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International Aquifer Management: The Hueco Bolson on the Rio Grande River

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INTERNATIONAL AQUIFER MANAGEMENT: THE HUECO BOLSON ON THE RIO GRANDE RIVER

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INTRODUCTION

Current and potential groundwater appropriation problems in the Hueco Bolson are related to the local geology and the water resource, to water use events in the study area which have extended over centuries, and to international cultural and institutional differences. In addition, actions taken throughout the Rio Grande and Colorado Basins and elsewhere have contributed to the water supply problems. The aggregate influence of these factors creates a complex decision making environment and presents a challenging opportunity to explore the notion that aquifers shared by two or more nations may be managed cooperatively. Cooperative management would promote international harmony and long term stability of the present and future cultures by assuring an adequate water supply.[1]

The Hueco Bolson is an interstate and international ground water reservoir shared by New Mexico and Texas in the United States and Chihuahua, Mexico. It is located in a topographic basin clearly delimited by isolated fault block mountains in both countries except on its northern edge. The Rio Grande has incised a broad southeasterly trending valley across the basin, from six to eight-miles wide and 200 to 250-feet deep for a distance of roughly 90 miles (Fig. 1). Stream flow enters and leaves through mountain gorges at either end of the valley, and river altitude varies from 3,700 to 3,450 feet above sea level in the upstream and downstream extremities of the study area. Locally the Rio Grande flood plain is called the El Paso-Juarez Valley. The climate is arid with mild winters and hot summers; agriculture is completely dependent on irrigation.[2]

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1. The International Law Association recommends an integrated approach to river basin management by co-riparian states which embraces surface and subsurface water in an interrelated system, *see* THE INTERNATIONAL LAW ASSOCIATION, REPORT OF THE FORTY-EIGHTH CONFERENCE, NEW YORK 1958, at ix (1959).

2. J. Gates & W. Stanley, Hydrologic Interpretation of Geophysical Data from the Southeastern Hueco Bolson, El Paso and Hudspeth Counties, Texas 4, U.S. Geological Survey, Open File Report 76-650 (1976).

Discussion of the Hueco Bolson water management experience begins with a review of the bolson geology and hydrology. This is followed by a description of water management institutions and law operating in the study area. Then, irrigation and urban water management action in both countries are reviewed and the potential for international ground water conflicts is examined. The paper concludes with recommendations for future water management needs in the study area.

BOLSON GEOLOGY AND HYDROLOGY

The Hueco Bolson water-bearing materials are differentiated into two groups: the clastic-filled graben is composed of fluvial, lacustrine, alluvial fan, and aeolian materials up to 9,000-feet thick;[3] the El Paso-Juarez Valley bolson sediments are overlain by Rio Grande alluvium normally 75 to 100-feet thick, with thicknesses varying locally up to 250-feet[4] (Fig. 1).

The Hueco Bolson contains significant reserves of fresh and slightly saline groundwater. The largest amount is found in a trough-shaped body which varies to 1,000-feet thick and 7-miles wide in Texas and probably to more than 600-feet deep in Chihuahua. This water generally contains less than 500 milligrams per liter (mg/1) dissolved solids[5] (Fig. 2). Recharge to the Hueco Bolson is believed to occur along the bordering Franklin Mountains, Sierra de Juarez, and other ranges delimiting the bolson.[6] Prior to the 20th century, the Rio Grande flood plain served as the locus of bolson discharges. Ground water probably moved from the south and north towards the river. However, developing cones of depression around deep wells in both countries have progressively diverted ancient flow patterns away from the river and into such groundwater indentations[7] (Fig. 3).

3. H. Alvarez & A. Buckner, Ground-water Resources of the El Paso Valley, Texas 23-24, Texas Water Development Board Open File Report (1974); Knowles & Kennedy, *Ground-water Resources of the Hueco Bolson, Northeast of El Paso, Texas* 19-20, U.S. Geological Survey Water Supply Paper 1426 (1958); Cliett, *Ground-water Occurrence of the El Paso Area and its Related Geology,* in NEW MEXICO GEOLOGICAL SOCIETY, GUIDEBOOK OF THE BORDER REGION, 20th FIELD CONFERENCE 209 (1969).

4. M. Davis, Memorandum on Availability of Water Having Less than 2,500 Parts Per Million Dissolved Solids in Alluvium of the Rio Grande near El Paso, Texas 5, U.S. Geological Survey Open File Report (1967); A. Buckner, Results of Exploratory Drilling by the Texas Water Development Board in Vicinity of San Elizario, Texas 22, Texas Water Development Board Open File Report (1974); personal communication with E. Leggat (Aug. 1977).

5. W. Meyer, Digital Model for Simulating Effects of Ground-Water Pumping in the Hueco Bolson, El Paso Area Texas, New Mexico, and Mexico, 12 U.S. Geological Survey Water-Resources Investigations 58-75 (1976).

6. *Id.* at 15.

7. W. Meyer & J. Gordon, Development of Ground Water in the El Paso District, Texas, 1963-70, at Fig. 4, Texas Water Development Board Report 153 (1972).

