground, and reclaimed water, other potential options for water sharing include binational facilities such as aqueducts, treatment plants, storage facilities, recharge

and extraction systems, desalination plants, and recycling/reclamation plants.

Furthermore, Geographic Information Systems (GIS) can act as a decision-support system by showing spatial water data and temporal projections. Currently, one GIS map is being developed for the Paso del Norte; a preliminary map already exists for the many water flows across the California-Baja California border.

INSTITUTIONAL AND FUNDING FRAMEWORK

For long-term solutions to border water problems, the current institutional framework and financial mechanisms are inadequate. To illustrate this, participants cited not a water scarcity but an “institutional scarcity.” While all agree that revisiting the binational treaties is either unlikely or counterproductive, the existing agency model can be extrapolated to include these tasks.

Although existing institutions can be catalysts for change, they are not yet allowed to be. The International Boundary and Water Commission (IBWC) can incrementally expand its activities to become a process convener and the North American Development Bank (NADBank) has the financial instruments in its low-interest fund to build the necessary conservation projects. Many Border Institutes agreed that this is a good opportunity for NADBank to be relevant. However, the problem is that so few organizations, such as irrigation districts or watershed councils, can handle the scope of the challenge of water management planning, much of which entails promoting conservation. Eleven conservation projects have been proposed but they need sponsors. The NADBank can only do half.

There was a clear consensus among many of the participants that, while states and local entities have important roles to play, much more federal attention is needed to help resolve pressing transboundary water issues. A comprehensive approach to addressing border water issues appears necessary to meet current and future challenges.

The following points made by Institute participants suggest a clear role for the federal governments in binational water management planning:

1. Compacts and treaties allocate the existing interstate surface waters. The IBWC and its Mexican counterpart, Comisión Internacional de Límites y Aguas (CILA) distributes international

surface waters in accord with the treaties. As surface waters are committed, used, degraded, and evaporated, prospective users increasingly look to groundwater as new and permanent sources of less-brackish water. Furthermore, water is drawn from subsurface sources at increasing rates without understanding the consequences or even developing binational or watershed agreements for sustainable use. There is no movement toward limitations on wells, a necessity if dry or salinated wells are to be averted.

2. The 1944 Water Treaty did not discuss groundwater, and there has been little progress since. IBWC, however, is proposing a comprehensive program to assess transboundary aquifers. The Border XXI Program had a framework for assessing contamination of groundwater resources, and hopefully the successor bilateral program, Border 2012, will continue in the same vein. Since many groundwater basins are rapidly being depleted or contaminated, the two nations cannot afford to wait for detailed studies.

3. It is particularly difficult to negotiate groundwater use because groundwater is a property right and an issue dealt with by U.S. states. But it is a federal matter in Mexico. To further complicate matters, there is a disincentive to establish serious dialogue between U.S. and Mexican states, or between the U.S. and Mexican federal governments, since many U.S. and Mexican states compete for water resources.

4. IBWC-CILA has recently shown its adaptability to new challenges and is encouraged to continue to evolve in the near future. Minute 306 on binational technical committees and ecosystems in the lower Rio Colorado is seen by many as a sign of this new direction.

5. IBWC-CILA has recently demonstrated its interest and capacity for dealing with groundwater issues by approaching each of the U.S. states to encourage them to begin their conversations with the Mexican federal government about groundwater agreements. The Mexican Commissioner of CILA, Arturo Herrera Solís, and the U.S. Commissioner of the IBWC, Carlos Ramírez, agree that the respective sections of IBWC-CILA can “extrapolate” from existing models to include assessment, testing, use, and recharge of groundwater as part of their regular activities.

6. Commissioner Herrera recommends that the Mexican federal government:

- Reduce state-to-state competition by allocating groundwaters
- Provide grants to fix water infrastructure leaks and inefficiencies
- Facilitate fee structures as revenue streams to finance bonds

7. Additionally, and significantly, the United States Geological Survey has promoted groundwater issues by proposing the development of a groundwater inventory in conjunction with IBWC-CILA. However, other federal agencies should step up to their roles as binational water management facilitators and leaders.

Interestingly, the federal governments had agreed to do exactly what they have been called to do. At the summit of the new U.S. and Mexican presidents in March 2001, they proposed a binational summit on border water issues. This has not yet materialized.

While many traditional water subsidies are perverse and counter-productive, conservation depends upon a series of positive and negative incentives. An abundance of overly subsidized, overly water-intensive irrigation projects are wasting water. Water is grossly underpriced. In many cases the price merely constitutes the cost needed to move the water to the user. The Comisión Nacional del Agua estimates 60% of agricultural water is wasted and between 35% and 53% of municipal water in Mexico is lost through leakage.

