A Brief History of Southwest Border Water

Humans first came to inhabit the region that is today known as the American Southwest approximately 11,000 years ago. Initially these inhabitants were hunter-gatherers, but over time these people's methods of providing for themselves changed and evolved until around 1,000 B.C. when they become a complex organized society that subsisted from agricultural production (Gran 7). Providing for themselves through agriculture required these peoples to develop methods to manipulate water in order to support their farming practices. These methods included:

> Moisture conservation systems, such as contour terraces, rock grid gardens, check dams, and gravel mulch gardens... The people also used a variety of floodwater farming techniques, constructing dams of logs, brush, mud, and rock to divert and retain water (Anschuetz, 1988). (Gran 7)

These water conservation and harvesting methods were totally dependent upon local precipitation and runoff, in other words, these people were able to subsist of the local supply of water provided by the natural hydrological cycle without significantly altering it (Rivera 1).

The above mentioned Native Americans were the Anasazi. They resided in the Southwest of the U.S. until around 1,100 AD when they abandoned their settlements for reasons that are still unclear today. After the Anasazi a number of other Native American Pueblo Indian tribes came to inhabit the area from between 1,200-1,600 A.D. They too developed their own methods for utilizing water agriculturally.

> Field studies point out that the Pueblo agriculturalists expended an enormous amount of time, energy, and resources to construct an extensive network of water-harvesting and conservation systems. Their accomplishments were intricate and innovative for their times; (a) dense coverage of low mesas by installation of gravel-mulched fields, (b) complexes of rock-bordered rectangular grids and cobble-step terraces on the high mesas, (c) the use of stone-lined ditches to channel water from one feature or depression to another, and (d) the placement of cobble alignments as check dams across washes to impound and divert water from natural drainage channels to designated planting areas along the floodplain. (Rivera 1-2)

Again, as with the Anasazi, these Pueblo Indians used methods to water their crops that were within the constraints of the local hydrological cycle.

Living within the constraints of one's local water supply as a way of life changed with the arrival of the Spanish in 1,540 A.D. (Gran 7). The Spanish were set on colonizing and distributing land grants in the area just north of modern day Ciudad Juarez, Mexico, and upstream along the Rio Grande. The Spanish colonization took place with no concern for developing in a manner that would insure the new settlements could meet their water demands with the local precipitation and runoff provided by natural hydrological cycles. The Spanish instead brought European farming methods, which involved very different techniques for meeting water demands than had been used by the previous Pueblo inhabitants (Rivera 2). The Spanish used, " irrigation by artificial diversions of water through acequias, ditches designed to transport water from a river and distribute it to the farm fields" (Gran 7). The acequias were engineered to divert large amounts of water from major rivers including the Rio Grande, the Rio Chama, and the Pecos (Rivera 2). The changes that the Spanish made in water use initially had significant impacts on the Native American's by causing a shift in the methods they used to subsist. "Native American methods of food production changed during this time, as hunting was replaced by livestock raising, and gathering declined as people began to spend more time tending irrigated fields" (Gran 7). Eventually the surrounding environment felt the effects of Spanish irrigation as the changes became larger and more invasive. "Manipulation began to cause environmental problems such as sediment buildup, waterlogging due to a rising water table, and accumulation of salts in the Rio Grande Valley" (Gran 7). These environmental effects came after 200 years of Spanish settlement that had resulted in the development of, "80 acequias irrigating over 123,000 acres" (Gran 7). As a result of these environmental problems the amount of irrigated land actually declined until 1925 at which time the amount of irrigated land reached a low of 40,000 acres (Gran 8).

These lands were eventually brought back into irrigation through the creation of, "a storage reservoir, four diversion dams, canals, ditches, and drains," along with, "channel shaping jetty jacks; the Jemez Canyon Dam (1935), Galisteo and Abiquiu Dams (1970) and Cochiti Dam (1975)" (Gran 8). Along with these changes, which were even more invasive than the acequias, there was also eventually the development of wastewater infrastructure and deep wells to meet the growing demand for water, which was caused by a growing postwar urban population in this same region (Gran 8).

This brief history of a particular sector of the Southwestern portion of the United States provides evidence of a trend in the allocation of water along the U.S. Mexican border. This trend is one in which, at a very basic level, water is allocated to the areas of greatest demand. Demand, as it is used in this paper, does not have the same meaning that is given to it in common English usage. Demand here is used in a manner similar to the way it is used in economics. "Demand indicates the quantity of a product that consumers are both willing and able to buy at each possible price during a given period of time, other things constant" (McEachern 46). The economic definition of demand is close to the intended meaning as it is used in this paper, but it is limited to a description of market phenomenon and it does not take into account how water is allocated through extra market means. A more accurate definition of demand, as it is used within the context of this paper, is something as follows: demand indicates the quantity of a product that consumers or both willing and able to acquire given existing constraints. Therefore restating the trend of water allocation that exists along the U.S. Mexican Border reads as follows: water is allocated to consumers with the willingness and ability to acquire it given existing constraints.