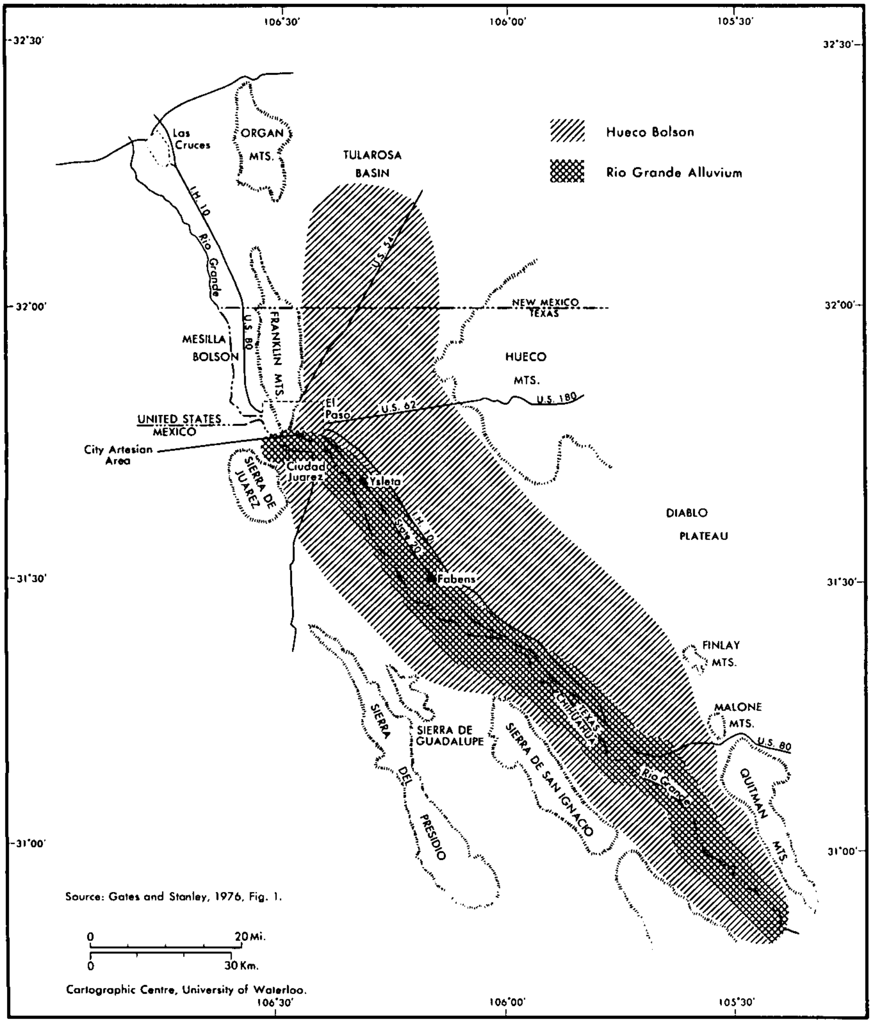

FIGURE 1

Hueco Bolson

Rio Grande alluvium ground water in the El Paso-Juarez Valley occurs at shallow depths and most irrigation wells tap these deposits.[8] It is predominantly slightly saline in El Paso County and moderately saline in Hudspeth County.[9] The generally poor quality of Rio Grande alluvium water probably results from long periods of salt concentra-

8. *Supra* note 2, at 18.
9. H. Alvarez & A. Buckner, *supra* note 3, at Figs. 10 & 11.

