Water Management in the Binational Texas/Mexico Río Grande/Río Bravo Basin

Mary E. Kelly
Executive Director, Texas Center for Policy Studies

ABSTRACT
The 180,000 square mile binational Río Grande basin presents a full range of complex water management challenges:

- An arid region, with limited surface and groundwater supplies;
- Rapidly growing population centers and an economic shift from agriculture to trade, manufacturing and tourism;
- A river system that has been dammed, diverted and largely managed for agriculture;
- A lack of incentives or funds for improving irrigation efficiency;
- Simmering rural/urban conflicts, particularly over groundwater;
- Aquatic ecosystems that have suffered damage from reduced stream and spring flows and from river channelization projects;
- Areas where municipal, industrial or agricultural discharges have caused severe water quality problems;
- Difficulties in meeting basic water needs of low-income populations in an affordable manner;
- In some areas, water management decision-making that suffers from a lack of basic data about water availability, water use and projected demands;
- A complex (and somewhat outdated) set of local, state, and federal laws and institutions affecting water policy management; and,
- A U.S./Mexico water treaty that is increasingly less than adequate for dealing with the binational management challenges facing the basin.

These difficult, but pressing, challenges demand that policymakers begin looking at water management in the Río Grande basin in new ways. In addition to increasing public awareness of the limits on water supply in the basin, long-held notions about the relationships among growth management, economic development and water supply, as well as about how water should be used in urban and rural areas, will have to be re-examined.

The importance of irrigated agriculture – to food production, local economies and a rapidly disappearing way of life in the basin – cannot be ignored, but the level of attention and resources devoted to making irrigation systems efficient must be greatly increased.

Moreover, if we are to preserve a semblance of the natural river system in the basin, adjustments will have to be made to help re-establish and protect instream flows and springs. And, finally, in this basin, there is an urgent need to improve – and maybe even renegotiate – the U.S./Mexico framework for management of transboundary water resources.

INTRODUCTION

The Río Grande, long an adequate though never voluminous river except in flood tide, has been attended in modern times by concerned management in its government conservancy districts; but in many places the river has become only a trickle, and in other entirely dry, to be replenished only by flood from otherwise dry or meager local tributaries and by diminishing groundwater, this always in the face of increasing needs of its resources in both the United States and Mexico. –Paul Horgan[1]

...we need to double water productivity – get twice as much benefit from each liter of water we remove from rivers, lakes and underground aquifers – if we are to have any hope of fulfilling the water requirements of 8 billion people and protecting the natural ecosystems on which economies and life itself depend. Meeting this challenge will involve making irrigation leaner and smarter.... –Sandra Postel[2]

[1] Paul Horgan, *Great River: The Río Grande in North American History* (Wesleyan University Press: Hanover, NH 1984; preface to the 4th edition).

[2] Sandra Postel, *Pillar of Sand: Can the irrigation miracle last?* (W.W. Norton & Company; New York; 1999).

The Río Grande basin encompasses 180,000 square miles and covers portions of three U.S. states and five Mexican states (Figure 1). From the New Mexico/Texas state line, the river runs just over 1,200 miles to the Gulf of Mexico. There are only a few major tributaries in this part of the basin: most important are the Río Conchos, which has its headwaters high in the Sierra Madre Occidental in Chihuahua, and the Pecos River, which begins in New Mexico and flows through a vast areas of West Texas before reaching the Río Grande. Most of the other significant tributaries lie in the Mexican portion of the basin, including the Ríos San Diego, San Rodrigo, Escondido, Salado, Alamo and San Juan.

Most of the Texas/Mexico Río Grande basin is characterized by low and sporadic rainfall, limited streamflow and low groundwater recharge rates. A notable exception is the high Sierra Madre Occidental in Chihuahua, a region of pine and oak forests.

From the New Mexico/Texas state line to just below El Paso, the river has been channelized, re-routed and otherwise managed more as an international boundary than a river system. Flow through this stretch is almost entirely dependent upon releases from two large upstream Bureau of Reclamation dams, Elephant Butte and Caballo. Completed in 1916 and 1939, respectively, these reservoirs are managed almost solely in response to the water demands of growers in the irrigation district of the Elephant Butte and El Paso Water Control and Improvement District (WCID). They are also used to supply Mexico with 60,000 acre-feet/year of Río Grande water, under a 1906 treaty.

From downstream of El Paso to just above the confluence with the Río Conchos, the flow of the river is severely reduced. This "Forgotten River" stretch is an isolated portion of the river, with only relatively smaller scale irrigation uses.

In normal rainfall years, the Río Grande is replenished by large flows from the Río Conchos, just above the sister cities of Presidio and Ojinaga.[3] The Conchos basin itself is heavily managed, with several large reservoirs having been constructed, primarily to supply irrigation districts. Most of the municipalities in the Conchos basin supply demand with local groundwater reserves.

Downstream of the confluence, the river flows through a series of large protected natural areas, including the Big Bend Ranch Texas State Park, the Cañon de Santa Elena and Maderas del Carmen protected areas in Mexico and Big Bend National Park. Downstream of Big Bend National Park to Amistad Reservoir, the river has been designated a Wild and Scenic River under U.S. federal law. River rafting is a popular and economically significant activity in this stretch.

Amistad Reservoir and the downstream Falcon Reservoir, both administered jointly by the U.S. and Mexico, are the primary water storage and supply structures on the Texas/Mexico stretch of the Río Grande. Completed in 1968 and 1953, respectively, they supply water for irrigation and cities on both sides of the lower stretch of the river. Together, these reservoirs provide a firm annual yield of about 1 million acre-feet/year.[4]

[3] Recent prolonged droughts in Chihuahua and increasing use of the Conchos have severely reduced its flows to the Río Grande in recent years. See section below on Water Availability; see also Mary E. Kelly, *The Río Conchos: A Preliminary Overview* (Texas Center for Policy Studies: Austin, TX, 2001, available online at www.texascenter.org/borderwater).

[4] Firm annual yield refers to the dependable supply, considering drought-of-record years.

Figure 1 Río Grande Basin Map Source: Río Grande/Río Bravo Basin Coalition

Downstream of the Amistad/Falcon system, water is diverted directly from the river through a series of irrigation diversions and municipal pumping. The only major inflows in this reach are from the Río Alamo and the Río San Juan, both of which have been extensively developed for agricultural and municipal use in the Mexican portion of the basin.[5]

The watershed narrows considerably as the river flows toward the Gulf.[6] By the time it reaches the sea, the Río Grande has been reduced to a trickle, compared to pre-1962 average flows of almost 2.4 million acre-feet/year. In February 2001, the river failed to even reach the Gulf, as a sand bar formed across Boca Chica Bay. Officials claimed the sand bar was the result of unusual wave action, not solely reduced river flow, but the symbolism was not lost on the public or policymakers.[7]

[5] See Jurgen Schmandt, et al. *Water and Sustainable Development in the Binational Lower Río Grande/ Río Bravo Basin.* Final Report to EPA/NSF Water and Watersheds grant program (Grant No. R 824799-01-0), (Houston Advanced Research Center, Center for Global Studies: The Woodlands, Texas, March 31, 2000 (available on-line at www.harc.edu/mitchellcenter/mexico/lrgv.html) (hereinafter HARC report) for a full discussion of management issues on the San Juan basin, and the relationship to growing water demand in the large industrial cities of Monterrey, Nuevo Leon and Saltillo, Coahuila.

[6] Irrigation return flows do not go back to the Río Grande in this reach; instead they pass through a series of canals and end up in the Laguna Madre of Texas or the Laguna Madre of Tamaulipas, both valuable hypersaline estuaries.

[7] See, e.g., "Río Grande flow interrupted by sand bar" *San Antonio Express News*, February 11, 2001.

POPULATION GROWTH

Population in the Texas/Mexico portion of the Río Grande basin is concentrated in several large urban areas, many of which are growing at extraordinary rates.[8] Table 1 shows the 1990-2000 population figures for the Metropolitan Statistical Areas (MSAs) in the Texas portion of the basin, and Table 2 shows comparable figures for major cities in the Mexican portion of the basin. The number of people living in the Monterrey area, the largest Mexican city in the basin, increased seven-fold between 1950 and 1995. Most rural areas of the basin are not densely populated; some are losing people or growing at very slow rates, though others are predicted to grow substantially over the next 50 years.

Table 1 1990-2000 Population in Major Metropolitan Areas of the Texas Portion of the Basin

MSA	1990	2000	% change
McAllen-Edinburg-Mission	383,545	569,463	48.47
El Paso	591,610	679,622	14.88
Brownsville-Harlingen-San Benito	260,120	335,227	28.87
Laredo	133,239	193,117	44.94

Source: 2000 Census Data, U.S. Census Bureau

Table 2 1990-2000 Population in Major Municipal Areas of the Mexico Portion of the Basin

Municipal Area	1990	2000	% change
Cd. Juarez	798,500	1,217,818	52.5
Cd. Chihuahua	609,059	670,208	10 (5-year)
Cd. Acuña	41,947	110,388	163
Piedras Negras	80,291	127,898	59
Nuevo Laredo	203,285	310,277	53
Monterrey	1,069,238	1,108,499	3.7
Reynosa	211,411	417,651	98
Matamoros	238,839	416,428	74

Sources: 1990 data: James Peach and James Williams, "Population and Economic Dynamics in the U.S.-Mexican Border: Past, Present and Future" in Paul Ganster, ed., *The U.S.-Mexico Border Environment: A Road Map to a Sustainable 2020* (Southwest Center For Environmental Research and Policy: San Diego State University Press, 2000), Chapter IV; 2000 data: Instituto Nacional de Estadísticas y Geografía, 2000 Census of Population and Housing, available on-line at www.inegi.gob.mx (Información por Entidad Federativa).

[8] For a more complete discussion of U.S./Mexico border area population trends, see the August 1999 issue of *Borderlines*, a monthly periodical published by the Interhemispheric Resource Center, available on-line at www.us-mex.org/borderlines. For extensive information on population and demographic trends in Monterrey and the lower portion of the Río Grande basin, see HARC report, supra, Chapter 3.

Demographic trends in the basin are characterized by a movement of people to urban areas, particularly Mexican cities right along the border, as well as high rates of natural increase in the population (due to a young population and, in some areas, high fertility rates). People have been attracted to the Mexican border cities by the presence of the maquiladora industry – these are plants, largely owned by U.S. and Asian companies, that conduct a variety of light manufacturing and product assembly operations. Mexico implemented the program in the early 60's in an attempt to meet its burgeoning need for employment, but it was not until the devaluations of the Mexican peso in the early 1980s that the program exploded.[9] There are now almost 3000 maquiladoras in Mexico, employing close to 1 million people, and maquiladora products represent the second largest source of export earnings in Mexico. Table 3 shows the number of maquiladoras and employees in major cities in the Mexican portion of the Río Grande basin.

[9] The 1994 devaluation of the peso (right after the North American Free Trade Agreement went into effect) caused another maquiladora growth spurt. Peso devaluations make wage rates in Mexico (which run about $1/hour in the maquiladoras) even more attractive to U.S. and other foreign companies.

