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Restoration of the Rio Grande/Rio Bravo in the Juarez Valley: An analysis

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ABSTRACT

The Rio Grande/Rio Bravo flow rate from El Paso/Ciudad Juarez to Fort Quitman/Cajoncitos has changed since the 19th century due to agriculture irrigation on both sides of the border. The river has been modified by agricultural infrastructure, as well as water quality degradation along the border due to wastewater discharges. Aquifers underlying the Rio Grande/Rio Bravo are being exhausted in the El Paso/Ciudad Juarez area as well. For these reasons, the ecosystems have been altered drastically. The vegetable and animal life that depend on the river and its riparian areas have been affected. The river water is legally tied to different users of this vital liquid, but ecosystem, as a user, is not included or considered in the water planning and management. Officially, there is no water allocation to maintain the ecosystems water needs downstream Ciudad Juarez- El Paso. The present condition of the Rio Grande/Rio Bravo is considered in the list "of the most threatened rivers" by conservation organizations, however, in México it has not been analyzed sufficiently, from an environmental and ecological point of view.

The main purpose of this work is to establish the basis for the ecological restoration of the Rio Grande/Rio Bravo in El Paso/Ciudad Juarez-Fort Quitman/Cajoncitos section. The methodology consists of the revision and analysis of the historic hydrological data and the water quality in this region to define a minimum ecological flow rate to the river, supported on hydrological studies; in addition, an inventory of flora and fauna will be made through an exhaustive bibliographical revision, interviews with officials of the Mexican government, representatives of water users of the Irrigation District 009, and people from the Juarez Valley, and field visits. In order to elaborate the scenarios of water reallocation in the region, the Rules of Water Use of International Rivers from The International

Association of Law (Rules of Helsinki) of the Conference of Berlin, 2004, is going to be taken, as well as the Project of Modernization and Technical Improvement of Irrigation Districts of the Conchos River. The economic contexts of development of both cities will be studied.

Scenarios for water reallocation in the region based on minimum flow maintenance will be formulated to permit the return or repopulation of native species while maintaining historical beneficial uses.

I. INTRODUCTION

Growing water demand of users worldwide has caused degradation of aquatic ecosystems. It results in ever more costly water supply sources. Water supply is the base for food security, people development and environmental sustainability in the planet.

Water is related to environmental equilibrium where plants and animal live. At the same time, this natural resource helps to regulate the mass and energy fluxes in nature. Up to now, water quantity and quality destined to preserve ecosystems, have not enlarged significantly in order to dilute contaminants and to maintain all the river users. Water conservation has not been a priority from the environmental and economic point of view for developing countries. Water policies have not been supported with growing agriculture alternatives. At the same time, low efficiencies in water use, mainly of the agricultural sector, avoid an increase of water volumes for flora and fauna. The research on crop productivity by unit of water and land; water management; water analysis; modern rules on international water distribution and environmental and ecology economics are important lines that have not been encouraged in our countries. In the El Paso del Norte Region (Las Cruces, El Paso and Ciudad Juarez) there is a hydrologic and ecological sub-basin whose integral planning and management should be carry out.

I.1 Antecedents

I.1.1 The Region from El Paso to Fort Quitman

The area of study is located in the Chihuahuan Desert, which is located in the Trans-Pecos region western Texas and southern of New Mexico in the United States, to the state of San Luis Potosí in Mexico. The area comprises Ciudad Juarez, Chihuahua/El Paso, Texas 31° 48' north latitude and 106° 59' western longitude to Cajoncitos/Fort Quitman (120 Km southeastern Ciudad Juarez/El Paso), 31° 00' north latitude and 105° 30' western longitude.

I.1.2 Demography

From 1940 to 1995 the population of the twin cities El Paso, Texas and Ciudad Juarez, Chihuahua, increased three and 19 times respectively, exacerbating water demand. It is calculated that the population in this area will duplicate for the year 2020 (EPA, 2003). The population in Ciudad Juarez is 1,218,817 (INEGI, 2000); both El Paso and Ciudad Juarez have a total population over 2,000,000. Population growth in the region has been the result of the accelerated boom of the maquiladora industry in Ciudad Juarez, mainly in the last 30 years; it has meant an enormous migration to that region.