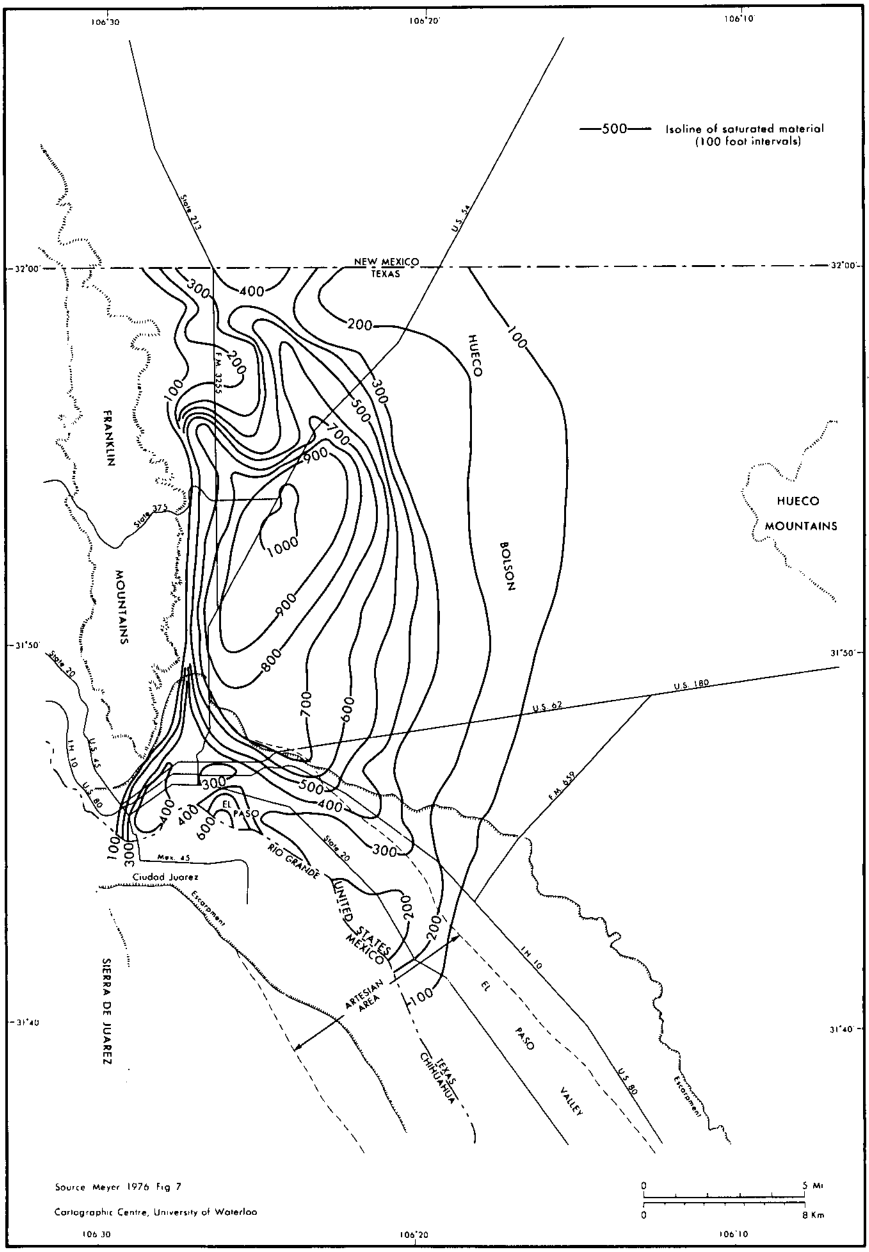

FIGURE 2

Approximate Thickness of Hueco Bolson
Saturated Fresh Water Deposits, 1973

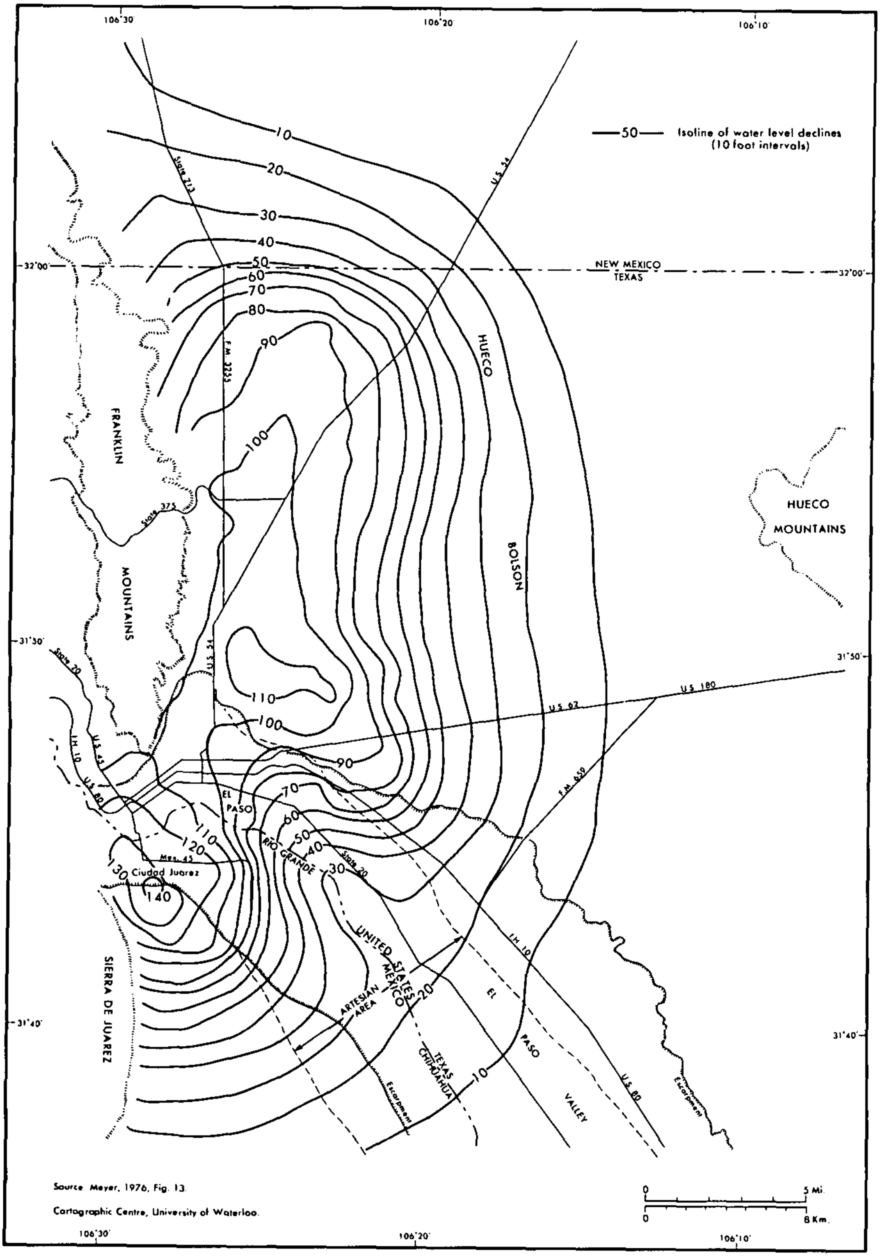

FIGURE 3

Predicted Decline in Hueco Bolson Water Levels: 1903-1991 tion by evapotranspiration when the river was the locus of Hueco Bolson discharges as well as downward percolation of irrigation water.[10] Southeast of Ysleta, bolson water deposits beneath the valley alluvium generally contain more than 5,000 mg/1 dissolved solids.[11] An exception to this generalization occurs southwest of Fabens where a zone in the Bolson aquifer is confined by thick clays. This localized zone is under artesian pressure which causes slightly saline water, ranging from 958 to 1,540 mg/1 dissolved solids, to flow on the land surface when penetrated by Mexican and Texan wells.[12] Mexican mountains to the south supply the water to this localized zone.

When Rio Grande discharge is low and little water is available for irrigation, large amounts of ground water are pumped from shallow wells in the Rio Grande alluvium for supplemental irrigation. However, prolonged use of this water for more than 5 years would severely impair soil productivity due to salt accumulation.[13] Rio Grande alluvium water levels recover in years of adequate surface flow except where the lining of 4.35 miles of the Rio Grande channel within El Paso-Juarez, which was done in 1968, prevents recharge.[14] Indeed, slightly saline water in the alluvium is now moving down and into the underlying fresh water bolson deposits in this area due to depletion of underlying bolson fresh water.[15]