Table 3 Maquiladoras in Major Municipal Areas in the Mexican Portion of the Basin

Area	YR	# Plants	# Employees	YR	# Plants	# Employees
Juárez	1980	121	42,412	2000	312	255,740
Cd. Chihuahua	1980	19	4,451	2000	85	52,722
Matamoros	1980	50	15,314	2000	38	14,475
Piedras Negras	1993	42	9,122	2000	38	14,475
Cd. Acuña	1992	50	18,615	2000	57	32,289
Nuevo Laredo	1993	54	16,418	2000	55	22,050
Reynosa	1993	78	34,258	2000	122	64 ,877

Data from December of each year; Source: Instituto Nacional de Estadísticas y Geografía, www.inegi.gob.mx.

Demographers predict that, even if fertility rates were to decrease and migration to the northern Mexican border were to slow, population growth in the border area will continue at high rates.

Population dynamics along the border suggest some demographically important patterns that permit forecasts regarding the future. First, Mexican municipios have shown strong natural increase – the excess of births over deaths – and levels of natural increase have traditionally been greater on the Mexican side of the border. But levels of natural increase on the U.S. side along the border, though generally lower than on the Mexican side, historically exceed the U.S. average.

To this strong natural increase is added the factor of an age distribution – especially on the Mexican side of the border – that favors future natural increase. Differences in age distribution across the border reveal that Mexican municipios have more "demographic momentum" than U.S. counties.[10]

[10] James Peach and James Williams, "Borderlands Demographic Trends", in *Borderlines*, August 1999 (Interhemispheric Resource Center: Silver City, New Mexico, available on-line at www.us-mex.org/borderlines).

Table 4 shows projected populations for some of the major urban areas in the Texas/Mexico portion of the Río Grande basin. One source predicts that the combined Las Cruces/El Paso/Juárez region could reach 6 million people by 2025 (compared to a current combined population of about 2 million).[11] The combined population of both sides Lower Río Grande Basin and Monterrey is expected to increase from about 5 million to 11 million by 2030.[12] Unquestionably, if such growth were to occur there or in other areas of the basin, it would put an untenable strain on water resources if current use patterns were to remain largely unchanged.

Table 4 2020 Population Projections from Major Municipal Areas in the Río Grande Basin

Area	"High" 2020 Scenario	"Low" 2020 Scenario	2000
El Paso	1.287,217	906,332	679,622
Laredo/Webb County	583,653	253,445	193,117
McAllen-Edinburg Mission/Hidalgo County	1,457,516	683,960	569,463
Brownsville-Harlingen-San Benito/Cameron County	688,835	420,140	335,227
Cd. Juárez	3,166,092	1,676,142	1,217,818
Cd. Acuña	492,484	146,798	110,388
Piedras Negras	262,996	197,117	127,898
Nuevo Laredo	728,248	450,103	310,277
Reynosa	742,085	535,293	417,651
Matamoros	854,216	610,587	416,428

Sources: 1990 data: James Peach and James Williams, "Population and Economic Dynamics in the U.S.-Mexican Border: Past, Present and Future" in Paul Ganster, ed., *The U.S.-Mexico Border Environment: A Road Map to a Sustainable 2020* (Southwest Center For Environmental Research and Policy: San Diego State University Press, 2000), Chapter IV; HIGH Scenario = continuation of 1990-1995 migration pattern by age and sex; LOW = Migration rates set to zero after 1995 to illustrate growth from natural births/deaths in existing population.

[11] James Peach and James Williams, "Population and Economic Dynamics in the U.S.-Mexican Border: Past, Present and Future" in Paul Ganster, ed., *The U.S.-Mexico Border Environment: A Road Map to a Sustainable 2020* (Southwest Center for Environmental Research and Policy: San Diego State University Press, 2000), Chapter IV

[12] HARC report, supra, Chapter 3.

A CHANGING ECONOMIC BASE

Local economies change over time, but in few places has such change been so dramatic and occurred so rapidly as in the Texas/Mexico portion of the Río Grande basin. Over the last few decades, the local economies in several areas of the basin have been radically transformed from heavy reliance on agriculture, including irrigated agriculture, to dependence on light manufacturing, transportation, trade, services and, increasingly, tourism.

For example, local economies in the El Paso, Laredo, McAllen and Brownsville areas are now dominated by retail trade, services, light manufacturing and transportation, though agriculture continues to play an important role, especially in the Lower Río Grande Valley. Table 5 provides some basic economic data on the economies of the major Texas cities along the Río Grande. The transformation in cities in the Mexican portion of the basin has been even more striking. For example, Ciudad (Cd.) Juárez now has over 300 maquiladoras, employing over 250,000 people.[13] Table 6 shows the transformation in the Juárez economy between 1970 and 1990.

[13] U.S. Environmental Protection Agency and SEMARNAP, *U.S.-Mexico Border Environmental Indicators* (U.S. Environmental Protection Agency: Washington, D.C., 1997, available on-line at www.epa.gov/usmexicoborder/indica97).

Table 5 Economic Characteristics of Major Areas in the Texas Portion of the Basin

Non-Farm Employment Composition (%) as of Jan. 2001)	El Paso	Laredo/Webb	McAllen-Edinburgh Edinburgh-Mission/ Hidalgo County	Brownsville Harlingen-San Benito/ Cameron County
Mining (includes oil & gas)	0	2	1	0
Construction	5	4	6	4
Manufacturing	15	3	8	11
Transportation, communication, public utilities	6	19	4	5
Trade (wholesale & retail)	25	24	26	24
Financial, Insurance Real Estate	4	4	3	3
Services	24	21	26	30
Federal Government	3	3	3	3
State Government	3	2	3	3
Local Government	15	18	21	17
Market Value of Agricultural Products Sold (1997)	$76,673,000	$28,198,000	$197,235,000	$79,414,000

Sources: Texas Workforce Commission, Labor Market Information (www.twc.state.tx.us/lmi/lfs/lfshome.html; USDA 1997 Census of Agriculture, Highlights for Texas (www.nass.usda.gov/census97/highlights/tx/tx.htm).

Table 6 Transformation of Cd. Juárez Economy Between 1970 and 1990

% Employment by Sector	1970	1980	1990
Extraction	0.3	0.2	0.16
Assembly/Manufactiring	17.7	21.6	41.3
Construction	8.2	6.8	7.9
Electricity Production	0.4	0.2	0.48
Commerce	17.8	14.3	14.6
Communication and Transportation	4.2	5.2	3.7
Services	31.1	15	26.7
Agriculture	8.7	3.1	1.3

Source: Cesar M. Fuentes, "Usos del Suelo y Configuración de la Estructura Urbana en Cd. Juárez' in *Río Bravo Journal* Vol. 2 (1):3.

Other border river cities like Cd. Acuña, Piedras Negras, Reynosa and Matamoros are also heavily dependent on the maquiladora industries, even though only a few decades ago they were sleepy small towns serving, tied to local agricultural and ranching activities. A few of the Mexican border towns just below Falcon dam, such as Camargo, Guerrero and Diáz Ordaz, have not yet had a major influx of maquiladoras, and their population has remained stable or even decreased.

These economic transformations have not necessarily fostered prosperity on a broad scale, however.[14] Unemployment and poverty rates remain high and average per capita income remains low in many areas of the Texas border, though there has been some improvement in the last decade. (Tables 7 and 8 and Figure 2). Despite the growing industrial base, poverty is endemic in Mexican border cities, with 65 to 70% of the population in most of the Mexican border cities in the basin living below poverty levels (defined as three times minimum wage).[15] Even though new jobs are provided by the maquiladoras, the wage rates are low, especially relative to the cost of living.

[14] Office of the Texas Comptroller, *Bordering the Future* (Texas Comptroller: Austin, TX, 1998, available on-line at www.window.state.tx.us/border/border.html) (Chapter 2 – Growth Without Prosperity?) and Alejandro Canales, "Industrialization, Urbanization and Population Growth on the Border" in Borderlines, August 1999 (Interhemispheric Resource Center: Silver City, New Mexico, available on-line at www.us-mex.org/borderlines).

[15] E. Su·rez and O. Ch·vez, *Profile of the U.S./Mexico Border* (Infomexus: CD. Juarex; 2000), p. 70.

Table 7 Average 2000 Employment Mix in Selected Major Municipal Areas in the Mexican Portion of the Basin

% Employment by Sector	Cd. Juárez	Cd. Chihuahua	Nuevo Laredo	Monterrey	Matamoros
Agriculture, Livestock, Hunting, Fishing	0.3	1.4	0.5	0.2	0.7
Extractive & Electricity Production	0.5	0.8	0.8	0.6	0.7
Manufacturing/Assembly	43.1	28.9	21.8	29.4	39.1
Construction	3.5	8.1	8.3	8.2	7.1
Commerce/Trade	16.0	18.6	17.1	19.2	15.2
Services	27.6	31.0	32.0	32.9	27.0

NOTE: Totals do not add to 100% because of 12-month average of monthly data. Source: Instituto Nacional de Estadísticas y Geografía, Incadadores Económicos de Coyuntura, available on-line ar www.inegi.gob.mx (Infromación por Entidad Federativa).

Table 8 Per Capita Income in Major Metropolitan Areas in Texas Portion of the Border

Area	1998 Per Capita Income	% Below Poverty (1997)	1993 Per Capita Income	% Below Poverty (1993)
El Paso	16,359	27.8	12,790	36.6
Laredo/Webb	13,870	32.6	10,757	46.9
McAllen-Edinburgh-Mission/Hidalgo County	12,759	37.6	10,085	52.2
Brownsville-Harlingen-San Benito/Cameron Co.	13,766	35.3	11,042	49.8
Statewide	25,369	16.7	19,145	24

Sources: 1998 Per Capita Income: Texas Department of Economic Development, www.bidc.state.tx.us/overview/16metropci.htm; 1997 Poverty levels: U.S. Census Bureau, www.census.gov/hhes/saipe/stcty/997_48.htm; 1993 Per Capita Income: Texas Comptroller, Texas Area Facts (Austin, TX: 1996); 1993 Poverty Levels: E. Suárez and O. Chávez, Profile of the U.S./Mexico Border (Infomexus: CD. Juarez; 2000), p. 70.

