Water Resources Economics in the Big Bend reach of the Rio Grande Basin

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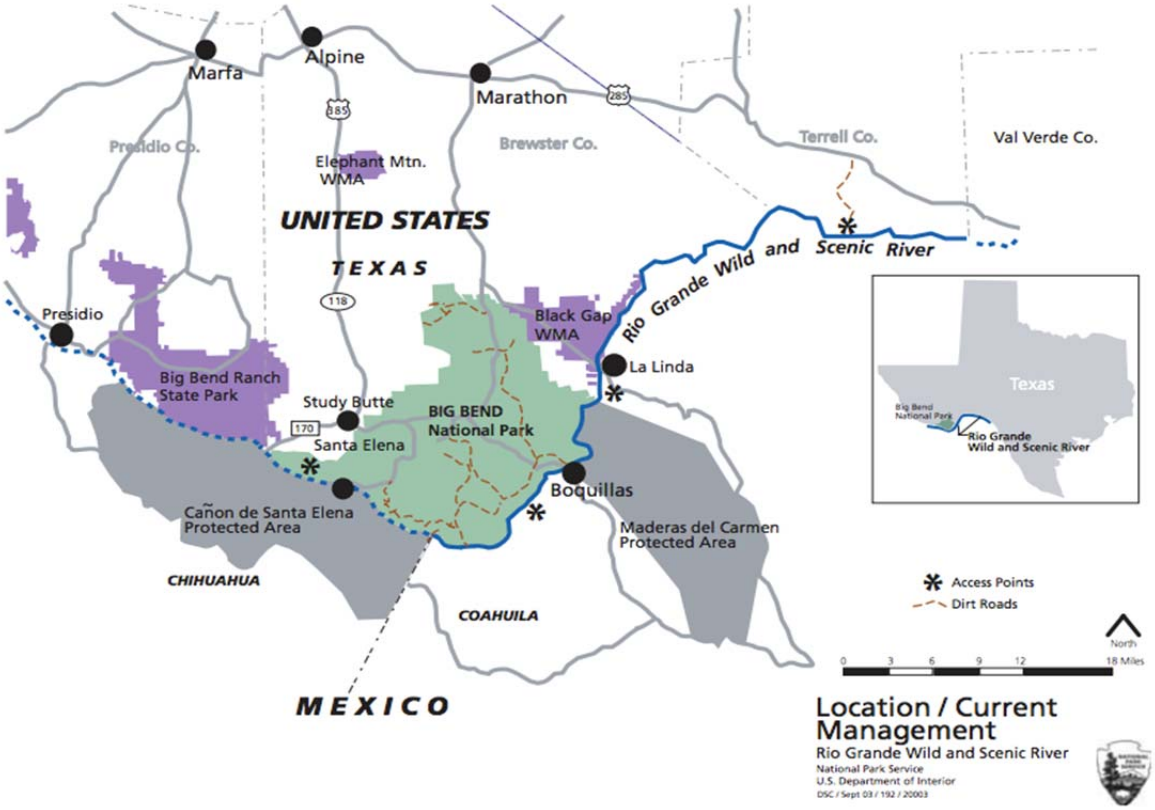
Abstract

The Rio Grande, the fourth largest river in the United States, runs from Colorado through to the Gulf of Mexico and provides many important resources for people in both the United States and Mexico. This project attempts to quantify the benefits of some of these water-related resources in economic terms. The costs and benefits of various economic activities relating to agriculture, flood control, and tourism were collected from numerous sources and analyzed. We then compared the value of these water-related activities to Rio Grande historic stream-flow and water supply levels as well as total annual water use. It was found that water supply and stream-flow are very important drivers of the economic activities that we examined.



(Deckart, 2004)

Introduction

The Rio Grande basin is a trans-boundary basin shared by the U.S. and Mexico. It flows from Colorado to the Gulf of Mexico, and is approximately 1,885 miles long, making it the fourth longest river in the United States and an extremely important contributor to agricultural and industrial water resources in the area. In 1994, 44% of surface water irrigation for agriculture in Texas was withdrawn from this river (Lurry, 2009). The Rio Grande is extremely valuable to the basin's inhabitants and industries, as well as the many native and endemic species that thrive along its course. The bi-national Big Bend reach of the Rio Grande contains important pristine Chihuahuan desert, including the Big Bend National and State Parks in the U.S. and the Maderas del Carmen, Cañon de Santa Elena and Ocampo Natural Reserve Areas in Mexico.