I.1.3 Agricultural Sector

This sector utilizes more than 80 percent of the diversions done of the Rio Grande/Rio Bravo the zone of study (King, 2004). The Treaty of 1906 between Mexico and the U.S. provides water for the irrigation of 5,500 has (13,590 acres) approximately of the 15,000 has (37,065 acres) of the District of Irrigation 009 in the Juarez Valley. The potential irrigation lands are of 25,000 has (61,775 acres) that are not irrigated for lack of water. This district also utilizes water from the subsoil and wastewater from Ciudad Juarez. Its global efficiency is 40 percent. The main crops are the alfalfa and cotton. The District of Irrigation of The Elephant Butte Dam (EBID), supplies water to 36,681 has (90,640 acres) in New Mexico. The total irrigation surface is 53,823 has (133,000 acres); 36,681 has (90,640 acres) that remain with its water rights at present, only 30,756 ha (76,000 acres) are irrigated. Its average district efficiency is 43 percent. The farmers grow pecans, alfalfa, cotton, vegetables like onion, lettuce, squash, and chili. The El Paso County Water Improvement and Irrigation District No 1. (EPCWID) supplies water to 27,927 has (69,010 acres) in Texas. The main crops are alfalfa, cotton, vegetables and pecans. The average district efficiency of irrigation is 47 percent. The Husdpeth County Conservation and Reclamation District (HCCRD) supplies water for 7,385 has (18,250 acres). The main crops are alfalfa and the cotton. The average district efficiency of irrigation is 40 percent. The average of the total efficiency of these four districts is 43 percent, that is to say, from each 100 liters destined for the crop growth, 57 liters are lost due to evaporation, failure or misoperation, infiltration, leaks, etc. (King, 2004). One of the main consumer of surface water supply of the Rio Grande/Rio Bravo, is the El Paso County, which uses 20,234 m^3 (50,000 acre-feet) of surface water for municipal and industrial uses.

I I.1.4 Groundwater

In general, groundwater is the water source and environmental reserve less understood in the hydrological system. Groundwater and surface water interact in a complex way so they convert the riparian zones in a very sensitive environment to the changes of water quality and quantity. Little is known about how much water is available in the subsoil, how much is currently consumed, how water flows in the aquifers, etc. In Mexico, there are 459 aquifers; 130 are damaged from overexploitation. The fresh water of the Hueco Bolsón aquifer, that supports around two million people of Juarez/El Paso, is being depleted rapidity and the collapse in 20 years is foreseen (FUMEC, 1998).

I.1.5 The industrial sector

The industrial sector has played in the last 30 years a very important role for the growth and economic development for Ciudad Juarez/El Paso and the nearby populations downstream. In the Mexican side, there are located near 278 bonded assembly plants (maquiladoras) (INEM, 2004). In 1999, this economic sector had a water consumption of 9.36 Mm^3/year, that is to say a consumption average of 802 m^3/user/month (WTF, 2002).

I.1.6. Institutional sector

In the past, in Mexico water had been managed almost exclusively by the federal government, nevertheless, in recent years, the government has been oriented toward a decentralization of the federal water management. In the environmental institutional sector several agencies and organizations work in both sides of the border. They are involved in the water distribution and control for the different rural and urban users. On the mwxican side there are involved institutions such as the Comisión Internacional de Límites y Aguas-CILA (International Boundry ans Water Commission), the Comisión Nacional del Agua-CNA (The National Water Commission), The Junta Municipal de Agua y Saneamiento-JMAS (The Municipal and Sanitation Water Utilities_), the Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación- SAGARPA (the Secretary of Agriculture, Stockbreeding, Rural Development, Fishing and Food, Secretaría de Medio Ambiente y Recursos Naturales-SEMARNAT (Secretary of Environment and Natural Resources). In the U.S. there are involved institutions and organizations such as the districts of irrigation above mentioned, the El Paso Water Utility, the Environmental Protection Agency (USEPA), the Department of the Interior Bureau of Reclamation (USDIBR), the Department of the Interior, National Park Service, International Boundary and Water Commission, etc., among other organizations. This gives us an idea of the complexity that signifies the water management in the region where different agencies interact with their own regulations from the states of Chihuahua, New Mexico and Texas.

