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The Texas-Mexico Water Dispute and its Resolution (?): Agricultural Liquid & Land Practice and Discourse along the Rio Conchos, Chihuahua, 1990-2005

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The Texas-Mexico Water Dispute and its Resolution (?): Agricultural Liquid & Land Practice and Discourse along the Rio Conchos, Chihuahua, 1990-2005

by

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“Man is a complex being: he makes deserts bloom - and lakes die.”

-- Gil Stern

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Coming up with a list of folks to acknowledge in the process of writing a dissertation – truly a collaborative process – is a bit daunting because there are so many people to thank. This is of course particularly difficult when most of the field research revolved around visiting with and interviewing people, some of whose names I never knew and will never know. To make the task easier, I'll divide it pre-field research, field research, post-research and those that assisted me throughout the process.

Pre-field Research. Even before arriving in Chihuahua to begin the dissertation fieldwork, there were a number of individuals who assisted in preparing the groundwork. First of all, the topic itself – originally conceived as "following a drop of water down the Rio Conchos in a time of drought and free trade," came in large part due to my employment at Texas Center for Policy Studies, where as an organization we had begun a project looking at water management in the Rio Grande watershed, including a particular focus on the Rio Conchos. For both offering me employment back in 1994, and including me – at least partially – in some of the work surrounding the Rio Conchos water management project there really is only one individual to thank: Mary Kelly of Austin, Texas. Her flexibility and support in the 1998-2002 period, allowing me to take significant time off for both my return to the University of Texas as a graduate student, as well as the rearing of my children, was truly remarkable in this day and age, as was her guidance within the confines of the office. Simply put, without her, the topic would not have presented itself for further research. Mary was also a key informant in the study, providing access to data and files, contacts in Chihuahua and advice on the topic throughout. In some sense, she was an honorary committee member.

There were a number of courses that I took at the University of Texas both before and during the onset of my fieldwork which were instrumental to the development of the topic and the ideas contained therein. First of all, Dr. Ian Manners graduate seminar on natural conservation and some of the ideas discussed in class – notably the idea of differential environmental perceptions – were key in the development of this PhD. In addition, both Dr. Gregory Knapp's course on Latin American Development, Environment and Conservation as well as Dr. William Doolittle's Environment, Development and Food Production introduced key concepts used in the methodology and fieldwork. Dr. Diane Davis's graduate seminars on political ecology also introduced key ideas about coerced conservation and the distributive consequences of conservation projects. Both Dr. Paul Hudson's undergraduate course on Fluvial Geomorphology and the graduate course on Human Impacts on Rivers gave the initial impetus to look at the different factors influencing low flows from the Rio Conchos during the 1990s, as well as introducing important concepts involving how rivers react to changing land use and environmental conditions. In addition, Dr. Peter Ward's course on qualitative methods in social science studies confirmed both the power – and drawbacks – of conducting a study based principally on qualitative methods. In the realm of Community and Regional Planning, Dr. Patricia Wilson's courses on alternative planning methods and her course on Latin American development issues were important in introducing concepts of power relations and decision-making important in farmer's decisions on natural resource use, while Dr. Robert Patterson's course on conflict resolution was obviously important in providing ideas and literature about how conflicts are resolved.

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In the Delicias Irrigation District, Dr. Concepcion Luján, professor in the Agroforestry School of the Universidad Autonoma de Chihuahua in Rosales, Chihuahua –son of Natividad and brother to Humberto – was an important source of information on the Delicias Irrigation District and helped establish contacts and gain access to dams and CONAGUA officials. In addition, former Rosales Water User Association President Humberto “Beto” Serrano and his

family in Congregación Ortiz were also instrumental in providing information and shelter in the area: in particular, his sister "Nela" Serrano and husband Javier "El Chino," and family, helped locate a small house to rent, invited me to attend their local church, and accompanied me to local festivities. In addition, current Rosales Water User Association president Jaime Rodriguez, general manager Jose Gomez, as well as the administrative assistants and canal operators were all key informants and provided data which was instrumental to understanding the changes occurring in the Rosales area of the Delicias Irrigation District. In Saucillo, Suacillo Canal president Rodolfo Parras and manager José García are credited with providing both their time, their data and helping visit projects being implemented in their area. In addition, local farmer and former El Suacillo Canal water user association president Martin Echaanic Chavez was an important source of historical information and giving a tour of his local pecan orchard. Finally, while the information was not included in the final version of the dissertation, Abelardo Lara, the manager of the Saucillo Water User Association, provided extensive information on "Module 2"'s efforts to implement water conservation projects in his geographic area.

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Finally, there are the main subjects of this dissertation: the natural resource users, more commonly called farmers. During the course of my travels and research, I surveyed some 200 farmers in the Carichi, Delicias and Ojinaga area, and conducted informal interviews with dozens more; I drank numerous sodas and glasses of water and the occasional beer with them; I was offered their

goods, including cheese, pecans, chile peppers, peanuts, corn, beans, apples and honey; I was treated to a luxurious goat meat, cooked to perfection in a hole in the ground by local Ojinaga farmer “Pepe” Sanchez; I was summoned to an elaborate seafood and meat soup outside of Congregacion Ortiz; I was invited to pick corn and apples in Bacabureachi in the Sierra Tarahumara; sort through pecan nuts outside of Saucillo; load squares of alfalfa hay into a truck for export; and throw watermelons into a truck near the Cerro Alto on the banks of the Rio Grande. I also followed farmers as they made their rounds to the top of mesas in Bacabureachi and El Consuelo; to the dams of the Rio Grande and the top of the Cerro Alto in Ojinaga; to the banks of the Rio Conchos at too many points to mention; and to a bevy of pecan orchards throughout Delicias and Ojinaga.

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Cyrus B.H. Reed, PhD
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Supervisor: Gregory Knapp

Between 1992 and 2005, Chihuahua's Río Conchos outflows were at less than 10 percent of their historical average, prompting a highly public dispute with the U.S. over water quantity under terms of the 1944 U.S.-Mexico Water Treaty. Still, Mexico made a number of water "payments" and achieved an eventual resolution of the dispute. The resolution focused on a number of steps, including investing over $140 million in irrigation district water conservation projects in the Río Conchos, which has historically provided two-thirds of the Río Grande's water below Fort Quitman.

Utilizing a case study approach rooted in political and cultural ecology, the research examines the factors – from drought to land use change-- purported by different interest groups as contributing to the transboundary Texas-Mexico water dispute and finds at least three major "narratives" emerged in the period to explain the low flows, including drought, dam management and agricultural expansion and land use changes. The dissertation shows, however, that the reduced outflows and reductions in "dam" water to farmers was just one factor in a changing agricultural context in which new land tenure rules, decentralization of water management and the enactment of a more open economic framework precipitated resource use changes within the agricultural areas.

In addition, the dissertation examines water and land resource use, including conservation projects, in three specific agricultural areas, and finds significant transformations in markets, policies and climate. Farmers were not just passive victims of reduced water use, the curtailment of government programs, and "privatization" of land and water resources, but adopted alternative water source strategies, began to examine more "conservationist-minded" agricultural practices and shifted cultivation to higher yield crops. Still, many farmers chose to abandon agriculture altogether, as there was some consolidation of resources among wealthier farmers.

The "transnationalization" of the Río Conchos which has resulted from the new focus on its water users may influence local decision-making, but the research contends that resource management decisions in the Río Conchos Watershed are influenced and determined by local practices and environments as well as by economic and legal changes brought about by Mexico's inclusion into a globalized economy.

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> **9** You care for the land and water it; you enrich it abundantly. The streams of God are filled with water to provide the people with grain, for so you have ordained it.
>
> **10** You drench its furrows and level its ridges; you soften it with showers and bless its crops.
>
> **11** You crown the year with your bounty, and your carts overflow with abundance.
>
> **12** The grasslands of the desert overflow; the hills are clothed with gladness.
>
> **13** The meadows are covered with flocks and the valleys are mantled with grain; they shout for joy and sing.

David, Psalm 65, 9-13. New International Version (International Bible Society, 1984 version, Colorado Springs, Colorado)

> **5** This is what the LORD says: "What fault did your fathers find in me, that they strayed so far from me? They followed worthless idols, and became worthless themselves.
>
> **6** They did not ask, 'Where is the LORD, who brought us up out of Egypt and led us through the barren wilderness, through a land of deserts and rifts, a land of drought and darkness, a land where no one travels and no one lives?'
>
> **7** I brought you into a fertile land to eat its fruit and rich produce. But you came and defiled my land and made my inheritance detestable.

Jeremiah 2:5-7 (New International Version) New International Version; 1984 by International Bible Society, Colorado Springs, Colorado).

I. Introduction

Drought is a complex concept. While a technical term used by hydrologists and water managers, it also has a meaning for some of, well, biblical proportions, and is seized upon by farmers, politicians and the public as a socio-economic – and not just hydrological or climactic – concept (Goodrich and Ellis 2006; Liverman 1999; Reyes-Gomez 2005). As complex as its multiple meanings are the differing explanations that are offered as drought's causes. The two biblical citations are case in point (International Bible Society 1984). On the one hand, God mysteriously provides the resources – the rain, the land, crops – that give humans the ability to produce food, all of which could be taken away. It is the grace of God or at least geoclimactic factors that contribute to aridity or fecundity. On the other, we humans by our own behavior can also bring about drought – either because we do not behave appropriately – or more in 20th century parlance, because we misuse our resources. We turn fertile land into desert. Between these two extremes – it's the weather's fault or our own – lie a multitude of explanations for the causes of drought.

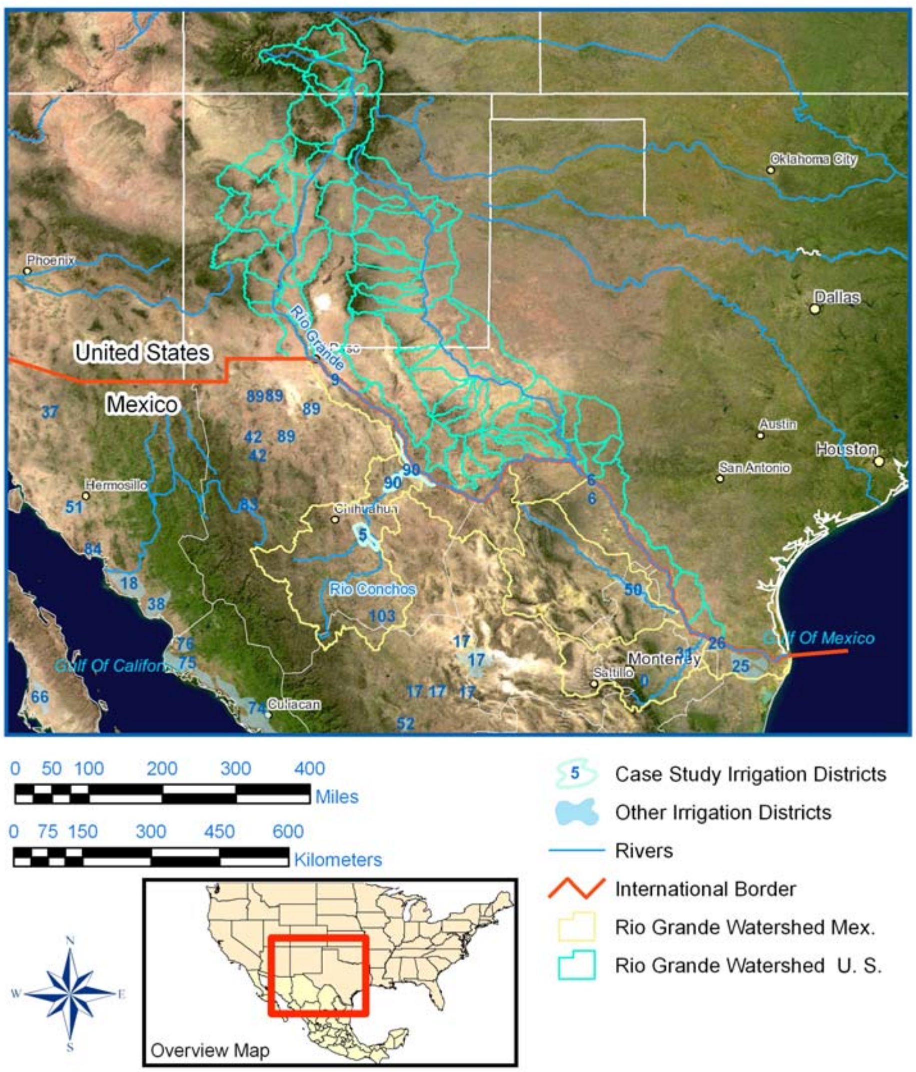
This dissertation examines changes in resource use among agricultural water users in one particular watershed while also looking at their discursive and practical reactions – as well as those of other interested parties – to one region-wide drought reported to have occurred in northern Mexico roughly between 1995 and 2004 (BECC 2002; Rodríguez Piñeda 2005 et al.; Brandes 2000; CONAGUA 2000). Hardly a "scientific" study determined to find out what caused the particular drought, it is a study of how drought – real and imagined -- causes different actors to react in terms of their resource use, and how geography — the particulars of a place and its resource users – influence these reactions.

The 64,700 square-kilometer Río Conchos watershed in northern Mexico, the vast majority of which is contained in the State of Chihuahua, makes up about 14 percent of the larger Río Grande Watershed. Since the Río Conchos itself flows into the Río Grande as it is called in the U.S. and the Río Bravo at is called in Mexico it turns a case study of resource use in a time of scarcity into a transboundary environmental issue (see Map 1).[1] This political fact – that the Río Conchos flows into a river "owned" by both countries – led Mexico and the United States to sign a treaty in 1944 "sharing" the waters of both the Río Grande itself as well as some of the tributaries that flow into the river, including the Río Conchos (IBWC 1944). Historically, the Río Conchos has provided about two-thirds of the Rio Grande flow below Fort Quitman, Texas (Collier et al. 1996).

More recently, when the amount of water flowing from Mexican tributaries was considerably less than required to meet the terms of the 1944 Treaty, the Río Conchos and its flow became the subject of considerable dispute. Between 1992 and 2004, outflows from Chihuahua's Río Conchos – as well as five other tributaries along the Texas-Mexico border – were at about 10 percent below their historical average, prompting a highly public dispute with the U.S. over water under terms of the 1944 U.S.-Mexico Water Treaty, a lawsuit by Texas farmers under the North American Free Trade Agreement for "expropriation" of their water, and highly charged political rhetoric from high-profile politicians on both sides (IBWC 2006). Despite this, between 2001 and 2005, Mexico made a number of "payments" on the water debt, and U.S. and Mexican negotiators, working through the International Boundary and Water Commission, as well as new institutions like the Border Environment Cooperation Commission and North American Development Bank, were able to achieve an eventual resolution of the Texas-Mexico water dispute (IBWC 2005a; IBWC 2005b). The resolution focused on transfers from the binational reservoirs along the Río Grande, releases from some non-Treaty tributaries, but also major investments – including $100 million in one irrigation district alone -- in water and land conservation projects in the Río Conchos water basin in Chihuahua. In return, farmers in these irrigation districts were expected to give up about a third of their water rights by 2007, which by treaty amendment would flow to the U.S. (IBWC 2003).

[1] Except in direct quotes when called the Río Bravo, for the sake of simplicity, it will be referred to as the Río Grande.

Map 1. Rio Grande/Rio Bravo Watershed



Source: Miguel Pavón, Borderlands Information Center, Texas Natural Resource Information Service, 2007.

Utilizing a case study approach rooted in political and cultural ecology and economic geography, this research looks at the potential factors – from drought to land use change -- impacting the transboundary Texas-Mexico water dispute and analyzes the different discourses utilized by different actors during the dispute. The dissertation then examines water and land resource use change between 1990 and 2005 in three specific agricultural areas, including the uplands, the major irrigation district in the central valley and the smaller irrigation district in the desert near the river outflow. In the process, the research highlights the practices of individual farmers and their communities within the context of a new transnational community of actors involved in the water decision-making process, including new binational institutions like the Border Environment Cooperation Commission and North American Development Bank, non-profit U.S.-based organizations like World Wildlife Fund and Environmental Defense, farmers in South Texas as well as state and national political leaders on both sides of the border. The “transnationalization” of the Río Conchos which has resulted may influence local decision-making, but the research contends that agricultural decisions made about resource management in the Río Conchos Watershed are influenced and determined by local practices and environments as well as by economic and legal changes brought about by Mexico’s inclusion into a globalized economy. It is thus an excellent example of the study of translocalized geographic space.

II. Research Objectives

The study has a number of research objectives and questions related to resource use and conservation, the role of different actors in decision-making about resources, and opinions and discourses on these issues.

Basic research objectives include:

1. Analyzing basic hydrological data, including average and peak flows, rainfall, and dam management in the watershed between 1990 and 2005;
2. Comparing and contrasting the different factors and discourse “narratives” developed to explain the reduced outflow of the Río Conchos over the study period;
3. Analyzing ownership and use of agricultural water and land in several selected agricultural communities, including what changes have occurred as a result of policy, economic and legal changes and why;
4. Investigating how the reduced amount of water available has impacted the ownership, control and use of water and land resources, particularly with regard to both private and communal ownership of resources;
5. Analyzing how local resource users – farmers – have responded to the lack of access to water, as well as to changes to policy involving land and water use, and new economic realities; and
6. Investigating how local resource users have responded to new conservation and irrigation technology programs and their promoters introduced in the irrigation districts, and new land conservation projects in the uplands.

Specific questions that the dissertation addresses and seeks to answer include:

1. What different factors – and narratives -- were put forward by actors – including the farmers themselves -- to explain the reduced flow from the Río Conchos into the U.S.?
2. What major changes occurred in the watershed of the Conchos in terms of land and water ownership and use? Were there differences in the impacts on larger and smaller farmers?
3. Did decentralization and privatization of irrigation districts and water resources impact the use and management of water and land?

4. Did changes resulting from changes in the Mexican Constitution involving land tenure actually lead to privatization and changes in land use in the specific areas of Mexico studied in this dissertation?
5. Did the local soil conservation efforts and the wider water conservation efforts meet with success? Did farmers feel their participation was "coerced"?
6. Were there equitable implications to the implementation of water and soil conservation programs in these study areas?

III. Methodology

A. The Case Study Approach

To achieve these objectives and answer the research questions, the project uses a multidisciplinary, multi-scale approach, employing a variety of quantitative and qualitative techniques to gather, analyze and decode this information. The overall framework used is the "case study" (Sjoberg et. al. 1991). This case study approach does not purport to be "scientific" or "objective", but is a suitable approach to examine how a natural resource conflict over water quantity is impacted and framed by economic, social and political factors and how local resource users have responded to a changed environment.

Just what is a case study? It is probably easier to say what it is not. Thus, a case study approach does not seek to study a particular issue from the inside and get a "world view" as a long-term ethnographic study might (Geertz 1973; Leví-Strauss 1963). Nor is it open-ended, where any subject, issue, focus might emerge from the research in the field.

Thus rather than what Clifford Geertz called “thick description” – ethnographic details about every aspect of a community (Geertz 1973) – the multiple cases presented here allow for comparisons and contrasts on specific issues – such as reactions to and perceptions of water and soil conservation projects among farmers and the changes made in terms of crop choices, inputs and technology.

Thus, case studies may be used to “test” a particular hypothesis, to provide greater in-sights into a particular problem or offer a longitudinal perspective (see Stake 1995: 87**).** They are studies that are bounded in some way. Here, the geographic component is the Río Conchos Watershed as well as particular communities of farmers living within the watershed. Social and thematic elements involve the study of resource use – water and land – by farmers in a particular time period, generally the period following the onset of a regional drought – real or otherwise – which began in the mid-1990s through the end of the agricultural year in 2005.

One of the major difficulties of using a case study approach – and one of its major criticisms -- is how to generalize from the uniqueness of the case study involved to identify overreaching processes that may have more applicability than the particular cases (Stake 1978: 5). This has of course been a common criticism of geographic studies– to what extent is the study only unique to that one studied area or to, as Paul Robbins writes when discussing cultural ecology, to what extent “it remains parochial in its outlook, focusing almost exclusively on underdeveloped rural contexts (Robbins 2004: 36).” There are two responses. In one sense, the present study is by its very nature intrinsic: it is only relevant to the case itself. The study of resource use among farmers in the Río Conchos basin in a time of drought and dispute with the U.S. over water inflows to the Río Grande and changing economic realities is a unique case that provides insight into what happened in the Río Conchos basin itself. The case study framework is useful precisely because it helps us understand something that is unique and particular and this study adds to the literature in geography which states that place and location matter (Massey 1994; 1995a).

At the same time, the present “case study” is a series of case studies within one geographic region. Thus, a way to get beyond the wholly “unique” is to compare more than one case. In this particular study, while it may be considered “one” case study of farmer resource use in the Conchos Watershed, in reality, it is a case study of case studies, including indigenous farming communities in the highlands of the Conchos, water user associations with geographic boundaries in the Delicias Irrigation District as well as in the Lower Río Conchos Irrigation District in Ojinaga. While the study does not try to directly “compare” each area with another – the highly modernized irrigation district of Delicias have little to do with the subsistence indigenous farmers of the highlands of the Sierra Tarahumara --- there is an attempt to compare different sets of farmers within a general region, as well as differences between the two irrigation districts. Why did farmers in one region within the watershed adopt these strategies while farmers in another adopted another strategy? What local differences led to these outcomes?

While the main purpose of a case study is not to prove or disprove a general hypothesis, it still can provide insight into a wider issue or help refine hypothesis or theories or be relevant to other regions. Generalizations do not have to be emphasized in all research designs (Feagin, Orum and Sjoberg 1991). As discussed further, the present study has relevance to a number of issues in the cultural ecology/political ecology, transboundary resource conflict and economic geography literatures that move beyond the particular “bounds” of the present study to add to theory development.

B. Actual Techniques and Method Used for Present Study

The case study, of course, is not a series of techniques or a method per-se, but "a choice of object to be studied (Stake 1995: 86)." The exact techniques and method utilized differ depending on the object of study and temporal aspects. A study of river flow might require an analysis of quantitative and longitudinal data, while an analysis of crop choice and resource use by farmers might require an analysis of relationships between the farmer, farmer organizations, market prices, government support programs and private agriculture supply companies (Doolittle 1984).

While there have been a variety of qualitative and quantitative techniques utilized in these case studies, one useful starting point in studying human use of resources within a larger socio-economic context is Andrew Vayda's development of "progressive contextualization" as an approach to understand human use of resources and choice among the many options they face in decisions about resource use. According to Vayda, progressive contextualization "involves focusing on significant human activities or people-environment interactions and then explaining these in interaction by placing them within progressively wider or denser contexts (Vayda 1983: 265)." Vayda argues "we can start with the actions or interactions of individual living things and can proceed to put these into contexts that make actions or interactions intelligible by showing their place within complexes of causes and effects (Ibid: 270)." In essence, this method argues that the decisions of local farmers can first be examined at the field level, and then through networks placed in a wider socio-economic context, of core interest to studies of human-environmental studies.

Vayda's elaboration of this webbed approach has both usefulness as well as difficulties. Thus, Robbins contrasts the Vayda methodological progressive contextualization approach with the “chains of explanation” as first developed in *Land Degradation and Society*, written by Harold Brookfield and Piers Blaikie, an oft-cited text in political ecology (Blaikie and Brookfield 1987; Robbins 2004). Robbins points out that Vayda’s approach assumes you can induce all of the factors that can influence “living things,” and empirically determine an explanation from simple observation (Robbins 2004: 74). Such a seemingly apolitical approach tends to ignore differing degrees of power and knowledge among users, disguises the politics of the observer/researcher himself and ignores the role theory plays in what issues a researcher will be examining. Thus, such an approach may allow someone to see resource exploitation but it might not allow you to see why (Robbins 74). According to Blakie and Brookfield, on the other hand, the chain of explanation approach:

> starts with the land managers and their direct relations with the land…the next link concerns their relations with … the wider society who affect them in any way, which in turn determines land management. The state and the world economy constitute the links in the chain. (Blaikie and Brookfield 1987: 27).

Blakie and Brookfield’s seminal work points out that much of land studies have concentrated on the single cause explanation of PPR – pressure of population on resources. This includes “neo-Malthusians” like Eckholm and Ehrlich and Ehrlich, but also Boserup (Ehrlich and Ehrlich 1990; Eckholm 1976; Boserup 1965, 1981). Boserup, however, turned the argument on its head, proposing that “the growth of population is a major determinant of technological change in agriculture (Boserup 1965: 56). Boserup utilizes PRP as the independent variable, and argues that as a reaction to these pressures, as well as improved technology and labor inputs, intensification and innovation can occur. Blakie and Brookfield point out instead that population pressure is just one factor contributing to agricultural change – sometimes leading to innovation and sometimes to degradation – and that their “chain of explanation” includes not only PPR, but also productivity of land, extension of cultivation, differing access to resources and even behavioral management issues (Blaikie and Brookfield 1987: 45). While they continue to advocate the need to consider the role of PPR as a causal component in agricultural and resource use change, their chain of explanation must also consider other links, including the wider link to the state and world economy. Thus, rather than looking for a single cause, their methodological approach seeks to understand how different factors put limits on the type of innovation that Boserup expounded (Blaikie and Brookfield: 48).

The present study builds on the idea of multi-causality, in relation to both the reduced flows in the confluence of the Río Conchos in the 1995-2005 period, as well as actual on-the-ground agricultural changes. Often in works that look at environmental degradation and conservation, there is – as J. Ellis has noted – a tendency to essentialize a "root cause" in environmental degradation, be it overpopulation or overuse of resources, drought or global warming. This root cause becomes part of the environmental discourse used by certain interests (Ellis 1996). Instead, by adopting a multiple hypotheses approach, the study seeks to identify several hypotheses – and causes – that either explain the low outflow – or perhaps of more interest – are adopted as a discourse by differing interest groups to explain the "crisis." The multiple hypothesis approach, first outlined by Chamberlain in the 1880s, stated that rather than testing a singly hypothesis, the researcher should be open to the possibilities and not let the evidence – the observations – fit into a pre-cooked hypothesis. (T.C. Chamberlain 1888).

Both the progressive contextualization and chain of explanation approach are themselves open to criticism of reducing reality to a single root cause because they move "upward" in scale, suggesting a "conceptual hierarchy of power" where ultimately the world economy somehow directly determines the land use choices made by local land use managers, albeit in an abstract sense. Instead, rather than a “chain of command,” political ecologists have advocated looking both outward toward the state and wider market, while also considering how local users interact directly with the global market through a network approach (Robbins 2005: 212). In particular, the identification of these communities as translocal – local communities which are connected through the economy to a higher scale of analysis through actual relations and not in some deterministic fashion – necessitates utilizing a variety of techniques to study both the individual decisions of farmers with the communal, regional and international structures that help determine those decisions (Swyngedouw 1997).

Consequently, the present project utilized four primary techniques of analysis -- a literature review, open-ended interviews with a wide variety of actors, semi-structured surveys and data analysis, including both the surveys themselves and secondary sources of information. The majority of this work was conducted between 2003 and 2005. In 2006, the survey data was analyzed (see Table 1.1)

Even before the present study began, the author had significant experience, contacts and communications in the region. From 1994 to the present, the author was employed at the Texas Center for Policy Studies, a 501-c-3 environmental policy and advocacy organization that has conducted frequent work, research and collaborations with organizations in northern Mexico. As such, the author developed relationships with a number of officials and organizations in Chihuahua that became important to the present study. In fact, one of the projects at TCPS during the late 1990s and early 2000s was to assess the impact of the North American Free Trade Agreement on certain communities in Mexico, including in the forested ejidos of southern Chihuahua (Guerrero, Kelly, Reed and Vegter 2002). Finally, beginning in 2001, TCPS received funding to assess the binational water crisis in general and more specifically, issues in the

Río Conchos watershed (Kelly 2001). The research and results of that work were instrumental to the present study. Thus, without doubt, these relationships and experiences influenced the present study.

Table 1.1. Timeline and Methodology of Present Study

Time Period	**Geographic Focus**			
	Watershed Focus	**Upper Conchos Watershed**	**Delicias Irrigation District**	**Lower Conchos Irrigation District**
Spring, 2003	Literature Review of Area and Analysis of Hydrological Data			
July and August, 2003	Reconnaissance of Conchos Watershed, visits to Border Environment Cooperation Commission and International Boundary and Water Commission	Initial Interviews and Visits to Projects and Agricultural Leaders. Identification of Case Study areas	Initial Interviews and Visits to Projects and Agricultural Leaders. Identification of Case Study areas	Initial Interviews and Visits to Projects and Agricultural Leaders. Identification of Case Study areas
July and August, 2004		In-depth interviews with agricultural leaders and government officials. Selection of case studies.	In-depth interviews with agricultural leaders and government officials. Selection of case studies.	In-depth interviews with agricultural leaders and government officials. Selection of case studies.
June- October 2005		Open-ended Interviews, Semi-structured Surveys, Data Gathering	Open-ended Interviews, Semi-structured Surveys, Data Gathering	Open-ended Interviews, Semi-structured Surveys, Data Gathering
October-November 2005	Interviews with IBWC, BECC, and Texas Governor's Office on Water Dispute; Attendance at Water Forum IBWC/CILA	Follow-up data gathering and visits	Follow-up data gathering and visits	Follow-up data gathering and visits
2006		Input and Analysis of Surveys	Input and Analysis of Surveys	Input and Analysis of Surveys

After completing a proposal, the author conducted dozens of interviews with a wide variety of actors in the three geographic areas selected as case studies during the irrigation season in 2003, 2004 and 2005. Using in-depth open-ended interviews through a network approach of those participating in decision-making about water and land use, rather than a standardized sample, is an excellent way to assess local decision-making. People have differing access to resources and differing knowledge of reality, and both local factors as well as international forces impact local decision-making. Thus, interviews within the case study approach "can provide us with fundamental sociological knowledge of human agents, communities, organizations and civilizations (Sjoberg et al 1991:48)."

In each of the three study locations, the groups interviewed and the meetings attended were slightly different. Often one interview would lead to suggestions for other important actors or farmers to interview. In addition to these dialogues, the researcher also walked with farmers in their fields and conservation projects to elicit more direct contact and understanding of the factors facing farmers. The author also participated and observed some formal and informal meetings.

In addition to the local sources of information, interviews were conducted with individuals with a more "watershed" rather than local interest in the issues addressed in this study, including academics, non-governmental organizations, political leaders and officials at both the International Boundary Water Commission and Border Environment Cooperation Commission and individuals working for the state of Texas.

In addition to these "expert" interviews, a common semi-structured survey was implemented in three different study areas (see Appendix A). While there were slight deviations in the survey to incorporate the uniqueness of each place, in general the same questions and unit of questions were asked of each surveyed farmer. During 2005, the researcher approached and conducted surveys with a total of 175 farmers in the three areas. There were opportunities for both structured responses and open-ended answers. As per University of Texas guidelines, each farmer was given a one-page description of the purpose of the study, which was briefly explained (see Appendix B). Surveys were conducted both literally "in the field" as well as in farmer homes. The surveys provided both quantitative and qualitative information, as outlined in the case study chapters.

Finally, in addition to the literature review, open-ended interviews, and semi-structured surveys, the study also involved obtaining and analyzing a significant amount of "data," mainly from government sources in Mexico, including water use, dam management information, precipitation, forestry, agricultural and industrial production, imports and exports of supplies, efficiencies of agricultural water delivery systems as well as some water quality and soil quality data. While data on sedimentation levels and studies of the dams and rivers was requested, in the end no data was provided. Instead, when discussing sedimentation, the author relied on personal observation – including multiple photographs -- the responses elicited from interviews and surveys, and data provided by the irrigation user associations in terms of the amount of money spent on cleaning out vegetation and sediment in the main canals.

While there are significant data limitations to some of these sources – discussed in detail in subsequent chapters – the data does provide an important backdrop to the present study. Indeed, one of the principle findings of the present study is to show how this data was utilized by different interests to support certain views of what was happening in the Río Conchos watershed in the late 1990s and early 2000s.

C. Dependent and Independent Variables?

This study is not a scientific approach attempting to prove a particular hypothesis in a quantitative manner. That being said, the study has a series of “dependent” and “independent” variables, at least implicitly.

First of all, the river flow itself – the actual volume of water which flowed past the International Boundary and Water Commission water flow gauge just above the outflow to the Río Grande – could be considered a dependent variable, influenced by a number of factors, including dam management, rainfall, water use, land use changes, regional or global climate changes, direct river channel modifications and other factors. Viewing the outflow as the result of actions and factors within the watershed is an important unifying, geographic concept.

Moreover, in terms of the case study chapter, independent variables –as developed in the land and water use survey – include such variables as size of land holdings, type of tenure (ejido versus private holdings), age of farmer, crop-based subsidies, and participation in soil or water conservation projects, while dependent variables include amount of land in cultivation, types of crops grown, changes in water source and water use efficiencies and other agricultural changes enacted over the years. While there is no “regression” analysis or real attempt to explain the weight of different factors, there is an attempt to see how the category of farmer by size of area irrigated might influence their answers, participation in programs, access to credit and type of crop grown.

D. Methodological Challenges

The present study adopted a variety of techniques within a case study approach to analyze water and land use changes among farmers in different locations within the Río Conchos watershed, and then attempting to see the causes and effects of this interaction in progressively wider contexts. In enacting any project of this scope, it is apparent that the researcher needs to take methodological care, particularly when examining actors' choices and perceptions. For when studying other cultures – particularly in another language – it is easy to ignore, misinterpret or misunderstand these cultural perceptions and choices, impose preconceived notions or ignore the impacts of the researcher on those studied. Fortunately, a body of literature in the alternative planning, empowerment and communicative action fields exists which offers at least partial solutions to the methodological challenges of studying other cultures (Umemoto 2001; Glesne 1984).

At the heart of this call for participatory planning is a recognition of the need for a kind of communication built on trust, rather than upon imposing views or power (see Friedmann 1992: 101-103; and Peattie 1987). A traditional planner or development agent might assume what is good for the community, while the reflective practitioner assumes that both the community and the planner have knowledge that can be useful. Planning becomes "learning-in-action (Wilson 1997: 748)." Other so-called social learning methods -- including Paulo Freire's "concientización", and other proponents of social learning have called for a dialogue as "a means to individual and group empowerment (Wilson 1996: 625)." More recent efforts for bottom-up development including Participatory Rural Appraisals, and the use of technology for indigenous mapping (Poole 1995 and Rocheleau et al. 1995), all of which point to ways for "experts" to bridge learning and vision for the community (Wilson 1996).

These experiences have relevance for the present study. Skills discussed and developed in participatory planning literature have relevance to any researcher operating in another culture and include active listening, relationship skills, groups process skills, such as conflict resolution, team building and leadership skills. Some of these same skills have been noted in the dispute resolution literature (Fisher and Ury 1981; Moore 1996). Thus, Moore mentions the need to help reframe discussions, develop trust, structure communication, establish legitimacy and know how to manage strong emotions as part of the required skills in mediation (Moore 1996: 161-190).

Geographers have made similar points of the need for researchers to have methodological care. When observing social relations, landscape or alternative cultural practices, the observer can misread what he is observing. The "outsider's trap," as geographer Anne Buttimer terms it "is one that looks at places from an abstract sky (Buttimer 1980: 171)." Buttimer notes " he or she tried to read the texts of landscapes and overt behavior in the picture languages of maps and models and is therefore inevitably drawn toward finding in places what he or she intends to find in them (Buttimer 1980: 171)." At the same time, Buttimer notes that there is also an insider's trap – who "may be so immersed in the particulars of everyday life and action that he or she may see no point in questioning..or seeing home in its wider or social context (Buttimer: 172)." It is the role of the geographer to be both the insider and outsider and avoid these difficulties.

Another methodological challenge is to recognize and understand the role of power within a community, difficult to ascertain as an outsider. Here, Umemoto recommends the use of "cultural translators." Cultural translators are:

> people who are culturally rooted in a traditional community and who are versed in the language of modernity. They often serve as bridges and help to identify differences in interpretation and facilitate cross-cultural communication (Umemoto: 26).

Several specific steps were taken to avoid some of these methodological challenges. First of all, even before the first field visit, the researcher was familiar with the area, had read extensively on many of the cultural features and local history, and had many contacts in the immediate area. This knowledge helped build initial trust.

Moreover, the study's purpose was made evident with every contact. Every farmer surveyed, every community leader or official interviewed was presented basic information – in Spanish – that listed the purpose of the study – dissertation research and subject area (Appendix B). In addition, in the Sierra Madre, as well as in the communities in the irrigation districts, the researcher made use of cultural translators. These were individuals well known in the community that helped the researcher make contacts, build trust and help interpret local culture.

Thus, in the case of the forest ejidatarios at the Conchos headwaters, the researcher worked primarily with CONTEC – a non-profit technical forestry training organization – to help identify and interview leaders within the ejidos. By following some of the projects developed in the community with the assistance of CONTEC and accompanying CONTEC to participate in workshops in the area, the researcher was "exposed" to the community, and gained a certain level of trust with local leaders. Similarly, through another community-based group – Fuerza Ambiental – the researcher was able to make in-roads into other communities in the area though in a more superficial manner. These cultural "bridges" thus became part of the study's methodology to overcome the difficulty of gaining trust and access to information in a different cultural context.

In Delicias and Ojinaga, the researcher – more through chance than design – developed close relationships with members of the community that helped bridge cultural gaps and gain access and insight. Thus, in Ojinaga, the researcher rented a room in the home of a local high school science teacher – Humberto Lujan – who was also a member of city council. The son of a farmer in the nearby community of Valverde, this individual helped the researcher gain access to both government officials and local farmers, and also helped answer and “interpret” questions about agricultural practices and local environmental challenges. In addition, the researcher utilized the assistance of a local grocery store owner – Guadalupe Torres -- in one of the agricultural communities who accompanied the researcher on several trips to survey local farmers. Having a “local” cultural bridge to interpret answers following the visits and introduce the researcher to local farmers was invaluable in gaining trust, access and understanding.

In Delicias, a local academic – Dr. Concepcion Lujan, brother to Humberto Luján – with substantial knowledge about local agricultural and forestry practices and connections to local irrigation officials also served as a “cultural” bridge for the researcher. These initial visits and connections proved invaluable in the design and implementation of the study.

Finally, in the small agricultural community of Ortiz, near Rosales, the researcher rented a room from the family of then water user association president Humberto Serrano. The relationship that developed with the family proved invaluable to understanding the history, culture and agricultural practices of this part of the Delicias Irrigation District, as well as having contacts with other farmers in the area and plenty of homemade chipotle salsa.

IV. Organization

The dissertation is organized geographically. Following this introduction, Chapter Two introduces readers to the region, including the Río Conchos watershed, and the on-again, off-again regional dispute over water and its use. Entitled *River*

Basin Woes, the chapter outlines the purported drought that impacted northern Mexico, the differing explanations and narratives offered to explain its causes and impacts, the dispute between the U.S. and Mexico – or more specifically between Texas and Chihuahua – over water and its (partial) resolution through the introduction of water and soil conservation projects. As such, the chapter is an indispensable recording of the overall socio-political context in which individual and community decisions were made about agricultural land and water use in specific communities, as well as the political reactions to it.

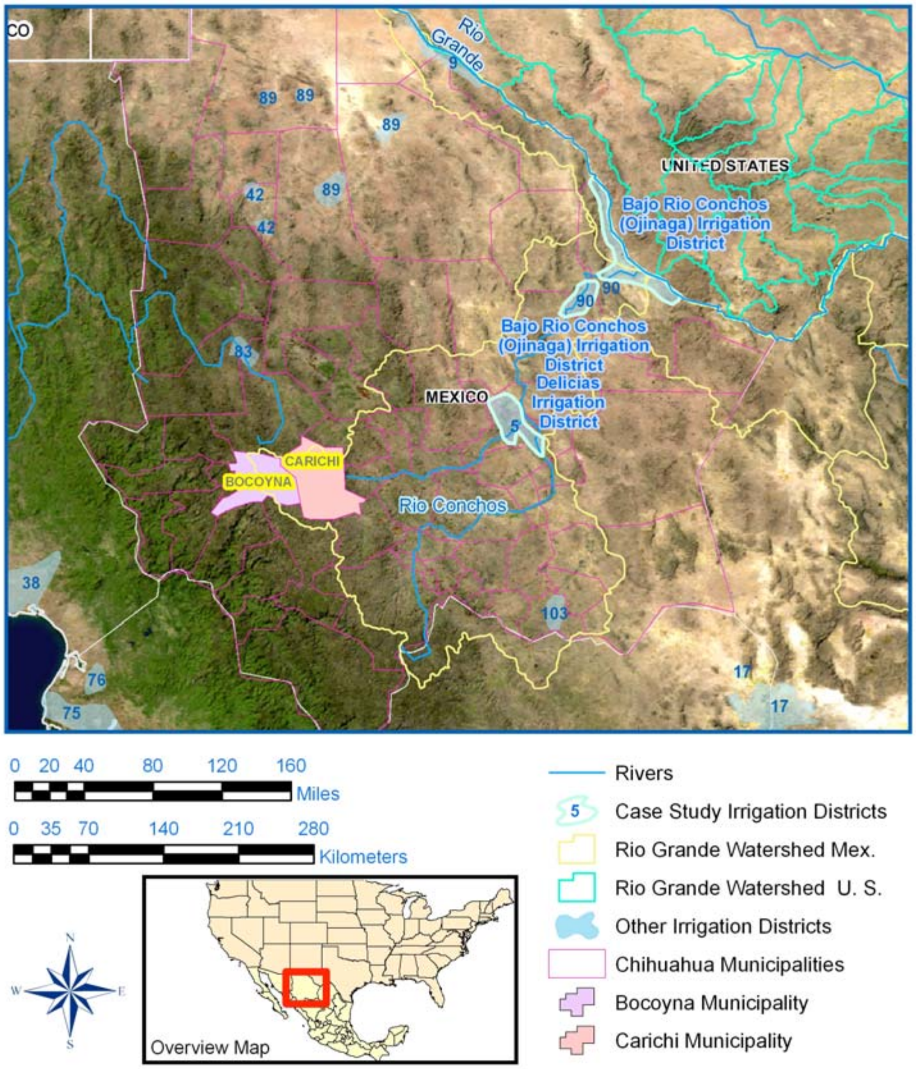
Chapter Three – entitled *Why the Pitiful Flows? Narratives and Facts about the Río Conchos Flows, 1990-2005* -- outlines the major factors purported to have caused the low-flows of the Río Conchos in Chihuahua, and provides some basic data about these factors, including rainfall, dam management, agricultural changes and water use, land use changes and some of the other major policy, economic and physical changes occurring within Mexico. The chapter helps shed some light on changes occurring in the region during the period, and while not necessarily arriving at a conclusion about which factors were the cause of the low-flows, helps crystallize the likely multi-causality of low-flows.

Chapters Four through Six present the actual on-the-ground case studies in three specific areas in the State of Chihuahua (see Map 2). While it was not possible given the time spent in each community to examine the political contexts of these case studies in the same way as the larger U.S. – Mexican debate, it was possible to detail the material changes and perceptions occurring there. Chapter Four – entitled *Mountain Voices* -- examines resource use – including soil, forestry products and water – by local farmers, most of them with strong ties to indigenous cultures, living in the mountainous oak and pine forests of the upper Río Conchos watershed. Specific land "conservation" strategies being implemented by subsistence farmers in concert with both governmental and non-governmental organizations are also presented in this chapter as well as a wider effort to implement a regional biosphere reserve. Along the way, differing narratives of environmental degradation and discourses are examined in the context of the debate over low-flows from the Río Conchos.

In Chapter Five – *The Delicious Valley* -- the major resource use changes that have occurred during the 1990s and early 21st century in the farms of the Delicias Irrigation District – a humongous 100,000 hectare irrigation community fed by two gigantic reservoirs are presented, as well as efforts to both conserve and sell water rights in an effort to reduce overall demand on the system (Jimenéz 2002). Moreover, the chapter also presents a much more detailed analysis of farmers reactions to those changes in two particular subsets of Mexico's second largest irrigation district. Known as "Modulos" or Modules, these two geographically based areas near the towns of Saucillo and Rosales are run by farmer-led water user associations which manage and operate the distribution of water, reflecting the move in Mexico toward decentralization and privatization of resource use.

In Chapter Six – *Pearl of the Desert or Gateway to Hell? Agricultural Change in* the *Lower Río Conchos (Ojinaga) Irrigation District, 1990-2005* – the farmers and resource use of this desert gateway to Mexico are highlighted. Located in the sandy soils and arid plains which surround the outflow of the Río Conchos, the roughly 1,000 farmers who once farmed 6,000 to 7,000 hectares of cotton, wheat, corn and sorghum have been reduced to a few hundred who still make a partial living off the land (Jiménez 2003). The chapter examines change in resource use, as well as the effort to shrink and consolidate the Lower Río Conchos Irrigation District through the sale of water rights and water conservation (Calderón 2005). More in-depth analysis was conducted on two of the "Modulos"– one in the hills overlooking the City of Ojinaga where cotton farming is still practiced widely – and one along the banks of the Río Grande.

Map 2. Approximate Location of Case Studies



Note: The three case studies are in the Municipality of Carichi, in the Delicias Irrigation District and in the Bajo Río Conchos Irrigation District.
Source: Miguel Pavón, Borderlands Information Center, Texas Natural Resource Information Service, 2007.

In the finale – Chapter Seven – *Droughts, Disputes, Discourse, Decentralization and Natural Resource Use in the Río Conchos Basi*n -- the major conclusions of the dissertation are presented, as well as reaffirming its importance to academic and geographic research as well as to water management policy in a semi-arid climate. Developments in the watershed since the completion of the research are also discussed as well as what the future might hold if drought-like conditions were to persist in the wider Rio Grande basin.

V. **Literature Review and Importance of Present Study**

This dissertation sheds light on three processes of international significance: resource management, economic integration and environmental conflict resolution. It thus makes a significant contribution to understanding political and cultural ecology – the nexus of political and economic forces on human use of resources -- while adding to the growing literature on resolving transboundary environmental conflicts. By providing on-the-ground analysis of the attempts to work with farmers toward more efficient water and land use as part of the resolution of an environmental conflict, as well as the wider attempt to improve “stewardship” in local communities through government and non-governmental organizations efforts, the dissertation also add to the literature on participatory development programs, while providing important lessons to geographers, development practitioner and water management specialists. Although not the primary focus, the dissertation is informed by and contributes to the literature of human impacts on watersheds by pointing to the complexity and interaction between climate, water use and management, land use and economic change.

A. Political and Cultural Ecology.

The present study moves beyond purely physical geography concepts of land-use change to examine social, cultural and perceptional factors. Cultural ecology focuses its attention on local agents' use of natural resources – the actual practitioners of land management – in examining land use change (Brookfield and Brown 1963; Boserup 1965). Political ecology looks at the empirical claims of ecological destruction and often finds that when political factors such as differential access to resources are ignored, people acting directly on the environment are "blamed" for their problems (Blaikie and Brookfield 1987; Blaikie 1999). This has led to "coercive" conservation programs, imposed by government (Peluso 1993) or outside conservation organizations, which create "truths" through their discourse of wilderness and conservation, ignoring local realities and conflicts (Proctor 1996; Sundberg 1998).

Cultural ecology has attempted to apply the concept of systems and ecological relationships to human societies, usually by focusing on local communities and impacts upon the land (Sauer 1938). In the 1960s and 70s, cultural ecologists began to study subsistence producers in the light of ecological systems theory (Bennett 1976). By its very nature, cultural-human ecology is an attempt to examine the interactions between people and their biophysical environments (Butzer 1992). Much of this early work looked at decisions about natural resource use and attempted to show how it made sense "in terms of maintaining cultural ecosystems (Knapp 1991: 13)." Cultural ecologists then saw the sustainable use of resources -- as the "choice of options", an "ongoing process of adaptation" -- as conflicts and contact between groups, changes in goals and catastrophes influenced choices made about natural resource exploitation (Knapp 1991: 2).

Historical geographer William Denevan notes that cultural geographers has at times suffered from a tendency to “look at cultures as uniform and relatively stable” when in fact, cultures have a “range of options to choose from,” or “a reservoir of alternatives that may be essential to survival (Denevan 1983: 400).” Instead, Denevan, Turner, Knapp and others looked toward cultural ecology as a subdiscipline that focuses on “cultural adaptation” to change (Knapp 1994). Denevan defines “cultural adaptation” as “the process of change in response to a change in the physical environment, or a change in internal stimuli, such as demography, economics and organization (Denevan 1983: 401).” Thus, the focus on adaptation looks at the question of why and when a particular technology or cultural practice is used (Ibid: 405). Thus, “adaptation is not a simple initial process which .. ceases … to allow the real business of culture to proceed, but involves continual choice, continual competitive evaluation of alternative cultural traits with respect to efficiency, flexibility and coevolution potential: it can in its broadest sense be seen as a synonym for culture itself (Knapp 1991: 15).”

An important component of this cultural ecological tradition has been the focus on the sustainable – and unsustainable – use of resources and the concept of conservation. (Sauer 1938; Meyer and Turner 1996; Bennett 1976). Bennett, in *The Ecological Transition*, attempted to show how modern non-traditional society had incorporated nature into culture in its use of natural resources. Bennett contrasts the more harmonious relationship with nature in traditional cultures as gradually losing out once “outside forces” gain control of locally shared resources. These outside forces make it more difficult to maintain “conservationist practices.” (Bennett 1976: 268). The “ecological transition” is the “tendency to seek ever-larger quantities of energy in order to satisfy the demands of human existence, comfort and wealth (Bennett 1976: 5).” Yet, ironically, out of this transition can come the recognition of the need for conservation.

Similarly, Charles Bowden contrasts how different cultures used water resources in the American southwest, and how technology and the need for ever larger amounts of energy – spurred by technological improvements like wells -- transformed their balance with natural resources, but lead to degradation, and eventually to a conservation ethic (Bowden 1977).

More recent work by cultural geographers has examined the relation between cultural preservation and environmental conservation (Johnson 1989, Sundberg 1998). In some case, these studies also show how “well-meaning appropriate development and environmental conservation projects can undermine indigenous self determination (Knapp 1994: 7).” Thus, geographers have begun to examine the impacts of the “imperialism” of environmental NGOs, who bring their concepts of environmental conservation to the developing world. Throughout highland Ecuador, this has led to “NGO landscapes,” with “their earnest plantings of introduced crops, optimistic terraces, transplanted raised fields, and proud signs with their international flags and logos (Sundberg 1998).”

Nonetheless, even more modern, less mechanistic cultural ecology has been subject to criticism for being either too “culturally” or too “environmentally deterministic” and for failing to address people’s interaction with the environment beyond a local scale (Batterbury et. al. 1997; Blaikie 1985). Taking a more structural approach, political ecology began to look at the empirical claims of ecological destruction (Blaikie 1985) and how when political and social factors are ignored – including differential access to resources – people acting directly on the environment are “blamed” for the problems, often in a coercive fashion (Peluso 1993). Thus, political ecology looks at differential access to resources, connections to the wider “structural” economic programs implemented in developing countries in the 1980s and 1990s, and the role of international trade and investment (Batterbury et. al 1997)

Political ecology itself has since come under some attack from cultural ecologists for being overly structural -- ignoring “ecology” and “human agency” (Vayda and Walters 1999) -- and ignoring the real decisions made by local resource users like farmers, irrigation system managers and others (Chowdhury and BL Turner II 2006; Batterbury et. al. 1997). Since then, political ecology has taken a wide variety of approaches, including a more poststructural approach, which begins to consider sociology of knowledge and postmodern approaches to understand nature. The “social nature” approach of political ecology, for example, contends that the knower/observer of nature is imbued with his own biases and social context and that is it therefore imperative to show how opinions of nature reflect social origin and to discern the “discourses of nature” (Castree and Braun 2001; Proctor 1996; and Zimmerer 1993).

These “post-structural” approaches have themselves been challenged by more political geographers as ignoring actual on-the-ground material use of resources – within the social relations of productions or what Peet and Watts call “the natural construction of the social (Peet and Watts 1996: 262-63).”

James Proctor, on the other hand, attempts to combine both a consideration of the objective social and economic context, as well as the subjective views of “constructed nature” within his own work on logging in the northwest and differing views of nature (Proctor 1996). Similarly, coming out of a more land-use, land-cover traditional cultural approach, B.L. Turner II has cited the emergence of a “hybrid” approach that seeks to balance the “structural” and political explanations for resource use change of political ecologists with the land manager agency approach of cultural ecology – "often employing an actor-conscious approach" (Chowdhury and B.L Turner II 2006; Zimmerer and Bassett 2003). Actors are bounded by structural and politico-economic realities, but also are active agents, reacting and choosing among options, and even at times transcending them. (Chowdury and B.L. Turner II 2006).

Cultural and political ecologists have also looked at the "internationalization" of the conservation movement, including the attempt to impose a particular view of conservation worldwide as well as the problems that can occur when U.S. –style conservation is imposed from above, whether when saving the rain forest in Brazil or attempting to create a Biosphere Reserve (Sachs 1991; Cockburn and Hecht 1989; Batisse 1986; Flores, Valentine and Nabhan 1990).

In the present study, in fact, there was a brewing debate in 2004 and 2005 over the possibility of creating a biosphere reserve in the Sierra Tarahumara, including parts of the Río Conchos watershed, which is explored in Chapter Four (Gingrich 2005).

Other geographers have focused more specifically on the specific role that Non-Governmental Organizations have played in promoting one particular view of environmental conservation or another (Dowie 1996; Sachs 1991; Price 1994). In looking at organizations in Latin America, authors have contrasted a first-world focus on conservation of natural resources and preservation of species, with a third-world focus on quality of life, livelihoods and control of resources, at times leading to conflict over methods and goals (Price 1994: Meeker-Lowry 1993; and Bebbington 1997; 2004). Others have studied the attempt by some international NGOs to create networks with local communities for the purposes of environmental stewardship and management, as well as certification of "products," be it fair trade coffee, certified forest products or organic agriculture, and geographers and others have been interested in analyzing these new networks (Espach 2006; Meeker-Lowry 1993).

In Mexico, geographers and others have studied the 10-year experiment with certification of Mexican forested communities by meeting the Forest Stewardship Council's certification standards (Gerez Fernández and Alatorre-Guzmán 2005). Nevertheless, these attempts are often perceived as a way to add additional "northern" conceptions of sustainability on southern communities, and because of the way markets and networks work, have not led to more material improvements in the forested communities themselves (Klooster 2006). There is a contrast between words, visions and deeds.

This dissertation both borrows and adds to this discussion within cultural and political ecology on natural resource use, discourse and conservation ideas and practice. Thus, in Chapter Two and Three, the dissertation considers the narratives that emerged among different actors to explain the low-flow and drought conditions. In particular, the notion that bad management practices among local user managers – such as upslope farmers in the forested regions of the Río Conchos --caused sedimentation in the dams, or changed local climate patterns, leading to less rainfall, is an important part of this dissertation. Or that inefficiencies in water use or expansion of agriculture by farmers and officials contributed to low outflows is a similar notion. Sometimes these discourses are in fact used as control methods to assure there is central control of communal resources (Blaikie and Muldavin 2004: 541). Recent literature on narratives of environmental degradation looks at "claims" of environmental degradation – be it deforestation, desertification, wood fuel crisis and overstocking of animals – and examines their legitimacy (Fairhead and Leach 1996; 2003). Thus, Blaikie and Muldavin detail how the notion that upstream erosion, deforestation and local wood fuel use in Indian and Chinese watersheds caused downstream flooding and sedimentation of local dams continues to be utilized as an official discourse among national environmental planners and policy implementers even as it has been debated and debunked by social scientists (Blaikie and Muldavin 2004).

In the later chapters, on the other hand, which focus more at the individual and communal land use decisions, a more agency-structure approach is examined, borrowing from both traditional cultural ecology and political ecology (Chowdhury and Turner II 2006). Here, the focus are the actual changes made by individual farmers in terms of water use and crop choice, as well as the water conservation and soil conservation projects being implemented in different communities both on an individual and communal level.

In these case studies, there is also attention to the different roles taken by both private farmland and communal lands through Mexico's ejido structure. While traditional development approaches – often based on biologist Hardin's "tragedy of the commons" idea – called for privatization of public lands as "the way to solve resource degradation in the arid tropics," alternative agricultural development theories call for support for the continued sustainable use of public lands (Hardin 1968; Bromley 1989: 868).

Since 1992 changes to its constitution, Mexico has been allowing ejidos to "privatize" these officially communal lands, and the State of Chihuahua began a process called "PROCEDE" to allow a wide variety of changes in land tenure. Rather than a simple story – ejidos turning toward privatization – the dissertation finds a complex process of some ejidos turning without hesitation toward privatization and others instead seeking to develop more explicit rules on use of the communal property so that it would not be used, abused and lost. Thus, the present study adds to this discussion of how communities utilize communal resources at a time when there is an official call and developed policy for privatization of these resources (Batterbury and Fernando 2006).

In addition, the present study also adds to the specific discussion of the politics of decentralization, in this case the decentralization of irrigation districts in Mexico, a process that began with changes in the 1992 National Water Law. There was substantial literature at that time about the need for Mexico to modernize regulation of its natural resource, and devolve control to the actual natural resource users. Among the arguments made were that such users would make their use of land and water more “efficient”. Recent scholarship, however, has suggested that this “efficiency” has come at the cost of equity, and, indeed, paints a considerably more complex picture of the decentralization process in Mexico’s irrigation districts (Wilder 2002: Wilder and Romero Lankao 2006).

The present dissertation also adds to the literature within political/cultural ecology on the differing narratives related to concepts like wilderness, environmental conservation, as well as the role that different actors “play” in developing those concepts, such as the idea of the “pristine” wilderness (Denevan 1992). In particular, non-governmental organizations with some U.S. influences have been important actors in the discussion over water and forest conservation within the Río Conchos watershed, including Environmental Defense, World Wildlife Fund, more “local” groups like Sierra Madre Alliance with international funding, and the Smithsonian Institute. In addition, the emergence of global warming as an international and national issue has also opened up a new dialogue about forest preservation and conservation being an option toward meeting global goals of reduced carbon emissions, and discussions, and programs, have begun which consider the Sierra as a “sink” for carbon emissions through local action. Some of these programs and narrative emphasize a caretaker role for indigenous communities and farmers, while others are more focused on the unique ecosystems of the region. Thus, an “environmental” role for Chihuahua’s forests and agricultural lands has been added as part of the larger discussion to counteract the rise in global warming gases.

B. Economic Geography and “Transnational” Free Trade Studies.

The present study also contributes to transnationalism research through the lense of economic geography, regional studies, and the study of the environmental and social impacts of free trade (Kelly and Reed 2003). Economic geographers have examined the process by which the “local” and “global” become increasingly intertwined through social relations of production. (Swyngedouw 1997) Economic geographers have insisted that space and place must consider the connection to outside economic forces, and that no place can be considered an island (Massey 1993, 1995). Some geographers have argued that the mitigating power of the state has been eclipsed, as local communities negotiate their existence with the global economy. Thus, “A new scale -- the “glocal” -- is continually (re) constituted, and requires researchers to look at both scales, and more importantly, at the social process between them (Swyngedouw: 139).”

Similarly, Massey is interested in how to incorporate the study of the spatial consequences of globalization with the importance of individual locations. Important in her theory is her definition of space and place and the necessity to look at both local (place) culture, social organizations, as well as the wider relations with the national and international economy. Her definition of space combines her idea that space is constituted through social relations and material social practices, with the idea that those social relations are spatially constructed (Massey 1994).

The definition "necessitates standing back, taking a broader view and setting (the place) in a wider context (Massey 1993: 144)." It is this definition of space which allows Massey to argue that culture and specific places are not being wholly subsumed through a globalized culture and economy, and that in fact, the meaning of culture and locality can be found in the relation between the two. As she states in her influential article “Questions of Locality:”

> The challenge for geographers is to retain an appreciation, and an understanding of the importance, of the uniqueness, of place while insisting always on the other side of the coin, the necessary interdependence of any place with others (Massey 1993: 146).

Thus, the study counteracts a traditional state-centered view of power, "in which the space occupied by states is seen as fixed (Agnew 1999: 174)." Thus, geographers like Massey have pointed to the need “to understand not only how the local is affected by the global, but how the actions of local people at local level are fully implicated in, and thus have some responsibility for, events in, and conditions of, people in lands which may often seem remote (Massey 1993: 144).”

Thus, rather than the often simplistic discourses of “scale” – the local use of resources versus the global power which ultimately sets the rules – and attempting to pinpoint an explanation of which holds sway in changes, the dissertation views scale as “highly fluid and dynamic” and thus in terms of research the interest is not in explaining which scale explains changes, but how local producers negotiate and operate across differing scales, “the process through which scales become (re)constituted (Swyngedouw 1997: 141).” The present research fits into this “politics of scale” discussion, as it attempts to consider both the local biophysical processes – land and water -- and the social processes – the harvests of crops, timber and cattle -- which go beyond the watershed scale (Zimmerer and Bassett 2003).

