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A Focus on a Binational Watershed with a View toward Fostering a Cross- Border Dialogue

ABSTRACT

Two border communities—Columbus, New Mexico, and Palomas, Chihuahua, bound by historical, familial, and economic ties—depend solely on groundwater extracted from the Mimbres aquifer, a “closed basin” located in arid southwestern New Mexico and northwestern Chihuahua. During the last twenty years, the region’s population has substantially increased. Agriculture contributes significantly to the social and economic makeup of the area but also accounts for 95 percent of the withdrawal and the depletion rates from the aquifer. Projected increases in population together with agriculture and industrial development will intensify pressure on the already declining water table. Contamination and alkalization are also concerns, and recurring drought has emphasized the need for water conservation.

The international border has made it nearly impossible for the two communities to jointly manage the aquifer upon which they both depend. Adequate mechanisms to deal with the dilemma are lacking. While both the New Mexico State Engineer and the Comisión Nacional de Agua (Mexico’s National Water Commission) develop plans for their users, each formulates its own rate of withdrawal without considering usage on the other side of the border. Furthermore, there has been little systematic gathering of data on water characteristics or behavior, and no formal sharing of existing data, much less joint planning for future usage and conservation. The lack of information about the aquifer makes it difficult for residents to make rational choices between proposed uses of water. It also presents problems for government agencies trying to predict the aquifer’s carrying capacity. To date, this has resulted in inappropriate policies, rendered current unilateral plans useless, hindered impact analysis, and impeded the consideration of options. Efforts to address the situation are underway. If Columbus and Palomas can apply the lessons of other regions, the border between them would no longer be an impediment to conserving the lifeblood of the region.

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INTRODUCTION

*Withdrawals from one country can drain life-giving water from a neighboring country and, as a consequence, be the source of severe and protracted conflict.*¹

Appropriately enough, as we begin a new century and millennium, people of all walks of life are grappling with the notion that water, our life-giver, can also be a looming source of conflict. These concerns have attained global status. March of 2000 saw the culmination of a number of international consultations, conferences, and activities that are considering ways to best address the multiplicity of strains and stresses.² Water being a resource vital to all, its scarcity in arid and semi-arid environments can and often does lead to political pressures. Thus, the equitable management of water resources must become a priority.

Water is not only essential to sustain life, but to support ecosystems, economic development, community well-being, and cultural values. How are all these values, which sometimes conflict, to be prioritized? What is to be sustained? For how long? What are the benefits? Who are the beneficiaries? In the context of fresh water resources, any discussion of sustainable development requires that we

1. Robert D. Hayton & Albert E. Utton, *Transboundary Groundwaters: The Bellagio Draft Treaty* 28 NAT. RESOURCES J. 663 (1989).

2. International Water Resources Association (IWRA) Xth World Water Congress from Mar. 11-17, 2000, in Melbourne, Australia, with a theme of "conflicts and opportunities" for balancing entitlements to water resources in the twenty-first century as demands for good-quality water place growing pressure on an increasingly scarce resource and for meeting the challenge of satisfying competing claims on the earth's waters through sustainable management. See International Water Resources Association, *Events* (visited Mar. 14, 2000) <<http://www.icms.com.au/worldwater/>>. The Second World Water Forum & Ministerial Conference on Mar. 17-22, 2000, The Hague, the Netherlands, sponsored by World Water Forum, World Water Vision, and the World Water Council, seeking a global water partnership and framework for action. See World Water Forum, *Events* (last modified Mar. 15, 2000) <<http://www.worldwaterforum.org/>>; World Water Council, *The International Water Policy Think Tank News & Events* (visited Mar. 14, 2000) <<http://www.worldwatercouncil.org/>>; World Water Vision, *Events* (last modified Sept. 3, 1999) <<http://www.watervision.org>>. World Water Day on Mar. 22, 2000. See UNESCO, *Natural Sciences* (last modified Mar. 6, 2000) <<http://www.unesco.org/science/waterday2000>>.

understand both the physical resource and the benefits or services that those resources must provide.³

As articulately phrased by the World Commission on Water for the Twenty-First Century, there is a "water gap."⁴ In order to feed an expected additional three billion people who will be living on the planet in twenty-five years, 20 percent more water will need to be made available.⁵ Even if water use efficiency levels are increased to 70 percent (from an average now of 45 percent), this additional water needed would still be 17 percent.⁶ Such demand will face competition from growing municipal, industrial, and environmental claims, making it even more difficult to find the water sources for agriculture.⁷

The global equation devolves into regions, each with their unique set of factors that reveal gaps, and each experiencing similar stresses. The U.S.–Mexican border area is no different. Population growth typically exceeds the states' averages, often in arid regions already experiencing "water stress."⁸

The transboundary water issues that confront the border region today are complex and interwoven. They require an

3. PETER H. GLEICK, HUMAN POPULATION AND WATER: TO THE LIMITS IN THE 21ST CENTURY 4-5 (1995) (available at Am. Assoc. for the Advancement of Science, Pacific Institute for Studies in Development, Online Library, *Human Population & Water, Fisheries & Coastal Areas: Science & Policy Issues* (visited Mar. 11, 2000) <<http://www.aaas.org/international/psd/fisheries/gleick.htm>>).

4. World Water Vision, Press Release, Mar. 30, 1999, *The World Water Gap: World's Ability to Feed Itself Threatened by Water Shortage* (last modified Jan. 29, 2000) <<http://www.watervision.org/clients/wv/water.nsf>> [hereinafter *The World Water Gap*].

5. See *id.*

6. See *id.*

7. See *id.* at 2. World Clocks underscore the sense of urgency, inexorably ticking away. See, e.g., International Development Research Centre, *World Population and Productive Land Resource Clocks* (last modified Dec. 15, 1999) <<http://www.idrc.ca>>. One clock indicates an increase of about three people a second by tracking both births and deaths, while the other shows that one hectare is lost every 7.67 seconds. See *id.* Productive land is made up of arable land, pastureland, and forest. See *id.*

8. One definition of water stress is as follows: low, less than 10% of total available is withdrawn; moderate, 10-20% of total available is withdrawn; medium-high, 20-40% of total available is withdrawn; high, more than 40% of total available is withdrawn. See United Nations Environment Programme, *GEO-2000 Global Environment Outlook, Chapter Two: The State of the Environment, Regional Synthesis, Freshwater* (1995) <<http://grid2.cr.usgs.gov/geo2000/english/ir2a.htm>>. The graphic indicates that while Mexico already falls within the medium-high classification, both the United States and Mexico will by 2025. See *id.* Another author defines scarcity, stress, and abundance: scarcity as less than 1000 cubic meters per person per year availability, stress as less than 1667 cubic meters per person per year availability, and abundance as more than 1667 cubic meters per person per year availability. See GLEICK, *supra* note 3, at 3-4.

understanding of the hydrology, the economies, the cultures, and the laws. Three of the most pressing problems are: increasing demands for water and the potential for water shortages; contamination of surface and groundwater by fecal coliform and nitrate due to inadequate wastewater treatment; and contamination from industrial discharge and agricultural runoff.⁹

Presently, "[t]he major use of water in all border states is for irrigated agriculture, the acreage of which has grown dramatically in recent years in response to market opportunities as well as government support for water resources development."¹⁰ The authors note that while farmers often hold the early water rights, municipal demand is growing at a rapid pace, and climate variation and change pose additional threats.¹¹ Newcomers frequently lack a "sense of place," and depending upon an area's prospects for economic success, may lack a sense of permanency as well. Balancing these interests and changes makes for extraordinary challenges. Because natural resources do not adhere to political boundaries, the ability to exploit and manage them efficiently is jeopardized by mere lines drawn on a page. Different legal, social, economic, and cultural structures hinder rational management. As conurbations such as El Paso, Texas, Ciudad Juárez, Chihuahua, and Doña Ana County, New Mexico, (together referred to as Paso del Norte) come to grips with the cross-border demands that both bind and restrict them, new methods will be needed to address these issues fairly and equitably.

With the number of people sharing transboundary aquifers increasing, there can be no greater challenge than to fashion a set of precepts or tools to ensure attainment of "[t]he fundamental goal to achieve joint, optimum utilization and avoidance or resolution of disputes over shared groundwaters in a time of ever-increasing pressures upon this priceless resource," as desired in the *Bellagio Draft Treaty*.¹²

These are noble words, but they are difficult to implement. A decade after these principles were drafted, there still is no viable agreement (at least between the United States and Mexico) to manage groundwaters

9. JEAN BOWMAN, *THE RIO GRANDE: A CONFLUENCE OF WATERS, NATIONS & CULTURES* (1993) (available at Texas Water Resources Institute, *Publications* (last modified Aug. 14, 1999) <<http://twri.tamu.edu/twripubs/WstrResrc/v19n2/text-0.html>>).

10. Diana M. Liverman et al., *Environmental Issues along the U.S.-Mexico Border: Drivers of Change and Responses of Citizens and Institutions*, in 24 *ANN. REV. ENERGY ENV'T* 607, 622 (1999).

11. *See id.*

12. Hayton & Utton, *supra* note 1, at 663. At such a time when water is being truly discussed on a global level, it is appropriate to recognize Albert Utton for his energy, time, and grace in moving us forward to this juncture.

shared by their peoples. Pressures have continued to mount as municipal and industrial claims rise.

A number of efforts, often informal in nature, have sprung up to address this vacuum. Successful ones are organizing around a watershed concept that provides a sensible framework within which to define and review regional problems. While acknowledging sensitive issues such as sovereignty, a positive dialogue can foster constructive approaches to issues rather than the all-too-familiar response of merely ignoring them. The recently issued "From Vision to Action" statement by the World Water Forum sets forth two objectives: "(1) mass public awareness and (2) political commitment."¹³ The Forum will generate the political commitment needed to address the looming crisis in water resources. It will be a political call to implement the World Water Vision and the Framework for Action.¹⁴

Rationale for the Study

The International Dialogue Forum on "Global Water Politics—Cooperation for Transboundary Water Management," held near Bonn in March 1998, drafted the "Petersberg Declaration."¹⁵ It focuses on the theme of "Water—A Catalyst for Cooperation" and "emphasizes the importance of water as an opportunity for regional cooperation; integrated management of transboundary river and lake systems as an especially positive example of regional cooperation; and international commissions in addressing management of transboundary water resources in the future."¹⁶

A prerequisite for a cross-border treaty, such as envisioned in *Bellagio*, is the creation of a common database. See, for example, the comment included in Article V: Establishment and Maintenance of the Database:

[t]here can hardly be anything more important in effecting international water resources management than the factual basis required for rational decision making. Consequently,

13. World Water Forum, *From Vision to Action* (visited Mar. 15, 2000) <www.worldwaterforum.org/index2.htm>.

14. See *id.*

15. See The African Water Page, International Round Table, *Transboundary Water Management: Experience of International River and Lake Commissions, Development Policy, Berlin Recommendations, Lessons Learned, Challenges and Issues for the Future* (last modified Mar. 11, 2000) <<http://www.africanwater/berlinrecom.htm>>.

16. *Id.* at 2.

the critical need...[for] not only more specific, but a unified, comprehensive data base is mandated.¹⁷

If the process were to continue to a planning stage, *Bellagio* proposes a framework in Article VIII: Comprehensive Management Plans.¹⁸ Section 3 of Article VIII lists factors to be considered if any allocations of water uses are necessary.¹⁹ Information collected for the data base should be likewise usable for this purpose. The *Bellagio* Draft Treaty provides for situations such as planned depletion (Article X) and drought planning (Article XII).²⁰ While conceding that groundwater mining may indeed be a rational decision, it is important to acknowledge that such mining often occurs unilaterally in a transboundary situation, giving rise to a "race to the bottom." Furthermore, factors influencing water usage may well be far removed from the local scene.

To be able to state with confidence that "[t]he Parties recognize their common interest and responsibility in ensuring the reasonable and equitable development and management of groundwaters in the border region for the well being of their Peoples,"²¹ and act on that recognition, will require a great deal of groundwork in each region. Together with seeking technical solutions, "[t]he key...is to generate public awareness, and from it behavioral change and the political will to create a better water future."²²

Consensual understanding of the operation of physical ecosystems is considered endogenous to the explanation of how transboundary cooperation emerges. Equally important, however, is the emphasis on inclusive dialogue that incorporates community values along with political power of interests and the knowledge of experts.²³

In addition to being equitable, obtaining and disseminating information should influence local action, even if no international action is taken. The complex web of events which continually gives rise to different scenarios may not be conducive to carrying out planning initiatives. Given that election cycles, procedures, and political systems vary considerably on

17. Hayton & Utton, *supra* note 1, at 688-89.

18. *See id.* at 695-702.

19. *See id.* at 696.

20. *See id.* at 703-09.

21. *Id.* at 682-84 art. II (General Purposes).

22. *The World Water Gap*, *supra* note 4, at 3.

23. HELEN INGRAM, FACULTY RESEARCH ON REGIONAL ENVIRONMENTAL COOPERATION: TESTING MODELS AGAINST EXPERIENCE IN TRANSBOUNDARY WATER RESOURCES MANAGEMENT 1 (1997) (available at <<http://www.eee.uci.edu/97y/50070/doc/1section2.htm>>).

either side of the border, not to mention the disparate economic levels, difficulties abound. Ultimately, whether or not a community gains attention due to its size or issues facing it, the decisions made will determine the fate of its residents. If they are knowledgeable about their resource base and the limitations it imposes and determine to act accordingly, mutually prudent goals can be devised and reached. Creating and sustaining broad-based political will can focus energy on positive solutions rather than on draining conflicts.

Meshing treaty provisions, watershed planning approaches, and community participation will provide the key for long-term survival of a region. Typically, watershed planning requires knowledge of water quantity, water quality, economic activities, social characteristics, and a baseline inventory of natural resources. All are fundamental to designing a workable management regime. However, data collection in and of itself is not sufficient to create and implement a plan. Without public education and involvement, the political will that is needed will not emerge.

The U.S. Environmental Protection Agency (EPA) has published several manuals on watershed management. In its "Welcome to the Principles of Watershed Management," four core principles are set out:

1. watersheds are natural systems that we can work with;
2. watershed management is continuous and needs a multi-disciplinary approach;
3. a watershed management framework supports partnering, using sound science, taking well-planned actions and achieving results;
4. a flexible approach is always needed.²⁴

For public participation to be useful, a knowledge base must be developed by the gathering and sharing of information which exists and then mutually seeking data and answers to address information gaps. Building such a common knowledge base will assist in formulating sensible solutions in a collaborative process, as opposed to top-down dictates that have run into difficulties when applied without awareness of the particular blend of resources, demands and conflicts of an area. The iterative process of information gathering and of sharing knowledge helps build community as well.

24. Kimberly Brewer & J. Trevor Clements, U.S. Env'tl. Protection Agency, *Principles of Watershed Management: Core Principles of Watershed Management* (last modified Feb. 19, 1999) <www.epa.gov/OWOW/watershed/wacademy/acad2000/watershedmgt/intro.html>.

Gathering and maintaining information conforms with community based natural resource management (CBNRM).

An attempt to find new solutions for the failure of top-down approaches to conservation, CBNRM rests on the recognition that local communities must be given direct control over the utilisation and benefits of natural resources (wildlife, forest products) in order to value them in a sustainable manner. CBNRM is both a conservation and rural development strategy, involving community mobilisation and organisation, institutional development, comprehensive training, enterprise development, and monitoring of the natural resource base.²⁵

To enable local and regional agencies on both sides of the border to plan for their areas, a common set of widely accessible data, with similar formats, needs to be collected. Thereafter, the local communities can begin to address these issues, and link with other agencies and NGOs when this will assist their efforts.