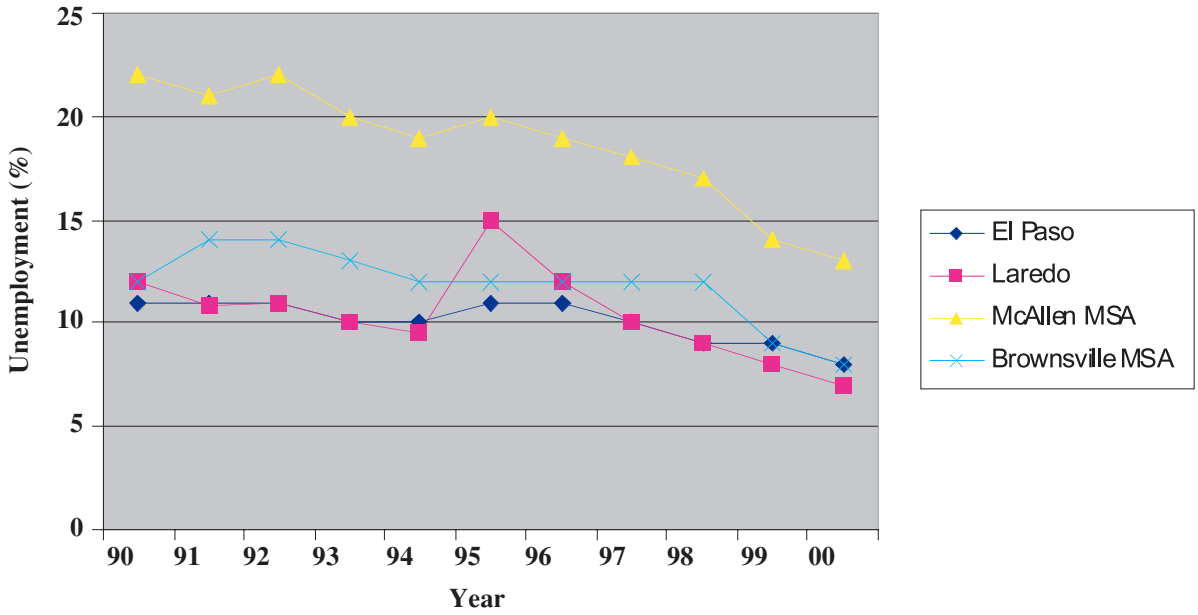

Figure 2 Unemployment Rate Trends in Major Municipal Areas in Texas Portion of the Basin Source: Data from Texas Workforce Commission, annual average rate. Data available at www.twc.state.tx.us/lmi/lfs/lfshome.html.

The rapid industrialization and growth of urban areas in the basin has imposed severe stress on schools, roads and, especially, on water and wastewater infrastructure. In an attempt to address these infrastructure needs, the U.S. and Mexico established the binational Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADBank) in a side agreement to the North American Free Trade Agreement (NAFTA).[16] While some progress has been made in funding new water and wastewater systems, most cities and rural areas in the basin cannot afford to borrow at NADBank's loan rates, and thus projects remain dependent on grant funds, a large portion of which have been supplied through the U.S. Environmental Protection Agency.[17]

[16] For more information on these institutions, see www.cocef.org and www.nadbank.org.

[17] See www.texascentr.org/bordertrade/borderwatch for more information on current issues related to BECC/NADBank operations.

WATER AVAILABILITY AND WATER QUALITY[18]

The limited water resources of the arid Río Grande basin have been developed and – in many instances – over-exploited to provide a year-round supply of water for irrigated agriculture, industry and the growing municipalities. During the 20th century, a number of large reservoirs were built on the Río Grande and its major tributaries and extensive well fields were drilled in the basin's aquifers. The dams, while providing storage, have greatly reduced the downstream flow of the main stem and its tributaries. In some areas, groundwater pumping has reduced or even eliminated spring flow or allowed the infiltration of saline water into fresh water zones.

Upstream of El Paso, the Elephant Butte and Caballo reservoirs are used to store about 2 million acre-feet of Río Grande waters, and releases from these reservoirs almost completely determine the flow of the river through the El Paso/Juárez area. These releases are tied solely to the needs of irrigators in the Elephant Butte and El Paso area irrigation districts and to provide the required 60,000 acre-feet/year to Mexico.[19] In a vigorous effort to move away from dependence on the rapidly diminishing Hueco Bolson aquifer, the city of El Paso now gets about half of its annual water supply from the Río Grande. It has secured this supply by leasing or otherwise acquiring irrigation water rights in the El Paso County Water Control and Improvement District No. 1.

El Paso's switch to surface water has not been easy. Barriers have included difficulties in negotiating acquisition of irrigation rights and poor water quality in the river during times of low releases from the upstream reservoirs. And, even with the move to surface water, El Paso still depends primarily on the local groundwater for the remainder of its supply.

These aquifers are being mined at dangerously high rates, however, as Cd. Juárez and El Paso have grown over the last few decades. Many observers have predicted that, at current pumping rates, the Hueco Bolson may run dry for all practical purposes in 20 years. Juárez is completely dependent on the Hueco Bolson, and is now being forced to investigate other local (and not so local) groundwater sources.[20] El Paso is meanwhile looking to west-to rural counties-for future groundwater. It has purchased some "water ranches" from which it hopes to export groundwater to the city. This move has predictably caused serious conflict with the rural counties, especially because Texas does not regulate groundwater pumping through state law. Essentially, Texas still relies on the "law of the big pump," more formally known as the "rule of capture." Under this doctrine, a landowner can pump as much groundwater as it wants, even if a neighboring landowner is damaged.

Reductions in the flow of the Conchos River at its confluence with the Río Grande have caused serious binational issues in the last few years. Due in part to drought, in part to increased use of water in the Conchos basin, and in part to a reservoir management strategy designed to preserve Conchos water for irrigation uses in Chihuahua, the flow of the Conchos has dropped well below the minimum 350,000 acre-feet/year (over a five-year period) required by the 1944 U.S./Mexico water treaty.[21]

[18] This section provides a very brief overview of water quality and water quantity issues in the Texas/Mexico portion of the Río Grande basin. For more detail on water supply, see references listed throughout this section, especially the Texas Regional Water Plans, the HARC report and the Texas Center for Policy Studies' Conchos Overview report. For more detail on water quality, see Texas Natural Resource Conservation Commission, *1994 Water Quality Assessment of the Río Grande Basin* (TNRCC: Austin, TX; 1996); International Boundary and Water Commission, *Binational Study Regarding the Presence of Toxic Substances in the Río Grande/Río Bravo Watershed and Its Tributaries* (IBWC: El Paso, TX; 1994 (Phase I) and 1997 (Phase II)).

[19] See, e.g. *Far West Texas Regional Water Plan* (Rio Grande Council of Government: El Paso, January 2001), pp. 1-42 to 43; 5-12 to 13.

[20] See, e.g., Diana Washington Valdez, "Juárez hunts new sources of water as crisis looms", in *El Paso Times*, February 14, 2001.

[21] For more discussion, see section below on Transboundary Implications and Mary E. Kelly, *The Río Conchos: A Preliminary Overview* (Texas Center for Policy Studies: Austin, TX, 2001, available on-line at www.texascenter.org/borderwater).

Most of the municipalities and industries in the Conchos basin currently depend on groundwater to supply demand. While complete hydrogeological studies of most of these aquifers are lacking, Mexico's National Water Commission (Comisión Nacional de Aguas or CNA) has identified several that are over-exploited (*i.e.*, annual pumping exceeds annual recharge) and is developing plans to help cities implement conservation measures and/or find new groundwater or surface water supplies.

Reduced flow from the Conchos has greatly reduced water storage in Amistad and Falcon, with the reservoirs reaching the lowest levels since they were put into operation in the 1960s, severely constraining water supply for municipalities and irrigators on both sides of the Lower and Middle Río Grande. On the U.S. side, the river is already over-appropriated (*i.e.*, paper water rights exceed, some say almost double, the amount of water routinely available in the system), and the low reservoir levels have made the situation much more volatile.

Drought is a relatively frequent occurrence in the Río Grande basin, though for the last several years dry conditions have been severe and persistent, especially in the Conchos sub-basin and on both sides of the Lower Río Grande Valley. Initially, below normal rainfall levels affected primarily dryland farmers and subsistence agriculture in northeastern Mexico. The drought has been particularly hard on indigenous communities in the Sierra Tarahumara in Chihuahua, affecting their bean and maize harvests severely and causing widespread hunger.[22]

Persistence of low rainfall patterns, however, and Mexico's decision to store water in the reservoirs in the parched Conchos basin, have resulted in greatly reduced inflows to and storage in the Amistad/Falcon system, constraining water supply for both municipalities and irrigators the middle and lower Río Grande. The reservoirs reached some of the lowest levels since their completion in the 1950s. By 1995, the situation forced the International Boundary and Water Commission to negotiate an emergency minute order under the 1944 Treaty in order to allow Mexico to borrow water for Tamaulipas municipalities.[23] The agreement was never implemented as late 1996 and early 1997 rains alleviated the immediate pressures on the municipalities.

Nevertheless, in Nuevo Leon and Tamaulipas, irrigation was curtailed and many dryland farmers didn't even plant crops. For example, in 1995-1996, estimates put crop losses at 600,000 acres of sorghum, corn, bean and wheat crops; Tamaulipas corn production dropped 44% in the 1994-1995 season and 1995-1996 was also extremely difficult. In 1996, the Mexican government was forced to import almost $2 billion worth of grain to alleviate growing hunger, with much of the grain going to northern Mexico.[24] Sugar cane, citrus and vegetable growers in the Texas portion of the lower Río Grande also suffered some substantial losses due to constraints in irrigation supplies in the 1994 to 1996 period, and municipalities were

[22] See, *e.g.*, "Drought on the Border", in *Austin American Statesman*, May 7, 1996; "Five-year drought shoves Northern Mexico toward disaster", in *San Antonio Express News*, May 19, 1996.

[23] International Boundary and Water Commission, Minute 293, Emergency Cooperative Measures to Supply Municipal Needs of Mexican Communities Located Along the Río Grande Downstream of Amistad Dam, October 4, 1995.

[24] See, *e.g.*, David Hurlburt and John Garrison. *The Drought in Northern Mexico* (Draft Report for the U.S./Mexico Policy Studies Program; LBJ School of Public Affairs, University of Texas: Austin, Texas, 1996); "Drought Continues, Grain Shortage Worsens", in *El Financiero International*, June 3-9, 1996; "Milionarias perdidas por sequía", in *El Bravo de Tamaulipas*, April 23, 1996.

forced to implement conservation plans. Flows from the Conchos continued to be much lower than normal during the late 1990s (Figures 3 and 4) and Mexico began to accrue a "deficit" under the 1944 Treaty (see Legal and Institutional and Transboundary Implications Sections below for more discussion). Briefly, for the October 1992 to October 1997 cycle used for Treaty accounting purposes, Mexico accumulated a deficit of just over 1 million acre feet; low flows continued after 1997, adding another 0.4 million to the deficit.

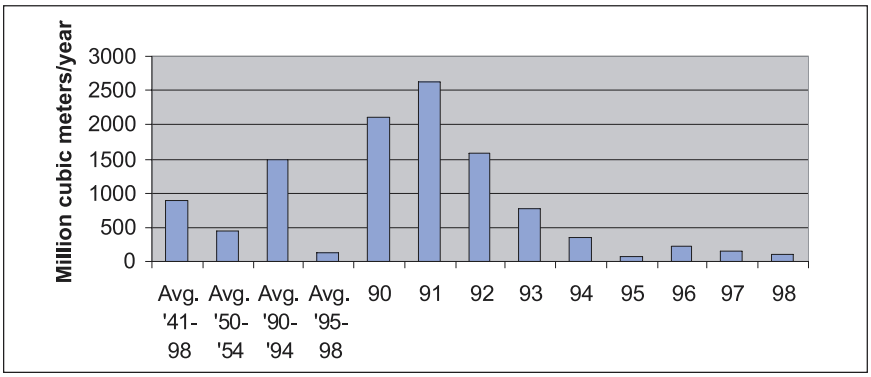

Figure 3 Flow of Río Conchos into Río Bravo. Source: Flow data from the International Boundary and Water Commission, El Paso, Texas.