This particular research takes this concept of place, space and scale – as a process-based mechanism -- and applies it to the Río Conchos watershed, from the Sierra Taruhamara to the arid plains of the Río Grande, and looks at how different agricultural communities have reacted to both local policies and practices and global changes. Of particular interest in the present study – as mentioned in the previous section – are the changes related to land tenure, including the 1992 Constitutional Change and resulting implementation of "PROCEDE"; changes in forestry law which opened up forested communities to outside investments and larger tracts of land development; and changes in the water policy which moved Mexico to a more decentralized and privatized approach to water management. In addition, the 1994 North American Free Trade Agreement opened up the Mexican economy to investment from abroad as well as slowly loosening restrictions on imports and exports. Thus, rather than a look at the contrasting power of local and global scales, it is an examination of the politics of scale itself.

C. **Transboundary Environmental Conflict Resolution**.

Recent literature has come to recognize how differences in water policy between the U.S. and Mexico makes binational collaboration on water management – including resolution of environmental conflicts - challenging (Nalven 1986; Browning-Aiken et. al. 2004; Brown and Mumme 2000). These include differences in the roles of local, state and national governments, a differences in some cases in water rights and water ownership and differences in the power of private and collective ownership of water.

In addition, under terms of the 1944 Water Treaty, water planning is placed in the powers of the binational commission known as the International Boundary and Water Commission. This agency has been subject to criticism for being unable to overcome institutional challenges as population and economic growth has increased along the border, necessitating a new role in issues like drought management and water quality issues (Brown & Mumme 2000). Some have given examples of how negotiating binational resource management has shifted from a purely state-department diplomatic process to one including translocal and transborder institutions (Milch & Varady 1999; Vasquez-Castillo 2001).

The research details how new actors – including farmers in South Texas, academics at state institutions, representatives from state government in what is traditionally handled as a "national-level" dialogue, and environmental groups helped influence the negotiation process. The Mexican-US dispute over water also relied on new institutions like the Border Environment Cooperation Commission and North American Development Bank to fill in the gaps. By the same token some of the solutions offered – notably the use of water conservation as a "win-win" solution to free up water to meet the terms of the treaty– was offered by local and state politicians and even CONAGUA itself as a solution to municipal water needs, showing how negotiated settlements are continually reinterpreted among societal actors.

D. Land Use/Land Cover Change and Its Impacts on River Systems

While by no means a "physical" geography work, the research does rely on and contribute to the discussion of the impacts of human land use change and water management on river systems. Land-use cover/change analysis in geography looks at global land-cover change trends and human activities that directly alter the physical environment (Goudie 1982, Meyer and Turner 1996). A much smaller subfield concerns human impacts on rivers.

The impacts of land use change on lands and water upstream and downstream are varied and not well understood. A number of factors– temporal, spatial, climate, habitat, scale and size, the timing and sequence of events and the multiplicity of causes – impact the consideration of the impacts of land use change (see Schumm and Lichty 1965; Schumm 1991; Wolman and Gerson 1978; Luna 1997; Wolman and Miller 1960; Macklin and Lewin 1989). Still, there is substantial evidence that certain land-use changes –such as the conversion of forested lands to agricultural fields (Wolman 1967; Knox 1977; Magilligan and Stamp 1997), the use of grasslands for grazing or the general phenomena of urbanization (Wolman 1967, Knighton 1988) – do have significant consequences both uplands and downlands. The impacts of cattle on land use change and downstream impacts have often been exaggerated, or consequences in one particular climate and habitat – usually the Midwestern and western U.S. --have been extended to other more tropical or arid environments without sufficient evidence (see especially Trimble and Mendel 1995). Many of the physical changes in rivers attributed to human impacts have been challenged by some as "received wisdom" not born out by actual on-the-ground studies (Trimble 2000; Fairhead and Leach 1996; 2003).

It is important to recognize that the consequences of land use change are not static. In addition to the natural feed-back loop of rivers, as they adjust to changes in flow or sedimentation, human decisions about land-use are also impacted by and impact downstream changes. Humans witness changes in the land, and may change their own practices accordingly, which in turn impacts the land. Fallow lands or agricultural fields affected by overgrazing, highly salinized waters or "tired" soils may be abandoned, thus allowing for restoration to occur, both on the fields and downstream. Humans react and adapt to land use changes and its impacts, including by improving land management (Doolittle 1984; 1989; Trimble 2000).

In the Río Grande basin, studies of the impacts of dams, vegetation and drought have also shown the importance of different factors – and their interactions -- in determining sediment and water flows (Everitt 1993 and 1998, Collier et. al. 1996), and this research contributes to that discussion. However, the research will seek to avoid the narrow focus on geomorphologic process, since it often ignores the larger driving forces of political and economic change.

It is also important to look at different scales. Thus, at a very localized level, construction of earthen canals in agricultural “arroyos”—intermittent streams – in eastern Sonora to capture flood waters, widen and deepen of their own accord once sufficient floods arrive, resulting in scouring and degradation (Doolittle 1984: 131). This leads to other consequences downstream and over time:

> Reorganization of agricultural space is a significant characteristic of the temporal landscape.(Doolittle 1984: 134)

Several studies of the use of water for irrigation and other uses have shown how technology has made some of these changes more permanent and potentially more damaging on the ecosystem (Bowden 1977; Green 1973). The present study – which looks at change in land and water use in certain agricultural communities since the advent of drought-like conditions – analyzes on-the-ground conditions and water use and flow data which suggest how particular communities reacted to and contributed to geomorphologic changes on the land. In particular, the change from strictly relying on “dam” water to the increased reliance on alternative sources such as direct river water pumping, shallow and deep groundwater wells is an important documented reaction which may have led to wider consequences.

VI. Findings and Conclusions

Through the close analysis of the various “glocalized” spaces covered in the research, a number of overall and site-specific findings are developed. These can be categorized into changes in the roles of key actors, socioeconomic and policy changes, and adaptive strategies implemented by the farmers themselves. Moreover, some findings are only applicable to certain areas, since, as this dissertation shows, location does matter. At the same time, there are several findings that could have implications beyond the specific application to the time, space and place covered in this dissertation.

A. Overall Findings

The Dispute. First of all, the debate, discussion and dispute between Mexico and Texas over water resources led to the utilization of partial data by different interest groups, depending on their underlying presuppositions and interests. Thus, while Mexico’s official position focused on average dam levels, average rainfall data and water releases to irrigation districts in the Río Conchos watershed and other tributaries contributing to the Río Grande, U.S. interests – such as the USDA, IBWC and south Texas farmers focused on “positive” balances in the dams, satellite imagery of dams and agricultural districts showing water levels and green fields, and total acreage irrigated over the period. Not surprisingly, the different sources and interpretation of data led to different discourses and responses.

While these two positions led to some interaction in the negotiation process, the opening up of the discussion to wider societal interests also led to new narratives about the causes and consequences of low flows into the Río Grande. These focused on climate change, land use change and water efficiencies rather than on overall dam management or rainfall. Still, these discourses were also tied to interests in opening up resources for riparian restoration and reforestation projects tied to environmental discourses of biodiversity.

While not a quantitative or scientific study intend on finding the causes of low flow over the period, the various discourses and data suggest that rather than a "root" cause, be it deforestation, agricultural water waste, "stealing our water" or simply less rainfall, both the surveys of the actual observers of climate and water – the farmers –suggest that geomorphologic changes in water flow were actually due to a myriad of changes occurring within the watershed. Thus, drought was just one factor, both a cause and a contributor to the low outflow of the Río Conchos to the Río Grande, which set in motion the dispute between the two countries. Other likely factors included: changes in the timing of rainfall; dam management as Mexican administrators chose to change the dam release schedule to favor summer crops over winter crops; the agricultural crop change as perennial and some summer crops "won out" over spring and winter crops that had been previously grown in the major agricultural district; the physical expansion of the districts in the 1980s which increased the demand on the dams; and physical changes in the landscape which increased sedimentation and choked the riverbed with sediment and vegetation; as well as an increase in the use of groundwater, impacting the river's base flow.

Part of the story of these changes is also the decentralization of the irrigation districts themselves, which perhaps contributed to the lack of oversight by the federal government as farmers turned increasingly to groundwater and other alternative water sources, potentially impacting riverflow.

B. Agricultural Change

This dissertation also revealed a watershed in the midst of major changes in agricultural production. In the upper watershed, where temporal, rain-fed, largely subsistence agriculture was examined, farmers continued to grow corn and beans as they have for decades, and indeed, centuries. Nonetheless, farmers said that the timing and amount of rainfall had impacted their production, and that local erosion, secondary vegetation and loss of forest cover had impacted erosion and soil retention. They had also been impacted by the loss of market outlets for selling any additional production or to sell more commercial crops like apples due to the loss of some government programs and the import of crops from the U.S. Still, farmers with stronger communal and indigenous ties rejected the use of hybridized seeds and continued to preserve native crops, albeit at times having to struggle to find them due to reduced yields. Farmers were also turning more to organic fertilizers – often from their own domestic animals – due to tired soils and increases in fertilizer costs.

Rather than the feared sell-off of ejido communal land that some predicted with changed in the forestry laws and Article 27 of the Mexican Constitution, many ejidos and ejido-like structures in the upper Río Conchos had reasserted the power of the community as important to their cultural and economic survival and had rejected calls for straight privatization of their resources. In the forging of this identity, they relied on new networks with local NGOs, new international institutions and NGOs. Some of these networks did suffer from differences in discourse and underlying interests common in such undertakings. Thus, in particular in the Municipality of Bocoyna, there seemed to be a disconnect between larger plans to “save” the watershed and the actual on-the-ground plants implemented through contracts with the World Wildlife Fund.

Still, within communities, the discussion over privatization of communal resources had resulted in continued tension, and in some cases, the de-facto privatization of communal resources was and continued to happen, even predating policy changes in forestry and land tenure laws. The basic reasons appeared to be the failure for many ejidos to develop internal rules on how to prevent a “tragedy of the common” –like situation from developing.

In response to drought and concern from local, governmental and international organizations over land degradation, a smattering of local reforestation, soil conservation and others projects were enacted throughout the 1990s and early 2000s. While there appeared to be disconnect between the small scale of the projects and the larger goals of these projects, local farmers were supportive of programs which they helped design, and indicated they did not feel “compelled” to participate or that the conservation programs had been imposed upon them.

In the agricultural irrigation districts, there was a shrinking of irrigated acreage between 1990 and 2005, the period of study. Similarly, official data from both the National Water Commission – CONAGUA – and individual water user associations revealed that overall water use declined over the period. Nonetheless, rather than a simple tale of contracting acreage and water use, overall district data as well as surveys revealed complex changes in the types of crops grown, their seasonality and the amount and source of water. Thus, in the Delicias Irrigation District in particular, there was a shift toward perennial crops like alfalfa and pecans – which require watering all year long – and a shift away from both “second” summer crops and winter crops, with shorter growing seasons.

First of all, farmers turned to these crops for several simple reasons – they were fairly tolerant of drought but of more importance the return on their investment in terms of profit compared to the input costs – including water – were favorable. Even though alfalfa and pecans required higher water inputs and costs than did other crops that fell out of favor, the result for the individual farmer was positive. Secondly, the turn toward higher water-use crops can also be explained by the use of "non-district" water as individual and communal farmers turned to a wide variety of "alternative" sources to water their crops as the "official" water rights were curtailed. Thus, farmers surveyed in both the Rosales and Suacillo area within the Delicias Irrigation District noted that a significant change had been the use of private and communal well water, direct pumping of the river itself, and a system of shallow wells and pits used on emergency basis to water their crops. This finding helps explain why negotiators were often split over the fundamental question of whether farming and water use was increasing and decreasing during the late 1990s. It depended on the water source.

Did producers increase their production of perennial crops like alfalfa and pecan production after normal winter releases were ended by CONAGUA, or was the decision to seriously curtail winter releases a reaction to the elimination of major winter crops like winter wheat? Again, while the two decisions – the turn toward perennial crops and the decision to curtail winter releases from the dams – were self-reinforcing, the surveys and interviews strongly suggest that farmers turned toward perennial crops because they were a better solution, and then figured out how to get them irrigated, rather than as a response to the curtailment of normal water releases from the dams.

While there was anecdotal and survey evidence that "wealthier" farmers with access to land, water, and especially bank and government support, had been able to make this transition easier, many smaller private farmers and ejido farmers were still making a living farming. Much of this limited “success” can be attributed to their ability to organize their production communally. Thus, a government program which relied on organized private and ejido farmers allowed farmers to grow crops for their dairy cattle and then sell the milk to local collection centers at a price above market, while local cooperatives helped farmers purchase inputs at below market cost.

While “communal” land – ejido common property – was not a major factor in Delicias, other than being an emergency place to graze cattle, communal water resources – such as shared deep wells -- were. Thus, in Congregación Ortíz, an ejido was able to utilize their access to communal wells to counteract the impacts of the drought and curtailed water use, and even gain access to additional resources which could be used for their own use or rented – for a profit – to others. Interestingly, this “shared” use of a communal resource was occurring even as the ejido itself sought to privatize its lands through the PROCEDE process.

In other ejidos, however, it was clear that the changing agricultural landscape impacted by drought and the import of basic grains from the U.S. after enactment of NAFTA had impacted their viability, and many farmers chose to rent or sell water and land rights.

In the Lower Río Conchos Irrigation District in Ojinaga, where alternative sources of water were not available, the impacts of the “drought” – the loss in water releases from the major dams – was not as severe as in Delicias precisely because farmers had already abandoned agriculture with their feet. Thus, as water levels dropped precipitously in the late 1990s and early 2000s, entire communities and farmers had already left the Lower Río Conchos Irrigation

District through out migration to the City of Ojinaga and into the U.S. The major factors facing farmers there were fundamentally changes in the social network of production. Wheat and cotton – the longstanding crops of choice historically in the region – both underwent severe crisis during the 1990s. Wheat mills and cotton gyns closed up shop, and the only locally-run cotton gyn was operating sporadically and below production capacity levels.

Farmers in the Lower Río Conchos Irrigation District that remained largely turned to production of cattle feed, including oats, sorghum and alfalfa. Indeed, whether producing feed as an input to cattle herds for meat or for producing cheese, or selling them to larger farmers or to the local cattle processing center, it can be said that the primary reason agriculture still existed in the Ojinaga area in 2005 was cows. A number of important networks had developed locally, with U.S. purchasers of young cattle working directly with cow producers and agricultural producers in a new network of agricultural production.

There also appeared to be an equitable component to this transformation, with smaller ejido farmers continuing to grow cotton in the upper part of the district, while the lower district turned increasingly to cattle feed, and in some cases, to pecan production. Generally, it was the wealthier farmers who were able to make this transition, and the buying and renting of land and water rights in the district allowed some farmers to consolidate holdings to make this transition.

C. Geographic Components of Agriculture Change

There were geographic consequences of agricultural change in the irrigation districts. First of all, as water conservation projects were being implemented, certain lands were "favored" over others. Thus, where canals were being lined or relined, “hydrants” placed at the corner of a farmer’s land, that land became more valuable, since ultimately the land could be irrigated more efficiently.

In places like Rosales, this meant that the lands that had received significant investment in irrigation infrastructure – particularly around Congregación Ortíz – were being farmed more frequently and more intensely. This is also related to the interconnection of communal wells owned by the farmers of Congregación Ortíz. These farmers in essence had an additional water supply that could be used in both summer and winter months when the main dam was no longer releasing waters during drought years.

In the Lower Río Conchos Irrigation District, lands nearest to the Conchos River – and to the main irrigation canal – were favored during the period, while more outlying areas – and particularly those relying on water that needed to be “pumped” to higher ground were not. This is related to both the higher cost of pumped water, the small amount of water conservation investment that went into these areas, problems of salinity on these lands, and water management issues. As CONAGUA transferred ownership of the pumps and canals to the Water User Association as part of the changes contained within the 1992 National Water Law, these associations clearly struggled with this responsibility, made more difficult by the abandonment of many of these lands. There was little money coming in to keep the pumps running, leading to further abandonment of these lands. The emergence of a water rights buy-back program sponsored by CONAGUA and SAGARPA, the agricultural ministry, complicated the issue, as water conservation projects scheduled for these areas were abandoned until a clear picture of who was still actually farming emerged. This geographic reality had an equity issue, since it favored private farmers with lands along the banks of the Conchos.

D. Communal Response to Soil and Water Conservation

Water conservation became a buzzword in the watershed in the period of study, and supported by millions of dollars in government programs – including monies from NADBANK, a unique binational bank – CONAGUA, and the agricultural ministry, the water user associations and individual farmers made significant changes in water distribution and water technology in both the Delicias and Lower Río Conchos Irrigation Districts.

In Delicias, the water conservation projects filtered down from CONAGUA to the individual water user associations. While local water user officials were critical of some initial problems – notably that CONAGUA wanted them to try every possible water saving technology and device – they were generally positive of the program, and the program appeared to be working. While there were some complaints that the program had had equitable consequences – with wealthier farmers seeing more benefits – the decision by local leaders to place much of the resources into “Communal” systems such as jointly-shared well distribution system or in Saucillo, the relining of a major earthen canal, appeared to have led to more efficient distribution and conservation of water. As such, the newly devolved power of the water user association appeared to be working to improve environmental management in the district in these cases.

Still, by utilizing access to loans and government programs, larger farmers with pecan and alfalfa fields were the major winners, utilizing water conservation to improve their efficiencies and yields. Interestingly, while farmers recognized that they might “lose” some of their water rights through agreement signed with the government – in which water savings would flow back to the government as water concessions were being curtailed– because they had not enjoyed their full rights in most years they were not overly concerned with the “reduction.” Indeed, more successful farmers saw the water conservation projects as a means to actually increase their acreage irrigated and their yields.

In the multiple contracts and increase in farmer interest in water conservation technology, a handful of local companies – some with international connections – entered the market, creating new social networks with farmers.

In the Ojinaga area, the experiment with water conservation was slightly less successful due in part to the overall loss of farming in the area. There were simply less farmers still actively engaged in farming and willing to take advantage of government programs. There were significant complaints that the water conservation projects were improperly implemented or had not benefited all farmers.

Part of the discord also flowed from a new government program designed to shrink the district and buy back water rights from farmers. While many initially balked, many farmers with land served by pumps, with salinized lands or land simply far from the main water distribution sold off their water rights. Indeed, an entire water user association ceased to exist in the space of a single agricultural season as farmers en masse chose to abandon their fields for a small cash gift. A similar program in Delicias also led to mass sell-offs of water rights in one particular geographic area, an area that had not been farming for several agricultural seasons and where water delivery was especially problematic.

While not a technical study of water use, survey results, data analysis and observation suggested that water conservation did appear to have resulted in water savings and decreased water use, although not to the degree promised in initial plans. It also appeared that where farmers helped design and implement the actual water conservation projects they were most likely to have reduced water use. Thus, not surprisingly, people involved in the decision-making process about how to reduce resource use were more likely to reduce it and report that water conservation was working for them.

In the upper portion of the watershed, where farmers rely on rainwater and not irrigation, there were a number of soil conservation and erosion control, reforestation, check and filtration dams and other projects designed to help increase water flows of the tributaries and creeks flowing to the Río Conchos. The analysis found that the discussion over the lack of rainfall in the watershed, and water in the Río Conchos had been a primary rationale for these projects, although more local concerns were also expressed. There was a different discourse between one local group working with several communities – emphasizing control of resources, participation by local actors and internal regulation of communal lands – and others, which emphasized more the physical benefits to the environment of better control.

An effort to “coordinate” funding and programs in the upper watershed between NGOs and government agencies was credited with improving coordination and progress toward common goals. Still, the particular issue of creating a “biosphere reserve” with United Nations funding created local tensions. Some saw it as a way to bring benefit to the local community while also benefiting environmental regional goals like protection of endemic species and increased water flow. Others feared that it would be use to take away local control and decision-making and embraced a “northern” vision of conservation that excluded people’s basic right to control resources.

E. Role of NGOs and Farmer Organizations

In general, farmers were supportive of organizations like cooperatives, associations and non-governmental organizations that worked in the community. Nonetheless, while farmers that lived in ejidos that were still “active” felt that the ejido leadership was useful to their livelihood, overall farmers were not supportive of the ejido structure, and many ejidos in Chihuahua did not appear to be active. In the more indigenous ejidos and agricultural communities in the upper Río Conchos watershed, on the other hand, the ejido was seen as an important mechanism toward agricultural change and improvement.

In Delicias, there appeared to be a much more active structure of farmer producer associations, cooperatives and other mechanisms to improve farmer livelihood and advocate for programs before the local, state and federal government, while in Ojinaga, those structures had either failed or simply did not exist. Ejido and private farmers alike appeared to be largely on their own, and relied only on governmental support programs to boost their livelihoods. Both Ojinaga and Delicias-area farmers complained that many government grant and loan programs were designed to assist wealthier farmers, and that with the reduction in credit opportunities, farming had become almost impossible for those with small tracks of land.

F. Decentralization of Water Management

One of the major policy shifts in water management in Mexico occurred over the last 15 years. Both the Delicias Irrigation District and Lower Río Conchos (Ojinaga) Irrigation District saw their water management shift from a model based on state-led management and operation to a more decentralized state-water user association shared responsibility.

This analysis found that there were differing degrees of “success” in this decentralization experiment. While most farmers surveyed were supportive of the notion that water management should be left up to the farmers themselves, they believed the transfer had been accomplished with little oversight, little support and little training. Because the transfer occurred only a year or two before the drought severely restricted access to water, these new geographic units of management were put in a difficult constraint – managing and distributing water at a time of scarcity. Many farmers complained that this distribution did not always occur equitably, with some farmers favored over others.

At the same time, the decentralization of water management allowed individual “Modules” to supplement their “cut” of the federal water rights distributed from the main reservoirs with “communal water supplies” such as river water, or deep wells, in essence creating a market for water rights and supplementing their incomes. Thus, those modules with additional water rights outside the “normal” irrigation system were able to improve access, affordability and more equitable distribution of water.

G. Glocalization?

Farmers in Carichi in the upper watershed, in the Delicias Irrigation District and in the Lower Río Conchos Irrigation District in Ojinaga were clearly involved in activities that extended well beyond the actual geographic region in which they were located. For one, the debate and discourse about the low flows from the river and the 1944 Water Treaty had “internationalized” the river to a greater extent, and caused activities in each area to be analyzed in terms of how it impacted other regions, as well as in the U.S. Farmers were generally aware that their use of land and water were part of a larger debate over resource use.

In the upper Río Conchos, they were also aware of the debate over a biosphere, its potential implications as well as government programs designed to pay them for environmental services. Similarly, farmers in Delicias and Ojinaga were generally aware that the water conservation projects were in part a response to the dispute between Mexico and the U.S., and thus the attempt to decrease water use and improve water efficiency was part of a larger discussion over resource use. They were also aware that another “giant”– the City of Chihuahua – was also eyeing these same water resources, which might ultimately impact their access to resources even more.

In addition, to this regionalization of resource use, farmers were part of a network of relationships which transcended their local scale. Thus, in Ojinaga, farmers both large and small were acutely aware that their economy and potential for farming was not only determined by local access to credit, inputs, land and water, but also to markets, contracts, prices and tariffs. Thus, more than local resource use and the impacts of drought, farmers in areas like Ojinaga saw input and output prices as the fundamental driver of agricultural change.

In Ojinaga, in fact, while a handful of farmers continued to grow cotton – with substantial state subsidies and interventions and one local cotton gyn supported by both local and regional investors – most had turned to a network of producers ultimately linked to the export of cattle to the U.S., a change necessitated both by more favorable rules for cattle exporters, as well as the disappearance of crops previously grown in the district, including corn, wheat and beans.

In Delicias, where farmers produce both for the domestic and export market, some export related crops like Chile peppers were being supported by a new network of credit and contracts with a foreign-based company, while local investors – having gained experience in the U.S. market – were setting up middleman companies for the buying and selling of pecan nuts and chile peppers. The expansion of pecans was helped in part by hurricanes in the southeastern U.S. which had reduced overall supplies. The local government-producer association pesticide board played a key role in the emergence of this new network by moving toward “organic” forms of pest control.

H. The Environment Makes its Own Statement?

The “environment” – that is the natural flow of the river, the birds and bees, native and invasive vegetation – was not absent in the practice and discourse of local resource managers. Farmers in the upper, middle and lower sections of the Río Conchos complained that the environment had negatively reacted to human modification of the “natural” environment. Thus, flooding in the lower section of the river caused shifts in the course of the river, and the lower flows that followed were joined by vegetation – notably *tamarisk* – taking over the banks and previous riverbed, impacting agricultural decisions and access to land. In the upper part, lower rainfalls led to dry conditions conducive to forest fires, which impacted successive species, leading to a prevalence in some cases of *Manzanillo*, which farmers claim dry up and lowers soil humidity, while local erosive properties decreased topsoil. Mining of sand and pebbles from riverbeds for roads and tourism development may have resulted in braided streams that adjusted, causing reduced flows into the Río Conchos, while local herders were forced to shift their normal grazing patterns in search of water and grass on higher ground.

I. Concluding Statement

This dissertation examines agricultural resource use within a particular geographic area – the Río Conchos Watershed – within the context of a particular issue – the reduction of outflows of the Río Conchos to the Río Grande, which set in motion a series of disputes between the two countries as well as a variety of proposed solutions, including water conservation. The debate often revolved around different narrative explanations of the cause of the low-flows, from a simple tale of drought to another of resource exploitation and expansion, with a third narrative focused more on land use change, and in particular, deforestation. For all these narratives, reduced resource use through conservation emerged as a win-win compromise strategy, though with differing strategic interests. The dissertation shows, however, that the reduced outflows and reductions in "dam" water to farmers was just one factor in a changing agricultural context in which new land tenure rules, changes in water management and the enactment of a more open economic framework precipitated changes within the agricultural areas.

Farmers were not passive victims of reduced water use, the curtailment of government programs, and "privatization" of land and water resources, but instead adopted alternative water source strategies, began to examine more "conservationist-minded" agricultural practices even as they shifted cultivation to higher yield crops. Still, the traditional ejido structure seemed to lose power and prestige, and many farmers chose to abandon agriculture altogether, as there was some consolidation of resources among wealthier farmers. Water conservation projects appeared to benefit wealthier farmers more in the two districts. Still, new networks of relations developed between individual farmers, producer associations and organizations -- as well as the wider water user associations – to adapt to these new resource and market conditions. While the research also reveals that soil and water conservation projects were generally successful when they included farmer involvement, they are not of themselves ultimate solutions to the wider problems facing farmers, which revolve around creating the networks to be successfully linked with the wider economy. How to create this link in an economically and environmentally sustainable way is another matter entirely.

Chapter Two: River Basin Woes

> "But averages aren't real," objected Milo. "They're just imaginary."
>
> "That may be so," the child agreed, "but they're also very useful. For instance if you didn't have any money at all, but you happened to be with four other people who had ten dollars apiece, then you'd each have an average of eight dollars. Isn't that right?
>
> "I guess so," said Milo weakly.
>
> "Well think how much better off you'd be, just because of averages," he explained convincingly. "And think of the poor farmer when it doesn't rain all year; if there wasn't an average yearly rainfall of 37 inches in this part of the country, all his crops would wither and die."
>
> --A Conversation between Milo and the 0.58 child in the Land of Infinity in The Phantom Tollbooth (Juster 1961: 196)

I. Introduction

At the Binational Río Grande/Río Bravo Summit held in November of 2005 in McAllen, Texas, academics, irrigators, mid-level workers from federal, state and local governmental agencies, environmentalists, and municipal interests came together, ostensibly to express their ideas on how to better manage the waters of the Río Grande/Río Bravo, which forms the border between Texas and Mexico (IBWC 2006). But they couldn't help rehash a debate that had gripped key interests along the border and beyond throughout the last 10 years: what were the causes of year after year of low-flows from Mexican rivers into the Río Grande, and more specifically, what had happened in the State of Chihuahua that caused the Río Conchos outflows to be so paltry?

“What we need to recognize is that there was a drought… for 13 years,” announced Luis Raul Caballero Ortíz, a major pecan producer from the Delicias Irrigation District “005,” and an official in the Sociedad Rural Limitada del Conchos, the farmer’s umbrella organization charged with distributing water to farmers from the main Conchos Canal in Mexico’s 2nd largest irrigation district. “Delicias Irrigation District 005, was formed before there was an international treaty and … for the last 13 years we have only irrigated 30 percent of our lands.”

Jaime Garza, president of the “Bajo Río Bravo” Irrigation District “025” in Tamaulipas, had a slightly different perspective. “CONAGUA began to give new water concessions without having a good idea of the volumes available, and that is the origin of the over-appropriation of the rivers,” Garza explained. “There may have been a drought, but there is an over-appropriation of water which affected us. Those of us downstream are suffering.”

If these differing opinions between two figures from competing Mexican irrigation districts emerged at the “Cooperation for a Better Future” forum, they were relatively tame and constructive compared to years of contradictory discourses on the causes and effects of low-flow into the Río Grande, expressed in press conferences, lawsuits, newspaper articles, and private meetings, particularly among the farmers of South Texas, also impacted by low inflows from Mexican rivers. As Commissioner Arturo Herrera, long-serving head of the Comisión Internacional de Aguas y Límites (International Boundary and Water Commission), told the forum participants at the concluding session, it had been difficult for the U.S. and Mexican officials to even speak to one in late 2004.

In 2004, the situation had been critical, not only between official negotiators for the two camps, but by continued pressure from “outside” negotiators, most notably major South Texas irrigation farmers. On August 27th 2004, various

South Texas farmers gathered at the Austin State Capitol for a hastily called press conference, and were joined by then Texas Department of Agriculture Susan Combs, Texas Commission on Environmental Quality Chairwoman Kathleen White and representatives of several other state agencies and political leaders. The 17 irrigation districts, 29 individual water rights holders and one water supply corporation used a controversial provision of the North American Free Trade Agreement -- known as Chapter 11, Article 1102 – to claim that Mexico had “expropriated” their water by not meeting the terms of the 1944 Water Treaty between the U.S. and Mexico (NAFTA Secretariat 1994).

Officially known as the ‘Treaty between the United States of America and Mexico Respecting Utilization of Waters of the Colorado and Tijuana River and of the Río Grande entered into on February 3, 1944,’ this treaty obligates Mexico to deliver an annual minimum of 431.72 million cubic meters (350,000 acre-feet) per year, averaged over a five-year basis from six tributaries into the Río Grande (IBWC 1944). Noted Washington-based property-rights lawyer Nancie Marzulla, president and founder of “Defenders of Property Rights”, and co-counsel with her husband to the powerful Washington, D.C. law firm of Marzulla & Marzulla, stated simply: “Mexico has seized and diverted 1,013,056 acre-feet of water over a ten year period, while tripling their crop production… and then selling that water to the U.S. in the form of crops.” (Marzulla & Marzulla 2004).

Then Agricultural commissioner Susan Combs pointed to a satellite photos of the Venustiano Carranza Dam in Coahuila produced by UT-Austin Space Scientist Dr. Gordon Wells, and noted that in Carranza alone, Mexico could nearly pay back the remaining debt since the dam had swelled to over 600,000 acre-feet (740 MCM) (Center for Space Research 2003). While she mentioned the Coahuila dam, the brunt of official and producer “anger” was directed at Chihuahua. The claim from Marzulla & Marzulla noted that “from 1992 to October of 1999, Mexico kept all of the water that fell above the Luis Leon Reservoir, retaining approximately 5 million acre-feet (6 billion cubic meters) of extra water that could have been used to fulfill the deficit." (Marzulla & Marzulla 2004). The Luis Leon Reservoir is in the heart of the Chihuahuan desert, some 120 kilometers from the Texas-Mexico border.

"Mexico allowed its own farmers in Chihuahua to expand at the expense of its own farmers in Tamaulipas and the farmers in South Texas," forcefully explained Joe Joe White, who headed up the Mercedes Irrigation District. "The water shortage was man-made, not an act of mother nature."

As if solidifying these claims, a press conference was held earlier that month on August 3rd, 2004, in the Sierra Madre Occidental mountains of Chihuahua, some five kilometers west of the town of San Juanito in the Municipality of Bocoyna. It is in this region that the Conchos River begins its snakelike voyage from the Mountains of Chihuahua and Durango through agricultural valleys and the Chihuahua desert to emerge into the Río Grande just upstream of the Ojinaga-Presidio bridge.

At the foot of a new dam, the Presa Sitúrachi, sporting a baseball cap, President Vicente Fox (2000-2006) shook hands with Chihuahuan Governor Patricio Martínez (1998-2004). It was – in the fourth year of his six-year term -- only the second visit Fox, the first man ever elected President from the opposition center-right PAN party, had visited Chihuahua and the more populist Martínez. The dam – conceived, constructed and built in less than 18 months -- was officially intended to supply water to San Juanito and other smaller communities but also to become a recreational center for the Mexican and U.S. tourists who flock each year to the oak and pine forests of the "Sierra Tarahumara." (see Photo 2.1 and Photo 2.2).

Governor Martinez announced that “all the water is for Chihuahua and not one drop will leave this entity.” (Topete 2004: A1). Echoing Martínez’s statement, the President announced that the “Presa San Juanito is for Chihuahua and not one liter will go for payments to the exterior.” Continuing, the president stated that the main concern of the country was not to comply with a treaty, but water for Mexicans and Chihuahuans. Later the President announced that payment of the remaining debt would depend “upon a good season of rain.” (Topete 2004: A1).

Encapsulated in these differing views and perspectives on the water “debt” between Mexico and the U.S. is a fundamental split between those who lay the cause of blame for the lack of inflow to the Río Grande on basic drought-like conditions and those who portray the situation as mismanagement and theft of a basic and precious natural resource.

This chapter examines the water debt incurred by Mexico, the dispute between the two countries which emerged roughly between 1997 and 2004, and the negotiations leading to its eventual resolution, focusing its attention to one of the six tributaries covered in the 1944 Water Treaty and the subject of this dissertation – the Río Conchos. Following a brief description of the river and watershed itself, this chapter will briefly revisit the high and low points in the international dispute, and some of the narrative discourses and data utilized by different interests and actors.

Photo 2.1. The Rio Situriachi Valley. The Agricultural Valley formed by the Río Situriachi and the Arroyo Setiapachi would become the site of the Situriachi, or San Juanito Dam. The photo was taken in 2003, about a year before the dam was completed in August of 2004.

Photo 2.2. The Situriachi, or San Juanito, Dam, 2005. The Dam was conceived and constructed on one of the tributaries of the Río Conchos during a time of conflict between Chihuahua and Texas over water flows. Photo taken in August of 2005.

II. Overview of the Río Conchos River Basin

The Río Grande, known as the Río Bravo in Mexico, divides two nations.[2] Stretching nearly 3,000 kilometers between Southern Colorado and the Gulf of Mexico on the Texas-Mexico border, for some 1,900 kilometers it "marks the border between the United States and Mexico—the longest river border in the world between countries at dramatically different levels of development" (Schmandt 1993: 1). Today the river is neither "Large" nor "Fierce". Nearly 100 years of substantial human management, primarily for agricultural use, and more

[2] The name of the river in the United States – the Río Grande – will be used in this document.

recently to provide water for a growing municipal population on both sides of the border, have left it a faint trickle of its former glory, as both the mainstem and its tributaries have been dammed, channeled and rerouted. In essence, the river and connected basin have been disjointed hydrologically, as well as politically, as a potpourri of governmental and non-governmental bodies control the flow, storage and discharge of the river and its tributaries (Natural Heritage Institute 2001: 2-3). The substantial human impacts on its quantity and quality caused American Rivers to list it as the nation's fifth most "endangered" river in 2003, although this particular report focused only on U.S. demands and decisions on river management (American Rivers 2003).

Flow in the middle section of the river is controlled by releases from Elephant Butte Reservoir and Caballo Reservoir in New Mexico, a gigantic reservoir completed in 1916 in New Mexico. Research examining this section of the river suggests the management of the Elephant Butte Dam, and resulting loss in historical spring flooding has been the main cause of the shrinking and aggradations of the once grand river in its middle section (Everitt 1993; Everitt 1998). A secondary effect and at least a partial subsequent cause of lower flows has been the more recent historical encroachment of various species of salt cedar, *Tamarix chinensis, which* was imported into the southwest as an erosion control device.[3] (Everitt, B.L. 1998; Sudbrock, A. 1993).

Below Presidio, the river's flow is fundamentally altered by the Río Conchos. The Río Conchos River Basin makes up 14 percent of the entire Río Grande/Río Bravo River Basin. Depending on definitions, the drainage area of the Río Conchos River Basin is approximately 68,000 square kilometers, although if the

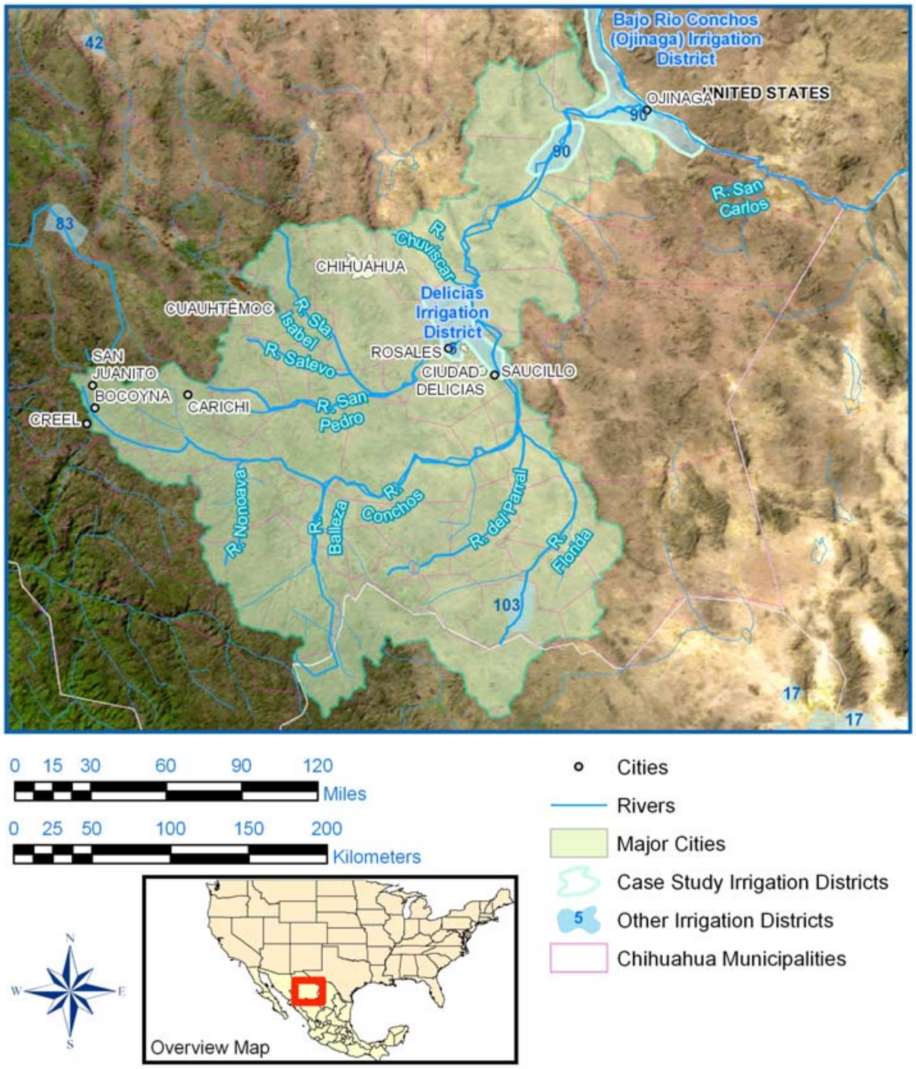
[3] Salt cedar taxonomy is still being developed. There are at least eight species, or subspecies found in the U.S. according to authors. While some continue to distinguish many species, others consider these shrubby plants as one variable species best referred to as T. pentandra (Sudbrock 1993).

subregion of the Mapimi River is included, that total increases to over 100,000 square kilometers.[4] The Basin includes nearly a third of the total area of the state of Chihuahua but also drains a small portion of the State of Durango (see Map 3). Beginning in the pine-forested areas of the Sierra Tarahumara, a range of the Sierra Madre Occidental, the primary tributaries and mainstem flow northeasternly before converging in the arid Chihuahuan desert and turning in a northernly direction and flowing into the Río Bravo/Río Grande near Presidio, Texas just upstream from the International Bridge (Photo 2.3). The basin drains important ranching, farmland, forests and forest activities, as well as metropolitan areas, some of which have important industrial centers of production. Table 2.1 provides basic information on the Rio Conchos watershed's physical and hydrological characteristics, while Figure 2.1 shows the land use within the basin, most of which is pastureland and non-populated. In all, an estimated 1.39 million people in 2005, with the majority living in the capital City of Chihuahua, as well as in Cuauhtémoc, Delicias, Hidalgo de Parral, Camargo, Jimenez, Meoqui and Ojinaga (INEGI 2000; 2005) (Table 2.2).

Interestingly, between 1990 and 2005, estimated total population within the basin increased some 26.5 percent, according to official census samples, yet the vast majority of this increase occurred in Chihuahua City, and to a lesser extent in Cuauhtémoc, Delicias, Hidalgo de Parral, and Meoqui. Smaller municipalities in both the forested mountain areas (Carichi, Nonoava), middle savannahs and plains (Cusihuiriachi, Valle de Zaragoza, San Francisco de Borja, San Francisco de Conchos, Camargo) and in the desert (Coyame de Sotol and Ojinaga) actually witnessed declines or virtually no population growth.

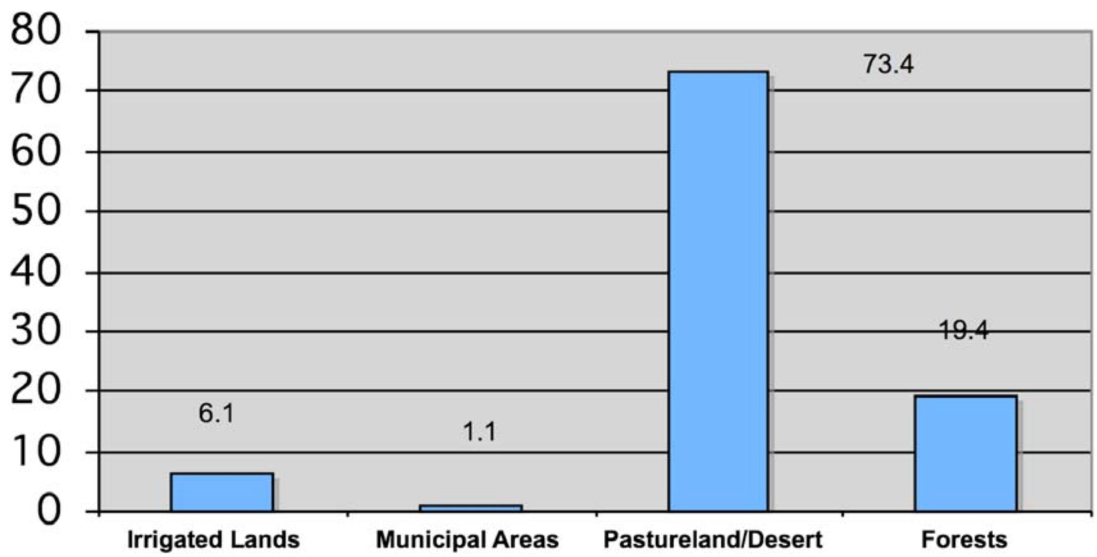
[4] For purposes of this dissertation, the Mapimi River Basin will not be included in the analysis.

Map 3. The Río Conchos Watershed



Source: Miguel Pavón, Borderlands Information Center, Texas Natural Resource Information Service, 2007.

Figure 2.1. Land Use by % of Watershed in the Rio Conchos Basin, 1995



Source: CONAGUA 1997

Table 2.1. Major Hydrological, Population and Topographical Characteristics of Río Conchos Watershed

Characteristic	Value
Basin Area	68,386 km^2
Estimated Population (2005)	1,399,000
Population Density	>20 people/ km^2
Mean Discharge	20.5 m3/s
Mean Annual Temperature	17^0 Celsius
Mean Annual Precipitation	40 cm
Terrestrial Ecoregions	Sierra Madre Occidental Pine-Oak Forests, Chihuahuan Desert
Length of Mainstem	640 km.
Relief	2700 m
Number of Major Dams	Seven (Luis León, La Boquilla, Francisco Madero, San Gabriel, La Colina, Chihuahua, Pico de Aguila)
Number of Fish Species	53 (38 native)
Number of endangered species	5

Sources: CONAGUA 1997; Kelly 2001; Kelly and Contreras 1998; Contreras-Balderas and Lozano-Vilano 1994; INEGI 2005; Edwards, Garrett et al. 2002; Hudson 2005.

Photo 2.3. Confluence of Río Conchos and Río Grande. The Río Conchos –the wider river – enters the Río Grande just upstream of Ojinaga at the U.S.-Mexico border.

Table 2.2. Municipalities of Río Conchos Basin, Population and Change, 1990-2000

Municipality	1990 Population	1995 Population	2000 Population	2005 Population	% Change, 1990-2005
Chihuahua	530,783	627,662	671,790	758,791	42.96%
Cuauhtémoc	112,589	120,140	124,378	134,785	19.71%
Delicias	104,014	110,876	116,426	127,211	22.30%
Hidalgo de Parral	90,647	98,385	100,821	103,519	14.20%
Camargo	45,814	46,386	45,852	47,209	3.04%
Jimenez	37,052	39,746	38,323	40,467	9.22%
Meoqui	34,995	38,152	40,018	41,389	18.27%
Ojinaga	23,910	23,581	24,307	21,157	-11.51%
Saucillo	32,612	31,048	30,644	28,508	-12.58%
Bocoyna	22,417	25,824	27,907	29,907	33.41%
Aldama	17,169	19,998	19,378	19,879	15.78%
Rosales	14,154	14,809	14,969	15,935	12.58%
Carichí	9,527	8,188	7,760	8,377	-12.07%
Valle de Zaragoza	6,641	6,123	5,309	4,341	-34.63%
Cusihuiriachi	6,467	6,198	5,784	4,835	-25.24%
Julimes	5,641	5,335	5,165	4,507	-20.10%
Nonoava	3,516	3,246	2,946	2,810	-20.08%
San Francisco de Conchos	3,231	2,991	2,843	2,669	-17.39%
San Francisco de Borja	3,220	2,635	2,341	2,243	-30.34%
Coyame de Sotol	2,262	2,114	1,708	1,453	-35.76%
Total Conchos Basin	1,106,661	1,233,437	1,288,669	1,399,992	26.51%
Total State	2,441,873	2,793,537	3,052,907	3,241,444	32.74%

Sources: INEGI 1991; 1996; 2001 and 2006.

The Río Conchos is fed and sustained by four major tributaries (see Table 2.3). The sub-basins which contribute most of the river's flow begin in the pine-oak forests of the Sierra Madre Occidental. Both the Arroyo San Juanito, often referred to as the headwaters of the Río Conchos, and the Río Sisoguichi, begin their journey to the Río Grande in Southern Chihuahua at the foot of several large mountains, in the Municipality of Bocoyna (see Chapter Four).

Table 2.3. Description of the Main Tributaries of the Río Conchos

Name of Main Tributary	Major Feeder Rivers to Tributaries	Location
Río Florido	Río Parral	Begins in mountains of Durango and flows through south Chihuahua, joins up with Río Conchos near Camargo.
Río Sisoguichi	Río Nararachi Río Aguas Caliente Río Nonoava Río Balleza	Begins east of San Juanito in High Mountains of Sierra Tarahumara in southwest Chihuahua, passes through Bocoyna and becomes Conchos, passing into the Boquilla Dam.
Río San Pedro	Río Satevo Santa Isabel	Begins in Southwest of state, passes through San Francisco de Borja and flows into Francisco Madero Dam (Las Virgenes), and then through Rosales and Meoqui, before meeting up with the Conchos near Julimes.
Río Chuviscar	None	Begins in western hills, passes through Ciudad Chihuahua and Aldama and enters the Conchos upstream of the Luis Leon Dam.

Source: Comision Nacional de Agua 1997: 3-10

The municipalities of Bocoyna and Carichí in the High Mountains of the Sierra Tarahumara through which the river flows are sparsely populated, and the major economic activities include farming, ranching, forestry, and tourism (see Chapter Four). Some 23 percent of the population above five in Bocoyna and about 43 percent of the population above five in Carichí is self-defined as “Tarahumara” or Raramuri, an indigenous peoples which have inhabited the area for centuries, migrating there once the Spaniards began to inhabit the area and enslave the indigenous for mining purposes (see Table 2.4)

The river proceeds easterly, descending rapidly, passing through the sloping hills home to acres of apples, corn, oats as well as cattle ranches. It passes near the burgeoning city of Cuauhtémoc, with its mix of mestizos, temporary indigenous workers from the Sierra Tarahumara and Menonites, descendents of the Canadian families of German heritage, who were invited to move to Chihuahua in 1922 by President Alvaro Obregón (Macías and Torres 2001: 13). Here, precipitation averages 400 mm per year (Schmandt 1993: 43). After being joined by the Nonoava and Balleza Rivers and other tributaries, the Conchos flows through central Chihuahua in the heart of the Chihuahuan high plains into the Valle de Zaragoza and La Boquilla Dam, also known as Lake Toronto. Begun in 1910, it is Chihuahua's largest dam.

Table 2.4. Indigenous Populations of the Río Conchos Upper Basin, 2000

Municipality	Population >5 years	Number >5 years which speak Indigenous Language	Number >5 that Speak Only Indigenous Language	Number of Ejidos or Agricultural Communities	Number of Ejido Members	Number of Ejidos where indigenous language is main language
Bocoyna	24,221	5,608	869	25	3,873	5
Carichi	6,844	2,940	791	25	2,164	8

Source: INEGI 2001.

The Río Florido for its part begins in the State of Durango near the Sierra's highest peak – Mount Mohinora – and passes into the San Gabriel dam at the border between Chihuahua and Durango. The dam is one of two serving the 10,000-hectare Río Florida Irrigation District. After being joined by the Río Parral, the Florido turns to the northwest and joins the Río Conchos downstream of the La Boquilla Dam south of Camargo, which is the main source of waters for the Delicias Irrigation District and other irrigated lands in the area (See Chapter Five).

The river itself continue in a north-easterly direction, passing near the City of Saucillo, where the old Saucillo Canal, built originally in 1884, spins off for some 40 kilometers to irrigate 4,000 hectares of pecans, chile and peanuts. The river continues to the north and east, passing near the City of Delicias, while the Conchos Canal – the main canal serving the irrigation district -- moves in a parallel fashion, moving past Estación Conchos, Saucillo, Delicias, Lazaro Cardenas and La Reforma before part of the canal shifts due north toward the Francisco Madero Dam, where it feeds into a control structure below the gates of the Francisco Madero reservoir, fed by the Río San Pedro.

The San Pedro River descends from the oak savannah hills near San Francisco de Borja and Cusihuriachi toward its impoundment at the Francisco Madero reservoir. Completed in 1949, this reservoir – more commonly known as Las Virgenes -- is used for sediment control and to supply irrigation to a large part of the Delicias Irrigation District. Below the dam, the San Pedro has become an intermittent stream which meets the Conchos near Julimes. Its artificial limb, the San Pedro Irrigation Canal, travels north, feeding thousands of hectares of irrigated lands near Rosales, Meoqui, Lazaro Cardenas and La Reforma, eventually petering out as it passes the Río Chuviscar.

Originating in the Serrania de Mesa Montosa in Western Chihuahua, the Chuviscar flows into the small Chihuahua Dam above the Capital City. Once used to supply the capital city's water, it now only supplies about five percent of the capital's water supply (Junta Municipal de Aguas y Saniemiento Chihuahua, Personal communication with author, 2003). The Río Chuviscar then proceeds through the city as a canalized flood control device before passing by the City of Aldama and San Diego de Alcalá. The Río Chuviscar joins the Conchos in the increasingly arid plains before it enters Luis Leon Dam (also known as El Granero).

Built in 1968 to provide irrigation and flood control, its waters are used for irrigation of pasture, alfalfa and cotton, both in smaller Unidades de Riego along the mainstem of the river and more importantly, for the Bajo Río Conchos Irrigation District (090), known more commonly as the Lower Río Conchos Irrigation District (see Chapter Six).

The Conchos travels 120 kilometers through the heart of the Chihuahuan desert after leaving Luis Leon, passing by smaller municipal centers such as San Pedro, Coyame and Cuchillo Parado, before the river enters two diversion dams – the Peguis and the Tarahumara – both of which siphon of river water for irrigated desert lands. Eventually, the river skirts around the City of Ojinaga and meets the Río Bravo/Grande, just one kilometer west of the main bridge which crosses between the bordering cities of Ojinaga, Chihuahua and Presidio, Texas. Annual flow at the mouth of the river averaged 910 Million Cubic Meters (737,000 acre-feet) per year through the 1980s, or about five times the Río Grande's flow before it meets up with the Conchos (Collier 1996: 36).

The climate of the basin varies considerably from subhumid, to semi-arid, to arid and very arid. In terms of vegetation, the oak-pine forests in the mountains give way to oak-juniper savannahs, and grasslands and eventually to the Chihuahuan desert ecosystem. Annual precipitation over the entire basin averages 393 mm per year, though this total varies considerably from the more humid headwater area in the Sierra Madre – with average annual precipitation of 838 mm at San Juanito to only 250 mm (about 10 in/year) at the mouth of the river, in the heart of the Chihuahuan desert (CONAGUA 1997). Throughout the entire Basin, almost all of the rain occurs in the summer and early fall months between June and October. Thus, some 73.4 percent of rain at the mouth of the river occurs in these summer and early fall months, while upwards of 80 percent of rain in the agricultural valleys of Delicias and Parral occur in those months as well (CONAGUA 1997: 5.1.1. a-8). Below average precipitations are relatively common historically, with a 30 percent probability that a region within the Basin will receive less than 80 percent of the annual precipitation, one potential index of drought conditions (CONAGUA 1997: 5.1.1-a-15).

III. The Dispute and its Aftermath.

When ill-fated Spanish explorer Cabeza de Vaca explored the area known as La Junta – the joining of the Río Conchos and Río Grande – and marveled at the vast farming communities and huts there, the Conchos already flowed into the Río Grande (Thompson 1985.) However, that was well before the Río Grande became "internationalized," with the signing in 1848 of the Treaty of Guadalupe Hidalgo after the United States –Mexico war. The Río Grande/Río Bravo was a physical boundary, easily visualized, and the fate of its water supplies was never a major international issue. Instead, the dispute over the river following the war involved the location of the boundary, not what to do with its waters.

The Convention of 1889 established an actual commission -- at that time known as the International Boundary Commission –to deal with the fact that the river – the boundary – was in continual motion, meaning that one day a piece of land might be on the United States side, and the next it might be on the Mexican. In the 1890s, disputes over utilization of the waters began to emerge between the two countries. The U.S. practiced what was known as the "Harmon" Doctrine. Named after Attorney General Judson Harmon in response to a dispute over the utilization of the Rio Grande in 1895, Harmon declared that "the rules, principles, and precedents of international law impose no liability or obligations upon the United States." The Harmon Doctrine asserts that in the absence of established law to the contrary, states are free to exploit resources within their jurisdiction without regard to the extraterritorial effects of such action (Lipper 1967).

In 1906, the first *Convention* specifically dealing with water deliveries was signed between the two nations, assuring a delivery of Río Grande waters to farmers near Ciudad Juarez, across from El Paso. The Convention of 1906 guaranteed these farmers 74 million cubic meters of water per year (60,000 Acre-Feet), to be delivered to the Acequía Madre, literally the Mother Canal, on a monthly scheduled basis. As part of the Convention, and to meet the provisions, the United States constructed the Elephant Butte Dam in its territory. The Convention includes the provision that in case of extraordinary drought or serious accident to the irrigation system in the United States, water delivered to the Mexican Canal shall be diminished in the same proportion as the water delivered to lands under the irrigation system in the United States (Kelly 2001). The treaty was a result of the plan to build large-scale dams in New Mexico as part of the development of large-scale irrigation projects in the U.S. Those dams – Elephant Butte and Caballo – would fundamentally change the flow of the upper Río Grande in the mid-to-late 1910s and the Convention assured Mexican farmers operating in Chihuahua that there would be a spring supply for their crops (Everitt 1998).

Still, the U.S continued to practice the Harmon Doctrine, which meant that any waters in the U.S.—such as the Pecos and Colorado – flowing into Mexico were still considered U.S. waters.

"The United States was trying to impose the vision of a country with "upstream waters" and it adopted for many years the Harmon Doctrine, according to which they could do anything they wanted without taking us into consideration," explained Dr. Alberto Székely, who served as the Foreign Ministry's chief negotiator during the recent dispute over the 1944 Water Treaty. "Mexico fought precisely the opposite thesis, which is now internationally consecrated, and that is the equitable and rational use of an international watershed." (Abella 2001).

Mexico began to develop its own irrigation districts and dams in the 1920s and 1930s and demanded that the different basins that stretched between the two countries – the Rio Grande, Colorado and Tijuana river basin be linked as part of one negotiation, which the U.S. resisted. With improved relations between the two countries during the Second World War, Mexico and the U.S. negotiated a treaty in Washington over allocation of the international waters, including the Río Grande. The Harmon Doctrine was dropped, and with it, rivers like the Conchos in Mexico and the Colorado in the U.S. became shared waters. Mexico also agreed to support the U.S. call for a United Nations as the Second World War winded down, as the water issue was linked with the U.S. attempt to increase its international presence (Fischhendler, Feitelson and Eaton 2004: 638).

Officially known as the "Treaty between the United States of America and Mexico Respecting Utilization of Waters of the Colorado and Tijuana River and of the Río Grande," the 1944 Water Treaty guarantees deliveries of U.S. waters from the Colorado River to Mexico, while also establishing that the U.S. has rights to one-third of the flow reaching the main channel of the Río Grande from the Conchos, San Diego, San Rodrigo, Escondido, Salado and Las Vacas Arroyo, so long as the flow averages at least 472 million cubic meters (350,000 acre-feet) per year averaged over five consecutive years (IBWC 1944).(see Table 2.5).

Under Article 4 of the agreement, if the annual 472 million cubic meter requirement is not met due to "extreme drought conditions" -- a term which is not defined in the treaty itself or subsequent amendments -- the amount should be made up in the next five year period (Brandes 2000: 1). The Treaty does not address what happens if drought-like conditions extend beyond a five-year period, however, which became a major sticking point between the two countries (Kenneth Rakestraw, IBWC, Personal communication with author, 2005).

The implementation of the 1944 Treaty is administered by the International Boundary and Water Commission (IBWC) in the United States and the Comision Internacional de Límites y Agua (CILA) in Mexico. The 1944 Treaty gave the bifurcated agencies their new names and increased their role to more explicitly deal with the allocation and management of international waters.

Table 2.5. Water Allocations Under U.S. –Mexican International Treaties

Treaty	RIvers	Mexico	United States
Convention of 1906	Río Grande above Fort Quitman	Mexico allotted 74 Million Cubic Meters (60,000 acre-feet) per year of the waters of the Río Grande to be delivered at the headgate to Mexico's Acequia Madre just above Ciudad Juárez, Chihuahua for irrigation.	Charged with building Elephant Butte Reservoir to control discharges in Upper Río Grande; Deliveries can be reduced in “extreme drought” by same proportion as allocations U.S. farmers receive.
Convention of 1933	Río Grande above Fort Quitman	Agreed to “straighten” and stabilize 249 kilometers of international boundary in upper Río Grande	Agreed to “straighten” and stabilize 249 kilometers of international boundary in upper Río Grande
Treaty of February 3, 1944	Río Grande Downstream from Fort Quitman to Falcon Reservoir	One-half of all flows occurring in the main channel, including from unnamed tributaries.	One-half of all flows occurring in the main channel, including from unnamed tributaries.
	Río San Juan and Río Alamo	All water reaching main channel, including return flow from lands irrigated by two rivers.	None
	Pecos and Devils Rivers, Goodenough Spring and Alamito, Terlingua, San Felipe and Pinto Creeks	None	All water reaching main channel, including return flow from lands irrigated by named rivers and streams.
	Río Grande below Falcon Reservoir	One-half the flow in the main channel of the Río Grande below lowest international storage dam (Falcon Reservoir).	One-half the flow in the main channel of the Río Grande below lowest international storage dam (Falcon Reservoir).
	Río Conchos, San Diego, San Rodrigo, Escondido and Salado and the Las Vacas Arroyo	Two thirds of the flow reaching the main channel from six Mexican tributaries, subject to U.S. right to an average of at least 431.7 MCM/yr (350,000 AF/yr) in cycles of five consecutive years.	One-third of the flow reaching the main channel from six Mexican tributaries, providing that this shall not be less, as an average amount in cycles of five consecutive years, of at least 431.7 MCM/yr (350,000 AF/yr).

Treaty	RIvers	Mexico	United States
	Colorado River	Guarantees the annual delivery of 1,850 MCM/yr (1.5 million AF/yr) to Mexico south of the border.	Delivery subject to drought conditions. If irrigators in California receive reduced deliveries, deliveries to Mexico can also be reduced by similar amount.
Minute No. 242, 1973	Colorado River		Establishes minimum and maximum salinity standards for delivery of Colorado Rivers under terms of 1944 Treaty.