Community management is a fundamental part of most programs for sustainable development, building on experience of community participation, but also going further. It can put people in charge in a flexible partnership with supporting agencies.²⁶ Community management is an approach, not a formula, that seeks to make the best use of the resources available within the community, with support from government agencies, non-governmental organizations, the private sector, and other communities.²⁷ Relationships among the partners may change and evolve as communities become better able to manage their own affairs.²⁸

For this paper, gathering of information to be shared with the two communities began as part of a team project. It is hoped that such information will help to give the residents a sense of place, and an understanding that their activities are intrinsically linked to water availability and, thus, must be carefully balanced to ensure all needs and concerns are considered. The second part of the paper briefly reviews current projects addressing transboundary natural resource issues in the region, concluding with thoughts of how next to proceed.

25. IUCN, The World Conservation Union, *Community Based Natural Resource Management Support Programme in Botswana* (last modified Mar. 17, 2000) <http://www.cbnrm.bw/pages_sub_dir/Main.htm>.

26. See IRC International Water and Sanitation Centre, *Community Management Puts People in Charge*, (last modified July 4, 1998) <<http://www.irc.nl/home/comg/comghome.htm>>.

27. See *id.*

28. See *id.*

MIMBRES DRAINAGE SYSTEM

"Unless the complete hydrologic picture, for both sides of the border, is made available to those attempting to plan future resource development, no one will be able to hypothesize the effect that either nation's development will have on the other's water users."²⁹ To better understand the water issues facing Columbus and Palomas, it is crucial to have a working knowledge of the region. This section contains a physical description as well as a socio-economic sketch of the area.

Physical Description

The Mimbres Basin,³⁰ encompassing 4,387 square miles, includes portions of Grant and most of Luna County in southwestern New Mexico.³¹ The major population centers on the New Mexican side include Silver City (located at 6,000 feet above sea level (fasl)), the county seat of Grant County, and Deming (4,445 fasl) and Columbus (4,000 fasl) in Luna County.³² Deming is positioned along Interstate 10 and is the county seat. Columbus is 35 miles south of Deming and three miles north of the international border. Palomas, Chihuahua, is situated just south of the border and is included in the *municipio* of Ascensión.³³ (See figure 1.³⁴) The *municipio* is served by both the Mimbres and the Río Casas Grandes drainage systems.³⁵ The town of Ascensión is the *cabecera* and is located near the Río Casas Grandes, which then heads northeast to the *ejido*³⁶ of Guadalupe Victoria and parallels the border twelve miles south of Palomas before turning south again, toward Laguna de Guzman. Palomas, partly

29. ALBERT E. UTTON & CLIFFORD K. ATKINSON, INTERNATIONAL GROUNDWATER MANAGEMENT: THE CASE OF THE MEXICO-UNITED STATES FRONTIER 51 (N.M. Water Resources Research Inst. Final Report, Project No. 1345626, 1979).

30. See U.S. Env't Protection Agency, *EnviroMapper for Watersheds* (last modified Apr. 20, 1999) <<http://www.epa.gov/nwapsurf/iwimapper/enviromapper/>>.

31. See R.T. HANSON ET AL., HYDROGEOLOGIC FRAMEWORK AND PRELIMINARY SIMULATION OF GROUND-WATER FLOW IN THE MIMBRES BASIN, SOUTHWESTERN NEW MEXICO 2 (1994).

32. See *id.*

33. A *municipio* is roughly the equivalent of a U.S. county. While Deming is the county seat of Luna County, Ascensión is the seat of government, or *cabecera*, for the *municipio* of the same name.

34. Elaine Moore Hebard, *Transboundary Water Management Planning*, TRANSBOUNDARY RESOURCE REPORT, Fall 1994, at 5,6.

35. While the present discussion focuses upon the Mimbres, much of the physical description could also apply to the Río Casas Grandes.

36. *Ejid*os are communal lands, with title held in trust by the government.

surrounded by ejidal lands, is situated on the edge of the ancient Mimbres waterway where several shallow lakes existed in the recent past.

As a part of the Basin and Range physiographic province, the Mimbres Basin is described geologically as an alluvial basin surrounded by uplifted fault block mountains to the west, north, and east.³⁷ The Mimbres' headwaters arise in the Black Range, located in southwestern New Mexico, which also form part of the Continental Divide.³⁸ The tallest point is at Black Peak (9,025 fasl).³⁹ The Divide heads southwest, following the ridge of the Pinos Altos mountains.⁴⁰ These mountains supply water to the San Vicente Arroyo, which runs through Silver City.⁴¹ The Arroyo, a seasonal stream, and the Mimbres River, which is perennial in its upper reaches, come together below Silver City and flow southeast.⁴² Near Deming, the water seeps into the basin.⁴³ The aquifer continues south toward Columbus and the Mexican border.⁴⁴ Historically, water resurfaced in lakes near Columbus and Palomas, but that has not occurred since the 1960s.⁴⁵ There is not consensus as to the southernmost reach of this aquifer, but at least one source indicates that it may extend some 35 miles into Chihuahua, terminating in Laguna de Guzman.⁴⁶ The water does not drain into any

37. See HANSON ET AL., *supra* note 31, at 6-10.

38. See *id.* at 4.

39. See *id.*

40. See *id.*

41. See *id.* at 16.

42. See *id.*

43. See *id.*

44. See *id.* at 20, 43.

45. See *id.* at 20.

46. See RESOURCE TECH. INC., 1 SOUTHWEST NEW MEXICO REGIONAL WATER PLAN 3-1 to 3-2, 9-3 (1991). The Mimbres and the Río Casas Grandes systems may or may not be connected. According to some studies, both terminate in Laguna de Guzman. The Mimbres basin's terminus has been the subject of some dispute. See, e.g., RESOURCE TECH. INC., *supra*, at fig.4-18 (Estimated Effect of Groundwater Withdrawal on Adjacent Surface Water Sources), tbl.4-2 (Ground-Water Inventory and Model Data) (both indicate that the Mimbres terminates at Laguna de Guzman); T. NEIL BLANDFORD & JOHN L. WILSON, LARGE SCALE PARAMETER ESTIMATION THROUGH THE INVERSE PROCEDURE AND UNCERTAINTY PROPAGATION IN THE COLUMBUS BASIN, NEW MEXICO 20 (N.M. Water Resources Research Inst. Report No. 226, 1987) (indicating that the "[u]nderflow travels out the southern end of the basin into Mexico and may at least partially discharge at a series of playas about 50 miles south of the international border," without specifying which ones); JOHN C. TYSSELING ET AL., PROJECTIONS OF WATER AVAILABILITY IN THE LOWER RIO GRANDE, GILASAN FRANCISCO AND MIMBRES DRAINAGE BASINS TO 2005 119 (N.M. Water Resources Research Inst. Report No. 212, 1986) (describes the Mimbres as a closed basin "hydrologically connected to the Rio Grande Basin"); JANET M. TANSKI ET AL., WATER QUALITY ON THE U.S.-MEXICO BORDER: AN ASSESSMENT OF THE MIMBRES BASIN AQUIFER AND THE REGION SURROUNDING COLUMBUS, NEW MEXICO, USA AND PUERTO PALOMAS, CHIHUAHUA, MÉXICO 5-6 (SCERP Project No. PP96II-19, 1998) ("Surface drainage from the

other outlet, hence it is considered to be a "closed basin." The underflow of groundwater within this basin is generally north to south, with localized drainage following the slope of the terrain.⁴⁷

The international boundary between Mexico and the United States transects the aquifer. Columbus, New Mexico, and Palomas, Chihuahua, are located at the lower end of the Mimbres drainage area. The absence of perennial streams or any other permanent source of surface water in the area compels both communities to be completely and mutually dependent upon groundwater.

The drainage area consists mostly of Quaternary sand and gravel, with the southern portion consisting of bolson fill (unconsolidated water-bearing alluvial deposits eroded from upland areas).⁴⁸ Much of the basin is a permeable aquifer of sand, gravel, and basalt overlain by a thick confining layer.⁴⁹ At several places, most notably west of Columbus, the aquifer-aquitard sequence is not so clearly defined. In these areas the principal aquifer may be unconfined or partially confined.⁵⁰ It also appears that in some places there is a shallow aquifer above the confining layer of a deeper one.⁵¹ The groundwater flow here is considered to be three-dimensional, meaning that water moves laterally and vertically, as well as in the direction of flow.⁵² The amount of leakage between the shallow and deep aquifers is not clear.⁵³

The floor or "bolson" of this basin [near Columbus] is known to be 4000 feet deep in places. The formation is highly porous, and forms an underground reservoir in which water has been stored over geologic time. Wide variations in the

U.S. part of the Mimbres-Los Muertos basins is mostly captured by the Mimbres River, which is the principal surface drainage in the study area. The Mexican section of the Mimbres-Los Muertos basins is also drained by the Mimbres River. The river ends in a low region known as Palomas Lake."); C.C. Reeves, Jr., *Pluvial Lake Palomas, Northwestern Chihuahua, México*, in *GUIDEBOOK OF THE BORDER REGION* 143, 143 (N.M. Geological Soc'y, 20th Field Conference, Diego A. Córdoba et al. eds., 1969) ("The basin of pluvial Lake Palomas extends from southeast of Villa Ahumada (30° 35' N., 106° 31' W.) northwestward to about 32° N., 107° 30' W."). This is not an idle debate. If connected, bilateral usage may affect the water levels in the two aquifers, and, thus, could determine where actions to protect the binational water resources will need to be implemented and by whom. A new study of groundwater basins of southwestern New Mexico, to be published by the New Mexico Water Resources Research Institute, may provide enlightenment.

47. See HANSON ET AL., *supra* note 31, at 43.

48. See *id.* at 21-22.

49. See *id.*

50. See *id.* at 22-24.

51. See *id.*

52. See *id.* at 43-45.

53. See *id.* at 43.

types of deposits and permeability of strata can create artesian aquifers (Resource Tech., 1991).⁵⁴

Infiltration from the Mimbres River and San Vicente Arroyo apparently does not reach the Columbus area.⁵⁵ Rather, surface waters drain into underground crevices and gravel beds to supply the aquifer.⁵⁶ The lower part of the aquifer is replenished by rainfall through (1) direct infiltration and (2) mountain front recharge, the latter mainly from the Tres Hermanas and the Florida Mountains.⁵⁷ Due to the geologic complexity, "replenishment" may also occur by virtue of upward seepage from deep aquifers to shallower ones.⁵⁸ Much of the run-off terminates in playas, or shallow lakes, from which most of the water evaporates due to caliche concentrations that make percolation difficult.⁵⁹

Most of the water table below Deming is considered "moderately vulnerable," as the water table is less than 200 feet below the surface.⁶⁰ Near Columbus, this average depth equals 200 to 500 feet.⁶¹ Above Deming the water table is considered "highly vulnerable" in that either the water table is shallow or is a highly fractured vadose, or unsaturated, zone.⁶²

Much of Luna County contains deep, fine-textured, level soils on alluvial fans, flood plains, and basin floors. Typically, the upper part of the Mimbres drainage basin contains mollisols, fertile dominantly grassland soils, and the lower part, including Luna County, consists of aridisols, low in organic matter content and easily subject to wind and water erosion.⁶³

The Mimbres drainage system contains five categories of vegetation. At the higher elevations, designated as Conifer Woodland, ponderosa pine can be found. Proceeding lower, through Montane Shrub, juniper, piñon and oak are dominant species. Riparian vegetation can be found along the Mimbres River and San Vicente Arroyo. Representative species include cottonwood and salt cedar. In the lower elevations, Chihuahuan Grassland and Chihuahuan Shrub cover a large part of the area. These contain species such as creosote bush, mesquite, and yucca. The lower portion of Luna County contains relatively barren playas and salt flats.

54. NANCY GORDON ET AL., *INFRASTRUCTURE MASTER PLAN FOR THE VILLAGE OF COLUMBUS, N.M.* 9 (1993).

55. See HANSON ET AL., *supra* note 31, at 42.

56. See *id.*

57. See *id.* at 37, 41.

58. See *id.* at 45.

59. See *id.* at 45-46.

60. See *NEW MEXICO IN MAPS 60-61* (Jerry L. Williams ed., 2d ed. 1986).

61. See *id.* at 61.

62. See *id.*

63. See *id.* at 64.

Within the Mimbres drainage basin, climate is quite varied from the upper to lower elevations. Generally, there are more precipitation and colder temperatures in the mountains than on the plains. The mean annual precipitation in the upper mountain areas ranges between 16 to 30 inches.⁶⁴ The mid-range elevations receive between 12 and 16 inches and the lower ones between 8 and 12 inches.⁶⁵ Usually, 44 percent of the annual rainfall occurs from June 1 to August 31 and 26 percent from September 1 to November 30.⁶⁶ Very little precipitation occurs between March 1 and May 31.⁶⁷ Snowfall ranges between 36 inches at the higher elevations to 0.3 inches in the lower ones.⁶⁸

As more fully shown in table 1,⁶⁹ the annual average precipitation for Columbus is 9.56 inches, ranging from 0.25 inches in April to the high of 2.11 inches in July. Average temperatures range from a low of 28.4°F in January to a high of 95.6°F in July. The high and low daily temperatures, however, show significant variation around these average values. As shown in table 2,⁷⁰ similar climate statistics are found for Ascensión, with an average rainfall being 9.83 inches, and temperatures ranging from 36.86°F to 83.84°F, with the average being 61.52°F.

The region has high evapotranspiration (ET) rates, which in turn affect both the amount of recharge and the types of agriculture that can be maintained. In 1977, Gabin and Lesperance calculated the ET rate for the area to be approximately 53 inches per year, resulting in a water budget deficit (the discrepancy between the average annual rainfall and the ET rates) of approximately 44 inches per year.⁷¹

Climatic conditions affect the amount of recharge to the area. Current conditions indicate that the year 2000 will be dry. The National Weather Service and the Natural Resources Conservation Service (NRCS) issued the New Mexico Water Supply Outlook Report as of February 1, 2000:

After a very dry autumn in New Mexico, the National Weather service reported a very dry winter as well. For the period October through December, 1999, precipitation was

64. See RESOURCE TECH. INC., *supra* note 46, at 3-4.

65. See *id.*

66. See *id.*

67. See *id.*

68. See *id.*

69. See Western Regional Climate Center, *Columbus, New Mexico Period of Record Monthly Climate Summary: 1/1/1925 to 8/31/1999* (visited Mar. 15, 2000) <<http://www.wrcc.dri.edu/cgi-bin/cliRECTM.pl?nmcolu>>.

70. See Instituto De Ecología, A.C., *Plan Hidráulico Gran Visión* (last modified July 5, 1999) <<http://www.sequia.edu.mx/plan-hidra.html>>.