In 1973, fresh water reserves were estimated at 10,600,000 acre-feet in the Texas part of the Hueco Bolson,[16] with an additional 6,200,000 acre-feet in the New Mexico fresh water trough extending 12 miles north of the state line[17] and possibly 4,000,000 acre-feet in Mexico.[18] The total thickness of bolson deposits saturated with fresh water varies from less than 100 feet to more than 1,000 feet in Texas and to probably more than 600 feet in Chihuahua (Fig. 2). Between 1903 and 1976, water levels fell as much as 73 feet in the center of El Paso and 85 feet in Ciudad Juarez. Based on a digital model study, Meyer predicts extensive Hueco Bolson drawdown by 1991 concentrated in the center of Juarez and northeast El Paso[19] (Fig. 3). Annual recharge to bolson aquifers may be as little as 5 percent of the annual withdrawal. Assuming the entire fresh water resource can be removed,

10. *Supra* note 2, at 18.
11. H. Alvarez & A. Buckner, *supra* note 3, at Fig. 14.
12. *Supra* note 2, at 17.
13. Interview with A. Buckner, Texas Water Development Board (April 1977).
14. *Supra* note 7, at 1 & 13.
15. *Supra* note 2, at 19.
16. *Supra* note 5, at 28.
17. D. Knowles & R. Kennedy, Ground-Water Resources of the Hueco Bolson, Northeast of El Paso, Texas 46, Texas Board of Water Engineers Bull. 5615 (1956).
18. *Supra* note 5, at 14.
19. *Id.* at Fig. 13.

the bolson reserve is being depleted at 1 percent annually given current pumping rates (1972-74).[20] And the rate of water use continues to grow rapidly in each country.

Pumping strategies which promote depletion of existing groundwater reserves could trigger a number of problems. Most importantly, drawdown could contaminate existing fresh water stocks. For example, in the City Artesian Area, fresh water is overlain by slightly saline water in the Rio Grande alluvium; pumping will cause alluvium water to infiltrate the fresh water below at an unknown rate. Depletion of bolson fresh water elsewhere could induce upward and lateral migration of poorer quality water into the fresh water trough. In addition, if water levels decline several hundred feet, especially in the City Artesian Area where significant thicknesses of compressible clays exist, land subsidence could be experienced in intensively developed urban areas.

There are possible adjustments available to extend the Hueco Bolson fresh water reserves. The more attractive of these include: blending slightly saline bolson ground water with fresh water to increase reserves; developing more distant water sources and piping water to El Paso-Juarez; treating sewage for reuse in El Paso; promoting water conservation and encouraging pricing strategies to decrease water use; and changing water uses from irrigation to less intensive needs.[21] Desalinization is an additional but extremely expensive and probably unrealistic alternative for many years given rapidly increasing energy costs. Finally, institutional arrangements could be explored to ensure that groundwater appropriation strategies in each nation are complementary to avoid conflicting developments and promote water conservation.

Urban, manufacturing, smelting, military, and agricultural developments within the El Paso-Juarez Valley create a large and rapidly growing water demand. The combined population of the El Paso-Ciudad Juarez conurbation and valley settlements (Fig.1) is approaching one million and rapid growth continues, especially in Mexico.[22] Indigenous Rio Grande groundwater supplies are already overdeveloped and serious doubts exist that there is sufficient water to support expected growth in total water demand.[23]

20. J. Gates, Quality and Availability of Water in Westernmost Texas 7, U.S. Geological Survey Open File Report (1975).

21. Gates mentions several of these alternatives, *id.* at 7 & 8.

22. J. Zwerneman, *Economic Development in the El-Paso-Juarez Area and Its Impact on Water Supply*, ——— at ; EL PASO CHAMBER OF COMMERCE RESEARCH DEPARTMENT, EL PASO PROFILE (1977).

23. U.S. Bureau of Reclamation, Status Report: Rio Grande Regional Environmental Project 1.

WATER MANAGEMENT INSTITUTIONS AND LAWS

A knowledge of the basic divergences between the legal systems adopted in both nations is important in understanding international study area differences in water development policies. In the United States, federal, state, and local governments are vested with the obligation to manage surface water. However, in spite of the fact that federal agencies are deeply involved in all aspects of water control and use,[24] each state is responsible for establishing water laws to govern surface and ground water resources within its territory.[25]

Groundwater law varies widely among states. Under the Texas system, ground water has traditionally been regarded as a resource belonging to individual property owners who are entitled to unlimited pumping without the threat of judicial redress should such action deplete reserves, or impair the water quality of neighboring wells.[26] Although recent Texas Water Code revisions authorize the creation of underground water conservation or subsidence districts to prevent unlimited groundwater use in designated areas,[27] the Texas part of the Hueco Bolson has not adopted this innovation.

In Texas, cities are responsible for providing municipal water service within their incorporated area. In El Paso, a Public Service Board was establsihed to supply the city's water needs. The Bureau of Reclamation contracted with landowners in the Rio Grande Project to supply water and related services to enable irrigation. The Board and Bureau are aided in discharging their functions by other Federal, state, and local agencies which include competent groundwater specialists on their staffs.

In contrast with the United States, ownership of rivers, streams, lakes, lagoons, and waters of international streams to which Mexico has a lawful right was assigned to the nation by the 1917 Mexican Constitution, following provisions were made to permit Agrarian Revolution.[28] Subsequently, revisions were made to permit nationali-

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24. THE PRESIDENT'S WATER RESOURCES POLICY COMMISSION, WATER RESOURCES LAW 3 (1950).

25. Interstate water allocation is usually arranged by compacts made by the states involved and approved by Congress which mutually determine minimum allowable flows, or quality, of water passing from one reach of the river to the next, Hutchins & Steel, *Basic Water Rights Doctrines and Their Implications for River Basin Development*, 22 L. & CONTEMPORARY PROB. 276, 298 (1957).

26. J. THOMPSON, PUBLIC ADMINISTRATION OF WATER RESOURCES IN TEXAS 131-32 (1960).

27. TEX. WATER CODE ANN. tit. 4, §52 (Vernon 1972, Supp. 1976); Tex. H.B. No. 552, 64th Legislature, Regular Sess. (1975), at Chapter 284.