Water pricing should be revised to encourage conservation. New development can pay the higher true cost of water while allowing current users to pay only incrementally more immediately, easing the transition to full pricing. “Water is too cheap to conserve,” was a refrain heard frequently at Border Institute IV.

RISKS OF THE STATUS QUO

Significant risk exists if the current situation continues. Indeed, the cost of implementing remedies is significantly less than addressing the long-term consequences of business as usual. Due to the acceleration of water degradation and scarcity, the U.S.-Mexican border region suffers tangible economic costs. It is estimated that:

- More than \$1 billion are accrued in health costs
- Nearly \$1 billion are lost due to water pollution
- Approximately \$1 billion are lost due to decreased recreational

and leisure use of water

- Billions of dollars of biodiversity are lost due to habitat destruction

There are 450 plant and animal species native to the region and 700 migratory species are found in the border area. Thirty-one percent of all species in the United States listed by the Department of Interior as threatened or endangered are found in the borderlands. On the Mexican side of the border, 85 species of plants and animals are in danger of extinction. The border region’s many parks and wildlife refuges need protection from water transfers that would further jeopardize ecosystem health.

All of the aforementioned add up to serious problems for the region’s “bottom line.” If left unaddressed, these multiple environmental stresses will ultimately have dire consequences for the region’s economic health.

The risks are not just to Mexico, which is running out of water faster than across the border. Water issues in Mexico will “boomerang” back to the United States if they are not addressed, resolved, and indeed, shared. Few want to guess at the full extent of transboundary effects if water becomes too expensive or limited for one sector or country to provide an adequate supply for its buyers and users. If the negotiations for the Transboundary Environmental Impact Assessment (TEIA) were not stalled in Mexico City and Washington, D.C., now would be the best time to expand the scope of TEIA to address such questions as water supply and to mitigate and minimize impacts.

SCENARIOS FOR RESOLUTION

Solutions mean addressing the asymmetries and differences across the border. The cultural and socioeconomic impacts of water availability and price must be studied and appreciated for both the U.S. and Mexican sides of the border.

Assuming active roles by the federal governments, solution scenarios are possible. An examination of binational case studies reveals both obstructions to successful water management planning as well as guiding principles. Numerous factors that impede cooperation include inflexible water allocation systems, different legal systems, different economic pressures and financial capabilities, centralized versus decentralized institutional structures, history of water dis-

putes, cultural differences that influence water use, different perspectives, and lack of comprehensive information regarding the water resources of the region. Principles of binational cooperation should rule water issues. One goal should be to build upon the success of local watershed councils and encouraging their capacity through small grants should be goals. Water sharing agreements can be supported by providing a broker and a database of potential buyers and sellers.

The principles leading to binational coordination and cooperation on water use are:

- Exchange of information, technology, and equipment
- Joint use of transfer and storage projects
- Local water exchanges and trades
- Emergency transfers across the border
- Binational approaches to watershed management
- Cooperative transborder groundwater recharge
- Protection of transboundary riparian habitat
- Understanding the differences (economic, perspectives, capacity, etc.) on both sides of the border
- Binational restoration of natural hydrology and flows
- Joint U.S. and Mexican flood control

Success stories discussed at Border Institute IV include the following features:

- Local coordinating mechanisms, such as the Border Liaison Mechanism, that enable local and state officials in the border region to talk directly about binational issues
- Joint university initiatives such as SCERP water quality, watershed, and water atlas projects
- The Committee on Binational Regional Opportunities (COBRO), a public advisory committee of the San Diego Association of Governments (SANDAG) that addresses cross-border planning in areas such as environmental management and water supply
- Binational environmental infrastructure such as the international wastewater treatment and reclamation plants at some twin cities
- Recognition that surface and groundwaters are connected
- The creation of transborder *consejos de cuencas*, or watershed councils
- Increased conjunctive use/perpetual reuse

- Alternative negotiation, such as the New Mexico-Texas Water Commission—formed as a result of a litigation settlement between El Paso and several New Mexico entities—to avoid long, expensive, and polarizing lawsuits
- Expansion of bi-state task forces to binational task forces such as the Paso del Norte Water Task Force, which unites water managers, water users, experts, and citizens to work cooperatively to promote a tri-state binational perspective on water issues that impacts the future prosperity and long-term sustainability of the region
- Evolving role of non-governmental organizations (NGOs) such as the Río Bravo/Río Grande Coalition, whose purpose is to support and strengthen grassroots groups of citizens working to sustain the river basin
- Implementation of Promagua, a program in Mexico designed to attract private investment to water projects via federal subsidies
- Open and transparent processes such as the Citizen Forums program, which was recently implemented by IBWC
- Recognition of states' rights issues by beginning subregional, state-to-state negotiations

RECOMMENDATIONS

Binational Water Management Planning

For far too long there have been calls on both sides of the border for water management planning that is binational, with transparent and transdisciplinary public participation. This also includes the call for comprehensive planning that addresses all the competing sectors in Figure 1, and that is wasteland-based in scale and scope. However, this has not been the reality.

