Resolutions to U.S.-Mexico Groundwater Disputes in the Colorado River Basin

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Abstract

Water use has been disputed for years in the Colorado River Basin, which extends from Wyoming, United States, to the Gulf of California, Mexico. Over-allocation of water has caused conflicts between the U.S. and Mexico which have led to the formation of several international treaties and agreements. However, none of the legislation has specifically addressed groundwater issues. Since the intentions behind groundwater distribution are not delineated clearly in the letter of the law, it may be interpreted in several ways. The lack of clarity has perpetuated the disputes, leaving both countries unsure of how to proceed in claiming their own rights to water usage. The U.S., being the wealthier upstream country, has been in a position of greater power in determining the distribution of rights. In search of a more equitable solution, however, both parties are discussing the general issue of water rights in the U.S.-Mexico border region, specifically in terms of the Colorado River. While the doctrine of equitable apportionment has worked in the U.S. to solve interstate water conflicts, it has not yet proved itself in the international arena, due to the lack of an ability to enforce international law. Also, groundwater in the lower Colorado River basin is already over-drafted, meaning that some parties would have to give up water they currently use. California has proposed lining the All-American canal, which would preserve more water for the state, but would also result in a net groundwater loss across the border in Mexico. In order to reach a specific solution, the U.S. and Mexico need to negotiate a new treaty to specifically address groundwater rights in the Colorado River Basin. However, before they can proceed, both countries first need to agree upon a protocol for establishing groundwater rights.

Introduction

In arid regions, disputes over water have existed throughout time, and are predicted to be one of the major sources of international conflicts in the future (Elmusa 1995). Groundwater is particularly essential to the livelihood of communities in arid regions, where underground aquifers provide storage of water which can be accessed seasonally or during drought years. The Colorado River supports more than 23 million people—21.5 million in the U.S. and 1.5 million in Baja California and Sonora, Mexico. Furthermore it is used to irrigate an agricultural zone of 250,000 ha in Mexico, representing 95% of the agricultural activities of Baja California (Valdés-Casillas *et al.* 1998).

According to theorists such as Albert Utton (1983), groundwater should be treated the same as surface water. However, the systems of groundwater flow and the groundwater problems that exist are drastically different from surface flow water. Unlike groundwater, surface water can easily be diverted, and it usually originates from precipitation (Davidson 1979). Groundwater, on the other hand, accumulates in underground aquifers for thousands of years, and only a small percentage can be recharged through precipitation. Continuous overdraft can cause the land to sink and aquifers to collapse, resulting in a loss of valuable water storage space to be drawn upon in times of drought. Furthermore, groundwater pollution can be more devastating than surface water pollution, since natural surface water cleaning mechanisms such as sediments are not available to serve the same function in the aquifers which hold millions of acre-feet of water.

Groundwater Hydrology in the Lower Colorado River Basin The Lower Colorado River Basin extends from Nevada, Utah, New Mexico, Arizona, and California, to Mexico—at which point the water exits the Delta region at the Gulf of California (see Figures 1 & 2). The total area of the Colorado River basin is 651,100 km^2, with 10,400km^2 or 1.6% of this in Mexico (International Water Law Project 2000). Groundwater is a vitally important component of the hydrological system, used to sustain the ecosystem and human actions including development and agriculture which take place in this arid region (Davidson 1979).

Groundwater is formed when water from precipitation, irrigation, or stream/river seepage is absorbed into the ground and then collects in aquifers (Wilson 1982). The formation of groundwater is a continuous process which has been taking place for thousands of years. Aquifers, which consist of porous underground soils that allow for water flow, can be stacked