Sources: International Boundary and Water Commission website (www.ibwc.state.gov/html/about_us.html), accessed December, 2005; and Kelly and Contreras 1998: 13.

Despite a few disputes over the movement of the boundary – resolved with the 1963 Chamizal Convention and subsequent “minutes” or amendments to the Treaty – and an ongoing dispute over salinity levels from the Colorado – in part resolved in the 1970s -- relations between the two Commissions have been fairly harmonious. Until the late 1990s.

The dispute between the U.S. and Mexico over Mexican water deliveries under the terms of the 1944 treaty began innocently enough, according to onlookers and participants. By the mid-1990s, agriculturalists from South Texas – the downstream users of the Falcon and Amistad dams – were already alerting politicians and the U.S. State Department that Mexico “was not complying with water deliveries.” (Buddy García, Texas Deputy Secretary of State, Personal communication with author, 2005). The 1995 Hydrological Year hit several regions hard, including Chihuahua – where no water was released from the irrigation dams – Nuevo León, Tamaulipas and the Lower Río Grande Valley. Water levels in the Falcon and Amistad International Dams began to fall precipitously as years of low inflow into the Río Grande and low precipitation locally took their toll.

Little happened diplomatically. Following the 1992-1997 five-year cycle, IBWC and CILA huddled and came to a rapid agreement on the total water deficit that had accumulated over the cycle.

"When the end of 1997 revealed the large debt, there was no official action, just a passing of letters recognizing there was a large debt of over one million acre-feet," noted acting IBWC Principal Engineer Kenneth Rakestraw. Rakestraw headed the Water Accounting Division at the time, and was thus most directly responsible for analyzing the numbers (Rakestraw, IBWC, personal communication with author, 2005). "It was the first time that there was a failure by Mexico to deliver…. It was an observation, but there was no real search for solutions."

Rakestraw's counterpart in Ciudad Juarez, CILA Principal Engineer Gilberto Elizalde, remembers a similar situation. "At that time there was concern about the deficit (with the U.S.), but we also recognized that rains might come … but the drought was much more extensive than had ever been known historically." (Elizalde, personal communication with author, 2005).

Despite official agreement about the amount owed by Mexico, by 1998 there were already differences emerging about the reasons why. For Mexico it was an extraordinary drought, for the U.S. it was a lack of political will.

"Mexico already carried with us the concept internally that the payment troubles were because of the extraordinary drought, while the U.S. said no," noted Elizalde. "The polemical situation existed because (Article 4 of) the treaty didn't specify what it (extraordinary debt) meant." (see also Mumme and Aguilar Barajas 2003: 64-65).

Rakestraw said the IBWC recognized there was reduced rainfall throughout much of the Southern U.S. and northern Mexico, but believed the real dispute had emerged by 1999 or 2000 “when it became clear that Mexico was not going to do anything.” Rakestraw said that as the issue began to show up in newspapers, politicians began to pay attention and call for action.

Politicians weren’t alone. South Texas farmers, incensed that the IBWC had no real enforcement powers, began to call for more drastic action – including boycotts of Mexican products or non-payment of the Colorado waters – the two riverbasins in fact linked by the 1944 treaty -- while Non-Governmental Organizations like World Wildlife Fund, and the Texas Center for Policy Studies with an “environmental” focus called for improved water management in the entire Río Grande basin – and more efficient use of water -- as the solution (Brock, Chapman and Kelly 2001; TCPS 2001).

The deficit continued to rise.

In response, in 2000, then IBWC Commissioner John Bernal commissioned Austin-based engineer Dr. Robert Brandes to assess the deficit. The idea for the study emerged from Bernal himself and an ad-hoc working group formed with U.S. farmers and officials, according to Rakestraw (Rakestraw, Personal communication with author, 2005). The study – *Preliminary Analysis of Mexico’s Río Grande Water Deficit under the 1944 Treaty* -- did not bring the two sides closer together, since it largely blamed Mexican management of dams for the lack of inflow into the Río Grande (Brandes 2000).

The “Brandes” report concludes that the inflow reduction to the Río Grande is fundamentally the result of Mexican water management. The report states:

> Mexico has substantially more storage capacity (than before) and therefore has the ability to store and use more of the runoff from the tributary watersheds before it reaches the Río Grande (Brandes 2000:16).

Rakestraw said despite the report, the IBWC never had a real interest in pinpointing the cause of low-flow, but wanted to point out that Mexico was not managing the dams as if the 1944 treaty existed. “Basically we agreed with the Brandes report that the reservoirs were not managed to meet the 1944 treaty and that they have never released any water to meet provisions of the treaty.”

The report was followed somewhat predictably by a Mexican written response led by CONAGUA – the National Water Commission -- although CILA also collaborated (CONAGUA 2000; Elizalde, CILA, Communication with Author, 2005). The CONAGUA report again emphasized that the water management policies were in response to the drought, which again was the primary cause of low in-flows. This in turn was responded to internally by another Brandes report which detailed more explicitly storage levels (Brandes 2002).

The Brandes report was seized on by South Texas farmers as proof that Mexico had no interest in meeting their treaty obligations, while the Mexican response was used by Mexico – and widely reported by the Mexican press and politicians -- to prove that the real problem was both a drought and the silting up of their dams, meaning the actual amount of water flowing in the dams was much smaller than gauges and satellite photos might indicate.

In the meantime, the Texas Center for Policy Studies[5], a small non-governmental organization in Austin, Texas, with a long history of working binationally on

[5] The author of this dissertation first began working at TCPS in 1994, and has served as its director from October of 2002 to the present. However, he was not the principal

border issues, released a report in January of 2001 (Kelly 2001). *The Río Conchos: A Preliminary Report*, was intended, according to its author, to present the facts, plane and simple, for a watershed which was suddenly in the spotlight in Mexico City, Washington and Austin. If nothing else, the report offered people a no-nonsense description of the basin and the challenges facing the irrigation districts.

"There were a lot of statements from a lot of people about the causes of the drought and the intentions of Mexico and Chihuahua," noted Kelly. "But we felt with a little truth shined on the subject there would be realization that there were both challenges and opportunities to solve the crisis."

In February of 2001 a truly extraordinary event occurred – the Río Grande dried up at its mouth. While the sand bar that formed across Boca Chica Bay probably was the result of unusual wave action, the reduced flow of the Río Grande and the increased vegetation choking its course were factors as well, and the symbolism was seized upon by politicians and policymakers alike (García, personal communication with author, 2005).

That same month, President George W. Bush and Mexican President Vicente Fox huddled at a ranch in Guadalajara Mexico to discuss a variety of topics, including the water deficit. Fox came armed with a proposal – a promise to deliver 740 million or 600,000 AF by September 2001, which was seized upon by Bush and the leaders pledged to make the promise a reality.

The IBWC continued to meet with their counterparts in Ciudad Juarez to work out the details of Fox's proposal, and the main players soon moved to Washington, DC, where the two sections were serving as the technical advisors to the main

author of the TCPS report on the Conchos, which was written by then director Mary Kelly.

negotiators, led by the State Department and Mexico's Secretaría de Relaciones Exteriores (Foreign Ministry). On March 16, 2001, both Commissioners – Acting IBWC Commissioner Roberto Ortega and CILA Commissioner Arturo Herrera – signed Minute 307, confirming the presidential agreement signed the month before (IBWC 2001).

Both governments were anxious to present some good news and the signing of Minute 307 in Washington was an indication of just how important the negotiations had become. Minute 307 also indicated both governments would begin work on a drought management plan and other measures to reduce overall water use.

"It made for good sound bites," noted then-Texas Deputy Secretary of State "Buddy" García, a point man for Texas Governor Rick Perry on both border issues and the water debt. "But it didn't lead to satisfaction and actually raised the ire of South Texas farmers, who felt that we – the United States – were hoodwinked."

Seizing on the apparent progress, TCPS began to meet individually and collectively with other Non-governmental Organization in the U.S. and Mexico and arrived at a common set of principles – a "Binational Declaration on the Río Conchos and the Lower Río Bravo/Río Grande" – that was meant to help both governments "work jointly to identify measures of cooperation on drought management and sustainable management of this basin," as in fact Minute 307 had announced (TCPS 2001: 1)." Among a host of measures, the declaration specifically called for international monies to be earmarked for water conservation, water use efficiency and water quality, better dam operation procedures, as well as plans to leave some waters in the increasingly dry rivers for “environmental needs,” sustainable forestry projects and a stakeholder process to develop a drought management plan.

Signed by 22 primarily environmental organizations, the declaration was an attempt to bring a different perspective into the negotiation process and highlight some of the efforts being pushed by the NGOs themselves (Mary Kelly, personal communication with author, 2005). The signers included some of the leading environmental organizations in Mexico such as ProFauna and Pronatura Noreste, as well as local groups like the Comision de Solidaridad y Defensa de Derechos Humanos, international groups like Environmental Defense and World Wildlife Fund-Chihuahua, and a host of smaller regional organizations such as the Southwest Environmental Center, Río Grande Institute and Friends of Big Bend National Park (TCPS 2001).

“There was a real optimism in 2001 that we could use the crisis of payments to change policy in both countries,” noted Mary Kelly, who was TCPS’s director at the time. “And in fact it helped focus attention on the need for water use efficiency in both countries, but many other opportunities for change were missed in the post-9/11 atmosphere and bickering between the two sides.”

Despite an early good faith payment, the resulting 740 MCM never arrived. By April of 2002 the total deficit had risen to not only some 1.25 billion cubic meters (1.02 million acre-feet) from the first cycle, but also nearly 620 MCM (500,000 acre-feet) from the second.

Again, the two sides repeated nearly the same discourse, with Mexico insisting 2000-2001 had been a particularly dry year, making it impossible to keep their commitment, and the U.S. simply repeating the mantra that they must comply with the treaty (Brandes 2002). “The climactic situation (discussed in Minute 307) simply did not occur," maintains Elizonde (Elizonde, personal communication with author, 2005).

Chief negotiator Székely, in an interview with a Mexican radio station in October of 2001, reiterated the Mexican position in regards to the water deficit.

"It is not really a debt, it is a treaty by where we are obligated to give some 431 million cubic meters to the U.S. annually, which comes from the Conchos system and that empties out into the Bravo," explained Székely. In fact, Székely insisted that Mexico was complying with the treaty by paying off the 1992-1997 cycle with the waters entering the Río Bravo during the ensuing cycle of 1997-2002 and would have the 2002-2007 cycle to pay off the 1997-2002 debt. "It is not about a problem of a strict debt, nor even non-compliance with the treaty, but if we have not delivered all the water, it is because there wasn't the water, and the Mexican users have suffered just as much the Americans."

The American farmers were incensed by Mexico's interpretation. "We are upset, angry and scared," stated Gordon Hill, general manager of the Bayview Irrigation District to *The New York Times* in September of 2001. "We've got farmers going out of business because Mexico has broken its promises on releasing water." (Milloy 2001: A14).

"They (the State Department) had expected to get praise, but received only criticism," noted García. "After (Mexico failed to comply with) the Minute, they turned to the State (of Texas) and said what can we do?" (Garcia, personal communication with author, 2005).

García said from 2002 to 2005 the State of Texas was included. He said part of the difficulty between the two sides was the discourse. While Mexico, as expressed in Szekely's statements, essentially wanted to treat the water deficit like a loan that they would pay back over time, the U.S. wanted a quick resolution and wanted Mexico to admit it was not complying with the treaty. The rhetoric and blame-game continued over the next six months.

"For Mexican politicians, it would be suicide to announce we are not complying with the treaty and must pay it back as soon as possible," García noted. García noted that Texas Governor Perry and Governor Martinez from Chihuahua were often at odds over the issue during the annual Border Governors Meeting and the 2002 to 2003 period was one characterized by strident rhetoric from Texas politicians.

At a rally organized by South Texas farmers in March of 2002, some six months before his election, Governor Perry personalized the message toward Governor Martinez. "Governor Martinez and President Fox need to know that Texans are hurting," Perry told the farmers and officials in attendance. "We have lost a billion dollars in economic activity because of Mexico's failure to deliver promised water .. and more than a half-million acres of irrigated crops because of Mexico's failure to deliver promised water." (Perry 2002).

Perry continued:

> Water is available in more than a dozen upstream reservoirs on Río Grande tributaries. That's how Mexico can irrigate crops in Chihuahua instead of living up to its treaty obligations. Since 1992, Mexico has kept all water that fell above the Luis Leon Dam on the Río Conchos, and Mexico's current debt is more than 1.4 million acre feet of water………Mr. President, "entrega nuestra agua!" Governor Martinez, please send us our water! (Perry 2002).

Governor Patricio Martínez was already doing some grandstanding of his own. In November of 2001, Martínez staged a mini-invasion of the desert dam of Luis León. State police agents seized the sleepy Comisión Nacional de Agua workers, charged with overseeing operation of the dam. For a time, they wouldn't even let the workers speak with their superiors in Chihuahua and Mexico City ("Rodriguez," Luis León Dam, CONAGUA, Personal communication with author, Luis Leon Dam, 2003).

Martínez's rationale was to ensure that with the main irrigation season having ended, no waters from the dam should be released during the winter to the U.S. Eventually, communication lines were opened, Martínez was reminded that the dam belonged to the Federal Government and not the state, and the state guards and police left in their helicopters and trucks as mysteriously as they had arrived (Rodriguez, 2003).

Still, US and Mexican officials and both sections of the IBWC continued to meet, and in June of 2002, signed Minute 308. Minute 308 obligated Mexico to pay a one-time contingency of 111 MCM (90,000 Acre-Feet) to the United States by releasing waters from the Amistad and/or Falcon Dam that had been attributed to Mexico (IBWC 2002). In addition, Minute 308 made reference to a Mexican program to invest monies in the modernization of irrigation districts in Northern Mexico and use the resulting savings in water to help meet their treaty obligations. While the Minute contained no details about the program, it was the first recognition that water conservation and efficiency projects might be used to help pay off the deficit. Minute 308 also discussed setting up a Drought Management Plan and an Advisory Council to help come up with solutions to the water management problems. While a somewhat ambiguous text, the Minute appears to recognize that the present water crisis was potentially due both to drought conditions and inefficient management practices.

Rakestraw said he is not sure where the decision to include information about a Mexican water conservation program came from, but said they viewed it as a way to put some positive ideas into the document. Elizalde said that CONAGUA had had a program to modernize and rehabilitate the irrigation districts for many years, but around this time had begun a more intensive program to “optimize” volumes within the Irrigation District and they began to share this information about efforts with their U.S. counterparts (Elizalde, Personal communication with author, 2005).

“It was the drought that caused CONAGUA to begin to look at the sustainability of the watershed,” Elizalde stated. “We began to share information about the whole Río Bravo watershed.”

Elizalde’s boss, long-time CILA commissioner Arturo Herrera, said the idea to put money into the irrigation districts as a solution to the water dispute came from CILA’s internal analysis of the causes of the water crisis (Herrera, Personal communication with author, 2005).

“We saw there being three causes of the drought in Mexico and we gave these three observations to the SRE (Foreign Secretary) as part of the negotiations. The first was the lack of rainfall and the climactic change which is a global problem where CILA has no jurisdictional power; the second was a regional problem which had to do with the problem of deforestation and deterioration – which we insisted could be solved but over the long term by beginning specific programs; and the third was a local problem – the overuse and inefficient use of water, which could be solved by investing money in water conservation.”

Kelly for her part, said the NGO Binational Declaration on the Río Conchos, as well as her long-time friendship with chief negotiator Szekely – a leading environmental lawyer in Mexico – helped put a focus on water conservation and drought management (Kelly, Personal communication with author, 2005).

Elías Calderón, CONAGUA's Manager of the Ojinaga Water District, said the roots of conservation as a solution to the water deficit actually lie in changes in Mexican law (Calderón, Personal communication with author, 2004). "The changes in the Water Law forced us (CONAGUA) to look at water rights on a watershed basis and we saw that the amount of water was no longer sustainable in our dams to meet water concessions to the districts." Calderón said the obvious solution was to reduce the water concessions by investing in the irrigation districts.

Following Minute 308, border agencies were quickly put into action to try and put teeth into the Mexican commitment to increase water conservation in the irrigation districts to "free up" water to the Río Grande.

The primary institutions were the Border Environment Cooperation Commission (BECC), headquartered in Ciudad Juárez and the North American Development Bank (NADBANK) – based in San Antonio, Texas. These binational institutions were established by a 1993 agreement between the U.S. and Mexico parallel to the North American Free Trade Agreement (BECC 1993; Varady et al. 1997.)

The BECC's stated goal was to assess potential environmental infrastructure projects within the first 100 kilometers of the border – principally potable water, wastewater treatment and solid waste management – and "certify" them for potential binational funding if they met basic certification criteria. Their sister organization – the NADBANK -- was a development bank which operates with “paid-in” and callable capital from both governments to lend out as well as grant to build the projects certified by the BECC. (Varady et. al. 1996).

While the focus of both institutions had largely been municipal border projects – wastewater treatment plants, landfills, and laying pipes – a reform effort in 2000 led the two institutions to add agricultural water conservation as another priority (Kelly and Reed 2000). The effort proved prescient as the two institutions became recast as instruments to help solve the water dispute. Both the BECC and NADBANK had Board of Directors that included representatives from many of the institutions involved in the water deficit dispute such as the IBWC, CILA, EPA, State Department, Treasury, SRE and Hacienda, and observers say it was only natural that these institutions would be asked to step into the ring (Arturo Herrera, CILA, personal communication with author, 2005).

More specifically, BECC was asked by its Board to assess, certify and make CONAGUA’s proposed district modernization project eligible for binational funding, and to do so in a matter of months, rather than the regular process, which often takes years (Gonzalo Bravo, BECC, personal communication with author, 2005).

Under BECC certification criteria, public meetings were required as well as acceptance by local communities, meaning the farmer associations making up the irrigation districts had to show approval of the project and it all had to be done publicly and quickly.

The elected presidents of every individual farming association from all three Río Conchos irrigation districts – Delicias, Florido and Bajo Río Conchos -- were called to a meeting in Delicias, Chihuahua so that officials from CONAGUA, BECC and the state government could explain the water conservation program in

August of 2002 (Kelly and Luján 2003). Essentially, the leaders were told that they would be getting a vast influx of cash and modernization in the districts, but in return, they would be asked to sign what essentially was a contract agreeing to reduce their water rights once the modernization project was complete. While initial plans called for BECC certification of water conservation projects in all three Río Conchos irrigation districts, eventually they reduced the number to one – the Delicias Irrigation District, by far the largest and logically the one where investments would lead to the greatest water savings. Still, the water conservation projects were also approved in the other two districts as national projects (see Chapters Five and Six).

After CONAGUA decided to refocus the project on Delicias Irrigation District itself, dozens of meetings were held in all 10 irrigation associations making up the district, and eventually with the upstream "old" irrigation units in Camargo and San Francisco leading to the signing of the paperwork by each individual farming association making up the district, with the exception of two "Modules" which initially refused to participate in the program (Luján and Kelly 2003).

Former Chihuahua State Rural Development Agency representative Martin Herrera said the process was intense and conflictive. "In essence we were under pressure to get these farmers to agree to give up their water rights, but do so in a way that showed them they would ultimately benefit which was difficult" (Herrera, Personal communication with author, 2005). The documents were signed by the Irrigation User Associations, the State Government through the Rural Development Agency, and CONAGUA officials in all three Districts, with the exception of the two Modules -- "Seven and Eight" -- within Delicias which missed out on the first year of water conservation funding.

The documents themselves state that the savings from modernization and from increasing irrigation technology would be split three ways: 25 percent to the farmers; 50 percent to meet Treaty Obligations; and 25 percent for CONAGUA to use as they saw fit. Most observers, however, knew what CONAGUA's portion of the water likely referred to: the behemoth that the City of Chihuahua has become with its vast and increasing water needs.

Under the project certified by the BECC in October of 2002, CONAGUA committed to spending over $104 million in the Delicias Irrigation District between October of 2002 and September of 2006, while the BECC certification would lead to an additional $40 million being spent with NADBANK monies earned from interest paid on the capital put in the bank by both countries (BECC 2002).

The prospect of paying Mexican farmers to give up their water rights did not sit well with many individual farmers who still felt the money should be used to free up water for further irrigation expansion. Some Mexican irrigation farming association leaders signed the documents reluctantly, remembered Herrera and other observers, while others initially refused.

"We said from the beginning that we would only reduce our water rights after the conservation projects were completed, and after they verified that the savings had actually occurred," remembered Arnaldo Valenzuela, President of Module 5 in the Lower Río Conchos Irrigation District from 2002 to 2005. (Valenzuela, Personal communication with author, 2005).

Many US farmers were also angered by the project, viewing it as a bribe to get Mexico to comply with the treaty. To sweeten the deal, negotiators – which included for the first time representatives from both the U.S. Treasury and the Finance Ministry (Hacienda) from Mexico -- doubled the amount of the

NADBANK grants to $80 million, with $40 million going to each country. The U.S. conservation projects – which stretched from California to Texas -- were designed and certified over the next several years, while the Mexican project was designed and certified in a matter of months.

In October of 2002, the Delicias project was certified amid some fanfare in Ciudad Juarez. The key to the certified project was that it obligated Mexico to make some of the water savings available to the Río Grande Basin, a fact that was put into writing in Minute 309, signed in July of 2003 (IBWC 2003). Minute 309 actually put information about the NADBANK and Mexican federal monies as an official amendment to the 1944 Treaty, listing what water savings could be expected and therefore the expected increased flows to Río Grande provided those savings occurred.

Interestingly, however, Minute 309 – which indicates all flows will flow to the Río Grande – contradicts the agreements signed by the farmer associations, which state that only 50 percent of the water conservation savings would flow to the Río Grande, indicating that the state-farmer agreements at the local level were different than the international agreements.

Rakestraw said the U.S. side was not so concerned with the details of the amount of water savings, but merely wanted to make sure there would be increased flows to the Río Grande. “They did release some additional waters in Mid-January to March 2005 from Río Conchos and we were advised it was due to savings,” he stated. (Rakestraw, Personal communication with author, 2005).

“You have to remember in Mexico water is a nationally-owned resource so basically CONAGUA decides where all the savings will go, and how to manage the water,” the CILA’s Elizalde explained. “If we deliver the water (required under the Treaty), the U.S. section doesn't have any reason to complain about where any savings might go." (Elizalde, Personal communication with author, 2005).

Still, if U.S. and Mexican meetings were leading to greater understanding, a unique agreement to pay for conservation in Mexican irrigation districts to free up water, and a less conflictive relationship, the lack of actual deliveries in HY 2002 and HY 2003 still caused ire among Texas politicians and farmers. In August of 2003, for example – after the BECC certification and Minute 309 had already been signed -- Perry would actually call for cutting off water deliveries from the Colorado River. "If diplomacy will not yield a fair result for our farmers, then maybe withholding regular releases to Mexico will get their attention," Perry told the Austin-American Statesman." (Herman 2003).

Even more vociferous was Texas Agricultural Commissioner Susan Combs. Combs continually took pains to present the water deficit as simply a matter of Mexico not wanting to comply, and used reports and satellite imagery to bolster her case. In October of 2002, Combs took part in a rally with South Texas farmers in calling for an economic boycott on Mexican products and economic sanctions for Mexico's failure to release more waters. Combs cited studies and satellite imagery provided by the University of Texas' Center for Space Research disclosing that Mexico had three times more water in its dams than it needed to pay off the U.S. (NewsMax.com 2003; Center for Space Research 2003).

According to Combs and the report, Mexico had more than 3 million acre feet of water in storage, and Combs used the report to tell White House officials that there were and are unprecedented amounts of water stored in Mexico. ``It's unbelievable that we can't push them on this, '' she told U.S. Water News, an online publication on water issues (U.S Water News Online, October 2003).

Combs' actions did not always sit well with some.

"We were not winning by calling (Chihuahuan Governor) Martinez names," recalled García. "Threats to boycott Mexican products was hardball… and you get more from honey than from vinegar."

García viewed the NADBANK/BECC projects as positive long-term, but said they were never going to resolve the crisis itself. "Even as they devised it as a solution, it was always intended to benefit the Río Conchos, and never intended to meet the needs of the Río Grande or Texas farmers," García asserted. (García, Personal communication with author, 2005).

García said the eventual roots of the resolution of the debt lay in two factors: increased rains and quiet, flexible diplomacy. "We weren't concerned anymore where the water came from because it wasn't going to come from Chihuahua." García said that Perry and Martínez eventually agreed not to beat each other up in the press.

Perry and Mexican President Vicente Fox met in Austin for face-to-face discussions on the water debt in November 2003, at which time Perry proposed that Mexico could repay its water debt by using water available in Mexican reservoirs other than Falcon and Amistad, or the Chihuahua dams.

At the same time, near record rains in several areas of the basin in the HY 2004 led, in Rakestraw's words to "the 2nd wettest year for wild water."[6] The rains helped ease diplomatic tensions and put a positive balance on the books as Mexico made a series of "payments", whether intentional or not.

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[6] Wild water refers to the runoff into Río Grande tributaries that is not released from dams but comes from localized rains and run-offs.

By October of 2004, in fact, the "deficit" from the 1992 to 2002 period had been reduced from some 1.7 billion cubic meters (1.5 million AF) to less than half, or 883 MCM (716,000 AF) (IBWC 2005). In March of 2005, Secretary of State Condoleeza Rice and Mexican Foreign Minister Luiz Ernesto Derbez came together for a one-day meeting in Mexico City on March 10th. Mexico agreed to repay the debt fully by September 30th of that year (IBWC 2005a).

Perry called a press conference in Mission, Texas the following week, and was joined by State Senator "Chuy" Hinojosa and other local politicians from the Río Grande Valley.

The new agreement was both specific and flexible (IBWC 2005a; Weissert 2005). It called on Mexico to:

- Transfer water from the Amistad and Falcon reservoirs to Texas, raising U.S. reserves from 95 percent of their storage capacity to 103 percent.
- Deliver at least the average minimum of 350,000 acre-feet of water per year for the remaining three years of the current cycle (from 2005-2007), and end the cycle without a deficit.
- Deliver remaining debt from any Mexican tributary, including those not covered by the 1944 Treaty;
- Give Mexico credit for evaporation and infiltration losses, in essence lowering the total amount of water owed by 170 MCM (138,000 acre-feet). (IBWC 2005a)

That same month, Mexico made the first transfer, some 210,000 acre-feet of water from the Anzalduas Dam, a small check dam upstream of the international dams, as well as from the Amistad and Falcon Reservoirs on the Río Grande. The Anzalduas relies on irrigation return flows from the San Juan watershed, which is considered 100% Mexican in the 1944 Treaty and thus not a required source of waters.

“To tell us to release water from the Conchos during a drought made no sense because the loss of water in the course of delivery was going to be enormous by the time it got to the Valley and no one would have benefited,” explained CILA’s Elizalde. “It was preferable … to say I am going to give you water where it makes sense for me to give you water.” (Elizalde, Personal Communication, 2005).

As September of 2005 drew to a close, negotiators and observers anxiously waited to see where the remaining water would be delivered. In fact, with less than 20 days left, Mexico still owed nearly 125 million cubic meters from the original debt of 1992-2002 as well as waters owed in 2005 (Osorio 2005: B1). Still, the debt was paid in full by September 27th, 2005 as Mexico made a series of transfers from the San Juan and Salado Rivers as well as from the international dams, some 13 years to the date from when “deficits” officially began to accrue (IBWCB 2005b). It would take a few more weeks to get totally caught up on the debt incurred in HY 2005, however (IBWC 2005c).

The final transfers actually came after CONAGUA reached an agreement with farmers in an irrigation district in Tamaulipas, similar in many respects to the agreement with the Chihuahuan farmers. In return for releasing water from their dam at the end of the irrigation season – thus lessening the amount of water they might have access to the following spring – CONAGUA agreed they would both spend money on “modernizing” the district, and build a rubber dam at the dam’s spill to increase the dam’s holding capacity by a reported 300 million cubic meters (Klerigan 2005). Thus, as in Chihuahua, CONAGUA felt it necessary to negotiate with farmers –- sweeten the deal -- to help Mexico comply with the

1944 Treaty. They would be giving up present waters in return for access to waters in the future.

“This is a tremendous victory for both countries,” Governor Perry said in a press statement following the IBWC announcement (Perry 2005). “Our farmers, ranchers and cities will have 100 percent of the water they are entitled to, not just for the rest of this year, but for all of 2006. Now that the debt is paid, both countries must continue to work in good faith to meet the water demands of citizens on both sides of the Río Grande for years to come.”

Again, South Texas farmers were less thrilled because they felt it was nature, and not political will that had allowed Mexico to meet its obligations. In fact, in the end rains – wild waters -- in the Conchos, Salado and San Juan watersheds led to much of the payments that reduced the debt in 2004, although Mexican also released waters from the international dams, the Conchos and San Juan River basins as good faith payments in 2005.

And just what lessons were learned from the last 13 years? According to the IBWC’s Rakestraw, what is positive is that IBWC and CILA became more open, more responsive to the public and still remained a positive mechanism in place to talk about the debt. On the other hand, “progress was slow and there was no enforcement … and there is a general acceptance they didn’t comply with the treaty.”

Rakestraw says Mexico “was generally more concerned with their own social situation than complying with the treaty,” a fact also agreed to by García. Elizalde did not disagree. “The two sides had always worked together in times of normal climate, never had we been faced with such an extensive drought,” Elizalde noted. “The IBWC-CILA mechanism worked, but it had to be handled at higher levels, but always with our technical guidance.”

“What is lacking in the Treaty is a specific rule or regulation on how to manage watersheds in times of normal rainfall, in times of abundance and in times of drought,” Elizalde explained. “During the drought, every person in Mexico saw their local problem, and what is needed is a more general vision in the country, a regulation to know how to share water in times of scarcity.”

IV. Conclusions

A fierce debate brewed between U.S. and Mexican officials during the late 1990s, as inflows from Mexican tributaries dried up or at least never reached the Río Grande, putting Mexico out of compliance with the 1944 International Water Treaty between U.S. and Mexico. In fact, between 1993 and 2002, Mexico built up a deficit under the 1944 Treaty of more than 1.5 million AF or 1.85 billion cubic meters. Because the Río Conchos – contained almost entirely in Chihuahua -- historically provided the majority of inflows to the Río Grande, much of the debate and discourse of different interest groups focused on rainfall and riverflow in that large subbasin, which stretches from pine forests in Southern Chihuahua to the outflow near Ojinaga in the heart of the Chihuahuan desert. While South Texas farmers and many Texas officials blamed expansion of Mexican irrigated agriculture in Chihuahua and management of the dams for internal use as the cause of low inflows, Mexican officials and academics put the blame almost squarely on the lack of rainfall – drought plain and simple. A more nuanced discourse among academics, environmental groups and some government officials focused on deforestation and land management as having impacted both sedimentation of the dams and local rains.

The negotiations went beyond the efforts of the official guardians of the 1944 Treaty – the International Boundary and Water Commission and the Comision Internacional de Limites y Aguas – to the highest level of government, including face-to-face meetings between President Bush of the U.S. and President Fox of Mexico. Negotiations both within the IBWC/CILA and at the higher-levels led to a number of important efforts and changes. For one, on the U.S. side, the State of Texas became part of the negotiation process. In addition, in 2002, the Border Environment Cooperation Commission and North American Development Bank, approved funding to improve water conservation in Chihuahua's irrigation districts, with the expressed intent of reducing water use in the districts, and increasing flows to the Río Grande (IBWC 2003). Significant monies were poured into water efficiency and conservation projects, particularly in the Delicias Irrigation District. Finally, however, negotiators reached a flexible agreement in March of 2005 and Mexico "paid" off the water debt it had incurred at the end of September of 2005, in part by releasing waters – the result of heavy hurricane-aided rains -- from tributaries not covered in the 1944 Treaty (IBWC 2005).

Chapter Three: Why the Pitiful Flows? Narratives and Facts about the Río Conchos Flows, 1990-2005

> “The river fell lower and lower as they went until there was almost no water in it. But where the Conchos entered from Mexico the river sprang back to life again with renewed flow from the great tributary; and similarly the life of faith was redoubled again in the friars when they came to first Indian town in the Junta Country and saw the first church built….

Horgan 1954: 299 reporting on the trip of Fray Nicolás López along the Río Grande in 1683. Paul Horgan. *The Great River: The Río Grande in North American History.* New York: Rinehart, 1954, reprinted 1984.

I. Introduction

Just what did happen to the Rio Conchos between 1990 and 2005? Why did a river which had always provided sufficient waters to the Río Grande Basin suddenly provide so little? Why did the ire of U.S. farmers and officials turn so virulently against Chihuahua as the main culprit in the water dispute? Why not Coahuila, or Nuevo Leon, or the growing city of Monterrey? This section analyzes the reduced flows themselves, before the next section turns to several of the potential factors in the reduction of flows, from drought to dam management, and what key actors said – or didn’t -- about those potential factors. Thus, the chapter provides insight into both the facts of the dispute as well as the narratives, and finds that most likely rather than a simple essential cause, a multiplicity of causes – sometimes one producing another – was the more likely explanation.

II. Just the Facts Jack: What Happened to the Río Conchos

A. The Conchos Water Station

Water flow data for the Conchos River at its mouth near Ojinaga, Mexico comes from a hydrological station maintained by CILA. Located approximately two kilometers upstream from where the clearer Conchos waters enter into the muddy Grande waters, the station has been in its present location since April of 1954. Previously, CONAGUA maintained a station closer to the actual outflow, but only yearly averages are available from 1940 to 1954. In fact, while officially a CILA station, it often fell upon CONAGUA to provide monies and personnel to maintain the station, and it is only after 2003 that CILA has assumed full responsibility and maintenance of the Ojinaga station (Elizalde, CILA, Personal communication with author, 2005).

The Ojinaga Streamflow Gauge consists of two structures (See Photo 3.1 and 3.2). One, located on a sandy bank filled with mesquite, grasses and tamarisk, is simply a 20-foot tower leading to a caged transport device – a kind of mini-gondola, which can travel by cranking a shaft toward the second tower. Resting on a cement pillar, which enters the sandy bottom of the Conchos, the tower houses a small platform above and a stream-stage ruler below. There is also – below the surface – a streamflow gauge. To one side, on the top of the pillar, a door is opened, revealing a lithograph paper which continually records the flow being measured by the gauge itself just below the surface of the water. To the other, and above, is a small caged container which, when unlocked, reveals a box containing a laptop attached to a satellite. This box dates only from 1999, as CILA added satellite telemetry to its Ojinaga station. The funding came from CONAGUA. Then, in August of 2005, CILA again upgraded its satellite technology, adopting the same satellite technology used by the US side, made by a company called Sutron, as part of a binational effort to improve the technology (Elizalde, CILA, personal communication with author, 2005).

Photo 3.1. CILA Hydrological Station, Ojinaga, 2005. Stream gauge is located two kilometers upstream of where the Conchos enters the Río Grande.

Photo 3.2. Close-up of CILA hydrological station. Round structure houses lithography, while box houses the satellite telemetry station.

Far removed from international negotiations or disputes over low-flow, the actual mechanisms – and personnel -- involved in measuring flow are decidedly rudimentary. Both the IBWC – from its new offices in Presidio, near the local High School and CILA – with its single office on the banks of the river in Ojinaga – share information from stations in the area (see Photo 3.3). “Nacho” Bañuelos is a young Mexican engineer who arrived with his wife in 2005 for the first time as a new CILA employee. His charge? Measure the flow of the Conchos, and watch the diversion of the Río Grande at El Mulato, some 30 kilometers downstream of where the Conchos flows into the Río Grande. There, a Mexican farming community has historically watered some alfalfa and cotton fields along the banks of the river. Other minor diversion points along the include a diversion device upstream within the Lower Río Conchos Irrigation District near Cuesta Alta on the Río Grande. There, farmers from “Modulo 5 –Labores del Paso” irrigate fields when local rains swell the border river (see Photo 3.4).

Photo 3.3. CILA office in Ojinaga at the Old Bridge, Ojinaga

Photo 3.4. Diversion dam near Cuesta Alta, on the dry Río Grande, 2005.

Bañuelos job is relatively simple (Bañuelos, personal communication with author, 2005). His office is in the old structure that housed the Mexican Customs Office of the original international bridge between Ojinaga and Presidio. A meteorological station sits in one corner, and his wife has assumed the responsibility of checking the readings and writing them down. Every two or three days, he gets up at the crack of dawn – to beat the hot Ojinaga sun – and visits the Ojinaga gauge, traveling in his CILA-commissioned pick-up truck along the levees of the Río Grande toward the Conchos outflow. Descending from the levee, he backs his truck to the banks of the Río Conchos, puts on his waders, and prepares his equipment. He will measure the flow at various points and depths across the river using a standard rod with a propeller before comparing that reading with the lithograph and satellite telemetry above in the tower (Photo 3.2).

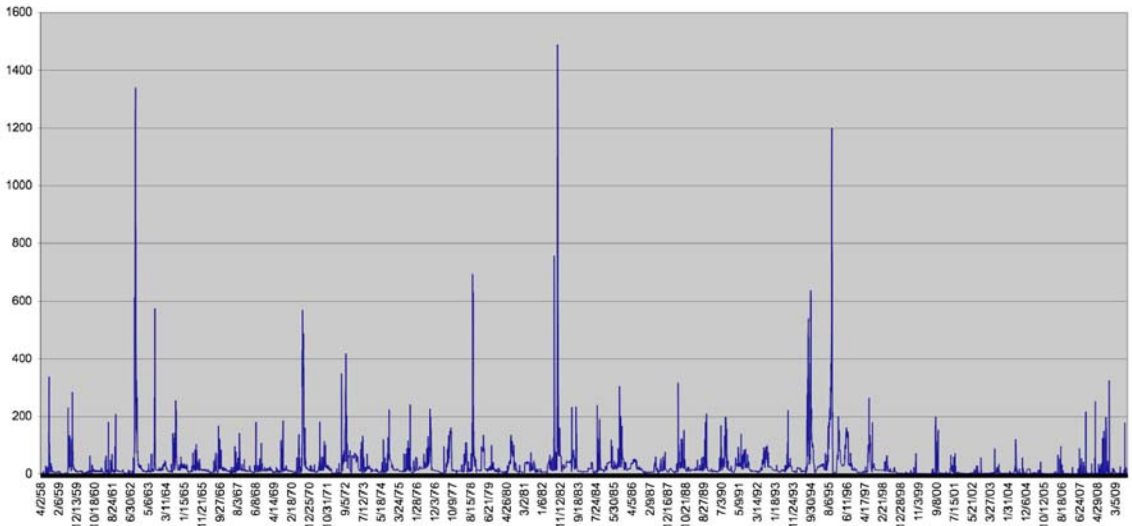
Photo 3.5. CILA employee measuring flow near Ojinaga Gauge Station

He then goes back to report his findings by telephone and/or e-mail both to his direct bosses in Ciudad Acuña, Coahuila, as well as to his counterparts in IBWC-Presidio. Every month it will be time to change the lithograph paper, and about every two to three months, or more likely after every big local rain, he will help clean the base of the station and small well underlying the water flow gauge itself as it tends to fill up with sand and silt, affecting the results. Bañuelos believes that there are times when water flow following storms is underreported since it is hard to take hand-held readings right after a storm and the gauge itself can be affected by sand and silt kicked up from the rains. Could the international dispute between the U.S. and Mexico been affected by mismanagement of the gauge station or misreporting of the numbers? While it is not likely, it is worth noting that Bañuelos was hired as a replacement after the previous manager in Ojinaga was let go. The rationale? He was not visiting el Mulato or the Ojinaga gauge with frequency, or cleaning out the silt and sand which can affect readings. Instead, he was using the old international bridge office as a car repair shop to make a little money on the side.

1. Average Daily Discharge at the Mouth

Daily discharge over the 1954-2005 time period averaged 24.25 cubic meters per second (CMS), with substantial variations by year (see Figure 3.1). Including yearly flow records available from CONAGUA from HY 1940 to 1954, the variation in flows by decade is clear (see Figure 3.2). While the data from the 1940s and early 1950s indicates an annual daily average of some 29 CMS, the 1955 to 1960 period – widely considered as a period of historic drought – dropped to 26.41 CMS. The 1960s saw further reductions overall, while the 1970s saw average daily discharges of some 31.4 CMS, the decade which was characterized by the highest flows. These high "averages" were paced by HY 1978, when huge floods spilled over the gates of Chihuahua's major dams and flooded huge swaths of fields. Taken as an average, the 1980s were a period of "normal" flows, while the average of the 1990s – at 22.67 CMS, was only slightly lower than the fifty-year average. Buried in these averages, however, were both high water years – 1991 and 1992 – and beginning in 1993, low water years. In fact, within that decade, the flows have varied from a high annual average of 91 CMS in Hydrological Year 1991, to a low of only 2.3 in HY 1998.

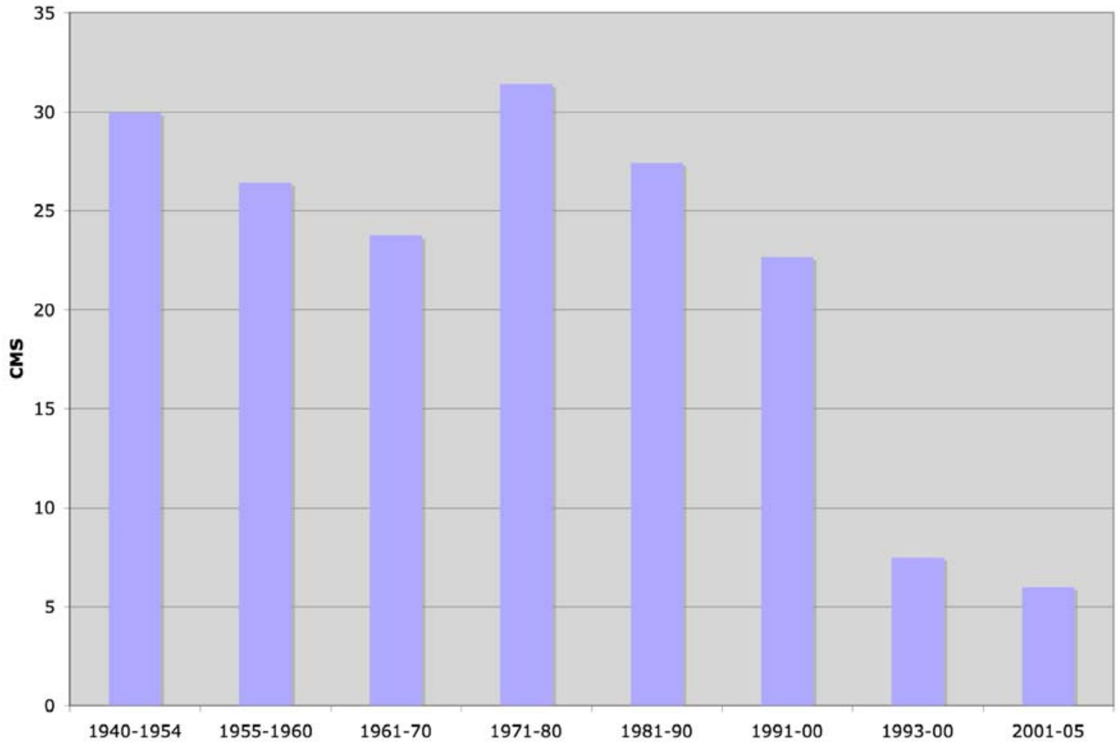
Figure 3.1. Average Daily Río Conchos Discharge at Ojinaga in Cubic Meters per Second, 1954-2005



Source: CILA, Ojinaga Steam Gauge, 2005.

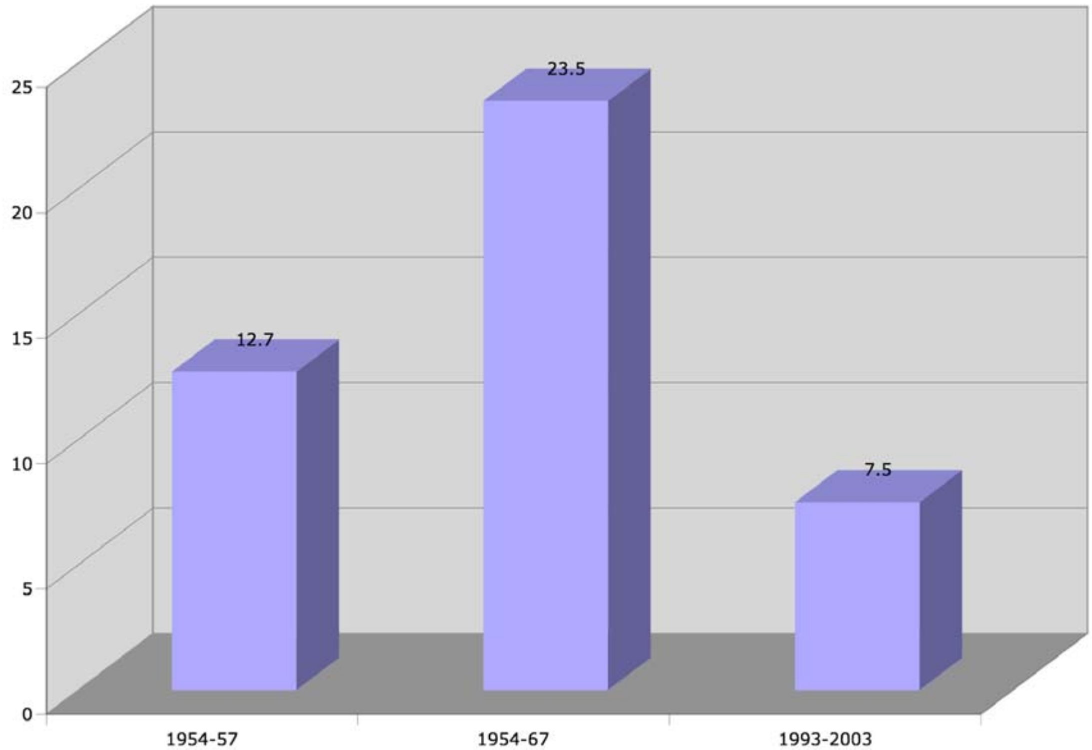
Between HY 2001 and HY 2005, the average daily flow plummeted to some 6.0 CMS, and even the supposedly wet year of HY 2004 saw daily averages of only 12.1 CMS flowing from the Conchos. The HY 1993-2003 period was particularly low, averaging only 7.5 CMS, while the 1954-57 period was similarly dry, with average daily discharges of only 12.7 CMS (see Figure 3.2). In fact, the more recent low-flow conditions – hydrological years 1993 to 2003 – compared with the low-flow conditions of hydrological years 1954 to 1967 there has been no comparison to the recent low-flow period. The record of fifty years for the gauge reveals a river that has suffered from three low-flow periods – 54 to 57, 62 to 67 and 1993 to 2003 -- with individual years of significant high flows, including HY 1958, 1966, 1978 and 1989 through 1991.

Figure 3.2. Average Daily Discharge by Decade in CMS, 1940-2005



Source: For 1940-1954, CONAGUA 2005.
For 1955-2005, CILA, Ojinaga Stream Gauge, 2005.

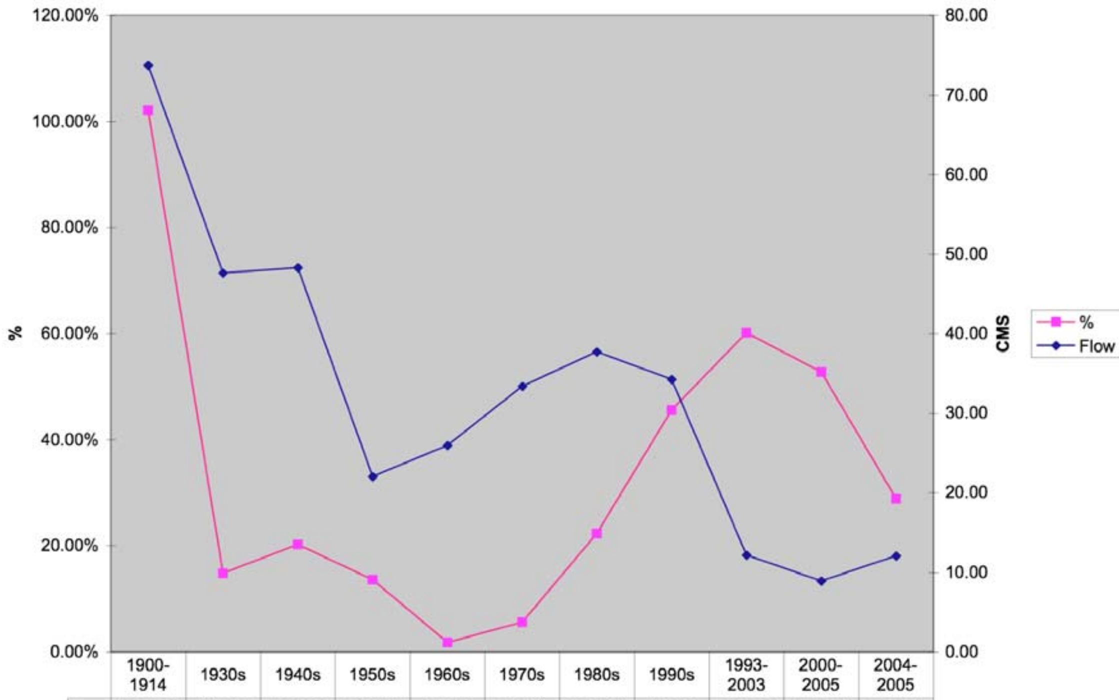
Figure 3.3. Average Daily Discharge for Different Low-Flow Periods at Conchos Outflow



Source: CILA, Average Daily Discharge, Ojinaga Stream Gauge, 2005.

Looking at data from the two nearest IBWC-run hydrological stations, the impact of the lack of flows in recent years from the Conchos is stunning (see Figure 3.4). Before the Upper Río Grande was dammed, the Río Grande itself provided some 35 percent of the average flow downstream of the entrance of the Conchos, while during the 1930s and 1940s, the Río Grande provided only 15 and 20 percent respectively of the flow at the *Below Conchos* station. Throughout the 1950s, 60s, 70s and 80s, the flow attributable to the Río Grande itself was less than 25 percent of the total flow – as the Río Conchos was providing between 75 and 98 percent of the flow in this section of the river through the 1960s. By the 1990s, however, the percentage attributable to the Río Grande itself shot up to 45 percent, a figure that would rise to some 60 percent between 2000 to 2005. The Río Conchos was no longer bringing the Río Grande back to life (Horgan 299).

Figure 3.4. Río Grande Flows Below Río Conchos in CMS and % of Río Grande Flow Below Río Conchos Attributable to Río Grande Above Conchos, 1900-2005



	1900-1914	1930s	1940s	1950s	1960s	1970s	1980s	1990s	1993-2003	2000-2005	2004-2005
%	102.17%	14.84%	20.23%	13.60%	1.74%	5.61%	22.32%	45.61%	60.17%	52.71%	28.89%
Flow	73.74	47.65	48.29	22.05	25.95	33.39	37.73	34.23	12.15	8.93	12.08

Source: IBWC, Daily Stream Flow Data at Rio Grande Stations and CILA, Ojinaga Stream Flow Data, 2005.

2. Peak Discharges

In general, high peak flows at the Ojinaga station occur in September or October. There have been 17 daily peaks above 1000 CMS through the period of record, but nearly all of them concentrated around three flood events in Hydrological Year 1959 (10/02/1958), in HY 1978 ((9/24/78) and HY 1991 (9/26/91), indicating the possibility of major flooding throughout the period of record. Peak discharge has varied considerably over time, though without a significant trend. In general, peak discharge values have fallen over the period of record. A closer look at the two periods of relatively low-flow (1954-1967 and 1990-2005), with some individual higher flow years, reveals that the average daily peak discharge has declined slightly in the present low-flow period.

Table 3.1. Peak Discharge Values for Different Low-Flow Periods at the Río Conchos Outflow

Time Period	Average Daily Discharge in CMS	Highest Peak Discharge in CMS	Date of Highest Peak
1954-2005	24.25	1490	10/01/1978
1954-1967	23.50	1340	10/02/1958
1954-1957	12.49	337	8/23/1954
1990-2004	18.5	1200	9/26/91
1993-2003	6.81	263	07/26/93

Source: CILA, Ojinaga Stream Flow Data, 2005.

It is apparent that in high flow years, peak discharge occurs later than in low-flow years. Thus in low-flow years, peak discharges occur earlier, such as in May, June, July or August, as opposed to September or October. Or perhaps more to the point, in low-flow years, the expected fall rains either do not occur, or have not made it all the way down the river system to the mouth of the river during the fall months.

An analysis of discharges during the period of record, as well as the two “low-flow” periods shows that the later period (1993-2003) has less high and low values and generally has a “flatter” flow duration curve. Again, the tables and figures suggest that there has been less variability than during the previous low-flow period in the present period, and a generally flatter flow duration curve, not unexpected with lower flows.

Table 3.2. Peak Values, as well as 5, 50 and 95% flow values during different time periods

Category	1954-2004	1954-57	1993-2003
Peak Value	1490	337	263
5 % Value (high flows)	920	52.4	24.0
50 % Value (median)	11.1	6.63	2.11
95% Value (low flow)	0.6	0.08	0.38

Source: Author calculation from information provided by CILA 2005.

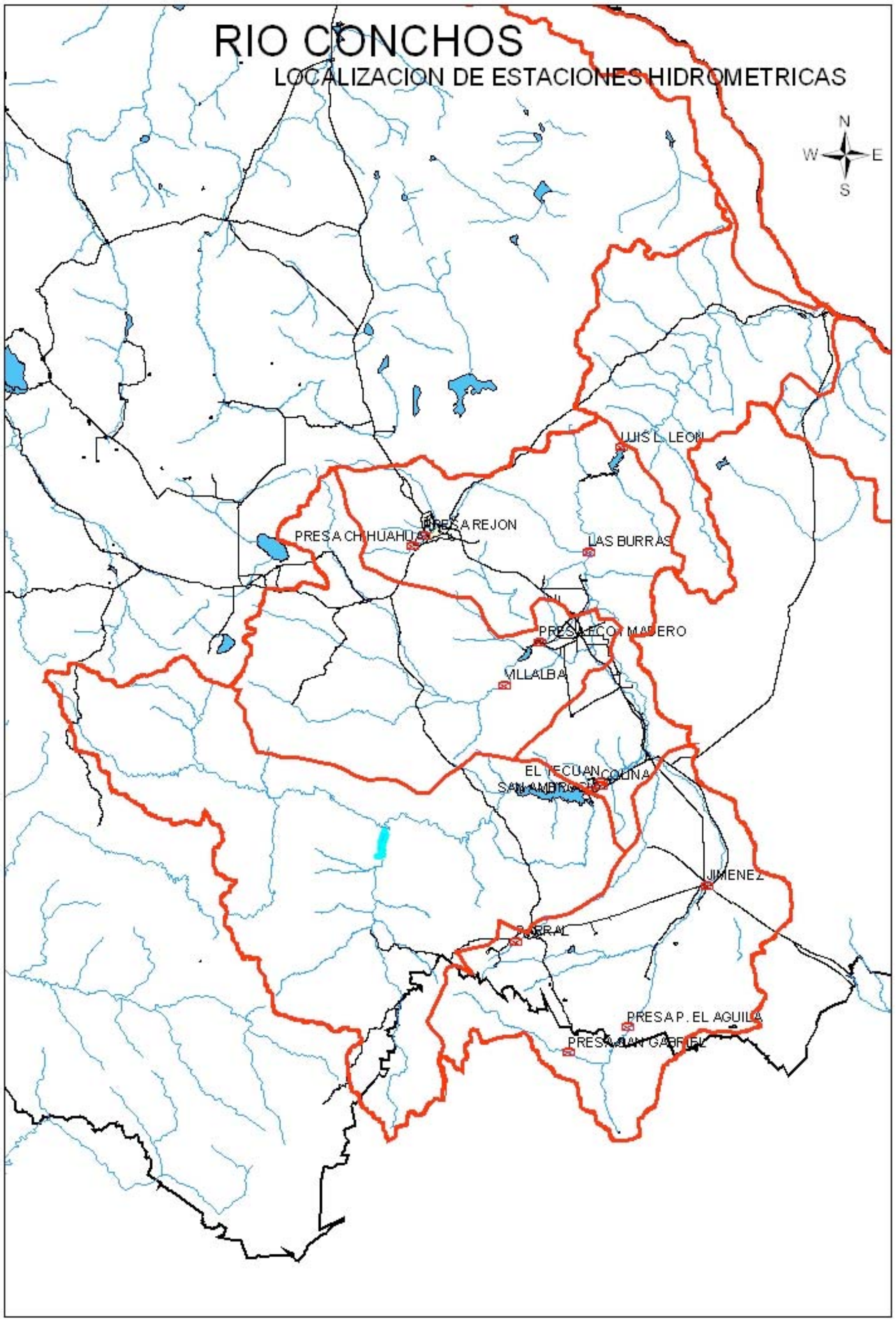
B. Other Hydrological Stations

The Ojinaga Hydrological Gauge is of course just a point on the river, although an important one because its flows are calculated as part of an international treaty guiding water distribution (IBWC 1944). Both CONAGUA and the Junta Central de Agua y Saneamiento from the state government have also invested in a network of hydrological stations. Many of these, however, are not currently in operation or have not been operating for long periods of time, making analysis of their daily discharge and flows difficult. In addition, many of the original stations were designed to measure flow in the series of canals making up the three irrigation districts of the watershed, not in the river itself. Sixteen different stations that were operating have been closed, most of them by the early 1990s. In 2004, only 14 stations were operating (CONAGUA, information provided to author, 2004). Several of these are located in the dams and serve more as “control” devices to measure outflows and inflows into the storage and distribution dams (see Map 4) In fact, there are no stations located in the Upper Conchos in the Municipalities of Bocoyna or Carichí, and there appears to be only one station along the Conchos itself which measures “natural” river flow: Las Burras near Julimes. Operations at Las Burras were suspended in 2003, however.

Still, there are some flow stations which serve as a relative yardstick of flows. Las Burras is located just downstream of where the San Pedro enters the Río Conchos as well as downstream of the major irrigation district. In addition, the Jimenez station along the Río Florido indicates the health of one of the main tributaries to the Conchos downstream of La Boquilla Dam. Finally, the Colina station indicates the amount of water being sent down the river just downstream of La Boquilla on the Conchos itself, but before being impacted by return flows. However, these last two have only been operated since 1983.

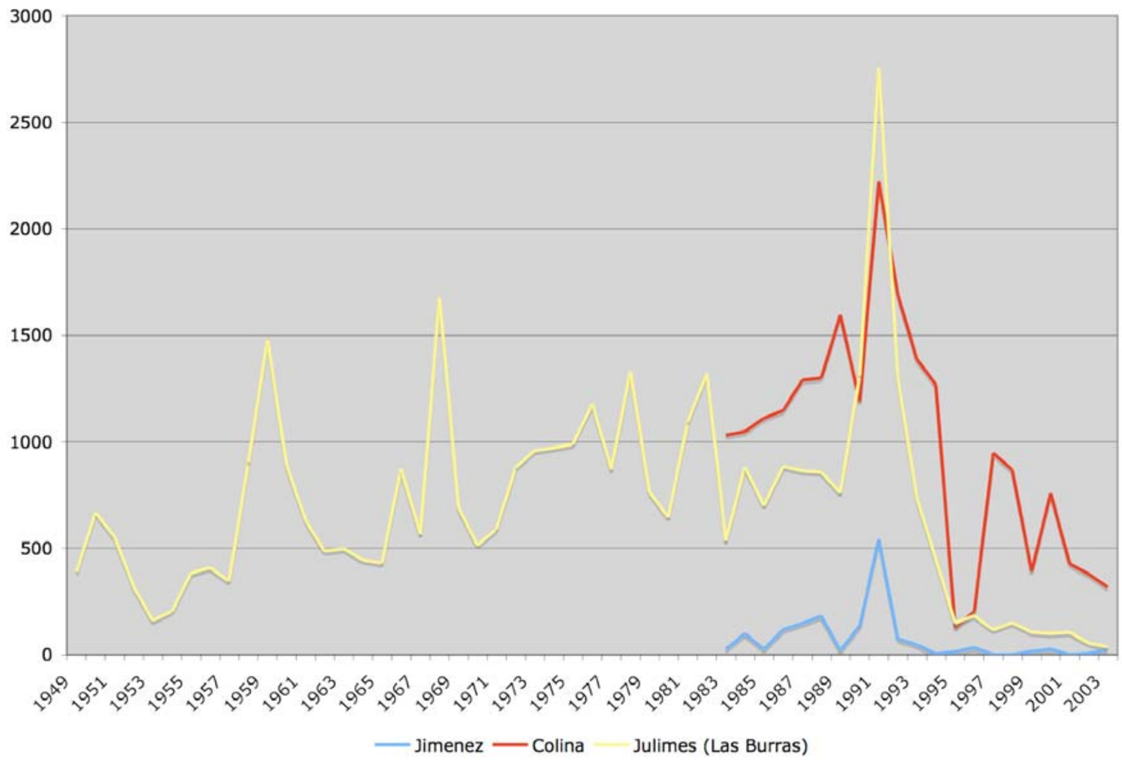
Average monthly flow data reveals that total flow in these stations correlates closely with flow at the Ojinaga station. Thus, for example, at Jiménez, La Colina and Las Burras, the 1993-2003 period had significantly less flow than in the previous 10 years (see Figure 3.5). Interestingly, during the later time period, flows at Las Burras were actually lower than those upstream at La Colina, indicating that flows released directly to the river from the distribution dam as well as from localized rains were not making it downstream, or that return flows from irrigation and municipal discharges were not entering the river itself. A look at the period of record also indicates that the timing of flow appeared to change slightly, with less flow available in winter months than in previous decades (see Figure 2.8). In fact, for approximately four months of the year (October to March), flows in both the Florido River downstream of the Florido Irrigation District as well as the Río Conchos, both upstream and downstream of the Delicias irrigation district appeared to come to a virtual stop.