Reexamining the above history in light of the explicit statement of this trend will prove useful in understanding current and future water allocation discussed later in this paper. The initial hunter-gatherers of the region under examination did not have the ability, and it is unknown if they had the willingness, to overcome existing constraints in allocating the locally available water in any manner other than what occurred without their intervention. As the hunter-gatherers evolved into an agricultural society (the Anasazi) they developed technologies that increased their ability to overcome existing constraints to watering their crops, which resulted in an increased demand for water. The other Pueblo Indians that followed the Anasazi also had a similar level of demand for local agricultural water use.

The Spanish's demand for agricultural water was significantly greater than the Native Americans that came before them. The Spanish had a much greater ability to overcome constraints to consume water for agricultural due to their European farming technologies, and they had a far greater willingness to overcome constraints to consume water for agricultural due to their population growth and distribution. The acequias that the Spanish brought, over a long period of time, created environmental problems that were constraining to agricultural production and the result was a drop in agricultural water demand. Eventually these new constraints were overcome with new technologies, dams and other more invasive water diversion and storage methods, that once again increased the local peoples' ability to consume water for agricultural purposes, and therefore increased agricultural demand for water. Finally, growing urban development resulted in an increased willingness to provide water for municipal use, through the enabling technologies of deep wells. Again, advancement in technology created an increased demand for water by overcoming constraints to water consumption, but in this last instance the demand was for municipal rather than agricultural use.

Global Demand for Water

Currently the demand for water all over the world is such that:

> Agriculture claims the lion's share of all the water taken from rivers, lakes, and aquifers, accounting for an estimated 65 percent of global water use**…** Industries make the second largest claim on the world's water bodies, accounting for a fourth of global water use…Water deliveries to households, schools, businesses, and other municipal activities account for less than a tenth of global water use today. (Postel 20)

This global pattern of demand is one that has been shifting over the years, just as demand has been shifting in the previous historical example. One aspect of this shift is that the global demand for water has grown significantly. "Over the course of this century, as the number of people to feed swelled from 1.6 billion to more than 5.4 billion, agriculture's water use increased fivefold" (Postel 20). This increase in demand has been a result of both an increase in ability, through technology, and willingness, through population growth, of the global base of consumers to overcome existing constraints to allocate water towards agriculture. Growing demand for water, however, is not totally a result of growth in population and advancement in agriculture watering technologies that are employed to meet the needs of a growing population. Growing water use is also in part due to increasing industrial and municipal water consumption, which are a result of growing industrialization and urbanization.

Another important aspect of the global trend of water use is the fact that demand for water is growing at a faster rate in non-agricultural uses than it is in agricultural use. One of the starkest examples of this is China.

> Of China's 617 cities, 300 are facing water shortages. In many, these shortfalls can be filled only by diverting water from agriculture. In the

> spring of 1994, farmers in the region surrounding Beijing were denied access to reservoirs, their traditional source of irrigation water, because all the water was needed to satisfy the city's fast growing needs. (Brown)

Along with China's water being allocated to municipal use over agricultural use, water is also going to industry over agriculture as well.

> The Farmers cannot compete economically with industry for water in China…The arithmetic is stark. A thousand tons of water produces one ton of wheat, which has a market value of $200, while a thousand tons of water used in industry yields an estimated $14,000 of output, or 70 times as much. (Brown)

Coming back to the Americas, one can see the same thing occurring in Mexico that is happening in China. "Agriculture accounts for roughly 5 percent of Mexico's gross domestic product (GDP). The share of GDP generated by agriculture declined in the last 30 years as the industrial and service sectors grew" (Mexico).

This shift in water use away from agriculture toward industry and municipal use, which is extremely pronounced in the example of China, is a result of the ability of municipalities and industries to over come existing constraints to consume water at a faster rate than agriculturalists. The reason for industries growth over agriculture is pretty clear when looking at China, for example. It is significantly more profitable, 70 times to be exact, to use water for industry than for agriculture. With such a situation existing a much greater number of resources can be applied to overcome existing constraints to water consumption by industry then can be applied by the agricultural sector. This extreme disparity in the profitability of water use is not exactly the same all over the world, but it is generally similar.

Understanding why there is a higher demand for municipal water than agricultural water is not a simple matter of comparing rates of profit as in the case of industry versus agriculture. In order to understand what is occurring with municipal water one must have a better understanding of the process by which all resources are allocated. Water provides an example of how one particular resource is allocated according to demand, but water is not the only resource that is allocated in this manner. Looking back at our historical example of the Native Americans and the Spanish we can see that labor was also allocated in the same manner as water. "Native American methods of food production changed during this time, as hunting was replaced by livestock raising, and gathering declined as people began to spend more time tending irrigated fields" (Gran 7). As with water, labor was allocated towards the Spanish method of agricultural production. The fact that labor is allocated according to demand is still true today, which can be seen in the example of Mexican industry.