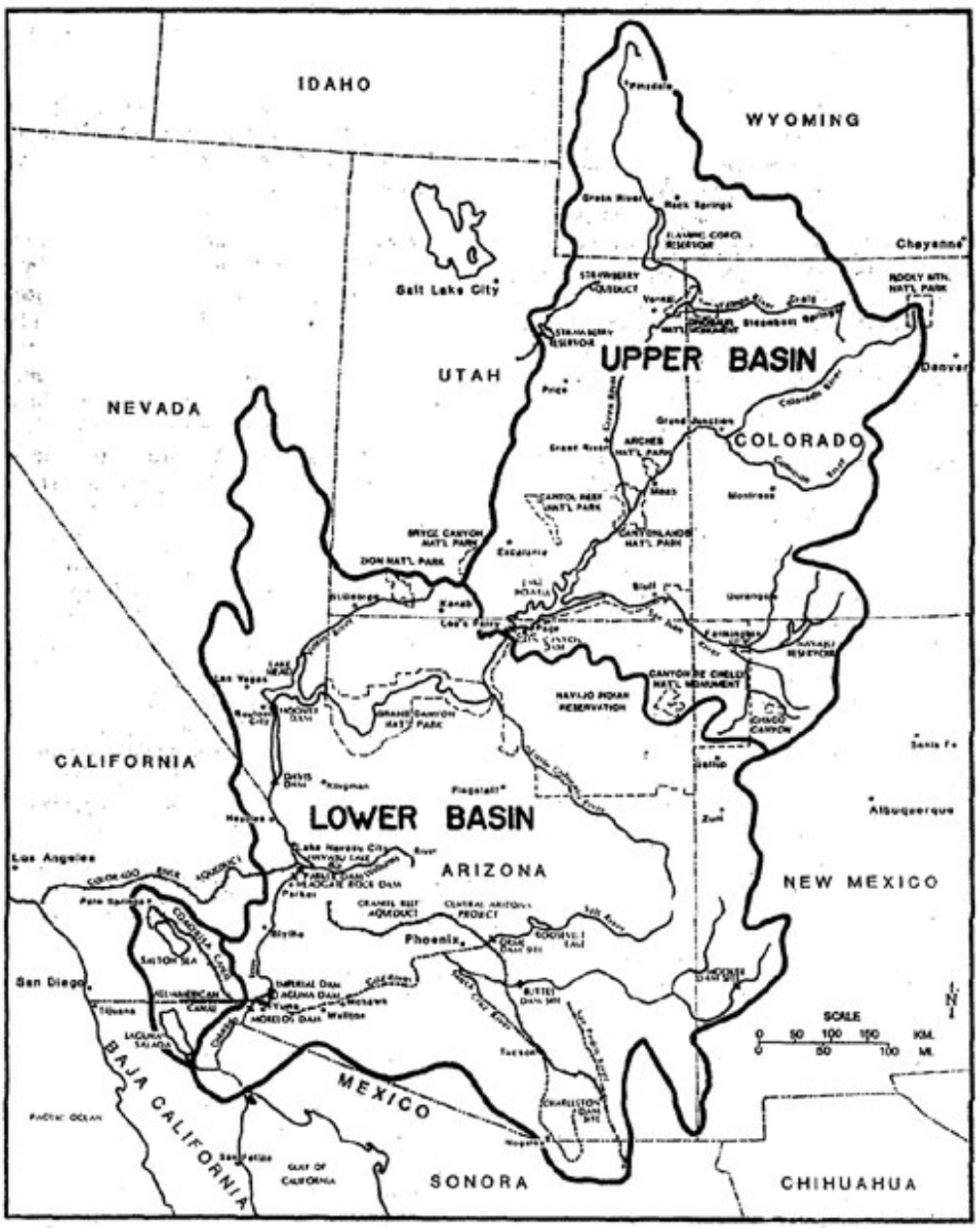

Figure 1: Map of the Colorado River Basin (Source: Morrison *et al*. 1996)