Many NGOs, including academia as independent and science-based facilitators, have tried to catalyze water discussions or agreements among users. The process itself is straightforward. The steps necessary to implement the plan—authorizing the process, convening stakeholders, approving the findings, and funding the bulk of the recommendations—are confounded by jurisdictional mismatches. This underscores the urgent need for the federal governments to play an active, facilitative, and supportive role. Ideally the two nations should grant joint planning authority to an existing

commission. Repeatedly, at Rio Rico and elsewhere, the IJC is cited as a potential model to emulate for reaching consensus about groundwater, water quality, ecosystem services, and other contentious issues. Already the Border Environment Cooperation Commission (BECC)/Comisión de Cooperación Ecológica Fronteriza (COCEF), whose mandate expansion includes water conservation, is investigating such a mechanism at the local level. Ultimately a binational water bank could be created that:

- Provides storage capacity during wet years
- Allots those reserves during dry years
- Adjudicates among potential buyers
- Allocates portions for natural systems and services
- Facilitates the mix and match trade schemes as illustrated in Figure 6

In the area of water quality, approaches such as lagoons, wetlands, and other SCERP-developed techniques hold promise in the border region as alternative wastewater treatment technologies. These alternatives, which require relatively inexpensive land and labor costs, should be recognized as viable options, and planned, funded, and promoted for small-scale applications and for rural and remote settings.

Sourcing, Transfers, and Storage

Because transferring water over long distances from traditional users often has unintended consequences, local water should be used first. The proposal to fallow fields in the Imperial Valley in order to send water to San Diego threatens the viability of the inland Salton Sea, which depends on agricultural drainage flows from Imperial Valley agriculture. Since many cities are depleting their water sources, water transfers are seen as options. However, water transfers should only be authorized for “saved” water and only if all parties, including natural systems, are not harmed.

Groundwater recharge standards are needed to take advantage of reclaimed water. For example, groundwater planning must begin with the understanding that an incurred debt to aquifers must be paid before renewed pumping may begin.

Throughout the U.S.-Mexican border region, water agencies are focusing upon conjunctive use of groundwater as a cost-effective source of water, even in times of drought. Numerous municipalities

are extending their local water supplies by improving brackish groundwater quality, and by blending surface and groundwater supplies. Water agencies are examining the possibility of desalinating groundwater resources with elevated salt levels due to the increasing costs and uncertainties associated with water transfers (particularly from the Colorado River). Since groundwater does not evaporate, groundwater storage is emerging as a vital water banking option to store water during wet years to use during times of drought.

Recommendations for binational water sourcing include:

- Reducing physical losses to the system by seepage, evaporation, and transpiration
- Avoiding contamination of sources that renders them unusable
- Planting less water-intensive and more salt-tolerant crops
- Improving storage, particularly subsurface storage
- Re-plumbing infrastructure to benefit the environmental and ecological systems
- Managing the intensities and durations of droughts

Drought Management

All Border Institute participants agreed that droughts are an opportunity and a call for action for both short-term solutions and long-term strategies. Solutions are available within the context of current and anticipated climate and weather patterns. Water management also requires drought management, which includes setting up municipal reserves in anticipation of severe and extended dry spells. Additionally, mandatory conservation measures should be established during droughts and post-drought assessments should be conducted.

Conservation

Conservation must be a priority for all border planning organizations. The priority has to be water conservation, but that is not currently a mission of existing border institutions. Water savings clearly start with agriculture. On average, agriculture uses 78% of all the water in the region, but all sectors can save. The Mexican government is drafting legislation to productively reorganize irrigation districts and units based on the criteria of efficient water usage and productive competition.

Irrigation districts can make tremendous savings, but these will have their costs. In the border region, most water conservation projects must focus on irrigation systems, which must be funded partial-

ly by grants. It is estimated that the cost of irrigation system improvements for Texas is \$400 million and \$100 million for the Lower Rio Grande Valley.