> Today, Mexico has embarked on a course of economic openness, and unless that whole effort is reversed, the process will require the absorption or reallocation of the labor that is being displaced from agriculture toward the production of other goods and services…. (Rodriguez-Sanchez)

What may not be abundantly clear at first from these two examples of labor allocation, but which is extremely important to realize, is that the urbanization process, which leads to increased municipal water use, is part of the industrialization process.

Industry exerts a high level of demand on many different resources because of its extreme profitability. Water and labor are two of these resources. In order for industry to utilize labor there must be a pool of laborers for industry to draw from. When there is not already a sufficient pool of labor to meet the needs of industry this becomes a constraint to industrial consumption of labor. This constraint is overcome by urban population growth and development, which results in a larger pool of labor for industrial use. The willingness of individuals to facilitate urban population growth and development is largely created by the perceived benefits of increased economic welfare that will result from such development.

The carrots of profit for the capitalists and higher wages for the laborers create strong incentives for these two groups to work together, thought not necessarily explicitly or intentionally, to develop the ability to overcome constraints to industrial consumption of labor, water, or any other resource that is essential to industrial development. Given this situation laborers and capitalists both have a vested interest in insuring that municipal water needs are at least partially met, for if these needs are met then they indirectly result in a stable urban labor force which can be employed in industrial production. As a result there is generally a far greater ability for municipalities to overcome constraints to water consumption, due to the connection to industrial production, than there is for farmers. As a result there is a higher demand for municipal water consumption than agricultural water consumption.

Now, just because municipal water use is growing faster than agricultural water use as part of the industrialization process does not mean that people living in urban areas are always having their water needs totally met. There are many ways and varying degrees to which the process of water allocation manifests itself. To some extent there is competition between municipal and industrial water use as well. The demand for industrial water use is greater than municipal demand when industry has more ability (money, political influence or both) and willingness (high profit potential) to overcome existing constraints on water consumption. The municipal demand for water use is greater than industrial demand when municipalities have more ability (money, political influence or both) and willingness (high marginal utility) to overcome existing constraints on water consumption. The variations in the willingness and ability of industry and municipalities to overcome existing constraints on water consumption ultimately determine exactly how water is allocated.

U.S. Mexico Border Water Use in Relation to Global Water Demand

Now that the fact that water is allocated according to demand has been elucidated, let us examine the specific situation of today's water allocation along the U.S. Mexican Border around the same region as our historical example, El Paso-Ciudad Juarez. The economy of this region has been significantly impacted by the Maquiladora program which was created by the U.S. and Mexico in an attempt to stem the flow of illegal immigrants coming into the U.S. from Mexico after the Bracero Program was ended in 1963. The Maquiladora program was set up to lay, "the ground work for the establishment of American industrial assembly plants in Mexico," specifically along the border with the United States, with the stated hope that they would provide employment for Mexicans who previously worked in the Bracero Program (Miller 192). As a result of the growth of Maquila plants along the border there has been a huge increase in urban population growth along the same corridor.

> Although steady during the 1960s, the valley's population exploded, doubling to more than 580,000 residents during the 1970s. By the 1990s, the population of the four valley counties would top 700,000, with many additional uncounted semipermanent residents, tourists, and illegal immigrants. (Miller 192)

This joint growth of cities and industry along the border, a pattern of development that we already examined when looking at the results of industrial demand for labor, created a huge demand for water along the border. In order to meet the water demands of industry and cities water has once again been taken away from agriculture.

> The El Paso_ Ciudad Juarez area depends on the Hueco Bolson aquifer, but this source is declining in quantity and quality and it is estimated that its potable water will be exhausted by 2030. The response to the growing water demand and finite underground supply has been a shift to using the Rio Grande for urban purposes. This has been reflected in declining agricultural activities and a dramatic reduction in the amount of land cultivated in the surrounding region. (Ganster 14)

It is pretty clear that along the U.S. Mexico border industries demand for resources is drawing more and more water away from agriculture, just as is happening all over the globe. This has taken place as a result of industry's direct demand for water for production and indirectly through industries demand for labor which has caused increased urban growth and therefore increased demand for municipal water.