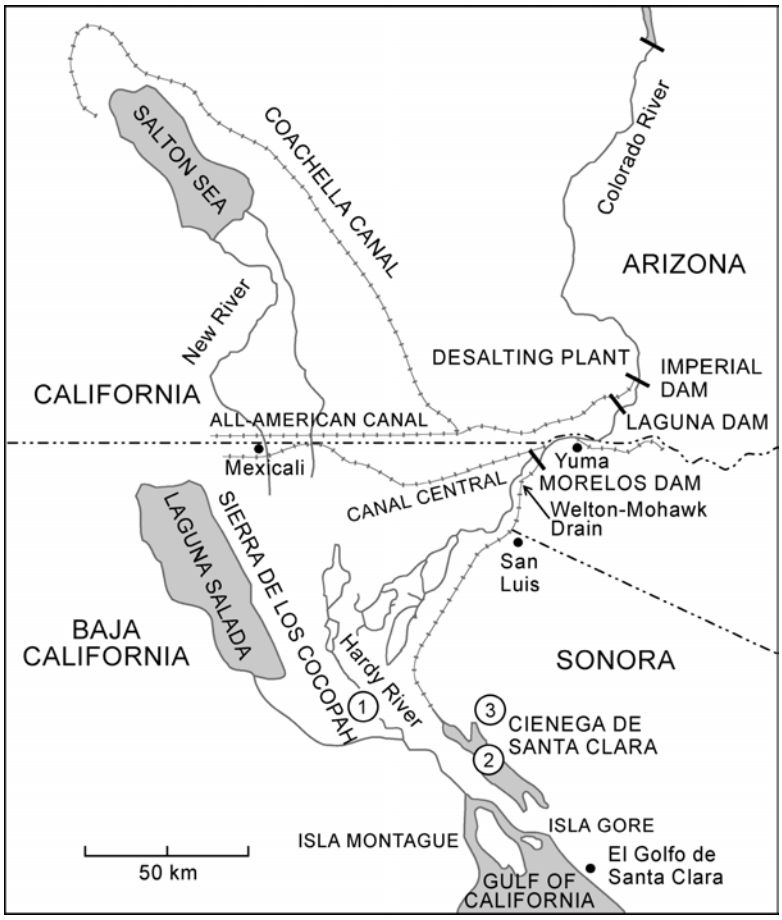

Figure 2: Map of the Lower Colorado River at the U.S.-Mexico Border
(Source: Morrison *et al*. 1996)

on top of each other horizontally, and separated by layers of more dense soil called aquitards (see Figure 3). Water can then be accessed by either pumping wells or by artesian wells, the latter of which bring water to the surface by making use of natural land slope and physical properties to force water out of the ground. Aquifers are an extremely important source of underground storage for water supplies that can be utilized in arid regions at all times, and most significantly, during drought years. A very small percentage of precipitation annually contributes to the groundwater levels—most recharged groundwater comes from contributory upstream aquifers and seepage from canals and streams. Throughout most of the Colorado River region, ground water is pumped from storage in excess of replacement. This causes a directly proportional increase between the pumping depth to water and to the volume of

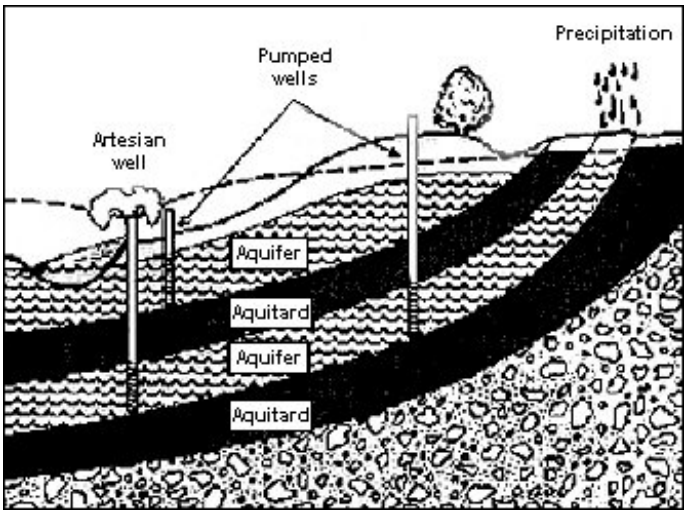

Figure 3: Groundwater Aquifer (Source: Wilson 1982)