Map 4. Hydrological Stations Operated by National Water Commission in Río Conchos, 2004



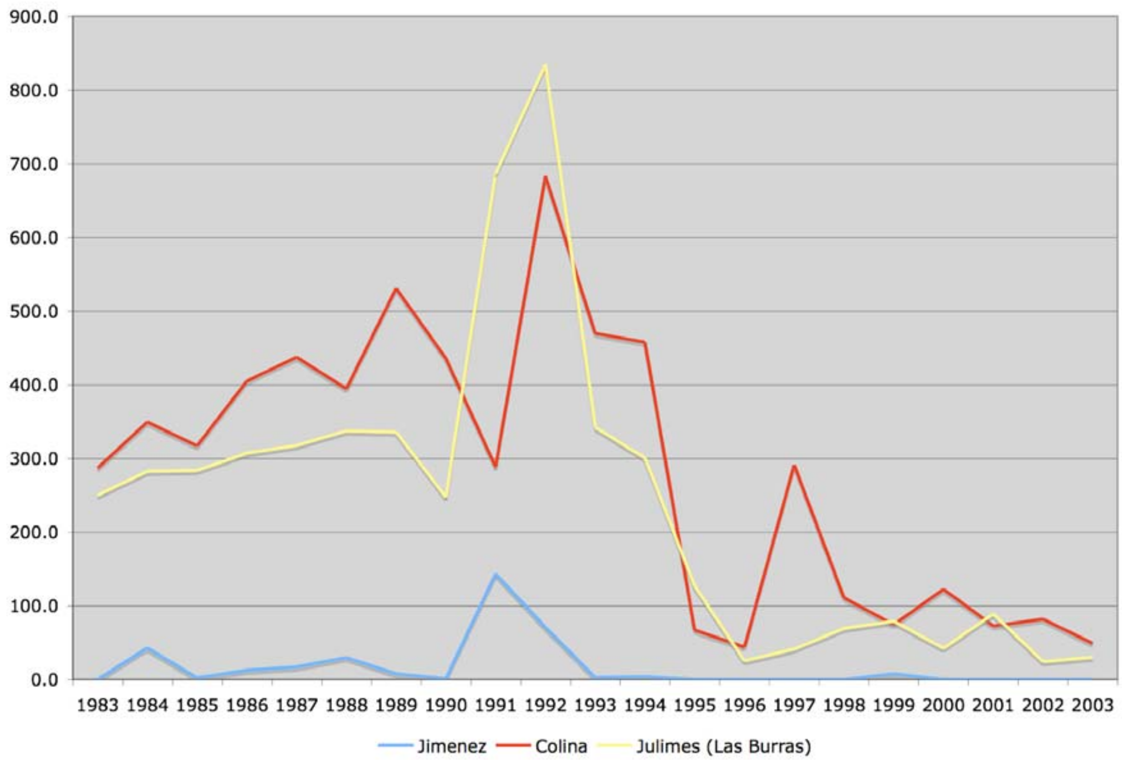
Source: CONAGUA, information provided to author, 2004.

Figure 3.5. Total Annual Flows (MCM) at Various Hydrological Stations, Conchos Watershed



Source: CONAGUA, Information provided to Author, 2004.

Figure 3.6. Annual Flow from October to March at Three Hydrological Stations in Million Cubic Meters, Río Conchos Watershed, 1983-2003



Source: CONAGUA, 2004, author calculation.

C. Conclusions

Average daily flows fell precipitously decade by decade in the Río Conchos. In addition, yearly flows also fell, with a few years of significant discharge, and many low-flow years, particularly between 1993 and 2003. Finally, a look at peak discharge revealed that the present low-flow period has a much "flatter" flow duration curve. In general, peak discharges in the more recent time period tends to occur earlier in the year rather than during the September and October period more characteristic of high flow years, as well as earlier decades. Data from hydrological stations both above and below Chihuahua's major irrigation district reveals a denuded river that flowed only sporadically during the winter months of the hydrological year between 1993 and 2003. Why, and what did people say?

III. The Causes: From Drought to Dam Management

This section looks at several of the potential factors in the reduced flow of the Conchos, including precipitation, dam management changes in crop production and land use changes and considers the evidence presented by various interest groups. In addition, it introduces some additional factors not often considered, such as legal changes that occurred in this period in water, forestry and agricultural laws, which have, at least partially, privatized and decentralized the management of water, land and forests, as well as economic and institutional changes as a result of Mexico's inclusion into the North American Free Trade Agreement. For the water crisis that engulfed both Chihuahua and by extension Texas can not be understood without also understanding the changes that occurred politically and economically, in part because of the changes brought about by NAFTA and related policy changes. In essence, the section argues that both local management decisions, climactic changes and more regional economic shifts must be considered when assessing changes in the physical hydrology of the Río Conchos and that most narratives ignored these issues.

A. Drought

Press releases, interviews by politicians, and official responses to U.S. government reports, as well as personal communication with officials indicate that officials from Mexico and Chihuahua have maintained that low-flows into the Río Grande have one overriding cause: drought (CONAGUA 2000; Rodríguez Piñeda, et. al. 2005). Drought itself is difficult to define. While climactic indexes such as the PDSI --Palmer Drought Severity Index -- are well established and important climactic and hydrological tools droughts are not only climactic constructs, but human and political constructs as well. Increased water use and increasing populations can make a relatively mild dry spell a drought, as demands on a river system increase.

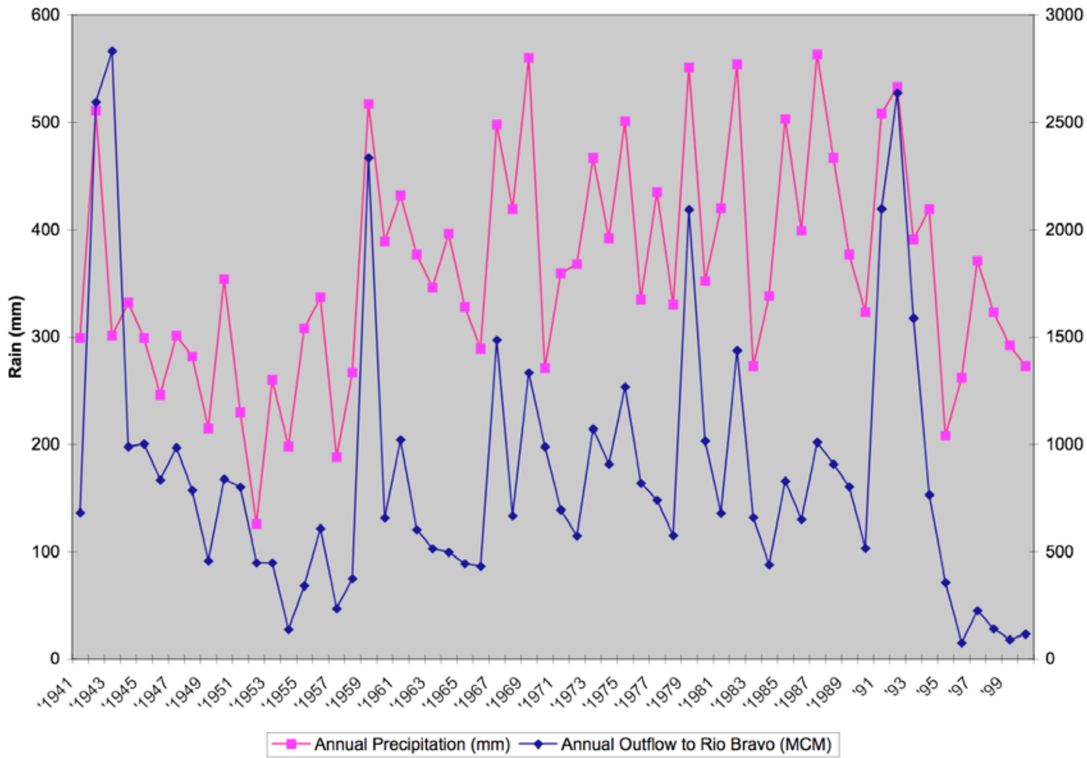
In the Southwestern U.S. and Northern Mexico, drought is a common occurrence (Liverman 1999). Climate in Mexico is influenced by latitudinal belts of atmospheric circulation which occur seasonally, ranging from the westerlies, which bring precipitation to northern Mexico in the late fall and winter, while in the center and south, the intertropical convergence zone (ITCS) deliver summer rains (Liverman 1999: 100). In Northern Mexico, droughts often correspond to "La Niña" years, when high pressure systems cool the Atlantic Ocean, weakening storm systems that bring rains to areas. Thus, droughts in Northern Mexico occurred in La Niña years, such as in the 1950s, 1974 and 1988, when average winter rainfalls were reduced, while droughts in Southern Mexico corresponded to "El Niño" events, when summer rains were reduced due to displacement of the ITCZ (Liverman 1999: 102-103).

The most obvious characteristic of a drought is lack of precipitation. It rains less. Complicating any examination of precipitation data, however, are changes in the location of meteorological stations, potential changes in the technology used to measure rainfall as well as data collection issues and human error. For example, in the Río Conchos watershed, there have been dozens of stations operated by the State Government, by CONAGUA, and even some operated “voluntarily” by individuals not directly employed by CONAGUA. Thus, there were 51 stations in Chihuahua that at one time were operated by entities that were no longer operating in 2004, including 27 within the Río Conchos watershed (Comision Nacional de Agua, 2004). Most of these were shut down in the early 1990s at a time of budget constraints, before the supposed drought occurred. While the state ran approximately 10 stations in the Rio Conchos, CONAGUA operated 24 stations within the State of Chihuahua, including 17 in the Río Conchos watershed. There are another five CONAGUA stations run by volunteers.

Based on these stations, CONAGUA has come up with an annual precipitation total for the Río Conchos watershed. By charting the annual discharge at the mouth of the Río Conchos in Ojinaga against annual precipitation throughout the basin, it is revealed that annual discharge from the Ojinaga station closely correlates with annual basin-wide precipitation (Figure 3.7). Nonetheless, the correlation between rainfall and runoff in the basin show it to be a highly variable basin in terms of flow. For example, while the ratio of runoff to precipitation shows an average of 2.39 million cubic meters of water flowing at the Río Conchos mouth per millimeter of rainfall over the period of record (Figure 3.8). However, the correlation between rain and runoff has been stronger in recent years during high rains and weaker during low rain periods, such as the past decade.

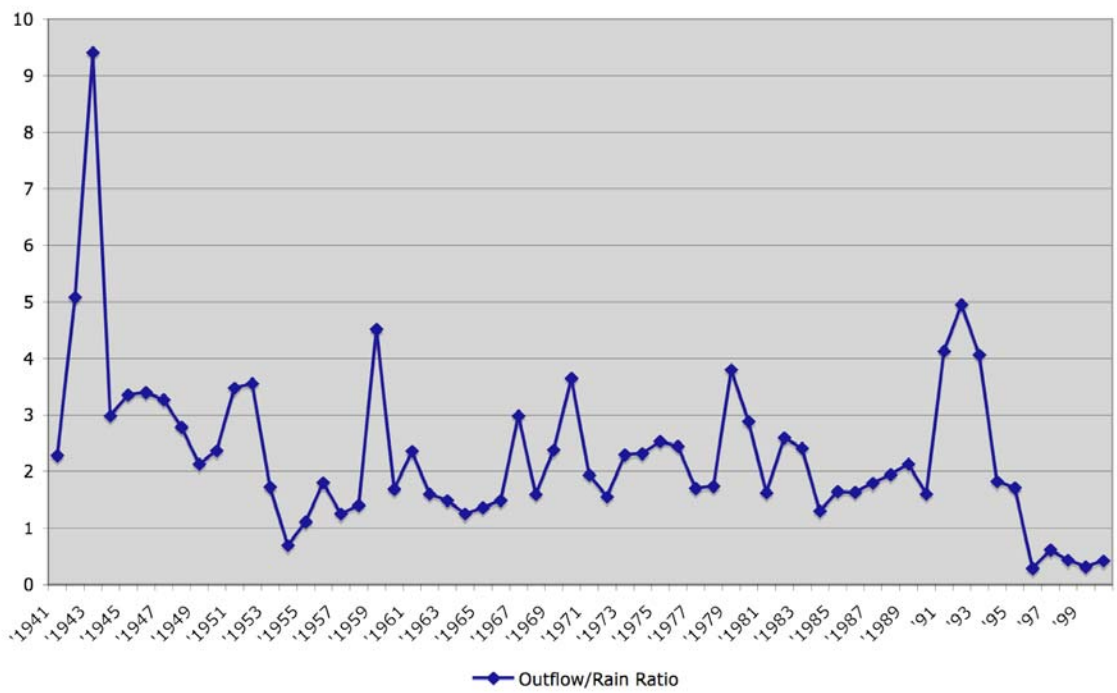
During the 1995-1999 five-year period precipitation averaged 412 mm per year, and annual discharge averaged only 131 million cubic meters per year, indicating a much lower rain to flow correlation than in past decades. The problem with these comparisons is of course they are only averages, and only by examining individual precipitation stations and their correlation to runoff and flow is it possible to make more definitive statements. Still, as a general rule, it shows that there appears to be less of a correlation between rainfall and outflow in the more recent low rainfall period than previously.

Figure 3.7. Calendar Year Outflow in Million Cubic Meters and Average Annual Basin-Wide Precipitation in Millimeters, 1940-2002



Source: CILA, Ojinaga Streamflow Gauge Data, 2005; CONAGUA, Rainfall Precipitation Data, Information Provided to Author.

Figure 3.8. Runoff/Precipitation Ratio on Río Conchos, 1940–2002



Source: Author Calculations from information provided by CONAGUA 2004.

The 2000 Brandes report – which became a bible of sorts to the South Texas farmers demanding their share of the Río Conchos water – makes similar observations by looking at dam inflows, precipitation and the outflow to the Río Grande. Thus, the report compares the 1958-1963 period of low rainfall with the 1992-97 period and finds that while the average amount of inflows into Mexican reservoirs was similar, the amount of water making it to the Río Grande was considerably less in the more recent period, approximately 179 MCM (145,000 acre-feet) rather than 567 MCM (460,000 acre-feet per year) (Brandes 2000).

Thus, there has been a fundamental shift during recent years as the discharge/rainfall correlation at the outlet has weakened, with less flows than would be expected from the rains, based on similar rainfalls in past decades. On the other hand, during times of high rains, such as in the HY 91-92 period, discharge is greater than annual precipitation levels would predict.

Still, Mexican academics and research centers have their own publications and monthly maps insisting that the drought in Chihuahua – and in the Río Conchos watershed in particular – was very real and is the primary factor in the low inflows to the dams and outflows to the Río Grande. One of the more prolific institutes has been the Centro de Investigación Sobre Sequía del Instituto de Ecología, AC (CEISS or the Drought Investigation Center of the Ecology Institute, A.C.). Born in 1996, but consecrated in 1998 with state and federal monies, the center is located in a spacious building among the pecan tree farms and desert plains just south of Aldama on the road between Ojinaga and Chihuahua. CEISS boasts modern offices, state-of-the-art GIS equipment and even a small meteorological station. With a small staff of eight in 2005, CEISS is dedicated to the study of the flora, fauna, water and climate of Chihuahua and northern Mexico, with a particular focus on drought, hydrology and forest fires (Dr. Victor Reyes, Personal communication with author, September 2005).

While director Dr. Victor Reyes said the nascent center has had no direct involvement in the conflict with the U.S., they have participated in meetings with CONAGUA and CILA as technical advisors and observers. They are trying to establish themselves as an entity similar in many respects to the U.S.'s Drought Monitor Center, only, as he remarks, "a whole lot poorer."

CEISS follows the same SPI (Standardized Precipitation Index) developed by Thomas B. McKee, Noland Doesken and John Kleist at Colorado State University, taking as its base monthly precipitation records at meteorological stations and comparing them to historical records[7] (McKee, T.B., N. J. Doesken, and J. Kliest 1993; CEISS 2004). Thus, CEISS publishes a monthly drought index for the entire state and uses a GIS system to produce a series of maps which help officials and farmers visualize drought regional impacts. Reyes credits the visual drought monitoring network with allowing CEISS a seat at the table in discussions on state policy.

In recent years, CEISS and its investigators have published a series of articles on the Chihuahuan drought. Thus, CEISS's Jose Alfredo Rodriguez Piñeda presented "Crisis Hidrológica Mexico-USA: Hubó o No Sequía en la Cuenca del Río Conchos en el Periodo 1993-2002?" (Mexican –USA Hydrological Crisis: Was there a drought or not in the Río Conchos Watershed during 1993-2002?) at the Binational Río Grande "Cooperation for a Better Future" Forum in 2005. Using data from 30 state and CONAGUA meteorological stations, the investigators analyzed data from 1970 to 2002, and concluded that drought had affected much of the state, most notably the "temperate zone of the State, that is the headwaters of the Río Conchos basin, which impacts the replenishment of the aquifers and availability of water (Rodríguez Piñeda et al 2005: 5)." With the exception of 1997, the report states that all 10 years had negative 12-month SPI values for the arid, semi-arid and temperate regions of the state. The extended drought in Chihuahua – including the Río Conchos riverbasin – can be classified, wrote Rodriguez, as "an extraordinary drought" since it is the "most extensive drought of the 20th Century." (Rodríguez 2005: 5).

While obviously a summary of data collected and analyzed by CEISS, Mexican participants cited the study presented at the Forum as confirmation that the geographical and temporal extent of the drought was the cause of the

[7] SPI is based on the number of standard deviations – literally the square root of the variance, a measure of the dispersion of values around a mean -- between a particular set of precipitation data and the historical average.

hydrological crisis in the Río Conchos. A longer unpublished article by some of the same investigators, however, gives a much more nuanced approach to the Chihuahuan drought (Reyes-Gomez, V.M. et. al 2005). In their article, the authors utilize information from 32 meteorological stations and compare different time periods to show that the present drought-like conditions were less "severe" than, 1970, but were more extensive geographically and more extended temporally. It was the extent and not the severity of the drought that caused a mild "meteorological drought" to lead to a hydrological, agricultural and socio-economic drought. They state: "It is an evident result that a prolonged drought can have more impacts in terms of runoff capture, than an intense drought of less duration (Reyes-Gomez 2005: 10)."

The authors then analyze the entrances and extractions of water from the major dams themselves, showing that in the last "six decades, the entrances have been affected by lack and variability of rainfall distribution," impacting in particular Luis León and Francisco Madero. The authors claim that rainfall data upstream of the major dams confirm that lack of rain can explain between 67 and 71 percent of the correlating decline in dam levels, although they note that these statistics "should be taken with much care" and "can not be validated until a greater number of observation and a better and more convenient distribution of rainfall gauges are obtained (Reyes-Gomez et. al. 2005)." The authors state that the lack of rainfall gauges upstream in the Conchos headwaters – where presumably most of the runoff getting to the dams actually comes from – is a major detriment to be able to correlate rainfall with water flow and dam inputs. The deficit approach used by these authors contrasts starkly with the Brandes report, which reports "accumulations."

In another of its publications, researchers associated with CEISS make a similar case that for certain regions of Chihuahua and the Conchos River Basin, the drought has been “severe” and in some cases “exceptional” (Gadsen et al 2003). The article puts the blame on low reservoir levels on drought in the Southwest of the State, and makes the case that some 59 percent of the forested areas – including areas in the “high parts of the Conchos River basin” – were suffering from severe to exceptional drought over several years according to a 12-month SPI. The article blames “the accelerated fragmentation over many years of the forest ecosystems located in the high parts of the Conchos River basin…. (which).. has made for rapid soil erosion and the decrease in replenishment of both the underground aquifers and the surface water supply.”

Thus, in concluding, the article states:

> In recent years we have found recurrent droughts that vary from severe to exceptional in the forest regions of Chihuahua’s Southwest. This may explain in part the reservoirs’ low levels in the Conchos medium basin; it affects agricultural productivity in this area and diminishes the amount of water that can be sent to the United States (Gadsen, et al, 2003: 107).

The articles and presentations by Chihuahua’s principle students of droughts show that even among their own publications, there is an ambiguity about the causes and severity of the drought. Clearly, however, they support the official view that the meteorological drought – the lack of rain – was the major factor in the hydrological drought – the lack of water in the dams and the outfall to the Río Bravo.

Thus, data from CONAGUA and other meteorological stations support the view that the drought was extensive and extended from 1992 to 2003 throughout Chihuahua, with the exception of HY 1997. It was not the intensity of the drought, but its duration, that led to such low outflows at Ojinaga according to this thesis. It is important to note that the lack of rainfall stations in the upper

Conchos complicated calculations and conclusions (Gadsen et al 2003). In addition to this discourse about the impact of climate and specifically drought, water use, dam management, land use and landscape are all recognized as important factors in the Río Conchos River Basin. Thus, within Chihuahua, important thesis began to emerge about the impacts of water use and degradation of landforms – including deforestation and soil erosion – which are also posited as major factors in the lack of water available to the river and users.

B. Damn the Dams?

Beginning in the 1910s, major dam construction along the river –primarily for agricultural use – has interrupted the natural flow and sediment regime of the river. There are eight major dams along the Río Conchos and its tributaries, as well as some 30 minor dams catching small amounts of water for irrigation and domestic water uses along both the tributaries and main stem (Schmandt 1993: 46). While the largest dam – Las Boquilla – was built long before the 1944 Treaty with the United States – Chihuahua's other major dams, including Francisco Madero (1949), Luis León (1968), and San Gabriel (1981) were completed after the 1944 Treaty was signed. In 2004, Chihuahua even added a small dam on one of the tributaries of the Río Conchos, near San Juanito in the Municipality of Bocoyna just 15 kilometers from where the river begins its course (Topete 2004).

By far the biggest dam in the state is La Boquilla, often referred to as Lago Toronto (see Photo 3.7). The history of the dam is a microcosm of Mexico's, spanning the Porfiriato – the hard-line regime of Porfírio Diaz – the Mexican Revolution, land reform and the development of major irrigation projects in Northern Mexico during the 1930s and 40s. It is also inextricably linked to the founding and development of Ciudad Delicias, Chihuahua's major agricultural center, and in fact to the 1944 Treaty signed with the United States (See Chapter Five).

The dam was built in the 1910s as a major energy project by the Compañía Agrícola de Luz y Fuerza, but post-revolutionary political figures viewed the dam as a wasted resource for a state which desperately needed employment and development. General Ignacio Enriquez, who as general of Chihuahuan forces often fought alongside Pancho Villa, was the catalyst (Jordan 1956). Enríquez was Chihuahua's first governor in the tumultuous post-revolutionary period (1916-20), and shortly after stepping down in 1920 worked with his successor Abel Rodríguez to turn Chihuahua – and the as-yet unnamed Delicias -- into a major agricultural center (Club Rotário 1983: 7).

In 1927 – with a federal water concession in hand -- a new study began under the White Engineering Corporation to irrigate 70,000 hectares from the Río Conchos and 80,000 hectares from the Río San Pedro. The major engineer on the project was Carlos Blake, founder of the City of Delicias. By 1936, all 105 kilometers of the Conchos Canal had been constructed, serving some 53,000 hectares of irrigated lands, in a stunning transformation of the Chihuahua's central semi-arid plains (Blake 1983:2).

Photo 3.6. Statue of Carlos Blake, Considered Founder of Delicias.

The dam planned for the “San Pedro Irrigator Association” was originally to be located at Villalba, well upstream of the present San Pedro dam at Francisco Madero. Difficulties in the financing, design and political maneuverings led Mexico in 1942 to begin construction of a much smaller Francisco Madero just upstream of the historic town of Rosales. In 1943 and 44, while negotiating the Water Treaty with the U.S., Mexican negotiators – led in fact by Blake himself –

assured the U.S. that the Madero Dam was smaller than originally planned and therefore the district would be closer to 100,000 hectares and not 150,000 or 200,000 hectares as originally conceived. The Madero dam was completed in 1947 (Photo 3.8).

The Rio Concho's other major dams were similarly conceived and built for the twin goals of irrigation and flood control. Planning for the Luis León Dam actually began in the 1950s, as local farmers complained of the frequent flashy rains which continually destroyed their crops. While paperwork was filed in 1955, the dam was constructed and finished in 1968, and the Lower Conchos Irrigation District 090 itself became official in 1976 as an 11,000 hectare area located some 120 kilometers below Luis Leon itself (see Photo 3.9). Similarly, the Florido Irrigation District between Hidalgo de Parral and Jimenez was initiated in 1981 with the completion of the San Gabriel dam, just south of Chihuahua in Ocampo, Durango, leading to the eventual irrigation of some 10,000 irrigated acres. Thus, three of the four major irrigation areas – San Pedro, Florido and Ojinaga -- and associated dams were completed after the signing of the 1944 Water Treaty, two of which came after the drought of the 1950s and 1960s.

Table 3.3. Major Dams in the Río Conchos Watershed

Official Name	Alias	Complete	Useful Capacity (in Mm3)[8]	River & Municipality	Purpose	Benefits
La Boquilla	Lago Toronto	1916	2,822.8	Conchos, Valle de Zaragoza	Irrigation, Energy	Delicias Irrigation District, "Old Works" in Camargo and San Franciso de Conchos
La Colina	Lago Leon	1927	23.7	Conchos, San Francisco de Conchos	Irrigation, Energy	Distribution Dam to Delicias Irrigation District, Conchos Canal
Francisco Madero	Las Virgenes	1949	398.8	San Pedro, Rosales	Irrigation and Sediment Control	Delicias Irrigation District, San Pedro Canal
Chihuahua		1960	25.8	Chuviscar, Chihuahua	Domestic Use, Flood, Sediment Control	City of Chihuahua
Luis León	El Granero	1968	320.2	Conchos, Coyame	Irrigation, Sediment and Flood Control	Lower Río Conchos Irrigation District
Federalisimo Mexicano	San Gabriel	1981	255.43	Florido (Durango)	Irrigation	Florido Irrigation District
Pico del Aguila		1993	50	Florido (Chih)	Irrigation	Florido Irrigation District
TOTALS		**Pre-1944:2 Dams 1944-Present: 5 Dams**	**3,962**			

Source: Comisión Nacional de Agua, Gerencia Estatal, Chihuahua, Provided to Author September of 2004.

[8] Useful Capacity varies by source. Information from the Irrigation District offices run by CONAGUA provided these figures, which are slightly lower than those provided by CONAGUA's central Chihuahua offices. The lower figures are probably more realistic

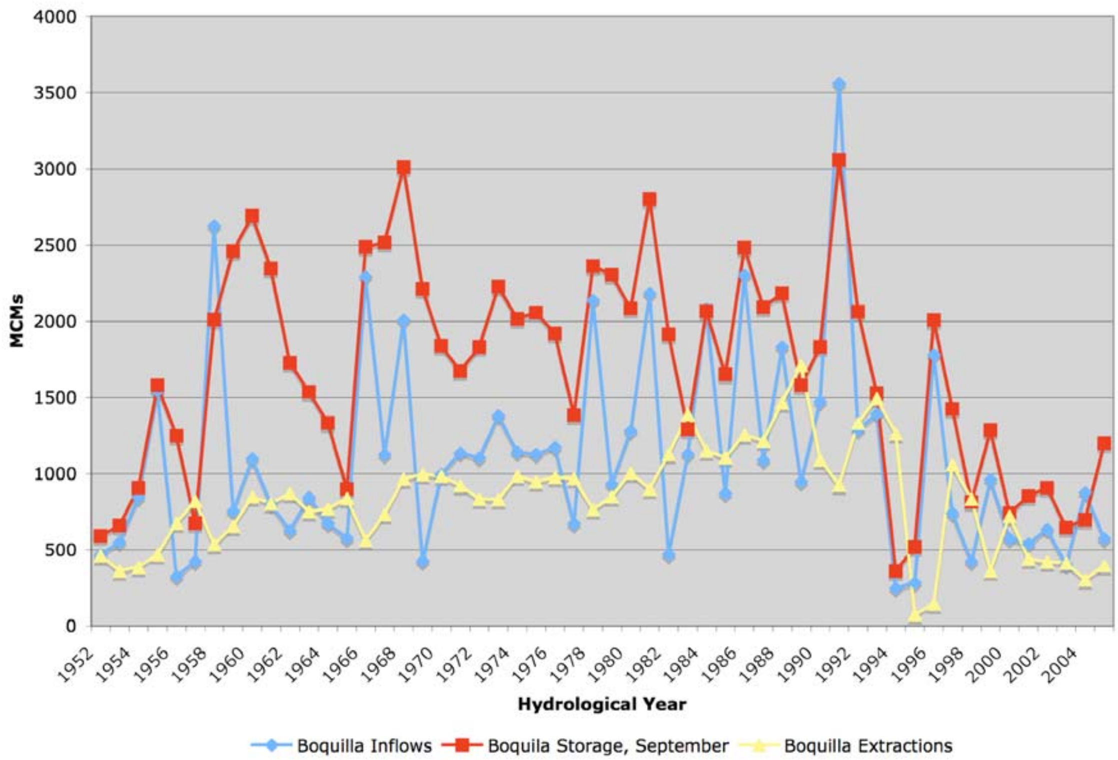
Photo 3.7. Boquilla Dam (Lago Toronto), 2003 at very low levels.

Thus, while Chihuahua's major dams irrigating the central valleys have been operating since the 1940s, the other dams – and irrigation districts – have only been operating since the 1960s. Historical records since the 1950s for La Boquilla and Francisco Madero of the annual storage, inflows and outflows from the two dams show that inflows, storage levels and extractions –both releases to the rivers and diversions to the canals -- all witnessed declines throughout the 1990s, compared with averages over the period of record. Most notable are the exceptional low levels of inflows in 1994 and the near zero releases in 1995, which followed high inflows and releases in the early 1990s. Similarly, after increased inflows in 1996, outflows increased substantially in 1997, only to fall again in 1998. The same occurred between 2000 and 2001. Higher inflows one year were followed the next by higher extractions (Figure 3.9; Figure 3.10; Figure 3.11)

Photo 3.8. Madero (De Las Virgenes) Dam, near Rosales, which serves Delicias Irrigation District, 2005

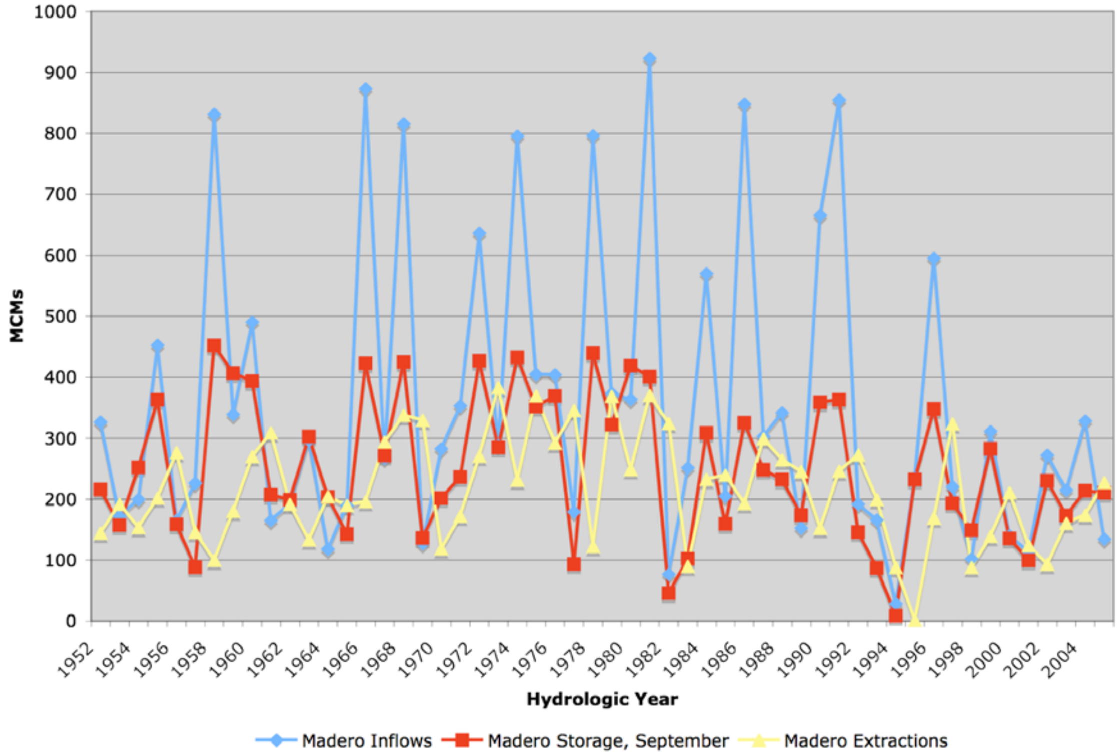
Photo 3.9. Presa Granero (Luis León Dam) provides storage for the Lower Río Conchos Irrigation District, as well as flood control for the lower Río Conchos.

Figure 3.9. Inflows, Storage Levels and Extractions from La Boquilla Dam, 1952-2005



Source: CONAGUA, information provided to author, 2005.

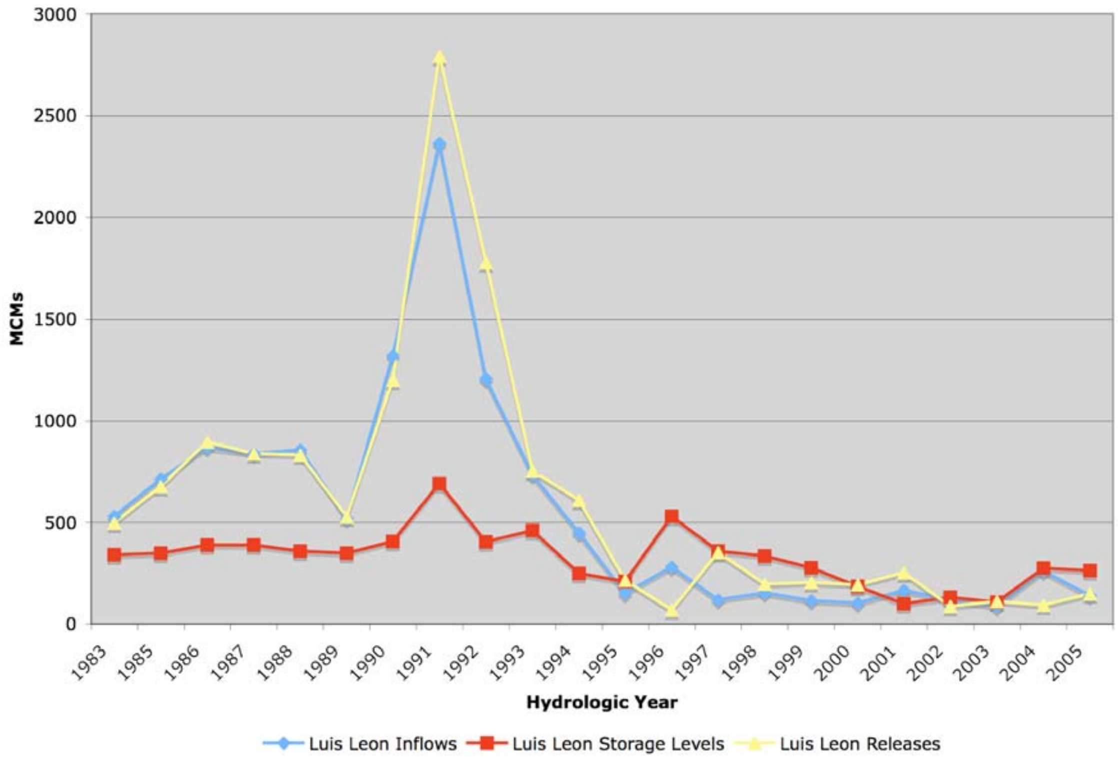
Figure 3.10. Inflows, Storage Levels and Extractions from (De) Las Virgenes (Franciso Madero) Dam



Source: CONAGUA, information provided to author, 2005.

Luis León has witnessed a similar trend in recent years. Data from 1982 to 2005 shows a dam that was in continual decline in inflows, storage levels and releases beginning in 1994, with a slight upward trend in HYs 2004 to 2005. The levels are in stark contrast to the 1980s and early 1990s (Figure 3.11).

Figure 3.11. Inflows, Storage Levels and Releases at Luis Leon (El Granero) Dam, 1983-2005



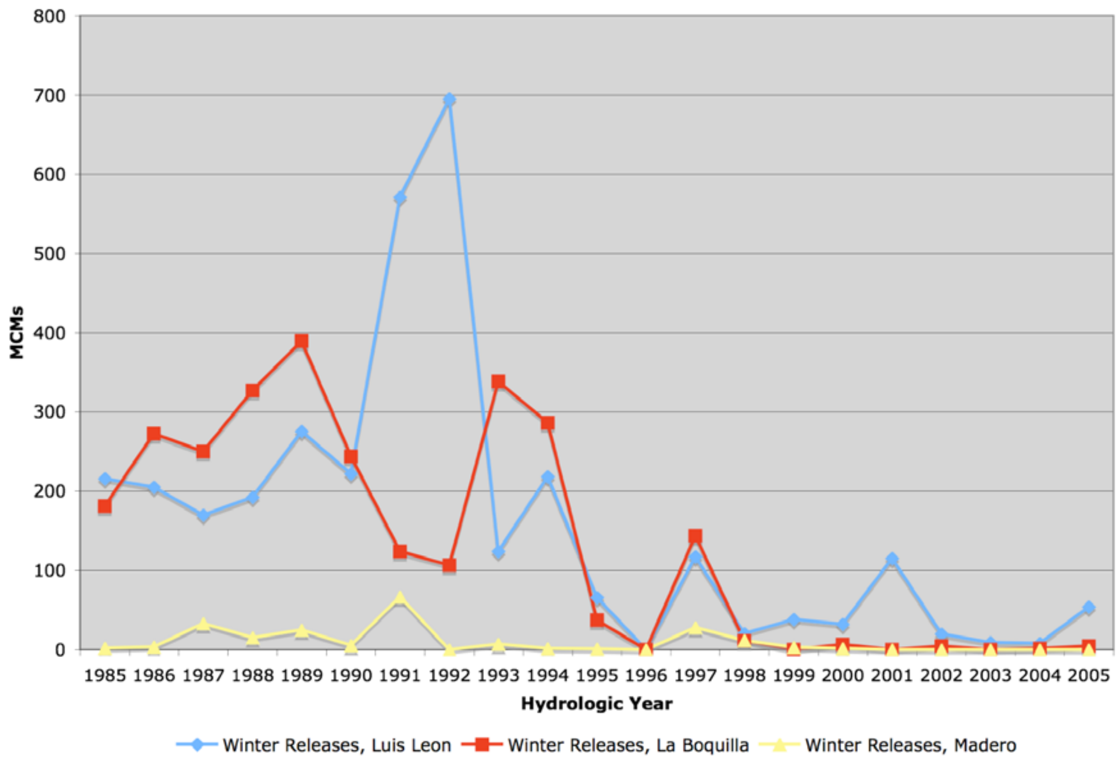
Source: CONAGUA, information provided to author, 2005.

Dams are controlled by humans, not simply by rainfall, and decisions were made that would fundamentally affect flow in the Río Conchos and by extension the Río Grande. Since 1995, virtually no surface water has been released from La Boquilla or Francisco Madero to the Delicias Irrigation District after the summer irrigation season ends on September 30th, meaning crops needing water in the winter – winter wheat, perennials like pecans and alfalfa and winter onions – have been watered with other surface and groundwater resources if at all. (see Chapter Five for full discussion). Thus, the amount of return irrigation flow during the winter months and of course direct river flow above Luis Leon Dam has been severely curtailed from October 1st to February 28th. At Luis Leon itself, releases during the winter months have also been severely curtailed. In fact, water released from the main gates of the Luis Leon Dam during winter months have been made on three occasions to help meet U.S. demands for more water, and not as a response to pressure from downstream Mexican farmers whose own water use was reduced. Releases occurred during the winter months of HY 1997, HY 2001 and HY 2005. (Oscar Lopez, CONAGUA, Lower Rio Conchos Irrigation District, personal communication with author, 2005).

Average monthly releases from the three dams during the winter months between 1985 and 2005 clearly indicate how quickly winter releases dropped following the end of the regular irrigation season. This is in stark contrast to previous years, when both irrigation needs, and major storms in October – such as those that occurred in 1991 and 1978 – led to severe flooding in Chihuahua, bolstering flows in the Río Grande (see Table 3.4). Because Luis Leon is operated as much as a flood control dam as an irrigation source, releases from Luis Leon are frequent to avoid the possibility of such flood spill events. Only in October of 1978 did waters actually spill over the dam doors (Interview, “Rodriguez,” CONAGUA official at Luis Leon Dam, August 2003).

Because of La Boquilla’s large size, flood spills have been infrequent there as well, occurring only in 1968 and during 1991-1992. Madero is another story, frequently spilling over its doors into the Río San Pedro, and thus increasing flows downstream at Julimes where the San Pedro meets the Conchos. However, only one flood event has occurred since HY 1992 – in September of 1996 – and the Río San Pedro has been turned into a denuded bank of construction materials, fundamentally affecting the flow of the Río Conchos at Julimes and below.

Figure 3.12. Winter Releases (October 1 – February 28th) from Luis Leon, La Boquilla and Francisco Madero Dams, 1985-2005



Source: CONAGUA, information provided to author, 2005.

While extensive studies of the upstream and downstream impacts of dams have not been conducted in the Conchos River Basin, considerable evidence from other semi-arid river systems show how dam construction can variably impact the flow and sediment transport functions of natural rivers. Thus, Williams and Wolman, from their classic 1984 study of the effects of dams on alluvial rivers, conclude that dams do generally affect river flow, depending upon the use of the dam and climatological conditions. Overall, their study of 21 U.S. dams found that average annual peak flows decreased between 3 and 91 percent, and similarly five percent flows – high flows -- were in most cases also reduced (Williams and Wolman 1984: 8). In general, you may expect to see a flatter flow duration curve, with more values in the middle range, and less at the very high and very low extremes (Williams and Wolman 1984).

Table 3.4. Dam "Spills" Due to Major Rain Events, 1950-2005 in Million Cubic Meters

Hydro Year	Beginning Date and Duration, Madero	Total Spill, Madero	Beginning Date and Duration, La Boquilla	Total Spills, La Boquilla	Total Spills, Both Dams
1955		26.1			26.1
1957		26.3			26.3
1958		185.4			185.4
1959	8/28/59 (12 Days)	184.6			184.6
1960	8/19/60 (37 Days)	157.6			157.6
1966	6/6/66 (68 Days)	55.3			55.3
1967	6/6/66 (68 Days)	320.3			320.3
1968	8/26/68 (41 Days)	175.5	9/8/68 (30 Days)	273.1	448.6
1969	8/26/68 (41 Days)	62.8			62.8
1972	9/12/72 (22 Days)	133.8			133.8
1974	9/24/78 (109 Days)	63			63
1975	9/24/78 (109 Days)	273			273
1978	9/26/78 (43 Days)	70.6			70.6
1979	9/26/78 (43 Days)	250			250
1980	9/01/80 (16 Days)	20.9			20.9
1981	9/16/81 (12 Days)	150.3	10/07/81 (23 Days)	406.5	556.8
1984	8/16/84 (16 Days)	38.5			38.5
1986	9/03/86 (17 Days)	107.3			107.3
1990	8/10/90 (70 Days)	475.6			475.6
1991	8/11/91 (143 Days)	565.1	8/28/91 (62 Days)	816.2	1,381.3
1992	8/11/91 (143 Days)	70.8	8/28/91 (62 Days)	729	799.8
1996	8/29/96 (35 Days)	295.8			295.8
1997	8/29/96 (35 Days)	0.3			0.3

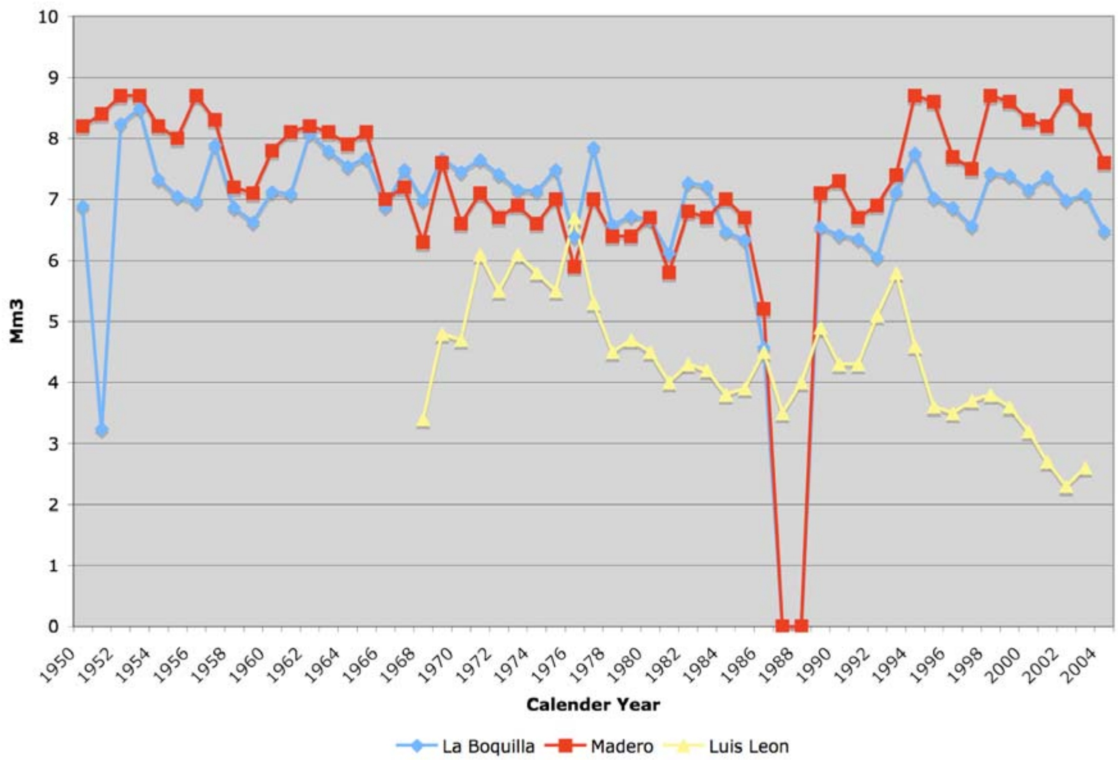
Source: CONAGUA, Gerencia Estatal Chihuahua, Information Provided to Author, September 2004.

Dams could also impact flows simply by the complex changes they beget in the geomorphology of the channel itself. While there is no universal pattern, many do lead to significant aggradations and channel narrowing, as is the case in the middle section of the Río Grande – impacted by the construction of dams upstream in New Mexico (Everitt 1993).

On the Río Conchos, the literature suggests that unlike the middle section of the Río Grande, dams have not significantly affected the flood history. For one, the literature emphasizes that dams operating on the Río Conchos have not traditionally been used for flood control, but for temporary water storage and use (Collier 1996: 35). Thus, flooding has continued to occur downstream at the entrance to the Río Grande after construction of the dams, while the largest flood on record is estimated at 162,000 CFS in 1904 (Collier 1996: 36).

Still, dams also obviously increase surface area and interaction between water and the atmosphere, leading to significant evaporation losses which would not occur at such high rates within rivers, reducing the overall flow of the river. Evaporation rates from CONAGUA show high evaporation rates over the last 10 years at La Boquilla and Madero, although similar to other periods of low rainfall, such as the 1950s (see Figure 3.13).

Figure 3.13. Average Monthly Evaporation Values at Chihuahua's Major Dams, 1950-2005



Note: Information not available for Madero Dam in 1988 and 1989.

Source: CONAGUA, Gerencia Estatal Chihuahua, Information Provided to Author, September 2004

Local farmers surveyed in Ojinaga and Delicias cited the sedimentation of the two dams providing water as one of the major causes for the lack of water available to water their crops (see Chapters Five and Six). Figures for the levels of sedimentation of the dams were not made available despite requests, but all local officials and farmers claim that sedimentation of the dams has occurred and insist that ongoing studies – never released – confirm this (Melchor Lopez, CONAGUA, Personal communication with author, October 2005). In fact, the supposed high sedimentation levels of Madero led farmers in the mid-1990s to press CONAGUA to increase the capacity of the dam even as no official study of sedimentation levels existed. Initially, CONAGUA had contemplated raising all dikes, cortinas and vertedores by six meters, but the cost was estimated at 200 million pesos, or about $20 million. In 1998, with funding of $30 million pesos from state, federal and user association help, a three-meter high inflatable “rubber dam” was added to the *vertedores* at Madero, increasing the capacity of the dam by 102 MCMs. (Ezequiel Bueno, CONAGUA, Delicias Irrigation District, 2005). The action incensed U.S. farmers and politicians.

“It was a problem between the two countries,” noted Genaro Sanchez Huerta, who works for FIRCO, a federal government agency which provides funding and technical assistance for agricultural and watershed projects in Chihuahua. “By satellite, the United States saw loads of water, but the base was full of sediment.” (Genaro Sanchez Huerta, FIRCO-Chihuahua, Personal communication with author, 2005).

Another major impact of dams in Northern Mexico and the American Southwest is the impact on bank vegetation. In the lower Río Conchos, the impact of years of flooding followed by years of drought is apparent to local farmers (see Chapter Six and Luján 2004). The river actually changed course following the floods of the early 1990s in Ojinaga, setting a new path through sandy soils, and denuding the landscape. According to local farmers, the floods also led to bank failure, apparently because the dry periods that have followed the flooding caused the banks above to be dry and be unable to support their weight. Essentially, the “angle of repose” becomes too great to be maintained (Knighton 1998: 113-118). Sandy islands in the Río Conchos have become common within the Lower Río Conchos Irrigation District and the denuded landscape has become lush with the invasive salt cedar *Tamarix peralta*. Luján, in a brief study of tamarisk invasion in the Lower Río Conchos Irrigation District, found that average ages of Tamarisk were generally less than 10 years, and were most pronounced in the lower parts of the district (Lujan 2004). Some have at least suggested that the Tamarisk “plugs” are a direct result of high levels of sedimentation, themselves produced by deforestation (Van Schoik et. al 2006).

In conclusion, precipitation loss led to major changes in the operation of Chihuahua’s major dams during the 1990s, including shutting off winter irrigation, and the reduction of flood spill events. These changes in turn may have spurred further sedimentation and drying up of the rivers in the Río Conchos Basin, while the invasion of the Salt Cedar in the lower Río Conchos has led to an aggraded, braided river, less able to carry waters into the Río Grande.

Thus, data at least partially supports the U.S. view that at least some of the low water inflows to the Río Grande during the 1990s and 2000s can be attributed to the impact of the dams and management decisions. The construction of Luis Leon helped Chihuahuan farmers as it reduced local flooding and provided storage for irrigation, but led to increased evaporation and lowered peak flows to the Río Grande compared with those periods prior to its construction.

C. Water Use Changes

When Texas Agricultural Commissioner Susan Combs marched to Washington on behalf of South Texas farmers in January of 2004, she came armed with recent reports from Texas A & M’s Center for North American Studies that claimed that “irrigated water use from surface and groundwater sources in Chihuahua more than doubled from 1980 to 1997 (CNAS 2003)” as well as reports from U.T.’s Center for Space Research, indicating the availability of surface water at Mexico’s northern reservoirs and suggested that Mexico had increased its application of irrigation water throughout the 1990s (CSR 2003; Rosson III, et al 2003). Mexico, Combs stated, and in particular Chihuahua, were stealing Texas’s water to engage in a major expansion of irrigated agriculture at the expense of South Texas's historically important farming community (U.S. Water News Online 2003).

What does the actual Mexican data show over the last 15 years? Agricultural activities are by far the most important water resource activity in the basin. Other major users include hydroelectric – a non-consumptive use since most of the water flows back into the river –domestic use mainly for municipalities, livestock and industrial use, while upstream forestry and mining activities may also have hydrological implications, both for their direct and indirect use of water, as well as because of their impacts upon the geomorphology of the river. Similarly, tourism in the upper basin may play a role in increased water use in the basin.

1. Agricultural water use

There is not a single type of agriculture in the basin, but a variety of different individuals engaged in agriculture. Some farmers – such as those in the forested uplands of the Río Conchos and the high savannah mesas – depend upon rainfall, and are thus "temporal" farmers. (see Chapter Four).

The largest farmers in the Río Conchos Basin rely on irrigation. These farmers may use individuals with wells, may be part of an Unidad de Riego (Irrigation Units), which distribute both groundwater and surface water to farmers, or form part of the larger Distritos de Riego (Irrigation Districts), which own and manage vast irrigation delivery systems, primarily from the major dams in the state which provide surface water for irrigation. Irrigation Districts are more organized and more directly regulated by the Comision Nacional de Agua than Unidades de Riego.

In addition, lands have different property regimes. Thus, many farm individual plots of land as private property, while others are part of an "ejido," a product of the Mexican revolution. These farmers may have both their individual plot of land for farming as well as access to communal lands. Some farmers in the basin are part of indigenous "communities" which predate the ejido structure itself. Finally, some farmers are part of "colonos" and have individual plots which over time have become considered equivalent to private property.

The Comision Nacional de Agua estimates that approximately 450,000 hectares in Chihuahua have been irrigated over the last several decades, including about 230,000 in the Conchos Basin (see Table 3.5). The majority of cropland is found in smaller Unidades de Riego, although the three irrigation make up more than 40 percent of total irrigated land in the watershed. A small number of individual farmers also irrigate within the basin using groundwater.

Table 3.5. Average Number of Irrigated Hectares in Río Conchos River Basin

Area	Unidades de Riego (Irrigation Units)– Hectares Irrigated	Individual Farmers and Ejidos not Part of Unidades de Riego – Hectares Irrigated	Distritos de Riego (Irrigation Districts)– Hectares Irrigated	Total Area Historically Irrigated in Hectares
Chihuahua	30,500	None	No Irrigation District	30,500
Delicias	34,500	None	76,000	110,000
Parral	13,500	4,000	No Irrigation District	17,500
Río Conchos (Ojinaga)	4,900	1,400	10,700	17,000
Río Florido	44,000	None	8,500	52,500
San Juanito	250	100	No Irrigation District	350
Total Hectares	127,650	5,500	95,200	227,850

Source: CONAGUA 1997: 5.1.22.f-1.

CONAGUA reports that there are 12,010 farmers registered as part of the three main irrigation districts. In any individual year, of course, some of these farmers will choose not to farm, either because they sell or rent their water rights or even land to another farmer, because of sickness, or because they have even given up farming in the area for good. Some may have actually migrated from Mexico in search of other opportunities in the U.S. (see Chapter Five and Six).

Table 3.6. Number of Farmers in Conchos Basin Irrigation Districts (Distritos de Riego) by Type of Property Regime

Name of Irrigation District	Number of Private Farmers including Colonos and Private Property	Number of Ejidatarios	Total
Delicias Irrigation Distinct	5,009	4,500	9,509
Bajo Río Conchos Irrigation District	605	553	1,156
Río Florido Irrigation District	470	875	1,345*
Totals	5,871	5,745	12,010

Note: * Includes about 300 farmers in the state of Durango.

Source: CONAGUA, Características Generales del Distrito De Riego, 090 Bajo Río Conchos, January 15, 2004, and CONAGUA, Características Generales del Distrito De Riego, 005 Delicias, 2004, and CONAGUA, Programa Hidraulico 1997, 5.1.2.f-1 – f-32.

Between 55 and 60 percent of all surface and groundwater use in the Conchos Basin occurs in the three irrigation districts, with the other 40 percent used in Unidades de Riego or individual farms or ejidos. About 82 percent of all the water used in Distritos de Riego comes from surface water; in Unidades de Riego, on the other hand, only about 25 percent comes from surface water. Overall, the biggest water users in the agricultural sector are the farmers of the Delicias District, using some 50 percent of all water in the Basin.

Table 3.7. Historical Annual Water Use in the Distritos de Riego in the Conchos Basin (Million Cubic Meters), 1995

Irrigation District	Groundwater Use	Surface Water Use	Total Water Use	Percentage Surface Water
Delicias	283	1,071	1,354	79%
Bajo Río Conchos	0	113	113	100%
Río Florido	0	131	131	100%
Total	283	1,315	1,598	82%

Source: CONAGUA 1997: 5.1.2.-3

Table 3.8. Historical Annual Water Use in the Unidades de Riego (Million Cubic Meters), 1995

Unidad de Riego	Groundwater Use	Surface Water Use	Total Water Used	Percentage Surface Water
Chihuahua	234	44	276	16%
Delicias	267	45	312	15%
Parral	27	94	120	78%
Río Conchos	11	33	44	74%
Río Florido	343	54	397	14%
San Juanito	0	2	2	100%
Totals	882	272	1,154	24%

Source: CONAGUA 1997: 5.1.2.-3

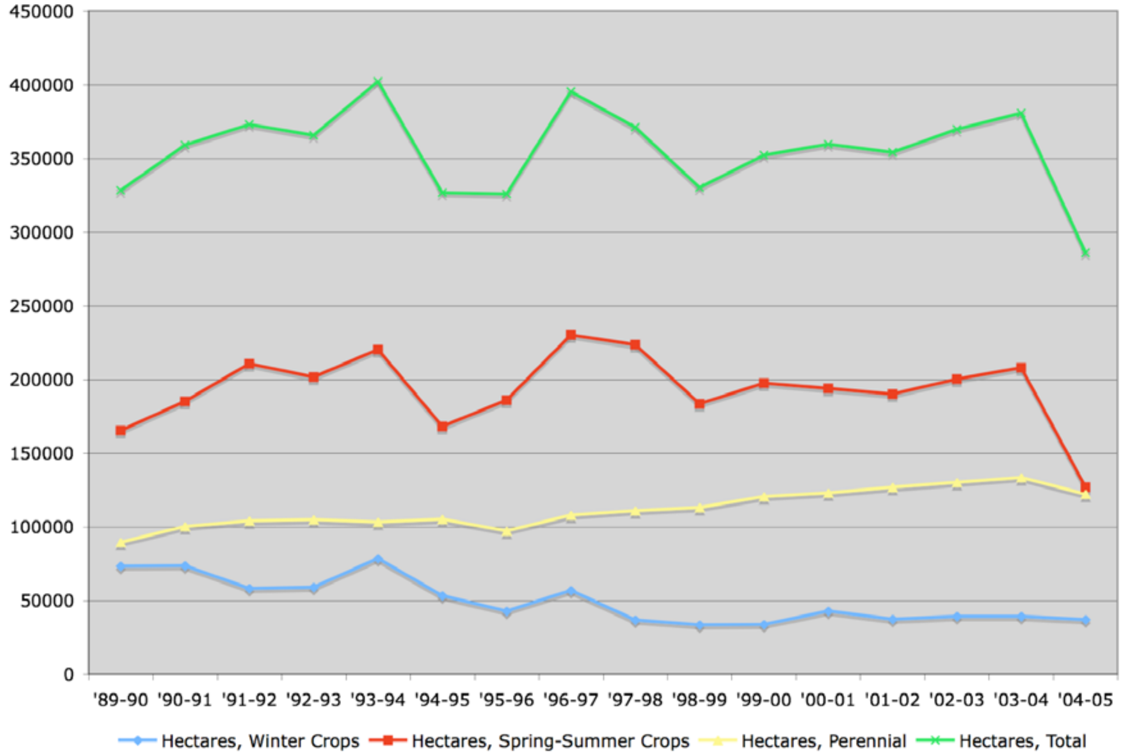
Yearly water use data in Chihuahua and the Río Conchos are incomplete. While the major irrigation districts keep very detailed statistics on water use and crop irrigation within the confines of the irrigation districts themselves, until recent changes, statistics only show water use originating from the major dams released to their canals and do not include water pumped directly from the river, or water from individual shallow or deep wells (Ing. Hernandez, Delicias Irrigation District, Personal communication with author, 2005). In addition, while some 40 percent of the crops irrigated in the Río Conchos basin do occur within the irrigation districts themselves, there has been significant development – both historical and recent – of irrigation outside the district in the Unidades de Riego, or URDERALES, and there is generally less complete water use information.