71. See BLANDFORD & WILSON, *supra* note 46, at 12.

well below normal over the vast majority of New Mexico....We estimate precipitation has been less than 50 percent of normal over 80 percent of the state during the past three months. Precipitation in some areas has been less than 10 percent of normal during the period. Drought indices continue to show drying everywhere in New Mexico....The Natural Resources Conservation Service is reporting snow water equivalents from its SNOTEL sites to be 5 to 60 percent of normal statewide. The driest conditions being reported, are on the San Francisco Water Basin in the Gila Wilderness in Southwestern New Mexico....The Surface Water Index indicates normal conditions throughout northern New Mexico and severe drought in southwestern New Mexico.⁷²

For the upper reach of the Mimbres Basin, where the river flows, NRCS reported that as of January 1, 1999, "[s]treamflow forecast for the Mimbres River Basin is down almost 500 percent from last year. The streamflow forecast is for 64 percent of median or 1600 acre-feet expected to runoff between January and May....Snowpack in the basin is 21 percent of average the lowest in the last five years."⁷³ In February, the report continued grimly that "[s]treamflow in the Mimbres River Basin is forecast to be 35 percent of the median which is down considerably from last year's 394 percent. Precipitation in the basin didn't fair much better coming in at 15 percent of average down from last year's meager 23 percent....Snowpack in the basin is 12 percent of average again down considerably from last year's 129 percent."⁷⁴ In March, it was estimated that snowpack was well below average at 5 percent.⁷⁵ And in April, the streamflow forecast for the Mimbres River Basin was reduced to "300 acre-feet (38 percent of average)

72. New Mexico Climate Center, *Drought Indicators—January 2000* (visited Mar. 15, 2000) <<http://weather.nmsu.edu/drought/advJan2000.htm>>. "On the New Mexico map, the area south of a line drawn from Reserve, east to Carrizozo and Roswell, and southeast to Hobbs, is considered to be in an emergency drought condition by the Drought Monitoring Committee...Many areas in these climate divisions have received less than 10 percent of their normal precipitation making soil and plant conditions extremely dry...Precipitation on the...Mimbres River Basin is 19 percent of average...." New Mexico Climate Center, *Drought Indicators—April 2000* (visited Apr. 27, 2000) <<http://weather.nmsu.edu/drought/advAPR2000.htm>>.

73. National Weather Service & the Natural Resources Conservation Service Weather Forecast, *New Mexico Basin Outlook Report—Mimbres River Basin* (visited Mar. 15, 2000) <<http://www.nm.nrcs.usda.gov/snow/forecast/wy1999/jan/nm1s23.htm>>.

74. National Weather Service & the Natural Resources Conservation Service Weather Forecast, *New Mexico Basin Outlook Report—Mimbres River Basin* (visited Mar. 15, 2000) <<http://www.nm.nrcs.usda.gov/snow/forecast/wy1999/feb/nm2s23.htm>>.

75. See National Weather Service & the Natural Resources Conservation Service Weather Forecast, *New Mexico Basin Outlook Report—Mimbres River Basin* (visited Mar. 15, 2000) <<http://www.nm.nrcs.usda.gov/snow/forecast/wy1999/march/nm3s23.htm>>.

of runoff on the Mimbres River at Mimbres between April and May" of 1999.⁷⁶

Through late February 2000, snowpack amounted to less than 70 percent of average and the surface water supply index factors are in the "severe drought" category, according to NRCS predictions.⁷⁷ The New Mexico Agriculture Department publishes a Weekly Ag Update in electronic form.⁷⁸ Summarizing from various issues, Deming's average precipitation is 10.58 inches—it received 11.65 inches in 1997, 9.89 inches in 1998, and 5.85 inches in 1999.⁷⁹ Through February 23, 2000, Deming had received 0.03 inches of precipitation for the year, while the normal is 1.02 inches for the same time period.⁸⁰ Finally, as of February 20, 2000, the snow water equivalent was seven percent of average and the accumulated precipitation was 15 percent, as reported at the NRCS SNOTEL site for the Mimbres River Basin.⁸¹

With reduced snowpack and run-off, there will be both decreased recharge and increased dependence on the aquifer. Since nearly any extraction exceeds the rate of recharge, this will increase the mining of the aquifer. "Prior to the onset of pumping, White (1929) believed that the aquifer system was in a delicate state of equilibrium. Pumping increased discharge from the aquifer so that it soon exceeded the natural recharge into the aquifer."⁸²

That water levels are dropping is clear. Long-term water level declines, along with seasonal fluctuations that coincide with agricultural needs, have been documented. However, the recovery level (during fall and winter) seldom has reached the pre-irrigation level of the previous year, resulting in a net decline in the water table for the year. The result is a disruption of the equilibrium and a net mining of the aquifer. In a study focused on the Mimbres Basin, researchers found that

76. National Weather Service & the Natural Resources Conservation Service Weather Forecast, *New Mexico Basin Outlook Report—Mimbres River Basin* (visited Mar. 15, 2000) <<http://www.nm.nrcs.usda.gov/snow/forecast/wy1999/april/nm4s23.htm>>.

77. National Weather Service & the Natural Resources Conservation Service Weather Forecast, *New Mexico Surface Water Supply Index Map* (last modified Feb. 1, 2000) <<http://www.nm.nrcs.usda.gov/snow/forecast/wy2000/maps/nm2swwsi.htm>>.

78. See New Mexico Agricultural Statistics Service (visited Mar. 16, 2000) <<http://www.nass.usda.gov/nm/>>.

79. See *id.*

80. See *id.*

81. See National Weather Service & the Natural Resources Conservation Service Weather Forecast, *Snotel Narrative* (last modified Mar. 16, 2000) <http://www.wrcc.dri.edu/cgi-bin/sno_narr3_pl>.

82. WILLIAM C. HANEBERG & ROBERT L. FRIESEN, *TILTING OF SURFICIAL STRATA AND GROUNDWATER FLUCTUATIONS IN THE SUBSIDING MIMBRES BASIN, NEW MEXICO 3* (N.M. Water Resources Research Inst. Report No. 274, 1993).

[t]he area experiencing the largest groundwater overdraft is south of Deming in the southcentral portion of the basin... (Contaldo 1989). The water table depression forms a cone that is overlain by a region of intense agricultural activity that has been the location of drawdowns in excess of 33 m from 1910 to 1987. The total area affected by dropping water levels is about 880 km² (Contaldo and Mueller 1991). Coinciding with the overdraft is subsidence of the land surface within the affected areas (Poland 1984; Lofgren 1976; Holzer 1984; Sato et al. 1984; Larson & Pewe 1986). Many cases of land subsidence caused by fluid extraction have been documented in other areas. As water levels drop, the effective stress upon aquifer materials increases, causing reorientation and compaction of the material and, eventually, subsidence of the land surface.⁸³

Significant declines in the water table had occurred by the 1970s in the Columbus area. "The area just east of Columbus has exhibited the most extensive drop, about 140 ft as of 1970 [from 1950]. This "mining" of groundwater is to be expected, since only a small portion of the annual rainfall recharges the aquifer."⁸⁴

A report prepared for the International Boundary and Water Commission (IBWC) in 1978 related that between 1950 and 1960, due to irrigation, water levels decreased about five feet adjacent to the international border.⁸⁵ This depletion continued, decreasing at the rate of three to four feet per year between 1960 and 1970.⁸⁶ Between 1960 and 1970, a related concern was the cone of depression, located approximately two to eight miles east of Columbus and two to six miles north of the border, where, due to concentrated irrigation, levels decreased as much as 80 feet.⁸⁷ "[A] large dewatered depression cone doubled in areal extent between 1960 and 1970. The central cone of maximum drawdown was about 7 miles east of Columbus in 1960, and it migrated westward by 1970 to about 4 miles northeast of Columbus."⁸⁸

In 1977, McClean plotted cones of depression for the area, and mentioned that a reverse flow from south (Mexico) to north was occurring.

83. *Id.*

84. BLANDFORD & WILSON, *supra* note 46, at 23.

85. See HARSBARGER & ASSOC., INC., OVERVIEW REPORT OF GROUNDWATER BASINS ALONG THE INTERNATIONAL BOUNDARY—NEW MEXICO, UNITED STATES AND SONORA AND CHIHUAHUA, MEXICO 31-32 (1978).

86. *See id.*

87. *See id.* at 32.

88. *Id.* (located approximately at the lower end of Seventy-Six Draw).

The post-development cones of depression plotted by McClean [1977] also indicate that in addition to storage depletion, a source of water for wells in the Columbus Basin is reduced underflow toward the basin's southern boundary. The cone of depression has locally induced flow from south to north—the opposite of pre-development conditions. The quantity of reduced underflow is unknown.⁸⁹

This reverse flow phenomenon was also mentioned in the Regional Water Plan.⁹⁰ At the present time, the water table is still dropping in the Columbus area. "(A) likely cause is the currently high groundwater withdrawals for irrigated agriculture from wells adjacent to the Village on the South and East, and possibly high withdrawals in Mexico."⁹¹

It is interesting to note the figures that Steve Reynolds (then State Engineer) sent in 1983 to Charles DuMars (at that time chair of a water study committee). Reynolds wrote that the State Engineer's Office estimated approximately 3.7 million acre-feet of groundwater remained available in storage in the Mimbres Basin at then current feasible pumping depths (230 feet) for irrigated agriculture.⁹² However, to a depth of 1,000 feet, there was estimated to be approximately 70 million acre-feet of recoverable groundwater.⁹³ Questions have been raised as to the accuracy of this assessment, since it is based upon a two-dimensional model, and may not provide a factual portrayal, not to mention other costs which may be involved.

Noting that little economic development in the Lake Palomas basin has occurred because it is too dry and because many of the soils are too immature and alkaline for crops, Reeves commented, "The long dry canal which once carried stock water from the Palomas springs into the northern part of the Bolson de los Muertos is now a mute testament of the falling water level."⁹⁴

DEMOGRAPHICS AND ECONOMIC ACTIVITY

The Mimbres serves a variety of needs—municipal, agricultural, industrial, mining, wildlife—of which the first two are the heaviest users of water. Concerns exist as to current or potential contamination, availability, increasing recovery costs and the impact of population growth

89. BLANDFORD & WILSON, *supra* note 46, at 23.

90. See RESOURCE TECH. INC., *supra* note 46, at 9-3.

91. GORDON ET AL., *supra* note 54, at 10.

92. See TYSELING ET AL., *supra* note 46, at 4 app.A.

93. See *id.* at 130, 4 app.A.

94. Reeves, *supra* note 46, at 153.

and economic development on the already strained resource. Uses of water may soon become a source of conflict here, as is already occurring in other arid regions.

Luna County⁹⁵

According to the 1990 Census, Luna County had 18,110 residents, comprising 1.2 percent of New Mexico's population, with 60 percent of the county classified as urban and 40 percent as rural.⁹⁶ During the 1970s, the County grew by 33 percent, outpacing the state's overall growth of 28 percent by five percent.⁹⁷ Growth has continued, with the County expanding by 16 percent during the 1980s, following the general trend in the state.⁹⁸ According to the Population Estimates Program of the U.S. Bureau of the Census, the population of Luna County increased by 33 percent from 1990 to 1998, to a present figure of 24,070.⁹⁹ Estimates for Columbus Village's growth placed the population at 643 in 1990 and 902 in 1998, a 40 percent increase; during the same time period, Deming grew from 11,422 to 14,517.¹⁰⁰ Much of the growth can be attributed to an increase in the agricultural sector and an influx of retirees.

Table 3¹⁰¹ shows population projections for the County through 2030. These projections exceed earlier predictions, which envisioned an increase to 24,199, or 34 percent, by the year 2020, a figure that has essentially been reached.¹⁰² If these population projections hold true, resources and infrastructure that already are experiencing stress will continue to do so unless solutions are identified and implemented.¹⁰³

95. While the Mimbres begins in Grant County, most of the discussion is limited to Luna County because of its closeness to the influence zone of border activities.

96. See U.S. Bureau of the Census, *American Factfinder, Social Characteristics 1990 Luna County, New Mexico* (visited Mar. 16, 2000) <http://www.factfinder.census.gov/java_.../dads.ui.fac.CommunityFactsViewPage?l>.

97. See *id.*

98. See *id.*

99. See *id.*

100. See *id.*

101. See Bureau of Bus. & Econ. Research, Univ. of N.M., *New Mexico Population Projections* (last modified May 23, 1997) <<http://www.unm.edu/~bber/demo/popproj.htm>>.

102. See *id.* Of note, in 1986 when Tysseling wrote *Projections of Water Availability in the Mimbres Drainage Basin to 2005*, Luna County's population was projected to be 21,200 in 2005, a number surpassed by 1995. See TYSSSELING ET AL., *supra* note 46, at 123.

103. Not included in these figures are the "snowbirds," retirees who come to the County for part of the year, and whose influence should be taken into account.

Table 4¹⁰⁴ profiles Luna County. Noteworthy is the percent of population under the age of 18 and over the age of 64, the two cohorts that experienced the most growth in the past twenty years. In addition to competing for scarce financial resources, such a disparate population may not share similar concerns for the long-term viability of the area. In 1990, a quarter of the families were below the poverty level, as compared with 17 percent in the state.¹⁰⁵ This represents a change from 1980, when 19 percent of Luna County families were below this level.¹⁰⁶ Some 31.5 percent of the county residents fell below the poverty level in 1989.¹⁰⁷ This number increased to 34.3 percent in 1993.¹⁰⁸ Another key socio-economic indicator of income in the County is median family income, which was 85 percent of that of the state in 1970.¹⁰⁹ By 1980 it fell to 68 percent and by 1990 it was 63 percent.¹¹⁰ It is now 64 percent, but since the state as a whole is 76 percent of the national average, Luna County has 49 percent of the national average.¹¹¹

In 1998, New Mexico had a 6.2 percent unemployment rate for nonagricultural jobs but Luna County had 25.9 percent, giving it the dubious honor of first place.¹¹² Unemployment overall swells during the winter due to the seasonal nature of agriculture work. The main economic activities in the County are agriculture, ranching, services, and food processing. Of the 5,419 employed persons 16 years and older in 1990, 13 percent were in the primary sector, 15 percent in the secondary, and 72

104. See U.S. Bureau of the Census, *USA Counties 1996: Luna, NM, General Profile* (visited Mar. 17, 2000) <<http://www.census.gov/statab/USA96/35/029.txt>>.

105. See *id.*

106. See *id.*

107. See *id.*

108. See *id.*

109. See *id.* New Mexico's population of 1,723,965 ranks 35th out of 51 states (the District of Columbia is included for ranking purposes) in the United States. See Regional Economic Information System, Bureau of Economic Analysis, *BEARFACTS* (last modified June 23, 1999) <<http://www.unm.edu/~bber/reis95/htm>>. In 1996, New Mexico had a per capita personal income (PCPI) of \$19,298. See *id.* This PCPI ranked 49th in the United States and was 76% of the national average of \$25,288. See *id.* "Luna County is one of the 33 counties in New Mexico...[and] its 1997 population of 23,585 ranked 18th in the State. In 1997, Luna [County] had a per capita personal income (PCPI) of \$12,353. This PCPI ranked 30th in the State, and was 64 percent of the State average, \$19,298, and 49 percent of the national average, \$25,288. The 1997 PCPI reflected a decrease of 0.1 percent from 1996. The 1996-97 State change was 3.6 percent and the national change was 4.7 percent." Regional Economic Information System, Bureau of Economic Analysis, *BEARFACTS: Luna County* (last modified June 23, 1999) <<http://www.unm.edu/~bber/reis95/35029-bf.htm>>.