water pumped and the physical character of the aquifer. Since aquifers tend to be more firmly cemented and less porous and permeable with depth, when water levels decline, the rate of decline commonly increases even though the pumping rate is held constant. The cost of pumping increases at a geometric rather than arithmetic rate, with the combination of water-level lowering caused by removal of water from storage and the increase in rate of lowering per unit of production (Davidson 1979). Over-drafting of groundwater can have serious consequences, because when water is depleted at a non-sustainable level, water tables can drop, causing need for deeper wells and thus more expensive equipment (McCarthy 1995). Furthermore, the aquifer can collapse, reducing valuable water storage capacity and causing flooding, and the land surface can sink or crack, costing large amounts of money to fix developments which reside on or near such land. A 1992 U.S. Geological Survey study estimated that due to aquifer compaction in California's Central Valley, over 16 million acre-feet of groundwater storage capacity has been permanently lost (Morrison *et al.* 1996). Seawater intrusion into fresh water aquifers can occur when high levels of groundwater extraction allow seawater to move inland (Governor's Commission to Review California Water Rights Law 1978). In addition, groundwater can easily be contaminated by the seepage of toxic substances contained in surface runoff and other sources of leakage which soaks into the ground or leaks through fissures (Schumann *et al.* 1987). Once a groundwater aquifer is polluted, it can be expensive and in many cases impossible to clean up, since the

aquifer is not as contained as a surface lake would be, and since the vast quantities of water stored underground have relatively small flow in and are recharged over
many thousands of years. Without the sediment filtration system in place which naturally cleans surface waters, groundwater typically remains contaminated for a longer period and thus poses a human health risk (Morrison *et al.* 1996).

Salinity is one of the more severe forms of pollution facing aquifers in the highly agricultural western portion of the U.S., including the Colorado River basin (Davidson 1979). Salt left over in farmers' fields percolates down into the ground, and creates contamination levels that harm downstream farmers' water sources, in addition to posing problems for the quality of downstream water for human consumption. While surface water salinity is monitored and controlled in the U.S., and a desalinization plant in Yuma, Arizona, was constructed to remove salt from water travelling to Mexico, groundwater does not currently face similar constraints and regulations.

Legal Background and Principles The U.S. has agreed with the international community to abide by the United Nation's judicial body, the International Court of Justice. However, as in most international political decisions, the U.S. controls its own destiny within the United Nations. From a judicial perspective, this is primarily because the international court's rulings serve in an advisory, rather than binding, capacity. Even so, there are two generally recognized principles of international law, as established by the International Court of Justice (Statute, Article 38). The first principle is "international custom, as evidence of a general practice accepted as law." This establishes that practices and customs between countries that have taken place in the past in compliance with the law should continue in the same manner. The second principle is "the general principles of law recognized by civilized nations." Treaties and other agreements, by the second principle, will be recognized as law. The U.S. and Mexico have used these principles in guiding the formation of international law dealing with the apportionment of the Colorado River.

According to Tarlock (1999), four allocation theories govern international water rules: absolute territorial sovereignty, absolute territorial integrity, limited territorial sovereignty, and community theory. The U.S. and Mexico follow the limited territorial sovereignty principle, granting the upstream party rights to use the water, while simultaneously granting the downstream party rights to have access to some of the water.

Agreement upon adoption of limited territorial sovereignty led to the signing of the Treaty of 1944 between the U.S. and Mexico (Tarlock 1999). The Colorado River flows into Mexico from California and Arizona. This treaty guarantees that the U.S. will supply Mexico with 1.5 million acre-feet of Colorado River water per year. In addition, in any surplus year, the U.S. will supply an additional 200,000 acre-feet (Getches 1997). Minute 242 of the International Boundary and Water Commission ensures that the salinity levels of the water leaving the U.S. for Mexico are kept below an agreed-upon level. In addition, the La Paz Agreement of 1983 provides protection of the environment in the border area (Beck, 1991). The International Boundary Water Commission (IBWC) was established by the 1944 Treaty as a binational commission charged with making sure that treaty obligations are met by each country. The IBWC has a branch office in the U.S., and one in Mexico; both offices interact to provide the communication and continuity necessary to fulfill their duties.