In 2011, Texas endured the worst single-year drought in its history, with statewide agricultural losses of $7.62 billion. The Texas State Water Plan states that Texas "does not and will not have enough water to meet the needs of its people, its businesses, and its agricultural enterprises." It predicts that "if a drought affected the entire state like it did in the 1950s," Texas could lose around $116 billion, over a million jobs, and the growing state's population could actually shrink by 1.4 million people. (www.npr.org, 2012) The impacts of this most recent Texas drought highlight the economic importance of water in arid regions, which is a main reason we chose to analyze water in the Big Bend reach of the Rio Grande Basin.

Being able to accurately quantify the benefits of these resources in economic terms is imperative to sustaining these environments for years to come. This project examines the relationship between economic activities and water flow in the Big Bend portion of the Rio Grande in Texas. The river is an important driver of economic activity in the area and we wanted to determine if and how water flow affects this activity.

Objective

The aim of this project is to compare water use and valuation across various economic activities that occur in the region. Specifically, the main objective is to quantify the value of water resources in the Big Bend reach of the Rio Grande across various economic sectors. The economic sectors we are evaluating are agriculture, tourism and flood control because they are major economic drivers of the region with available data on water use and value. Tourism is

estimated to bring in $23.5 million a year to the Big Bend area, with an average of over 300,000 visitors per year to Big Bend National Park. (Kastrin, 1995). One of the main recreational activities that draws people to Big Bend is rafting, which is directly affected by the available flow in the river. We analyzed a 55-year monthly time series of flows from 1969 to 2009 and compared this data to the costs and benefits of water use for agriculture, flood control, and tourism. Lastly, we analyzed the 1971 flood control report and evaluated the cost and benefit of the project as well as comparing it to the updated 2008 project.

Data Sources

We gathered data from various sources including the U.S. National Parks Service, the Comision Nacional del Agua (CONAGUA) and the International Boundary and Water Commission (IBWC). Regarding benefits from tourism, we gathered information on visitation and price rates as well as data on river permits distributed by Big Bend National Park from the National Parks Service. We also gathered information from the "State Task Force on Texas Nature Tourism" that was compiled by the executive director of the Texas Parks and Wildlife Department (TPWD) and the executive director of the Texas Department of Commerce (TDOC).

The 55-year monthly time series of flows we analyzed was based on gauge station measurements by the Comisión Nacional del Agua (CONAGUA, 2008), the federal authority responsible for water management in Mexico, and the International Boundary and Water Commission (IBWC, 2009). The data on water volume and pricing for agriculture use was based on annual information provided by Mexican Irrigation District 090, which represents the largest water demand on the Rio Conchos. The Flood Control report was gathered from the International Water and Boundary Commission. The report was published in 1971 and has a 2008 update. The report is for the Presidio Valley, which is in Mexico and the U.S.

Methods and Assumption

Tourism

We used data from the National Parks Service (NPS) on the annual number of park visitors and the park entrance fees, and made a low cost estimation of $5 per person per day based on NPS data to calculate the minimum annual benefits of tourism to Big Bend National Park. We then compared the annual benefits to Big Bend National Park with the *average flow in March* at

the Johnson Ranch gauge station (because March is the busiest month for tourism) as well as the t*otal annual volume* at Johnson Ranch within the hydrologic period previously described. We also attempted to obtain data on benefits from tourism companies in the area that provided both raft rentals and rafting/canoe tours, but were unable to get enough information for analysis of these benefits in relation to the flow at Johnson Ranch.