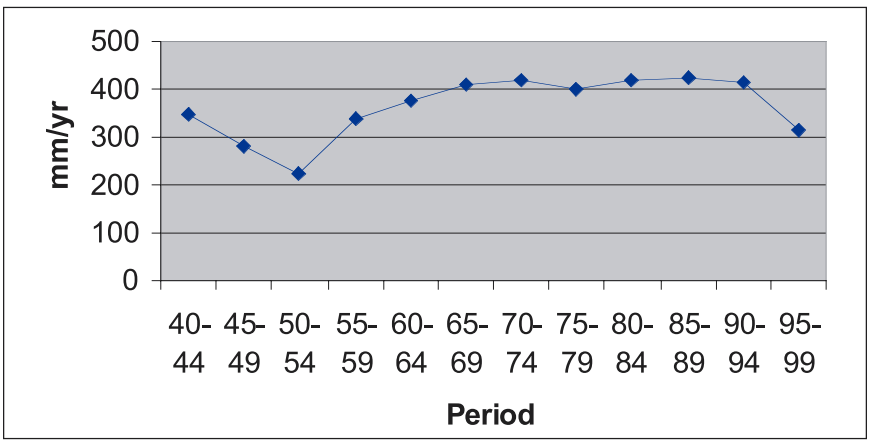

Figure 4 Average Annual Rainfall in the Conchos Basin. Source: Rainfall data from the International Boundary and Water Commission, El Paso, Texas.

Continued low levels of rainfall in the Valley and over Falcon/Amistad system aggravated irrigation shortages in the Lower Río Grande Valley of Texas. Last year, Valley farmers began tallying up their losses, which some claim have reached $400 million/year, and started demanding immediate "repayment" of the deficit that Mexico had accrued.[25] In March 2001, the IBWC signed a new minute order that attempts to set out a plan for meeting immediate needs (through the summer 2001 growing season), while looking toward better drought management and basin management plans to prevent a similar situation from occurring. (See Appendix at the end of this article and Legal and Institutional and Transboundary Implications sections below).

[25] See, *e.g.*, "Parched Battle: Río Grande Valley drought sparks friction on both sides of border" in Dallas Morning News, March 26, 2000.

Water pollution complicates water supply management, and this is evident in many parts of the Río Grande basin. Pollution from dairies and irrigation return flows makes the river water above El Paso unusable for municipal purposes during low flow periods. Brackish water from irrigation return flow drains in the El Paso/Juárez area has also degraded water quality in the shallow Río Grande alluvium aquifer. Below El Paso/Juárez, the flow in the river primarily consists of treated wastewater from El Paso, untreated wastewater from Juárez and irrigation return flows. With a BECC/NADBank-supported project, Juárez is just now getting sewage plants-though they will provide only primary treatment at this point.

Municipal and industrial discharges (no cities in the basin have functioning secondary sewage treatment), irrigation return flows and agricultural chemicals have degraded water quality in the Conchos basin.[26] A 1994 binational water quality study and a follow-up study in 1997 found high levels of arsenic (possibly from arsenic based herbicides used on cotton) in the Lower Río Conchos, as well as other toxic pollutants.[27]

The Pecos River is notoriously high in total dissolved solids and is typically unsuitable for municipal or domestic needs, though it is used for irrigation in some of the rural counties through which it passes.

Water quality in Amistad and Falcon reservoirs remains relatively good, largely because of the size of the reservoirs. Downstream of Amistad, sewage and industrial wastewater from Nuevo Laredo and discharges from the Laredo area have caused water quality declines. In the stretch from Falcon to the mouth of the Río Grande, sewage from Mexican border municipalities, which can include industrial discharges, has also lowered water quality. High salinity is also a concern in this stretch.[28] In this lower portion of the river, reduced river flows have also allowed saltwater infiltration from the Gulf. This change has reduced the diversity of aquatic species and several freshwater fish have disappeared, replaced by more salt-tolerant species.[29]

Some of the Mexican municipios are now on the road to having at least primary sewage treatment, however again, with technical and financial support from the BECC/NADBank institutions. Municipal wastewater projects approved by BECC and financed by NADBank are slated for Cd. Acuña, Cd. Juárez, Piedras Negras and Reynosa.

Little information is readily available on water quality in the other major Mexican tributaries.

CURRENT AND FUTURE DEMAND FOR WATER[30]

Irrigation is by far the largest use of water throughout the Texas/Mexico portion of the Río Grande basin. In the El Paso/Far West Texas region, it accounts for about two-thirds of water use; in the Lower Río Grande Valley of Texas it is closer to 85%; in the Conchos basin, irrigation accounts for over 90% of water use.

[26] Mary E. Kelly, *The Río Conchos: A Preliminary Overview* (Texas Center for Policy Studies: Austin, TX, 2001, available on-line at www.texascenter.org/borderwater), page 11-12.

[27] International Boundary and Water Commission, *Binational Study Regarding the Presence of Toxic Substances in the Río Grande/Río Bravo Watershed and Its Tributaries* (IBWC: El Paso, TX; 1994 (Phase I) and 1997 (Phase II)).

[28] Region M Regional Water Supply Plan, August 2000, pp. 1-36 to 1-38.

[29] HARC Report, supra, Chapter 7.

[30] Detailed data on current and projected water uses are available in the following: (1) For El Paso and the upper Texas/Mexico portion of the Río Grande: Far West Texas Regional Water Plan;(2) For the middle and lower Río Grande: Regional Water Plans for Region J and M and HARC report, supra; and (3) For the Conchos basin: TCPS' Conchos Overview report, supra, and Comisión Nacional de Aguas, *Programa Hidráulico de Gran Visión, Estado de Chihuahua (1996-2000)* (1997). For information on the regional water planning process in Texas and contacts for obtaining the plans, see www.twdb.state.tx.us.

In the U.S. portion of the basin, municipal water demand is the next largest category of water use, ranging from 10-45% of use, depending on location. (Municipal use in the El Paso county area, for example, represents over 40% of total use, while in the Lower Río Grande Valley, it accounts for only about 14%).

Municipal use in the Mexican portion of the Río Grande is reported to be about 14% of total use, though in some areas (such as the Conchos basin) it is less than 10% of total use and in some areas (such as the Cd. Juarez area) it exceeds 35%. Other significant consumptive water uses in the basin include industrial operations,[31] livestock watering, electricity generation, and oil and gas production. Hydropower production occurs in a few areas, most notably at the Las Boquillas dam in the Conchos basin.

A major factor in current water use is inefficiency-in both municipal and irrigation systems. Table 9 shows reported water use efficiency information for various irrigation districts and municipalities in the basin. Clearly, reducing these losses will be critical to meeting future water demands, and some efforts are already underway. For example, a recent study of irrigation in the Lower Río Grande Valley of Texas revealed that the Brownsville Irrigation District was able to reduce water use by 33% by just implementing surge irrigation and metering.[32]

[31] For example, in El Paso, which has more manufacturing than other Texas border counties, industrial water consumption accounts for about 3% of total use in the County.

[32] "Extension recommendations playing key role in reducing water demand", Texas A&M University Agricultural Extension Service, Press Release, March 8, 2001; contact g-fipps@tamu.edu.

Table 9 Reported Water Use Efficiencies in Selected Irrigation Districts and Municipalities

Entity	Reported Efficiency	Source
El Paso Water Control and Improvement District #1	41 to 66% "historical" efficiency (may be improved by some recent canal lining, but no data to confirm)	Texas Natural Resource Conservation Commission, *1994 Water Quality Assessment of the Río Grande Basin* (TNRCC: Austin, TX; 1996) and Far West Texas Regional Water Plan
Conchos Basin Irrigation Districts	About 40%	Comisión Nacional de Aguas, *Programa Hidráulico de Gran Visión Estado de Chihuahua (1996-2000)* (1997)
Irrigation Districts in the Lower Rio Grande	About 64% overall	"Extension recommendations playing key role in reducing water demand," Texas A&M University Agricultural Extension Service, Press Release, March 8, 2001, contact g-fipps@tamu.edu
Major Municipal Areas in Mexican portion of the basin	40-80%	Comisión Nacional de Aguas, various reports
Water delivery efficiency for cities in the Lower Río Grande that receive water from the irrigation districts	75%	Region M Regional Water Plan

In urban areas, inefficiency results from leaks in water distribution systems and, in Mexican municipios, a lack of metering of water use. In the Conchos basin, for example, Cd. Chihuahua is estimated to have a 30% loss of water from its municipal system, though losses may, in fact, be higher because only about 3/4 of the distribution system is metered.

Even with these inefficiencies, however, per capita municipal water consumption in Mexican municipalities is generally only about one-half Texas per capita consumption rates. This difference is largely the result of comparatively much higher water use in the U.S. for lawns, landscaping, and swimming pools.

With respect to both irrigation and municipal use of water, price incentives for conservation have generally been lacking, in both the U.S. and Mexico. Irrigation water itself is generally very low cost (though farmers in both countries are beginning to have to bear an increasing share of the cots of constructing, operating and maintaining irrigation works). Similarly, the cost of water for municipal use has been low. Water for domestic use has been essentially free in most Mexican municipalities, as these cities are just beginning to meter and charge for water. With the exception of El Paso, cities in the Texas portion of the basin have been slow to adopt conservation price structures (*i.e.*, charging more per unit of water as use increases).

One real constraint on increasing the price of water for domestic use, however, is the low-income levels of a high percentage of border residents. Many people along the Texas border are already paying a large share of their monthly income for water (and this is especially true for residents who do not yet have centralized potable water service).[33] In Mexican cities, there is public resistance to paying for water service, linked largely to doubts about the reliability of the service and concerns about transparency in municipal management of revenues.

Most areas of the basin are predicted to experience an increase in municipal and industrial uses and a decline in irrigation water use over the next few decades. Tables 10 and 11 summarize some readily available recent water use projections.

Because irrigation accounts for such a tremendous share of water use throughout the region, strategies for meeting future demand must be focused on conservation in the irrigation districts. In addition, in some areas of the basin there is a more fundamental need to reexamine how reservoir releases are managed.

In the Lower Río Grande Valley of Texas, for example, the regional water planning group has projected future municipal and industrial needs can be met through aggressive conservation in the irrigation and municipal sectors and targeted water re-use. This won't come cheap, however. The planning group found that about $200 million would be required over the next 30 years to make the necessary improvements in irrigation efficiency. Even with these improvements, however, the planning group's analysis predicts that in a "drought-of-record," some irrigation demand will go unmet.

[33] For an overview of the problems with lack of water and sewer service in Texas "colonias" visit http://chud.tamu.edu/chud/colonias/colonias.html.