Problem and Approach Leading policy experts have agreed that there is much confusion between the U.S. and Mexico in dealing with groundwater boundaries. "International competence over aquifers divided by the [U.S.-Mexico] frontier is largely undefined; it is fair to say that the legal and institutional situation is chaotic" (Utton and Atkinson 1979). Several of the current issues at stake between the U.S. and Mexico are interrelated and affect each other's outcomes (Sax 1999, pers. comm.). Groundwater depletion is not addressed explicitly by the U.S.-Mexico treaties and agreements. Furthermore, California plans to line the All-American canal, which will result in groundwater and seepage loss to Mexican farmers who currently benefit from such "extra" water. Despite the current conflicts, the U.S. does meet its legal obligation, as specified explicitly in the treaties and agreements with Mexico (Sax 1999, pers. comm.).

Groundwater issues involve questions of both quantity and quality. According to Tarlock (1999), Professor Albert Utton, a leading international groundwater scholar, believes that groundwater issues should follow the same principles as surface water issues. However, in the case of the U.S.-Mexico groundwater disputes, many questions are left unresolved by such principles and further law-making may be needed to resolve conflicts and clarify intentions.

Is the development of new legislation and formal agreements necessary in order to resolve groundwater disputes and achieve a consensus over the distribution of Colorado

River groundwater between the U.S. and Mexico? In order to answer this question, I will be testing the following hypotheses:

H_1: The Treaty of 1944 and subsequent legislation do not provide a standard for determining distribution of transboundary Colorado River groundwater which originates in the U.S. and flows to Mexico.

H_2: New legislation and treaties between Mexico and the U.S., coupled with agreed-upon standards for transboundary groundwater quality and distribution, will create a more equitable mechanism for resolving groundwater disputes.

Methods

In order to conduct my research, I gained a background in water rights and laws, by reading relevant water law texts and speaking with law faculty about the principles involved in international water law. By reading journal and research articles, searching the World Wide Web, speaking with professors and professionals, and attending two water rights conferences (Water Rights in Oakland, California, and Water Issues in Mexicali, Baja California), I gained a background in and an understanding of Colorado River issues, specifically groundwater issues. I gathered information presented at the conferences I attended, both in the form of note-taking and speaking to key water rights stakeholders. In addition, I contacted representatives from the International Boundary and Water Commission and other agencies, as well as direct stakeholders in the groundwater struggle. In meeting such people, I asked for information about the current situation and the history of the struggle, as well as information about analyses that have already been completed relating to groundwater rights over the Colorado River. I analyzed the primary documents involved in the research and applied currently accepted international law theories to the information, in formulating a qualitative analytical answer to the research question.

According to Berring and Edinger (1999), there are general methods used in legal research. The first step is defining the research question. Next is understanding the background of the legal doctrine(s) being researched. A research plan should then be created, and the most current information should be used at all steps in research, since laws and statutes change often. Finally, after gathering all the relevant sources, the researcher should create an answer to the question using the sources.

Sax (1999, pers. comm.) encouraged information-gathering by way of attending conferences. Huneeus (1999, pers. comm.) added that in conducting legal research in an area of continued development, it is often crucial to meet stakeholders and others who have been working on the legal doctrine or legislation, look up past cases that have occurred and been ruled on after adoption of the doctrines or legislation being examined, and use references provided in secondary sources to trace back through the literature.

The materials I have used in this research are source documents, such as the U.S.-Mexico Treaty of 1944, Minute 242 to the 1944 Treaty (1961), the La Paz agreement (1983), and the North American Free Trade Agreement (NAFTA) Environmental Side Agreement (1993). Furthermore, I have gathered secondary documents such as materials on the hydrology of the Colorado River basin, international water law standards, and the conference proceedings from the Water Issues in the Colorado River Basin workshop in Mexicali, Mexico (1999).