Equity Issues

The existing framework is inadequate to define or assure equitable distribution of water. Existing water resources are inequitably distributed across the border and among sectors. Because many groups lack sufficient access to information and institutions, institutions should incorporate various mechanisms to insure their flexibility and accessibility. Solutions to equity issues that should be taken into account to promote sustainable use of resources should include flexible and inclusive binational planning mechanisms; regulated market mechanisms, including creative and flexible water pricing schemes; the reallocation of subsidies; water education; and a leveling of the playing field through capacity building. The recognition that “equitable use” needs rigorous attention to integrate science, environmental justice, and social welfare considerations is a significant research challenge for SCERP and others.

Ecosystems

Transferring water away from natural communities and processes today reduces water quality and quantity for human uses tomorrow. Ecological use of water is recognized by the 1983 La Paz Agreement and later by IBWC-CILA minutes, especially Minute 306 addressing the Lower Colorado River Delta. Advantages offered by natural systems and ecosystem services include flood control, navigation, pollution abatement, climate buffering, and fisheries and other natural habitats for economically important species. The numerous benefits associated with allocating water to the environment include:

- Increased wildlife habitat and biodiversity
- Increased groundwater recharge
- Increased surface and groundwater storage
- Increased economic development potential for communities
- Increased water quality
- Decreased storm water peak discharge rate
- Decreased stream channel erosion
- Decreased frequency of local flooding
- Decreased pollution through cleaning action of riparian vegetation

Perhaps the environment can be better understood as an “in-between” user to store, filter, and move water. The public perception of wastewater needs to shift from that of “waste” to “recyclable.”

Database/Knowledge Sharing, Monitoring, and Indicators

The issues need to be quantified, understood, and resolved. Indeed, there is as much disinformation as misinformation about water. Few consistent long-term data sets, along with a need for comparable methods of data analysis, have resulted in data stress. The harmonization of protocols would improve the process of collecting, analyzing, and distributing water data.

Water use indicators are needed to determine how to direct funding for this work, as well as to encourage appropriate sourcing, conservation, sequential reuse, and sharing. Academia is especially good at determining and maintaining data quality; gaining access to governmental or proprietary data; and aggregating up or disaggregating down in scales, both temporal and spatial. Better presentation of existing data is necessary to support border water policy decisions. Although existing data need to be improved and more data collected, Institute participants agreed that decisions should not be delayed due to lack of complete, perfect, or symmetric databases.

Water Education

Water, which traditional cultures have considered sacred since time immemorial, has become transformed into a mere utility. As such, drought education is crucial to sensitize and prepare people to deal with the realities of water scarcity. As competition for water continues to increase (and the cost of exploiting new water resources is often prohibitively expensive) it is imperative to institute water education programs to promote a more realistic and appreciative water-conscious “culture.” These programs should involve schools, communities, and the media. Additionally, conservation measures must be shared among all people, including the wealthy, and that water for all sectors—especially for the most vulnerable, including the poor, tribal nations, and the environment—is distributed sensibly and equitably. In essence, the sanctity of water needs to be rediscovered.

CONCLUSION

Water issues along the border are infinitely complex and include incessantly rising demands; a finite, depleting, and degrading supply; competing sectors; and, in some cases, cumbersome and antiquated regulating institutions on both sides of the border. Because of the interconnectivities and interdependencies of water and other concerns, a solution for one issue often becomes a problem for another. As a result, the U.S.-Mexican border faces unprecedented sustainability challenges. It is time for policymakers on both sides of the border to accept proactively the reality that water scarcity is the norm rather than an anomaly. These challenges underscore the importance of tackling solutions collectively, which is the primary purpose of the Border Institute—to bring together academics, policymakers, industry leaders, and other border stakeholders from both sides of the border to address key issues. Solutions were formulated during Border Institute IV and many of the possible outcomes were elucidated and dissected to avoid unintended consequences.

Because of the sheer complexity of these problems, however, solutions will have to emanate from compromise. At best, solutions should work for all sectors; at worst, they should not harm any. Interdisciplinary and sustainability science—SCERP’s aim and mantra—should be at the forefront to ensure long-term solutions.

Whether or not these proposed solutions—however imperfect—after implemented, the United States and Mexico will face consequences. If actions are not taken, many (if not all) sectors will be affected; institutions and individuals will have to change their habits and large sums of money will have to be invested. In short, everyone and all institutions will have to conserve. The 1998 reportings of the first Border Institute were clear: The border population will likely increase by 6.3 million people by 2030. Unless most of the recommendations from Border Institute IV are followed, the burgeoning population will lead to increased demand for water—water that is already inadequate in terms of quantity and quality. The current situation is simply unsustainable. All sectors face untold and irreversible ramifications if border water scarcity is not addressed now. Put simply, the U.S. and Mexican federal governments must take proactive roles and competing sectors must work together to avert environmental, economic, and social disaster.