110. See U.S. Bureau of the Census, *supra* note 104.

111. See *id.*

112. See N.M. Dep't of Labor, Econ. & Analysis Bureau, *Nonagricultural Wage and Salary Employment: New Mexico, 1st Quarter 1997 Benchmark* tbl.A, tbl.B (1998).

percent in the tertiary sector.¹¹³ Some 24 percent, or 1,301, were employed by various governments.¹¹⁴

Located along Interstate 10, Deming is the economic center for Luna County. Retirees, east-west travelers, and Mexican nationals purchasing durable goods make up a significant part of the economic base,¹¹⁵ although that has changed somewhat with the paving of a highway between Columbus and Santa Teresa. The border crossing at Columbus also provides substantial revenue. In the past, primary imports were cattle, wood products (moldings and picture frames), fertilizer, and lead.¹¹⁶ Primary exports were farm machinery, along with agricultural equipment and supplies.¹¹⁷ Although cattle quarantine facilities are located at the border,¹¹⁸ the opening of the Santa Teresa site has reduced the number of cattle now crossing at Columbus. At the present time, probably the largest users of the U.S. Department of Agriculture inspection facilities are the chile producers. "Columbus last year beat the three other ports (El Paso, Presidio and Santa Teresa) combined when it admitted more than 22 million kilograms of fresh chile peppers. For 1998, the figure was running at 21 million kilograms just by early October," and that figure does not include the cayenne chile.¹¹⁹ Truck border crossings continue to increase.¹²⁰

Cattle raising and agriculture are important components of the economic and social characteristics of the area. According to official New Mexico agricultural statistics, in 1996 Luna County ranked eighth statewide in cash receipts for all farm commodities.¹²¹ These proceeds have continued to grow in the last few years—\$60,619,000 in 1994, \$63,855,000 in 1995 and

113. Luna County had 699 employed in primary, 798 in secondary, and 3922 in tertiary. See U.S. Bureau of the Census, *supra* note 104. Columbus had 27 employed in primary, 9 in secondary, and 80 in tertiary. See *id.*

114. See *id.*

115. See RESOURCE TECH. INC., *supra* note 46, at 3-9.

116. See SUNWEST FIN. SERV. INC., N.M. PROGRESS ECON. REV. 58 (1991).

117. See *id.*

118. See Kent Paterson, *Mexican Wood Export Business at a Historic Crossroads*, 1998 FRONTERA NORTE SUR ___ (available at Frontera NorteSur, Archives (last modified Mar. 16, 2000) <www.nmsu.edu/Research/frontera/public_html/Archive/1998/jan98/198wood.htm>).

119. Kent Paterson, *NAFTA Chile Imports Flood New Mexico*, 1999 FRONTERA NORTE SUR ___ (available at Frontera NorteSur, Archives (last modified Mar. 16, 2000) <www.nmsu.edu/~frontera/old_1999/jan99/feat3.html>).

120. In 1998 the total number of trucks crossing was 4535; privately owned vehicles 359,582; pedestrians 161,231; people traveling by truck 6462; and people traveling by privately owned vehicles 553,470. See Frontera NorteSur, *Border Crossing Statistics* (last modified Jan. 2000) <www.nmsu.edu/~frontera/cros.html>. The numbers increased to 5243; 382,856; 194,852; 6290; and 1,167,681 respectively in 1999. See *id.*

121. See N.M. Dep't of Agric., *Agricultural Statistics: Luna County 1996* (last modified Dec. 16, 1999) <nmdaweb.nmsu.edu/MD/Counties%2096/luna.html>.

\$70,049,000 in 1996.¹²² While recently there has been a decrease in the overall number of cattle raised—from 40 thousand head in 1996 to 35 thousand in 1997—it is still an important part of the economy, bringing in \$15,719,000.¹²³ The majority of the county is publicly owned.¹²⁴ Ninety-six percent of the land within the county is used for grazing, much of it subject to grazing allotments, about which concern has been expressed over soil erosion from rangeland use.

Underscoring the importance of agriculture to the area, table 5¹²⁵ shows that the amount of irrigated cropland in Luna County has increased by 74 percent since 1960, from 42,610 acres in 1960 to 71,460 acres in 1970, before leveling off at 73,950.¹²⁶ The acreage figures include both planted land as well as idle and fallow land in crop rotation; the acreage actually irrigated in 1990 was 44,250 and in 1995 was 48,195.¹²⁷

Table 6¹²⁸ describes the major crops grown over a period of time together with present cash receipts.¹²⁹ The acreage devoted to chile more than doubled from 5,700 in 1986 to 12,400 acres in 1992. Less has been planted recently, but Luna County still leads Doña Ana County, the second highest producer in the state.¹³⁰ The chile crop also accounted for forty percent of the agricultural cash receipts, although it is facing increased

122. See *id.*; See N.M. Dep't of Agric., *Agricultural Statistics: Luna County 1996* (last modified Dec. 16, 1999) <nmdaweb.nmsu.edu/MD/Agstt96/Econ/Crcnty.htm>.

123. See N.M. Dep't of Agric., *Agricultural Statistics: Luna County 1996* (last modified Dec. 16, 1999) <nmdaweb.nmsu.edu/MD/Counties%2096/luna.html>.

124. The Bureau of Land Management controls 759,220 acres (40%), State trust lands comprise 549,560 acres (29%), and private owners account for 586,340 acres (31%). See U.S. DEP'T INTERIOR, BUREAU OF LAND MANAGEMENT, MIMBRES RESOURCE MANAGEMENT PLAN, MIMBRES RESOURCE AREA 1-2, tbl.1-1 (1993).

125. See N.M. State Univ., Agric. Experiment Station, *Sources of Irrigation Water and Irrigated and Dry Cropland Acreages in New Mexico, by County, 1989-1991 and 1994-96* (visited Mar. 17, 2000) <<http://nmdaweb.nmsu.edu/MD/Agstat96/Misc/Watrsrce.htm>>.

126. See *id.*

127. See BRIAN C. WILSON, WATER USE BY CATEGORIES IN NEW MEXICO COUNTIES AND RIVER BASINS, AND IRRIGATED ACREAGE IN 1990 36, 134 tbl.11 (N.M. State Engineer Office, Technical Report No. 47, 1992) [hereinafter WILSON-1990]; BRIAN C. WILSON, WATER USE BY CATEGORIES IN NEW MEXICO COUNTIES AND RIVER BASINS, AND IRRIGATED ACREAGE IN 1995 tbl.11 (N.M. State Engineer Office, Technical Report No. 49, 1997) [hereinafter WILSON-1995].

128. See N.M. Dep't of Agric., *Agricultural Statistics: Luna County 1996* (last modified Dec. 16, 1999) <nmdaweb.nmsu.edu/MD/Counties%2096/luna.html>; N.M. DEP'T OF AGRIC., NEW MEXICO AGRICULTURAL STATISTICS __ (1992); N.M. DEP'T OF AGRIC., NEW MEXICO AGRICULTURAL STATISTICS 1985-1995 __ (1996); N.M. DEP'T OF AGRIC., 1996 AGRICULTURAL STATISTICS 24, 50, 51, 54, 57, 68, 70 (1996).

129. Does not equal the full agricultural receipts of \$54,330,000 as this sum includes other minor crops.

130. See N.M. Dep't of Agric., *Agricultural Statistics: Luna County 1996* (last modified Dec. 16, 1999) <nmdaweb.nmsu.edu/MD/Counties%2096/luna.html>.

competition from Ascensión.¹³¹ Onions are the other leading cash crop, while cotton, though planted extensively, does not have as high a rate of return.¹³² One report projected that the acreage devoted to agriculture may double again within the next 40 years.¹³³

Population and economic activities demand water. The total withdrawals, return flows, and depletions for surface and groundwater in Luna County for the years 1990 and 1995 are summarized in tables 7¹³⁴ and 8.^{135, 136} Of the nine water use categories reported by the State Engineer (public water supply, self-supplied domestic, irrigated agriculture, livestock, self-supplied commercial, industrial, mining, power, and reservoir evaporation), irrigated agriculture accounted for over 95 percent.¹³⁷ In addition, Deming pumped nearly 3,500 acre-feet for domestic users, which amount is projected to increase to between 4,923 and 7,010, depending on population estimates and per capita usage.¹³⁸

Figures 2 and 3 underscore that more water was utilized in 1995 than 1990. In Luna County, the 1990 net water depletion was more than 63,700 acre-feet (net water depletion being the difference between the amount withdrawn and the return flow). Net water depletion increased in 1995 to 84,570 acre-feet. Although not everyone agrees that the net depletion is correctly calculated, there is undeniably extensive water use that has increased.

The area around Columbus is agricultural, especially to the south and east. While exploitation of groundwater resources began about 1910, it was only after 1950 that these resources began to be heavily utilized. From 1950 to 1970, the area just east of Columbus witnessed a dramatic 140 feet drop in the water table.¹³⁹ The two municipal wells in Columbus have

131. *See id.*

132. *See id.* In 1996 Luna County was the largest producer of onions in the state, accounting for 49% of total production. *See id.* At 33% of total production, Luna was the lead producer of chile. *See id.* It was the fourth largest state producer of pecans and New Mexico was the third largest in national production. *See id.* Luna County was the fourth largest producer of sorghum and cotton in the state as well. *See id.*

133. *See* RESOURCE TECH. INC., 2 SOUTHWEST NEW MEXICO REGIONAL WATER PLAN F3.5 tbl.F3-1, F3.6 tbl.F3-2 (1991).

134. *See* WILSON-1990, *supra* note 127, at 83 tbl. 4.

135. *See* WILSON-1995, *supra* note 127, at tbl.4.

136. While the statistics used in tables 7 and 8 are for all of Luna County, and agriculture is practiced around Deming to an even greater extent than around Columbus, they are employed partly because the water usage has not been disaggregated and partly because the effect of upstream withdrawals, especially over a long time period, is unknown.

137. *See* WILSON-1990, *supra* note 127, at 83 tbl.4; WILSON-1995, *supra* note 127, at tbl.4.

138. *See* RESOURCE TECH. INC., *supra* note 46, at tbl.5.4.

139. *See* BLANDFORD & WILSON, *supra* note 46, at 23.

seen a significant drop in water levels since their installation.¹⁴⁰ A new well was drilled that is currently supplying all of the water for the village. There is an industrial park that abuts the border, but the area has not been successful in attracting businesses.¹⁴¹ Recently low-income housing has been constructed next to the park. While Columbus is presently not using the full amount of its water rights, should it do so, the demands for water may well increase. The Infrastructure Master Plan for Columbus, dated March 1993, reports an average annual drawdown of two feet in the area but also estimates that, should all of the groundwater rights be put to use, this would increase to five feet.¹⁴²

Beyond the water level decline, concern is justified over the deterioration of water quality. In a recent study for the Border Health Office, several private wells were sampled.¹⁴³ Potential problems, such as high levels of total dissolved solids (TDS), were listed in the report, and are set forth in Table 9.¹⁴⁴ The fluoride level is quite high; typically tests indicate 7 mg/L, whereas the maximum contaminant level (MCL) is two for children and four for adults.¹⁴⁵ Because of the high fluoride levels, the United States Environmental Protection Agency (EPA) required the Village of Columbus to install a reverse osmosis system to remove as much as possible.¹⁴⁶ The Village has not been able to afford to provide defluoridated water to its residents, opting instead to install a unit at the fire station where individuals proceed to fill their own containers for household use.¹⁴⁷ "Excess fluoride causes mottling of teeth and a large excess will cause chemically induced arthritis (stiffening of connective tissue) and brittleness

140. The depth of the Columbus municipal north well was 158 feet and of the south well was 110 feet in 1984. See GORDON ET AL., *supra* note 54, at 10. In July of 1992, the depth of the north well was 208 feet. See *id.* In 1993, the south well went dry while pumping at 252 feet. See *id.* While this may not reflect the static rate during low use times, this still represents a significant decline.

141. Mayor Ken Riley indicated that the lack of infrastructure is a hindrance. Interview with Ken Riley, Mayor, Columbus, N.M., in Columbus, N.M. (Dec. 4, 1998).

142. See GORDON ET AL., *supra* note 54, at 10.

143. See TANSKI ET AL., *supra* note 46, at 29-30.

144. See INTERA, WELL-WATER QUALITY ASSESSMENT FOR SOUTHERN NEW MEXICO 62-65 tbl.8 (N.M. Border Health Office Report, 1997). While not tested, certain wells were included to show the variability of depth to groundwater in the region. See *id.* at 16. See also TANSKI ET AL., *supra* note 46, at tbl.2.2.

145. See TANSKI ET AL., *supra* note 46, at tbl.2.2.

146. See Interview with Ken Riley, *supra* note 141.

147. See *id.*

of bones."¹⁴⁸ Other tests show high salinity counts—up to 2,000 ppm near the border.¹⁴⁹

Other areas of concern regarding water quality include potential contamination due to inadequate water treatment (Columbus, which had no community treatment facility, is presently constructing a lagoon system to serve the central part of the community), as well as a wide variety of agricultural enhancements entering the groundwater. As more water is pumped, the overall quality of the water is deteriorating. White mineral deposits coat fields on both sides of the border. Since domestic, municipal, and industrial wells also draw from this same water source, concern is shared by all. It is unknown to what extent the aquifer contains potable versus less potable water.

[A]ll groundwater contains some mineral matter, and if large volumes are allowed to evaporate on the land this matter will accumulate as 'alkali' in or on the soil and finally render it unfit for plant growth.¹⁵⁰

Municipio of Ascensión

The demographic growth seen in Chihuahua in general, and along the border in particular, is due in part to the perception of economic opportunities that the region offers. While comparisons of censuses in the United States and Mexico should be avoided due to use of dissimilar methodologies, comparisons within Mexico indicate that striking demographic changes are occurring within the entire Republic, the state of Chihuahua, and the *municipio* of Ascensión, as can be seen in table 10.¹⁵¹ During the twenty year period from 1970 to 1990, Mexico's population increased by two-thirds while that in Chihuahua increased by half. As México's largest state in size, Chihuahua in 1990 contained only three

148. TANSKI ET AL., *supra* note 46, at 30. A dispute arose at the Columbus Elementary School. See Carlos Miller, *School System in Dispute with Parents over Water*, SUN-NEWS, Jan. 21, 1999, at A-7, A-7. Parents had understood that the reverse osmosis system was in place, entrusting their children to use the drinking fountain. Much later, it was discovered that while the system had been installed it was never connected, and the school is being blamed for the discolored and brittle teeth. See *id.*; Personal interviews held by author in Columbus, N.M. (Jan., 1999).

149. See TANSKI ET AL., *supra* note 46, at 29.

150. N.H. DARTON, UNDERGROUND WATER OF LUNA COUNTY, NEW MEXICO 30 (1914).

151. See INSTITUTO NACIONAL DE ESTADÍSTICA, GEOGRAFÍA E INFORMÁTICA, CENSO GENERAL DE POBLACIÓN Y VIVIENDA DE CHIHUAHUA __ (1970); INSTITUTO NACIONAL DE ESTADÍSTICA, GEOGRAFÍA E INFORMÁTICA, CENSO GENERAL DE POBLACIÓN Y VIVIENDA DE CHIHUAHUA __ (1980); INSTITUTO NACIONAL DE ESTADÍSTICA, GEOGRAFÍA E INFORMÁTICA, CENSO GENERAL DE POBLACIÓN Y VIVIENDA DE CHIHUAHUA __ (1990).

percent of the nation's population.¹⁵² Nevertheless, the 1990 Mexican census reported that two out of every nine residents in Chihuahua were not born in the State.¹⁵³ Currently, Chihuahua's population is 2,959,173, a 21 percent gain since 1990.¹⁵⁴

Although only 0.7 percent of the state population resided in the *municipio* of Ascensión in 1990, it increased 76 percent from 1970 to 1990, to a population of 16,361.¹⁵⁵ It has continued to swell, and in 1996 the population continued to increase at the average annual rate of 3.76 percent, to 20,416.¹⁵⁶ Ascension's major population centers are Ascensión, Palomas, and the agricultural ejido Guadalupe Victoria. It should be noted that while the official population count lists Palomas as having 4,980 residents, personal observation, conversation, and even electrical hookups indicate that it is much larger, closer to 10,000. That is not to suggest that the percentage of population in relation to the *municipio* is incorrect, rather that the population figures for the entire region may be understated.