Moreover, SAGARPA – Mexico's agricultural ministry – keeps detailed agricultural statistics at a different scale of measurement than CONAGUA. Thus, before 2001, SAGARPA generally kept statistics for the State of Chihuahua by Rural Development Districts, which did not always fall along municipal lines, and certainly not along irrigation district boundaries. After 2001, SAGARPA began to keep statistics at the Municipal Boundary unit, but again these do not necessarily correspond to Irrigation Unit or District boundaries, cutting across municipal boundaries.

According to SAGARPA statistics, irrigated agricultural for the whole state decreased slightly during the time period from 1990 to 2005, although not as much as those highlighting the negative impacts of drought-like conditions have cited (see Figure 3.14). Thus, in the 1989-1990 period, the total number of hectares irrigated in the state was about 325,000, a total that would rise to 400,000 hectares in the 1993-94 agricultural year. While the total amount of irrigated lands would drop in the 94-96 period, it rose again in 1996-97 to nearly 390,000 hectares, and then fell slightly over the coming years. In 2003-2004, it rose back to about 375,000, certainly a decline from ten years earlier – some seven percent -- but an actual increase in irrigated lands from 1990.

Beyond those summary totals, however, are some interesting trends. In general, the total number of irrigated lands during the spring and summer hovered around 200,000, but the real change was found in winter crops and perennials – those needing watering the entire year. While total winter crops declined from a high of 75,000 in the 1993-1994 period, by 2003-2004, the total had fallen by roughly half, to 37,000. Perennials, on the other hand, rose from roughly 100,000 in the state, to some 130,000 hectares by the 2003-2004 period, a stunning rise during a supposed water crisis.

Figure 3.14. Total Irrigated Hectares Planted, State of Chihuahua, 1990-2005

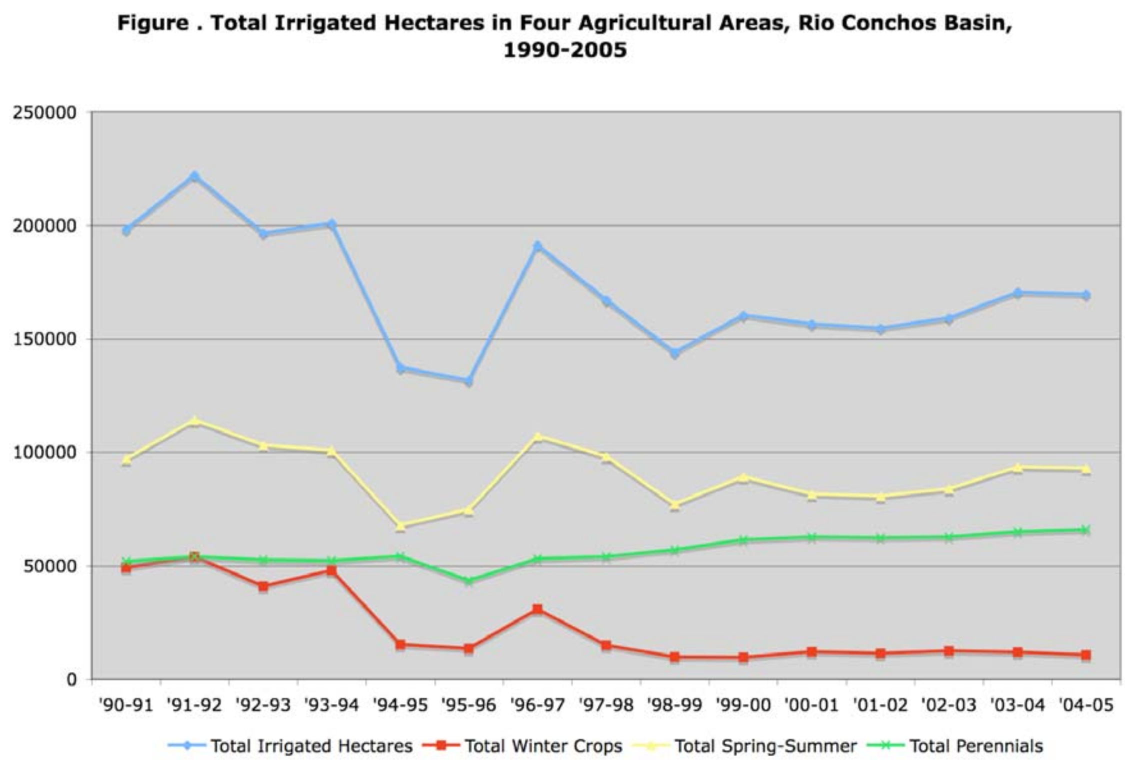


Source: SAGARPA, Chihuahua State Office, 2005.

The state totals obviously include substantial areas outside the Río Conchos basin, including irrigation districts in the agricultural valleys along the Río Grande outside of Ciudad Juarez, as well as areas heavily irrigated by groundwater in the Nuevo Casas and Janos Municipalities. A look at four agricultural areas which fall nearly entirely within the Río Conchos basin tells a similar story. Figure 3.15 shows data from Rural Development District 013 (Delicias), Rural Development District 09 (Ojinaga, Coyame and Manuel Benavides), Rural Development District 06 (Cuauhtémoc) and Rural Development District 014 (Río Florido area). The trend is similar. Thus, while the total number of hectares irrigated with waters in the 1991-1992 period before the drought stood at 222,208 hectares, by the 2002-2003 period, the total number of hectares irrigated that agricultural season had shrunk to 159,202 hectares, a 28 percent drop.

While roughly half the crops irrigated in 1992-93 were during the spring-summer season, a quarter in the winter and a quarter for perennial crops like alfalfa, pecans and apple trees, by 2003, about 55 percent were during the spring-summer, about 35 percent for perennial crops and less than 10 percent for winter crops. Thus, in both Chihuahua as a whole and in the four largest agricultural districts within the Río Conchos riverbasin, the trend is similar: a slight shrinkage of summer crops, a huge decline in winter crops and a substantial increase in perennial crops (See Chapters Five and Six).

Figure 3.15. Total Irrigated Hectares in Four Agricultural Areas, Río Conchos Basin, 1990-2005



Areas are comprised of the Cuauhtémoc, Delicias, Rio Florido and Ojinaga Agricultural Rural Districts.
Source: SAGARPA, State of Chihuahua Office, Information Provided November, 2004.

In Delicias, the total amount of water released from diversion dams for surface water irrigation within the District closely followed the reduction in crop irrigation, with both reduced some 60 percent when the two time periods are compared. This is surprising given the obvious increase previously cited in perennial crops such as alfalfa and pecans, which generally require much greater amounts of water than do winter crops previously grown in the area. *The reason is again that the data does not reflect the use of non-traditional forms of irrigation, like individual and communal well water.* Additionally, the data may reflect some increase in efficiency in irrigation as irrigators made use with less water by irrigating more carefully than they did in pre-drought conditions and in some cases installing new technology. Similarly, in Ojinaga, when comparing the two periods, average cropland irrigated was reduced by 28 percent, while average water use declined 25 percent, indicating a slightly higher amount of water used per hectare. This again may reflect the growth in perennials – and in particular of alfalfa -- in Ojinaga (see Chapter Six).

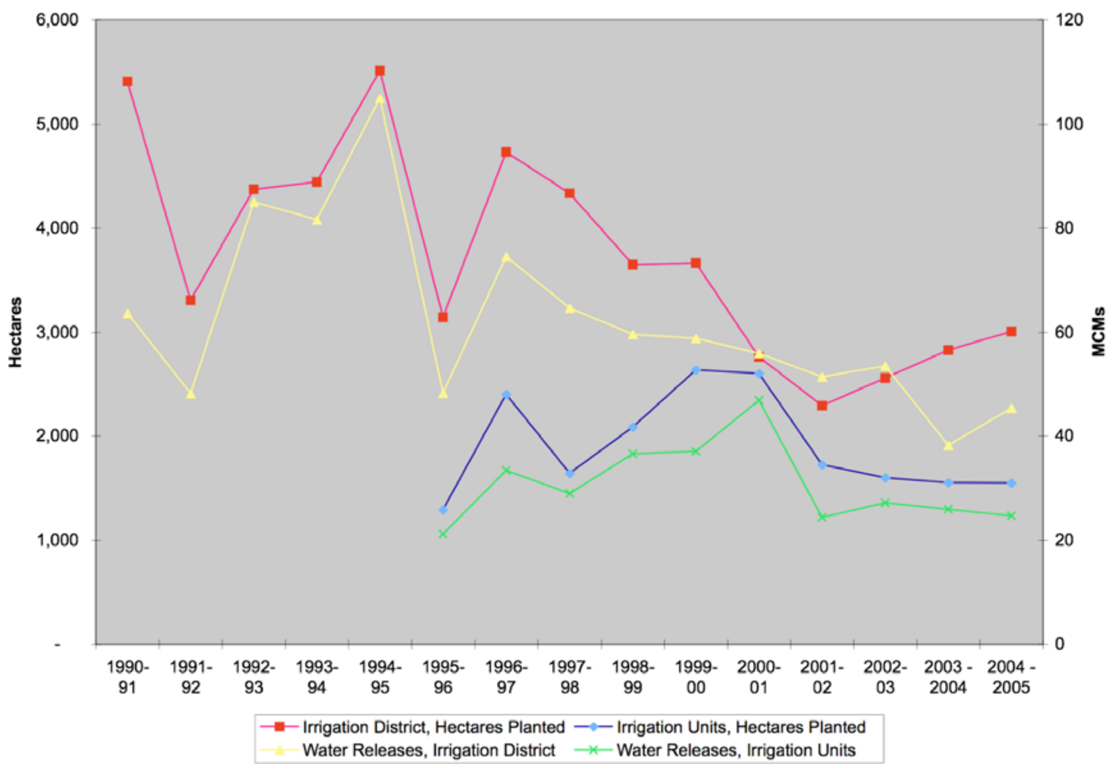
Table 3.9. Irrigation District Surface (Dam) Water Use and Irrigated Cropland in the Río Conchos Watershed in Pre-Drought and post-Drought Periods

Irrigation District	Principal Crops	Average Hectares Planted (89-94)	Average Total Water Used, 89-94 (Mm3)	Average Hectares Planted (95-2005)	Average Total Water Used (95-05)(Mm3)
Río Florido (103)	Maize, winter wheat, alfalfa, pecans, oats	7,300	145	3,800	80
Delicias (005)	Maize, winter wheat, alfalfa, pecans, sorghum, chile, cotton, peanuts, soybeans	85,000	1,435	32,300	520
Bajo Río Conchos	Pasture, cotton, alfalfa, melons, maize, winter wheat	4,600	77	3,300	55
Totals		96,900	1,657	39,400	655

Source: CONAGUA 2000, Anexo 38 and CONAGUA, Information provided to Author, October 2005.

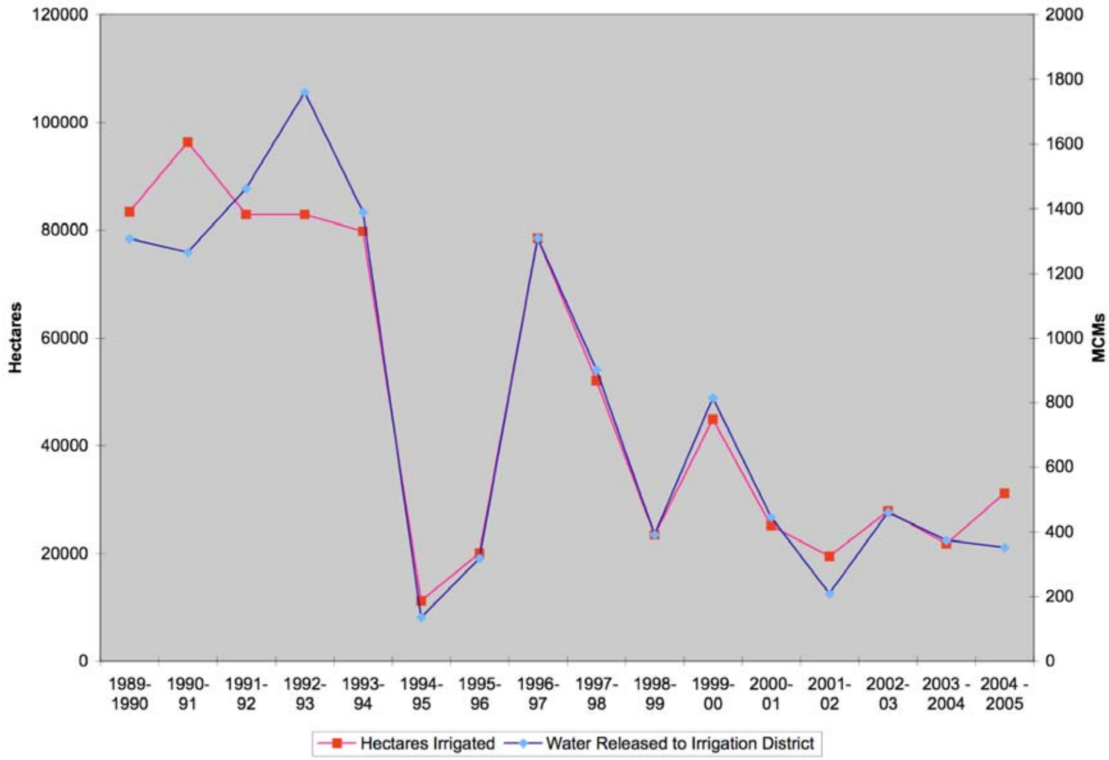
Surface water data from the irrigation districts is even clearer. The shrinkage of the Lower Conchos Irrigation – Ojinaga -- district over the last fifteen years has been substantial, while the Delicias Irrigation District – again only considering surface water – has endured an even more stunning contraction in total hectares irrigated (Figure 3.16 and Figure 3.17). These figures, however, present a much more dire experience than the reality. Thus, for the Delicias Irrigation District, it does not include a whole series of deep-well dams built by irrigation user association and individual farmers, nor does it include emergency shallow-wells built in the 1995 period when the dams were closed. It does not include water pumped directly from the Río Conchos, water diverted from the Río Conchos and even from the Río Grande in the Lower Río Conchos Irrigation District with small dams, nor the reuse of municipal wastewater. It is an incomplete picture.

Figure 3.16. Total Irrigated Lands and Water Released to Lower Rio Conchos Irrigation District and Unidades de Riego Below Luis León Dam, 1990-2005



Source: CONAGUA, Lower Río Conchos Irrigation District, information provided to author, 2005.

Figure 3.17. Total Irrigated Croplands with Dam Water and Total Water Releases from Dams in Delicias Irrigation District, 1989-2005



Source: CONAGUA, Delicias Irrigation District, information provided to author, 2005.

Water use figures on individual cropland from surface water also show that less water is being used per hectare compared to the early 1990s, but not at a rate as might be expected given the lack of access to water for individual farmers. In fact, water use per hectare actually increased in the late 1990s as farmers chose to reduce total surface area but irrigate more for more productive crops like alfalfa, chile and pecans, but then declined in more recent years in part due to new irrigation technologies and water conservation techniques (see Chapter Five).

Just how many wells are currently in use in the Delicias District? In 2005, there were 144 “official” deepwells which are owned by the irrigation user associations, meaning they actually are used to deliver water to a number of farmers within the Modules making up the Irrigation Districts. These wells extract approximately 120 million cubic meters of water per year. However, in addition to these “official” wells, CONAGUA reports another 755 individual wells, the vast majority of which have been dug in the last 10 years. In addition, there are 49 wells built for industrial or municipal use within the district boundary – most notably the City of Delicias – and some 16 private wells used mainly for rural domestic waters or for livestock (CONAGUA, Information provided to author, 2005). Not surprisingly, with the exception of some well data kept by the individual user associations, there is little overall data on water use from wells in the District.

Because of the increasing use of groundwater to serve irrigation needs, some of the aquifers are being mined, leading to problems with salinity, arsenic and even in some cases heavy metals (see Table 3.10). The sudden increase in groundwater use in the mid-1990s led CONAGUA to declare “zonas de veda” or “prohibition zones” in four aquifers throughout the Río Conchos Basin in 2005, including those near Delicias, Camargo, Cuauhtémoc, and Jiménez (Vergara Gonzalez 2005: 5A). The prohibition means that new wells can not be dug in these agricultural areas, unless the producer purchases a water right from a preexisting well.

In addition to the trends – greater use of groundwater and a change in crop production – between 2002 and 2005, CONAGUA implemented two new efforts in its irrigation districts designed to reduce overall water use. First of all, CONAGUA has been implementing in all three Chihuahuan Irrigation Districts the water conservation measures outlined the project certified by the Border Environment Cooperation Commission in October of 2002, and codified in Minute

309, signed by both governments in 2003 (IBWC 2003; BECC 2002). These projects have led to millions of dollars being spent over the last three years in all three irrigation districts, with the expressed intent of saving water (see Table 3.11). Chapters Five or Six provide more detail on these programs, their effectiveness and farmers' perspectives.

Table 3.10. Major Aquifers of the Río Conchos Basin and Estimated Use

Aquifer	Total Average Annual Pumping in Mm3	%Over-Exploitation (Above Estimated Recharge)
Bajo Río Conchos	8.9	Under-Exploited
Los Lamentos	0.3	Under-Exploited
Alto Río San Pedro	15	Under-Exploited
Alto Río Florido	22	46%
Chihuahua-Sacramento	125	127%
Jimenez-Camargo	580	88%
Parral-Valle de Verano	32	21%
Tapaloapa-Aldama	66	19%
Delicias-Meoqui	460	11%

Source: CONAGUA, 1997 and CONAGUA, Caracteristicas Generales del Distrito de Riego 005, 2004).

Table 3.11. Investments, Expected Volumes of Water Saved and Achieved in Delicias and Lower Río Conchos Irrigation Districts

District	Total Monies Expected to be Invested, 2002-2007	Total Monies Invested, 2002-2005 (million pesos)	Base Volume of Water Used in District, 96-98	Total Water Expected to be Saved in Five-Year Period Remaining	Total Water Savings Achieved from 2002-2004
Delicias Irrigation District	$1,360	$822	857	343	43
Lower Conchos Irrigation District	$110	$98	96	25	NA
Río Florido District	$65	$42	91	28	NA
Total	$1,535	$962	1,044	396	NA

Sources: IBWC, Minute 309, July 3, 2003; Comision Nacional del Agua, Gerencia Estatal Chihuahua, Residencia General Delicias and Residencia General Ojinaga, 2005.

The other program is known as PADUA – the Programa de Adquisicion de Derechos de Uso de Agua (Water Rights Acquisition Program). First implemented in the Lower Río Conchos Irrigation District in 2003 as the "Desincorporation, Compaction and Tecnification of Areas en the Bajo Río Conchos Irrigation District 090" , the program has now become a national program in Mexico and its intent is, in the words of Lower Río Conchos Irrigation District manager Elías Calderón "to shrink the districts (Elias Calderon, Personal communication with author, 2005)" Under the program, CONAGUA negotiates with the farmers both individually and collectively to definitively sell their water rights back to the government in areas where economic, environmental and geographic realities have made irrigation of lands unviable

In the first year of the program, over 640 water rights holder sold their rights to 4,500 hectares – including 2,500 in the Lower Río Conchos Irrigation District alone, which is about 20 percent of its total area – thus losing any chance to irrigate those lands in the future. In return, they gained about $87 million pesos, or about $12,400 dollars per water right. (See Chapters Five and Six for more details).

Table 3.12. Farmers, Hectares, Water Rights and Monies Expended under Water Rights Acquisition Program, 2004

Year and District	No. of Water Rights Holders	Hectares Covered	Surface Water (million cubic meters)	Ground-water (million cubic meters)	Funds Paid to Farmers (million pesos)
2004, Delicias	394	2,222.22	26.3	5.28	$65.10
2004, Ojinaga	250	2,515	19.7	0	$32.2
Total	644	4,737.22	46	5.28	$97.30

Source: CONAGUA, Irrigation District 090 and Irrigation District 005, Information provided to Author, 2005.

The data for agricultural water use are incomplete and at times contradictory. As Chapters Five and Six will show, it is apparent that while overall water use declined during the period – particularly from the dams themselves – there was likely a substantial increase in groundwater use as well as direct pumping of the river, which may have impacted baseflow. While water use likely increased on a per-hectare unit as farmers turned to higher water-demand crops, recent efforts aimed at water conservation and buy-back of water rights eventually led to overall reduction in both the total volume of water used and the per-hectare water use. Thus, the complexity of agricultural water use and crops irrigated in the Conchos River Basin belie a simplistic notion of either rapid expansion or severe curtailment, as were the common discourses from the two sides seeking a settlement to the U.S.-Mexico water dispute.

2. Municipal/Domestic Use

The other major water resource activity in the Río Conchos Basin that might directly impact river flows is the domestic use of water. Although precise annual data is lacking – due to huge water losses in domestic water systems and the lack of individual metering– CONAGUA estimates that domestic water use rates in the Conchos River Basin total between 260 to 300 liters per capita per day (about 70 or 80 gallons per day). Nonetheless, there is significant variation between social class, ethnicity and location in terms of water use.

While municipal water use only makes up a relatively small percentage of total water use, over the last 10 years population in the basin has increased by some 25 percent, and CONAGUA is conservatively assuming that it will continue to increase even more. Assuming a reduction in water loss from 30 to 25 percent, and significant water conservation efforts, for example, CONAGUA estimates that water demand in Chihuahua City will increase to 119 million cubic meters by

2020. Other cities with lower population growth will actually witness a decrease as conservation measures are adopted.

Table 3.13. Water Demand in Major Cities in the Conchos Basin in Million Cubic Meters, 1995-2020

City	1995 Demand	2020 Demand
Chihuahua	95.7	119.0
Hidalgo de Parral	11.4	14.2
Delicias	19.2	17.3
Camargo	7.3	6.6
Jimenez	6.1	5.3
Ojinaga	9.0	4.8
Saucillo	2.3	1.9

Source: CONAGUA 1997: 6.2.4

These figures – the expansion of population and water use within the basin – as well as the use of groundwater by both municipalities and agricultural users, point to a potential conflict between the Conchos's two main water user groups. Of most direct concern to farmers is the threat that the thirst of Chihuahua City might lead state and federal officials to convert Chihuahua's irrigation dams into municipal supplies. During 2003, press reports began to surface that Governor Patricio Martinez wanted to feed Chihuahua's burgeoning population and industrial sectors with a pipeline from Luis León Dam. When an initial study of the project indicated the cost of pumping water over two mountain ranges would be gigantic, the plans were quickly shelved. By 2005, as concerns about the sinking Chihuahua-Sacramento aquifer levels rose, a new project had emerged: piping water from the Boquilla or Francisco Madero Dams to the big city in the desert (Escobedo 2005: 4B).

In fact, the agreements reached between CONAGUA, state officials, and farmers in the Irrigation Districts in 2003 about the modernization of the Irrigation Districts are helping pave the way for the possible transfer of water to the Capital City. The agreements state that 25 percent of the savings from water conservation will be used by CONAGUA "for the national interest." (CONAGUA 2002; IBWC 2003) Clearly, the attempt to conserve water in the irrigation districts – while intended to increase flows to the Río Conchos and Río Grande as laid out in Minute 308 – was also intended to free up water for municipal uses. Thus, as in many watersheds throughout the world, the need for domestic supplies in the Río Conchos is causing both the government and others to figure out how to lower agricultural water use. Within the period of study, when no major reservoirs or major domestic supply projects occurred, and when cities continued to depend overwhelmingly on groundwater resources, it is unlikely that municipal water use impacted the Conchos' flow to the degree that agricultural water use can and did. As a future issue, however, the increasing thirst of Chihuahua's cities and industrial bases is very real.

D. A Change in the Land? Land Management as the Cause of the Loss of River Water

If water use changes during the last 10 to 15 years in the Río Conchos Basin witnessed some dramatic trends, many have posited that there have been similar changes in the use of land – which in turn influences water use through run-off, erosion and infiltration. In fact, a thesis began to emerge over the period that the cause of lowflows in the Río Conchos was due not only to an extended drought, but land use changes, including soil erosion, deforestation and desertification, leading to sedimentation in the dams and reduced flow in the river. Essentially, this thesis says, baseflow of the rivers has dried up as vegetation and porous soils have failed to capture rain. Instead, reduced rainfall has flown overland, but been filled with sediment from the vegetative-lessened soils.

The twin culprits of these land use impacts are overgrazing by cattle and other livestock and deforestation. "We are causing desertification by overgrazing with the resulting water and air erosion that carry millions of tons of sediment into the dams, lakes, and watering holes," explained Genaro Sanchez Huerta, who works for the Chihuahua state delegation of FIRCO, a federal lending, grant and technology transfer agricultural agency. "Our lands are ending up in the dams, 160 tons of earth lost every year on every hectare, taking away the useful life of our dams and lakes." (Sanchez Huerta, personal communication with author, 2005).

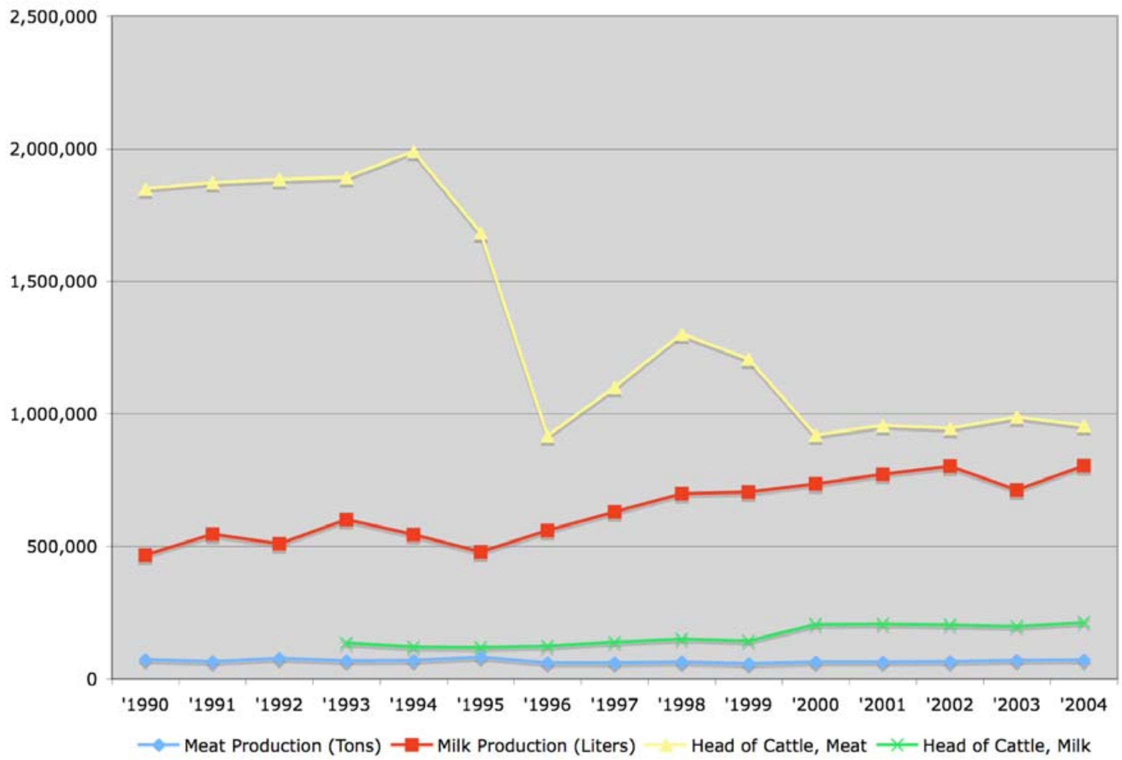
In their introduction to a recent book on transboundary ecosystem management, Van Schoike, Lelea and Conner suggest that it was the deforestation in the upper basin that led to sedimentation of streams, creating an ideal habitat for invasive species – in this case a tamarisk plug in the Río Conchos -- and inhibiting the delivery of water to the U.S., a clearly subjective interpretation of the cause of the dispute (Van Schoik, Lelea and Conner 2006: xix). To be fair to the authors, the example is merely illustrative of how events in one watershed may have greater impacts on another and they are not attempting to "prove" this causality. But it is illustrative of the discourse that has emerged that deforestation is part and parcel of the cause of the Conchos's low-flows.

1. Ranching and Cattle

Ranching and livestock have a long history in the State of Chihuahua, and were one of the principal drivers of the economy –along with mining -- from the time the Spaniards arrived in the late 1500s (Jordan 1957). Livestock raising, primarily on natural pasture in the central valleys and northwest regions of the state, was estimated to take place on 13.6 million hectares in 1995, about 55 percent of the total land area of Chihuahua. According to 2004 statistics from SAGARPA, today milk production from cattle ranks the State of Chihuahua 7^{4h} among all Mexican states, while meat production ranks sixth (SIAP 2005). In terms of total cattle, however, the state only ranked 12th, however, well behind states like Chiapas and Veracruz (IBID).

There were large losses of cattle during the mid-1990s, as many ranchers slaughtered cows with the advent of the drought. The total amount of cattle in Chihuahua went from roughly 2.1 to 1.1 million between 1994 and 1996 according to the agricultural ministry. Between 1996 and 2004, the number of cattle has risen slightly. In general, while the number of cattle for meat production has remained relatively steady since the mid-1990s – hovering around one million – the number of cows for milk production – as well as milk production itself -- has soared (see Figure 3.18).

Figure 3.18. Meat and Milk Production and Number of Head of Cattle in Chihuahua, 1990-2003



Source: Servicio de Información Agroalimentaria y Pesquera (SIAP), Anuario Estadístico 2005.

The majority of cattle grazing do occur within the Río Conchos Basin, mainly in the central valleys in Camargo, Saucillo and Delicias, as well as around the capital city of Chihuahua. The Cuauhtémoc region is also an important region for meat production, and grazing is common in the high plains west of Cuauhtémoc and in the oak-juniper savannahs near Carichi and Cusihuiriachi (see Table 3.14).

Most cattle in the Delicias/Camargo area are associated with milk production, as major dairy operations such as Lecheros Zaragoza and Ganaderos Productores de Leche Pura (ALPURA), a national cooperative of milk producers, are found in the region. Data provided by the local Rural Development District shows a marked increase between 2001 and 2004 in the number of head of milk cattle and production as the region became one of Mexico's major milk production centers, eclipsing to some degree the area found near Torreón (See Chapter Five).

Table 3.14. Milk and Meat Production by Rural District, State of Chihuahua, 2004

DDR (Rural Development District)	**Total Meat Production (Tons)**	**Total Milk Production (1000 Liters)**
Chihuahua Total	71,779	803,728
Chihuahua	4,378	55,208
Delicias	14,796	325,208
Cuauhtémoc	31,859	207,574
Ojinaga	896	664
Río Florido (Jimenez)	2,744	52,665
San Juanito	1,275	353

Source: Servicio de Información Agroalimentaria y Pesquera SIAP 2005.

Moreover, Chihuahua has become specialized in exporting young cattle to the U.S., where they are fattened in U.S. pastures and cattle feeding lots. Thus, in the 2004-2005 period, Chihuahua exported 28 percent of all head of cattle in

Mexico, including 66 percent of all female cattle and 25 percent of all male cattle (see Table 3.15). Ojinaga is an important chain in the production of meat, since the "Unidad Sanitaria de la Union Ganadera Regional de Chihuahua" -- the stockyard from which cattle are inspected and exported to the U.S. – is located just a few kilometers east of the City. Thus, many of the cattle raised throughout the basin are trucked to the Unidad Sanitaria, where they are inspected by both Mexican and U.S. authorities before export (see Figure and Photo 26). Market forces, regulatory changes and the mad cow disease scare in Canada have led to ebbs and flows in the export trade (Dr. Vaca, Unidad Sanitaria, Personal communication with author, 2005). As a state, Chihuahua has continued to specialize in the production of young cattle and subsequent export to the United States. The increase in exported cattle has in part fed the expansion of alfalfa and sorghum raised by local producers in Ojinaga (see Chapter Six).

Table 3.15. Total Number of Cattle Exported from Chihuahua, 2004

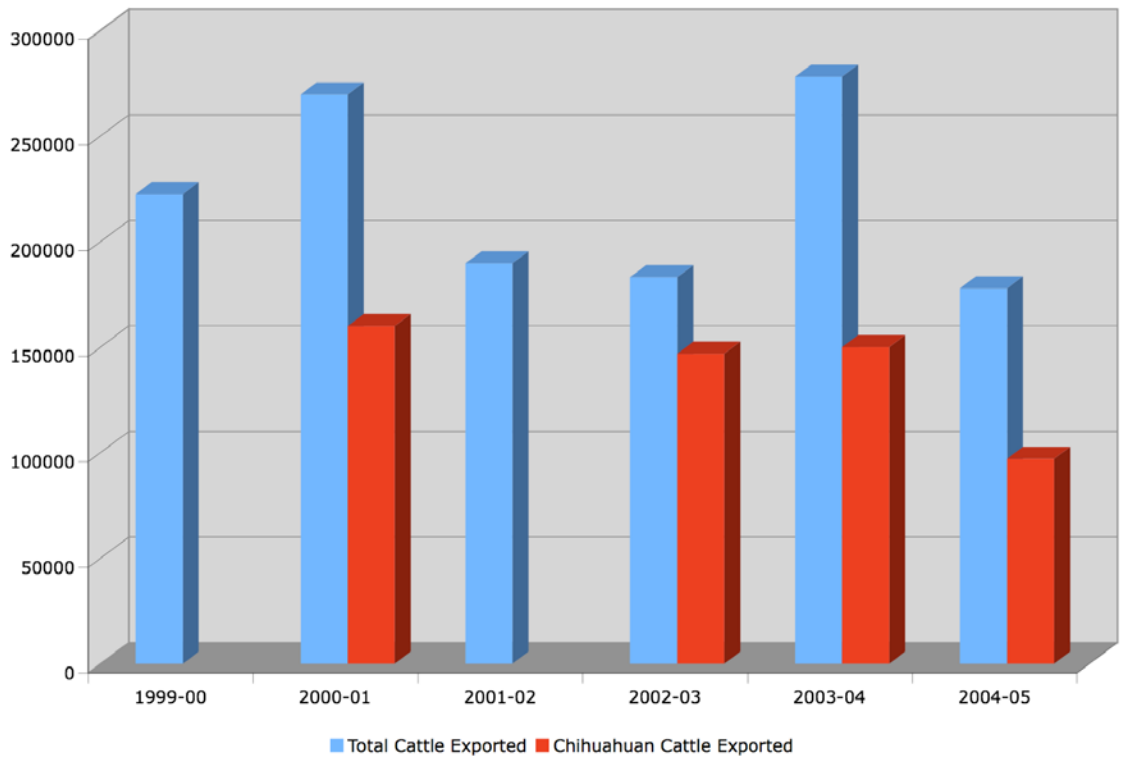
	Number of Head	**Percentage of National Total**
Male Cattle	291,907	25
Female Cattle	66,809	66
Total	358,716	28.5

Source: Servicio de Información Agroalimentaria y Pesquera (SIAP) 2005.

While the data suggest there has been an increase in cattle production both for milk and meat in recent years, it is more difficult to draw the conclusion that erosion from cattle ranching has increased. For one, overall there has been a decrease in the total number of cattle, both within the state and within the basin, compared with 1994. For another, the increases that have occurred in the last few years have mainly been in the central valleys in large dairy operations, not along riverbanks or in hilly slopes where erosion might be more prevalent. More importantly, an increase in cows does not necessarily correspond to an increase in erosion and sedimentation of local rivers. In fact, many of the cattle produced in Chihuahua are young and remain only short times on the land, before they are sent to the U.S. for fattening in feedlots.

Photo 3.10. Cattle Export Center near La Estación, Outside of Ojinaga

Figure 3.19. Cattle Exported from Ojinaga Export Center, 2000-2005



Source: La Estación Cattle Export Center, information provided to author, 2005.

However, given that there is significant cattle grazing in the hills in the municipality of Cuauhtémoc, Carichí and Cusiriachi near the headwaters of the Río Conchos – some of it associated with deforestation -- as well as in the central valleys, grazing and destruction of native grasslands likely has impacts on local flow and sedimentation of the rivers and of the downstream dams, resulting in less water for agricultural use. Farmers living in the Municipality of Carichi, in the upper Río Conchos Basin, complain that overgrazing and subsequent erosion is common in the oak-juniper savannah hills that typify the region. Anyone visiting the area can see the erosional gullies along the dirt roads, creeping up into both cattle ranches and cropland. The question, however, is did this noted erosion increase substantially over the previous decades or is it part of a common problem that has occurred over a longer period of time (see Photo 3.11).

In the more arid environment of Central Chihuahua and Ojinaga, cattle are found on the banks of the Conchos itself. There, cattle appear to prefer the riparian zones, leading to a more pronounced and localized impact. However, again it is important to note there appears to be a threshold at which grazing in riparian zones has a significant impact on bank sliding, erosion, loss of vegetative cover and channel morphology changes. Light or moderate grazing may have little discernible impact, depending upon the type of soils and vegetative covers (Trimble and Mendel 1995: 246).

Photo 3.11. Erosional Gullies outside Carichi, Río Conchos Basin

“There is no regulation of overgrazing in Mexico,” noted “Pepe” Treviño, the Federal Delegate to Chihuahua for SEMARNAT, the federal environmental agency. “You can’t restrict or fine if ranchers go over the grazing coefficients that have been recommended, you can only try and raise the consciousness of the farmers.” (José Treviño, Personal communication with author, 2005).

FIRCO’s Genaro Sanchez Huerta says the problem lies in the land tenure system itself, since most land is held by communal ejidos, not private property owners. In essence, the small indigenous farmers are in part to blame for the high levels of erosion.

“The private property owner respects his land, but the ejido does not follow their own rules,” explained Sanchez simply (Sanchez Huerta, Personal communication with author, 2005). Reflected in this statement is a belief that “Common” areas such as those contained in most Mexican ejidos – where members are given a grazing right without specific individual borders --- will invariably lead to overexploitation over time. The “Tragedy of the Commons” thesis was developed and refined by Biologist Garret Hardin, who was concerned with the progressive ecological destruction of “common” property as population and institutional pressures cause humans to exploit and destroy nature (Hardin 1968). As Chapter Four will show, however, the reality of what is occurring in the ejidos of the upper Río Conchos is considerably more complex than a simple case of “Tragedy of the Commons.”

Nonetheless, whatever the reality, or despite the lack of regional studies, Chihuahua officials, environmentalists and others have begun promoting the notion that overgrazing – particularly in the highlands -- is the cause of oversilting of the dams and thus of reduced water flows to the United States.

As Chapters Five and Six will attest, however, a much more direct impact on water use in the Río Conchos basin has been the need to feed these cattle, necessitating a change in crop production toward corn (for feed as opposed to grain), alfalfa, rye grass and sorghum, with impacts on the total volume and per-hectare rate of water use.

2. Deforestation

As with cattle grazing in the hills in the Municipality of Cuauhtémoc and Carichí, there is widespread concern that deforestation may be impacting downstream flow patterns in the Río Conchos. While no specific studies have been conducted region wide within the Río Conchos Basin on deforestation rates, a number of estimates suggest that significant areas of the Sierra Tarahumara have been deforested over decades. Studies suggest that while once nearly six million hectares covered Chihuahua with pine-oak forests, today only four million hectares remain. Thus, S.R. Felger and M. Wilson estimate that only 2 percent of the old conifer forests remain in the central region of the Sierra Tarahumara, while another study found that only 19 areas – about 0.61 percent of the Sierra's original pine-oak forests – remained intact (Felger and Wilson 1995; J.M. Lammertink, Rojas-Tome et al 1997; Turner 2001). A more recent study using landsat images found a loss of 6.3 percent in forest cover over the last eight years in one area of Sierra Tarahumara, although another 1.7 percent of the total cover had been reforested (Turner 2001). While the three studies mentioned cite virtually the same causes of this deforestation -- demands for wood products, illegal cutting, conversion to agricultural and grazing lands and disputes over land titles -- the emphasis each author places on each factor is distinct.

The deforestation thesis being spouted off by officials, and environmental organizations is similar to the thesis that cattle ranchers have increased erosion, filling up Chihuahua's dams. Deforestation – the cutting down of trees – in the upper Río Conchos, combined with frequent forest fires during the drought years, has denuded the landscape. With less trees, the vegetation is no longer capturing the rains–and releasing it back into the hydrological cycle through transpiration. Thus, reduced rainfall coupled with deforestation leads to further reductions in precipitation. Secondly, because there are no trees, rains are splashing off the denuded landscape, carrying soils, aggrading channels and generally stopping good flows. Finally, because the rains are running off, rather than infiltrating the earth, tributary baseflows have disappeared, and streams which once ran continually today are intermittent (Gadsden et al. 2003).

There is of course a significant literature which suggests that deforestation can have serious impacts upon watersheds. By removing natural vegetative covers – through the agency of cutting, burning and grazing – deforestation accelerates erosion and sedimentation (Goudie 1982: 188). The higher supply of sediment supply generally leads to channel bed aggradations, which in turn leads to an increase in overbank flows. The increase in sediment load also has been generally associated with wider, shallower and less sinuous rivers (Knighton 1988: 319).

When President Vicente Fox entered office in 2001 as Mexico's first president from an opposition party, one of his first major environmental program was the "National Crusade for Forests and Water," (*Cruzada Nacional por los Bosques y el Agua*) a concentrated educational and programmatic effort to protect forested areas, reforest and reduce deforestation since most Mexican rivers begin in heavily forested mountains. In the press announcement announcing the program in March of 2001, the government cited the loss of 600,000 hectares per year of forested areas in Mexico, and deforestation was listed as a chief cause of reduced inflows to Mexican dams (Fox 2001).

While there was no citation given, the 600,000 hectare figure appears to be related to an annual 1997 study by the Food and Agriculture Organization of the United Nations (FAO) (FAO 1997), which estimated deforestation rates between 1990 and 1995 [9] Changes in the 1997 Forestry Law led to a variety of new federal programs designed both to help forestry producers but also to increase funding for soil conservation and reforestation efforts throughout Mexico (see Table 27). In addition, in 2000, the government formed CONAFOR, the National Forestry Commission as a semi-autonomous agency to help set forest policy and implement programs in Mexico.

Table 3.16. Major Forestry Programs in Chihuahua

Name of Program	Main Agency Responsible
Program for Forest Development (PRODEFOR)	CONAFOR – Comisión Nacional Forestal (National Forestry Commission)
Program for Plantation Development (PRODEPLAN)	CONAFOR
Soil Conservation Projects	CONAFOR
Environmental Service Payments	CONAFOR
Hydrological Service Payments	CONAFOR
Mini-Watershed Planning	FIRCO

Source: CONAFOR, information provided to author, 2005.

The focus on deforestation as a root cause of the Chihuahuan drought is not new. In the post-Second World War period, logging in the Sierra Tarahumara expanded due to demand from the U.S. for wood products, and new sawmills, permits for cutting and other facilities connected to the wood industry began to sprout up throughout the Sierra. A new forestry law was passed to try and control

[9] A more recent estimate by the FAO said that Mexico lost an estimated amount of 395,000 hectares per year between 2000 and 2005 of primary forests and jungles (FAO, 2005 Forest Resources Assessment). The 1997 FAO study said Mexico lost an average of 510,000 hectares per year, while a government document in 1995 gave 13 different deforestation rates ranging from 370,000 to 1.5 million hectares per year (Anon. 1995; *Programa Forestal y de Suelo 1995-2000*, Secretaría de Medio Ambiente, Recursos Naturales y Pesca, Mexico, pp.10-12

the sudden growth, but according to some, bribes and exceptions to the more stringent rules were frequent.

Afterwards, according to Historian Fernando Jordan, politicians began to push for and enacted a prohibition against cutting, and even an end to the sawmill industry in the name of the forest. “Politically the measure was a great solution; economically, it was a crime,” he writes (Jordan 1956: 406; Author translation). Jordan continued:

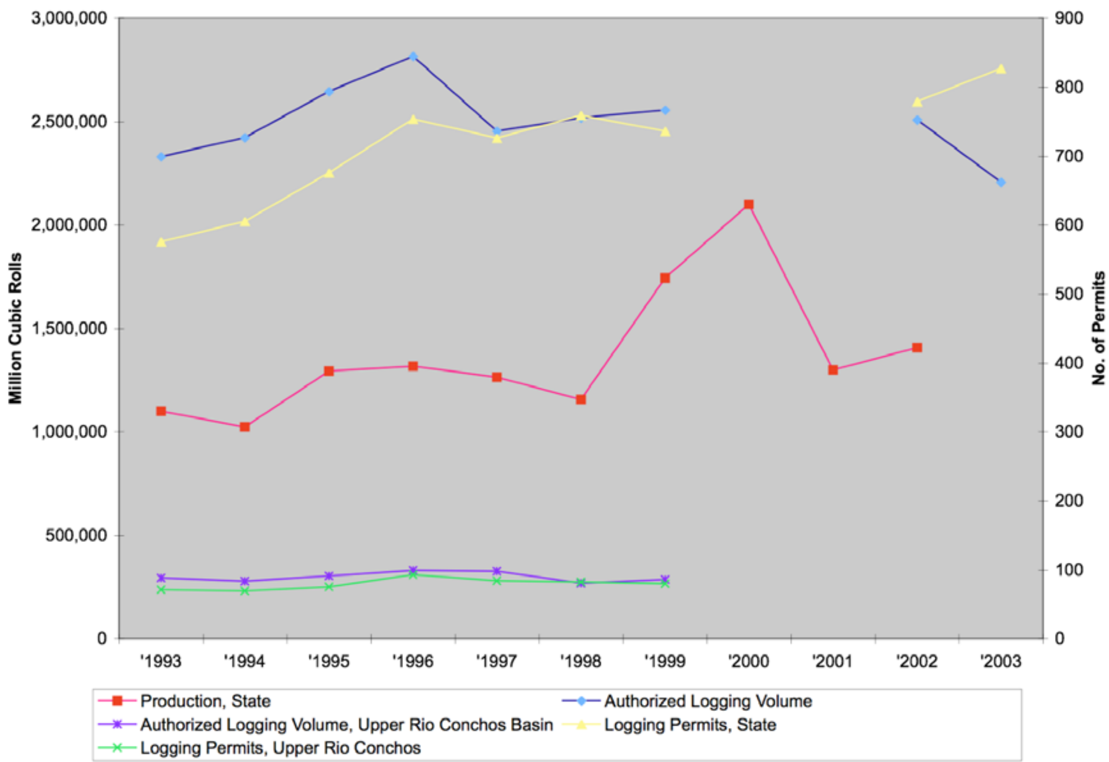
> Along with the law came the great trick: they gave the press the scandalous and irresponsible news that Mexico was almost to the point of having no trees. Theories were invented and it was stated that the long drought was caused by, principally, the cutting down of trees” (Jordan: 406. Translation by author).

With more than 7.5 million hectares of forests and jungles, Chihuahua has more forested lands than any other state and is second in total wood production from its forests, second only to its neighbor of Durango (Secretaría de Desarrollo Rural, Estado de Chihuahua 2004). Forests are harvested both by individuals, ejidos and – through contracts with individual land owners – by companies. Most forestry production – about 90 percent -- occurs on ejidal forestry lands in the State of Chihuahua (Guerrero et al, 2002: 7).

Virtually all of this production occurs in the Sierra Tarahumara. For example, in 2003, 827 permits were issued in Chihuahua, authorizing the harvesting of a maximum of 2.5 million cubic meters of wood. The vast majority – some 700 -– and virtually all of the wood -- were authorized for ejidos and communities located in the 20 municipalities making up the Sierra Tarahumara (Secretaria de Desarrollo Rural, Estado de Chihuahua 2004). Within the four municipalities with significant forest resources in the Río Conchos River Basin, however, there were relatively few permits for forestry. Thus, in 1999, there were two communities in

Carichi, two in Nonoava and 56 in Bocoyna with forestry permits. In addition, since part of the Municipality of Balleza is within the Conchos River Basin, it is likely that some portion were within the basin as well (see Table 3.17). Thus, relatively little – legal – production has occurred in the actual rivershed itself, at least in the 1990s (Figure 3.20).

Figure 3.20. Forestry Permits and Volume Authorized in State and Upper Conchos Watershed, 1993-1999



Source: INEGI, Anuario Estadístico Forestal.

In fact, beginning in the mid-1990s forest production in the pine-oak forests of the Sierra Tarahumara declined due to the peso crisis, weak domestic demand for wood and products, imports and inefficient forestry production methods (Guerrero, Kelly et al. 2002). Production picked up again in the late 1990s, reaching a peak in 2000, although recent years have seen a decline in total wood production. Similarly, the number of “permits” to cut trees also increased in the late 1990s as did citizen complaints about the illegal cutting of wood throughout the Sierra. (Guerrero et al. 2002).

Table 3.17. Forestry Production, Permits and Fires in the Río Conchos Basin, 1999

Municipality	Wood Production (tons)	Permits for Logging	Authorized Volume for Logging	No. of Fires	Hectares Burned
Balleza	104521	30	142529	57	2647
Bocoyna	40261	50	125200	123	2093
Carichi	65	2	577	NA	NA
Total Upper Conchos	144847	82	268306	180	4740
Chihuahua	1,156,592	759	2,517,870	360	9,480

Source: INEGI, Anuario Estadistico del Estado de Chihuahua, 1999, Seccion Silvicultura.

For their part, CEISS, the drought research institute, spends much of its time examining the impacts of and the efforts to mitigate forest fires in the Sierra Tarahumara. As previously mentioned, in their examination of the drought, they have argued that the biggest reduction in rainfall has been in the forested southwestern portion of the state, and that deforestation – whether from forest fires or logging -- may be one cause of the reduced rainfall (Gadsden 2003: 107).

Similarly a number of high profile groups have made preservation of the Sierra Tarahumara and deforestation a major focus and cited it as a principle cause of reduced rainfall and flows. In the late 1980s, the Latin American arm of the World Bank in fact supported a major expansion of the forestry sector in Chihuahua and Durango, a loan that was actively opposed by local indigenous groups, many political leaders and environmental organizations from both Mexico and the U.S. (Randall Gingrich, Personal communication with author, 2005). From the Texas Center for Policy Studies in Austin, Texas, to the Chihuahuan-based Human Rights Commission (COSYDDHAC) to international groups like the Sustainable

Forestry Council, the coalition put international attention on resource use in the Sierra Tarahumara and on forestry policy. Their efforts eventually led to the cancellation of the bank loans in 1993 and the large-scale roads and sawmills supported by the project never occurred.

“The World Bank loan, and the coalition of groups fighting it, led me to fall in love with the Sierra Tarahumara,” noted red-bearded US expatriate Randy Gingrich from his office in Chihuahua City. Once an Arizona native organizing conferences about the Sierra Tarahumara, Gingrich has gone on to become an active, and sometimes controversial figure in the effort to preserve the Tarahumara forests. Gingrich has been working with federal officials from the Comision Nacional de Areas Protegidas (National Protected Area Commission) to have portions of the Tarahumara forest declared a Biosphere Reserve, a controversial proposition which split communities and organizations fighting for land rights and better resource management in the Sierra in the period of study (Maria Teresa Guerrero, Personal communication with author, 2006). (See Chapter Four).

Another group, World Wildlife Fund (WWF) opened an office in Chihuahua City in 2001. WWF had actually begun work in Chihuahua in 1998 as part of the Chihuahuan Desert Program, but operating out of offices in Monterrey, according to current director Dr. Hector Arias.

“But you can’t focus on the Chihuahuan Desert and the Río Conchos without looking at its headwaters and the forested areas,” he notes, and the group began to document factors leading to riverflow loss through a series of workshops, documents and programmatic work, such as its “Integrated Management Plan for the Río Conchos Basin.” The document was released to the public in a workshop in 2004, Arias said, and puts an emphasis on the need to reforest the headwaters to preserve flow (WWF 2004). He says that the focus must be on creating livelihoods for ejidos that do not involve cutting down more forests, which has become a focus of WWF in Mexico for many years.

Yet another group active in resource use issues in the Upper Río Conchos is led by Chihuahuan sociologist Maria Teresa Guerrero. Guerrero worked for years with COSYDDHAC, a human rights organization in Chihuahua City which has a history of working on land rights issues with the Sierra's indigenous people. Guerrero also helped lead the fight over the World Bank loan, and says that deforestation is real, but is related to poor enforcement of forestry laws rather than an increase in actual production, and is not the root cause of the drought. In June of 2000, in fact, on behalf of several indigenous communities, Guerrero helped COSYDDHAC file an Article 14 submission to the Montreal-based Commission for Environmental Cooperation (CEC) arguing that in the Sierra Tarahumara, Mexican environmental authorities were not enforcing environmental and forestry laws designed to keep deforestation rates low. In January of 2006, the CEC released a factual record on Mexico's alleged failure to effectively enforce its environmental law by denying access to environmental justice to indigenous peoples of the Sierra Tarahumara, in the state of Chihuahua.

The lawyer in Chihuahua responsible for putting the document together for the Article 14 submission was Agustin Bravo, who in 2005 was running his own organization called Fuerza Ambiental (Environmental Force). Fuerza Ambiental is one of the local organizations which have contracted with WWF to enact participatory natural resource use plans in the Upper Río Conchos (see Chapter Four). Bravo supports the view that enforcement problems and illegal logging are the main causes of deforestation, and not the traditional indigenous producers. (Agustín Bravo, Personal communication with author, 2005).

Thus, local producers, communities, ranchers, ejidos, environmental organizations and governmental agencies have put forward the argument that deforestation has been both a cause and a consequence of the low rainfall during the 1990s and subsequent hydrological drought. Figures from SEMARNAT suggest that after wood production fell in the mid-1990s, production, permits for logging and the total amount of volume authorized for logging has increased in the late 1990s and early 2000s, both in Chihuahua as a whole and within the four municipalities with some forestry activities. In addition, a large number of complaints involving natural resource use in forested ejidos in the Sierra Tarahumara were filed with environmental authorities during the 1990s, indicating conflicts over the legality and use of forested lands.

In some sense, whether or not the thesis that deforestation and soil erosion were major causes of low flows in the Conchos during the 1990s and 2000s is difficult to prove and it may not even be important. The discourses on nature and its destruction create their own truths in Chihuahua (Castree and Braun 2001, Ellis 1996). The concerns about deforestation and soil erosion as a cause and consequence of the Chihuahuan drought has led to increased federal and state funding for reforestation and soil conservation efforts, as well as increased attention from organization, communities and grass-roots organizing. These efforts range from efforts to declare the Sierra Tarahumara as a biosphere reserve to individual participatory projects to decrease soil erosion and increase water retention. These issues will be further discussed in Chapter Four.

IV. Policy Changes: Resource Use goes to the Market?

A final factor in Chihuahua's Río Conchos Watershed during the 1990s was changes in natural resource management policies. Since the early 1990s, there has been a concerted effort to devolve power – both from the central state to the state and local governmental structures – and also to replace public with private management and ownership of natural resources (Wilder 2006). This is apparent in major changes in land ownership, forestry and water rights policy.

A. Land Tenure Policy

One major change over the last fifteen years was the decision in 1992 for Mexico to fundamentally change its policy regarding land tenure. Mexico's social ownership of land is contained in Article 27 of the Mexican Constitution, which sets out both very specific limits to land ownership as well as recognition of communal lands embodies in agricultural communities known as Ejidos. In 1992, Mexico changed its long-standing rules for ejidos by reforming Article 27 of the Mexican Constitution as well as making changes to the Rural Development Law. The modifications to Article 27 allow ejido land to be rented or sold to individuals or to foreign or domestic corporations. If they chose and followed certain procedures, ejidatarios could sell their private forest holdings to whomever they chose, or be able to offer their land rights as collateral for loans (Guerrero et al. 2002: 7). In addition, the changes allowed ejidos to set up associations open for investment by outsiders, and within forested areas, allowed private ownership of up to 20,000 hectares for development of forest management areas or forestry plantations, a large increase from the previous limit of 100 hectares (Guerrero et al. 2002: 7).

In making these fundamental changes, the Carlos Salinas administration (1986-1992) was seeking to both increase productivity on ejido lands, as well as attract direct investment from domestic and foreign corporations, in anticipation of signing a major free trade agreement with the United States (Cornelius & Myhre 1998). To critics, however, these changes represented a betrayal of the principles of the revolution and a naked land grab by the country's wealthiest citizens, and potentially by foreign corporations as well.

Despite dire warnings, in Chihuahua at least through 2005, Article 27 did not result in a giant privatization of ejido lands, but a lengthy process whereby ejidos could choose to participate in changing land management. In Chihuahua, the state has been held up to the rest of the nation as exemplary in the implementation of the land reforms embodied in the 1992 change. Under PROCEDE – literally El Programa de Certificacion de Derechos Ejidales y Titulacion de Solares (Program of Certification of Ejidal Rights and Titling of Household Lots) -- every agricultural community and ejido with social property has been given the opportunity to measure their lands, title them, and if they wish, privatize them. The efforts by the various state and federal agencies to "modernize" ejidos through the PROCEDE process has led to the fear among some that small farmers and livestock raisers have been hoodwinked to privatize lands, making them more susceptible to selling to larger farmers or other interests (Maria Teresa Guerrero, CONTEC, personal communication with author, 2005).

"We did not object to determining the boundaries of ejidos, or even titling individual household lots, but to put subsistence indigenous farmers in the land speculation business is a recipe for disaster," noted Guerrero. "It may be an appropriate process for urbanized ejidos near Chihuahua City, but in the Sierra it can tear communities apart." (Guerrero, personal communication with author, 2005).

Initial figures from the Chihuahua office of the Federal Agrarian Reform show that PROCEDE has led to titling of individual homes and crop areas, but for the most part not communal lands. For example, out of 983 communities with "social lands" in the State of Chihuahua, including 907 ejidos and 76 agrarian communities, 854 entered the PROCEDE process in some form or another by September of 2005 (Reforma Agraria 2005). However, there was a wide variation among these 854 communities about how "far" they went toward privatization. Thus, only a handful chose what is called "dominio pleno" – where the individual household lots, plots of cropland and communal lands are all certified, measured and titled, and thus available for direct sales to others, including "outsiders." Out of those 854 communities that had entered PROCEDE, only 36 sought and had received "dominio pleno" as of September of 2005, although several more were somewhere in the process. Virtually all of those seeking "dominio pleno" were located near major city centers like Delicias, Chihuahua and Ciudad Juarez and thus facing pressure for land speculation and urbanization.

Indeed, the attempt to "modernize" the ejido structure in some cases has actually led indigenous ejidos to cement their support of the ejido structure. Many ejidos and agricultural communities in the Sierra have chosen not to participate, while others have chosen only to measure their physical boundaries, and perhaps their individual household lots, but not to divvy up either their agricultural or communal lands among individual plot owners and thus more easily transferred to outside forces (Father "Nacho," personal communication with author, 2005). Still, as the case studies will show, it is also apparent that many small farmers with social lands have legally or otherwise sold both their individual plots and communal land rights in response to economic difficulties, including access to water and lack of rainfall. Rather than a case of the land use changes tied to Article 27 directly impacting drought or low-flows, this slight tendency toward break-up of ejido land and privatization can be seen as more of a consequence of urbanization, changing policies, poor farming conditions and low access to water.

B. Water Law

In addition to land reform changes, Mexico's water law has also seen fundamental changes over the last 15 years. While both surface and groundwater are state property, the system for granting individual water rights to farmers, cities and other interests has in general increased the power of water right holders over the central authority. For example, Mexican municipalities have been charged with providing water supply to its citizens since a 1983 change to the Mexican Constitution. The change has meant individual municipalities have been involved in planning, building and operating municipal water supply. Following changes to the National Water Law in 1992, in fact, some municipalities have also privatized municipal service to contract their water management responsibilities to subsidiaries of transnational corporations, although this had not occurred in the municipalities of the Rio Conchos Basin (Wilder 2006).

On the agricultural front, CONAGUA began to cede control of irrigation use to the irrigation districts themselves through long-term water right concessions. While farmers had participated previously in the control of water through an association known as a Sociedad Rural Limitada – Limited Rural Society -- the new law led to the formation of much smaller associations known as Módulos, or Modules. Rather than one large concession covering an entire canal, each "Módulo" was given part of the water right concession, and the Módulo User Association given significant control over how to distribute the resource to its users by hiring staff, holding elections, distributing water and collecting payments. All of the Módulos together now help form the SRL, which ensures that no one geographic region of the irrigation district controls the SRL itself. In the Río Conchos Basin, these changes were swift, with the Delicias Irrigation District the second district in the country to cede control to the Water User Association in 1993, only a year after the National Water Law changes were made, while the Lower Río Conchos Irrigation District made the transition in 1995 to separate water user associations. (CONAGUA 2004a, 2004b).

Since the federal government has ownership and jurisdiction over virtually all surface water and groundwater, CONAGUA is charged with issuing permits – including both concessions to private interests and assignments to governmental entities – for water use. However, in many areas the hydrological and current water use data needed to determine water availability may not exist, be insufficient or unreliable (Kelly 2001: 21). Mexico's water rights registry is still incomplete and inconsistent, although it has been greatly improved with funding from a World Bank loan. The World Bank gave the loan to help Mexico have an accurate water rights registry, which could presumably help with the development of a water rights market.