Implications

There is a global trend that is afoot in which demand for water is growing and it is growing in such a manner that less and less water is going to produce food. Many countries have to import their food to make up for this loss in agricultural production. “Smaller countries, such as Israel and Saudi Arabia, have already experienced severe water shortages... These smaller countries typically divert irrigation water to cities and industry as needed, importing grain to offset irrigation losses” (Brown). Mexico is included in the list of countries that will have to import food in order to deal with reductions in agricultural production due to industrial and municipal demand for water. “According to USDA's baseline projections, Mexico will import larger amounts of grains, oilseed products, and meats over the next decade. Scarce water, arable land, and low use of modern technology will restrict Mexico's productive capacity” (Mexico: Basic Information). The more a Mexico moves to importing food instead of producing it, the more the country becomes subject to international prices of food and fluctuations in currency values. This international market exposure may eventually make it more profitable for Mexico to start reallocating water towards agricultural production since farmers will be able to acquire a higher price for agricultural products as imported food become more expensive for Mexican consumers, but this is not sure to happen soon enough for many of the poor people in Mexico, many of which reside along the U.S. Mexican border.

Moving Towards Sustainable Water Use

The current situation may appear bleak. Global water demand has been on the rise at a rate that is clearly not sustainable. "Global consumption of water is doubling every 20 years, more than twice the rate of human population growth" (Barlow). On top of this water is being directed towards municipal and industrial use at the expense of food production, significantly decreasing food security. The process of increasing consumption of water is a result of increasing demand that is due to an increasing ability and willingness of consumers to overcome constraints to water consumption. The process of diverting water away from agriculture is directly and indirectly a result of industry's ability and willingness to overcome constraints to water consumption, which is made possible by the extreme profitability of taking such action. When water is both being used at a faster and faster rate and being allocated in a manner that reduces food production because it is profitable to do so, the situation looks bleak indeed, especially for resident in areas like Ciudad Juarez who do not have the income necessary to insure that they will have the ability to overcome existing constraints to personal water and food consumption.

This process, however, does not have to continue as it has, and there is evidence to show that it will not. "Slowly the idea is spreading that managing demand rather than continuously striving to meet it is a surer path to water security —while saving money and protecting the environment at the same time" (Postel 147). This is a result of the fact that it is actually becoming more expensive to expand water consumption than it is to increase efficiency of water use … (Postel 23). Managing demand, instead of meeting it, must eventually be done in all three areas of water consumption, not only to make sure that global water needs are met, but also to insure that the most economically rewarding path is taken, which has clearly been a major motivator for the current path of water development. Unfortunately, however, it is difficult to insure that the necessary framework will exist in the poorer areas of the world, like Ciudad Juarez, to insure that the proper incentives are put in place to encourage industry and municipalities to increase their efficiency. Fortunately this is not the case for agriculture, for the incentives are already in place.

Farmers are being pressured through urbanization and industrialization to reduce their water consumption and they have primarily three methods to do this. They can stop farming, which will lead to a decreasingly secure food supplies and is therefore not an ideal path to be taken, farmers can stop irrigating their crops and return to dry land farming methods, or farmers can reduce their irrigation needs by increasing the efficiency of their irrigation methods. These three choices are exactly the choices that Mexican farmers along the border face today. In order to insure food security for Mexicans methods must be adopted to insure that Mexican farmers do not have to resort to retiring their land from agricultural production. One very important way to achieve more efficient water use that will increase the chances that Mexican farmers can continue producing food is to develop small-scale water projects. Some examples of such projects include micro dames, shallow wells, and low-cost pumps. These kinds of projects have been used effectively in other less industrialized areas with great effectiveness. Small-scale projects are much likely to benefit Mexican border residents because they are more cost effective and less socially and environmentally disruptive than larger water projects which have typically been used in the past to meet water needs (Postel 116). Along with small-scale water projects, which create more efficient means to irrigate fields, there are also water conservation methods that would have great benefits for Mexican farmers as well. Interestingly many of the watering conservation methods that would prove most fruitful for poor Mexican farmers are those that were used by early Native Americans examined at the beginning of this paper. These methods were adapted to the local environment and they are labor intensive instead of capital intensive. Both of these factors make them highly appropriate for the economically disadvantaged residents and farmers of the border region who have relatively large amounts of labor and small amounts of capital to direct towards water development.

Given that agricultural water use along the border *is* declining, and *will* continue to do so, it is important that Mexican farmers reduce their water consumption through the adoption of more efficient irrigation methods or dry land farming methods instead of retiring their land from food production. The advantages of taking such a path are significant because they will not only increase the food security of Mexicans, but they will always provide workers with employment opportunities by providing Mexicans with the opportunity to work in agriculture. If more Mexicans are able to provide for themselves by working as laborers on farms, or as farmers, then there will be fewer people who have to move into cities along the border to find work which will reduce the demand for border municipal water us as well. In addition industrial water demand will eventually fall as well due to the fact that there will not be as many workers available for industrial production because they will be working to produce food instead.

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The Political Economy of U.S. Mexico Border Water:

Is it Sustainable?

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