Table 10 Water Use Projections for Selected Areas in the Texas Portion of the Basin

Region	2000 Sector	AF/year	%	2050 Sector	AF/year	%
Far West Texas (El Paso and nearby rural counties along the Río Grande)*	Irrigation	342,848	67	Irrigation	298,848	51
	Municipal	137,956	27	Municipal	252,270	43
	Other	28,622	6	Other	34,624	6
	TOTAL	**509,426**		**TOTAL**	**585,742**	
Region M- Lower Rio Grande Valley of Texas (Maverick to Cameron County)**	Irrigation	1,532,737	85	Irrigation	1,233,925	71
	Municipal	252,451	14	Municipal	486,618	28
	Other	10,032	1	Other	17,380	1
	TOTAL	**1,803,221**		**TOTAL**	**1,737,923**	

AF is acre-feet; one-acre foot is equal to 325,851 gallons – approximately enough water to cover a football field one-foot deep.
* Source: Far West Texas Regional Water Plan
**Source: Lower Río Grande Regional Water Plan

Table 11 Water Use Projections for Selected Areas in the Mexican Portion of the Basin

Area	2000 estimated	2020
Cd. Juárez municipal use	150,000 AF/yr	300,000 AF/yr
Cd. Chihuahua municipal use	81,000 AF/yr	98,000 AF/yr with aggressive conservation
		140, 000 Af/yr without aggressive conservation
Tamaulipas Border Region (municipal and industrial use)	86,000 AF/year	379,887 AF/yr

As noted above, in the El Paso/Juárez areas, both cities are looking for additional sources of groundwater to meet future needs, as well as to conservation and transfers from irrigation to municipal use and even, at least in the case of El Paso, to desalination of brackish water. The Far West Texas regional water plan, however, did not examine the kind of aggressive irrigation conservation that is being relied up on in the Lower Río Grande Valley plan.

In the Conchos basin, the Mexican federal government developed estimates in 1997 of the resources it will need to make the necessary municipal and agricultural conservation investments, to better monitor flows and operate reservoirs and to better monitor water quality. The total investment needs projected for the state of Chihuahua between 1997 and 2000 was about $500 million, or about $170 million per year, with the majority being for agricultural water conservation. This level of investment would be equivalent to about 80% of the state's total budget in 1996.

Where will these funds come from? The government identified federal sources of funding such as various government infrastructure programs (some of which are largely funded by loans from the World Bank) and credit from Mexican national development banks, including BANOBRAS and BANRURAL. It also projects that some funds will come from Chihuahua state government programs and from the U.S./Mexico binational border development bank, NADBank. There is plenty of competition for these for these limited funds, both within Mexico and along the border, however. It remains to be seen what level of priority will be given to the investment needs in Chihuahua and in the Conchos basin in particular.

More fundamental questions about future water demand are not yet fully on the table in most debates and planning efforts; however, some questions are increasingly lurking around the edges. These questions include:

- Will border urban areas formulate growth management plans that more directly tailor economic development and growth policies to a sustainable level of water availability – rather than the current approach of seeking out new water supplies to meet growth "projections"?[34]
- What is the future role of irrigated agriculture in the basin, in terms of the types of crops that are grown, the precedence of irrigation rights in major reservoir systems and the need to maintain food production and viable rural communities?
- How might climate change affect overall water availability in the basin?[35]
- How can urban areas, particularly in the U.S., move their residents toward more understanding of the limits of local water resources, reducing expectations that every homeowner can have a big green lawn, a swimming pool and live in a subdivision with giant fountains at the entrance drive?
- How can environmental water needs be fully integrated into water management planning?

WATER FOR THE ENVIRONMENT

There is no escaping the fact that water for environmental needs (instream flow and spring flow) ranks low on the totem pole in an arid basin with irrigated agriculture and growing municipal water demand. This is evident from the way the Río Grande and its major tributaries have been managed over the course of the last several decades. Río Grande flows below Elephant Butte/Caballo, between El Paso and the entry of the Río Conchos, and in the lower reaches of the river upstream of the Gulf of Mexico have all been severely reduced over the years, with a consequent degradation in aquatic habitat and changes in or loss of riparian habitat. Overgrazing and extensive groundwater pumping have combined to reduce and even eliminate spring flow in many areas of the basin.[36]

[34] See Texas Center for Policy Studies, *Growth At Any Cost: Reconciling Economic Development Policy and Water Conservation in the Lower Río Grande* (TCPS: Austin, TX, July 2000, available on-line at www.texascenter.org/publications) for a discussion of these issues in the Texas/Mexico Middle and Lower Río Grande areas.

[35] See, generally, *Preparing for Change: the Potential Consequences of Climate Variability and Change; Southwest Assessment* (1998), available on-line at www.ispe.arizona.edu/research/swassess/index.html.

[36] Regarding these impacts in the upper portion of the Texas/Mexico Río Grande basin, see Mary E. Kelly & Salvador Contreras, *Water Use and Water Management Policy in the Chihuahuan Desert Ecoregion* (Prepared for the World Wildlife Fund, 1998; available from the Texas Center for Policy Studies); Eric Dinerstein, et al (eds.), *Ecoregion-Based Conservation in the Chihuahuan Desert: A Biological Assessment* (World Wildlife Fund, et al: Washington, D.C., October 2000). See also HARC study, supra, Chapter 7 (re: Lower Río Grande Basin).

As discussed in more detail in the next section, the legal framework for water management in both Texas and Mexico generally treats environmental water needs as a low priority and offers few real opportunities to ensure that minimum instream flow needs are met, especially where rights to use river water have already been appropriated, or, in much of the basin, over-appropriated.

For example, recent water planning efforts in Texas were, in theory, supposed to establish regional plans that would ensure sufficient water will be available for the protection of natural resources.[37] The RWPGs were required to consider environmental water needs, including instream flows, during the development of the regional plans. The planning guidelines required the evaluation of alternative water management strategies for their effects on environmental water needs and directed the RWPGs to consider and pursue environmentally sensitive water management strategies where feasible.

In general, both the Region E and Region J planning groups fell short in accounting for, and allocating water to, environmental flows. Prior to the finalization of the plans, comments were taken on the draft plans. The U.S. Fish and Wildlife Service (USFWS) comments on the draft Far West Texas plan stressed that it was "very concerned about instream flows in the Río Grande and springs that support Independence Creek in Terrell County...."[38] Comments of the Texas Parks and Wildlife Department (TPWD) on the draft Far West plan include concern that environmental needs are not categorized as a water demand. The department also raised concern that the plan lacked strategies to protect the existing quantity of water flowing in the Río Grande river and that the plan did not provide for protection or even consideration of the natural resources, such as the Río Grande River, that are supporting a growing ecotourism and recreational tourism industry. Planning group officials say they will take these comments seriously and try to address them in the next phase of regional planning.[39]

The TPWD comments to the Plateau Region's draft plan (Region J) state that the plan is deficient in its evaluation of environmental flow needs and that the degree of impairment of these flows, due to existing and proposed water development, had not been properly assessed. The review of both region E and J's plans by the National Wildlife Federation (NWF) raised this same concern.[40,41]

Thus, near-term efforts to restore instream and spring flow are likely largely be based on voluntary cooperation among non-governmental organizations, governmental agencies, water users and landowners. One such cooperative effort is just getting underway for the stretch of the river from Fort Quitman (about 80 miles downstream of El Paso) to Amistad Reservoir. As noted, this is a relatively isolated stretch of the river, much of it bordered by desert ranchland and state and federal protected natural areas.

In June 2000, former Interior Secretary Bruce Babbitt and his Mexican counterpart, SEMARNAP chief Julia Carabias, signed a "Joint Declaration to Enhance Cooperation to Protect the Ecological Integrity of the Río Grande/Río Bravo." The Declaration expresses the two governments concerns over

[37] The Regional Planning Guidelines are included in 31 Texas Administration Code (TAC) part 10 ß357.

[38] Letter to Tom Beard, Chairman, Far West Texas Regional Water Planning Group, dated September 29, 2000, David Frederick, U.S. Dept. of Interior, U.S. Fish and Wildlife Service.

[39] Barbara Kauffman, Río Grande Council of Governments, pers. communication, 2/28/01.

[40] Letter to Tom Beard, Chairman, Far West Texas Regional Water Planning Group, dated September 29, 2000, Myron Hess, National Wildlife Federation, Gulf States Natural Resource Center.

[41] Letter to Jonathon Letz, Chairman, Region J Water Planning Group, dated November 1, 2000, Myron Hess, National Wildlife Federation, Gulf States Natural Resource Center.

"declining water quantity and quality, habitat degradation, drought conditions and development pressures" in the Fort Quitman to Amistad reach. It set up a binational task force to examine "options and opportunities" to secure minimum instream flows in the reach and conserve the native riparian habitat. The Task Force, under the direction of the International Boundary and Water Commission (IBWC) has held a number of meetings to begin implementing the Joint Declaration.

The two primary options for securing significant instream flow in this reach are both beset by difficulties, however. One option is to increase the volume and year-round nature of flows from Elephant Butte and Caballo. While this could also have important benefits for El Paso (if the water was ultimately returned to the river), there are major legal, institutional and political hurdles to overcome to change the way these two reservoirs are managed. The second option, applicable from the confluence with the Río Conchos down to Amistad involves ensuring that flows from the Conchos remain at levels about minimum treaty flow requirements. That option, which involves a number of sticky binational water management issues, is discussed in more detail below.

LEGAL AND INSTITUTIONAL FRAMEWORK FOR WATER MANAGEMENT

Water management in the Texas/Mexico portion of the Río Grande basin involves a complex set of laws and institutions, as well as highly charged policy debates. Relevant laws include the 1906 and 1944 Water treaties between the U.S. and Mexico; the Río Grande Compact; the Pecos River Compact; Texas surface and groundwater statutes; and, Mexican federal water law. Important institutions include the U.S. and Mexican sections of the International Boundary and Water Commission; the Texas/New Mexico and Pecos River Compact Commissions; Mexico's National Water Commission; various state agencies and local governments on both sides of the border; and, irrigation districts.

TREATIES AND COMPACTS

- 1906 Río Grande Convention (U.S.-México)
- 1944 U.S./México Treaty for the Utilization of the Waters of the Río Grande (and the waters of the Colorado River)
- 1938 Río Grande Compact (Colorado, New Mexico, Texas)

Two treaties govern binational management of the Río Grande. The 1906 Río Grande Convention requires that the U.S. deliver 60,000 acre-feet/year of water to Mexico, just above Juárez. This water comes from the Elephant Butte/Caballo system, and has generally been used for irrigation in the valley south of Cd. Juárez. Given the extensive drawdown of local aquifers, it is likely that Juárez will soon seek to move this water to municipal use.

The pertinent features of the 1944 Treaty regarding binational allocation of the surface waters of the Río Grande from Fort Quitman to the Gulf of Mexico are shown in Table 12.

Table 12 Major Features of U.S./Mexico 1944 Water Treaty

MEXICO	UNITED STATES
All waters reaching the main channel of the Río Bravo from the Río San Juan and the Río Alamo, including the return flow from the lands irrigated from these two rivers.	All waters reaching the main channel of the Río Bravo from the Pecos and Devils Rivers, Goodenough Springs and the Alamito, Terlingua, San Felipe and Pinto Creeks.
One-half the flow in the main channel of the Río Bravo below the lowest major international storage dam (Falcon), so far as it is not specifically allocated under the Treaty to either of the two countries.	One half of the flow in the main channel of the Río Bravo below the lowest international storage dam (Falcon) so far as it is not specifically allocated under the Treaty to either of the countries.
Two thirds of the flow reaching the main channel of the Río Bravo from the Ríos Conchos, San Diego, San Rodrigo, Escondido and Salado and the Las Vacas Arroyo, subject to the U.S. right to an average of at least 350,000 AF/yr in cycles of five consecutive years.	One-third of the flow reaching the main channel of the Río Grande from the Ríos Conchos, San Diego San Rodrigo, Escondido, and Salado and the Las Vacas Arroyo, provided that this third shall not be less, as an average amount in cycles of five consecutive years, than 350,00 AF/yr. The U.S. does not acquire rights in the Mexican tributaries in excess of the 350,00 AF/yr except the right to use one-third of the flow reaching the Río Bravo from these tributaries, although the one-third may be in excess of 350,00 AF/yr.
One-half all other flows of the main channel of the Río Bravo not otherwise allotted, including contributions from all unmeasured tributaries between Fort Quitman and the lowest major international storage dam (Falcon)	One half of all the flows of the main channel of the Río Bravo not otherwise allotted by the Treaty, including contributions from all unmeasured tributaries between Fort Quitman and the lowest major international storage dam (Falcon).