In Mexico, employment figures include all persons 12 years and older working at the time of the Census. Of the 4,806 economically active residents in the *municipio* of Ascensión in 1990, 40 percent were engaged in the primary,¹⁵⁷ 30 percent were in the secondary and 27 percent were in the tertiary sector, as shown in table 11.¹⁵⁸ According to the 1990 Census, the three sectors were fairly evenly represented in the town of Ascensión (35 percent, 36 percent, and 29 percent).¹⁵⁹ However, 73 percent were employed

152. See INSTITUTO NACIONAL DE ESTADÍSTICA, GEOGRAFÍA E INFORMÁTICA, XI CENSO GENERAL DE POBLACIÓN Y VIVIENDA DE CHIHUAHUA __ (1990).

153. See *id.*

154. See Gobierno del Estado de Chihuahua, *Centro de Información Económica y Social: Municipio de Ascensión* (last modified June 14, 1999) <<http://www.chihuahua.gov.mx/>> [hereinafter CIES].

155. See INSTITUTO NACIONAL DE ESTADÍSTICA, GEOGRAFÍA E INFORMÁTICA, ANUARIO ESTADÍSTICO DEL ESTADO DE CHIHUAHUA 67 (1992).

156. See CIES, *supra* note 154. In 1995 Ascensión had 19,676 residents; Palomas 4,980; Guadalupe Victoria 1,396; Col. Modelo 221; and Mina Bismarck 1,092. See INSTITUTO NACIONAL DE ESTADÍSTICA, GEOGRAFÍA E INFORMÁTICA, ANUARIO ESTADÍSTICO DEL ESTADO DE CHIHUAHUA 122 (1997).

157. Note the definitions of these sectors: *primary* includes agriculture, ranching, hunting, forestry, fishing and services related to these activities; *secondary* includes mining, extraction of gas and petroleum, manufacturing industry, electricity and water, and construction; and *tertiary* includes commerce, transportation, communications, and services. See INSTITUTO NACIONAL DE ESTADÍSTICA, GEOGRAFÍA E INFORMÁTICA, XI CENSO GENERAL DE POBLACIÓN Y VIVIENDA DE CHIHUAHUA 460 (1990). These are not identical to the U.S. definitions, another reason why direct comparisons can lead to skewed results.

158. See CIES, *supra* note 154; See INSTITUTO NACIONAL DE ESTADÍSTICA, GEOGRAFÍA E INFORMÁTICA, ANUARIO ESTADÍSTICO DEL ESTADO DE CHIHUAHUA 102, 109 (1990).

159. See INSTITUTO NACIONAL DE ESTADÍSTICA, GEOGRAFÍA E INFORMÁTICA, ANUARIO ESTADÍSTICO DEL ESTADO DE CHIHUAHUA 102, 109 (1990).

in agriculture in Guadalupe Victoria, while 81 percent were employed in the latter two sectors in Palomas.¹⁶⁰ Note the change that occurred within a mere five years for the entire *municipio*, with a substantial percentage of the population ceasing to be employed in the primary sector.¹⁶¹ There were three *maquiladoras* in Palomas in 1990, employing approximately 140 people.¹⁶² The employment figures may not include laborers who cross the border into the United States.

Land ownership and land use in Ascensión is shown on table 12.¹⁶³ Agriculture and cattle ranching are major economic activities in the area. Livestock accounted for nearly \$85 trillion pesos in both 1990 and 1993. One interesting change occurred in sheep ranching. There were 3,000 head in 1984, yet only 220 at the end of 1990.¹⁶⁴ By 1993 there were no sheep reported.¹⁶⁵ Indeed, except for pigs, all livestock numbers have been in decline (see table 13¹⁶⁶).

Table 14¹⁶⁷ details the agriculture in the *municipio*, all of which is irrigated.¹⁶⁸ It is interesting to note that in 1990 the chile crop was so insignificant that it was not listed separately.¹⁶⁹ Either due to the removal of subsidies, increased pumping costs and/or increased returns on other crops, chile and other non-traditional crops are now being planted, often replacing traditional ones like corn, which plunged from 4,345 hectares planted in 1994 to just 374 in 1998. Ascensión was the state's largest cotton

160. *See id.*

161. *See CIES, supra* note 154.

162. *See id.*

163. *See id.* (citing DEGUE, OFICINA DE CATASTRO).

164. *See* INSTITUTO NACIONAL DE ESTADISTICA, GEOGRAFIA E INFORMÁTICA, ANUARIO ESTADISTICO DEL ESTADO DE CHIHUAHUA 228 (1992).

165. *See id.* at 288.

166. *See* INSTITUTO NACIONAL DE ESTADISTICA, GEOGRAFIA E INFORMÁTICA, ANUARIO ESTADISTICO DEL ESTADO DE CHIHUAHUA 228, 230 (1992); INSTITUTO NACIONAL DE ESTADISTICA, GEOGRAFIA E INFORMÁTICA, ANUARIO ESTADISTICO DEL ESTADO DE CHIHUAHUA 288, 290 (1994); INSTITUTO NACIONAL DE ESTADISTICA, GEOGRAFIA E INFORMÁTICA, ANUARIO ESTADISTICO DEL ESTADO DE CHIHUAHUA 288, 290 (1996); INSTITUTO NACIONAL DE ESTADISTICA, GEOGRAFIA E INFORMÁTICA, ANUARIO ESTADISTICO DEL ESTADO DE CHIHUAHUA 348, 352 (1997); *CIES, supra* note 154.

167. *See* Information provided to author by the SAGAR office in Ascensión, Jan., 1999 & 2000.

168. While nearly all of the agricultural activity occurs within the Río Casas Grandes, it is included here for similar reasons as was the data for Luna County, i.e., because the figures have not been disaggregated and because such activity is important to the welfare of the entire *municipio*. Furthermore, it underscores the competition between the two areas for a particular crop and may well indicate where stresses may occur, especially if the two basins are connected.

169. *See* Information provided to author by the SAGAR office in Ascensión, Jan., 1999 & 2000.

producer in 1983, contributing 32 percent of the total cotton production.¹⁷⁰ At that time, there were 8,256 hectares in cultivation, versus 5,500 in 1990.¹⁷¹ As can be seen, planting of cotton has once again increased, nearly tripling from the 1994 planting of 5,330 hectares to the high of 16,114 in 1997, before decreasing to last year's 8,994 hectares. This emphasis on cotton will likely continue, given that there are four new cotton gins lining Highway 2 between El Entronque and Ascensión town. The other crop that is on the rise is chile, with nearly six times the amount of acreage devoted to it in 1998 than in 1994.

Similar to Luna County, the average precipitation is 297.2 mm, or 11.7 inches.¹⁷² (See table 2.) The drought has been even more prolonged in Chihuahua. Table 15¹⁷³ summarizes water usage in the planning region of the Closed Basins, which includes the *municipio* of Ascensión, as well as that for the communities of Ascensión and Palomas. It is noteworthy that agriculture uses the vast majority of water, as in Luna County. Table 16¹⁷⁴ calculates the water balance of surface waters for the same Closed Basin region. Based upon the water balance calculations, each area is determined to be over- or under-exploited, or in equilibrium. The determination has been made, based upon available data, that the area around Palomas is under-exploited, while that around Ascensión is over-exploited, as can be seen in table 17.¹⁷⁵

Water usage is increasing in Ascensión. Traditionally, Mexican households have not used domestic water as intensely as have American homes. However, this may change with industrialization and rising levels of affluence (reflected in adoption of water-intensive appliances). In a meeting of farmers from the area including Guadalupe Victoria in November 1992, the general consensus was that water levels in areal wells were dropping 10 to 20 feet annually. That trend has continued. One

170. *See id.*

171. *See id.*

172. *See CIES, supra* note 154. The drought has been even more prolonged in Chihuahua. *See Frontera NorteSur, Today's News, State of Chihuahua Declared "Disaster Area"* (Apr. 18, 2000) <www.nmsu.edu/~frontera/today.html> ("The Mexican federal government has declared the state of Chihuahua as a natural disaster area because of the prolonged and abnormal drought in the region that has depleted water resources and brought particular distress to the lower income population...Yesterday's declaration comes in part as a response to a February 25 request by Chihuahua Governor Patricio Martinez which claimed that the state has been effected for ten years by this drought which has also limited the development of the farming industry.").

173. *See COMISIÓN NACIONAL DEL AGUA, II PROGRAMA HIDRAULICO DE GRAN VISIÓN DEL ESTADO DE CHIHUAHUA 1996-2020* § 6.5 (1997) (*available at* <<http://www.sequia.edu.mx/plan-hidra.html>>).

174. *See id.*

175. *See id.*

farmer from Colonia Modelo continued to deepen his well for the last decade to where it is now at 775 feet.¹⁷⁶ It went dry in 1998, and he has stopped farming.¹⁷⁷

Palomas has three municipal wells. The new one, 750 feet deep, is located in the southwest quadrant of town. The other working well is west along the border, while the third, next to the border cattle crossing, has been closed. In the past, the older well broke down, forcing residents to go to the fire station in Columbus to obtain their household water. Since this is also where the reverse osmosis treatment for fluoride system is located, concerns have been expressed about the cost of this program. As in Columbus, high fluoride content in the water is found to exist naturally.

Another source of potential contamination is the sewage treatment facility. In Palomas the sewer system is antiquated. Different size pipes form bad fits, leaking sewage under the streets. It is expensive to hook up to the system, and many have done so illegally. While there is a primary treatment facility, treatment is limited to separating out the solid waste from the liquid, which is discharged into the playas east of town, evaporating or seeping into the ground. Although the discharge site was recently moved further from the town and the border, the untreated sewage is now being deposited where the groundwater has traditionally surfaced, so the potential for contamination is great. Many residents have their own facilities—septic tanks or privies. Plans are underway to improve this situation, but require funding, which is difficult to secure.¹⁷⁸

The international cattle crossing is next to the main well in Palomas, which is now closed. Concern still remains that seepage of wastes will affect the aquifer. It is unknown what the Mexican industrial sites do with their waste other than utilize the municipal system. There is a battery recycling plant approximately six miles south of Palomas and a larger one west of the junction, on the road to Ascensión. Unless great care is taken, problems similar to those that are now being seen just north of Socorro, New Mexico, could arise.¹⁷⁹

176. Interview with a farmer from Colonia Modelo (Jan., 1999).

177. *See id.*

178. During a recent interview, Marta Elena Sainz, Secretario to the Presidente Municipal said that tax receipts were down by over fifty percent from what they were normally for this time period. Interview with Marta Elena Sainz, Secretario to the Presidente Municipal, in Ascensión, Chihuahua, Mexico (Jan., 2000).

179. An automobile battery recycling plant operated between 1979 and 1981, and left a legacy of heavy metals, including lead, arsenic, cadmium, mercury, nickel, silver, and thallium, and aromatic hydrocarbons in soils and waste materials on the site. *Superfund Site near Socorro Due for Cleanup in October*, ALBUQUERQUE J., Aug. 28, 1993, at D3. A former Superfund site, it would cost an estimated \$1 million to clean up. *See id.*

Nonpoint source pollution may also be a problem. Agricultural enhancements, be they pesticides, herbicides or fertilizers, may also finally seep toward the aquifer. Increased pumping may lead to an increase in salinity, affecting economic development in a variety of ways.

WATER MANAGEMENT STRUCTURES

This section begins with a very brief overview of the relevant water management structures. "[I]nternational competence over aquifers divided by the frontier is largely undefined; it is fair to say that the legal and institutional situation is chaotic."¹⁸⁰

Both the U.S. and Mexico accept the principle that each has a responsibility to ensure that its activities do not cause significant harm in the other country. That is, to some degree, they acknowledge an *extraterritorial responsibility* in matters related to the cross-border environment. However, both countries have lagged in adopting mechanisms to implement this principle and until recently have done little to try to empower citizens in the region to act together to reduce environmental damage.¹⁸¹

United States

In the United States, groundwater policy is decentralized. While several federal agencies are deeply involved with various aspects of water control and use, the individual states have the responsibility to manage water, balancing local and regional issues. New Mexico historically has considered water to be a resource belonging to the public and subject to appropriation for beneficial use.¹⁸² The State Engineer is responsible for managing the resource, including its measurement, appropriation, and distribution.¹⁸³ Both administrative and adjudicative duties are involved, such as the allocation of surface waters and of groundwaters in declared basins.¹⁸⁴

180. Albert E. Utton, *An Assessment of the Management of U.S.-Mexican Water Resources: Anticipating the Year 2000*, in THE U.S.-MEXICO BORDER REGION: ANTICIPATING RESOURCE NEEDS AND ISSUES TO THE YEAR 2000 365, 378 (César Sepúlveda & Albert E. Utton eds., 1984).

181. Carlos Rincón & Peter Emerson, *Binationally Managing Air Quality in the U.S.-Mexico Borderlands: A Case Study*, BORDERLINES, Jan., 2000, at 1, 2.

182. See N.M. STAT. ANN. § 72-1-1 to §72-15-28 (Michie Repl. Pamp. 1997).

183. See § 72-4-20.

184. See § 72-4-20, § 72-12-3.

The Mimbres was declared as a basin in 1931 and is fully appropriated.¹⁸⁵ Much of the area has been closed to new drilling, and the rest is so restricted that it is nearly impossible to drill new wells without adversely impairing existing rights. Instead, one must generally purchase existing rights and apply to the State Engineer for a change of use. In 1982, the State Engineer established certain criteria for the use of wells in the Mimbres basin.¹⁸⁶ An annual rate of decline of 2.5 feet, to a maximum of 230 feet, was set.¹⁸⁷ Under *Mathers v. Texaco*, the State Engineer has the power to determine the useful life of an aquifer.¹⁸⁸ Should this be exceeded, senior users would be able to impose a claim of impairment, preventing junior users from using the water.¹⁸⁹ That fact becomes important as water needs shift. The criteria are based solely on usage within New Mexico.

Regional water planning is underway in many regions throughout New Mexico, with the aim toward creating a statewide water plan. The objectives of such planning, according to the Office of the State Engineer's web site, are the following:

- will assemble existing information to develop water budgets for the major stream systems and groundwater basins of the state;
- will include a detailed road map and financial budget for all the work required to finish the state water plan;
- will compile data from the existing and ongoing water resources assessment and regional water planning work, and provide regional water plans with the information they need; and
- will accomplish several tasks of concern to New Mexicans, including:
 - evaluate evidence of diminishing water yield due to deteriorating watershed conditions;
 - plan for ongoing measurement of stream flow and monitoring of water resources in the state; and
 - identify water uses that now rely on mined groundwater that can be met by renewable surface water allocated to New Mexico but as yet undeveloped, and outline the steps that must be taken to switch to renewable water supplies.¹⁹⁰

185. See RESOURCE TECH. INC., *supra* note 46, at 5-3; RESOURCE TECH. INC., *supra* note 133, at 22 app.G12.

186. See RESOURCE TECH. INC., *supra* note 133, at 23 app.G12.

187. See *id.*

188. *Mathers v. Texaco, Inc.*, 421 P.2d 771, 774-75 (1966).