28. Legal Problems Relating to the Utilization and Uses of International Rivers 59-60, 5 U.N. GAOR, U.N. Doc. A/5409 (1950).

zation of groundwater as well.[29] Although groundwater is normally under the control of individual landowners, the Ministry of Agricultural and Hydraulic Resources is empowered to regulate extraction and use and establish prohibited development zones when further development affects public interests or existing groundwater users.[30]

Contrary to the United States' policy which has proliferated federal, state, and municipal agencies charged with water management, control of all water uses, except hydroelectricity, is delegated to the Mexican Ministry of Agricultural and Hydraulic Resources (SARH). The Ministry is empowered to plan and control the appropriation and use of all surface and subsurface water in the nation. Mexican water resources were allocated among urban and rural users by this agency beginning in 1947; since 1926, the SARH and its predecessor have controlled Mexican irrigation water use.[31]

IRRIGATION WATER SUPPLY

Colorado, New Mexico, and Texas agreed to apportion the waters of the Rio Grande above Fort Quitman by adopting the Rio Grande Compact in 1938, under the duress of antagonistic relationships among the three states. For it was clear that sufficient discharge was not obtainable from the Rio Grande to supply irrigation water to areas serviced by existing canal systems[32] as well as to satisfy the 1906 United States' obligation to deliver 60,000 acre-feet of water to Mexico.[33] For most of the first 35 years of the Rio Grande Compact operation both Colorado and New Mexico delivered insufficient water to satisfy the Compact requirements, although New Mexico liquidated her debit by 1972[34] and Colorado is in the process of reducing her debit. As a consequence, less than the anticipated water releases were available from Compact storage for the Rio Grande Project. Surface water deliveries made to satisfy the United States' obligation to Mexico under the 1906 Water Convention fell short of the target level in 20 of the 35 years, 1940-74 (Fig. 4). Indeed, in the driest year, 1964, only 6,650 acre-feet rather than 60,000 were received by Mexican irrigators, and a corresponding deficiency was experienced in Texas.

29. Ramirez, *Aspectos Legales del Agua Subterranea en Mexico,* 21 INGENIERIA HIDRAULICA EN MEXICO 197 (1974).

30. MEXICO, DIARIO OFICIAL, Tomo CCXIX, Num. 50, at Articulos 2 y 3 (1956).

31. *See generally* Anaya, *Mexico and its Water Resources Policy,* in INTERNATIONAL CONFERENCE ON WATER FOR PEACE IV, at 687, Dep't of State Paper 694 (1967).

32. Hill, *Development of the Rio Grande Compact of 1938,* 14 NAT. RES. J. 197 (1974).

33. Treaty with Mexico on Distribution of Waters of the Rio Grande for Irrigation, May 21, 1906, 34 Stat. 2953, T.S. No. 455.