The 1944 Treaty has, up until the last few years, worked reasonably well and disputes between the U.S. and Mexico over division of the waters of the Río Grande have been minimal. With the recent prolonged drought and increased use of the river, however, the inherent weaknesses of the Treaty are becoming more apparent. For instance, the treaty fails to define what constitutes an "extraordinary drought." This has caused dispute about whether the prolonged period of reduced rainfall in Chihuahua over the last few years is the type of drought recognized by the treaty.

In addition, the Treaty essentially uses a process whereby Mexico must "repay" water in subsequent years when it fails to provide the minimum 350,000 acre-feet/year (over a five year cycle). It is unclear whether such "repayment" is sensible or feasible in situations such as the present where Mexico, for whatever reason, has accumulated a large deficit. Even if Mexico had the water to make up the deficit, moving such a vast amount of water into the Amistad/Falcon system between now and the end of the current repayment period (October 2002) makes little sense, as much of the water would likely be lost to evaporation and transpiration from the reservoirs.

Finally, the treaty does not address binational allocation of transboundary groundwater reserves, currently a problem in El Paso/Juárez, but potentially troublesome in other areas of the Texas/Mexico border as well.

In the last few years, these weaknesses in the Treaty have forced the U.S. and Mexico (generally through the IBWC) to scramble to negotiate *ad hoc* agree-

ments for resolving immediate crises, as political pressure mounts in both countries.[42] To date, these negotiations have focused almost exclusively on short-term solutions, rather than on developing medium to long-term basin and drought management plans.

There are some signs that this is changing with the current crisis. Through IBWC Minute #307 (see Appendix to this article), signed on March 16, 2001, Mexico has now agreed to provide enough water for Texas farmers to irrigate during the summer 2001 growing season, and the countries have agreed to cooperate developing some type of drought response and "sustainable management" plan for the basin. This more comprehensive approach, however, has come from individual policy makers responding to political pressure, and is not something fostered or encouraged by the Treaty itself.

Texas/New Mexico interstate disputes over management over Río Grande basin waters have sometimes rivaled the current binational conflict.

The 1938 Río Grande Compact sets out obligations of New Mexico to deliver water to the Elephant Butte reservoir, from where it is transferred to downstream users, including those located in Texas. The Compact allows for certain accrued credits and debits between the states, which in the past has resulted in heated controversy and costly litigation. Currently, New Mexico and Texas have, for the most part, resolved most of their differences and are working more cooperatively through the Texas/New Mexico Compact Commission, though the U.S. Bureau of Reclamation's quiet title suit may bring new confusion and disputes.

The 1948 Pecos River Compact between Texas and New Mexico governs the allocation of the Pecos River basin above its confluence with the Río Grande. The Compact provides that New Mexico must deliver to Texas, subject to streamflow and other conditions, the same amount of flow that Texas received from the Pecos in 1947. It provides for a cooperative program for salvage of water from consumption by phreatophytes (water-consuming vegetation) and alleviation of high salinity in certain areas of the basin. Texas and New Mexico have also litigated the provisions of this Compact. In 1990, the states settled their dispute, with New Mexico agreeing to pay Texas $13.8 million in damages.

Interstate conflicts have also arisen in the Mexican portion of the basin, though there are no interstate compacts to govern distribution of waters between Chihuahua and downstream Mexican states or between basin states such as Nuevo Leon and Tamaulipas. Irrigated agriculture and municipalities in Tamaulipas have had their allocations from the Río Grande severely reduced over the last few years as a consequence of reduced inflows from the Conchos River.

In addition, growers in the Río Bravo Irrigation District in northern Tamaulipas have been battling the adjoining state of Nuevo Leon and the city of Monterrey over the effects of the El Cuchillo dam. Completed in 1994, this dam cut off much of the flow of the Río San Juan in order to store the water for municipal and industrial use in Monterrey. Downstream irrigators in Tamaulipas were supposed to receive return flows from Monterrey's new sewage treatment plants to replace the San Juan waters. The border city of

[42] This was the case with IBWC Minute #293, providing for the U.S. to loan water to Mexico to meet municipal needs in the Mexican portion of the Lower Río Grande Basin and with the more recent Minute #307.

Reynosa, Tamaulipas was forced to switch its supply from the San Juan to the Río Grande main stem. The return flows never materialized and many of the Tamaulipas farmers suffered substantial losses. Political controversy, social unrest and litigation ensued, eventually resulting in the resignation of Nuevo Leon's governor and forcing the federal government to promise compensation to the Tamaulipas farmers.[43]

Texas essentially relies on the prior appropriation doctrine for surface water management, though it also recognizes riparian rights claimed before 1969. With the exception of the El Paso to Fort Quitman stretch, the state has adjudicated water rights in the Texas portion of the Río Grande basin. The El Paso to Fort Quitman stretch adjudication was initiated in 1997 by the Texas Natural Resource Conservation Commission (TNRCC), but has been stayed pending resolution of a "quiet title" suit brought by the U.S. Bureau of Reclamation over water rights in the Elephant Butte/Caballo system.[44]

As noted above, most of the water rights in this segment are irrigation rights held by the El Paso Water Control and Improvement District No. 1. The city of El Paso has been leasing or otherwise acquiring these water rights and converting them to municipal use in order to reduce its dependence on the Hueco Bolson aquifer.

Texas rights to use Río Grande water from Fort Quitman to the Gulf of Mexico are administered by the Río Grande Watermaster.[45] In cooperation with the IBWC, which manages the Amistad/Falcon reservoir system, users below the reservoir make a "call" for releases from the reservoir. As noted above, the Río Grande in Texas is "over-appropriated:" that is, paper water rights exceed the firm annual yield of the river/reservoir system. State law requires a minimum reserve of water in the system to satisfy municipal water rights and, thus, in times of low storage levels irrigation users may not receive their full allotment.

The presence of the Watermaster and the manner in which water rights are administered in this stretch of the river[46] have fostered a growing water rights market in the Lower Río Grande Valley, with municipalities leasing or purchasing irrigation rights to meet growing demand. This is likely to continue, as suburbanization continues to take over Valley farmland. Some municipalities, however, pump directly from the river and/or depend on the irrigation district distribution system for transport of the water to the municipal system.

Groundwater in Texas is not regulated at the state level. Instead, Texas continues to rely on the "rule of capture" or "absolute ownership." Under this rule, the surface estate owner has ownership rights to all the groundwater she can pump for use at any location in any manner, without bearing responsibility to neighboring landowners or other users of the aquifer. Despite that fact that this court-made doctrine is based on outdated assumptions – *i.e.*, that the movement of groundwater is unknowable – the

[43] For more information on the El Cuchillo controversy see HARC report, supra, final sections of Chapter 4 on agriculture in Tamaulipas.

[44] For further discussion of this important litigation, which has now been transferred from federal court to New Mexico state court, see Paso del Norte Water Task Force, Water Planning Report, *supra*.

[45] Distribution of water rights among Texas users was hashed out in a series of Texas court cases in the late 1950s and early 1960s. The record drought of the 1950s forced users and the state to court to get a firm definition of water rights. It is this court adjudication that essentially resulted in over-appropriation of the river downstream from Fort Quitman.

[46] Essentially, because all water used must be "called" from the upstream Amistad/Falcon system, there are no "third party" adverse impacts to consider in the transfer of rights from one use/place of diversion to another.

courts have declined to move to a rule of "reasonable use" and the political barriers to legislative change have so far been insurmountable.

Thus, groundwater management in Texas has been confined to those areas of the state where local interests have formed "groundwater management districts." Among other things, these districts can require meters, prevent waste, regulate well spacing and, under current law, limit exports of groundwater outside the district.[47] Rural counties in the west Texas portion of the Río Grande basin are increasingly looking to formation of groundwater districts to protect their local groundwater supplies from export to El Paso and other urban areas.

Water resource management in Mexico is largely the province of the federal government. Article 27 of the Mexican constitution establishes the legal framework for water resources management in Mexico. It essentially provides the federal government with ownership of and jurisdiction over almost all surface water and groundwater. The federal government issues permits for water use, pursuant to the 1992 federal water law.[48] The "permits" include concessions to private interests and assignments to governmental entities, such as municipal water supply systems. These permits can be in force for anywhere from 5 to 50 years, with extensions available. No permit is required for domestic uses that do not involve construction of a water distribution system.

In theory, permit issuance is contingent on water being available. In many areas the hydrological and current water use data needed to determine water availability may not exist or may be insufficient or unreliable.

Mexico has not developed what is known in the U.S. as a "prior appropriation" system for allocating water in times of shortage. Under the prior appropriation doctrine, "senior" water rights (*i.e.*, the oldest water rights) can be fully satisfied before junior water right holders in the same basin get their water. Thus, under Mexico's system it appears that all users may have their allocations reduced during times of shortage. The 1992 water law gives the federal government broad discretion to impose water use restrictions and allocations in areas of shortages or periods of drought. Significantly, use restrictions can also be imposed to "protect or restore" an ecosystem, as well as to prevent over-exploitation of aquifers, preserve potable water sources and prevent contamination.

Mexico's water rights registry is still somewhat incomplete and inconsistent, but it has been greatly improved over the last several years with funding from a World Bank loan. Developing an accurate and complete water rights registry will be important to the success of future water management efforts (including the potential for a water rights market) in the Conchos basin, and in Mexico as a whole. In Chihuahua, for example, CNA reports that it has registered about 3,850 water rights (122 for surface water use and 3753 for groundwater use). According to CNA, this accounts for about 27% of the water use systems, but about 77% of the annual volume

[47] Legislation has been filed in the current session of the Texas legislature to limit the powers of groundwater districts to regulate exports.

[48] Water use authorizations issued prior to the 1992 law remain effective if they area registered in the Public Water Rights Registry established by the 1992 act.

of water used in the state. In the Conchos/Río Bravo basins, CNA reports that the registry has about 27% of the known water supply projects included, but the registry's reported volume of water "extracted" exceeds the extraction estimated from other sources of data by 25%.

The federal government imposes a fee for development and use of surface and subsurface water, with certain important exceptions. In 1996, the fee varied with the location of the use and the time of year, but generally ranged from about $1 per thousand cubic meters for use in aquaculture, recreation centers or generation of hydroelectricity to $50 to $100 per thousand cubic meter for potable water. The government does not charge a fee for extraction and use of water for personal domestic use, for domestic use in small towns and villages, or for agricultural use in irrigation districts or unidades de riego (with the exception of "agro-industrial use").