Thus, recent legal and policy changes led to a more privatized system of water use permits, and decentralization of water management, with the potential opportunity for buying and selling of these permits and concessions. As Chapters Five and Six will demonstrate, in part because drought conditions made water availability that much more important, these changes helped to concentrate control over these resources in the hands of larger farmers with better access to credit and markets and potentially to grow crops such as alfalfa and pecans that require more water. Still, the major change in the Delicias Irrigation District in terms of water use was the switch to groundwater usage after 1995 for many farmers, which likely did impact river baseflows through the use and exploitation of alluvial aquifers.

C. Forestry Law

Mexico began regulating its forested lands and forestry sector in 1884 during the reign of Porfirio Diaz (Weaver 2000: 2). During this period, major concessions were given to large U.S. interests to cut old-growth timber in the forests of Chihuahua and Durango (World Bank 1995: 31). In 1960, new reforms decentralized services and agencies to a regional level and relied on better trained foresters. The 1986 Forestry Law replaced the parastatal companies with private groups known as UCODEFOs – Unidades de Conservacion y Desarollo Forestal – while strengthening regulation of the forestry sector and attempting to protect the environment from its potential impacts (Environmental Law Institute 1998: 43). Despite these efforts, and in keeping with the times, the forestry sector complained the law was overly burdensome and actually put Mexico at a competitive disadvantage. Indeed, forestry production diminished by 22.7 percent between 1986 and 1991, while imports of cellulose and other forest products increased exponentially (Guerrero et. al 2002).

In 1992, a new Forestry Law deregulated many of the controls and permits of the 1986 Law, leaving the "Forestry Management Plans" as the main mechanism for most forest projects. For example, the 1992 Law deregulated the transportation of forest goods, and the activity was no longer controlled by documentation known as "Guias Forestales." Mexican authorities blame these changes – specifically the loss of documentation of the Guías Forestales – as making documentation of wood production virtually impossible and potentially increasing illegal logging during the 1990s (PROFEPA 1998).

In 1997, Mexico again reformed its Forestry Law, reestablishing documentation and control of activities such as harvesting, transport, storage and processing. Still, many of these rules to implement these changes were not adopted by individual states until 2000, as is the case in the State of Chihuahua, and critics contend that until then, illegal logging was widespread in the Sierra Tarahumara (Guerrero et al 2002: 10). In addition to these changes, the 1997 plan also created the new Program for Forest Development (PRODEFOR) – for social forestry -- and the Program for Plantation Development (PRODEPLAN) – for larger scale private timber crops -- which provided government subsidies for the production of wood from natural forests and commercial plantations. While PRODEFOR is active throughout Chihuahua, only a few companies have attempted to use PRODEPLAN start large-scale plantations, such as Christmas tree or eucalyptus plantations, most of which have had limited success.

Thus, changes to the Forestry Laws has emphasized increased private ownership and management of forestry resources through increasing the amount of land individuals can own and through the creation of plantations. Still, the law also continued to emphasize the social ownership of forested lands, using the "Forestry Management Plans" as a means to develop "sustainable" harvesting, and creating a new government agency – CONAFOR – and new government programs to support both harvesting and reforestation efforts. Chapter Four will look at some of the efforts of local communities to use these tools to improve land management practices in the upper catchment area of the Río Conchos watershed.

VI. The New Internationalism: NAFTA and Beyond

Someone once said that no man is an island, and it stands to reason that neither is any place. Any study of space and place must consider the connection to outside economic forces (Massey 1993). Chihuahua – located just south of Texas and New Mexico – is of course inextricably connected to its neighbors to the North. Even before "Pancho" Villa used the border in a cat and mouse game with Porfirio Diaz federales at the beginning of the 20th century, goods, services and people crossed the Texas - Chihuahua border. Indeed, leading U.S. industrialists owned ranches and forested lands in Chihuahua, helped build the first railroads which crisscrossed the state and invested in new gold and other metal mines. Following the Mexican revolution, thousands of Chihuahuan farmers came legally to the U.S. to work in the Braceros program and indeed many of the first farmers of the Delicias Irrigation District were ex-braceros sent packing following the Great Depression.

Still, perhaps no change has been as dramatic as the opening of the Mexican economy to imports and investment from the U.S. and the world over the last 20 years. Beginning with Mexico's incorporation into GATT – the Generalized Agreement on Tariffs and Trade – in 1986, their admittance to the World Trade Organization, and generally the leading role internationally the last three administrations have taken in calling for a "neoliberal" free market economy, has led Mexico to "integrate" their economy with the U.S. and the world. Indeed, Mexico has often served as a poster child for other developing nations to open up their economies and reduce government subsidies of productive activities (Gallagher 2004).

A final piece of the puzzle of the changes over the last 15 years has been implementation of the North American Free Trade Agreement, approved by Mexico, Canada and the U.S. in 1994. A managed trade agreement more than a truly free trade agreement, most analysts agree that the agreement has led to both winners and losers for major agricultural sectors of Mexico and the United States (Gallagher 2004)

NAFTA was the centerpiece of President Carlos Gortari's (1988-1994) efforts to open up the Mexican economy to investment and lower tariffs among the U.S., Canada and Mexico. The early years of NAFTA were not well received by many Mexicans. Citing NAFTA as the final straw, on January 1, 1994 – the day that NAFTA went into effect -- masked gunmen in Chiapas appropriated the name of Emilio Zapata, calling themselves Zapatistas, and led a brief battle with the Mexican army. Of more immediate impact, however, was a major financial crisis which caused incoming President Ernesto Zedilllo (1994-2000) to devalue the peso as he stepped into office. Overnight, millions of small and large farmers, businesses and residents were left holding loans they could not repay, thousands of businesses went under, and a movement of farmers, household owners and small businesses in debt arose as part of the "El Barzon" movement, which has sought forgiveness or reduction of large debts owed to both state and private banks. The lack of credit for agriculture is cited continually as an obstacle to continued investment in fields, according to farmers in Chihuahua (Reed, Chihuahua Land & Water Use Surveys, 2005).

The agricultural sectors of both countries have been especially sensitive to changes related to NAFTA according to recent reports (Martinez Rodriguez and Reed 2002; Nadal 1999). The Agreement has meant a gradual opening of Mexican grain markets to North American exports and an opening of United States markets to Mexican fruit and vegetable exports. While the ultimate impacts of NAFTA might not be felt until the tariff elimination process ends in 2009, evidence points to a growing disparity between Mexican and U.S. farmers in the production of wheat and corn, and a growing dependency on U.S. markets for Mexican export crops.

At the national level, NAFTA gradually reduced tariffs and quotas on imports of corn into Mexico, allowing more corn from the United States to enter Mexico without tariff duties. In fact, following the peso devaluation, and reductions in production, Mexico actually sped up the imports of corn in 1996. While Mexican policy toward corn imports has gone through several phases, under NAFTA, by the year 2008, corn quotas and tariffs are to be eliminated.

An analysis of Mexican corn production shows that in terms of grain production for human consumption there was a significant decrease in the number of hectares planted and total production between 1994 and 2000, suggesting that some growers could not survive the new open market. Yet by 2004, production had actually increased significantly even as the number of hectares in production stayed relatively stable. In addition, production for feed – for animals – actually increased substantially between 1994 and 2004. In essence, domestic corn production levels increased slightly for both grain and feed, but not nearly as much as total demand for consumption. Imports have risen to react to the demand, growing from 3.1 million metric tons in 1994 to 5.6 million metric tons in 2004 (Table 3.19).

Table 3.18. Corn Import Quotas and Actual Tons Imported from the United States without Tariffs and with Gradual Tariff Reduction, 1994 – 2008

Year	Tons from U.S. With No Tariffs	Tariff Ad-Valorem after Quota	Actual Imports from U.S. to Mexico
1994	2,500,000	206.4	3,058,148
1995	2,575,000	197.8	2,853,699
1996	2,652,250	189.2	6,314,387
1997	2,731,817	180.6	2,566,264
1998	2,813,772	172.2	5.247,763
1999	2,898,185	163.4	5,068,619
2000	2,985,131	145.2	5,146,666
2001	3,074,685	127.1	5,592,398
2002	3,166,925	108.9	5,326,755
2003	3,261,933	90.8	5,589,645
2004	3,359,791	72.6	5,613,794
2005	3,460,584	54.5	5,841,835
2006	3,564,402	36.3	
2007	3,671,334	18.2	
2008	Free	0	

Source: FIRA, Development Opportunities for Mexican Corn; Informative Bulletin Number 309; Mexico, October 1998; and FATUS, Foreign Agricultural Trade of the United States. Foreign Agricultural Trade of the United States Database. Available at http://www.fas.usda.gov/ustrade/.

Table 3.19. Changes in Mexican Corn Production since 1994

Year	Total Demand (tons)	Tons, Corn for Grain	Tons, Corn for Feed	Tons, total corn	Area, Corn for Grain (Ha)	Area, Corn for Feed (Ha)	Total Area (Ha)	Imports from U.S.
1994	22,100,000	18,236,440	4,336,315	22,572,755	9,196,478	174,649	9,371,372	3,058,148
2000	24,100,000	17,559,776	5,375,051	22,934,827	8,446,102	299,019	8,745,120	5,146,666
2004	27,900,000	21,689,070	8,954,397	30,643,467	8,404,569	326,869	8,731,438	5,613,794
Change 1994-2000	9.0%	-3.71%	23.95%	1.60%	-8.16%	71.21%	-6.68%	68.29%
Change 1994-2004	26.2%	18.93%	106.50%	35.75%	-8.61%	87.16%	-6.83%	83.57%

Source: Sistema de Información Agropecuaria de Consulta (SIACON); FATUS, Foreign Agricultural Trade of the United States. Foreign Agricultural Trade of the United States Database. Available at http://www.fas.usda.gov/ustrade/

Analysis shows that economic liberalization has had the greatest impact on corn production in northern Mexican states (Nadal 1999; Gallagher 2004; Martinez Rodriguez and Reed 2002). While the traditional grain production states like Oaxaca and Chiapas have continued and even increased corn production, Chihuahua, Sonora and Sinaloa have seen a strong shift away from corn and sorghum and toward the production of new crops. Given the low prices paid for basic grains, the high cost of irrigation to grow corn and other grains in the arid North and the increased competition with nearby subsidized United States producers, this shift is not surprising. Essentially, larger farmers who depend upon water inputs through irrigation have switched to other crops, or chosen to grown corn only for feed, rather than to sell corn to local tortilla factories (Nadal 1999).

In fact, while corn production has remained relatively resilient – in part because of a switch to corn for feed – other basic grains have seen much greater reductions in production and areas planted. Thus, between 1990 and 2004, unmilled wheat imports rose from approximately 360,000 to more than 2.8 million metric tons, while soybeans rose from 830,000 thousand tons to 2.8 million metric tons over the same 14 year period. Sorghum has, on the other hand, seen much more varied imports, and current level imports are actually lower than pre-NAFTA levels. (U.S. Department of Agriculture, FATUS Database, 2005).

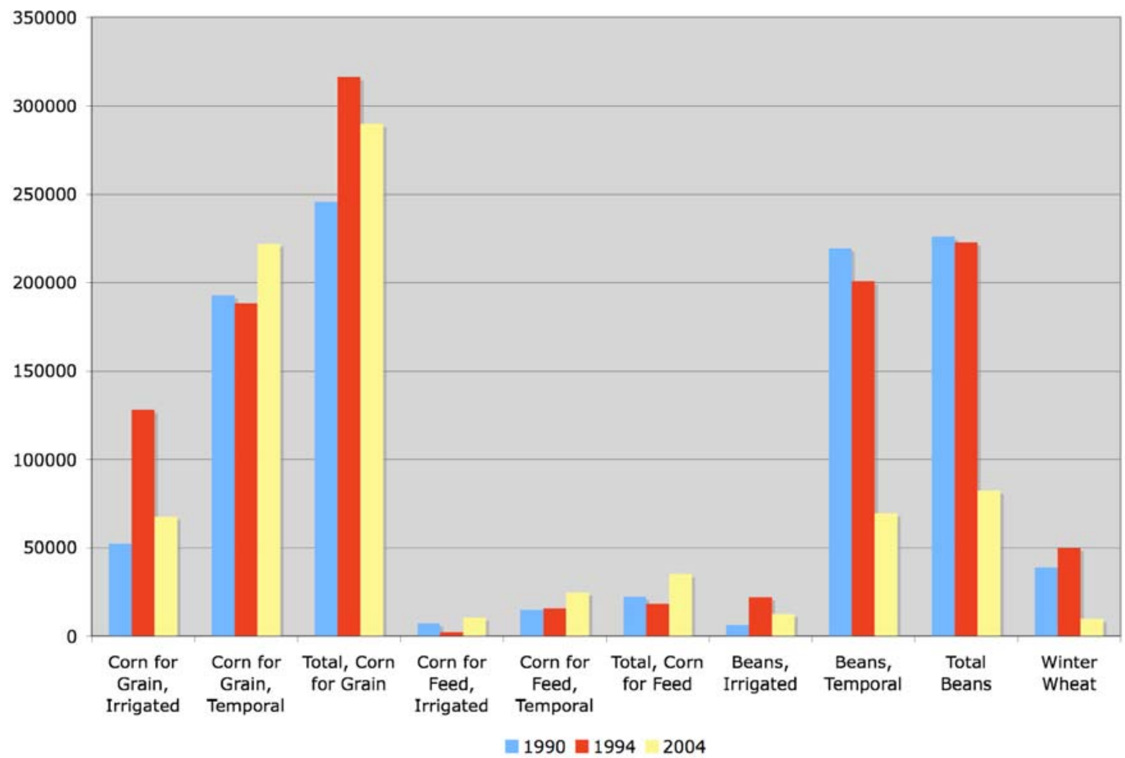
NAFTA itself is of course only one factor in the increase in imports of basic grains and feeds from the U.S. to Mexico, but there is little doubt that at least in the years following enaction of NAFTA, Mexican production of corn, wheat, soybeans and other beans fell, and Mexican farming associations were quick to blame NAFTA. In Chihuahua, new farmer associations like the Frente Campesino Democrático believes NAFTA is one of the principle causes of the loss of farming in Chihuahua and throughout Mexico (Mario Lerma, Frente Campesino Democrático, personal communication with author, 2004).

“NAFTA was intended to gut the Mexican campesino, to move the bean and corn producer off the land,” explained the Frente’s Mario Lerma. “Local corn production was replaced with corn imports at lower, subsidized prices which has helped the tortilla maker but not the farmer.” (Lerma, personal communication with author, 2004).

While overall the number of hectares of corn has declined slightly over the period, the largest declines have been in irrigated hectares for corn grain, even as corn feed actually rose in the number of hectares planted (see Figure 2.23). Similarly, while bean hectares did decline substantially, the biggest declines are in irrigated lands, while winter wheat has nearly disappeared from the state. Thus, the fundamental shift in Chihuahua away from winter crops like wheat may be due both to the decision to close the irrigation dams in the winter months, but also to the difficult competitive environment faced by wheat farmers with the sudden importation of vast quantities of low-cost wheat.

As the case study chapters shall show in more detail, one of the factors in the increased use of high-water crops in Chihuahua was the loss in market power of some lower water use crops like corn, sorghum and winter wheat.

Figure 3.21. Total Hectares Planted in Corn, Beans and Wheat, Chihuahua, 1990-2004



Source: SAGARPA, information from Chihuahua Delegation provided to author, 2005.

VI. Conclusions

This chapter examined changes that had occurred over the last fifteen years in terms of flow, rainfall, dam management, water use and land use, based both on data and perception by various interested parties to the dispute over the low flows of the Río Conchos. The chapter found that data from both the Conchos' outflow at the Río Grande, as well as several hydrological stations along the mainstem, support the view that flow in the Conchos witnessed huge decreases in riverflow, as well as reductions in inflows into Chihuahua's major dams. These declines were particularly pronounced in winter months. Mexican academics and institutions support the view that the hydrological drought was due primarily to a climactic drought. A look at rainfall data found that reduced rainfall was a major factor in these reduced flows, yet the lowflows over the past ten years are much reduced compared to other historical periods when drought impacted the Río Conchos.

The brief analysis also found that dam management – and the specific decision to only provide water to farmers in Delicias during the spring and summer irrigation seasons and not the winter – has also been an important factor in the change in river flows. Thus, the climactic drought led to political decisions that in turn helped cement a hydrological drought. The decision has changed flow rates and curves in various areas of the Conchos itself, leading to reduced flows, peak flows, and even changes in timing of flows. At the same time, on at least three occasions, Mexico did release waters to help comply with the 1944 Water Treaty from the Luis León Dam. Thus, when examining drought and hydrological flows, it is of course necessary to examine management decisions made by natural resource managers.

Furthermore, a look at water use and irrigated crops within the Río Conchos River basin's major users – farmers – reveals a much more complex picture than either side presented during the discourse over water use in Chihuahua and the U.S. –Mexico water dispute. For example, U.S. farmers and officials – armed with reports by Texas universities and academic institutes – argued that Chihuahua increased their irrigation of lands with "their" water, while Chihuahua officials and CONAGUA, the national water commission, showed quite different data, showing a sharp decline in irrigated acreage. Nonetheless, data from both CONAGUA and SAGARPA reveal that while there was a slight decrease in irrigated agriculture over the last fifteen years in Chihuahua as a whole, there was a substantial decrease in acreage irrigated by Chihuahua's major dams confirming the view that Mexican farmers were impacted by drought. However, by looking at only surface water use coming directly from the dams, the giant shrinkage in water use and irrigated cropland between the pre-"drought" and post-"drought" period was exaggerated. Data from SAGARPA in four agricultural areas within the Río Conchos Basin – including the three main irrigation districts -- revealed a more complex trend, with a spiked decline in winter crops, a substantial decline in summer crops and a substantial increase in perennials. Thus, both the Mexican contention of reduced water use and the U.S. contention that green areas – i.e. perennial crops like alfalfa and pecans -- within Chihuahua were increasing -- are supported by the data. The missing data piece appears to be the large-scale shift from surface water to groundwater which occurred over the period of study, a view that is supported and explained more thoroughly in the case study chapters.

In addition, the chapter outlined arguments being made by Mexican and U.S. environmental organizations and some officials that erosion from livestock and deforestation were major factors in the reduced flow. Both the number of cattle as well as wood production fell in Chihuahua and the upper Río Conchos Basin in the mid-1990s, but has risen slightly since, in partial support of these arguments. However, the discourse about sedimentation and deforestation has taken on a life of its own, as there has been a concentrated effort by organizations, communities and governmental agencies to work with communities to "improve" agricultural and livestock management practices, as well as reforestation projects. Thus, whether or not the evidence supports the view that deforestation and expansion of cattle farming and ranching in the upper catchment of the basin impacted flows downstream, this view has been seized upon by a variety of interests to push more “sustainable” land management practices at a variety of scales. This is not dissimilar as what has occurred throughout the world, with upstream farmers and loggers in part blamed for the problems downstream (Blaikie and Muldavin 2004).

Finally, the chapter outlined some of the legal, political and economic changes over the last 15 years which may also have impacted natural resource management issues and thus the flow of the Río Conchos. Thus, changes to Mexico’s Article 27 of the Constitution and corresponding changes to the Land Reform Law has led to the possibility of privatization of Mexican communal and agricultural lands through a process called PROCEDE, though initial analysis does not suggest a whole scale change in natural resource use.

Similarly, changes to both the forestry and water laws have led to a more market-oriented focus for forestry production and water rights within the irrigation districts. Specifically, the 1992 National Water Law decentralized water management from CONAGUA to individual geographically-linked Water User Associations within irrigation districts. Finally, the chapter noted that the drought and lower flows to the Río Grande occurred within the context of major economic changes in the agricultural sector in part related to changes in tariffs, quotas and investment as part of the North American Free Trade Agreement, and that these economic and policy changes were perhaps the major reasons for changes in crop production, not the changes in access to water resulting from drought-like conditions.

Thus, the analysis of low-flows contained in this chapter reveals a complex tale of a myriad of causes that contributed to the conditions, as well as how differing interest groups chose to emphasize those causes differentially and how they communicated that through discourse. The case studies that follow better explain the actual practices of local farmers in Chihuahua in three distinct areas as they reacted – and perhaps contributed to – the drought-like conditions and changed economic circumstances of the study period.

Chapter Four: Mountain Voices

> The Tarahumar of Chihuahua, Mexico, constitute perhaps the most important remnant of the semiagricultural people who inhabited the northern portion of the Sierra Madre Occidental and its eastward plains in Chihuahua when Tarahumar number approximately 50,000, and most of the Indians have not been integrated into the mainstream of Mexican cultural life. Hence, these Indians are worthy of serious study, not only because their way of life must inevitably be altered by completion of the railway from Chihuahua to the west coast through the Tarahumar habitat, but also because of present efforts of the Mexican government to bring the Indians into the mainstream of Mexican cultural development (Pennington 1963: preface).

> “Where there is forest, there is rain; where there is no forest, there is no rain” -- Farmer in El Consuelo, Municipality of Carichí, Survey, 2005.

> Romúrachi desciende hacia todos lados. Es el “techo” de la Sierra Madre de Chihuahua… Romúrachi, situado a medio longitud, es la major atalaya para ver, a ojo de pájaro, el reino de las coníferas y la cuna de todos los ríos de Chihuahua. (Jordan 1956: 390).

I. Introduction

Everyone these days, it seems, wants a piece of the Sierra Tarahumara. The pine-oak forest and oak-juniper savannah mainly situated in the State of Chihuahua is home to endemic trout, bird and vegetative species, which peaks the interest of “conservationists” – Mexican and international alike (Alcalá 2002; Arriaga et al 2000; Felger and Wilson 1995; CEC 2001; WWF 2002; Guerrero et al. 2002). The presence of differing cultures, mainly represented by the Tarahumara – or raramuri – indigenous peoples, sparks the interest of human and indigenous rights groups (Pennington 1963; Guerrero 2002; LaRochelle 2003). And it is also serves as the headwaters – the birth – of six different rivers, including the Rio Conchos, which become important sources of water for agricultural interests in Chihuahua, Sonora, Sinaloa and Texas (Jordan 1956; Schmandt 1993; WWF 2004). Finally, as a region still looking for the next great bonanza, government and development interest in tourism –including communal and ecological tourism -- has been part of a major effort over the last fifteen years (Secretaría de Desarrollo Rural 2004). All of these different interests – sometimes at odds sometimes in congruity – involve a discussion of natural resource use in the forests, agricultural lands and cattle pastures making up the region. The chapter reveals that this discussion was sharpened by the dispute between the U.S. and Mexico over reduced flows into the Rio Grande as different interests search for the causes and solutions to the water payment crisis.

This chapter examines natural resource use – both discourse and practice -- among agricultural farmers in several communities in the Municipalities of Bocoyna and Carichí which serve as the headwaters to the Rio Conchos watershed in the context of these new identified needs of the Sierra – as biological reserve, tourism enclave, preserver of culture and catcher of water for the entire Rio Conchos watershed, and its thirsty neighbors to the north.

Following a brief description of the methodology utilized, the chapter begins with descriptions of some of the communities in Bocoyna where the Rio Conchos begins and the attempt by some organizations to influence natural resource use and management, as well as the responses by the local communities. After a brief discussion of the larger attempt to create a “Biosphere Reserve” in both Bocoyna and Carichí and several other municipalities, the chapter than turns to communities within Carichí, the implementation of soil conservation and other projects, and survey results among local farmers about resource use. Finally the chapter provides a brief conclusion and summary of the major findings.

II. Methodology

Field research for this chapter occurred during 2003, 2004 and 2005. Methodological techniques included open-ended interviews with farmers and ranchers, local political leaders, ejido leaders and Indigenous governors, governmental agency workers, church leaders and non-governmental organization representatives working in Bocoyna and Carichí on natural resource management issues. In addition to these interviews, on-site visits to agricultural fields, soil conservation projects, water projects and other walks through woods, mesas and pasture land occurred. In addition, in September and October of 2005, 38 surveys were conducted in three ejidos in the Municipality of Carichí in El Consuelo, Arroyo del Agua and Bacabureachi. A brief focus group discussion was also held in 2004 with about 20 residents from Arroyo del Agua and El Consuelo in the local ejido meeting house in the area as well (Morgan 1988). Finally, the author cut oats in Panalachi, picked apples in Bacabureachi and husked corn in several fields in El Consuelo and Bacabureachi. Appendix B has a copy of the Spanish-language survey conducted in 2005. While the present chapter presents an overall summary of the survey results, more detailed survey results are available from the author upon request.

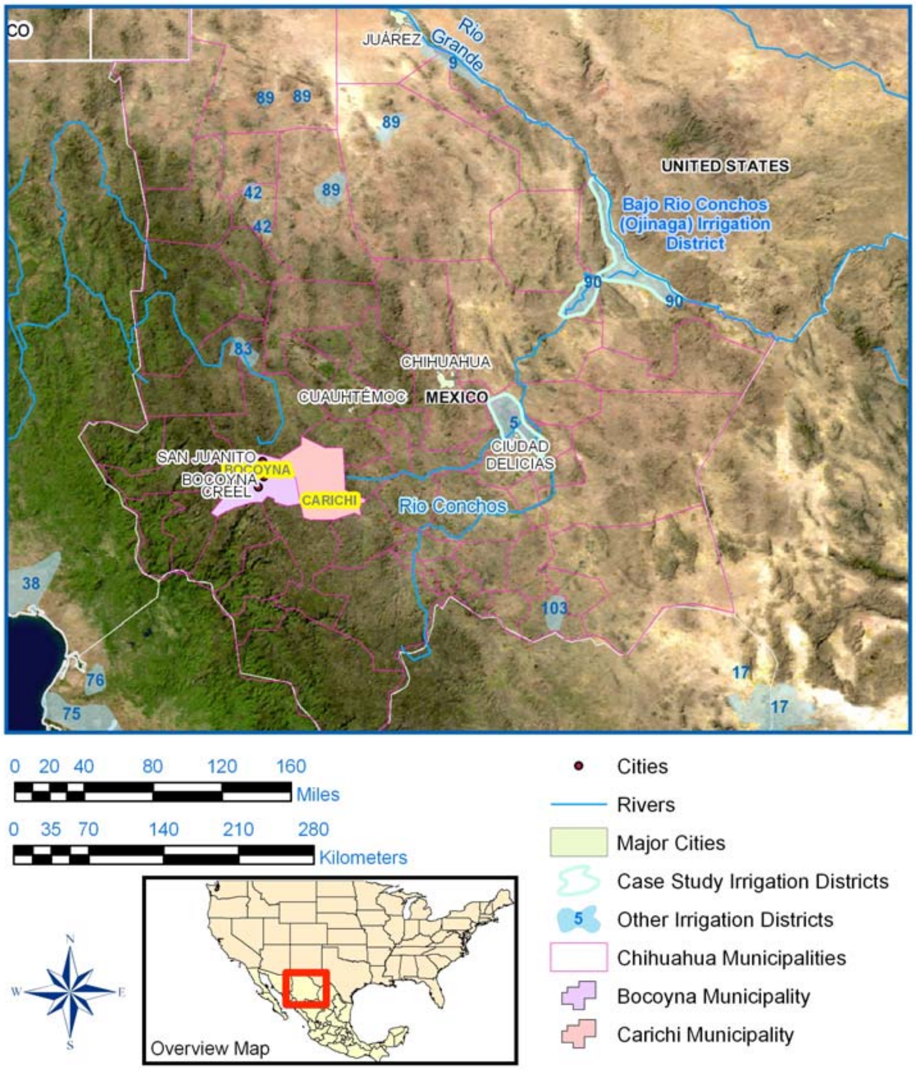
III. Bocoyna: Where The Rio Conchos Begins

A. Voices of the Sierra under the Shadows of Mt. Romúrachi

Under the shadows of Mt. Romúrachi on its east side sits an ejido known as Arroyo de la Cabeza (literally Stream of the Head, or Headstream), a vast expanse of pine forests, agricultural lands, sparsely populated communities and livestock (Photo 4.1). As the land incorporating the headwaters of the Río Conchos, there is currently substantial interest among governmental agencies, local leaders and non-governmental organizations in the peoples and lands making up the ejido. The dominating presence of Mt. Romúrachi also provides a unique mountain habitat for various important biological species, including the Pinabete trees (Picea chihuahuana), various endangered species of owls, hawks, black bears, snakes and the endangered cotorra serrana, or thick-billed parrot (*Rhynchopsita pachyrhyncha).* (Alcalá 2002).

At some 9,500 hectares, the medium-sized ejido is located approximately 15 kilometers north-east of San Juanito in the Municipality of Bocoyna. At 2,950 meters, Romúrachi is omnipresent to the residents of Arroyo de la Cabeza, as well as to a large swath of private property in the middle of the ejido. The residents are clustered in five towns – Agujas, Naqueachi, Arroyo de la Cabeza, Tucheachi and San Miguel – whose 636 residents inhabit 133 wood and 31 adobe shacks among the valleys and hills of the pine forests (Fuerza Ambiental 2005: 10). About 47 percent of the population is less than 20 years old, while only eight percent is over 60. Most homes are built with the same pines that dot the valleys and line the hillsides, though government aid in recent years has seen many deteriorating pine roofs replaced with zinc "lamina" roofing. The roofs themselves often serve as storage places for locally-grown crops, which are thrown up on top, both to dry them out in the sun and keep them safe from local livestock (see Photo 4.2). About 75 percent of the homes have "mangueras" – rubber hoses – that bring them water from local springs and aguajes – water holes -- while others must travel to spring outflows to bring household water.

Map 5. Location of Bocoyna and Carichi Municipalities



Source: Miguel Pavón, Borderlands Information Center, Texas Natural Resource Information Service, 2007.

Photo 4.1. View of Mt. Romúrachi, Arroyo de la Cabeza Ejido, 2005.

Almost all the residents – about 99 percent – self-identify themselves as *Rarámuri* – sometimes translated as “the men of light feet" – more commonly known in Spanish as the Tarahumara indigenous celebrated in Pennington’s opening words. They are agriculturalists, living off the land. Wherever their home in the five communities, they are part of the Arroyo de la Cabeza ejido, established back in 1934. There are currently 142 members. They are served by ejido officials– the *Comisariado* himself, the secretary and treasurer – and a *Consejo de Vigilancia* – an advisory-like committee. Ejido officials normally serve three years.

Photo 4.2. Home in Naqueachi, Arroyo de la Cabeza, 2005.

In addition to the ejidal structure, there is a traditional indigenous governing structure, with an Indigenous Governor serving the Tucheachi – Bahureachi area and another serving in Las Agujas (Fuerza Ambiental 2005). There were not governors serving the other two towns.

While the ejido structure deals with the everyday issues of land, crops and livestock, as well as decisions about timber extraction, the indigenous governors are charged with both overseeing traditional customs and celebrations, and coordinating aid from both religious organizations, non-profit organizations and the government (Fuerza Ambiental 2005). Not surprisingly, at times there are conflicts between ejido and indigenous leaders, and the differing visions they may have for the community (Gina Uribe, Fuerza Ambiental, Personal communication with author, 2005). Traditionally, indigenous governors and other elders resolve land and other conflicts, preserve oral traditions and give advice on agricultural and other techniques, but those roles have been eviscerated by the ejido structure itself, recognized as the arbitrators of land tenure issues by the Mexican government (Fuerza Ambiental 2005: 15).

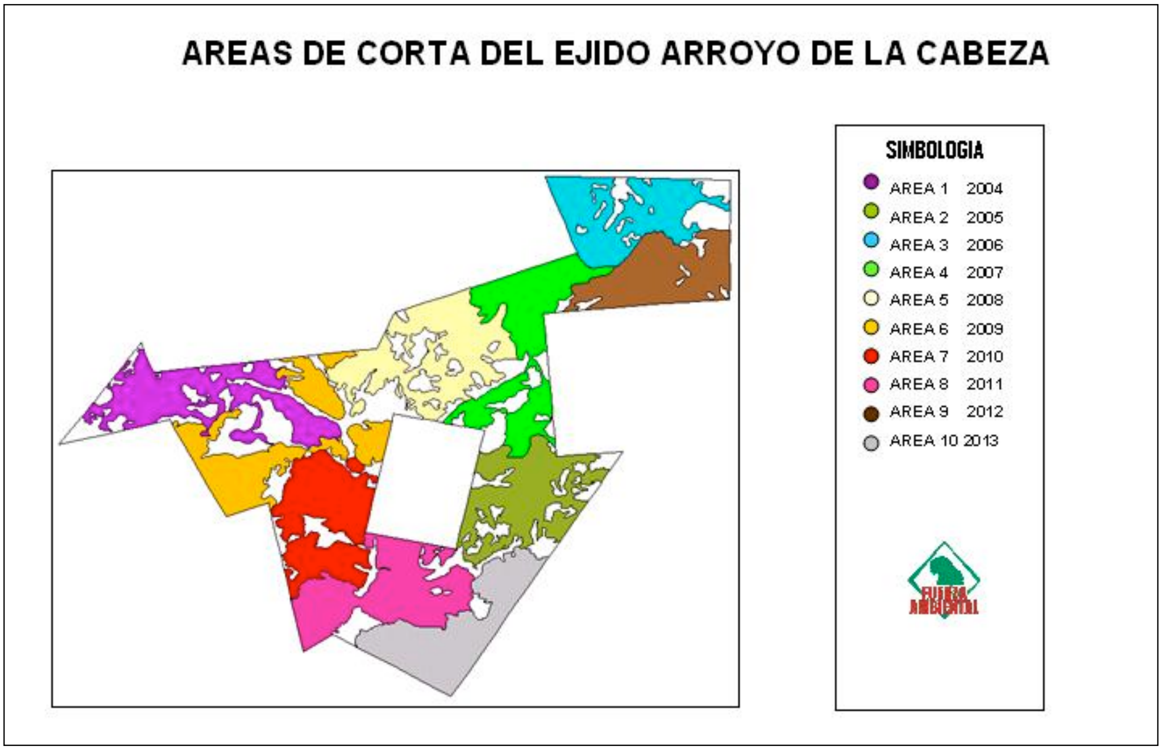
As in most of the Sierra, virtually everything that is and has been grown is for personal or livestock consumption. Major crops grown in recent years include corn, oats, various types of beans, including cabra, chicharro and haba, and potatoes. Corn was by far the most prevalent crop.

Roughly half of the livestock – generally the cattle -- roam free within the ejido, while goats and sheep tend to be placed in pens or fenced in lands at night. While a few farmers reported building areas for livestock to drink water, most let them roam in or near riverbeds, springs, or aguajes (Fuerza Ambiental 2005: 36). In general, there has been no or little effort by local leaders to attempt to refrain the free ranging of animals (Photo 4.3). Instead, to protect their crops, ejiditarios have built both wood and wire fences around their crops to keep animals out. (Felipe Ontiveros, Ejido Arroyo de la Cabeza, Personal communication with author, 2005). Both local ejidatarios, non-governmental observers, indigenous leaders and others believe that roaming animals, and the lack of effort at keeping livestock away from river beds has led to erosional features on the landscape (Ontiveros, Personal Communication, 2005).

Photo 4.3. Erosional gullies near stream in Naqueachi, 2005.

In 2004, led by Ejido President Ontiveros, Arroyo de la Cabeza obtained a new Forestry Management Plan (Plan de Manejo Forestal) to continue cutting down the pine forests it calls home. The ten year plan – which was approved by SEMARNAT – the federal environmental authoriy –divides the ejido into roughly 10 areas, each of which is marked for cutting for a different year. Under the plan, the community is legally able to cut a yearly average of 6901 cubic meters of pine, 947 cubic meters of oak and 56 of táscate (juniper). In 2005, the cutting of wood earned each ejidatario $1,200 pesos, roughly $100 dollars (Ontiveros, Personal communication with author, 2005).

Map 6. “Areas of Cutting” (Forest Management Plan) of Arroyo de la Cabeza Ejido



Source: Fuerza Ambiental 2005: 38.

It was to Arroyo de la Cabeza that two young recent graduates from a local Chihuahuan forestry school arrived as representatives of Fuerza Ambiental. Young and energetic, they worked under a subcontract with World Wildlife Fund (WWF) to perform both a diagnostic of the community and in concert with the community put together a Community Action Plan to “help increase productivity and live more sustainably with the natural resources.” (Agustín Bravo, Fuerza Ambiental, personal communication with author, 2005).

B. Arrival of “The Panda”

World Wildlife Fund’s interest in Arroyo de la Cabeza was based on its location as the “start of it all,” the beginning of a river that forms the major input into the Rio Grande from the Mexican side (Dr. Hector Arias, WWF, Personal communication with author, 2005). WWF picked the area based on its location and not on any existing relations within the community or even stated biological criteria, although clearly the near “virgin” conditions of some of the slopes of Mt. Romurachi peaked their interest (Arias, 2005; WWF 2002; WWF 2004).

Current Chihuahua WWF director Dr. Arias began his work in government, first working with the federal agricultural agency, and later became an academic, as a soil and watershed management expert at an academic research center. Among his accomplishments, he worked with the SALSA program – The Semi-Arid Land-Surface-Atmosphere ("*SALSA*") Program -- a multi-university and agency research effort that “seeks to evaluate the consequences of natural and human-induced changes in semi-arid environments” and which was focused on the Rio San Pedro between Arizona and Sonora. (Arizona State University, Website).

He said the roots of the work in Chihuahua are not the drought or debate over water between the U.S. and Mexico, but its location as the “lifeblood” of the Chihuahuan Desert. WWF-USA had begun pushing the international organization to focus its efforts on “ecoregions” rather than piecemeal programs or areas, and WWF began a Chihuahuan Desert program in 1997, opening offices in Las Cruces, New Mexico and later in Monterrey, Nuevo León. WWF had incorporated in Mexico City in 1992, but had focused mainly on southern Mexican jungles and central volcanoes. While an early focus of the program was Big Bend on the U.S. side and newly formed protected areas in Chihuahua and Coahuila along the border, the work began to evolve toward freshwater management and restoration, especially as a link between the pine-oak forests of the Sierra – already an identified “ecoregion” – and the Chihuahuan desert (Arias, Personal Communication, 2005).

“The International Union of Conservation Networks (IUCN) was pushing the Living Planet Index which indicated that there was no habitat more threatened than rivers and freshwater habitats,” explained Arias. The focus on freshwaters later became incorporated as part of World Wildlife Fund, Inc.’s “Living Waters” program. As a WWF consultant, Arias advised WWF’s Latin American office and others within the organization that a focus on watershed and specifically on the Rio Conchos should be a major part of the Chihuahuan Desert program, and it later was added as one of the priority eco-regions (Arias, 2005).

In 2002, Arias became the director of the Mexican side of the Chihuahuan Desert program and established an office in Chihuahua City. At that time, he was the only full-time staff and the budget was limited, most of it used to contract a water economics expert to study water pricing, crops and water use in the Delicias Irrigation District, a report released in 2002 (Puente Gonzalez 2002).

“It was obvious that if we were to focus on water use and the Conchos, we had to get a handle on Delicias Irrigation District,” Arias explained.

Arias said the international discussions between Mexico and the U.S. over more efficient use of water in the Delicias Irrigation District – and more specifically the proposed certification of a water conservation project through the Border Environment Cooperation Commission – gave their work immediate relevancy but was not its cause.

In fact, the information actually helped officials at BECC – the Border Environment Cooperation Commission – prepare the documents needed for its certification of the Delicias Irrigation District conservation project partially funded by the North American Development Bank (Puente González 2002; BECC 2002).

In February 2002, the British bank HSBC announced a $50 million “Investing in Nature” program, which included a $18.4 million grant to WWF to restore 2 million hectares of river basin habitats in the Amazon in Brazil, the Yangtze in China and the Rio Grande in the US, “returning the natural flow of rivers, protecting fish and other freshwater species, and securing fresh drinking water for millions” (HSBC 2002**).**

While Arias said the amount of money has often been exaggerated and misreported in press reports and by government officials, the HSBC agreement in 2002 included approximately $7 million stretched over seven years for the Rio Grande work. The money is split evenly between the Las Cruces and Chihuahua offices. Still, the funding from HSBC, as well as significant amounts from Ricoh Corporation in Japan has allowed the international organization to significantly increase its presence in Chihuahua, bolstering its staff from one to eight, move into a much more spacious office in the heart of Chihuahua’s governmental and arts district – complete with the Panda Logo outside -- and paved the way for the increased attention on the Rio Conchos and water management in general.

In 2003, WWF began to contract with local organizations to work toward better resource management in the upper Rio Conchos. “It was very difficult to be here in lobbying and political work and also there in the Sierra,” Arias explained. “So my strategy was to find local organizations with experience working with communities, designed by the community itself.”

WWF awarded contracts to begin working in four ejidos in Bocoyna and Carichí (see Table 4.1). The first year’s goal was to come up with a diagnostic of the communities, and the second year’s was to come up with more of a technical guidance document for implementing the community’s action plan.

Table 4.1. Communities in which WWF had contracts with local organizations for participatory natural resource management planning, 2004-2005

Name of Ejido/Community	Local Chihuahua Organization with WWF Contract
Arroyo de la Cabeza, Bocoyna	Fuerza Ambiental
La Laguna, Bocoyna	Fuerza Ambiental
Panalachi, Bocoyna	GAIA
Sisoguichi, Carichí	ALDECO

Source: WWF 2004.

Arias said it is a participative program with the community that is similar to that developed by FIRCO's "micro-watershed" program. FIRCO – literally Fideicomiso de Riesgo Compartido (The Shared Risk Fund) – is a decentralized federal government program that began in the 1970s as a lending and technical aid program to farmers, but has at least partially morphed into a participatory planning exercise to help restore Mexico's dilapidated rivers and streams (Gerardo Saenz, FIRCO-Chihuahua, personal communication with author, 2005). In fact, some of the money to conduct the work contracted by WWF has been funded by FIRCO.

"The reality of the Sierra is that the agricultural capacity is minimal," noted Arias. "Few hectares, uneven farming lands, hail, freezes, droughts, and really lands that are not apt for farming," he stated.

Arias said the purpose of the program – "Integrated Watershed Management" -- is to both preserve the lands while providing some economic sustainability for the community, "without forestry exploitation, or overgrazing."

Toward this end, WWF has been promoting the idea of "environmental services" payments, where communities that took care of their lands would be paid for their management by downstream interests, much as they are currently paid by the forestry industry to cut down their forests.

“If they have to cut down the forest to survive, then if we could instead set up a mechanism of cooperation so that those that need the water would pay them for providing water,” he noted.

In May of 2005, WWF signed an “inter-institutional” agreement with the State Government of Chihuahua focused on restoring and protecting the Rio Conchos Watershed. While Arias freely admits the agreement has no “teeth”, he said it has led to an inter-institutional working group which meets regularly to review funding opportunities for communities.

The multi-million dollar donations with HSBC, the further donations from the Japanese Ricoh Corporation, the agreement with the Chihuahuan government and the regular meetings between a high-profile NGO like WWF and key federal and state governmental ministers, however, is a long way from the dirt roads and corn fields of the Sierra’s indigenous ejidos and communities. Local leaders and NGOs contracted by WWF say there is often a disconnect between the official rhetoric and press releases and the reality transpiring on the ground (Agustín Bravo, Fuerza Ambiental, personal communication with author, 2005)

“We basically threw them in there,” noted Fuerza Ambiental director Agustín Bravo from his Chihuahua office about the young college graduates they sent to work with the community in Arroyo de la Cabeza. Bravo said that without the support of the European-based Christensen Fund it would have been impossible to complete both the diagnostic and community action plan required by WWF through its short-term contract.

“It’s a maquila model,” explained the no-nonsense Bravo. Large foundations like Hewlett Packard, or corporations like HSBC, as well as the U.S. government through U.S. AID give contracts to groups like WWF and Conservation International, who in turn give contracts to more “local” groups like Fuerza Ambiental. Fuerza Ambiental then contracts workers and particular community members to get the product produced in a certain amount of time to satisfy both the BINGO – Big NGOs – who in turn must satisfy their own funders. In fact, recently U.S. AID announced funding for a watershed restoration project in forested areas, which focuses on three rivers in Southern Mexico and the headwaters of the Conchos Watershed in the Sierra Tarahumara (U.S. Agency for International Development 2005). The recipients of the monies to help implement this restoration are limited to major international environmental organizations: WWF, Conservation International and The Nature Conservancy.[10]

A lawyer by training from Guadalajara, Bravo first became involved in the Sierra while representing indigenous communities on legal cases with the human rights organization COSYDDHAC, but his focus changed to “social capital” and development.

“You could stop illegal logging through legal action, but logging might continue in another place in the community, either legal through forestry permit or from outsiders,” Bravo noted. He said they began to work on community-level organization through new tools like “Ordenamiento Ecologicos (Ecological

[10] “The Government of Mexico has identified water and forests as critical to Mexico's national security. USAID is cooperating with a range of U.S. and Mexican organizations to introduce new technologies that improve watershed management, and promote sustainable enterprises that conserve Mexico's biodiversity.

USAID is partnering with three internationally recognized conservation organizations: The Nature Conservancy (TNC), Conservation International (CI), and the World Wildlife Foundation (WWF). These environmental organizations in turn work closely with Mexican public and private institutions.” (US Agency for International Development, Mexico: US AID Profile, FY 2005, Available at http://www.usaid.gov/locations/latin_america_caribbean/country/program_profiles/mexicoprofile.html).

Planning), Forestry Management Plans" and other tools having to do with social organization and natural resource decision-making.

Fuerza Ambiental formed an alliance with Sierra Madre Alliance, led by American ex-patriate Randy Gingrich. Working in the lower Sierra Tarahumara in the conflictive ejidos of Pino Gordo and Colorado de las Virgenes brought international press attention to the conflicts over logging and gave both Fuerza Ambiental and the associated Sierra Madre Alliance considerable attention and access to funding. While the alliance worked for a time, Bravo said mismanagement, personal and professional conflicts and a particular fight over whether to promote the "candidacy" of Tarahumara forestry activist Isidro Valdenegro for the prestigious Goldman Prize led to a split-up a short time later. (Bravo, 2005; Gingrich 2005).

Gingrich, for his part, says the "divorce" was unfortunate given the groups similar goals, and made similar accusations of misconduct. He said he was particularly incensed when Fuerza Ambiental began "secretly" negotiating with a group out of Boston called Ecological Development Fund, and the United National Development Program and Global Environmental Facility about investing money in the Rio Conchos watershed to help set up a kind of payment program for protection of the Conchos watershed.

"I was absolutely furious since we had just spent over $400,000 in Guadalupe and Calvo (in the lower Sierra Tarahumara canyon areas) and had been talking to the same financial sources – UNDP and GEF – about supporting protection work in the canyon lands."

Fuerza Ambiental turned to the contracts with WWF to work in Arroyo de la Cabeza and Comunidad La Laguna. Bravo says Fuerza Ambiental saw the WWF contracts as a way to work with new communities and further the goals of environmental justice and sustainability. Bravo said WWF has been very respectful in the process and does not interfere with any results, though the success of the projects have been limited.

“They are short-term contracts as if you were contracted a business for providing services, where you pay part after the contract has been completed,” he noted. “We understood it would be a four or six year contract, but in reality we have to compete for another contract every eight months or so, and only for some $16,000 dollars for the whole year.”

Bravo’s co-worker at Fuerza Ambiental, Gina Uribe, is a veteran of work in the Sierra. Originally working with the State of Chihuahua’s first Environmental Agency in the late 1980s, Uribe began work in the Sierra for the “failed” Bosque Modelo (Model Forest) project supported by the Canadian Government, a good project that was “hijacked by the same clique of forestry engineers, corruption and mismanagement.” The work in *Arroyo de la Cabeza*, according to Uribe, was “even more difficult.”

“It was picked by WWF because of its strategic importance at head of the Conchos, but no one had any links there,” noted Uribe. Throughout 2004 and 2005, they developed the community diagnostic and community action plan. Initially they approached the head of the ejido, who put them in touch with one of the local indigenous governors (Gina Uribe, Personal communication with author, 2005).

The relations between WWF’s program in Chihuahua City, the smaller NGOs they hired to implement them, and the indigenous people on whose land WWF wished to change practices is obviously complex and not strictly one-sided. In other words, the indigenous peoples not only react to the “participatory” efforts of the NGOs, but impose their own understanding of participation and action on the relationships. As a recent article by Walker, Jones III et al make clear in discussing a similar but more established WWF program in the state of Oaxaca, Mexico, the proposed participation model developed by WWF and other major NGOs to include indigenous peoples in a more sustainable development path often conflicts with a more geographically-based local vision of “empowerment” of local communities (Walker, Jones III et. al. 2007; Chapin 2004). Thus, these local leaders begin to ask who should be in charge of the meetings and agendas. To their credit, says Bravo, WWF attempted to allow Fuerza Ambiental to work with the needs and vision of the community, but the short time-frame and the needs of the funders often caused a conflict between a homegrown territorial based vision of the community and the wider attempt at habitat restoration.

The Arroyo de la Cabeza community identified three main issues: protection of water sources in Tucheachi; the monitoring of a reforestation projects; and a discussion about sustainable livestock management practices.

Uribe explained that forestry officials at SEMARNAT had provided the ejido with funds to reforest some lands with trees grown at a nursery near Delicias, but in their excitement to plant, the community had failed to plant the trees at the required spacing, and much of the project appeared to be failing.

Uribe said goals developed in 2005 for Arroyo de Cabeza and La Laguna were modest, because taking on issues like the forestry permit itself held by the community would create dissension in the community. They have had workshops and talks about the possibility of preserving some lands within the ejido as “hands off,” including Mt. Ramurichic itself, with its high number of endemic species and its prime importance as the source of several mountain streams which help form the Rio Conchos.

Bravo said that the high-profile announcement by WWF of its agreement with the Chihuahuan government – and its efforts to focus institutional aid in the communities of the Sierra in which it has contracts – had sewn “ridiculous expectations among community leaders that major aid was arriving.”

“The big problem is that the community is ready to act, but we don’t know about money from WWF or the government,” Bravo reiterated.

For his part, Gingrich said he has avoided having the Mexican organizations with which he coordinates joint campaigns apply for WWF funds. “I was very weary to work with them because of their past relationships with Profauna, which they gave $60 or $80 thousand to for a study of the Conchos,” Gingrich said. Gingrich says that study was limited in scope, and focused on the environment, but not people. He said he would only work directly in the Conchos if the support were to go directly to the communities and not to the NGOs “for more studies.” In essence, he says, he is wary of working with organizations like Profuana or WWF which have little history working directly with communities.

Interviews with leaders in the communities confirmed some of these concerns, but also that leaders welcomed the sudden interest in their ejidos. Indigenous governor Efrén Villalobos sits quietly on a fence of a pigpen outside his house, which overlooks a tiny apple orchard owned by his mother just outside of the center of Tucheachi. Finding his house involves crossing a stream and walking past a corn field. Villalobos tells the story of his involvement with Fuerza Ambiental and WWF (Villalobos, Efrén, Tucheachi, Personal communication with author, 2005).

“They told us they wanted to work on soil conservation and also help find roof tiles, solar plates, the necessities identified in the Action Plan,” Villalobos explained. “We want retention of the soil within our fields, within our mountains and within our streams as the water carries it all away.”

Villalobos said their first priority has been protection of the “aguajes,” the mountain springs which provide water to the community and which have often dried up in modern times (see Photo 4.4).

“Our animals and pigs have been using these, bathing in them, digging at them, ruining them,” he explained. Villalobos said his only contact with WWF had been at a retreat in Creel with other indigenous leaders, and they had yet to see any positive results from the community diagnostics.

For his part, ejido Comisariado Ontiveros said organization and lack of training were the main problems facing the local communities. Standing just outside his field of golden-colored oats, he is reaping his harvest using a modern scythe bought several hours away in Cuauhtémoc, with the oats intended for his eight cattle (Photo 4.5). Ontiveros says he did not participate much in the meetings held by Fuerza Ambiental. “They spoke to us about the microwatershed and the rivers and a way to keep more forest and more soils, but up to now there haven’t been any actual projects,” he said. “But it might be positive if we can become better organized and make changes.”

Photo 4.4. Aguaje in Tucheachi is covered by boards to protect it from animals

Ontiveros said it was likely they could make changes in the ejido in terms of where and when they graze cattle, but felt it was very unlikely there would be any changes to the forestry permit itself.

“We will always cut the forest because it not only provides us with a rent – but also work for those cutting, carrying and driving the wood to San Juanito to a sawmill,” the ejido leader explained (Ontiveros, Personal Communication, 2005).

Photo 4.5. Oat field in Arroyo de la Cabeza with “Modern” Scythe for harvesting oats

Based on both visits to the communities and interviews with leaders, a document prepared by Fuerza Ambiental has this to say about the problem of the lack of water in a community which averages over 500 mm of rain per year:

> The problems associated with “water scarcity” as they are identified by the inhabitants, are intimately related to the processes of logging, fires and other natural disasters, and the high grade of over-grazing and erosion that exist in the lands of the ejido, especially near the population centers.
>
> Fuerza Ambiental 2005

For their part, Fuerza Ambiental said it applied for funding from both SEDESOL and SEMARNAT to implement the projects identified in the Community Action Plan. Despite the working of the interinstitutional group led by WWF, and the inclusion of the projects in a community-adopted action plan, no funds were forthcoming from government entities as of late 2005 (Bravo, 2005)

Still, indigenous governor Villalobos' tone about changing practices in the Sierra is hopeful. He said everyone recognized that it was problematic to destroy the very forest that helped provide your home.

"We have our permit to destroy the forest and that's what the ejidatarios live on, but we already are getting less then we used to because there is less wood and the government is more strict about what areas you can cut," Villalobos noted. "They – Fuerza Ambiental – came to speak to us about this idea they have that we will create a conservation area, that we could come to an agreement to get as much money as we get now for preserving the forest without cutting it down, but it's just an idea."

C. Paying to Preserve: Ecological Service Payments

The idea Villalobos is referring to is the idea of ""Payments for Environmental Services" or *Pagos de Servicio Ambiental*. An idea that is has become popular throughout the world, PES pays communities to take action through "a voluntary, conditional agreement between at least one "seller" and one "buyer" over a well-defined environmental service-or a land use presumed to produce that service (Wunder 2007: 48)." In Mexico, the program was just getting off the ground, according to the Comision Nacional Forestal, or National Forestry Commission, in 2005 (Roberto Velasco, Chihuahua Office, CONAFOR, personal communication with author, 2005).

Currently, CONAFOR has two programs which could loosely be called PES. The first, called PPSAH (Programa de Pago por Servicio Ambientales Hidrológicos) – Hydrological Payments for Environmental Services Program – rewards forested communities that agree to limit logging their land as long as certain hydrological criteria are met (Velasco 2005). Most of the Conchos headwaters are not considered eligible because they do not meet the current criteria – such as 80 percent of their lands being forested.

The second program – Carbon Capture, Biodiversity and Agro-forestry Payments for Environmental Services or PSA- CABSA (Programa de Servicio Ambientales – Captura de Carbón, Agrofestal y Biodiversidad) – grows out of Mexico's signatory to the Kyoto Protocol and is a two-step process also incorporated into the 2003 law. Its goal is to mitigate climatic change caused by global warming by paying for "environmental" services. It includes a variety of programs related to carbon capture, biodiversity retention and non-traditional agro-forestry programs (see Table 4.2).

Currently, nine ejidos within the Sierra have applied for the new program, which began in 2004, although none of them are within the Conchos Watershed. In 2005, two of these ejidos received their first payments of 400,000 pesos each, covering about 6500 hectares (Velasco 2005).

Table 4.2 Types of Programs under CONAFOR's Payments for Environmental Services Programs

Name of Program	Elaboration of Program	Implementation of Program
PPSAH – Hydrological Payments for Environmental Services Program		$300 per hectare for pine forests; $400 per hectare for jungles for 5 years
Carbon Capture	Up to $400,000 per Project	$50 per ton of Carbon Dioxide Equivalent plus additional points
Biodiversity Protection	Up to $400,000 per Project	Up to $500,000 Per Year for Five Years
Reconversion of Agricultural Lands to Agro-Forestry Lands	Up to $400,000 per Project	Up to $1,000/hectare per year for five years
Improvement of Existing Shade-Grown Crops	Up to $400,000 per Project	Up to $500/hectare for Organic Certified Shade-Grown Products; or $400/hectare for non-organic products

Source: CONAFOR, SEMARNAT, 2005, information from website.

Finally, according to both the Kyoto Protocol and the 2003 Law, a company or foreign investors could invest money directly in an ejido to elaborate a plan for "environmental carbon bonds" and implement the plan to be used to meet Kyoto targets. In fact, Fuerza Ambiental's Bravo believes that interest by companies such as Japanese manufacturer Rico in supporting WWF as well as interest by U.S. AID is predicated on finding "deals" to help companies meet carbon dioxide targets by investing in social forestry and conservation programs (Bravo, 2005).

Despite the very limited budgets and goals of these programs, they have already sparked some controversy. On the one hand, ecologist Jose Luis Montes, who directs GAIA, a Chihuahua-based NGO also working in the Conchos Watershed through a contract with WWF, says "you can't start a conservation program without a budget.” In addition, he said the selection of programs had been arbitrary, with municipalities selected for political reasons.

A larger criticism, however, is that the projects are viewed as attempts by outsiders to pay traditional communities to give up their collective rights over land. CONTEC, a local group out of Chihuahua which also works with communities in the Sierra, has been vocal in its opposition to larger carbon “bonds” where ejido lands would be in essence sold off to foreign investors in return for limits on ejido land practices.

“Servicios Ambientales is another concept that became satanized,” noted Fuerza Ambiental’s Gina Uribe. “There was a reaction against it here from the Catholic Church and some groups. Basically you pay someone for doing nothing and the indigenous and their supporters against it are correct – you give up control of your resources.” (Uribe, personal communication with author, 2005).

For her part, CONTEC director Maria Teresa Guerrero said they have never been opposed to payments in return for assuring better land management and water, but are opposed to ceding control to outside organizations. She has held a number of local workshops and paid for local leaders to attend conferences in Mexico City to expose indigenous leaders to the idea of the environment, environmental services and environmental bonds. (Guerrero, CONTEC, Personal communication with author, 2006).

“What worries us that since Kyoto was approved as a way to mitigate climate change, they are opening a great market of titles and environmental bonds which represent the beginning of privatizing life and the wild areas – the forested areas – which is where the indigenous people live and which could lead to an ethical problem.”

D. Dams on the Mind: The New Water Supply Boom

San Juanito – largest of Bocoyna's towns with a population of 10,000– had a problem in 2002. There was no water. Drought-like conditions and increasing water use had caused streams and springs to dry up. There were protests in the streets and frantic calls to Chihuahua City for help (Presidente Seccional, Personal communication with author, 2004). The town relied in large part on a dilapidated pump in a stream in an agricultural valley a few kilometers west of the burgeoning capital. A visit to the pump revealed that at least on this day, as much water appeared to be filtering out of the pump itself as was being pumped from the valley over the mountain toward San Juanito (Photo 4.6).

The lack of available water for town residents led to meetings with state and federal officials and the decision to pursue construction of the Situriachi Dam just southwest of San Juanito. It was there, in 2004, that Mexican President Vicente Fox and his political opponent Patricio Martinez would jointly announce the opening of the dam as a response to the lack of water in the Sierra, while further announcing that none of this water would find its way to the United States (Topete 2004).

The road to Situriachi leads through lands owned by the Ejido of San Juanito. As owners both of forested lands and a local sawmill, it is a relatively wealthy ejido. It is also an area that has been rapidly deforested, at least based on recent photographs (Photo 4.7).

Photo 4.6. Water from this pump served the burgeoning town of San Juanito in 2003 before the San Juanito Dam was built.

According to officials at the state JCAS, the dam will provide water for San Juanito, as well as for Bocoyna and Creel, a major tourist center for both Mexican, U.S. and even European tourists, and even for several towns in the Municipality of Urique down the road into Copper Canyon (JCAS 2005). In 2005 and 2006, private companies bid on contracts to complete the extension of the water from the Situriachi Dam to these outlying cities. The development of tourism has in fact spurred a variety of water projects in the area due to the high demands of local hotels and associated tours.

Photo 4.7. Denuded landscape in Ejido of San Juanito, 2005.

While the dam has been continually cited by local officials as a successful project, it is not the only project in the area. Near an area referred to as "El Huerfano" – the Orphan -- funding from CONAFOR helped local ejidatarios with a variety of soil conservation programs. The Conservation and Forest Ecosystem Restoration Program (PROCOREF) is designed to provide money for infrastructure in ejido forested communities for soil retention and conservation.

According to PROCOREF local director Nestor Chavez, despite a small budget, the program – along with PET – a temporal work number -- and CONAFOR's Reforestation Program– has helped restore soils, forests and agricultural areas. In 2005, Chavez says, 33 soil conservation projects were implemented –

covering almost 3,000 hectares -- along with 164 reforestation projects in Chihuahua and Coahuila (Nestor Chavez, Personal Communication, 2005).

“El Huerfano” has become one of those preferred pilot projects shown off to visiting dignitaries and held up as an example of an environmental restoration project that will improve livelihoods, at least based on its inclusion in local conferences on forestry. The building of the filtration dam itself – a rock and wire structure that is built along an existing intermittent stream – is supposed to lead to local rainfall infiltrating the soils, retaining sediment on-site and leading to baseflow downstream. Because the local hills have been largely deforested, the building of the dam was accompanied by the reforestation of approximately 100 hectares surrounding the filtration dam.