Flood Control

Our flood control data was based on a report, published in 1971, which was titled *Proposed Flood Control Project Rio Grande, Presidio Valley, Texas.* We used the flood control data (page 2) to analyze the costs and benefits associated with the project. Then we compared them to the most recent update on the project that occurred in 2008. In the 1971 report, the total cost of the facility, from Haciendita to Alamito Creek, was $2,704,800 with an incremental cost to flood control of $2,211,900. The difference between the two costs is the replacement of the existing levee as part of the Treaty channel relocation work. The federal costs for construction was $2,096,200. The total non-federal cost was $115,700. The annual benefits included: crop losses prevented, prevention of damages to land and facilities, prevention of damages to railroads, prevention of loss of business due to bridge closure, etc. This total benefit was $218,000. The annual costs were categorized into a 50 year and 100 year analysis. The 50 year analysis was $160,550 and the 100 year analysis was $151,830. Then, by taking the annual benefits and dividing by the annual costs for both the 50 and 100 year analysis, we get benefit to cost ratios of 1.36 and 1.44 respectively. In general, if the benefit is greater than the cost, which is true in this case, then the project is a good investment.

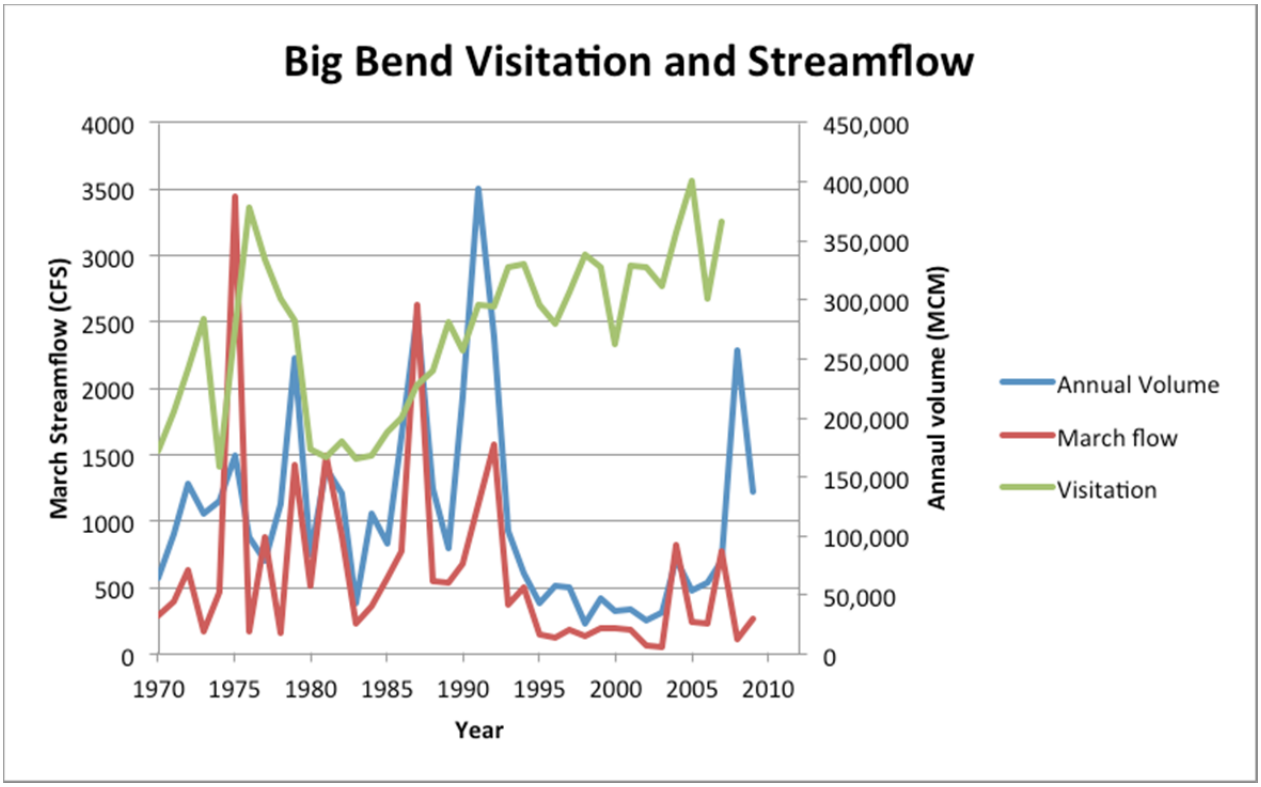
In 2008, there was an update released by the IBWC entitled *Update on Rio Grande Flood Conditions; River Level Drops at Presidio, Amistad Dam on The Rise.* The U.S. Section of the International Boundary and Water Commission (USIBWC) continues to monitor Rio Grande flood control levees at Presidio, Texas due to ongoing flood conditions. As of September 23, Rio Grande flow has decreased to approximately 1000 cubic meters per second (35,000 cubic feet per second) and the water is four to five feet below the top of the levee. As of September 23, storage was at 89% of conservation capacity. Farther downstream at the Commission's Falcon Dam at Falcon Heights, Texas-Nueva Ciudad Guerrero, Tamaulipas, storage was at 55% of conservation capacity. According to the most recent update, flood control is being managed and improving.