189. See *id.* at 775-76.

190. See generally Office of the State Engineer, *Publications: A Plan to Complete Water Planning* (visited Apr. 27, 2000) <www.seo.state.nm.us/publications/w1-spring-98>.

There is a potential federal role in managing groundwater, especially in transnational basins. Using Commerce Clause and treaty powers, the federal government could pre-empt state laws regulating groundwater.¹⁹¹ A groundwater treaty, if created, could only be forged between the two federal governments. Entering into such a treaty does not require local or state concurrence. It is difficult to know what would happen to individual state laws. Perhaps implementation would be left to a binational entity, or such an entity would monitor the individual states, which would work out the details.

Mexico

In accord with Article 27 of the Mexican Constitution, all water is owned by the federal government.¹⁹² The National Commission of Water (CNA) has been delegated the authority to manage it.¹⁹³ In December of 1992, the National Water Law was enacted, supplanting the 1972 Federal Water Law.¹⁹⁴ While a permit must be obtained in order to drill a new well, CNA has the authority to create regulated zones in the public interest.¹⁹⁵ The agency can prohibit or restrict new well drilling, basing its decisions on the pertinent water balance (the net difference between withdrawn water and water recharged to the aquifer).¹⁹⁶ For example, as seen earlier in table 17, the area surrounding the town of Ascensión was found to have a deficit in its water balance while Palomas was found to have a surplus (note, however, that the water balance was figured solely on Mexican usage).

Scant information is available about the experiences of the *Consejos de Cuenca* (Water Advisory Boards in Mexico). However, reviewing the statutory structure, it would appear to be aimed toward involvement by major water users, or stakeholders, rather than grassroots organizations or the public at large. The process enunciated in the *Cuenca del Río San Juan: Informe de Avances hacia el Desarrollo Sostenible*¹⁹⁷ does foster confidence that

191. The U.S. Supreme Court found that groundwater came within the ambit of the Commerce Clause of the U.S. Constitution and restrictions on its transfer would be subject to scrutiny. *Sporhase v. Nebraska ex rel. Douglas*, 458 U.S. 941 (1982). The Court went so far as to state that "[g]round water overdraft is a national problem and Congress has the power to deal with it on that scale." *Id.* at 954.

192. Constitución Política de los Estados Unidos Mexicanos, CONST. art. 27 (available at <<http://www.juridicas.unam.mx/cnsinfo/fed00.htm>>).

193. *See id.*

194. LEYES Y CÓDIGOS DE MÉXICO, LEY DE AGUAS NACIONALES (1993).

195. *See id.* at 14-16.

196. *See id.*

197. *See* Querétaro, *Cuenca de Río San Juan: Informe de Avances hacia del Desarrollo Sostenible* (visited Mar. 17, 2000) <<http://rds.org.mx/FSC/GON/sanjuan/sjindice.html>>.

public considerations will be included in the process. CNA, in supporting the development of Water Resources Planning and River Basin Council Support, stated that such inclusion

would provide the necessary framework for a change in water policy formulation towards decentralized management and strong and effective participation of all stakeholders, particularly the water users organizations. Within this framework, local groundwater conservation districts could be implemented as the organizational arrangement to design a win-win strategy for aquifer stabilization. Actually, in several critical over-exploited aquifers, following the water users initiative and under CNA sponsorship, Aquifer Conservation Committees (Comites Técnicos de Aguas Subterráneas, COTAS) have been implemented or under implementation. The COTAS should be the pivotal institutional organization for creating a consensus and reaching decisions on the shared common objective of aquifer stabilization and sustainable groundwater use.¹⁹⁸

Both the New Mexico State Engineer and CNA plan for their own users. Remarkably, neither makes mention of water usage on the other side of the international border. Rates of withdrawal and water balances are established without such consideration. With no treaty between the United States and Mexico regarding underground water, water use is limited only by the ability of each side to pump it to the surface. This allows unilateral appropriation to the detriment of the binational region as a whole. It is notable that both New Mexico and Chihuahua have drought planning in place, but once again there is no official connection.¹⁹⁹

The drought plaguing the border region over the last few years continues unabated. As of June 1, 1999, nine states in the northern half of Mexico have been declared disaster areas, and dams and reservoirs in the area are down to an average of 19% of capacity. This extended drought, combined with overpumping of groundwater, has led farmers to dig ever-deeper wells. This has raised their costs at a time when bank credit has been extremely hard to come by due to the

198. Comisión Nacional del Agua, *Programa Hidráulico de Gran Visión del Estado de Chihuahua 1996-2020* (visited Mar. 17, 2000) <<http://www.sequia.edu.mx/plan-hidra.html>>.

199. New Mexico's 1998 Drought Plan can be found at New Mexico Drought Planning Team, *Drought Plan* (visited Mar. 19, 2000) <http://weather.nmsu.edu/drought/drought_plan.htm>; Chihuahua's 1999 equivalent at Comisión Nacional del Agua, *Estrategias para Enfrentar La Sequía, Delineadas en El Plan de Gobierno del Estado de Chihuahua* (visited Mar. 17, 2000) <<http://www.sequia.edu.mx/proyectos/plan-estrategico.html>>.

December 1994 economic crisis. An estimated \$20 billion of the \$72 billion that private Mexican banks hold in unpaid loans comes from the agricultural sector. Farmers complain of high interest rates and accuse the banks of being quick to foreclose—yet another face of water-related conflict.²⁰⁰

International Boundary and Water Commission (IBWC)

There is a role in this situation for the International Boundary and Water Commission (IBWC). Created over 100 years ago, the IBWC, among other duties, administers the 1944 U.S.–Mexico Water Treaty²⁰¹ (which governs the binational management of the surface water of the Río Grande/Río Bravo and the Colorado River) and implements binational agreements, such as the supervision and management of waters which cross into one country from the other or form the border.²⁰² The IBWC is composed of two national sections, each with a commissioner and each being responsible to its respective government's State Department.²⁰³ The IBWC's authority is further added to by minutes, which, like executive orders, have the standing of a treaty.²⁰⁴ It has been argued that Minute 242 (signed in 1973 to deal with the salinity problem in the San Luis, Sonora, area) provided the legal foundation for cooperative management of groundwater resources by the IBWC because it committed each nation to consult the other on plans for future groundwater development along the border.²⁰⁵ The IBWC claims that Minute 242 allows it only to (a) exchange information and (b) deal with contamination issues.²⁰⁶ Although the IBWC has been hesitant to extend its authority without clear direction, such as a formal treaty, this attitude appears to be changing.

200. Irasema Coronado & George Kourous, *Water Conflict in the Borderlands: The Challenge of Equitable Allocation*, BORDERLINES, July, 1999, at 1, 3.

201. Treaty Regarding Utilization of Waters of the Colorado and Tijuana Rivers and the Rio Grande, Feb. 3, 1944, U.S.–Mex. 59 Stat. 1219, T.S. No. 994.

202. See Stephen Mumme, *Innovation and Reform in Transboundary Resource Management: A Critical Look at the International Boundary and Water Commission, United States and Mexico*, 33 NAT. RESOURCES J. 93, 94-95 (1993).

203. See *id.*

204. See *id.*

205. See Albert E. Utton, *The Transfer of Water from an International Border Region: A Tale of Six Cities and the All American Canal*, 16 N.C. J. INT'L L. & COM. REG. 477, 489-90 (1991); C.R. Bath, *Transboundary Resource Management Models: Applicability to the El Paso-Ciudad Juarez Region for Groundwater Management*, 10 TRANSBOUNDARY RESOURCES REP. 1, 1-3 (1996).

206. See Mumme, *supra* note 202, at 110, 113-14.

A REVIEW OF BINATIONAL WATERSHED INITIATIVES

New Mexico

The previous section provides a snapshot of the region. It sets forth information and enumerates reasons why the status quo should not continue. In summary, the following are some of the resource management problems:

- Lack of a transboundary mechanism (and a lack of internal coordination);
- Quality and quantity concerns (overdrafting, reverse flow, contamination);
- Paucity of useable data, incomplete measurements and inadequate access to information;
- Differences in perspectives and in water management on each side; and
- Authority void, ranging from local communities to state and federal agencies charged with administering various aspects.

As water usage has increased due to population growth and economic development, the water table has declined on both sides of the international boundary. This has raised serious concerns as to the viability of ongoing and planned activities. However, Palomas and Columbus, where life itself depends on the same source of water, lack a mechanism to protect this vital resource.

As can be seen by the quantity of studies cited above, the situation in the Mimbres basin is known. But that underscores one of the basic problems—the studies have been largely academic or agency-driven, and have not been shared with the public. Without a library in Palomas, access to information is limited, especially when studies routinely disappear after each administration.

Steps have been taken toward initiating a binational dialogue between Columbus and Palomas. Public involvement in gathering information was built into the project that produced the *Ecological Baseline Model for the U.S.–México Border Region*.²⁰⁷ Basic information about the communities' water resources has been provided in a number of venues by agencies such as the New Mexico Border Health Office, as well as by the author. One successful strategy in educating the general public has been

207. DAVID S. HENKEL ET AL., *AN ECOLOGICAL BASELINE MODEL FOR THE US-MEXICO BORDER REGION* (1997).

the *Festival del Agua*. First held in 1997, it has helped to elevate the discussion of water issues into every-day conversation.²⁰⁸

Because binational agreements must be federally approved, the international boundary hinders local, state, and bioregional management of natural resources. Nevertheless, in August of 1998, Chihuahua, New Mexico, and Texas entered into a three-state strategic plan in accord with the 1996 Ten State Retreat of the Border Governors (sponsored in part by the Western Governors Association's U.S.-Mexico Border Environment Dialogue Project).²⁰⁹ But, when compared with the three other U.S. border states, New Mexico's involvement has been minimal.²¹⁰ Until recently, there were few non-governmental organizations (NGOs) located in New Mexico that focused on border concerns. This has changed.²¹¹

208. Some 400 people attended and 800 students and 15 agencies participated at the first festival. The second one, held March 20, 1999, drew approximately 1,000 persons (nearly 10% of the areal population), and it has now become an annual event.

209. See CHIHUAHUA-NEW MEXICO-TEXAS STRATEGIC ENVIRONMENTAL PLAN: A FRAMEWORK FOR COOPERATION (1999) (available at Texas Natural Resource Conservation Commission, *Border Activities: State to State Strategic Plans* (last modified Mar. 17, 2000) <<http://www.tnrcc.texas.gov/exec/ba/activities.html#strategic>>).

210. For a comparison, see the Arizona-Mexico Commission and its counterpart, the Comisión Sonora-Arizona (visited Mar. 17, 2000) <<http://www.azmc.org/default.asp>>; ARIZ. DEP'T OF COMMERCE & ARIZ.-MEXICO COMM'N, ARIZONA-SONORA PARALLEL TRACK PLANNING PROCESS (1995).

211. Noteworthy examples include the following. The Rio Grande/Rio Bravo Basin Coalition located in El Paso, Texas, has a mission to facilitate local communities in restoring and sustaining the environment, economies, and social well-being of the Rio Grande/Rio Bravo Basin. The coalition supports following goals of international cooperation to develop and promote projects which preserve, restore, and sustain the Basin's natural and human resources and address its challenges to ensure clean water, clear air, safe food, cultural diversity, and biodiversity while encouraging economic development in the balance. Further, the coalition seeks to promote projects aimed at developing a motivated constituency and fostering an ethic of stewardship for the Basin and to coordinate cooperative international research and technology to share conservation and sustainable use of the Basin's multiple resources. Finally it seeks to provide information, technical assistance, and networking to local communities. The web site is Rio Grande/Rio Bravo Basin Coalition (visited Mar. 17, 2000) <<http://www.rioweb.org>>. The New Mexico Border Health Council, located in Las Cruces, New Mexico, is a volunteer organization formed to help address health issues created by the rapid population growth and economic development in the New Mexico border region. See New Mexico Border Health Council (last modified Apr. 16, 1999) <<http://www.NMSU.Edu/~bho/bhc>>. Project del Rio, also located in Las Cruces, New Mexico, is a water quality monitoring program for secondary students in the United States and Mexico. The project introduces the students to the study of real world environmental problems through the collection and analysis of water quality data from the Rio Grande. The project uses the concept of a watershed as a unifying theme for the interdisciplinary study of environmental issues. See Project del Rio (visited Mar. 17, 2000) <<http://www.igc.apc.org/green/delrio.html>>. The InterHemispheric Resource Center is located in Silver City, New Mexico, and publishes

OTHER EFFORTS AND EXPERIENCES

"Non-governmental organizations are asserting newly found voices in transboundary affairs and are forming binational and multinational linkages often outside national or formal governmental channels."²¹² Whether the responsibility lies with the federal, state or local governments, none of these activities are yet addressing transboundary groundwater management in the Palomas/Columbus area. Hence, the search for other models, existing or proposed, from which lessons can be drawn and the void hopefully filled. Since the federal governments have not been able to reach formal agreement, and the state and local governments cannot do so in absence of a federal treaty, NGOs and educational institutions may be best suited to assist.²¹³

One of the more exciting undertakings is the joint effort between the Nature Conservancy, *Instituto del Medio Ambiente y Desarrollo Sustentable del Estado de Sonora* (IMADES), and the International Sonoran Desert Alliance (ISDA) to create a comprehensive biregional planning process for the Sonoran Desert. While it is too early to determine the political outcome of this project, it appears to be a sincere effort to work with the local residents. It thus provides a model for other communities to follow. ISDA, in turn, can look to the experiences of the Northeast Sonora-Cochise County Health Council in dealing with binational issues through a participatory process.²¹⁴

The *Paseo del Norte Sustainable Water Use Strategy* was an effort to conduct a region-wide, binational assessment of surface water use.²¹⁵ It

BORDERLINES, a superb periodical that addresses issues relevant to the *frontera*, together with an Action Kit of contacts and information about specific topics. See IRC (last modified Sept. 14, 1999) <<http://www.irc-online.org/bdrprj.html>>. Others include the Colonia Development Council, La Clinica de Familia, the Southwest Environmental Center, WaterWorks, and the Border Environmental Health Coalition, all of which have special niches and interests. There is a monthly Border Breakfast Meeting in Las Cruces where agencies that focus on border issues meet and discuss common issues.

212. INGRAM, *supra* note 23, at 1.

213. This discussion is limited to the U.S.-Mexico border region. An in depth study of border models *per se* could be the subject of another paper.

214. See, e.g., Andrea Brown et al., *Public Participation in the Development of Municipal Environmental Projects in the U.S./México Border Region: A Model Project for the Greater Agua Prieta/Douglas Region* (Nov. 15, 1994) (unpublished working paper, on file with author).

215. See Ctr. for Env'tl. Resource Management at the Univ. of Tex. at El Paso, *Paseo del Norte Sustainable Water Use Strategy: An Economic Development Strategy for the Sustainable Use of Water in the Paseo del Norte Region* (last modified June 29, 1998) (available at <<http://www.utep.edu/rio/>>).

emphasized the costs and benefits to the region of various uses of the Rio Grande.²¹⁶ While the project began with a high priority of being binational in scope, the final plan deleted many of the more innovative binational strategies.²¹⁷ The process did not prepare a plan with time frames for implementation, but focused on five categories, such as water supply. The final document sets forth the issues and makes recommendations and action ideas, leaving it up to others to actually execute them. The procedures used during the process to engage the public were varied and innovative. For instance, the use of the Internet for posting drafts of the plan, along with an easy method to comment on them, should become a standard for all planners in the future.