Results

International groundwater law does not have an established precedent in the field of international law. The U.S.-Mexico Treaty of 1944 (United States 1944) fails to address groundwater concerns explicitly (Beck 1991). When the treaty was signed in 1944, little was known about groundwater and many believed that it could not be depleted. Since groundwater issues were not understood properly or of public concern in 1944 when negotiations took place (Sax 1999, pers. comm.), the Treaty of 1944 did not explicitly set limitations guiding groundwater usage between the U.S. and Mexico. No binational agreements between the U.S. and Mexico have been signed to explicitly deal with groundwater rights. Minute 242 (1973) to the 1944 Treaty does make one specific limitation to groundwater withdrawal in the San Luis boundary area of Arizona and Sonora—due to a case-specific need to control salinity and thus limit groundwater depletion. More general basin groundwater management issues, however, have been neglected in the legislation between the U.S. and Mexico.

Without groundwater regulations, the U.S. has not obliged itself to preserve or protect the Colorado River Basin groundwater upon which Mexico relies for both irrigation and human uses. As the U.S. continues to overdraw on its groundwater supply, it is predicted that the underground aquifer further south will become polluted, dry up, or even collapse, which

directly affects the condition of groundwater in Mexico (Morrison *et al.* 1996). As a participant at the Water Issues (1999) workshop stated, the degradation of the local aquifer in the Mexicali Valley has been one of the most negative impacts in the area in the last 50 years. Furthermore, too much groundwater withdrawal in the U.S. has prevented underground water from at some point surfacing above ground in rivers which feed into the Mexican delta. The groundwater in the lower Colorado Basin is already over-drafted, with 1.24 million acre-feet (maf) of groundwater annually being over-pumped in the lower basin (Morrison *et al.* 1996). The Colorado River delta ecosystem is fragile— a shortage of groundwater in the U.S. translates into less surface water reaching the delta region, and a smaller quantity of water than the amount currently reaching the delta will have negative ecological impacts, as has been witnessed in recent drought years (Water Issues 1999). Also, pollutants in U.S. groundwater will harm the Mexican farming industry and the fragile delta ecosystem, including the many species of threatened and endangered birds which use the delta for nesting and habitat purposes. The Mexico delta is "a stopover on the Pacific Flyway and a wintering ground, as well as a breeding area for passerines. In all, more than 170 species of birds use the area, including more than 6300 endangered Yuma clapper rails in the Cienaga de Santa Clara" (Huerta 1999). In addition to being a crucial habitat for waterfowl, the delta supplies the native Cocopa tribes with resources such as fisheries and farming lands to sustain their community, and offers American scientists valuable research opportunities.

Furthermore, California's proposal to line the All-American canal will have a huge economic impact on the Mexican farmers across the border who currently rely on the use of water from seepage from this canal (Castañeda 1999). The currently proposed lining could conserve as much as 106,000 acre-feet of water annually. This water would be lost to Mexican farmers, who currently make use of the supply when it infiltrates the aquifer, flows under the border, and is pumped out in the Mexicali Valley. Since groundwater pumping already exceeds recharge in the aquifer, there is no option to make up for the loss by increasing groundwater pumping capacity. Before any construction on the All-American canal begins, California legislature requires an analysis of the impact that lining the canal would have on Mexicali farming communities (McCaull 1999). Such an assessment is currently in progress. However, there is no standard for the level of impact at which the California legislature would choose to reverse its decision to line the canal. In other words,

California may complete its impact study to satisfy political and public concerns, but is not committing itself to take action at any given threshold point to diminish the negative impacts which may be revealed in the study.