I.1.7 Water distribution history

The U.S.-Mexico water treaty (1906) supplied a fix and small portion of the river's annual flow to Mexico. The treaty was the result of a controversy between these two countries and, from the Mexican perspective, the convention was unfavorable to Mexico (Bustamante, 1999). The Environmental Cooperation Commission considers that Mexico resigned to any and all the claims to the Rio Grande/Rio Bravo water between the beginning of the present Mexican Canal (Acequia Madre) and Fort Quitman (CCA, 2001). The water allocation to México is 74 million m^3/year (60,000 acre-feet/year) that were given by courtesy by the U.S. In case of a drought, the U.S. is not compelled to deliver any water quantity. This water volume is insufficient for cultivation field in the Juarez Valley. The irrigation infrastructure both side of the border is the cause that in the region of study the water runoff comes from irrigation return flows Figure 1 and 2.

Figure 1 U.S. Drain at the river flow

Figure 2 Mexican Drain

I.1.8 Value of agricultural production

The value of agricultural production in the Juarez Valley was, in the season 1999-2000, 26,109,690,000 U.S. dollars (Salazar, 2002).

I.1.9 Technologies of irrigation

Gravity irrigation is the most utilized technology; it is inexpensive but unsustainable. Other irrigation technologies exist such as sprinkling, microsprinkling, drop irrigation, etc. These systems signify greater costs for the farmer, but improve the efficiencies in the water use up to 80 and 100 percent (King, 2003).

I.1.10 Water transfers

The marginality of the agricultural activity in the Valley of Juarez, the economic stagnation and imperfect property rights as a result of the treaty of 1906, difficult the establishment of a free market in water rights among irrigation users.

I.1.11Demands of municipal water

According to the Master Plan of Drinking Water and Sanitation 2000-2020 (JMAS, 2002) the projected Juarez demand for the year 2020 is of 372.8 Mm^3/year. For El Paso is about 445 Mm^3/year.

I.1.12 The Helsinki Rules

These rules comprise international regulations that establish the basis for managing international waters. The fundamental principles are the reasonable and equitable water use ILA, 2004).

I.1.13 Toxic substances in the study area

The study area is one of the most contaminated zones mainly in the urban part between Ciudad Juarez and El Paso (stations 1 and 2, respectively, according to EPA and CNA, 2204). In this zone high presence of agricultural residues was observed, and other heavy metals as cadmium and copper that surpass the norms.

I.1.14 Paradigms in environmental economy

This region is a clear market failure example, since the assignment of the water could not be distributed in an efficient way. The same nature of the contamination processes are the causes of such failure. The principles of exclusiveness and rivalry that applied to the free market economy were mechanical applied. Another cause of the market failure is the externalities, since the actions of some people or countries affected other people or countries without their authorization (Kolstad, 2001).

I.1.15 Flow ecological base

According to the historical review of the water flow rates through the Rio Grande/Rio Bravo and other bibliographical sources the minimum ecological flow rate is about 2.6 m^3/s, corresponding to 83 Mm^3/year approximately.

I.1.16 The flora and the fauna

The study is located in the Chihuahuan Desert with extreme climatic conditions (unstable; at the maximum of historical patterns). The biotic communities that have adapted to the region have been little taken into account by humans, in such a way that have been ignored in the economic activities carried out in the region such agriculture and industry. It was gathered in this study the following list of species with comments like invaders plant species and evaluation related to the Mexican official norm NOM-059-ECOL-2001 (Refer to table 1).