The 1998 *Water Supply Planning For The Middle Texas–Mexico Border Region*²¹⁸ was a collaborative effort including the Texas Center for Policy Studies, setting forth certain project activities:

- Establish a framework for dialogue by assisting governmental and non-governmental entities on both sides of the border to create a system of on-going communications and cooperation in developing and implementing solutions to their water supply problems.
- Develop a local “library” with an accessible database of information and analyses and projected water supply and demand issues and alternative management strategies, with the ability to update the information.
- Identify implementation strategies for water resources management options by finding potential solutions appropriate to the region.²¹⁹

At this point, it is unclear as to how much further this effort will proceed.

216. *See id.*

217. *See, for example, Priority Action 1.5-A-1, which originally stated, “The U. S. and Mexico should enhance dialogues regarding surface water management and allocations, groundwater management, and joint use of treatment facilities, and open up the process by making other interested stakeholders a party to those dialogues.” This was changed in the final version to “[p]rovide for enhanced international water planning and management either through an existing entity or the creation of a new entity, that would coordinate groundwater withdrawal rates, exchange data and address water quality.” *Id.* Evidently some felt that (a) Mexico need not participate since the focus was on surface water, which is already dealt with by treaty; and (b) the IBWC/CILA was well positioned to monitor these water resources.*

218. Texas Center for Policy Studies, *Water Supply Planning for the Middle Texas-Mexico Border Region* (last modified Oct. 1, 1999) <<http://www.texascenter.org/bwproj/bwbroch.htm>>.

219. *Id.*

In 1998, New Mexico State University received funding to develop a Center for Regional Policy Studies at both NMSU and the *Universidad Autónoma de Cd. Juárez* in order to create a cooperative process for examining regional policy concerns. One enunciated goal is "to examine water from a regional perspective in the Paso del Norte area...anticipat[ing] better communication, increased cooperation and development of a regional perspective among policy officials."²²⁰ This effort is linked with the Paso del Norte Water Initiative, which, together with the Paso del Norte Water Task Force, was created in the spring of 1999.²²¹ So far the Task Force has met twice and issued a working paper.²²² The Initiative and Task Force are using as their model the Paso del Norte Air Quality Task Force. This group has had remarkable successes in its effort to grapple with transboundary air quality issues. To enable transboundary governance, the Task Force recommended the creation of an International Air Quality Management District with significant local leadership.²²³ Eventually, a binational agreement, signed May 7, 1996, as an appendix to Annex 5 of the La Paz Agreement,²²⁴ "commits the countries to implement a strategy of binational management of air quality in the Paso del Norte area through national laws."²²⁵ In addition, citizens are given a role in developing strategies and an international air basin was formally established. All of this will mean a "move toward decentralization and a deepening of the democratic process," reflecting "communities needs."²²⁶

Entities which stress citizen involvement include Border XXI and the Good Neighbor Environmental Board.²²⁷ The Border Environmental

220. Jose Garcia, New Mexico State University News Releases, *NMSU Professor Says International Cooperation Needed to Tackle Regional Issues* (News Release Sept. 1998) <http://www.nmsu.edu/General/ucomm/public_html/Releases/1998/Sept98/water.html>.

221. See Houston Advanced Research Ctr., *Center for Global Studies: Paso del Norte Water Initiative* (visited Mar. 17, 2000) <<http://www.harc.edu/cgs/mexico/paso.html>>. "The Task Force is a non-political advisory organization that bases its work on input from scientific analysis and community consultation. Members include the managers of the city water utilities from El Paso, Juárez, and Las Cruces, managers of the major irrigation districts, large water users, experts, and citizens at large. The U.S. and Mexican Commissioners of the International Boundary and Water Commission serve as ex-officio members of the Task Force." *Id.*

222. See *id.*

223. See Rincón & Emerson, *supra* note 181, at 4.

224. Agreement on Cooperation for the Protection and Improvement of the Environment in the Border Area, Aug. 14, 1983, U.S.-Mex., T.I.A.S. No. 10,827.

225. Rincón & Emerson, *supra* note 181, at 4.

226. See *id.*

227. Border XXI is a program jointly adopted by the U.S. EPA and the Mexican SEMARNAP. U.S. ENVTL. PROTECTION AGENCY, EPA NO. 160-R-96-003, U.S.-MEXICO BORDER XXI PROGRAM, FRAMEWORK DOCUMENT AND 1996 BORDER IMPLEMENTATION PLANS

Cooperation Commission (BECC) requires public participation in its own meetings as well as for any project coming before it for authorization. It has issued guidelines that could be utilized by border communities, which would also be useful should any project be developed and submitted to BECC.²²⁸ A participatory learning process is also in keeping with objectives of the World Water Vision Exercise.²²⁹

CONCLUSION

As Helen Ingram reminds us, "Water is associated with three important community aspirations"—Opportunity, Security and Control.²³⁰

1 (1996). The Good Neighbor Environmental Board was created by the Enterprise for the Americas Initiative Act of 1992, and its Mexican counterpart is the National Advisory Council for Sustainable Development. See GOOD NEIGHBOR ENVIRONMENTAL BOARD, ANNUAL REPORT 1 (1998).

228. See BORDER ENV'T COOPERATION COMM'N, GUIDELINES FOR PROJECT SUBMISSION AND CRITERIA FOR PROJECT CERTIFICATION 12-14 (1995). Other transboundary frameworks exist, including the Commission for Environmental Cooperation, *San Pedro Initiative: Advisory Panel Report on the Upper San Pedro River* (last modified Nov. 1998) <<http://cec.org/english/new/spagre.cfm?format=1>>. This initiative had three objectives: (1) initiate a process where diverse stakeholders from the region can develop and implement economically and environmentally sustainable strategies for enhancing and preserving the riverine ecosystem of the Upper San Pedro watershed; (2) develop a model of cooperation that could have relevance to other transboundary basins; and (3) inform the broader public about the regional importance of preserving migratory bird habitat and the challenges and opportunities in conserving and protecting valued transboundary resources. See *id.* Another is the Transboundary Water Management, *Experience of International River and Lake Commissions: Berlin Recommendations, Lessons Learned, Challenges and Issues for the future* (last modified Mar. 11, 2000) <<http://www.sn.apc.org/afwater/berlinrecom.htm>>. See *supra* text accompanying notes 15-16.

229. See Water Vision, *Moving from Crisis to Vision* (last modified Sept. 2, 2000) <<http://www.watervision.org/>>. Its three primary objectives of integrated water resource management are (1) empower women, men and communities to decide on the level of access to safe water and hygienic living conditions and the types of water-using economic activities that they wish and to organize to obtain it; (2) produce more food, create more sustainable livelihoods for women and men per unit of water applied (more crops and jobs per drop), and ensure access for all to food required for healthy and productive lives; (3) manage human water use to conserve the quantity and quality of freshwater and terrestrial ecosystems that provide services to humans and all living things. See *id.* The five key actions to achieve these objectives are: (1) involve all stakeholders in integrated management; (2) move to full-cost pricing of water services for all human uses, (3) increase public funding for research and innovation in the public interest; (4) recognize the need for co-operation to improve international water resource management in international water basins; and (5) massively increase the investments in water. See *id.*

230. Helen Ingram, U.S./Mexico Water Management: An Ambos Nogales Example 1 (1992) (unpublished paper, on file with the North American Institute Conference on Border and North American Water Issues).

This may explain some of the reluctance to seek out solutions. Perhaps nowhere in the world are the political, economic, social and cultural differences between two nations more apparent than between the United States and Mexico. Negotiations over water resources are fraught with a number of explosive issues, ranging from historical events to current sovereignty concerns.

Many different dreams and visions can be described. Without some positive vision, without some thought about what truly sustainable water use means, society risks continuing on a path that will take us further and further in the wrong direction. We can choose a different path and try to define and attain a different future. But we must make that choice soon.²³¹

The most effective means of improving water quality and protecting public health in the border region is through binational coordination and collaboration. While the shared aquifer creates a unifying framework, serious differences remain in terms of legal and administrative systems, the level of knowledge, available data, sufficient time to participate, experiences, and cultures. Most critical is that understandings on each side of the border of what public participation means may vary.

Research suggests that simply holding public meetings about water quality or quantity, although important, is insufficient. In order to obtain an acceptance of a water planning process and of the results, public involvement needs to be sought and encouraged throughout. Augmenting the existing information and putting it to use follows the mandates contained in New Mexico Regional Water Planning, the *Consejos de Cuenca*, and the Bellagio Draft Treaty. Community-based natural resource management adds the impetus to empower local communities. Even without official action, a water dialogue should be initiated. Such a dialogue will help local citizens understand what the resource is, including its present condition and potential, and how they may best conserve and preserve it. It would also provide agencies responsible for managing the resource an opportunity to disseminate information, discover and respond to information needs, and identify additional aspects requiring investigation and research.

Once local citizens become aware of and are interested in their watershed, they are more likely to become involved in decision making as well as hands-on protection and restoration efforts. With local involvement, watershed management can build a sense of community, help reduce conflicts, and increase the public's commitment to meeting environmental

231. PETER H. GLEICK, *THE WORLD'S WATER 1998-1999* 2 (1998).

goals. Unless citizens from both sides of the border are engaged, it is unlikely that cross-border efforts will flourish.

With drought conditions on the horizon, it is an optimal time to address the issues. The *Festival del Agua*, by initiating water education on a very basic level, represented a first step toward developing a binational discussion. By utilizing ongoing water planning initiatives currently underway in New Mexico and Mexico as springboards, and by keeping abreast of the other groups' successes and failures, a Regional Planning Group/*Consejo* or *Comite* centered around water could be formed to create a joint dialogue process.

TABLE 1: MONTHLY CLIMATE SUMMARY FOR COLUMBUS, NEW MEXICO PERIOD OF RECORD: JANUARY 1, 1925 TO AUGUST 31, 1999

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Maximum Temperature (F)	58.4	63.9	70.8	79.2	87.4	96.4	95.6	92.8	88.3	79.2	66.9	58.6	78.1
Average Minimum Temperature (F)	28.4	31.8	37.5	44.6	53.1	62.8	66.9	65.0	58.9	47.3	35.2	28.7	46.7
Average Total Precipitation (in.)	0.49	0.42	0.37	0.25	0.24	0.31	2.11	1.90	1.45	0.88	0.48	0.68	9.56
Average Total Snow Fall (in.)	0.8	0.5	0.2	0.1	0	0	0	0	0	0	0	1.2	3.1

TABLE 2: MONTHLY CLIMATE SUMMARY FOR ASCENSIÓN

Precipitation (in millimeters)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average	12.5	10.2	5.5	4.1	5.5	8.8	62.0	56.3	34.6	21.7	11.9	16.6	249.7
Ave 61-90	12.1	9.5	5.5	4.8	6.7	8.6	68.1	64.2	39.4	22.7	15.6	17.5	274.8
Max	72.0	39.0	42.0	28.0	42.5	47.0	165.0	191.6	137.0	126.5	67.0	96.1	409.8
Min	0.0	0.0	0.0	0.0	0.0	2.0	19.0	20.0	21.0	0.0	0.0	0.7	96.8

Temperature (°C)

Average	6.2	8.7	11.8	16.0	20.8	25.7	26.4	25.1	22.3	17.2	10.5	6.6	16.4
Max	9.2	11.5	16.5	19.7	24.8	28.8	28.5	27.1	25.1	20.4	14.0	9.0	28.8
Min	2.7	4.3	4.4	11.8	17.9	23.5	23.3	22.4	19.7	13.6	7.9	4.1	2.7

Average Evaporation 1964-1980 (mm)

Average	98.4	136.2	233.7	299.7	344.5	398.0	311.2	273.1	218.3	188.8	137.2	108.4	2747.5
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**TABLE 3: NEW MEXICO POPULATION PROJECTIONS FOR NEW MEXICO AND LUNA COUNTY
(CALCULATED AS OF JULY 1 EACH YEAR)**

	1990	1995	2000	2005	2010	2015	2020	2025	2030
State	1,519,889	1,686,299	1,821,078	1,956,725	2,090,678	2,232,424	2,380,802	2,534,964	2,691,578
Luna	18,175	22,121	25,041	28,220	31,640	35,229	39,102	43,168	47,405

TABLE 4: CENSUS DATA FOR LUNA COUNTY

From the 1998 General Profile	
POPULATION AND HOUSING	
Total resident population:	
1997	23,922
1995	22,121
Percent under 18 years	24%
Percent 65 years and over	20%
1990	18,110
1980	15,585
Population: percent change, 1990 to 1997	32.1%
Population: percent change, 1980 to 1990	16.2%
Public school enrollment (NCES): number, fall 1994-1995	5,354
Public school enrollment (NCES) number, fall 1991-1992.	4,800
MONEY INCOME AND POVERTY	
Social security (SSA): total benefit recipients, 1996	5,229
Social security (SSA): total benefit recipients, 1990	4,730
Fed funds & grants: per capita expenditures & obligations 1997	4,250
Personal income (BEA): per capita (\$), 1994	12,070
Personal income (BEA): per capita (\$), 1990	10,973
Money income: median household income (\$), 1993	15,835
Money income: median household income (\$), 1989	15,684
Poverty: percent persons below poverty, 1993	34.3
Poverty: percent persons below poverty, 1989	31.5
LABOR FORCE (BLS)	
Civilian labor force (BLS): number, 1996	11,165
Civilian labor force (BLS): number, 1990	7,479
Civilian labor force (BLS): unemployment rate, 1996	28.2
Civilian labor force (BLS): unemployment rate, 1990	12.7

TABLE 5: ACRES OF IRRIGATED CROPLAND, INCLUDING IDLE, FALLOW, AND DIVERTED ACREAGE IN LUNA COUNTY 1940 TO 1995

1940	1945	1950	1955	1960	1965	1970	1975	1980	1990	1995
21,240	22,240	33,110	38,260	42,610	50,990	71,460	72,440	73,940	73,950	73,950

TABLE 7: SUMMARY OF WATER USE (IN ACRE-FEET) IN LUNA COUNTY, 1990

Category	Withdrawal: Surface Water	Withdrawal Ground- water	Total Withdrawal	Depletion: Surface Water	Depletion Ground- water	Total Depletion	Return Flow: Surface Water	Return Flow: Ground -water	Total Return Flow
Public Water Supply	0	3,510	3,510	0	1,755	1,755	0	1,755	1,755
Domestic (self- supplied)	0	285	285	0	128	128	0	157	157
Irrigated Agriculture	5,280	98,527	10,3807	2,295	58,691	60,986	2,985	39,836	42,821
Livestock (self- supplied)	96	423	519	96	422	528	0	1	1
Commercial (self-supplied)	0	144	144	0	118	118	0	26	26
Industrial (self- supplied)	0	157	157	0	125	125	0	32	32
Mining (self- supplied)	0	375	375	0	111	111	0	264	264
Power (self- supplied)	0	0	0	0	0	0	0	0	0
Reservoir Evaporation	0	0	0	0	0	0	0	0	0
TOTAL	5,376	103,420	10,8796	2,391	61,350	63,741	2,985	42,070	45,055