34. Reynolds & Mutz, *Water Deliveries Under the Rio Grande Compact,* 14 NAT. RES. J. 205 (1974).

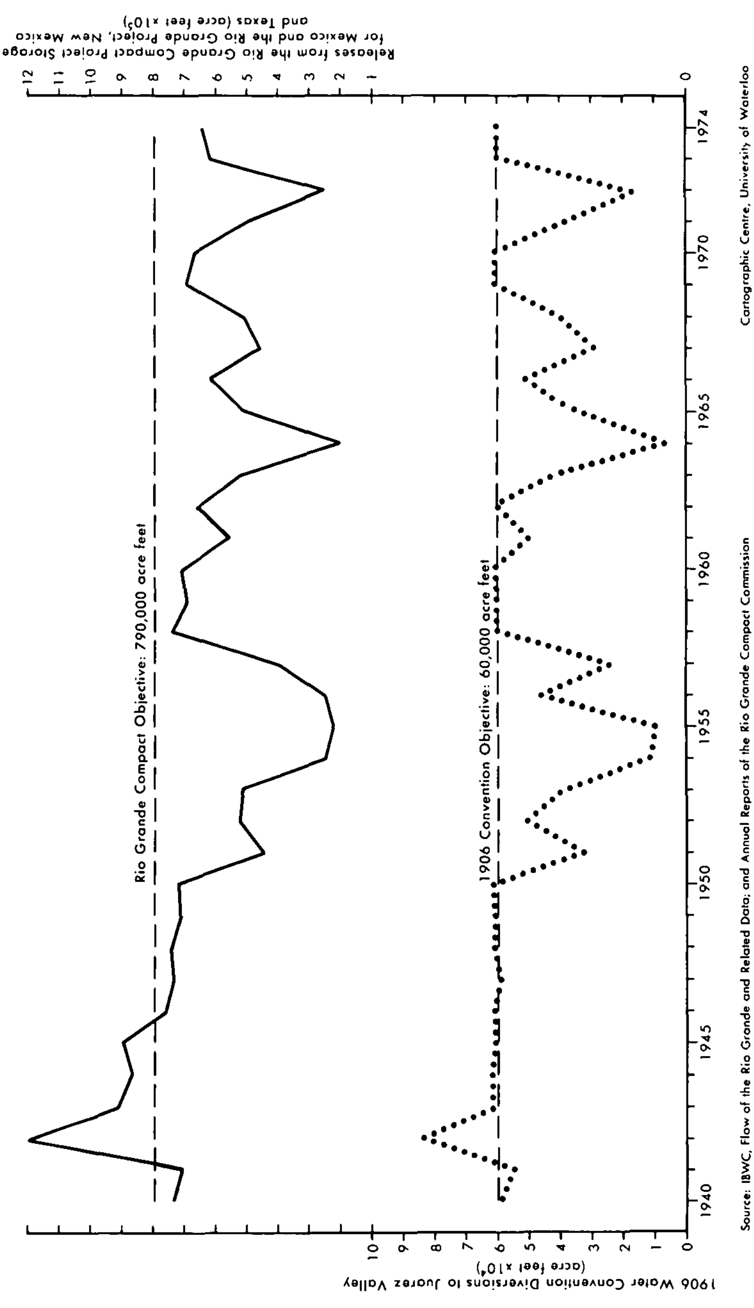

FIGURE 4
Rio Grande Discharge

In adjusting to prolonged and recurrent droughts in the El Paso-Juarez Valley both nations used a variety of complementary measures. Although farmers mainly rejected recommendations of the Bureau of Reclamation in Texas[35] and the Ministry of Agricultural and Hydraulic Resources in Chihuahua[36] to reduce water conveyance losses by rehabilitating water delivery systems in the 1950's and 1960's, considerable improvement was achieved in the following decade. Approximately 45 percent of secondary canals in Texas are being lined to reduce conveyance losses.[37] A far more ambitious program is underway in Mexico to construct a new fully lined principal canal which will be extended to service all valley irrigators; most laterals are also being lined as part of this 218 million peso rehabilitation and extension program and volume water sales initiative.[38]

The Mexican agricultural community has traditionally blended water from three principal sources to produce their irrigation supply: Rio Grande flow supplied under the 1906 Convention, sewage from Ciudad Juarez, and private and public wells. Plans have been adopted to extend the total irrigated acreage from 37,000 to 60,500 acres in the 1970's based on water conveyance savings and an ambitious ground water development program in shallow and deep aquifers.[39]

As an adjustment to the drought of the 1950's, more than 525 wells were drilled in Chihuahua, mainly in shallow Rio Grande alluvium.[40] The number of functioning wells increased to 665 by 1976, of which approximately 70 were constructed by the government. More than 50 wells tap deep bolson aquifers, although about 20 percent of these service the needs of small valley municipalities. The total number of wells will be increased by 200 in the near future as drilling is

35. Interview with Mr. Farias and Mr. Smirkey, Rio Grande Project Office, El Paso, Texas (August, 1967). *See also* U.S. Bureau of Reclamation, Plan of Rehabilitation for El Paso County Water Improvement District No. 1: Rio Grande Project (1956); U.S. Bureau of Reclamation, Reconnaissance Report on Water Conservation Plans for the Rio Grande Project (1956); J. Kirby, Water Resources, El Paso County: Past, Present, and Future 93-98 (1968) (unpublished thesis in U. Tex. El Paso library).

36. U.S. Congress, House Comm. on Foreign Affairs, Int'l Boundary & Water Commission, U.S. & Mex., Minute 129, at para. 9; La Comision Nacional de Irrigacion, Departamento de Informacion, *Avance de las Obras de la Comision Nacional de Irrigacion durante el Año de 1942*, 24 IRRIGACION EN MEXICO 14 & 16 (1943); interviews with Ing. Eduardo Mario Fores Rios, District Chief, Senor Guillerma Alvarez Coronado, and Ricardo Castenada, Distrito de Riego 9, Cuidad Juarez (Nov. 1966).

37. Interview with James W. Kirby, Project Director, Rio Grande Project, El Paso (April 1977).

38. Interview with Ing. Ricardo Castenada A., Jefe de Hidrometria y Estadistica, Distrito de Riego 9, Cuidad Juarez (April 1977).

39. *Id.*

40. Ing. Eduardo Mario Flores Rios, Mechanizacion de la Agricultura en el Distrito de Riego 9, Secretaria de Recursos Hinraulicos, Cuidad Juarez (1963).

extended to the Mesa area south of the Juarez Valley and the Rio Grande alluvium.[41]

Rio Grande Project water requirements in Texas east of El Paso are normally supplied by streamflow and supplemented by shallow wells in low streamflow years. During droughts in the 1950's, 485 wells were establsihed and this number increased to 525 in 1966.[42] A decade later, more than 800 wells have now been drilled. These are primarily used for supplementary water needs in drought years; it is believed that with prolonged well-water use, salinization would impair soil productivity.[43]

In summary, El Paso-Juarez Valley irrigators in both countries rely heavily on shallow groundwater aquifers to supply water needs. A 60-percent expansion in irrigated acreage is underway in Chihuahua based heavily on new groundwater development and an extensive well field is already established in Texas. In the aggregate, nearly 1,500 wells were installed during the past three decades for users other than urbanites in the El Paso and Ciudad Juarez conurbation. This development proceeded without international coordination or liaison concerning the configuration, operation, and total pumpage from the well systems in both countries. However, the present time, groundwater draw down experienced during droughts has always been recovered during wet years.

MUNICIPAL WATER SUPPLY

El Paso and Juarez both rely almost exclusively on deep aquifers for their water needs. Historically this decision can be traced to the 1906 Water Convention which divided Rio Grande water between Mexico and the United States for irrigation purposes. This allocation pattern has been maintained by the Mexican Ministry of Agricultural and Hydraulic Resources which could have transferred some surface water to Juarez municipal uses by reducing irrigated acreage. El Paso also had an opportunity to use river water in the 1920's but instead opted for groundwater as its principal water source. Subsequently, only a small amount of surface flow has been allocated to this Texas municipality.[44]

There are marked differences in municipal water use across the Rio

41. Castenada, *supra* note 36.
42. U.S. BUREAU OF RECLAMATION, IRRIGATION WELL SURVEY: RIO GRANDE PROJECT (1961); interview with Daniel Farias, Hydrologist, Rio Grande Project (Aug. 1967).
43. Interview with A. W. Buckner, Geologist, Tex. Water Dev. Board, El Paso, Tex. (April 1977).
44. Day, *Urban Water Management of an International River: The Case of El Paso-Juarez*, 15 NAT. RES. J. 460 (1975).