Calculation/Results

Annual benefits of tourism for Big Bend National Park compared with water availability

Year	Annual Total Volume @ Johnson Ranch (MCM)	March Average Flow @ Johnson Ranch (CFS)	# of park visitors	Annual Benefits of tourism to Big Bend Nat. Park (~ $5/p)
1970	567	289	172,600	$863,000
1971	896	395	205,000	$1,025,000
1972	1274	624	240,904	$1,204,520
1973	1048	174	283,300	$1,416,500
1974	1150	464	158,700	$793,500
1975	1484	3443	275,500	$1,377,500
1976	871	164	378,600	$1,893,000
1977	693	882	334,000	$1,670,000
1978	1124	161	301,198	$1,505,990
1979	2223	1422	282,941	$1,414,705
1980	751	515	174,008	$870,040
1981	1395	1488	167,332	$836,660
1982	1210	893	180,144	$900,720
1983	383	222	164,926	$824,630
1984	1049	363	167,665	$838,325
1985	832	575	188,045	$940,225
1986	1628	771	200,622	$1,003,110
1987	2549	2626	227,921	$1,139,605

1988	1241	547	239,595	$1,197,975
1989	798	533	281,728	$1,408,640
1990	1927	683	257,378	$1,286,890
1991	3499	1122	296,470	$1,482,350
1992	2389	1578	294,535	$1,472,675
1993	924	366	327,907	$1,639,535
1994	604	503	330,417	$1,652,085
1995	383	144	295,460	$1,477,300
1996	510	127	279,454	$1,397,270
1997	492	185	305,882	$1,529,410
1998	228	138	338,442	$1,692,210
1999	418	197	327,649	$1,638,245
2000	321	187	262,320	$1,311,600
2001	333	184	328,927	$1,644,635
2002	251	60	327,747	$1,638,735
2003	309	49	312,384	$1,561,920
2004	714	818	357,723	$1,788,615
2005	470	240	400,947	$2,004,735
2006	530	232	301,080	$1,505,400
2007	696	769	367,023	$1,835,115
2008	2279	114	364,876	$1,824,380



Since 1970 visitation rates to Big Bend National Park have fluctuated yearly with an average of approximately 330,000 visitors per year over the past 10 years. At our estimation of $5 per person, this is an average of $1.7 million dollars in annual benefits received directly from entrance fees to the park. While there is a strong relationship between the annual volume and March flow at Johnson Ranch as expected, we found no significant correlation between the visitation rate to Big Bend National Park and either the average annual flow or the March flow.

We believe that river permitting and the annual benefits to the rafting industry will be highly correlated with stream-flow, but we have been unable to find enough relevant data to perform this analysis during this project. While we cannot complete the analysis ourselves, several sources we found state the direct relation between river permits and flow in this region. When flow drops to below 125 cubic feet per second (cfs) in the Santa Elena Canyon or below 200 cfs in the Mariscal Canyon, the park limits the number of trips commercial rafting companies are allowed to launch each day. If the flow in these canyons decreases much more below 125 or 200 cfs, rafting or canoeing can become impossible because the water level is simply too low (NPS, 1996). The National Park Service also provided data on the amount of

river users from 1998-2000, and reported that *river use increased dramatically from 4,332 to 5,840 people in 1999 due to high water levels compared to the previous year* (Deckart, 2004).