While technically a success, the dam has become in its few years a local watering hole for cattle and horses, meaning that some of its success has been compromised by the practice of using it as watering source. The livestock are impacting vegetation on the slopes, according to local NGO representatives.

“With check and infiltration dams the people will take advantage of resulting vegetation to put their cattle there and the check dam will create a widening of the river banks and it will fail,” Fuerza Ambiental’s Uribe noted. She says she has seen many examples of “successful” filtration and check dam projects which have failed due to poor management.

Photo 4.8. "El Huerfano" Infiltration Dam Designed to Recharge Local Streams, 2004

E. Comunidad Indígina La Laguna

Downstream of the Municipal Capital of Bocoyna, the Bocoyna River makes its way through La Laguna, a gigantic piece of land owned by indigenous communities. Unlike Arroyo de la Cabeza, La Laguna is not an ejido, but an indigenous community which predates the legal entity known as the ejido. Organizationally, it is quite similar. Individuals work plots of land, but the community owns the land, and members have rights to those communal lands – rights for grazing and rights for mining its sands and gravel along the river.

The increasing tourism in the area has not only spurred the need for water development but also for roads, and the President of Communal Goods (presidente de bienes comunes) – somewhat akin to the Ejido Comisariado – has been selling off sand and gravel along the banks of the river for several years to local companies, and the state, with each member receiving a share of the profits.

“It has been a disaster without control,” notes a middle-aged man tending sheep along the banks of the river, near the town of Gupitare, which now resembles a denuded moonscape (Photo 4.9). The sheep herder says that while the extractors of material do pay 12 pesos per cubic meter of sand and gravel, benefiting the community, there appears to be no oversight of the process and “the river has changed course and eaten the land below.”

In 2004, Fuerza Ambiental won the WWF contract to help local leaders identify their priorities and think about how to better manage and restore their natural resources. Uribe said they began in the La Laguna community by building on an existing “Micro-Cuenca” (micro-watershed) project, which Uribe called somewhat dismissively “the flavor of the month-type project (Uribe 2005).”

They first began to meet with the members of the “watershed committee” set up through FIRCO and discuss with them the meaning of a watershed management plan.

“They really had no concept of the geographic, hydrological idea of a watershed as something that transcended political boundaries” despite their participation as a member of the watershed committee, Uribe explained (Uribe, personal communication with author, 2005).

Photo 4.9. The Bocoyna River – which further downstream is named the Conchos – serves as a mining center for sand and gravel needed for local roads and construction in Comunidad La Laguna.

Still, Fuerza Ambiental chose to continue with the existing committee structure. Two overall goals were identified which transcended individual communities: protection of the water sources on which they depend; and protection of stream beds and banks through improvement of livestock management practices.

Named for a large water body long since dried up, La Laguna's roots date from some 300 years before when it is believed the raramuri indigenous first inhabited the area (Fuerza Ambiental 2005b). While the community was recognized and inhabitants had both local planting and communal land rights since 1905, over the last 20 to 30 years a series of land invasions had caused a "loss" of communal rights. Approximately 25 years ago, they turned to the Mexican communist party, later to become PSUM, to provide assistance to community leaders in their efforts to have their lands recognized and have their boundaries more properly determined. According to local residents, the process was slow, in part because of the “caciques” – local groups of leaders interested in maintaining their power – illegal logging of the forests, and an Agrarian Reform Agency most interested in maintaining the status quo than in recognizing the true historic boundaries (Fuerza Ambiental 2005b). Following a mass take-over of the plaza in Cd. Chihuahua, and a series of legal battles, 167 members of the communities making up La Laguna were recognized as the true owners of the land.

Based on its current boundaries, Comunidad La Laguna spans 9,300 hectares, and is a huge pentagon that begins on the road between Bocoyna and Sisoguichi. The community is crossed by both the Rio Conchos, known locally as the Rio Bocoyna, the Rio Sisoguichi – the river’s other main branch – as well as other important tributaries such as the Gorachi, Nerochachi and San Antonio. Typified by high mesas and alluvial valleys, with slopes from 20 to 50 percent in some areas, and altitudes ranging from 2,200 meters to 2,500 meters, predominant vegetation includes pine forests, pine-oaks forest, and quaking aspen. Some 772 indigenous and mestizo inhabitants can be found in six populated areas, about 75 percent of which are self-identified as indigenous (Fuerza Ambiental 2005b).

At a bank in Los Aguatos along a local stream – a tributary to the Rio Bocoyna -- stands Lorenzo Gonzalez with two cattle that he is herding along the banks of the river. While upstream the river has been impacted by the extraction of materials, here the stream runs freely on this September day, albeit meekly (Photo 4.10).

“The river no longer has soil,” Gonzalez observes sadly. “its bottom is pure rock.”

Gonzalez blamed the denuded riverbed both on a variety of problems, including soil erosion, deforestation from fires, cattle management practices and the town of Creel, which placed a straw in Aguatos's local river approximately 10 years before. (Gonzalez, Lorenzo, personal communication with author, 2005). The pump carries water from the Aguatos valleys over the hills and to the burgeoning tourist pole.

Photo 4.10. Pump draws water from the town of La Aguatos for Creel in the La Laguna Community.

Gonzalez is President of the “Microcuencas del Conchos” Committee, a committee composed of other farmers and local leaders concerned about the loss in functioning and flows of the dozens of streams which feed the Rio Bocoyna.

When Fuerza Ambiental arrived, he admits he had little technical understanding of the watershed concept, but did have a profound knowledge of local rivers. He said the community spoke with one voice in identifying the main problems, including the loss of water at local springs, watering holes and streams; the increase in erosion and loss of soils from their lands; and fires which impacted the woods surrounding the valley.

Limited steps -- such as putting fences around the watering holes – have resulted from the Action Plan developed by the community and Fuerza Ambiental both in Aguatos and other communities. However, major plans to enact soil erosion mitigation measures, reforestation projects and further protection of water sources has yet to occur.

“There has not been any money for the community,” Gonzalez said. “I agree that I should not be paid directly for my organizing activities, or to come to a meeting, but to do the actual work to protect our community people must be paid. Otherwise, people emigrate to find work in Creel or other communities so they don’t lose work and they don’t remain without nutrition.”

The work in changing natural resource use within the community has been hampered both by the lack of funding but also by the dichotomous leadership structure within the community. While all of the communities within La Laguna have indigenous governors who were relatively active in Fuerza Ambiental’s development of a community diagnostic and action plan, the elected “Communal Lands” president, secretary and other leadership were not.

Explains one Fuerza Ambiental document:

> With the Action Plan, the attempt was to reinforce the traditional authority of indigenous governors, and while the strategy has worked well, traditional authority does not involve itself in the decision-making about the policies involving the use of resources, which makes it difficult to take the decisive steps toward a land use plan.” (Fuerza Ambiental 2005b, author’s translation).

Thus, the action plan acknowledges that the forestry management plan being pursued by the community’s leadership, the existence of a sawmill in one community, and the extraction of materials from riverbeds are important issues, but does not directly address them. On the other hand, notes Fuerza Ambiental’s Uribe, it is precisely because they do not directly advocate immediate change of the use of resources which provide direct financial benefits to the community that the action plan has largely been accepted by the communities as a good first step toward more careful use of the resources upon which they depend.

Fuerza Ambiental’s record of their meetings indicated that in Aguatos, the inhabitants concluded that “the most severe problem was the loss of the forests and the lack of training.”

Thus, part of the challenge for the community was simply to identify existing government programs – such as the Temporary Employment Programs, reforestation and soil conservation programs supported by the National Forestry Commission and the related federal agency SEMARNAT – that could be used to help reforest their lands. But the lack of any discernible action was clearly frustrating to the community.

On the road from Bocoyna to Sisoguichi lies a fork in the road, and a drive down that road along the San Antonio Stream takes one into a river valley that is dotted with corn, bean and oat fields. At times the road is the stream, at others it snakes through the forested hills and reemerges in the stream. Here and there a young indigenous boy herds goats. Some five kilometers along the stream, a bundle of pine wooden homes surround a white adobe church. At the top of the hill lies the modest home of Miguel Angel Saenz, president of the Local Micro-Watershed Committee of Nararachi, a community of approximately 60 families.

Eating a tortilla made from traditional blue corn, Saenz says that water is the main concern of the local residents. While a system of hoses and a check dam brought water to many of the homes some 12 years earlier, years of neglect, wandering livestock and trucks and the inclement weather has destroyed many of the structures (see Photo 4.11). But beyond the physical infrastructure problems, the sources of water have also been impacted both by low rainfall and recent fires which destroyed some 200 hectares of forest upstream of the community. Saenz says the community, working with Fuerza Ambiental and "with the help of WWF talking with the government" has received some three to 4 thousand pine trees to begin a small-scale reforestation process and have put fences around some of the springs upon which they depend (Saenz, Miguel Angel, Nararachi, personal communication with author, 2005).

Still, these small-scale projects – financed both by government and funds received by Fuerza Ambiental from the Christensen Fund – are only a small part of the larger projects envisioned in the community's action plan.

"We want to put fences along some parts of the streams, and change the cattle grazing to other parts so that nature can return," Saenz says. "So we need to work and talk with the owners of the cattle."

Photo 4.11. Two mules bathe in the San Antonio Stream downstream of Narurachi.

Saenz says they are well aware that outside aide does not always work. As an example, he cites the corn often sent to local communities by the local municipality since yields have been scarce during the years of drought.

“The seeds they send don’t work in these climates, it’s a very weak variety,” he notes. He said he has heard of criticism of WWF – that they are trying to create a biosphere reserve or take the water – but says he knows nothing of the particulars, nor does it seem to concern him. His concern is focused on local issues such as getting local resource users to change the way they raise and graze cattle and goats.

Says Fuerza Ambiental's Uribe "the idea is range management – to work one field or one part of a river area and then change to another and let the earth recover. The idea is not to prohibit cattle, but change the amount and timing of where they graze."

But as of 2005, the WWF-led contracted effort to change resource use in the Sierra Tarahumara – as a potential solution to low-flows in the Conchos – was incremental and haphazard, as the glossy brochures in Chihuahua City contrasted with the on-the-ground difficulty of working within indigenous communities own needs, and the limited government funding available.

IV. The Sierra Tarahumara Biosphere Reserve

One controversial effort in the Sierra Tarahumara related to natural resource use has been the effort to have the mountains and canyons declared a "biosphere" or "biocultural" reserve, an UNESCO designation that would open the area to some international oversight and funding (UNESCO 2002; Comisión Nacional de Areas Protegidas 2005). The roots of this efforts go back several years, and in fact to the early 1990s, when a World Bank backed-loan would have opened up significant logging opportunities in the area and some environmental groups instead called for a biosphere reserve (Lowerre 1994). In 2004, the idea became a formal proposal within the Mexican Government.

In November of 2004, Mexico's SEMARNAT announced the availability of the studies:

> performed to justify the Decree in which it is intended to declare as a naturally protected area with the character of a "Biosphere Reserve," the zone known as the "Sierra Tarahumara," with a surface area of 848,333 hectares, located in the Municipalities of San Francisco de Borja, Carichíc, Bocoyna, Nonoava, Urique,

> Batopilas, Guachochi, Guadalupe y Calvo, Balleza y Morelos, in the State of Chihuahua. (Cárdenas Jiménez 2004; Author translation)

What emerged following the announcement was a growing opposition among miners, foresters, the Catholic Church, some indigenous groups and, perhaps, surprisingly, many "environmental" groups. Thus, an umbrella organization that includes many of Mexico's major forestry experts and academics with an interest in social forestry – the Consejo Civil Mexicano para la Silvicultura Sostenible, A.C, stated in a newsletter:

> In the Civil Council, an analysis of the study justifying the Decree (of the Reserve) showed that it is a document that does not provide concrete details to justify the creation of such a large indigenous Biosphere Reserve. The study does not offer information about the social, economic or environmental impacts of the creation of such a reserve. The Civil Council will demand that before an actual reserve is declared, that they have clear and overwhelming justification and evidence, as well as local community approval (CCMSS 2005:3).

Rumors began to circulate about who was behind the effort – was it an attempt for environmentalists to control the Sierra's resources or could it be a U.S. government effort to assure the water from the Conchos flows to the U.S.? WWF – and its panda bear emblem – were often linked – at least in rumors -- to the biosphere concept, an idea that Chihuahua director Dr. Hector Arias categorized as "entirely false." (Arias, WWF, personal communication with author, 2005).

Alter the "preproject" was made public, Chihuahuan groups and officials working in the Sierra Tarahumara began to discuss the issue publicly during monthly meetings under the auspices of PIAF – a federal program to assist the Tarahumara.

“It became very obvious that none of the groups working there had promoted this idea and that the main promoter was Randy,” explained Fuerza Ambiental’s Gina Uribe referring to Randy Gingrich. Fuerza Ambiental immediately issued statements to the press and letters to board members to make it abundantly clear that they were not behind the idea of a Biosphere Reserve, since they had worked so closely with Gingrich’s Sierra Madre Alliance on other projects.

Gingrich said the controversy that emerged about the Biosphere Reserve throughout 2005 grew out of misunderstandings about what the reserve entailed. Gingrich said the original concept was to limit the biosphere to the area of canyon lands in the lower – not the upper Tarahumara through which the Conchos flows-- but that CONANP and the State Government and governor had wanted to make it a bigger project and had consulted with him in coming up with appropriate boundaries. Gingrich’s group was contracted in 2004 to consult with communities and come up with a plan. An original proposal that was even larger – almost 1.2 million hectares – was scaled down, but still included the lands of the Río Conchos watershed, which had become newsworthy and part of the dialogue (Gingrich, personal communication with author, 2005).

“Whether or not the Conchos watershed is included, I could care less,” he states matter-of-factly.

The “backlash,” he said, didn’t occur until after the original studies and boundaries were made public, even though he and others through a CONANP contract had been consulting with municipal and indigenous leaders for months. “The Jesuits – and some of the NGOs – went berserk on a total disinformation campaign that you wouldn’t be able to burn wood or harvest medicinal plants based on dated information from negative experiences with other biosphere reserves..”

In an effort to “add to the discussion” WWF, SMA and others decided to sponsor a forum on the Biosphere Reserve Idea called “Indigenas, Campesinos y Recursos Naturales (Indigenous, Campesinos and Natural Resources) in June of 2005 and brought in experts to discuss the positive and negative experiences of other biosphere reserves.

“The idea was not to present the Sierra Tarahumara as a possible reserve, but just discuss in detail what the experience had actually been of other reserves,” explained WWF’s Arias (Arias, personal communication with author, 2005). “What we showed is that there was no example of reserves actually forcing indigenous off their land – as many were claiming – but at the same time they had not lived up to their potential.”

If Arias’s gamble to enter the discussion sought to allay fears, it appears that the forum cemented the view that WWF was actually a closet supporter of the idea, and that there were continual problems with biosphere reserves in Mexico affecting indigenous rights.

“WWF organized the big conference on the Biosphere Reserve in part in response to the criticism and it was informative, but what was alarming is that there were no indigenous peoples,” remembered Fuerza Ambiental’s Gina Uribe. “It showed that the Biosphere Reserve hadn’t really benefited anyone.”

Officials in Carichí – one of the proposed municipalities inside the proposed boundaries – were clearly opposed to any discussion of the idea in 2005.

“We have told WWF and everyone else that we have no interest in a Biosphere Reserve,” noted Carichí’s Rural Development Director, Leopaldo Calzadillas.

“There have been successful and not so successful cases, but we don’t want anything that could take the indigenous off their land. Everyone here – the ejidos, the police, the municipality, the church, the private landowner – is against this idea.” (Calzadillas, Leopoldo, Personal communication with author, 2005).

Padre “Nacho” is one of three priests who runs the Catholic Church in the Municipal Capital of Carichíc. A member of the “Congregation of the Most Holy Redeemer” – a Roman Catholic missionary order dedicated to providing “dignity for the poor” founded in 1732 by Saint Alphonsus Liguori – Padre “Nacho” had been working in the area for nine years. (Padre Nacho, Personal Communication, 2005).

“They are offensive expressions when groups like WWF talk about the natural “riches” of the area and … they say shamelessly what interests them is not the land but the water,” he explained. “They don’t give any information about their true goals and they just decide where they will work.”

He contrasted this fly-by-night approach with CONTEC and COSYDDHAC, which he said had worked cooperatively for years with local communities.

“No one disagrees with the need to protect mother earth, that’s not the point of the debate, but what do the terms of a reserve really mean,” he explained. “What happens to people and their culture when suddenly you say in the name of a reserve they must use natural gas not wood?”

Maria Teresa Guerrero, fiery leader of CONTEC, a community-based non-governmental organization with some 15 years experience working in the Sierra, is decided in her approach to the reserve idea.

“I am opposed for three reasons. First, the reserve should have been the culmination of a public process, not the beginning. Second, the care of natural resources can only come from the local community not from a decree and third, a reserve area does not guarantee its care, what it does lead to is a privatization of land.”

In September of 2005, nearly a year after the announcement was made, and after several attempts in the national congress failed to advance the project, CONANP announced it was looking to hire a group or consultant to “advice and develop the previous study justifying the decree and fix the limits of the Sierra Tarahumara Biosphere Reserve.” The contract would pay about $1,500 per month and would operate out of CONANP offices in Cuauhtémoc. (Comisión Nacional de Áreas Naturales Protegidas 2005)

Writing in a journal article in 2005 before major opposition to the Reserve emerged, Gingrich advocated a bottom-up decentralized planning process to put teeth into the reserve concept, which would build on the work that the Sierra Madre Alliance, its Mexican counterpart organization – the Consejo EcoRegional -- and groups like CONTEC have performed with local communities. Gingrich writes:

> The results to date and potential for watershed restoration and regional conservation are impressive: a 3 million acre “**Sierra Tarahumara**” Biosphere Reserve has been proposed by the National Commission of Protected Areas (**CONANP**), the State of Chihuahua, and the Consejo EcoRegional. This large scale reserve will integrate a number of community proposed protected areas, as well as regional watershed and riparian area restoration initiatives planned in the Conchos, Fuerte, and Papigochic watersheds. Nine municipios, once dependent upon timber, have joined with over 50 indigenous governors to date to support the Biosphere Reserve proposal. They are beginning to embrace conservation as an

> integral part of rural development. These accomplishments are being made by listening to and supporting the most difficult local priorities such as resolution of land conflicts. In the future, international and multilateral funded programs must respect the growing strength of NGO and citizen participation. CONANP and the Consejo EcoRegional are setting new standards of grassroots participation, a process that needs to be nurtured with greater international and national support. (Gingrich 2005: 364.)

Still, by 2007, the wider biosphere reserve idea was officially dead, and instead a series of smaller "cultural" reserves in specific locations were being advocated by Gingrich, CONANP and others. In explaining the death of the larger biosphere project, while acknowledging that part of the problem was the government's fast-tracking of the proposal without first seeking community input, Gingrich wrote in the Sierra Madre Alliance website:

> Despite the clear indication of positive benefits for indigenous groups and other residents, opposition from the Jesuits and CONTEC continued to mount in 2005. International mining companies and some of the most corrupt logging interests in the state continued to aggressively attacked the proposal……SMA and CONANP for a time were ludicrously labeled the biggest threat to the economic security and culture of the Sierra Tarahumara by this coalition of hysterical clergy and industry leaders. (Gingrich 2007).

Instead, Gingrich, the SMA and others went back to working in individual communities to build up support for a "grassroots" Biosphere Reserve ejido by ejido:

> Eventually, this network of certified community reserves will form the grassroots basis for recognizing the Sierra as a natural Biosphere Reserve. The groups which stalled the Biosphere Reserve planning process do not represent either the ejidos or the indigenous pueblos who own the lands, or the municipios who will

> benefit from economic diversification and promotion of the region. (Gingrich 2007)

The often bitter fight over the designation of the biosphere reserve – while outside the more narrow bounds of the dispute over low-flows from the Río Conchos – was part of the larger battle over who is invited to participate in decision-making over natural resource use, and how that participation is perceived by various interests. What is interesting is how perception of larger NGOs like WWF – culled through investigations of other experiences in other parts of Mexico – was seized upon by local clergy, NGOs and indigenous leaders to counter a proposal that was not even being advocated by WWF. Local communities are reacting to

V. Jesús de Carichíc: Cattle and Conservation

A. Municipal Festivities

The mood is festive in the Municipal Capital of Carichí – officially known as Jesús de Carichíc -- on October 8th, 2005. It is the new mayor's (municipal president) first Government Report – el Primer Informe de Gobierno –a requirement in all of Mexico's municipalities.

Pick-up trucks filled with indigenous farmers and mestizo ranchers flow through the few streets of Carichí, the municipal capital toward the town Gymnasium, built under the previous three-year administration (Photo 4.12). School buses bus whole communities in from more distant lands. Others arrive from outlying communities by horse or even by foot.

Filling up the rows inside the gymnasium are representative of the two main cultural groups making up Carichí's population of approximately 10,000. Indigenous women in traditional, bright skirts and frilly shirts occupy entire rows, while their husbands, most in more modern dress, but with their traditional sandals and worn feet, sit behind, white hats squarely on their heads. More traditional Raramuri men wear instead a brightly-colored headband and traditional loose shirts. The next rows are occupied by Carichí's mestizo business class, women in dresses and high heels, ranchers in tan-colored sombreros and leather cowboy boots with tight jeans. Mexican flags adorn the podium. A large banner declares the theme of the governor's first year in office: *United in Effort*.

"They came for the free barbecue, not the lies," remarks a local priest sardonically.

New President Santiago Martínez Gutierrez is a local rancher from El Álamo de Ojos Azules, down the hill from Carichí itself, and a relative newcomer to politics. His 30-minute presentation, accompanied at times by power-point slides with digital photographs, is largely a litany of projects that his administration has brought to both the municipal capital, and outlying communities -- utilizing municipal, state and federal funds. If there is a theme to the evening, it is that this administration will not favor one group over another, but listen to all Carichí residents and look for solutions "united by effort." (Martinez 2005: 48.)

Surprisingly – or not – missing from Martinez's pronouncements are any mention of the main difficulties that local farmers and ranchers often cite: a drought of some 15 years, the loss of fertile soils and vegetation for cattle, and the deforestation which is blamed as a partial cause of these other problems as well as the lowflows of the tributaries to the Conchos.

B. Carichí Revealed

Located 160 km west of Chihuahua City, and 60 kilometers west of Ciudad Cuauhtémoc, the Municipality of Carichí spans 2,780 square kilometers with altitudes ranging from 2,100 to 2,400 meters above sea level. While the road from Cd. Cuauhtémoc to Carichí is paved, virtually all others roads within the Municipality are not. Traveling from Cd. Cuauhtémoc, one passes the well-ordered homes of the agricultural communities of the Mennonites, to the mestizo ranches of Ojos Azules and other communities, typified by grassy high plains spotted with boulders, which themselves slowly give way to an oak-juniper savannah. It is the dividing line between the high plains and grasslands of the center of the state and the Sierra Madre Occidental to the west.

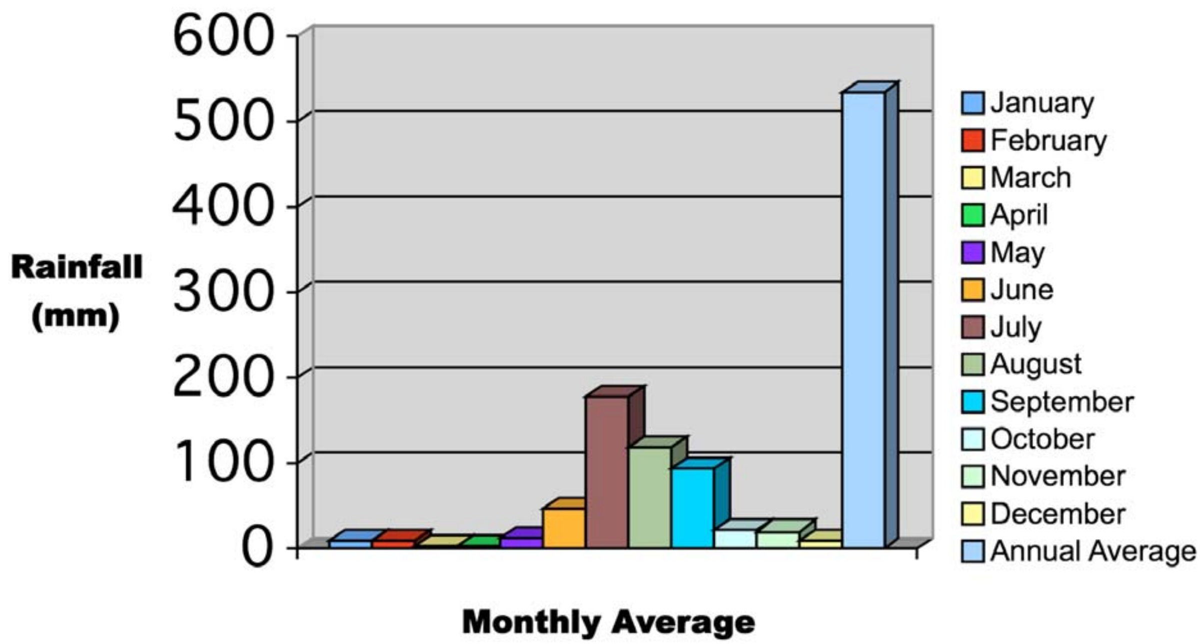
The vegetation corresponds closely with altitudes, with higher altitudes typified by pine-oaks forests (2400 meters and above), medium elevations typified by oak-piñón, and oak-juniper forests and the lowest elevations by grasslands. However, because grasslands are generally in those areas used for agriculture and cattle raising, few of the original grasslands which typified the area are still present (Guerrero 2002: Schmidt 1992: 93).

Precipitation averages 400 to 500 mm per year, with a dry period of approximately seven or eight months, and a wet period of four or five (Figure 4.1). Nonetheless, although a climactic station was operated by State Government from 1977 to 1994, there has been no meteorological station run in the Municipality since, complicating analysis of drought and rains in the area (CONAGUA, Information Provided to Author, 2004). Temperatures taken at that station ranged from a high average of 20.2 grades centigrade in June to 6.1 grades centigrade in December and January, with an annual average temperature of 13.3 grades centigrade. (Portillo Terrazas 2005).

Given its rural nature, land use is typified by temporal and irrigation farming, fruit orchards, pasture lands for cattle, and forested lands. Like much of Mexico's forested lands, the majority of the lands – some 77 percent – are held by agricultural communities called ejidos, rather than private hands (Table 4.3). There are 22 ejidos in Carichí. Among agricultural fields, only a handful of hectares are irrigated – either by surface water through gravity or by pumped groundwater – all of which are on private lands, most of which is for apple orchards. However, in recent years, irrigation of both orchards and hybridized corn has increased, in part due to government support and the continued persistence of drought-like conditions (Salvador "Chava" Vargas, SAGARPA Delegate, Carichí, personal communication with author, 2005).

Photo 4.12. Oak-Juniper Savannah Grasslands of Medium-Altitude Hills near Carichí

Figure 4.1. Average Monthly Rainfall, Carichí



Source: Servicio Meteorológico, Gobierno del Estado de Chihuahua

When compared to the 1990 Census, there has been a marked decrease in population. According to local officials, these changes are due to out-migration from the area – principally to Cuauhtémoc and Chihuahua City – and the challenges faced by agriculture and cattle raising in recent years (Leopoldo Trujillo, Personal communication with author, 2005).

Almost all crops in Carichí are grown in the summer and early fall, when temperatures and rainfalls make production possible. Local officials say that since 1990, the number of hectares planted has shrunk in Carichí, although there has been a slight increase in individual crops, notably oats, corn grown for cattle, and in the lower regions, apples (Salvador Vargas, Personal Communication, 2006). In essence, agricultural production in Carichí has shifted partially to feed cattle, a more profitable "crop." As mentioned, here has also been a slight increase in irrigation of apples as drought-like conditions have forced some farmers to search for alternative sources of water and to increase yields. In the ejidos, on the other hand, traditional crops – beans, corn, oats, and potatoes – have continued to be grown as sustenance crops, albeit in reduced yields and acreage due to drought-like conditions over the last several years (Figure 4.2).

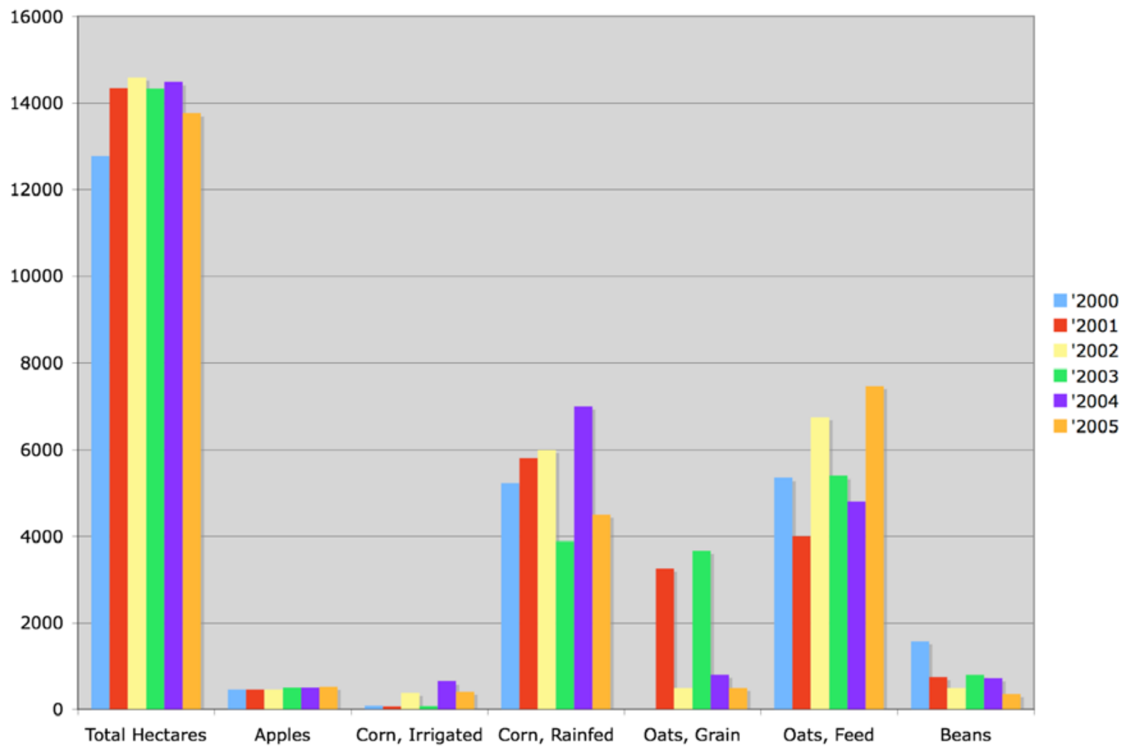
Table 4.3. Land Use and Property Type, Carichí Municipality, 2000

Land Use	Private		Ejido		Total
	Hectares	%	Hectares	%	
Irrigation by Gravity	1	<1	0	0	1
Irrigation by Pump	11	<1	0	0	11
Orchards in Development	5	<1	0	0	5
Orchards in Production	14	<1	0	0	14
Rain-fed Agricultural Fields	3,513	7.1	4,555	1.9	8,068
Pasture land	45,617	92.8	86,718	36.3	132,335
Forested/Not Identified	0	0	147,347	61.7	147,347
Other, Not Identified	0	0	0	0	21,099
TOTAL	49,161	15.9	238,620	77.2	308,936

Source: Portillo Terrazas 2005.

While most of the farmers on the eastern slopes on the road toward Cuauhtémoc use "hybridized" and improved seeds for corn and oats, most ejido growers use locally-grown seeds for corn and beans, although they may use "improved" seeds for oats (Salvador Vargas, Personal Communication, 2005).

Figure 4.2. Major Crops Grown by Hectares in Carichí, 2000-2005



Source: SAGARPA, State Office, Information provided to Author, 2005.

The other major economic activity in Carichí centers around cattle. Carichí has been no exception to the statewide trend to breed young cattle for export. According to the Municipality, there are about 45,000 heads of livestock in the municipality, including some 10,000 cows. While the largest cattle populations lie in ejidos and private lands east of the municipal capital, ejidos in the forested mountains also have significant populations of livestock. Most ejidatarios have a few mules or horses to help with transportation and tilling fields, and others have small populations of cows or goats to provide milk, meat and the occasional calf, for sale to middle-men, who then export the young cows to the U.S. for fattening. According to Carichí Municipal authorities, during FY 2005, some 7,293 cattle left the Municipality in 1,164 trips – paying duties to the Municipality – as well as 344 smaller livestock such as goats or sheep (Martinez 2005: 26).

A recent diagnostic prepared by Municipality listed the following problems in the indigenous mountainous regions of Carichí:

- Self-subsistence agriculture
- They are not open to applying appropriate technological packages to their lands
- They are mainly indigenous producers
- There are linguistic barriers
- They are very traditional
- Most governmental dependencies have programs that are not used or do not have the right regulations to reach the population. (Portillo Terrazas 2005, author translation)

Thus, according to the diagnostic, the very traditional nature of the ejidos in the mountains present barriers to development and progress, while in the hills, the lack of technology, overgrazing and some poor soils are the causes of low yields. Thus, the problems listed are a combination of farmer ignorance and mismanagement and faulty government programs which have not lived up to their potential. (Portillo Terrazas 2005).

According to the author of the Diagnostic, the municipality has enacted a number of rural development plans designed to foster change in the traditional forms of government to farmer relationships, a change reflective in recent policy changes in Mexico to move toward greater decentralization of government decision-making. Portillo Terrazas writes:

> From the traditional model of Campesino Organization linked to a governmental protectionism and structure toward a new form of autonomous organization founded in consensus and open mechanisms of participation; from an organization centered only around production to one which looked at all the public interests

> and positions and different levels of government. The economic crisis and the deterioration of natural resources demands overcoming the centralism and the politics of a one-size fits all approach. Toward the recognition of the diverse natural resources and the heterogenous methods of products of producers. A greater decentralization of the Nacional and State Institutions and a greater protoganism of the local social and municipal groups. (Portillo Terrazas 2005).

Decentralization has been promoted heavily by the Fox Administration, with significant support from the World Bank's Latin American arm (Wilder 2002). This effort toward decentralization would help "solve" issues of mismanagement and equity and promote more sustainable use of natural resources. In Carichí, the decentralization is occurring, albeit slowly. The main agricultural support programs are supported by the federal government through a program called "Alianza para el Campo," Alliance for the Country." In 2005, after years of being run out of the local SAGARPA offices in Cuauhtémoc, it was "municipalized," being turned over to the Municipal Rural Development Department. The program provides approximately $2 million pesos (about $200,000) per year, according to Rural Development director Leopoldo Calzadillas. (Calzadillas, personal communication with author, 2005).

The Municipality also helps coordinate various federal programs that bring money for rural development projects. Thus, between 2003 and 2005, the Municipality worked with SEMARNAT to bring $10,000 to four communities – Consuelo, Molinares, Bacabureachi and Arroyo del Agua – for soil conservation projects through PET program – Temporary Employment Program.

Portillo said a previous program which paid 500 pesos per hectare– aimed at mitigating the high number of "carcavos" – literally eroded holes in the ground -- through soil erosion controls – largely failed, because once the projects were implemented, no special measures were taken to limit cattle or other livestock from the area and no follow-up occurred. There was, said Portillo, “no supervision.”

The two other main government projects are still in the hands of SAGARPA, the federal agricultural ministry. In 1993, in anticipation of the North American Free Trade Agreement, Mexico established a program paying farmers growing certain crops a direct subsidy to help them compete with internationally-grown crops or transition to other crops. PROCAMPO – literally El Programa de Apoyos Directos al Campo (Direct Payment Programs to the Farms) – has been dolling out millions of dollars to hundreds of thousands of farmers ever since.

While the program was approved initially for only a few basic grains, it was expanded in 1996 and now includes rice, corns, beans, cotton, soybeans, sorghum, cartámo (safflower), barley and wheat (Salvador Vargas, personal communication with author, 2005). Payments are given so long as farmers continue to work the lands – even if for example their lands have been turned into apple orchards or even cattle ranches or even an “ecological” project. Thus, if you were growing one of the crops covered by the 1996 expansion in 1993, and continue to work the land, you will receive the subsidy, intended to keep farmers on their land.

About 13,000 hectares in the municipality are covered by the program. Taking the call for “decentralization” more seriously, the last few years, SAGARPA representative Salvador “Chava” Vargas has taken his government truck directly to the ejidos to hand out payments, rather than waiting for ejidatarios to make the often long and costly trek to Carichí. At some point, the program is supposed to be taken over by the municipal Rural Development offices, but “things move more slowly in Carichí” according to Vargas.

The program is often criticized by local farmers who say that because it is based on surface area, those farmers having the most surface area – the largest and wealthiest – receive the most benefit, which is certainly reflected in the statistics. Thus, in the case of Carichí, the 92 farmers in the program with 10 hectares or more received 26 percent of all the payments in 2005. Still, at approximately $1000 pesos per hectare, these "poverty" payments have been one of the keys to the continued survival of farming in the Sierra.

Table 4.4. Payments to Farmers under PROCAMPO, Municipality of Carichí, 2005

Category	**Number of Farmers**	**Percentage**	**Total Hectares**		**Total Payments**	**Percentage**
All	1,684	100	12,658	100%	14,200,087	100%
Between 1 and 10 hectares	1,573	93%	9,218	73%	10,341,045	73%
10 hectares or more	92	6%	3,284	26%	3,684,023	26%

Note: Total do not add up, because payments to approximately 20 farmers covering approximately 150 hectares were still being resolved as of November, 2005.
Source: Salvador Vargas, SAGARPA, Delegation to Carichí, Cuauhtémoc Rural Development District, State of Chihuahua, 2005.

The second major agricultural program was begun in 2003, and was designed to bolster cattle production, and in particular, production of young cattle which are prized for export to the U.S. market. The program paid 350 pesos per fertile "womb" to eligible cattle raisers in 2003, a total that was raised to 500 pesos in 2005. Not all cattle raisers applied in time to qualify however. In Carichí in 2004, for example, only 27 families and 2,130 "wombs" – about 25% of the cattle that might be eligible -- applied in time to take advantage of the program.

The program is supposed to come with a catch – to be eligible, ranchers must prove that they are grazing at less than the recommended five hectare per cow grazing intensity coefficient established for the region. Nonetheless, SAGARPA officials admit that inspections have been rare, and thus far, no payments have been taken away for failure to meet these guidelines. Supposedly, in 2006, SAGARPA will crack down on those not meeting cattle ranging guidelines.

"Farmers usually just underreport the number of cattle they have so they will be eligible for PROGAN," admits Vargas. "But we certainly don't want to be subsidizing soil erosion."

C. Molinares and El Consuelo

1. Fishing for Pesos

In the town of Molinares, Municipality of Carichí, there is an ejido meeting set for 10 am on a sunny Friday morning in October of 2005. Members of the ejido arrive slowly, meeting initially outside the local DICONSA – a state-supported but individually run local rural store with basic foods and goods. The ejidatario member who runs the store sells chips and sodas to the arriving farmers. Soon, the ejido comisariado – akin to the president -- his brother and father arrive in pick-up trucks from the nearby town of Arroyo del Agua and sit on the porch steps. Even getting enough ejidatarios to make a quorum can be problematic. But then this meeting holds some promise – the Municipal President from Carichí has promised to bring subsidized corn seed and the Ejido president has told those meeting that there is approximately $50,000 – about $5,000 U.S. – from SEMARNAT for some soil conservation projects within the ejido. Free corn seed and potential employment has a way of attracting participants.

By 12 p.m, about 35 ejidatarios move from outside the DICONSA store and file into the Ejido meeting hall. Although Municipal President Santiago Martinez has yet to arrive, the ejido's comisariado, Reginaldo Mendoza, decides to start the meeting. Speakingly haltingly, the 40 year-old Mendoza announces that "help has arrived" in the form of $50,000 pesos from the federal environmental agency SEMARNAT for soil conservation. The idea, he says, is to make filtration dams and trenches on the slope of a mountain overlooking the town of Molinares. Some two years previous, a fire had taken out dozens of hectares of pine forests, and slides of mud and swift run-offs of rains has been common since, affecting downslope agricultural fields and pasture land (Photo 4.13).

Photo 4.13. Farmers discuss denuded hill above agricultural fields and cattle pastures of Molinares, Carichí. Truck in foreground is from municipality and has subsidized corn seeds.

The community members agree that they will all meet the following Sunday at 10 am on the hillside and begin work. Those that work will be paid. Several ejido members discuss how they will let those who work in Cuauhtémoc know so they can "benefit" from the soil conservation program.

Municipal President Martinez arrives in his pick-up, followed by a large flatbed truck, which rolls down the mountain side, carrying 50-kilo sacks of yellow corn wrapped with rope. Martinez, after signing the ejido ledger, reiterates his desire to run a "unified" government where all communities benefit, says that he is here to discuss municipal programs, listen to their ideas, and distribute the "corn feed." The community decides that each ejidatario will receive 100 kilos for free, while each "neighbor" that does not have land will receive one fifty-kilo bag.

Martinez then launches into a discussion of the other programs and projects being considered by the Municipality. *Alianza del Campo* (alliance for the fields) he announces, is available for applications. "Much of the help from Alianza comes only to the municipal capital," Martinez laments. "But I would like to see the ejidos apply…."

An ejidatario stands up and tells Martinez that he wants to apply "but we lose our enthusiasm when we have applied for many years and there are always commitments with the politicians. These programs are raffled off at the top."

Another says, referring to a program to partially support the purchase of cows or "improved" bulls, "how are we going to buy anything, if we have no bills with which to pay?"

Martinez agrees that improvements are needed, and that he is overseeing the Rural Development Committee to make sure the wealth is spread throughout the Municipality. The farmers stream out of the hall and begin to load up their horses or pick-up trucks with the sacks of corn and begin the long treks back to their homes, fields and pens.

2. Molinares: Just the Facts

Molinares was first recognized as an ejido in 1938, when then President Lopez Portillo made the official declaration. At 4,800 hectares, it is a small ejido, and the majority of families live in Molinares itself, a ramshackle town in an alluvial valley surrounded by pine forest hills, although the deforestation of the hills above and the gully formations in the valleys below are obvious. Traveling from Maguillachi , on passes Molinares itself on a dirt road, which continues over a mountain pass and descends into another town, Arroyo del Agua, where other ejidatarios live. A river runs through the community, with homes mainly in the hills above the river valley itself. Finally, if you continue along the same road – and again pass over a mountain -- you arrive at El Consuelo, a newer community, whose residents may have lands in the ejido of Molinares or the newly christened ejido of El Consuelo.

There are 48 ejido members in Molinares, and interestingly, it is one of the few ejidos in Carichí that is a “mixed” ejido, with 18 “mestizo” ejidatarios and 30 “tarahumara” indigenous ejidatarios. According to current Ejido Comisariado Mendoza, the ejido was actually founded by the “mestizos,” even though there are more indigenous, but generally relations are good “between the two races.” Mendoza, speaking from his home in Arroyo del Agua, some 100 meters from the local stream itself, should know, the product of a Tarahumara mother and a father who emigrated here from the State of Coahuila many years ago to “find land.”

Mendoza says recent years have been difficult for the ejido. Rains have arrived too late and too infrequently for corn yields to be sufficient to feed families and cattle, and the previous source of income – a forestry permit to allow for logging – was canceled in 2003.

Table 4.5. Some Basic Information about Molinares Ejido

Category	Number
Official Date of Founding of Ejido	1938
Number of Ejidatarios	48
Total Hectares in Ejido	4,800
Total "agricultural" lands available for farming	307.25
Average/Maximum/Minimum Hectares per Farmer	6.4/21/2.5
Communal Land "Pasture" Right per Farmer	150 hectares
Total Number of Livestock	876
Total Number of Cattle	494
Average/Maximum/Minimum	3.85/30/0
Total Number of Tractors	3
Last year ejido had Forestry Management Plan for logging	2003

Source: Portillo Terrazas 2005: Appendix A.

"We asked for another permit, but they did a study, and said we no longer had enough forest," he notes. Mendoza said part of the problem was due to illegal logging from "outsiders," as well as some corruption with a previous "administration," meaning the ejido was being fined "for something that wasn't our fault." He notes that even gathering dead wood for heating homes and cooking "is now controlled by the Municipality."

In 2004, Mendoza took the community through PROCEDE – the program instituted by Mexico as part of its 1992 reform of Article 27 of the Constitution. Under the program, ejidos can voluntarily have the boundaries of their ejidos properly measured and certified, as well as their household plots, agricultural lands – and if the ejido chooses – their "common lands," the lands used mainly for either forestry activities or grazing of animals.

In Molinares, the Assembly decided to have both their household lots and agricultural lands titled, and have their common property certified, but not measured off as private property. “It means that any ejidatario can sell his land or his common property right to another ejidatario without getting permission,” Mendoza explained, “but not to someone outside the community.”

While Mendoza is in many ways the public face of the ejido before government officials, other government aid and “spiritual” issues – traditional dances and festivals, church-related activity and indigenous issues – is coordinated with the Indigenous Governor, “Nacho,” who lives up the hill from Mendoza, among pine trees overlooking the alluvial valley (Photo 4.14).

Photo 4.14. Home of “Nacho,” indigenous governor to El Consuelo and Arroyo del Agua.

As a leader in Arroyo del Agua, Nacho is the “indigenous governor” for both Arroyo del Agua and Consuelo, working with ejidatarios and neighbors from both El Consuelo and Molinares. He is an “indigenous” bridge between two communities and has been serving in that post for five years. (Gobernador Nacho, Arroyo del Agua, personal communication with author, 2005).

“You make a request and you direct the support when it arrives, which is very rare,” he stated. He said the most positive change in the community was the long struggle to bring potable water to homes after streams and previous shallow wells and springs seemed to dry up. “It’s a community good that we had to fight for.”

3. El Consuelo: the “new” ejido

The roots of Arroyo del Agua and El Consuelo date back some fifty years, when the children of the original residents of Molinares began to settle in the alluvial valleys in El Consuelo and Arroyo del Agua to be closer to the land they were farming. However, as that land was distributed among members of the Molinares Ejido, their children began to open up new farming lands in “bajiíos” – lowlands with fertile alluvial soils outside the boundaries of the Molinares ejido itself. They did so peacefully, without incident, before a land dispute erupted.

According to an elderly Tarahumara ejidatario who lives in the town of El Consuelo, the residents began to seek legal rights to the land in the mid-1960s. Nevertheless, when they sought rights to the land they had been farming, two families claimed the land was theirs, and even began putting up a fence to raise cattle (Gumercindo Torres, personal communication with author, October 2005).

“I was the local police representative for the community, and they began to put a fence up, but we took it down,” Torres, walking among his oat fields, remembers. “The guy who helped me was Governor Fernando Baeza, who gave me an order allowing me to take the fence down. Then the rich sent the “Federales (federal police)” there but I showed them the order to stop the fence construction. The “outside” families continued the court battle over the land. But we told the court in Chihuahua….. go to our land, their homes do not exist. The lawyer was very angry because the poor people – us – won that case.”

While they won that particular fight, the land dispute was far from over. While Torres himself stopped going to Chihuahua, a new group of leaders from Arroyo del Agua and El Consuelo took up the legal fight and in 1992 asked for 2,600 hectares of land to benefit 41 families. Finally, in 1996, in a partial victory, a Presidential Resolution granted 1,805 hectares to the 41 families. In 2000, the PROCEDE process determined that only 29 families remained in the area.

In 2005, El Consuelo continued to fight for an additional 800 hectares that is still the subject of a dispute with another private landowner, but have left the case largely in the hands of CONTEC, a non-governmental organization which is continuing to pursue the case (María Teresa (“Peti”) Guerrero, personal communication with author, 2005).

Today, El Consuelo is home to 29 ejidatarios split between Arroyo de Agua and El Consuelo. The town of El Consuelo is home to 14 families and 83 people, although several of the families have ejidal rights to farming land within the boundaries of Molinares. About 70 percent of the population is less than 30 years old. Among the 29 ejidatarios, on the other hand, only five of the 29 were less than 30 years old in 2004, indicating a potential future problem of land for the their sons and daughters (CONTEC 2004).

Like Molinares, residents depend on subsistence farming and livestock to eke out a living among the hills and valleys, and many have a family vegetable garden to supplement their diet (Photo 3.15). Residents and farmers interviewed by the NGO CONTEC reported that following the drought years of the 1950s – when many animals died and crops were scarce – the 1960s were typified by high rains and high corn yields, and low production costs, since most fertilizers consisted of animal wastes and seeds were grown locally. By the 1990s, however, rains and yields were low, and the use of “artificial” fertilizers and costs were now high, since farmers often had to purchase seeds from outside the community. (CONTEC 2004).

Photo 4.15. Home in El Consuelo with Family Garden and Greenhouse.

Table 4.6. Some Basic Information about El Consuelo Ejido

Category	Number
Official Date of Founding of Ejido	1999
Number of Ejidatarios	29
Total Hectares in Ejido	1,805
Total "agricultural" plots available for farming	113
Average/Maximum/Minimum Hectares	3.9/10/1.0
Communal Land "Pasture" Right	Informal right, no specific amount earmarked
Total Number of Livestock	245
Total Number of Cattle	101
Average/Maximum/Minimum Number of Cattle	3.5/21/0
Total Number of Tractors	3
Last year ejido had Forestry Management Plan for logging	------

Source: Portillo Terrazas, 2005, Diagnóstico Carichí, Appendix A and Interviews with Community Leaders, 2005.

Despite the continued unease about the differing land claims in the area, the new ejido of El Consuelo is a success, say its residents. In 1999, they elected their first ejido comisariado, Juan Jose Sinaloa, a middle-aged tarahumara who lives in Arroyo del Agua. Sinaloa, who served as both the first comisariado (1999-2002), and its most recent (2005-2008), is energetic, optimistic and generally appears be well-liked in the community.

Sinaloa said the community has resisted calls to divvy up their land or give up the fight for the 800 hectares which lies to the north of the ejido's present boundaries. "We prefer not to proceed with PROCEDE to divide up our lands," he noted from his front porch. "It is better to give your land to a son, then to divide up the ejido." (Juan José Sinaloa, Comisariado, Ejido El Consuelo, Carichí, personal communication with author, 2005.)

Unlike Molinares, there are not many suitable places for cattle grazing, and while there are approximately 100 cattle in the ejido, the majority are kept in pens at night and grazed in certain locations during the day, although it is not uncommon to see a pair of cows grazing at the top of a hillside (Photo 4.16).

Photo 4.16. Cows Forage in the Pine and Oak Hills Above El Consuelo

Most members of the community wish to preserve the forest and land they have, Sinaloa believed. While they have a *Plan de Manejo Forestal* – a Forestry Management Plan – it is designed to help them reforest the area, not cut down trees, and there is an agreement among the farmers not to change the terms of the plan to allow logging, at least until the forests return (Sinaloa, personal communication with author, 2005).

Between 1999 and 2005, the community worked on a variety of projects designed to make better use of their lands and resources. In addition to developing a non-logging Forestry Management Plan, the community began a land use identification and planning effort knows as an "Ordenamiento Ecológico.".[11]

Walking hand and step with them was CONTEC, the small NGO headquartered in Chihuahua City that has clashed so publicly with the Sierra Madre Alliance over the biosphere reserve project. Director Maria Teresa Guerrero, a sociologist by training, had been working for COSYDDHAC, the human rights advocacy group, since 1990 and had been focusing on both indigenous rights and environmental issues like deforestation, toxic wastes and garbage disposal. Nevertheless, she started CONTEC with substantial international support when it became clear to her that the key was not only legal victories over land use, but "better organization" within the community.

In 2005, CONTEC was working with eight communities in the Municipality of Carichí, as well as others throughout the Sierra Tarahumara. The roots to the work in El Consuelo started both with CONTEC's involvement in the decision before the Agrarian Tribunal as well as their "Winter Schools," workshops with indigenous leaders in the nearby ejido of Maguillachi. The workshops were generally focused on natural resource use and communal organization. Guerrero said they are careful to work within existing structures of the community – but avoiding those who would use the process for political gain -- and allow the community to be the ones who do the inviting to avoid the type of "participation" for which so many larger NGOs working in rural environments have been criticized (Walker et. al 2007).

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[11] *Ecological Ordering* is a land use planning tool established in the Mexican general federal environmental law. INE, Ley General del Equilibrio Ecológico y Protección al Ambiente, Titulo Primero, Art.3 fracción XXIII

Several of the residents of Consuelo attended these workshops, which included, among other projects, efforts to impart a new technology – known as Estufa Lorenas (Lorena Ovens)– wood-burning stoves to cook and heat the wood and adobe homes. The stoves cook more efficiently and require less wood than traditional tarahumara stoves, an example of "appropriate technology" according to Guerrero.

Another major effort were the soil conservation projects, which CONTEC calls "agroecological" practices. These projects attempted to use tried and true campesino land management techniques – including Tarahumaran "trincheras" which can be used as a kind of check dam to catch fertile soils --to lower the erosional forces of wind and water common in the area (Doolittle 2000). Rather than seeding and plowing in straight lines using horse drawn plows, the winter "school" taught farmers to follow the contour of the lands through the use of topographical "curvas de nivel" when seeding – rather than using straight lines so that the corn and beans could take advantage of the natural contours of the land. In addition, depending on the slopes of the land, trenches were added every ten yards or so – wider ditches called zanjas de filtración with a trinchera mound on either side to provide an area for water and soil to run off into – a place for any gullies forming to be stopped in their track. Finally, at the end of agricultural fields – particularly in areas close to streams – *muros de contención* – contention walls – of stone and wood were added as a final resting place for eroding lands.

The experiments with fields began in Maguillachi, where COSYDDHAC had already been working. Then, in the winter of 1999 and 2000, as part of their "winter schools", farmers began to perfect the techniques. The work was supported both by the Municipal Presidency and SEMARNAT over a three-year period in a variety of ejidos in Carichí. A similar project also began in the town of Bacabureachi, closer to the Municipal Capital. Between Maguillachi, El Consuelo and Bacabureachi, farmers working with CONTEC made changes to 65 agricultural fields covering approximately 50 hectares with the intention of maintaining soils, decreasing erosion, helping to restore riparian areas and keeping soils humid (Table 4.7) In Consuelo, approximately 15 farmers implemented soil conservation projects on at least one of their fields between 2003 and 2005, and a handful in the neighboring ejido of Molinares have done the same (Sinaloa, personal communication with author, 2005). Experiments to measure the amount of soil retained in 2003 revealed that over 180 tons of soils were being "retained" in agricultural fields that might otherwise have washed into local streams.

Table 4.7. Soil Conservation Projects enacted by farmers in three communities in Carichí in coordination with CONTEC, 2003

Ejido	No. of Ejidatarios	No. of Parcels in Soil Projects	No. of Hectares	Meters of Work (walls, ditches)	Tons of Retained Soil
Consuelo	29	24	21	5388	92.1
Maguillachi	74	20	9	1685	28.8
Bacabureachi	94	21	12	3664	62.6
Total	**197**	**65**	**42**	**10737**	**183.5**

Source: CONTEC, information provided to author, 2005.

Still, while generally positive about the "soil erosion" projects, local leaders say the lack of support since 2003 has kept the projects from being extended ejido-wide. In addition, because of low rains in recent years, the advertised positive benefits have not all materialized – there is no rain to catch and therefore no soil run-off to maintain or of more concern, no crops even being grown in some areas. Finally, the projects have not been universally successful, depending upon the type of soils, slope of the land, and care with which they have been implemented (Reed, Water and Land Use Survey, Carichí, 2005).

“There hasn’t been such a positive result because it hasn’t rained,” explained Sinaloa. “We had planned on evaluating their success again this year, but because the rains were late, very few people have actually planted their fields this year, and there is nothing to evaluate.”

Photo 4.17. Field in El Consuelo owned by Ejido Comisariado Sinaloa which participated in soil conservation projects.

Another major effort encapsulating several of CONTEC’s programs is reforestation efforts. Frustrated by the experience of reforesting part of the El Consuelo ejido that had been affected by fires using trees that did not acclimate well to the particular area, Guerrero and the local ejidos begged, borrowed and worked to create their own nursery. Today, the nursery sits behind the community store in Maguillachi and it is hoped that it will provide the seedling to reforest vast areas of Carichí denuded by fire, deforestation and drought (Photo 4.18).

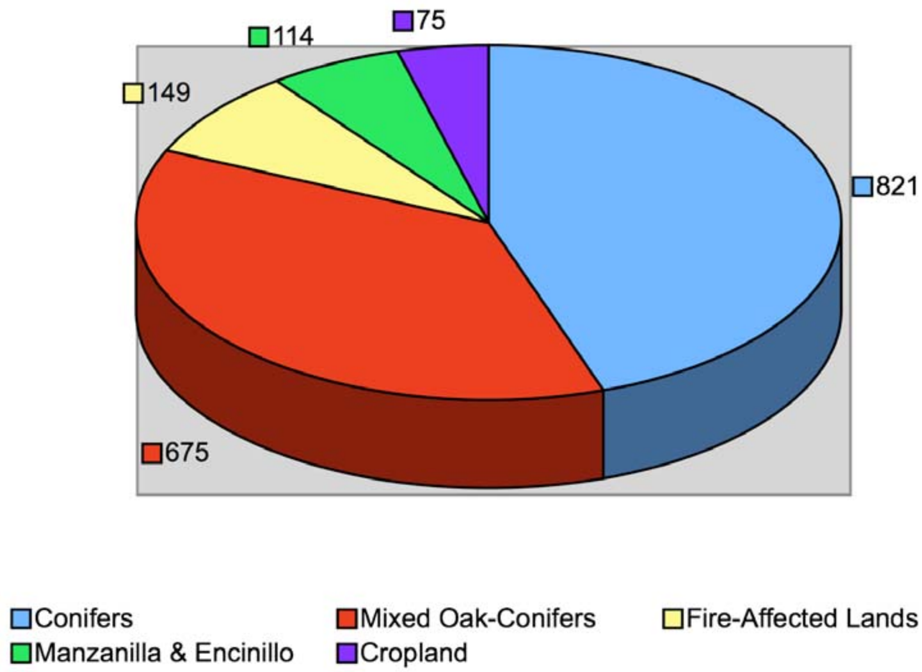
Photo 4.18. The new nursery in Maguillachi, supported by community and local NGO, CONTEC.

One of the major efforts of CONTEC is to use the “watershed” as an organizing principle, as a way to get the community to think about its resources.

“Our unit of work is really the boundaries of the ejido, not the watershed itself, but the watershed – which is a technical term – helps bridge the connection between the political boundaries and the natural boundaries, " Guerrero said. Through a series of winter workshops, some 15 ejido and non-ejido members of the communities of Consuelo and Arroyo del Agua participated in the winter workshop and began to study the hydrology of their lands as a precursor to full-scale Ecological Planning. They traversed fields, studied soils and vegetations, found the origins of springs and streams and generally mapped their ejido in a participatory manner.

They also spoke about the problems facing their communities – the drought, erosion of soils, the impacts of some kinds of fertilizers, the loss of the forest, the dependence on monoculture of corn, the loss of native seeds, fires, and the lack of access to agricultural land, among other challenges cited (CONTEC 2004). Another more specific problem mentioned was the "invasion" by a species of shrub which often appears following logging or forest fire: Manzanilla. Scientifically known as *Arctostaphylos Pungens* (Manzanilla or Mexican Manzanita), the smooth red-barked shrub with dusty green leaves grows well in dry climates, tolerates alkaline soils and crowds out and often prevents reforestation of pines and oaks (Photo 4.19). According to the community diagnostic, CONTEC found that manzanilla and other "secondary" succession plants dominated about 20 percent of the landscape, with conifer forests, mixed woods, fire denuded landscape and cropland making up the rest (Figure 4.3).

Figure 4.3. Land use type in El Consuelo Ejido



Source: CONTEC 2004.

In an agricultural survey conducted in 2003, CONTEC found that farmers were using approximately half their farmland to grow corn, only eight percent to grow beans, five percent for oats and the rest of the land – 36 percent -- was resting in fallow (CONTEC 2004).

It was against this backdrop that the community began both the soil conservation programs and the reforestation of 20 hectares of a hillside, which had been burned to a crisp in 2000. Using both pinus engelman y arizonica, the ejido received trees from a nursery in Ciudad Juarez and planted them with assistance from CONTEC in 2002 and 2003. The reforestation effort, according to Sinaloa, has been "mediocre" as many of the trees have not responded to the particular climate of El Consuelo as well as to continued relatively dry years.

Photo 4.19. Manzanilla dots this fire-affected landscape, Ejido of El Consuelo, 2004

"This side of the mountain does not receive much rain," Sinaloa remarked after traversing up the side of the mountain with the author. On the other side, vegetation of all types – oaks, pines, ferns and flowering plants -- had returned with a vengeance, without the aid of replanting.