TABLE 8: SUMMARY OF WATER USE (IN ACRE-FEET) IN LUNA COUNTY, 1995

Category	Withdrawal Surface Water	Withdrawal Ground-Water	Total Withdrawal	Depletion Surface Water	Depletion Ground-Water	Total Depletion	Return Flow: Surface Water	Return Flow: Ground-Water	Total Return Flow
Public Water Supply	0	4,210	4,210	0	2,105	2,105	0	2,105	2,105
Domestic (self-supplied)	0	810	810	0	365	365	0	446	446
Irrigated Agriculture	21,785	119,550	141,335	10,048	71,356	81,404	11,737	48,194	59,931
Livestock (self-supplied)	87	360	447	87	360	447	0	0	0
Commercial (self-supplied)	0	192	192	0	139	139	0	53	53
Industrial (self-supplied)	0	62	62	0	44	44	0	18	18
Mining (self-supplied)	0	256	256	0	66	66	0	190	190
Power (self-supplied)	0	0	0	0	0	0	0	0	0
Reservoir Evaporation	0	0	0	0	0	0	0	0	0
TOTAL	21,872	125,440	147,312	10,135	74,435	84,570	11,737	51,006	62,743

TABLE 9: WATER QUALITY FOR PRIVATE AREAL WELLS SAMPLED IN 1997 (mg/L)

<u>Well</u>	<u>Location</u>	<u>Depth</u>	<u>Test Results</u>
M048	West of Columbus	500'	TDS - 800; Sulfate = 269; Uranium = 0.041
M049	West of Columbus		TDS - 1030; Sulfate = 250; Nitrate = 10
M113	Columbus	390'; 275' to water	TDS = 686; Fluoride = 7.9
M110	N of Columbus	390'; 275' to water	TDS = 668; Fluoride = 7.8
M030	N of Columbus	~300'	TDS = 612; Fluoride = 7.55
M031	N of Columbus	300'	TDS = 610; Fluoride = 6.0
M032	Seventy-Six Draw	~100'	Uranium = .067; Sulfate = 712
M029	Seventy-Six Draw	38' to water	
M002	Sunshine	200'	
M003	Sunshine	~220'; 160' to water (uncovered well)	
M001	Sunshine	~200'	

TABLE 10: POPULATION TRENDS IN MEXICO

	1970	1980	1990
México	48,225,238	66,845,833	81,249,645
Chihuahua	1,612,525	2,005,477	2,441,873
Ascensión	9,316	11,985	16,361

TABLE 11: ECONOMICALLY ACTIVE POPULATION

	1990	PERCENT	1995	PERCENT
Ascensión				
Primary Sector	1,942	40.4%	2,595	29.6%
Secondary Sector	1,453	30.2%	3,349	38.2%
Tertiary Sector	1,275	26.5%	2,770	31.6%
Not specified	136	2.8%	52	0.6%
Puerto Palomas				
Primary Sector	200			
Secondary Sector	430			
Tertiary Sector	415			
Gaudalupe Victoria				
Primary Sector	285			
Secondary Sector	46			
Tertiary Sector	57			

TABLE 12: LAND USE AND LAND TENURE, 1996 (IN HECTARES)

LAND USE	Private		Ejidal		Communal		Total	
	Has.	%	Has.	%	Has.	%	Has.	%
Area Of Irrigation								
Irr. by gravity	285	0.04	0	0.0	0	0.0	285	0.0
Irr. by pump	16,037	2.10	0	0.0	0	0.0	16,037	0.0
Orchard in dev.	0	0.0	0	0.0	0	0.0	0	0.0
Orchard in prod.	483	0.06	0	0.0	0	0.0	483	0.0
Non-Irrigated	1,287	0.17	5,760	1.1	0	0.0	7,047	0.0
Pasture	744,669	97.63	521,668	98.9	88	100.0	1,266,425	100.0
Forest	0	0.0	0	0.0	0	0.0	0	0.0
Unspecified	10	0.0	0	0.0	0	0.0	10	0.0
Total Municipio	762,771	59.1	527,420	40.0	0	0.0	1,291,712	0.0

TABLE 13: LIVESTOCK IN ASCENSIÓN

	Cattle	Pigs	Sheep	Horses	Poultry	Total
1990	86,013	2,349	220	7,670	5,897	
	\$81,884	\$651	\$29	\$2,320	\$55	\$84,939
1993	56,926	2,500	--	1,540	--	
	\$82,087	\$1,378	--	\$2,373	--	\$85,838
1995	36,557	547	--	853	4,333	
	\$82,636	\$741	--	\$2,346	60	\$85,783
1996	65,535	460	150	800	4,100	

(In thousands of pesos)

TABLE 14: CROPLAND IN ASCENSIÓN (IN HECTARES)

Spring Crop	1994	1995	1996	1997	1998	1999
Cotton	5,330	12,575	13,865	16,114	14,937	8,994
Soy	214	214	--	28	--	--
Beans	2,594	1,452	1,188	2,309	2,139	2,516
Grain Corn	4,345	264	532	315	374	803
Grain Sorghum	1,188	1,411	1,841	859	865	644
Forage Sorghum	366	471	506	498	825	976
Peanuts	14	5	2	5	22	1,184
Potato	205	190	206	200	180	317
Chile	1,280	2,796	2,574	4,316	6,328	4,709
Tomato	12	69	57	25	25	36
Melon	67	120	108	126	98	151
Watermelon	58	298	196	437	583	525
Onion	5	108	32	24	67	246
Cucumber	243	173	94	106	102	83
Orchards	270	76	10	50	46	65
Forage Oats			45	20	20	133
Sorghum Escobero				486	18	--
Total	16,191	20,222	21,256	25,918	26,629	21,392
Fall Crop	94/95	95/96	93/94	96/97	97/98	
Wheat Grain	1,510	1,572	1,808	988	603	
Oat Grain	916	552	1,412	965	999	
Oat Forage	427	281	180	216	261	
Annual Pasture	581	545	297	505	603	
Barley	20	--	--	--	--	
Total	3,454	2,950	3,697	2,674	2,466	
Perennials	93/94	94/95	95/96	96/97	97/98	
Alfalfa	555	738	950	963	831	
Nuts	118	194	194	198	238	
Pasture P.	196	172	199	188	157	
Total	869	1104	1343	1349	1226	

TABLE 15: SUMMARY OF WATER USE FOR THE CLOSED BASINS, ASCENSIÓN AND PALOMAS, 1995

Sector	Cubic meters per second	Millions of cubic meters	Percent of all usage	Ascensión (mm ³)	Palomas (mm ³)
Domestic	1.1	33.3	2.1	0.3	0.004
Industrial	0.1	2.6	0.2	0.03	--
Commercial	0.1	1.7	0.1	0.95	0.18
Agriculture	48.7	1,538.10	96.5	169	21.45
Livestock	0.5	15.9	1.0	2.8	0.33
Mining	0	0.9	0.1	--	--
Tourism	0	0.2	0.0	--	--
Total	50.5	1,593	100	173.08	21.97

TABLE 16: WATER BALANCE OF SURFACE WATERS IN CLOSED BASINS, 1995

Surface(km ²)	87,818.0
Average Precipitation (mm)	357.0
Rainfall (millions of m ³)	31,333.0
- actual evapotranspiration	29,662.4
+ returns	12.5
- extractions*	199.7
- evaporation in canals	13.6
- rainfall infiltration	908.7
- irrigation infiltration	90.0
- other losses	561.1
= Surface Water Balance	0.0
	Percent of Total
Actual evapotranspiration	94.7
Consumptive uses	0.3
Canal evaporation	0.0
Infiltration	3.2
Other losses	1.8
	100.0
*Included in extraction is irrigation infiltration	

TABLE 17: WATER BALANCE CALCULATION (MM³/YEAR)

Geohydrologic Zone		Agriculture	Municipal	Domestic/Livestock	Industrial	Total
Ascensión		187.00	1.50	3.46	0.00	191.96
Palomas, Guadalupe Victoria		21.50	6.00	0.34	0.00	27.84
Volume (mm ³ /year)						
Recharge	Extraction	Additional Available	Over Exploitation	Balance	Actual Exploitation	Local Over Exploitation
150.00	(1) 191.96	0.00	41.96	-41.96	Over-Exploited	B SL
52.00	(1) 27.84	24.16	0.00	24.16	Under-Exploited	D SL

- A. Aquifer strongly over-exploited by domestic and livestock users
 - B. Aquifer slightly over-exploited by users outside the zone of over exploitation
 - C. Aquifer in equilibrium
 - D. Under-exploited aquifer, with excess available for all uses
- (1) Preliminary geohydrologic study

FIGURE 1: THE MIMBRES BASIN

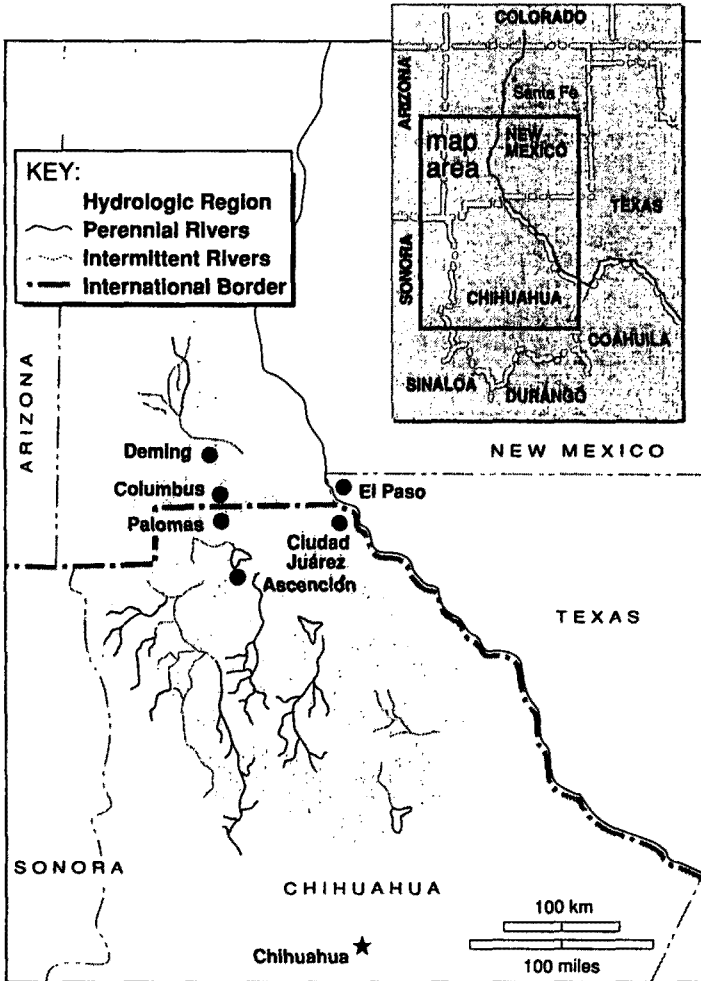
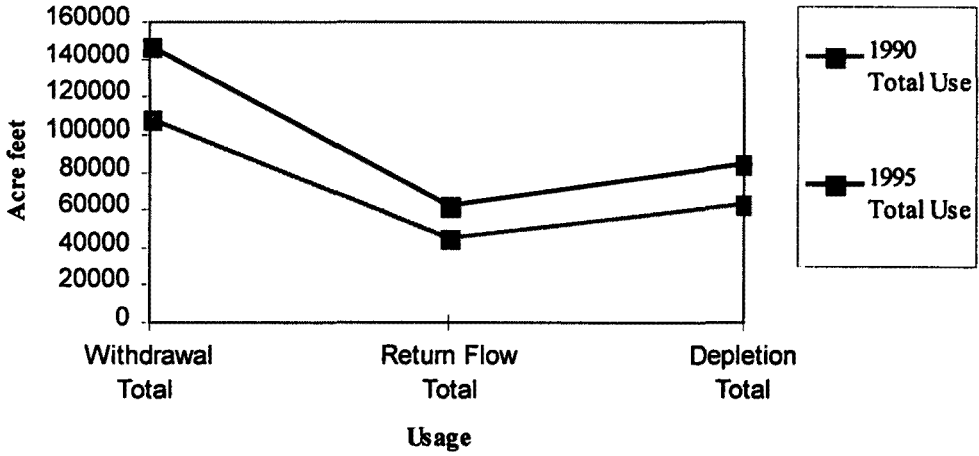


FIGURE 2: TOTAL WATER USE IN LUNA COUNTY 1990 AND 1995



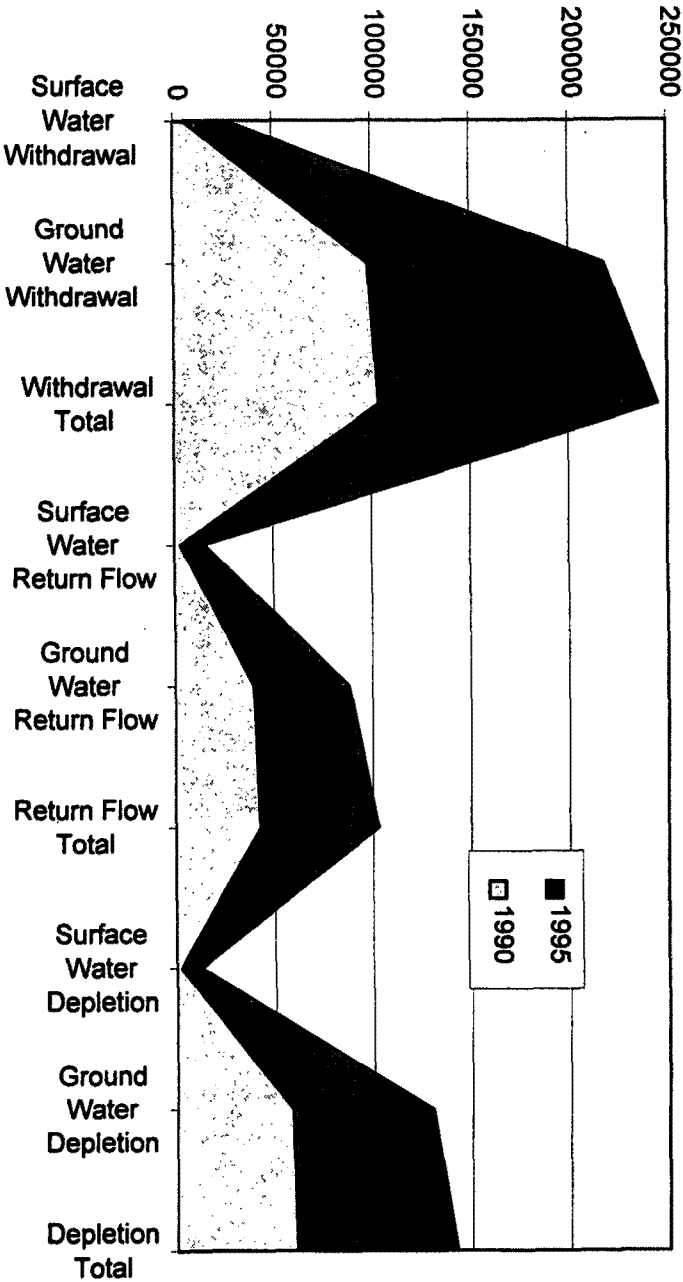


FIGURE 3: IRRIGATED AGRICULTURE WATER USE IN LUNA COUNTY, 1990 AND 1995