Annual Valuation of Water for Crop Irrigation

Ag year	Total Crop Value (Pesos)	Total Crop Value (U.S.$)	T	Present Value	Water Volume Used (MCM)	$/MCM
2004 - 2005	$ 54,247,250	$ 4,160,764	7	$ 5,117,215	54,038.8	$94,695
2006 - 2007	$ 61,389,280	$ 4,708,558	5	$ 5,458,509	46,106.2	$118,390
2007 - 2008	$ 46,860,720	$ 3,594,217	4	$ 4,045,323	56,502.5	$71,595
2008 - 2009	$ 61,921,250	$ 4,749,360	3	$ 5,189,754	51,657.5	$100,465
2009 - 2010	$ 85,308,560	$ 6,543,167	2	$ 6,941,645	62,062.4	$111,849

Estadisticas Argricolas de los Distritos de Riego, Bajo Rio Conchos, Comision Nacional del Agua, Mexico, 2004-2010

To assess the value of water in crop irrigation for agriculture, a main economic driver of the Big Bend region, we first converted the total value of crops irrigated by Irrigation District 90 Bajo Rio Conchos (DR 90) from Mexican pesos to U.S. dollars. We then used the Future Value equation Ft=P(1+i)^T to change benefits to present value with an interest rate of i=.03 and T= 2012 minus the year the values were determined (T, column 4 above). We then used the total volume of water used annually in irrigation by DR 90 to determine the value of water for irrigation per million cubic meters (MCM).

Economic Factor	**Average Annual Net Benefits**
Flood Control	$ 57,450
Big Bend National Park Entrance Fees	$ 2,727,748
Irrigation District 90 Agriculture	$ 5,350,489

Conclusions

Water flow in the Big Bend stretch of the Rio Grande is an important economic determinant in flood control, agriculture and tourism according to our analyses and the data we have compiled. Big Bend National Park saw average annual benefits of $2,727,748 from entrance fees. While visitation rates to Big Bend National Park itself were not directly affected by flow levels, the river is one of the main reasons people outside of Texas are drawn to the park. With thousands of people visiting per year specifically for direct use of the river, it is clearly important that flow stays above a minimum that allows these visitors to raft and canoe. Average annual net benefits of flood control in the area came to $57,540. The benefits of the flood control systems on the Rio Grande were found to far outweigh the costs of implementation of the system and the damages that would occur if the system were not in place. The average annual net benefits for Irrigation District 90 agriculture were $5,350,489 and the cost of water for irrigation was around $100,000 per million cubic meters of water. This information can be compared to the value of water for other uses to determine the relative economic importance of water for this region across various economic sectors.

In 1971, the flood control report said that the flood of September 1968 caused serious flood damages to lands along the Rio Grande in the Presidio Valley in the United States. Major damages occurred during the floods in 1917, 1932, 1938, 1942, and 1958 and a repetition of these floods would cause major damages. The final recommendation from the report was a presentation to and authorization by the Congress for a 15.9 mile levee project for the protection of lands in the Presidio Valley of Texas, as described herein, to be constructed, operated and maintained under a coordinated plan with Mexico. Since the river is partly in the United States and partly in Mexico, it is important that the two stakeholders have good working relations and communication about the project and as reported in 2008 update, “The USIBWC has also been coordinating closely with Mexican officials regarding flows and dam releases on the Conchos River.”

Recommendation/Limitations

We recommend that the U.S. maintain good relations with Mexico so that there is agreement between the two key stakeholders. The flood control update of 2008 seems to provide evidence that the flood control plan is working. Maintaining the system is in the highest interest for the general public, as our results show that the benefits of the system outweigh the costs. Tourism in the Big Bend National Park and the Big Bend area of Texas has been shown to be a significant economic activity in the region, and reduced stream-flow and/or water supply could reduce the economic benefits currently received from tourism and outdoor recreational activities.

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