At the Water Issues workshop which I attended in Mexicali in 1999, workshop participants identified increasing water demands and the lack of a hydrologic model as factors hindering effective binational water resource management. According to Laird-Benner of the US Environmental Protection Agency (Water Issues 1999), groundwater aquifers have not been described adequately due to data gaps, pollutants need to be monitored, and a scientific base needs to be created in order to better understand the need for freshwater inputs. In the absence of complete data, it becomes difficult to understand current conditions and dangers, and reach agreements about future goals. For example, "there is no data from the [Colorado River] upper gulf on metals such as selenium, suggesting a need for research" (Alvarez-Borrego 1999). Furthermore, groundwater supplies along the U.S.-Mexico border are threatened by dumping of raw sewage, agricultural runoff, and industrial and hazardous waste pollution (Southwest Center for Environmental Research and Policy 1999). In the La Paz Agreement (1983), the U.S. and Mexico agreed to prevent and control pollution in the "border area", defined as the area "situated 100 km on either side of the inland and maritime boundaries between the Parties." These efforts were to include water pollution in the border area. However, the La Paz Agreement failed to specify how such pollution would be monitored and controlled.

Discussion

The U.S., as the upstream country in the Colorado River Basin, has no monetary incentive to negotiate with Mexico and share water rights. However, according to Barrett (1994), the U.S. undertakes negotiations and discussions with Mexico to keep peace across the border, and because the U.S. does not want water rights conflicts to affect binational negotiations on other issues such as illegal immigration. Furthermore, the U.S. does not want countries upstream from it (namely, Canada) to follow its example if it was to refuse to engage in negotiation over water rights with Mexico.

Despite U.S. interests in engaging Mexico in agreements, the 1944 Treaty itself was negotiated on highly unequal grounds, with Mexico not being in a bargaining position to give

up any rights to Colorado River water by refusing to sign (Yruretagoyena 1999, pers. comm.). Thus in creating the treaty, the U.S. was the dominant negotiator. The Treaty of 1944 also failed to forecast the population growth in the Mexicali region of Mexico, and an increased population, coupled with the over-subscription of water, has led to increased water shortage problems (Bernal 1999). However, in recent years many non-governmental organizations in the U.S., in collaboration with government officials and the Cocopa Indian tribe, have put the conflict in perspective and now advocate for a more equitable approach to forming binational agreements. Even so, with the water in the Colorado River Basin being over-allocated (Morrison *et al.* 1996), ensuring that every stakeholder gets enough water is virtually impossible. As Bernal (1999) stated at the Water Issues conference, "There are different values between the countries: the U.S. is talking about golf courses while in Mexico basic needs are unmet." This comment addresses some of the basic inequities at stake in the dispute between the U.S. and Mexico—societal usage of water for want versus need.

Groundwater is the area of water rights concern least addressed in the legislation. Many theorists (most notably, Albert Utton) have determined that groundwater and surface water requirements should follow the same model, or that groundwater should be treated essentially as if it were surface water. If this were the case, however, Mexico would be entitled to no more than the 1.5 maf of water owed to it according to the 1944 Treaty (United States 1944). In order to allocate to Mexico enough groundwater to meet their basic needs, or at least a certain level of access to groundwater, a different model of groundwater requirements would have to be followed. The lack of clarification and general consensus on this issue brings about a need to clarify in the legislation the specific groundwater rights held by both the U.S. and Mexico with respect to the Colorado River, thus forming the functional specifics of groundwater management into law.

Groundwater rights disputes between countries internationally have produced different kinds of agreements. In the case of Palestine v. Israel, allocation is based upon the doctrine of equitable apportionment, which ensures the most equitable distribution of water based upon need and usage (Elmusa 1995). Similar to the U.S.-Mexico conflict, the conflict between Palestine and Israel lies partially in the fact that Israel takes a much larger share of the water and has more control over its allocation. "The need for reallocating the common water resources is predicated on: (1) the unilateral, disproportionate appropriation by Israel

of the common waters; (2) the substandard level of water consumption of the Palestinians; and (3) the wide water gap between Palestinians and Israelis" (Elmusa 1995). In much of the region, the chief source of water is groundwater. While equitable apportionment is sought, the main barrier to its effectiveness is the very nature of international law—the lack of enforcement mechanisms due to national sovereignty rights. While in the U.S. the doctrine of equitable apportionment has been used to solve interstate water conflicts (Utton 1983), on an international level, the lack of an effective international court system to serve as enforcement of the doctrine may render it unrealistic. "International water resources are different insofar as no third party has the authority to enforce an agreement among nation states, let alone to impose an agreement. Such agreements must be self-enforcing." (Barrett 1994).