Table 1. Different ecological conditions for the study area species

Flora	Species	Conditions in the NOM-059-ECOL-001			Special Conditions
		Threatened	Protected	Endangered species	
Trees	9				Invader of the river bed
Bushes	13				
Cacti	9		1		
Herbaceous	78				1 Invader in cultivations and urban areas
Grass	7				1 Invader in cultivations and urban areas
Total Flora	116		1		3
Fauna					
Amphibious	12		3		
Arachnids	8				

Birds	113	5	6	1	1 Threatened in the region
Insects	46		1		
Mammals	53	9	3	1	
Miriapodes	3				
Fish	6				1 Eradicated in the region.
Reptiles	54	4	3		
Total Fauna	295	18	16	2	2
Total of Species	411	18	17	2	5

Fuente: Gatica, A., 2005, personal communication; people from the riparian communities, personal communication.

Species mentioned with special characteristics were personal observations of invading plant species (*Rapistrum rugosum* Figure 2,*Tamarix ramosissima* Figure 3*, and Cynodon dactilon*) and works that has been carried out at present for U.S. repopulating projects that existed in the study area. Those species have been eradicated or its population has been diminished in an important way (*Empidonax traillii and Hybognathus amarus*).

Figure 3

Figure 4

I. 2 Justification

The serious deterioration in water quality and as in the quantity of the river due to the urban and agricultural demand in El Paso del Norte Region has caused the loss of the environmental and ecological original conditions. There is not a deep analysis by the water stakeholders with relation to the river restoration.

I. 3 Objectives

I.3.1 General Objective

The main objective of this work is to establish the basis for the ecological restoration of the Rio Grande/Rio Bravo in the section of Ciudad Juarez-El Paso/Fort Quitman/Cajoncitos

I.3.2 Specific objectives:

- To identify the present conditions of flora and fauna
- To identify the international and national laws for environmental protection.
- To determine the minimum ecological flow rate, as well as its quality for the river recovery in the study section.

II. METHODOLOGY

II. 1 Bibliographical Revision

The present study carried out a bibliographical revision to know the antecedents of the area, its present condition and the tendencies of the water use in order to determine the possibilities of river restoration of the zone. No document related to this topic was found.

II. 2 Field work

The study area was visited in practically all its sections to observe the present environmental conditions. There is not a plan for river restoration by any Mexican or U.S. agencies. In the field work, people of the region consider that this region has been affected lately. They have not seen since traditionally common species of animals such as coyote and puma. They consider also that agriculture in the region is no longer so attractive neither productive as it was in other times; that the prices of production at present are very high, the credits for the agricultural production are few and costly, etc. There were some interviews with M.C. Ana Gatica of the Institute of Biomedical Sciences of the UACJ, to enrich the bibliographical part related to observed animals in the region. There were some interviews with Ramiro Luján in order to revise the modernization irrigation projects by CILA and BECC.

V. CONCLUSIONS AND RECOMMENDATIONS

According to this study, it is necessary to respond to the present and future needs of water urban demand (domestic, industrial, public and commercial) and agricultural in the region. It is important to understand that in the region, a large quantity of species of plants and animals live, which demands the vital liquid. Water conservation is necessary in agricultural practices to make more efficient the water use by the plants, since this sector is the major water consumer of the region. The canal and drain systems in both sides of the river are a fundamental cause of the environmental and ecological imbalance for which is necessary to reorganize such systems trying to return the minimum flow rate to the river. Water management in this region has to be handled in an integral way, that is to say, taking into account the set of natural resources. It is suggested an ecological minimum flow rate of 2.6 m^3/s corresponding to 83 Mm^3/year approximately. It is suggested also the establishment of Council for Economic Development of El Paso del Norte Region. The increase in the life quality levels of the people in this zone is fundamental, for which is suggested to elevate the salaries of the Mexican side to match them with the ones in the

U.S. side. This would create the conditions to elevate the environmental and ecological social conscious.

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