Grande. Per capita demand in El Paso is approximately three times that in Juarez. Since 1971, however, the El Paso water utility has promoted desert landscaping in an effort to decrease water use.[45] The El Paso pricing structure currently promotes water use by decreasing the cost of water per gallon as more water is used, while the Juarez rate structure increases slightly with increasing water consumption.[46]

International institutional differences have produced a striking dissimilarity in the well patterns constructed to supply the cities. Faced with Texas laws which give landowners the right to appropriate unlimited amounts of groundwater, El Paso has been forced to purchase land far beyond its municipal boundaries to the north and southeast, in an effort to ensure an adequate future water supply. Conversely, all Juarez wells are concentrated in a small area within its urbanized territory as the Mexican Federal government can protect more distant potential water reserves for municipal use within or beyond the Hueco Bolson. This largely reflects deficiencies in storage and distribution facilities in Juarez which necessitate a system of neighborhood wells to supply small numbers of users.[47]

Municipal wells beneath Juarez and wells in the El Paso City Artesian Field have begun to influence each other, although a serious problem has not yet developed. Cones of depression beneath each city are coalescing to induce drawdown in wells across the international border.[48] The location and operation of existing wells contiguous to the international boundary is not coordinated by the two cities.

INTERNATIONAL AQUIFER MANAGEMENT INITIATIVES

Both countries took a number of actions in the 1970's in an effort to better understand the nature of the shared Hueco Bolson water resource and international implications of water appropriation in Texas, New Mexico, and Chihuahua. In the United States a major initiative coordinated by the Bureau of Reclamation is underway to provide knowledge needed for future planning of land and water use in light of local environmental and social circumstances and aspirations of the population. This effort involves relevant municipal, regional, state, and federal agencies concerned with land and water management. An important component of this work has been accelerated water resources investigations in the southeastern part of

45. Jones, *Will the Well Run Dry for Future El Paso Residents?*, El Paso Times, June 7, 1976, at 11a.

46. *Supra* note 44, at 465.

47. *Id.* at 465-67.

48. E. Leggat & M. Davis, Analog Model Study of the Hueco Bolson near El Paso 8, Texas, Tex. Water Dev. Board Rep. 28 (1966).

the Hueco Bolson, the Rio Grande alluvium, and contiguous aquifers by the Texas Water Development Board and the United States Geological Survey.[49]

A complementary study initially proposed by the Texas Water Development Board involves an international data exchange concerning groundwater conditions and use in the Hueco Bolson and Rio Grande alluvium. It has been coordinated by the International Boundary and Water Commission (IBWC) and heavily supported by the Texas Board. In 1973, the Commission was authorized to consider the need for a comprehensive ground water agreement on the shared border between the United States and Mexico as part of an agreement seeking to solve international salinity problems of the Colorado River.[50] Subsequent investigations by the U.S. Section IBWC revealed:

> . . . that there is a groundwater basin which straddles the international boundary in the El Paso-Juarez area and that users in the United States and in Mexico are both pumping from this common source of water. Further, at least in parts of the basin, pumping may be expected to increase. Therefore, a potential problem of one country drawing water from the other may develop, and the concern of the State Department and this Section is to prevent such a problem from developing to the detriment of the United States users.[51]

Naturally, the Mexican Section was similarly motivated to cooperate in the cooperative study in an effort to prevent an international groundwater conflict.

In Texas, the response to the IBWC data exchange program was indignation; many believed that the IBWC had already decided a treaty is necessary. Speaking on behalf of Rio Grande irrigators who would potentially be affected by such an agreement, Texas Commissioner Gilmer of the Rio Grande Compact Commission objected to IBWC involvement in the El Paso-Juarez Valley groundwater on several grounds: that the U.S. State Department does not have Congressional authorization to enter into negotiation of a potential groundwater treaty; that investigations which could lead to such a treaty by the U.S. Section are illegal; that the U.S. Section had been secretive in not revealing between 1973 and 1976 that investigations

49. *Supra* note 23.

50. International Boundary and Water Commission, United States and Mexico, *Permanent and Definitive Solution to the International Problem of the Salinity of the Colorado River*, TIAS No. 7708, 68 AJIL 376 (1974), 12 ILM 1105 (1973).

51. Letter from Comm. J. F. Friedkin, U.S. Section, Int'l Boundary & Water Comm'n, United States and Mexico to Jesse B. Gilmer, Tex. Commissioner, Rio Grande Compact Comm'n, El Paso, Tex (Dec. 22, 1976) at 1.

and a possible groundwater treaty would be considered for the El Paso-Juarez area; that both rural and urban Texans would probably be negatively affected by such an agreement; that U.S. citizens who would be affected had not been adequately consulted; and many others.[52] The City of El Paso basically agreed with the tenor of Gilmer's message that the U.S. Section, IBWC, should not recommend a groundwater treaty without first receiving a request to consider the topic and consent to any potential agreement by all affected citizens.[53]

In responding to Gilmer, Commissioner Friedkin of the U.S. Section, IBWC stated that the responsibility of his office was to take a comprehensive view of potential groundwater management problems:

> . . . this office is responsible to the authorities and water users of all four border States in international water matters along the boundary with Mexico (Texas, New Mexico, Arizona, and California). Therefore, this office must consult with and have the advice of all four border States. But first, the technical studies need to progress further to more fully enable definition of potential future groundwater problems. Then, and if, there are real problems, I will be consulting with the interests in each of the States to determine what, if any proposal should be made to protect groundwaters on the United States side of the boundary.[54]

Thus, while progress has clearly been made to enhance the level of understanding of the international implications of the Hueco Bolson ground water developments, Texans have not been enthusiastic about the data exchange program to date.