The only regulation on groundwater that currently exists is specified in Minute 242 to the 1944 Treaty. According to the Minute, "each country shall limit pumping of groundwaters in its territory within five miles (eight kilometers) of the Arizona-Sonora boundary near San Luis to 160,000 acre-feet (197,358,000 cubic meters) annually" (IBWC 1961). This negotiation was done on a case basis, as was necessary for preserving the groundwater quantity and quality in the region. One approach that has been suggested to manage groundwater in the Colorado River Basin is by examining the issue case by case (Utton and Atkinson 1979). However, this may not work as a preventative measure to preserve regional groundwater quantity and quality. Furthermore, case by case decisions can be time-consuming, inequitable, and wrapped up in politics—altogether as ineffective as inaction.

Another approach suggested by researchers (Utton and Atkinson 1979) is an international joint management of the Lower Colorado River Basin region. Such an approach, however, is not agreeable to the U.S. or Mexican governments, both sides of which seek to protect their sovereignty, and who do not want to give up any powers to an international commission. In addition, an international management system would conflict with existing property rights and allocations in the region. Since the problem of groundwater management is one in retrospect (i.e. groundwater was over-appropriated before we were aware of its limitations and the consequences of overdraft), any solution that requires individual stakeholders to give up their rights will be another source of conflict. Even in California, the vast majority of groundwater is unregulated, with attempts to develop groundwater regulations being met by

fierce opposition typically from agricultural interests who fear pumping restrictions, and local water districts opposing oversight (McCarthy 1995). As groundwater law throughout most states in the U.S. has remained relatively underdeveloped, many private water rights owners have not previously faced withdrawal restrictions of any kind, and vehemently oppose regulations which would restrict the levels of water they currently extract unchecked.

Conclusion

The Colorado River aquifers are being over-drafted at an unsustainable rate, and pollutants entering the aquifers cause a further decrease in the available groundwater supply. Considering the human health, ecological, and economic implications of groundwater pollution and shortages, it is vitally important for the U.S. and Mexico to resolve their groundwater disputes.

In order to reach true consensus on the issue of groundwater rights in the Colorado River Basin, the U.S. and Mexico should formally negotiate an agreement which delineates the exact specifications for groundwater usage and rights in the region. The doctrine of equitable apportionment, if governed by the International Boundary Water Commission and approached from a regional perspective, rather than a strictly binational one, may be the best solution to efficiently and fairly distributing water rights. Such regional governance would potentially allow political power differentials to be cast aside in solving the water shortages in the area. However, barriers to success are not only the lack of enforcement of international law, but also the disputes that would arise on the U.S. side of the border between property rights owners, farmers, native Indian tribes, and the government. Since the water is over-allocated as is, to give more groundwater rights to Mexico means to take more groundwater rights away from U.S. stakeholders.

Before the exact specifications can be written, however, the U.S. and Mexico need to come to a consensus as to what is the spirit of the groundwater law. Agreements need to be reached in terms of how to prioritize the need for water, based on whether the water is to be used for subsistence purposes such as agriculture, or to provide less utilitarian goods, such as golf courses and swimming pools. In addition, the U.S. needs to figure out on a state-by-state basis what it can do to free up some of the over-allocated water supply without causing too much harm to current stakeholders. Furthermore, more scientific research needs to be

conducted in order to gather information about the hydrology of the Colorado River basin's underground aquifer system, and groundwater pollution needs to be monitored. Only after these preliminary solutions are obtained can the U.S. and Mexico move forward in negotiations to produce an equitable agreement which resolves current disputes and sustains a clean groundwater supply in the Colorado River basin.

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