The federal government's dominant role in water resources management is lodged in CNA, which is now part of Mexico's environmental agency, SEMARNA (Secretaria de Medio Ambiente, Recursos Naturales). There is a division of CNA that deals with water in the northern border states, and a part of that division is devoted to oversight of water issues in Chihuahua. Recently, CNA has begun to work more cooperatively with state governments, including that of Chihuahua, involving the states more closely in planning and decision-making.

At the state level, there are "Juntas Centrales de Agua y Saneamiento" (Central Directorate of Water and Sewer) that are primarily responsible for the state's role in water issues. Larger municipalities have their own water and sewer departments and there are also "Juntas Rurales de Agua Potable," rural water supply directorates.

Irrigation districts are generally established by presidential decree. In recent years, the federal government has moved to delegate responsibility for operation of the districts to "user associations." The user associations hold title to the water rights and are to implement a system of fees to help pay for the operation and maintenance of the water delivery structure. The ultimate objective is to have the districts be financially and operationally self-sufficient.

The 1992 water law contains a procedure for establishing "Consejos de Cuenca," or basin management councils. The purpose of the basin council is to improve inter-governmental coordination in water resources management and to improve cooperation among the governmental entities, water users and other interests, including the public. A Consejo de Cuenca for the Río Bravo basin in Mexico, including the Río Conchos, was established in 1994, but there has been almost no progress in getting the Consejo off the ground.

TRANSBOUNDARY IMPLICATIONS

As discussed above, the persistent drought in Chihuahua has led to significantly less water from the Conchos reaching the main stem of the Río Bravo. In fact, flows have been reduced to the point where Mexico is now is a "deficit" situation with respect to the 1944 U.S./Mexico water treaty that governs allocation of the Río Bravo/Río Grande.

The 1944 Treaty provides that one-third of the flow reaching the main channel of the Río Bravo from the Ríos Conchos, San Diego, San Rodrigo, Escondido and Salado and the Las Vacas Arroyo is allocated to the United States, provided that this third shall not be less, as an average amount in cycles of five consecutive years, than 431,721 Mm^3/year (350,000 acre-feet per year). The vast majority of this water comes from the Conchos basin, as flow in the other tributaries is minimal during much of the year.

In the five-year cycle ending on October 2, 1997, Mexico owed the U.S. about 1,240 Mm^3 (1.024 million-acre feet). This is more than double the deficit incurred by Mexico during the drought of the 1950s, which is the only other time Mexico has failed to meet the minimum flow requirements during a five-year cycle. By February 2000, Mexico had accumulated an additional 0.48 Mm^3 (0.40 MAF) deficit in the current five-year cycle.

According to Article 4 of the treaty, total flow from these Mexican tributaries can average less than 350,000 acre-feet/year over a five-year cycle without Mexico being in "violation" of the treaty if there is a situation of "extraordinary drought." The treaty requires that Mexico make up the deficit in the subsequent five-year cycle.

Unfortunately, the treaty does not provide further definition of the term "extraordinary" drought. This lack of certainty is now at the heart of a raging controversy, as U.S. farmers in the Lower Río Grande are alleging that the drought in Chihuahua was not so severe as to justify Mexico's withholding of flows in the Conchos basin. Based on a report by the consulting firm R.J. Brandes and Associates, the farmers essentially claim that the Conchos basin received about 80 percent of its normal rainfall during the 1993 to 1997 period and that because flow in the Mexican tributaries did not cease "entirely" there was no "extraordinary drought."[49] They further claim that, under the treaty, Mexico should have released water stored in reservoirs in the Conchos basin to meet the 350,000 acre-feet/year requirement.

Mexico has responded that the lower levels of rainfall, particularly in the Conchos basin, do constitute an extraordinary drought, though it did not dispute the Brandes report calculation of an average 80% of normal rainfall during 1993-1997. Nevertheless, as shown in Figure 4, above, only during the late 1940s and early 1950s was average annual rainfall in the Conchos basin less than during the 1995-1999 period. Mexico further argues that it is entitled, under the treaty, to withhold enough water in reservoir storage to meet water demands in the Conchos basin, before water is released to the

[49] The Brandes report places annual average rainfall in the Conchos basin at 47% of normal in 1994 and 69% of normal in 1995, with three others years (1993, 1996 and 1997) experiencing normal or near normal rainfall levels.

Río Bravo to satisfy treaty requirements, as long as it pays back the water owned in the subsequent five-year cycle. It also states that the storage capacity of the reservoirs on the Conchos is less than assumed by the U.S. since there has been significant sedimentation in some of those reservoirs.

The dispute has reached the level of the respective state departments in Mexico and U.S. The International Boundary and Water Commission (IBWC), a binational agency set up under the treaty to administer the water allocation between U.S. and Mexico, has been meeting with government agencies and water users in both countries in an attempt to resolve the disputes. Since February 2000, through a combination of releases from the Conchos and transfer of Mexico-owned water in the Amistad/Falcon reservoir system to U.S. ownership, Mexico has reduced its deficit for the 1992-1997 cycle to about 841 Mm^3 (690 MAF). Under the treaty, this entire deficit must be repaid by the time the current five-year cycle ends on October 2, 2002.

IBWC Minute # 307, included in the Appendix to this article, is the most recent result of these negotiations. It may provide a "short-term" fix and set the two countries on a better path to dealing with Río Grande basin management issues and drought planning. Nevertheless, fundamental problems remain to be addressed. The current controversy over the interpretation and implementation of the 1944 Treaty indicates the need for the two countries to better define the term "extraordinary drought" and, possibly, to clarify other provisions of the treaty. Moreover, in the future it is not unlikely that there will be increasing controversy over the use of transboundary groundwater in the basin, and the 1944 Treaty is silent on those matters.

WATER POLITICS AND PROSPECTS FOR PROGRESSIVE CHANGE

Water management policy is one of this desert region's thorniest issues. Water politics in the Texas/Mexico Río Grande basin involves many different and sometimes powerful interests, and often these interests are in direct competition, with only a narrow middle ground.

In the Texas portion of the basin, a diverse set of actors participates in water policy decision-making, including municipal water supply entities, irrigation districts, ranch and farm associations, environmental and conservation organizations, community organizations representing low-income residents lacking access to clean water, industrial water users, academic researchers, the state water agencies, inter-state compact commissions, the federal Bureau of Reclamation and, to a lesser extent, the federal Environmental Protection Agency, the National Park Service and the U.S. Fish and Wildlife Service.

In the Mexican portion of the basin, the set of actors is similar but somewhat less diverse due to the centralization of water policy management decisions at the federal level and the limited resources of non-

governmental organizations. Most of the decision-making authority resides in the Comisión Nacional de Aguas (Mexico City and regional offices), which is housed in the national environmental agency, SEMARNAT. Other actors include policy divisions of SEMARNAT, irrigation districts and agricultural users associations, state and municipal water supply systems, industrial users, residents associations, and some academics and conservation and human rights organizations.

At a binational level, management of the shared surface waters of the basin is largely in the realm of the International Boundary and Water Commission, though the BECC and the NADBank are starting to play more important roles regarding water and wastewater systems, and state and local governments are more involved every day in cross-border water discussions. Over the last several years, the IBWC has become more open to dialogue with state and local governments and user groups and, by necessity, more interested in drought management, basin management and environmental restoration issues. In times of dispute, such as the present, both the U.S. State Department and the Secretaría de Relaciones Exteriores in Mexico play a significant, and often determinative, role.

In neither country, however, is water management policy free of political party influence. In Texas, the historically strong opposition of many farmers and ranchers to changing the rule of capture means that groundwater is often used as a political issue. Property rights issues associated with water pricing, conservation requirements or water rights marketing can also be taken up as political issues on a local or statewide basis.

In Mexico, water allocation can also become a hot political topic – used by one of more of the parties to build public support or accuse opponents of corruption or mismanagement. Access to water can become an issue in local urban political fights, as officials sometimes seek to garner support for their party as a trade-off for building or improving water supply structure for a particular industrial park or neighborhood.

This wide variety of interests and the tendency for water issues to become highly politicized, combine with other factors, to pose substantial barriers to progressive changes in water management policy in both Texas and Mexico.

In Texas, one of the most intractable barriers to changes has been, and will likely continue to be, resistance to change, especially on the part of large irrigators. As municipal and industrial water needs grow, agricultural water users have developed legitimate concerns about whether they will be able to maintain adequate water to support their operations. In some cases, these concerns go to the core values of quality of life and the ability to sustain viable rural agricultural communities. In others, the concerns are more directly related to profit margins in crop production or to preserving legal title to water in order to be able to market it in the future to municipalities or others.

This resistance comes into play with regard to several aspects of water management policy in the Texas portion of the basin, including: (1) addressing

subsidy and water pricing issues; (2) the need for a better framework for groundwater management and (3) the need to restore or preserve instream flows and reduce aquifer depletion.

Although it is one of the most direct tools for change, litigation may also be an obstacle in some instances. For example, the Bureau of Reclamation's "quiet title" suit over the Elephant Butte/Caballo project – whatever its merits – carries the risk of polarizing the positions of different interest groups. On the other hand, without litigation, there is sometimes no leverage to begin the complex negotiations required to move toward more progressive water management. This has been the case throughout Texas – and much of the rest of the Western United States – for many decades.

Another obstacle to change is the lack of political will on the part of decision-makers to confront the many complex and controversial issues surrounding water management policy in the Texas/Mexico Río Grande basin. Political will often requires a broader public awareness and knowledge of the issues than generally exists on most water management issues. In most areas of the basin – with the exception of severe drought periods – discussion of water management issues is often confined to professionals, government officials, and interest groups instead of taking place in newspapers, on television or in other spheres of general public participation.

This situation is beginning to change somewhat. Examples include the relatively high profile of water issues in the El Paso/Juárez area[50] and the widespread publicity given to the demands of farmers in the Lower Río Grande Valley that Mexico repay its "debt" under the 1944 Water Treaty. The latter situation has yet to move beyond accusations and finger pointing, however, though that may change in the near future.

Similar obstacles exist in the Mexican portion of the basin, as well as others not faced in Texas. With the traditional centralization of water management authority in the federal government, the states and local governments, water users, and other interests are fighting for a voice. On paper, the Río Bravo Consejo de Cuenca provided one potential venue for more non-federal involvement, but it has not materialized as an active or influential forum.

Another issue in Mexico, at least with respect to municipal water supply systems, is that when the local administration changes, there is often a wholesale change in technical personnel. This lack of continuity can seriously interfere with plans to improve efficiency of water distribution systems and with longer-range planning for water supply and conservation.

A third issue in Mexico is the need for development of better opportunities for public participation in water management decisions. In the U.S., there are several opportunities, including water rights hearings, rulemaking, planning processes (such as the Regional Water Planning groups) and open forums where interested parties are encouraged to openly discuss water issues. Such opportunities are fewer and farther between in Mexico, though they are increasing every day. SEMARNAT's new focus on Water and Forests should help considerably in this

[50] With the support of the respective federal governments, local leaders have now formed the binational Paso del Norte Water Task Force to discuss more sustainable long-term water management policy for the El Paso/Juárez/Doña Ana region.

regard. Some opportunities have also been provided by the BECC project certification process, which is open and participatory, and involves local communities directly in decisions about new water and wastewater supply projects.