CONCLUSIONS

The existing Hueco Bolson water management system is unsound ecologically, socially, and economically. In spite of the fact that Rio Grande flow and contiguous groundwater aquifers are over-committed, rapid urban growth continues in both countries. Although the imbalance in expanding water use and long term availability does not pose an immediate problem, over the long term water supplies for the international community, which is presently heavily dependent on the Hueco Bolson, will probably become more distant, more

52. Letter from Jesse B. Gilmer, Tex. Commissioner, Rio Grande Compact Comm'n, to Comm. J. F. Friedkin, U.S. Section, Int'l Boundary and Water Comm'n, United States and Mexico, El Paso, Tex. (Nov. 16, 1976).

53. Interview with T. E. Cliett, Geologist, El Paso Pub. Service Board, El Paso, Tex. (April 1977).

54. *Supra* note 51, at 12.

expensive, more scarce, and possibly of lower quality. Scientific evidence at hand does not permit an accurate estimate of the probable cost of alternative urban water sources.

The number of wells for both irrigation and municipal water supplies is increasing rapidly without international coordination of well spacing and rates of water use. This increase has induced limited international drawdown in deep Hueco Bolson aquifers within the contiguous urban areas. Similar international drawdown interference could potentially be experienced in the Rio Grande alluvium in the future.

International cooperation in two directions would be useful to avoid potential international groundwater conflicts. The first would continue to encourage international understanding of jointly managing the shared groundwater resource. This would permit national technical experts to exchange all relevant surface and groundwater data. Compliation and evaluation of such information would permit a first approximation toward an understanding of the shared aquifers and the definition of questions which need to be answered before realistic international management options can be defined. Substantial progress has already been achieved under the auspices of the International Boundary and Water Commission data exchange program and this work should continue. But the effort should be accelerated and detailed technical studies initiated. These should attempt to estimate the total water resources which will be available to the study area, and projected population and per capita water consumption growth data in each country to define the future demand for, and supplies of, water in the Hueco Bolson.

The second and sequel initiative concerns long term benefits of jointly managing shared aquifers. It would explore management alternatives open to each nation to limit water appropriation to the practical sustained yeild of the shared El Paso-Juarez Valley alluvium, the Hueco Bolson, the Rio Grande, and all other sources. This is the amount of water which can be withdrawn that does not exceed mean annual groundwater recharge, surface flow, and imported supplies. Movement toward such a management position should be continuously updated to reflect new water supplies that become available to Hueco Bolson residents by increasing supplies or reducing water demands.[55] It would also attempt to arrange management strategies to ensure that each nation receives an equitable amount of ground

55. For example, it has been suggested that 1,500 times the reserves from existing surface water storage facilities in the Upper Rio Grande Basin are available from groundwater sources in Colorado and New Mexico. See: Robert L. Bluntzer, "Water Supply Problems in the El Paso Area, Texas." Paper presented to the American Society of Civil Engineers Irrigation and Drainage Specialty Conference, Logan, Utah, August 1975.

water by compensating for major international drawdown induced by each country in the other. Such a process would investigate the potential to mine aquifers during dry periods and to replenish them during wet years without impairing the existing fresh water resource by salinization, other contaminants, or aquifer subsidence. In this process, mutually acceptable international standards to optimize recovery of, and minimize harmful effects on, the shared groundwater resource should be established and enforced.

There should be no need for institutional proliferation to undertake this work. Both nations have competent hydrologists, engineers, and scientists to do the job. National committees need to be formed from interest groups and agencies with a groundwater management interest, right, or obligation. The International Boundary and Water Commission, United States and Mexico, with its long experience in resolving complex problems is the logical agency to coordinate such a task. Massive strides have been taken elsewhere under the auspices of the IBWC to promote international cooperation throughout the Rio Grande Basin associated with river rectification, the Chamizal boundary settlement, dam construction programs, hydroelectric generation, water conservation, flood control, and salinity management, as well as more distant actions related to the Colorado River salinity control initiatives, and many others. In comparison, the scale and complexity of Hueco Bolson groundwater management problems in the El Paso Juarez Valley are no greater.

The major obstacle to cooperation appears to be Texas laws which have traditionally viewed groundwater as private property belonging to individual landowners. Although this water doctrine was undoubtedly a useful arrangement when initially established, it does not promote scientific groundwater management today reflecting advances in the understanding of the formation, movement, and the finite nature of the resource. A team of specialists familiar with the Texas legal and insitutional circumstances should be appointed to explore the full range of politically feasible alternatives to control ground water use in the Texas part of the Hueco Bolson and Rio Grande alluvium. To do so would enhance the prospects of achieving expanded cooperation in managing the Hueco Bolson in Texas, or in both countries, if such actions seem desirable in the future.

RESUMEN

Los problemas actuales y potenciales de apropriación de las aguas subterráneas en el valle de El Paso-Ciudad Juárez, una cuenca topográfica de 90 millas, vienen de las circunstancias locales de aguas

subterráneas, diferencias en leyes internacionales y en instituciones, y también en acciones tomados por todas partes de las cuencas del Río Bravo y del Río Colorado y en otras partes. Desarrollos históricos resultaban en una dependencia casi total en aguas subterráneas para aguas municipales en El Paso-Ciudad Juárez cuando la corriente superficial fué destinado a riego. Durante las décadas de 1950 y 1960, habían períodos prolongados de escaceses de agua que causaban desarrollos rápidos de recursos de aguas subterráneas por regardores en los dos lados de la frontera. Los regardores mexicanos usaban basuras municipales también. No ha sido ninguna coordinación internacional de projectos de desarrollo de aguas subterráneas ni entre las areas urbanas y los tejanos. Por esto, los niveles de aguas subterráneas están disminuiendo.

Existe la necesidad de cooperación internacional inmediata en dos direcciones para manejar las aguas subterráneas comunes; primera, el fomento de un conocimiento internacional de acuíferos comunes; y segunda, la exploración de alternativas administrativas para limitar el bombeo al nivel práctico para asegurar que cada nación recibirá una cantidad justa del recurso común.