One important element of meaningful public participation in the water policy arena (in both countries, for that matter) will be increased availability of good information on water use and water supply. In Mexico, in particular, water users, non-governmental organizations and researchers often have difficulty in obtaining basic information held by the Comisión Nacional de Aguas or municipal or state water supply entities.

The dominant issue in water politics in Mexico, however, is money. More resources are needed to improve government data collection and analysis; to strengthen the agencies responsible for water management; and to improve the water management capabilities and infrastructure of irrigation districts and municipal water supply systems. Currently, competition for scarce financial resources tends to put most water management decision-making in Mexico at constant risk of politicization.

Despite these formidable obstacles, there are some prospects for progressive change on the horizon. Though the recent drought in northern Mexico has caused devastation to many farmers and ranchers and ignited a war of words on the part of Lower Río Grande Valley farmers, it has also had the effect of elevating Río Grande basin water management issues on the binational, national and state policy agendas. This has coincided with a national, and even global, focus on freshwater supply issues that provides an important backdrop. The central challenge is to maintain this level of interest and engagement even if the immediate effects of the drought subside in the next few years.

Part of taking up this challenge is the need to demonstrate that there are opportunities for progress-opportunities that can help break policy gridlock or spur new alliances of interest. Several opportunities in the basin deserve special attention:

- **Opportunities for Agricultural Water Conservation:** Given that irrigation is by far the dominant use throughout the basin, and given the relatively low to moderate use efficiencies, this is the sector where conservation will have the most benefit. Achieving significant conservation in the irrigation sector, however, will require substantial financial investment. Where will the resources come from? First, they can come from municipalities that need additional water rights. These municipalities have an incentive to fund irrigation system improvements, though there is work to be done to make sure the legal framework clearly allows the municipality to secure the rights in the water that is conserved (and in some cases, a portion of the conserved water might be dedicated to instream flow needs). This approach will likely be easier in the U.S. than in Mexico, given the lack of resources available to most Mexican municipalities.

In other cases, it is going to take substantial government investment to improve old and inefficient distribution systems – and, for Mexico, that probably means money borrowed from the World Bank or other lending institutions, such as the BECC/NADBank.

Agricultural conservation can also be achieved through discouraging production of high water use crops in water short areas; through better metering of use; and – though politically difficult – through appropriate water price adjustments.

- **Opportunities for municipal water conservation:** Municipal conservation will be necessary in the Texas portion of the basin to reduce per capita consumption to sustainable levels. This will mean more widespread adoption of native plant landscaping ordinances and increased use of treated effluent for aquifer recharge or various outdoor watering uses. In Mexico, the biggest opportunity to reduce municipal use is improving the water distribution infrastructure to reduce the 30-50% losses occurring in some systems. The BECC/NADBank process may provide some of the resources needed for these projects, but major investments will be needed.
- **Development of viable water rights markets that have public acceptance and transparency:** Water rights markets are one of the most important parts of a future overall sustainable approach to water management in the basin. Developing viable water markets, however, will require appropriate water price incentives, clear legal titles (an important challenge in Mexico), a framework for an appropriate degree of transparency to water rights transactions to prevent speculative profit-taking on what is essentially a public resource, a framework to prevent adverse effects on rural communities and a way to account for and meet environmental water needs.
- **Increased emphasis on potential stream and spring restoration projects:** While current opportunities for instream flow and spring flow restoration may currently be somewhat limited in the basin due to over-appropriation of water, in some instances rural communities and conservation organizations may find common ground in restoration projects that benefit both the environment and local economies, by attracting or retaining tourism and outdoor recreation opportunities. The current binational efforts surrounding the "Forgotten River" stretch will be an important pilot project.
- **Developing and making available more and better data on water use and water supplying and increasing public awareness of the basin's water supply constraints:** In many areas of the basin, but particularly in the Mexican sub-basins, more information is needed on water use patterns, water availability and environmental water needs. The availability of water from many of the

basin's aquifers is not well understood. And, we lack good scientific knowledge of the instream flow required to maintain healthy aquatic ecosystems and riparian habitats.

But having more and better data is not alone an answer. There must be a concerted effort on the part of water management agencies and non-governmental organizations to build broader public awareness of water scarcity and water policy issues in the basin. The efforts of the Río Grande/Río Bravo Basin Coalition, with its annual Día del Río and water issues conference are a good step in the right direction, but much more is needed in this large and diverse region.[51] The public needs a better understanding of who is using water for what purpose, where conservation opportunities exist and what happens if we fail to take advantage of these opportunities. This education needs to be done in a manner that, to the extent possible, avoids further polarization among water users and interest groups, but it is essential to building the political will necessary to grapple with the difficult choices that must be made in the coming years.

- **Building a better binational framework:** The current Mexico deficit under the 1944 Treaty, and other information, is demonstrating some of the inherent weaknesses of the treaty. While political obstacles are likely to prevent a broad renegotiation of the treaty, there are now opportunities to make necessary adjustments, including defining "extraordinary drought" and developing drought management and basin management plans that prevent future disputes and provide for meeting consumptive and non-consumptive water needs on a more consistent basis. In addition, local and state cross-border discussions are beginning to increase binational understanding of the limits of water resources in the Río Grande basin, but there is still a long road ahead. Both countries will have to confront the need to rethink long-held notions about the relationships among growth management, economic development and water supply, as well as how water should be used in urban and rural areas.

[51] For more information on this broad and growing binational coalition, see www.rioweb.org.

MARY E. KELLY is the Executive Director of the Texas Center for Policy Studies (TCPS), a public interest policy research and technical assistance organization based in Austin, Texas. Areas of expertise at TCPS include U.S./Mexico border environmental issues including Río Grande freshwater ecosystem, the state of the environment in Texas, and the relationships between economic development decision-making and the environment. Ms. Kelly has written extensively on border environmental issues. She is currently working on an assessment of the Río Conchos basin in northern Mexico. In conjunction with the Comisión de Solidaridad y Defensa de Derechos Humanos, A.C., she recently completed a study for the North American Commission for Environmental Cooperation examining the effects of NAFTA on forestry in Chihuahua. Ms. Kelly obtained her law degree in 1985 from the University of Texas, with honors. She also holds a Bachelor of Science degree in Chemical Engineering from the University of Arizona (1979, with distinction) and spent four years as an engineer with Radian Corporation. She is "of counsel" to the Austin law firm of Henry, Lowerre, and Frederick and was an associate and partner at that firm from 1986 to 1990.

Mary E. Kelly, Texas Center for Policy Studies, 44 East Avenue, Suite 306, Austin, TX 78701 mek@texascenter.org

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

Washington, D.C.
March 16, 2001

Minute No. 307

PARTIAL COVERAGE OF ALLOCATION OF THE RIO GRANDE TREATY TRIBUTARY WATER DEFICIT FROM FORT QUITMAN TO FALCON DAM

The Commission met at the Department of State in Washington at 10 a.m. on March 16, 2001, with high-level representatives and officials of the two Governments, to consider measures proposed by the Government of Mexico in the fourth year of the current five-year accounting cycle, in partial fulfillment of its obligation under subparagraph (c) of paragraph B of Article 4 of the United States – Mexico Treaty for Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, dated February 3, 1944.

The Commissioners made note of the discussions by United States President George W. Bush and Mexican President Vicente Fox Quezada held in San Cristobal, Guanajuato on February 16, 2001, at which the request was made of Mexico to provide to the United States a volume of 600,000 acre-feet (af), equivalent to 740 million cubic meters (Mm3) of water through July 31, 2001 in order to reduce the present deficit in the allocation of the portion of the Mexican Rio Grande tributaries. In furtherance of that conversation, the Commissioners reviewed the data provided by the Principal Engineers and observed that from the end of September 2000 through March 3, 2001, a volume of 232,674 af (287 Mm3) had been accounted in favor of the United States, such that there remains to be covered through July 31, 2001 a volume of 367,252 af (453 Mm3). They observed that this volume could be covered based on the following estimates:

a) Unmeasured Treaty Tributary Runoff – It is estimated that from March 4, 2001 to July 31, 2001, runoff to the Rio Grande, from rainfall to the unmeasured tributaries, will be between 159,710 af (197 Mm3) and 239,159 af (295 Mm3).

b) One-third of Treaty Tributaries Runoff - It is estimated that from March 4, 2001 to July 31, 2001, the runoff to the Rio Grande from the six Mexican tributaries and one third assignment of this volume to the United States in accordance with the Treaty, will range from 64,046 af (79 Mm3) to 84,314 af (104 Mm3).

c) Venustiano Carranza Dam Releases - An additional net volume of 38,103 af (47 Mm3) can be expected from Venustiano Carranza Dam, which is the one-third that corresponds to the United States, after losses, from the 138,631 af (171 Mm3) which are pending transfer from this dam.

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

Based on the above, the Commissioners observed that the Principal Engineers of the Commission identified two scenarios, a more positive one under which one could expect a volume of 594,250 af (733 Mm3) by July 31, 2001 and a more conservative estimate under which one could expect a volume of 494,533 af (610 Mm3), which includes the flows delivered since October 2000. On this basis, there results a range of 494,533 af to 594,250 af, which is the volume that could reasonably be expected by July 31. The above demonstrates that it is necessary to agree to a contingency plan in the event that the more favorable scenario does not occur and that by July 31, Mexico has not been able to deliver the requested volume of 600,000 af (740 Mm3). This contingency plan could consider in the first case, the extension of assignment of the unmeasured tributaries through September, which could be feasible to meet the United States request. In the second case, consideration could be given to covering the shortfall through September 30 with waters from the Luis L. Leon, La Fragua, Centenario and San Miguel Dams.

The Commissioners made note that for the estimates provided by the Principal Engineers on the above mentioned quantities an average of runoff recorded in 1993 – 1999 and an average runoff recorded in 1999 were considered.

The Commissioners discussed the need for the two Governments to continue discussions through the Commission to arrive at an agreement before the end of 2001 on additional measures that the Government of Mexico will take to cover the outstanding prior cycle deficit and on any other measures that they consider necessary concerning the last year of the current cycle.

At the same time, they observed that the two Governments, animated by a spirit of friendship that prevails in the relationship between the two countries and committed to prevent recurrence of the situation considered in these discussions will work jointly to identify measures of cooperation in the areas of drought management and sustainable management of this basin.

Based on the above, the Commissioners submit the following recommendations for the approval of the two Governments:

1. That the two Governments adopt the framework described in this Minute to ensure that Mexico provides to the United States 600,000 af (740 Mm3) in accordance with the two scenarios described above.

2. That the two Governments continue discussions, through the Commission, to arrive at an agreement before the end of 2001 to develop additional measures that the Government of Mexico will undertake to cover the outstanding prior cycle deficit and on any other measures that they consider necessary concerning the last year of the current cycle.

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

...3

3. That the Government of the United States and the Government of Mexico, animated by the spirit of friendship that prevails in the relationship between the two countries and committed to prevent recurrence like the situation considered here will work jointly to identify measures of cooperation on drought management and sustainable management of this basin.

4. That this Minute shall enter into force when the Government of the United States and the Government of the United Mexican States have approved this Minute.

The meeting was adjourned.

Robert Ortega
Acting United States Commissioner

J. Arturo Herrera Solís
Mexican Commissioner

Manuel R. Ybarra
United States Section Secretary

Jose de Jesus Luevano Grano
Mexican Section Secretary