The hydrological study conducted by the Ejido with assistance from CONTEC is detailed and reveals a ejido, that while in the Rio Conchos (and Rio Grande/Bravo) watershed, is home to dozens of micro-watersheds. Using both modern techniques – GIS and GPS – and participatory mapping techniques, the experiment allowed the residents to gain an understanding of how their land and rivers are connected to their neighbors, regionally to the City of Delicias and eventually to the U.S.

Photo 4.20. Reforestation project, El Consuelo, on hill above agricultural fields.

“We had heard something about the Conchos watershed, but we didn’t know that we were part of it. Now we know that we are part of the discussion with the United States,” said Fidencio Garcia, the former comisariado of the ejido (2002-2005).

Local residents say the workshops help them understand what they already instinctively knew – that both climate and land vegetation and use played a role in the availability of water for their crops, cattle and homes. It also led to decisions about protecting certain areas within the ejido.

“In 2002, there was no water in the streams,” Fidencio García explained. “We learned to take care of the springs, give them maintenance, protect them, take care of the vegetation of the recharge zone, prevent logging and animals in the areas near the springs.” (Fidencio García, personal communication with author, 2005).

“In the past we would make our trenches and crops as straight as possible with oxen and horses because it was easier and we did not think about how it cut across the natural slope of the land,” García remarked. “Over time, though, we began to see how the currents of water from rain were cutting through the *zurcos*, carrying the soil into the streams.”

4. Surveying the Community: Voices of Consuelo and Molinares

During September and October of 2005, 20 surveys were conducted with residents of El Consuelo and Arroyo del Agua (see Appendix A). The surveys, which were anonymous, were conducted with those residents who had agricultural land – either owned or rented. The survey generally took approximately 30 to 45 minutes to administer. A sheet of informational material in Spanish was also provided to the respondent explaining the purpose of the survey, information about the author, as well as the fact that it would be collected and analyzed anonymously (see Appendix B). The information contained on the paper was summarized verbally by the surveyor and the respondent was asked if it were acceptable to proceed.

Respondents were sought in their homes in both El Consuelo and Arroyo del Agua. It is important to note that all who were approached did express a willingness to participate in the survey, although in some cases it was necessary to return at a more convenient time.

The survey is divided into nine sections: Demographic Information, Land Property, Land Use, Water Use, Drought Severity and Impacts, Conservation Projects, Free Trade Impact and Organizational Support and Opinions (see Appendix A). All surveys were coded and entered into a basic statistical program called SPSS 11.0. In all, there were 10 respondents from El Consuelo, 9 from Molinares and one from Maguillachi. The average amount of hectares that was owned was 5.13 hectares, with totals ranging from a single hectare to 13, but the average number of hectares that were planted in 2005 was slightly less at 4.07, because half of the respondents left some of their land fallow. Thus, while 10 reported planting all of their land that year, the other nine owning land planted between 38 and 75 percent of their land with crops.

Table 4.8. Property and Livestock Owned. Survey, 2005, El Consuelo and Arroyo del Agua

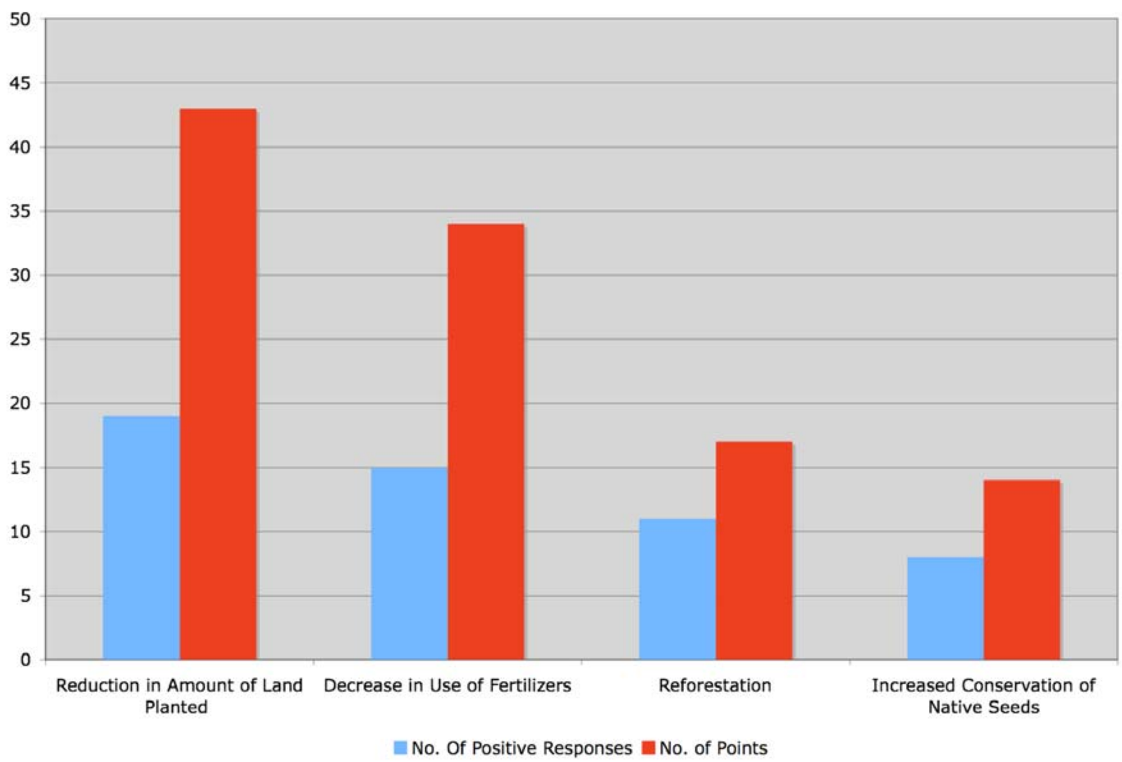
Category	N with Valid Response	Minimum	Maximum	Average	Standard Deviation
Agricultural Lands Owned within Ejido	19	1.00	13.00	5.13	2.88
Agricultural Lands Planted 2005	19	1.00	13.00	4.07	2.92
Number of Large Livestock	16	2.00	20.00	8.06	6.21

Source: Reed, 2005. Survey.

This brief section will highlight some of the major findings, related to agricultural change, the drought, soil conservation projects and organizational support. While the present chapter presents an overall summary of the survey results, more detailed survey results are available from the author upon request.

Respondents were asked a series of questions about changes that had occurred in their lands over the last 10 years and asked to rate to what degree there had been changes in that particular factor (see Figure 4.4). There was also an opportunity for respondents to add other factors that might have changes over the last 10 years that were not part of the standardized answers.

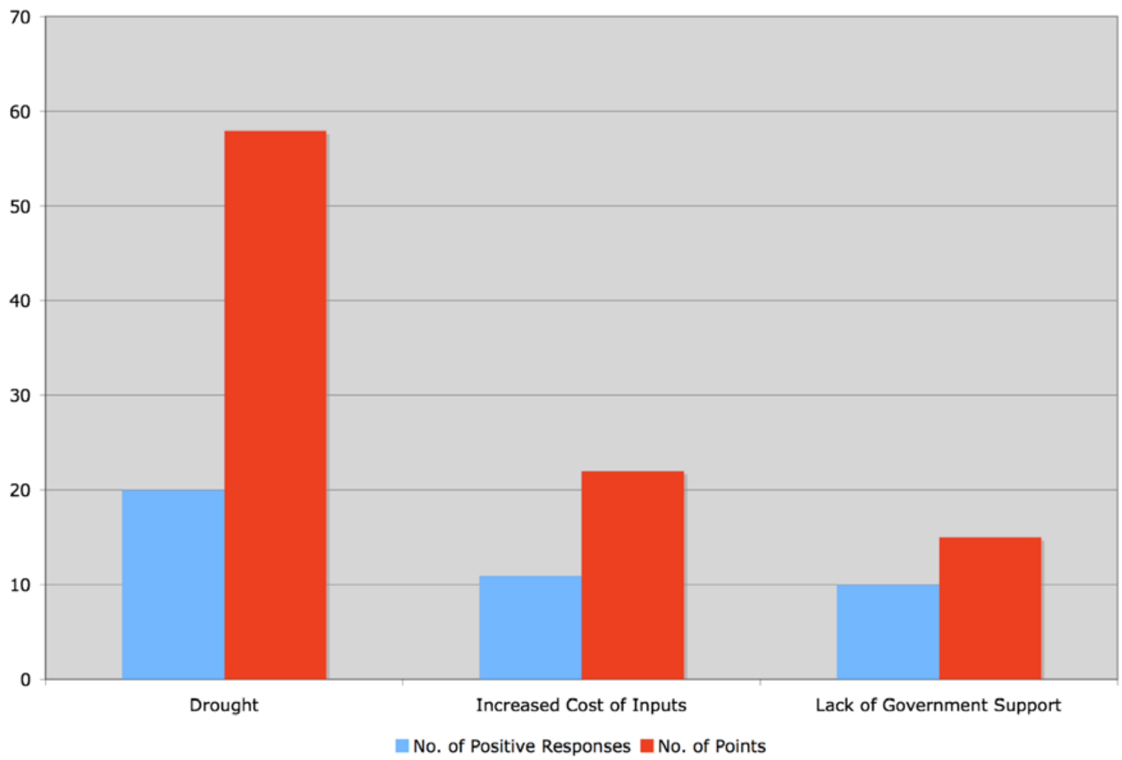
Figure 4.4. Number of Affirmative Respondents and Points for "Changes" identified on their fields over last 15 years (N=20, Maximum Number of Points =60)



Note: Three points were assigned for a "large" change, two points for a medium change and one for a small changed, based on the opinion of the surveyed.
Source: Reed, 2005 Chihuahua Land and Water Survey.

Farmers said they were planting less hectares of crop, using less fertilizer, conserving more native seeds and were involved in reforestation projects. They also mentioned the increased use of organic fertilizers and soil conservation projects outside of the standardized survey results when asked to expand on their answers. There were three main reasons why they were farming less and attempting to conserve more: the drought, the increased cost of fertilizers and the lack of government support (see Figure 4.5). Other factors – including NAFTA, market prices and costs – were barely mentioned for these non-market-based farmers, while physical changes such as tired soils, late rains and invasion by secondary species such as Manzanilla were mentioned when farmers were asked for more detailed information than the structured survey provided.

Figure 4.5. Number of Affirmative Respondents and Points for Major "Factors" identified as contributing to their fields over last 15 years (N=20, Maximum Points =60)

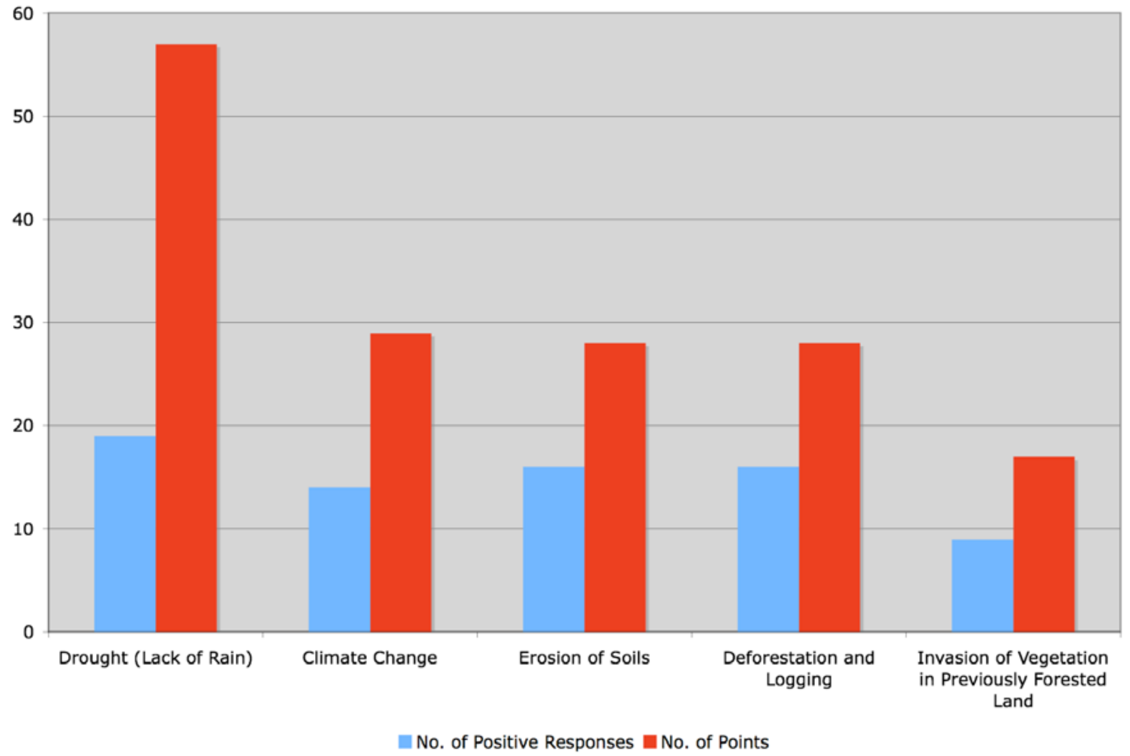


Note: Three points were assigned for a "large" change, two points for a medium change and one for a small changed, based on the opinion of the surveyed.
Source: Reed, 2005 Chihuahua Land and Water Survey.

When asked why there was less humidity in their soils, by far the biggest response was climactic. All farmers recognized the existence of a drought, and 16 of the 20 said it was the worst they had ever experienced. While the majority cited the drought itself as the major factor causing the loss of humidity, others mentioned “climate change” – a change in the timing of rain – soil erosion, deforestation and invasion by secondary species as impacting the humidity of their soils (Figure 4.6). Thus, whether young or old, from Consuelo or Molinares, the farmers surveyed had fairly similar explanations of changes in rains and humidity losses in their soils. The primary cause was climate -- it rained less, the rains were later, it froze less, the earth was hotter – which itself led to secondary causes -- there were more forest fires leading to more erosion, and invasive secondary species were further drying up the earth. Thus, although they may have played a role through poor land management practices in previous decades, the problem was the climate. They also recognized that they would need to reforest, conserve soils and fertilize organically.

As a result of the drought, a number of the farmers surveyed had implemented conservation projects in their soils, although there were differences in opinions about what the best way to conserve soil was. In all, 10 of the 20 farmers surveyed participated in the CONTEC-led soil conservation projects. The farmers were then asked a series of questions about conservation, and whether they felt the projects were imposed by outsiders or were benefiting only some and not all. The main finding was that farmers who actually participated had generally positive feelings about the projects, and those with negative feelings were those that had not participated.

Figure 4.6. Number of Affirmative Respondents and Points for Major Factors Related to Drought and Lack of Humidity in Soils in El Consuelo and Molinares (N=20, Maximum Points =60)

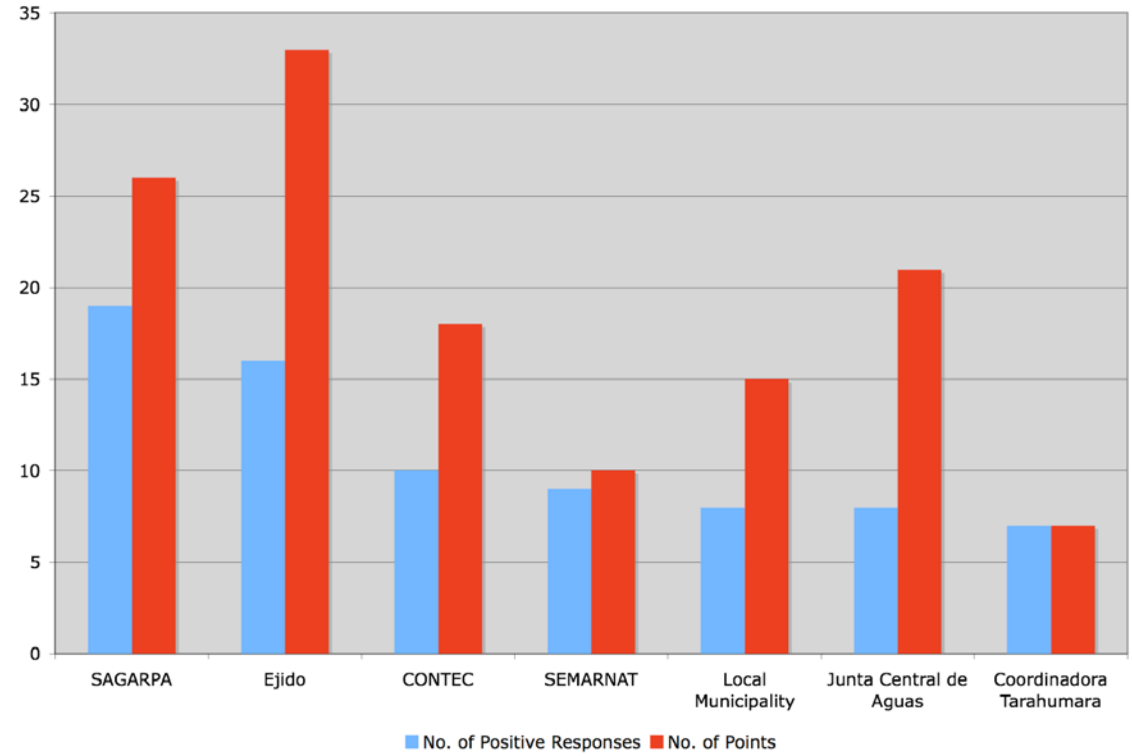


Note: Three points were assigned for a "large" change, two points for a medium change and one for a small changed, based on the opinion of the surveyed.
Source: Reed, 2005 Chihuahua Land and Water Survey.

Farmers were then asked more specifically if they had made any physical changes to their lands or the way they farmed in order to increase humidity to the soils. Here, the answers depended to a significant degree on whether they had been part of the soil conservation projects guided by CONTEC. Those who had generally spoke of the *curvos de nivel*, *zurcos* and *muros de contención*. While it is difficult to characterize the answers about how they farmed some common themes emerged. For one, they were often tilling their soils later to try and take advantage of later rains, and sometimes tilling twice – including after a frost – to try and increase humidity in their soils. In terms of soil conservation, most had added a trench at the beginning of their field to prevent rains from washing them away, as well as a wall at the end, but those involved with the CONTEC-led projects had added ditches and raised mounds throughout their fields and attempted to follow the topographical contours of the land when planting. Several of the older members of the community disagreed with this approach, since they said it took a part of the land out of production to build mounds and trenches.

In fact, CONTEC had one of the highest positive ratings among organizations that farmers stated had helped them, along with the Agricultural Ministry, the ejido, SEMARNAT – which provided the reforestry and soil conservation grants -- the municipal president, the church and the Tarahumara Coordinator (see Figure 4.7). Most of these positive comments were related to direct projects – such as the Procampo payments from SAGARPA – or organizational help, such as that provided by CONTEC and the ejido itself. When a cross-tab calculation was performed to compare the ejidatarios surveyed from Molinares versus those from El Consuelo, it was apparent that El Consuelo respondents were much more likely to be positive about their ejido and the role CONTEC has played, indicating that the participatory techniques and organizational meetings to improve the ejido management had had an impact on residents' opinions. In essence, these respondents felt that their active participation in projects like land use planning produced positive feelings about their ejido – and CONTEC.

Figure 4.7 Who Helped Them? Affirmative responses (N=20) to organizational help and total number of points (N=60) in Molinares and El Consuelo



Note: Three points were assigned for a "large" help, two points for a medium help and one for a small help, based on the opinion of the surveyed.
Source: Reed, 2005 Chihuahua Land and Water Survey.

5. Conclusions: Molinares and El Consuelo

The communities of El Consuelo and Arroyo del Agua have been faced with climactic and land use policy changes over the last 10 years. Since the mid-1990s in particular, the new Ejido of El Consuelo worked with Chihuahuan-based organizations to legalize their status as an ejido and begin a land use planning experiment, which included significant investments in soil and land conservation. This relationship appeared to engender good feelings among participants that they were actively improving their futures, but climactic change and challenges – including forest fires, deforestation, invasion of succession plants and the continued drought – put a damper on these initial successes. Farmers in both communities clearly believed that climactic changes –including changes in the timing of rain -- had been the major factors affecting their yields, though the lack of government support, soil erosion and deforestation were also important factors. Many farmers did turn to soil erosion control projects, reforestation, the increased use of native seeds, a decrease in commercial fertilizers which "burned" their land and an increase in organic fertilizers. There also appeared to be a much more positive feeling for soil conservation projects, their own ejido and CONTEC from members of the El Consuelo ejido more actively participating in these projects than in the neighboring ejido of Molinares.

E. Hot Springs and Valleys: Bacabureachi

1. Introduction to the Hot Waters

The scene is a familiar one throughout the Sierra on a sunny day in October. Some 12 tarahumara farmers – both men and women, some old, some young – are engaged in the yearly ritual of the "cosecha," the picking of the corn husks off the stalks at the end of the agricultural season. With bags around their shoulders and necks, and wearing the familiar rustic sandals, they travel down rows of corn, snapping off cornhusks, husking and inspecting their ware, and in most cases throwing the corn into the bag. In some cases, they pick off bad parts, or remove caterpillars. Both blue and white corn are in abundance. A few dogs run among the legs of the farmers, barking happily.

One of the men carry a bottle with some milky-yellow mixture inside, a traditional alcoholic drink made from – of course – corn kernels and unrefined sugar called ***tesgüino*** or Batari. They pass it among themselves all morning and into the afternoon. The smell is pungent, the effect immediate, but none refuse it. It is hard work, hands are numb, and backs are tired. They talk among themselves as they pick. In this case, the land belongs to a farmer who lives above the field who has broken his leg. The community – most are relatives – are lending an extra hand. There is a reason for their speed. With the corn ready for picking, every day that passes might provide the chance that free-roaming cattle jump over or barrel through the makeshift fence and eat the year's crop in a matter of hours. After they are done picking, cattle will be allowed to roam here, eating the discarded husks and stalks and leaving behind fertilizer for next year's crop.

Apples are ready for harvest and Juan Rascón and family meet at his ¼ hectare apple orchard, locating just 100 meters from his home at the banks of the river. Recent years of low rainfalls have been unkind to apples, Rascón explains (Juan Rascón, personal communication with author, 2005). It is the only product he sells on the market, but because he does not have access to the market directly, he most rely upon a local merchant from Carichí to bring him the ladders and crates and carry the apples off to a truck in Carichí, from which they will be shipped. The local middleman says this year he is paying 15 pesos per crate and selling them for 25 pesos. While 15 pesos per crate might seem like robbery, Rascón says it is better than nothing, given the low yields in corn and beans.

Photo 4.21. Tarahumara indigenous in the "transitional" community of Bacabureachi pick corn in October, 2005.

Another farmer makes his way slowly up the rocky hill to the Mesa of the Duraznito – the Little Peach Mesa – where his agricultural fields lie. On the way, he asks whether I can help him find his "colorados" – his cattle which often traverse up the mountain in search of greener vegetation. His eyesight is not what it once was. They are there, sitting beneath an oak tree, about halfway up the mountainside. We circle behind them and scare them down, until they find the path going back toward the valley below. He will gather them that evening he says.

Along the way we pass the farmer with the broken leg whose corn field was being harvested, who is making his way using a cane up the mountain to "inspect his beans." Above, his corn and bean fields are doing relatively well, but yields this year are low. One of his fields is cut across diagonally by a ditch – a canal formed from a recent rain which tore out the white corn stalks by their roots. Mesa farming is tough – it is cooler than the valley below and more susceptible to freezes, but it is also more protected from hungry livestock (Photo 4.22).

Bacabureachi lies at the bottom of a valley some 25 kilometers west of the Municipal Capital of Carichí. At about 2050 meters above sea level, it is considerably warmer than the ejidos to the west and is typified by oak, junipers and pine tree savannah. The town is named after the raramuri word for the reeds that once lined the river in the canyons just upstream, although the reeds themselves have largely disappeared (Nacho Rascón, Bacabureachi, personal communication, 2005). The "town" is a cluster of homes which dot the valley and hills around the Bacabureachi river.

It is also home to Carichí's only Ejido-run tourism project, the "Baths of Bacabureachi," stone, mortar and wood cabins that emerge from a hill overlooking the town, canyon and the river just upstream of the residents. They are there because the area is home to a number of hot springs which provide bath water year round before entering the river itself. The Bacabureachi River, also known as Rio Agua Caliente, or "Hot Water River," eventually empties into the Rio Conchos to the south.

Photo 4.22. Corn field on the Mesita del Duraznito, Ejido of Bacabureachi . A ditch of eroded soil cuts through the cornfield.

As such, hundreds of tourists from throughout Mexico arrive here in the spring, summer and fall, providing an extra income to the ejido residents who collect the entrance fee and rent out the cabins. Some 30 years old, the tourist project should be the type of “eco-tourist” project that allows a community to both make a living while holding on to their land. Instead, while the project has provided more options to local residents, management issues, as well as wider unemployment, soil erosion, overgrazing and a conflict between those farmers who would like to “privatize” grazing rights and those who want to keep the land communal have prevented a truly successful project.

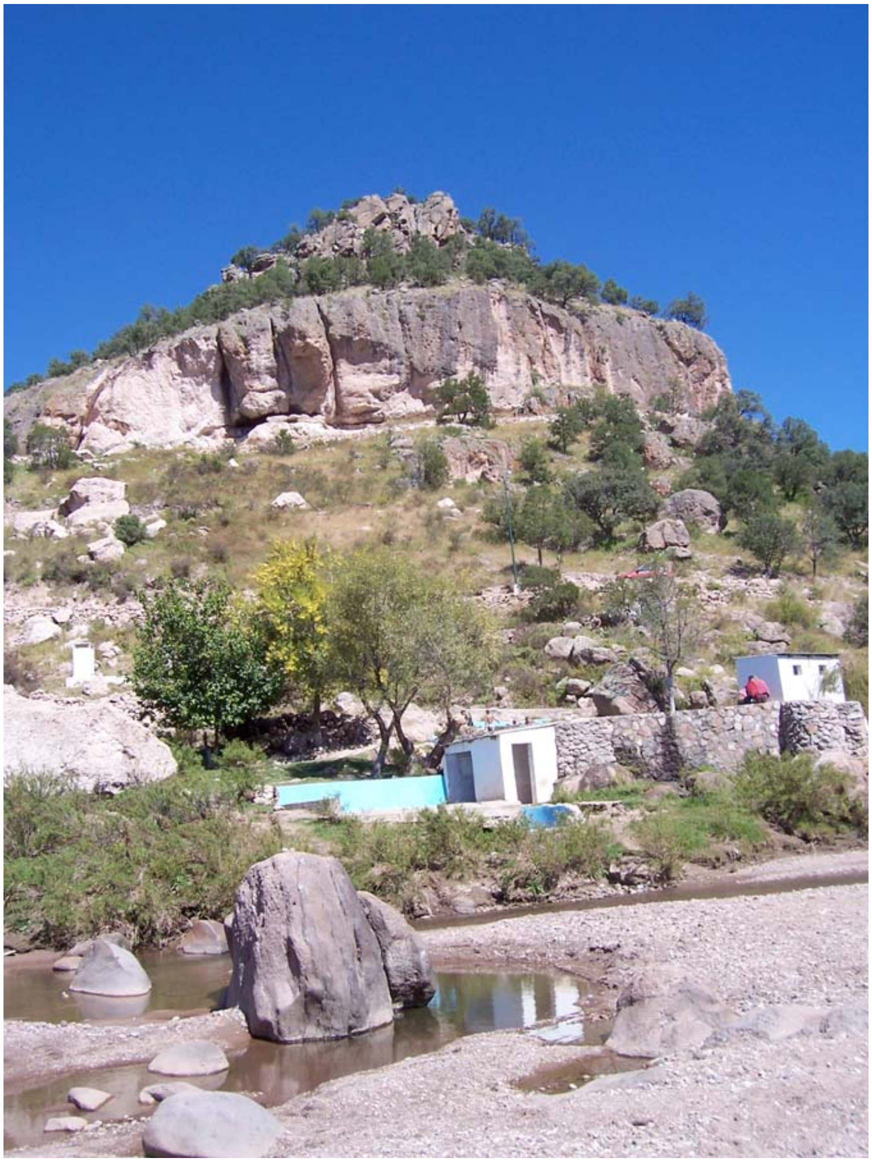


Photo 4.23. Part of an eco-tourism project: the Bacabureachi Hotwater Baths.

2. Bacabureachi: Just the facts

With 64 initial members, Bacabureachi was granted its ejido status in 1921. In 1952 it was expanded to a full 10,758 hectares and included 30 more ejidatarios (INEGI, Carpeta Básica, Bacabureachi). It is bordered by private lands to the East, Panalachic to the West, Churachic to the South and Las Juntas to the North. While the majority of the ejidatarios live in or near the town of Bacabureachi itself, other residents can be found on the top of mesas overlooking the valley of the hot springs, in other communities such as Pachera, Las Juntas and Babuchique, or in the municipal capital of Carichí. Largely tarahumaran, but with several "mestizo" members as well, it is a transitional community, where most younger residents no longer speak the native language, none of the males wear traditional clothes – except for special festivals – and even most women no longer wear traditional skirts and headscarves.

Table 4.9. Some Basic Information about the Ejido Bacabureachi

Category	Number
Granting of Land	1921
Establishment of Ejido	1926
Original Size	4,960
Original Number of Ejido Members	64
Year of Expansion	1952
Present size of Ejido	10,758
Current Ejido Members	94

Source: INEGI, Carpeta Básica, Bacabureachi.

According to residents, the ecotourism project came about almost by accident. It started when the community built a makeshift pool around one of the hot springs and those outside the community –as well as locals – swam in the pools. In

1978, the community built their first two cabins using a grant of cement and materials from INI -- the Instituto Nacional Indiginista, or National Indigenous Institute. Later, in 1990, the community received a loan of $1,200,000 pesos from INI – today called the CDI -- and added another dozen cabins above the original cabins, all complete with solar panels for electricity.

In 2005, the Municipality of Carichí brought electrical lines to the tourist cabins at a cost of $850,000 pesos "since sometimes the solar panels don't work on cloudy days," a move which some of the locals don't believe was really needed (Pedro González Dominguez, Tourism Committee Secretary, Bacabureachi, personal communication with author, 2005). Each year, an assembly of ejido members elects a committee to run the cabins. The Tourism Committee decides who will provide maintenance, clean the rooms, pools, those who stand guard at the entrance gate, etc. They also in essence decide whether or not any "profits" will be distributed to the community or invested into paying back the loan or improving the product.

"Generally those who are in charge don't really want to listen to any opinions about how to make the center better," said González, the current Tourism Committee secretary. "Each group runs it as they see best." González said that when he is part of the leadership, he prefers to put profits back into the project or in paying back the loan, rather than giving out a token amount to the community.

"If I give profits to the community, they will just expect more," he said. "Better to not give the profits, until we are running a clean operation that brings in enough tourists."

Despite bringing in some 10,000 tourists per year, González said the original loan has never been paid off and in fact no one is quite sure how much is owed because of disagreements between the government and community. Despite the problems, González says the center has been the lifeblood of the community as it has prevented more farmers from leaving and provides an outlet for selling kindling, beans, tortillas, sodas and other goods.

Agriculture, on the other hand, has witnessed a downward spiral over the last 10 years, according to residents, a combination of late rains, erosional soils and significant conflicts over grazing practices and rights (Reed, Land and Water Resource Use Survey 2005). At 10,780 hectares, each of the 94 ejidatarios has a grazing right of over 100 hectares, but the how, what and where of those communal rights are not specified. The roots of the grazing crisis, say residents, actually began decades earlier as some wealthier ejidatarios began to bring in more cows than had been seen previously.

“One of our members was the mayor of Carichí,” noted present Ejido Comisariado “Fernando”. “He told us they were going to let “state” cattle graze in our valley and they put in 100s of head of cattle here and they finished off the grasslands in the entire valley.” (‘Fernando’, Comisariado Ejido Bacabureachi, Personal communication with author, 2005).

The ejido does have a “reglamento interno” – internal regulations which state that each ejidatario has the right to graze up to 20 cattle. If an ejidatario has more than 20 cows, he is required to pay an extra fee or rent for each cow to the ejido. Nonetheless, residents say that no one has been keeping close tabs on such activities – or collecting the extra fee. It is common for ejidatarios to “rent” their grazing right to private landowners or other ejidatarios living outside the community without seeking permission.

“There are some that say they have no cattle, but they might have 20, and other who say they have fifty but maybe they have 100,” added González. “It is going to be difficult to change these practices.”

“Nacha” a middle-aged woman and wife of an ejidatario is one of the more vocal members of the community. She said the grazing rights issue has always caused conflicts in the community.

“Some are from outside the ejidatario and they look for an ejidatario without cattle to take care of their cattle,” she said. “People used to pay the grazing right if they had more cattle, but the money just stayed in the pockets of whoever was the Comisariado and we never saw any benefit.” (“Nacha,” Ejido Bacabureachi, Personal communication with author, 2005).

In addition, several of the wealthier ejiditarios have slowly begun fencing off areas to graze their cattle. On the dirt and gravel road which descends from Carichí to the Bacabureachi valley, one passes several open oat fields, followed suddenly by a fenced in area that extends for hundreds of meters. The land is “owned” by David Aranda, a mestizo member of the ejido who says his grandmother was a “tarahumara.” Aranda is a well-known local merchant in Carichí, owner of a grocery store, restaurant, private land complete with trout fishing and cabins, and the beer distributor. He served as the Municipality’s mayor in the early 1990s and it was his father who began introducing cattle into Bacabureachi in the 1950s when he was Presidente Municipal. Aranda explains that over the last 10 years his family has bought four or five grazing rights from other ejiditarios and to prevent his cattle from impacting agricultural lands has put up a fence. He estimated the fenced off land as being about 250 hectares, even though he has the rights to raise cattle on some 500 hectares. (David Aranda, Carichí, personal communication with author, 2005).

“The son has fenced off all the land above the ejido and he has said that others can share it by putting their cattle there, but he acts as if it is his, not the ejidos,” noted Fernando.

Far on the other side of Bacabureachi, by walking above the canyons in which the tourist cabins rides, an hour-walk up to a mesa – known as the Mesa del Durazno – the mesa of the peach tree -- one arrives suddenly at a fence (Photo . At about 2,200 meters, the mesa is home to oak, piñon pines and larger pines, as well as pastureland. In the middle of the fenced off area is a wide swath of pastureland, but the land is heavily eroded, with huge gullies. Intermittent stream banks have failed, creating a hole which runs through the land. The mesa was fenced off nearly a decade ago – in clear violation of local ejido rules – but no action has been taken by the ejido itself. If you walk for approximately two kilometers along a stone wall, over a field, through another gate, follow a makeshift road along a stream, you suddenly emerge out of another gate into a small community of homes, one of which is built not in the tarahumara style, but as a modern Mexican home. There is a small check dam and reservoir on the stream, and several Tarahumara adobe structures, long abandoned.

The issue of the “illegal” fenced off areas became even more controversial when Aranda and others led an effort to “privatize” grazing rights through the PROCEDE process. Bacabureachi had already been through PROCEDE, and opted to have both their individual agricultural lands and household lands titled. Then, in 2005, the federal Reforma Agraria – Agrarian Reform – announced that there was interest in the community in also titling communal lands used for grazing.

According to Bacabureachi's Juan Rascón, the "second" indigenous governor from the ejido, "no one understood what "dominio pleno" (outright domain) – was." (Juan Rascón, Indigenous Governor, Bacabureachi, personal communication with author, 2005).

"Nacha" remembers the meeting well. "A group of us began to talk about how dominio pleno would fraction the ejido and it wasn't positive – and the ejido rejected it."

Photo 4.24. Traditional Fence – in violation of ejido rules – on Mesa del Durazno, Ejido of Bacabureachi.

Nacha said the main promoter was David Aranda "who argued he wasn't using all the land he was entitled to because he had bought 4 rights to the common area, he wanted everyone to fence off their own areas, but the problem is some lands are better than others." (Nacha, Ejido Bacababureachi, Personal communication with author, 2005).

Others interviewed on the PROCEDE process said the process had reenergized the community to defend the concept of "common" land. González said in the end he feels PROCEDE has been a negative experience for the ejido, other than having the overall boundaries of the ejido set.

"As soon as they started to measure and title individual lands, the sales started," González noted. "You can't sell your common use rights, at least not without an ejido assembly, but we now learn that all these common rights have been sold off. The Agrarian authorities know about it, but here in the ejido we don't know about it."

"Bacabureachi is your classic class war," noted CONTEC director Maria Teresa Guerrero, who led a series of workshops to help prepare the community for the meetings on PROCEDE. "Those with private lands already wanted to privatize the ejido, but the people were trained and organized and they said no. They said no because this has always been land that belonged to everyone." (Guerrero, 2005).

Another organization working in the community has been the Catholic Church, through the Congregation of the Most Holy Redeemer, which is currently in charge of Carichí's main church. Padre Nacho, a thirty-something missionary priest, says the Redemptorist's main goals are to work with poor people throughout the world, bring them the good news, and improve their lives, while maintaining their cultural rights and dignity. The church has focused mainly on smaller projects like home gardens, preservation of medicinal knowledge and education, though they have also hosted larger meetings on organizational aspects. (Padre Nacho, Carichí, Personal Communication, 2005).

Photo 4.25. Church of the Redemptorist in Carichí is often a center for community trainings for ejidos.

“At is base what PROCEDE is really looking for is putting land on the sales market,” Padre Nacho explained. “What is so serious about Bacabureachi is that if they are given “dominio pleno” – they will be more likely to sell their parcel and common lands. There really is no reason to force people to measure their household lot, parcel, common area, other than to force them to sell it.”

CONTEC began working with some individual farmers on soil conservation programs. Despite some success, Guerrero and local leaders said the problem of cattle grazing onto lands has made widespread application of the projects problematic. Instead, in 2005, CONTEC began – slowly – working toward development of internal rules about grazing and other natural resource use issues and began with a survey of cattle and other livestock. Eventually, as in Consuelo, the idea is to come up with an “Ordenamiento Ecologico” as well as internal regulations that will bring order and understanding to the community.

González, who also serves as President of the Soil Conservation Committee, says while the soil conservation projects have been impacted by a lack of funds, the larger benefit has been more attention to taking care of the land. The land is impacted by a series of “creatures”, from “longostas” –a type of grasshopper -- to red spiders and a variety of caterpillars, making protection of crops difficult (González 2005). González said that the workshops have helped the community gain exposure to alternatives to traditional fertilizers and pesticides, such as a communal pesticide which uses “chile de arból,” onion, garlic and soap to create a liquid pesticide.

Ignacio Rascón, who served as Comisariado from 2001 to 2004, has been one of the most energetic proponents of the soil conservation projects. He pointed out to several areas where the projects had allowed land to recover. Walls of stones at the downslope side of cropland next to the banks of rocky rivers have sprouted “verdelonga” – used by farmers for salads – while land at the edges of agricultural fields – the humidity slowly filtering rather than running off – had sprouted grasses (Photo 4.26).

“Those outside the lands with soil conservation are benefiting from this vegetation since the livestock eats it.’ Rascón explained. Still, in an ejido spanning 10,000 hectares, the “12 or 15” fields with improved soil conservation have made only a "slight" difference. (Ignacio Rascón, Ejido Bacabureachi, personal communication with author, 2005).

Photo 4.26. Verdelonga lines the "Muro de Contención" – retention wall – as part of the soil conservation projects implemented in Bacabureachi.

3. Survey Results

As in El Consuelo, a number of more formal questionnaires were administered to those owning or using land for agriculture in Bacabureachi. With the exception of one farmer living in Carichí, all of the other 17 surveys were conducted in Bacabureachi itself. Care should be taken when interpreting these surveys, since they only represent 18 of the 94 ejidatarios and only those working in one portion of the ejido – those located near the town of Bacabureachi. Still, the survey provides important information about the ejido, their practices and opinions. In addition, the survey shows that while there are similarities with the ejidatarios in El Consuelo and Molinares, there are also substantial differences in the challenges. The following section summarizes the results related to key aspects to the present study. Detailed survey results are available upon request.

a. Land Use and Agricultural Changes

All 18 respondents reported using ejido lands for agricultural use, while one respondent also owned private land outside the ejido. While the average size of the ejido plot of the 18 respondents was 6 hectares, the maximum was 23 hectares and the minimum was one hectare. Some 14 of the ejidatarios reported owning livestock which they grazed on the communal land, from a low of two to a high of 200, and seven of those reported actually fencing off an area for livestock, from a low of one to 200 hectares (see Table 4.10).

Table 4.10. Some Basic Demographic and Land Use Data from Surveys

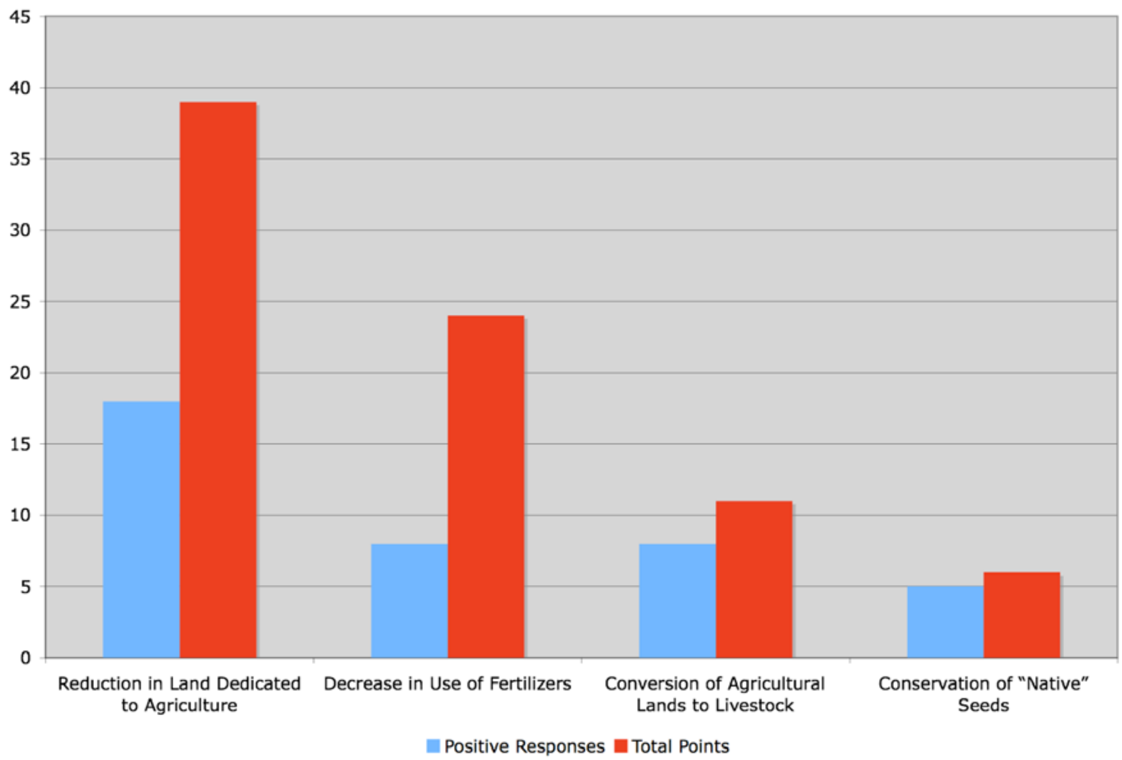
Category	**N**	**Sum**	**Minimum**	**Maximum**	**Mean**	**One Standard Deviation**
Estimated Age	18		34	86	58.33	13.73
Ejido Hectares Owned	18	108.5	1	23	6.03	5.93
Ejido Hectares Planted	18	51.25	0	14	2.85	3.12
Ejido Communal Land Used	7	315.5	1	200	45.07	77.70
Number of Livestock Reported	14	328	2	200	23.42	51.63

Source: Reed 2005, Survey.

An average of half the agricultural lands owned by ejidatarios was planted in 2005. By far the most widely grown crop among the respondents was corn, with 16 respondents. Most reported growing a variety of white corn, although blue and yellow varieties were also mentioned. Beans, apples, oats and rye grass were the other crops mentioned, although the rye grass was actually grown on private land outside of the ejido itself. Seven respondents reported “calves” as a crop.

When asked about changes in their land use, the change receiving the most responses was reduction in the amount of land dedicated to agricultural production. The other major changes cited by farmers were reduction in fertilizers, a slight reduction in pesticide use, increased in conservation of native seeds and an increase in the amount of land converted to use by livestock. (See Figure 4.8). Other non-structured comments were related to poor soils, the impact of grazing on agricultural lands and the increase in organic fertilizers.

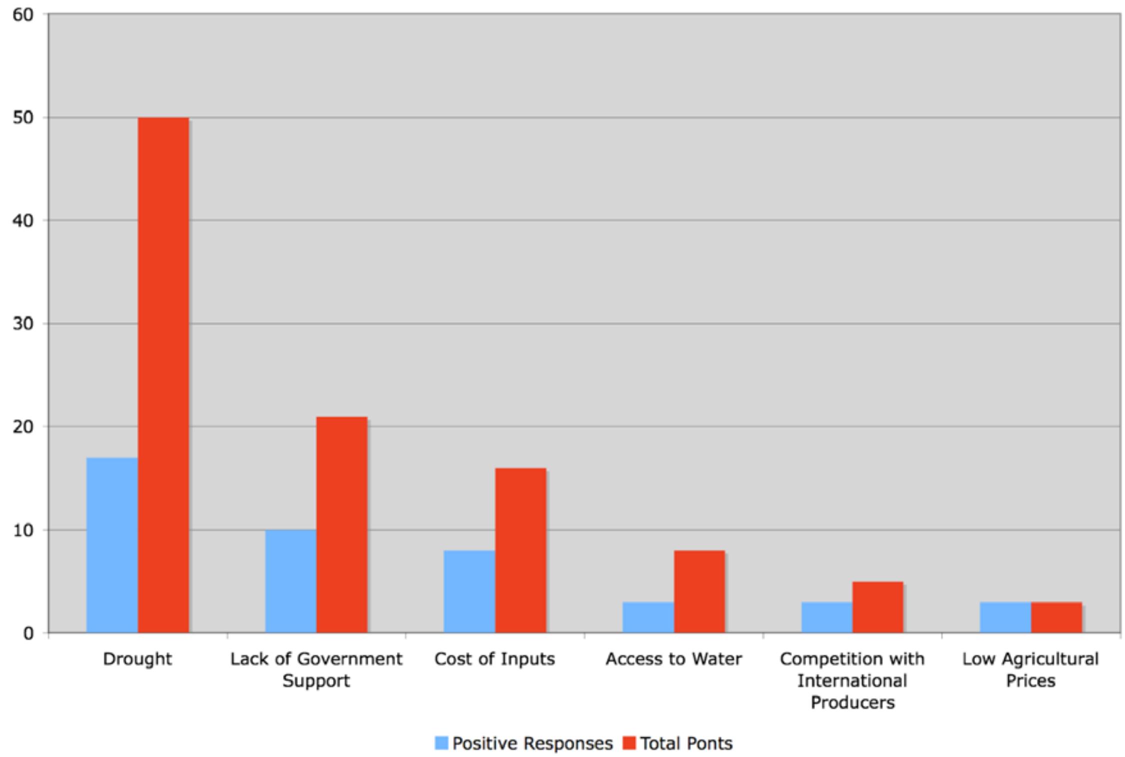
Figure 4.8. Agricultural Changes in Bacabureachi by Number of Responses (N=18) and Total Points (Maximum=54)



Note: Three points were assigned for a "large" change, two points for a medium change and one for a small changed, based on the opinion of the surveyed.
Source: Reed 2005.

What caused these changes? The drought, the increased cost of agricultural inputs – notably fertilizers – and the lack of government support. Only one respondent mentioned policy changes – the land reform changes to Article 27 – as impacting their lands, and in this case, because of improper measurements of lands on the mesas (see Figure 4.9).

Figure 4.9. Factors Causing Agricultural Changes in Bacabureachi by Number of Positive Responses (N=18) and Total Points (Maximum=54)



Note: Three points were assigned for a "large" factor, two points for a medium factor and one for a small factor, based on the opinion of the surveyed.
Source: Reed 2005.

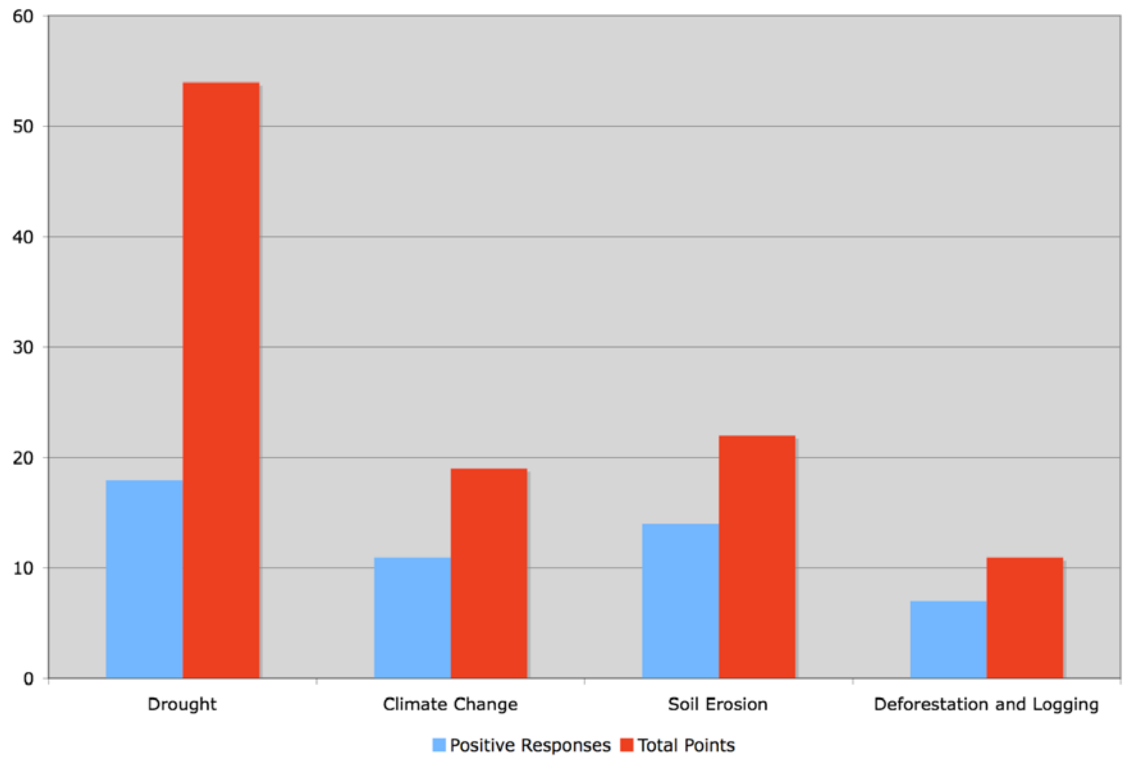
b. Drought, Causes and Consequences

Some 13 of the 18 farmers felt the drought had been the worst they had ever experienced, caused – quite obviously – by a lack of rain, but also by erosion of soils, deforestation and logging and climate change. Given an opportunity to mention other factors responsible for the lack of water in their community, nearly all of them related to changes in the climate and overgrazing.

As a consequence of the drought and soil erosion, farmers in Bacabureachi initiated a number of changes. Seven in all said they were now plowing in winter time to try and get humidity and dead vegetation into the soils, while three others mentioned plowing the land right after the fall harvest. Other respondents mentioned the “trincheras” – the built stone, wood and earthen mounds spaced particularly uphill and downhill of croplands to help water filter into the agricultural fields but not run off the fields. Seven respondents who had implemented soil conservation projects had added infiltration ditches, *curvas de nivel* and mounds of rocks to their lands, either on their own or with the assistance of CONTEC. Of the seven participants, three rated the projects as “regular,” three as “good” and one as “bad.” Another mentioned the rotating of lands and leaving more land fallow. Another respondent mentioned adding organic fertilizers – pine needles – while another mentioned fencing off their land to prevent the invasion of cattle. The responses indicate that farmers did not sit idly by while changing climactic conditions impacted their lands, but were active participants in shaping their local environment as a response.

The soil conservation projects were viewed on the whole positively. Responses indicated that participants and non-participants – with one exception – felt that soil conservation projects were a good idea and did raise crop productivity. The participants did not feel the soil conservation projects were imposed upon them, but indeed they had implemented them voluntarily, while two of the non-participants believed they had been imposed upon the community. A final statement – that the soil conservation projects benefited some more than others – received agreement from both the participants and non-participants, though non-participants had more positive responses. Thus, there was some feeling that some farmers had benefited more than others.

Figure 4.10. Causes of the Low Humidity and Lack of Water for Crops in Bacabureachi by Positive Responses (N=18) and Total Points (Max=54)



Note: Three points were assigned for a "large" factor, two points for a "medium" factor and one for a "small" factor, based on the opinion of the surveyed.
Source: Reed 2005.

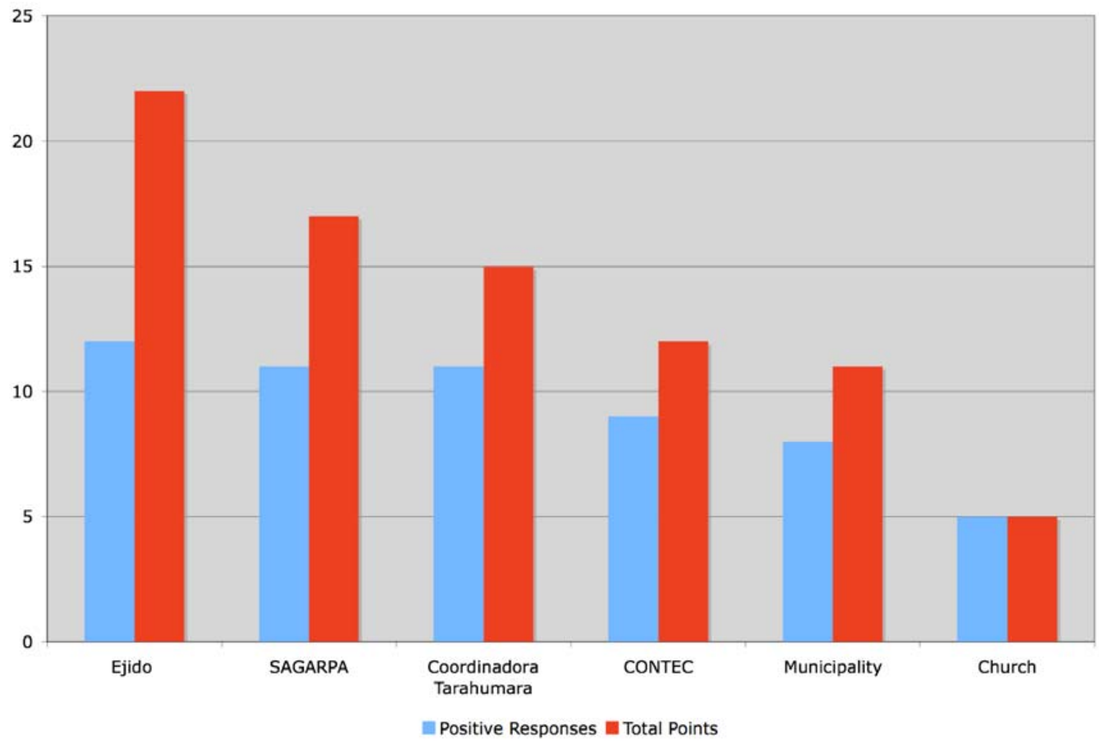
c. Organizational Help

The final section of the Survey asked about opinions and help from government, private and non-governmental organizations. The organizations which were cited the most included the Ejido itself (Bacabureachi) – mainly for the ecotourism project -- SAGARPA – the federal agriculture ministry – CONTEC, the Tarahumaran Coordinator -- SEMARNAT – the federal environmental ministry – and the Municipality, including both the Presidency and Rural Development, and the Church. None of the respondents mentioned any aid from banks, credit unions or private companies, although one respondent noted that he had credit from BanRural – a government run bank – before the fall of the peso in 1994 eliminated credit for farmers.

There were only two negative comments related to the ejido. One farmer said there was no benefit to remaining an ejido because it was too disorganized and just stole rights. “I don’t see any benefit to the communal lands,” noted the main detractor. “There is no organization, no one makes improvements to feed their cattle well, and because it is communal you can’t make improvements yourself.”

The vast majority of the comments about the ejido made the opposite argument: the communal and agricultural lands gave livelihood and that the organization of the ejido provided a buffer against those who would seize their land.

Figure 4.11. Organizational Help in Bacabureachi to Farmers by Positive Responses (N=18) and Total Points (Max=54)



Note: Three points were assigned for a “large” help, two points for a “medium” help and one for a “small” help, based on the opinion of the surveyed.
Source: Reed 2005.

4. Conclusions: Bacabureachi

Surveys and visits to the hot valleys and oak and juniper mesas of Bacabureachi revealed a unique community with important communal resources, including significant grazing lands, alluvial valleys filled with tiny apple orchards, and an eco-tourism project run by the community. It also revealed significant community tension caused by the lack of formal rules and enforcement of rules on cattle grazing and use of communal lands as well as by low rainfall and agricultural yields in recent years. With the aid of the NGO organization CONTEC the community has been discussing and working toward the development of more formal rules and land use planning to deal with these challenges. An attempt by some community members to privatize the communal lands in the interest of better management had led to the community embracing its communal traditions.

Survey results showed that all respondents believed a significant drought – changing the amount and timing of rain – had impacted the community over the previous decade, and that deforestation and invasions of cattle had impacted humidity in the soils. Some farmers had turned their farming land over to the cattle themselves. Opinions were favorable toward the soil conservation projects being implemented with CONTEC, although significant challenges – the lack of tired soils and free-ranging cattle – remained toward making them truly effective. Farmers had turned away from the use of commercial fertilizers in recent years because of the cost and effect on hot soils and begun to use organic fertilizers. High costs, the lack of government support and the lack of rain were all major challenges for farmers.

Most farmers relied on government support payments – PROCAMPO – from SAGARPA, as well as some soil conservation work from SEMARNAT, but cited their biggest helper as being the ejido itself, through which, for example, they had access to communal lands and ran the eco-tourism project. The surveys thus revealed that – guided in part by CONTEC workshops – the community had largely embraced its communal organization even as wealthier members sought privatization and the challenge of invading cattle remained unresolved.

VI. Summary of Major Findings

During 2003, 2004 and 2005, interviews, visits and surveys were conducted in several primarily agricultural communities in the Municipalities of Bocoyna and Carichí. In addition, interviews were held with government institutions and non-governmental organizations working in the area.

This research revealed a land being contested between different interests and visions of the future of the Sierra Tarahumara. Yet many of the opinions and discourse was the same: deforestation, overgrazing and climate change had resulted in low, untimely rains, loss of crop productivity and denuded landscapes. Differences emerged, however, in solutions of these problems.

In Bocoyna, a number of communities began in 2004 to work with organizations contracted by WWF – the World Willdlife Fund – which had only begun to work in Chihuahua in the late 1990s. As part of an overall project focused on the Chihuahuan Desert Ecoregion and the Conchos Watershed, WWF has a vision of changing natural resource use practices in these communities in the upper Rio Conchos to help increase water resources in the area. This work was being funded by large foundations and corporations including HSBC, the U.S. Agency for International Development and the Ricoh Corporation. Nonetheless, the short-term contracts, limited community participation and instability of the funding concerned both residents and NGOs contracted to do the work.

At the same time, controversy emerged among NGOs and the communities about various government programs – including environmental service payments and a proposed 830,000 hectare Biosphere Reserve. These discussions created confusion among communities about the true goals of the WWF's involvement in the area and other projects. There was some "demonizing" of the interests involved and a mistaken belief that WWF was actually behind the biosphere reserve proposed. The group actually promoting the Biosphere – the Sierra Madre Alliance – believed that those opposed were purposefully mischaracterizing the biosphere for their own purposes. Even as these larger scale projects were being discussed, smaller scale projects were implemented with government support to help improve soil conservation, reforest areas or "filter" water, with mixed success.

In Carichíc, on the other hand, CONTEC, the main non-governmental organization working in agricultural communities there, began working in the area in the late 1990s with a focus on organizational support of the indigenous ejidos. In the new ejido of Consuelo, CONTEC worked both for the ejido's official legal recognition, while also beginning basic workshops on ejido rules, organizations and an "Ordenamiento Ecologico," or land use plan. The longer-term commitment in the community by CONTEC appears to have created a better working relationship. Still, many of the projects implemented – such as the soil conservation projects – have had only modest successes in part due to continued drought-like conditions as well as limited resources.

Farmers surveyed who participated in the projects viewed them as beneficial and felt that they were participating alongside the NGO in their development – rather than having a vision imposed upon them -- although some felt that the projects did not work properly. The community as a whole – which includes ejidatarios from Molinares and El Consuelo – is facing many challenges, most notable of which has been the lack of rain and resulting forest fires which have impacted their lands. Farmers surveyed indicated that they have met these challenges by in some sense returning to more “traditional” ways – such as using organic fertilizers, increasing their use of native seeds and implementing soil conservation by following the contours of the land – with the help of CONTEC.

In Bacabureachí, a community with a unique eco-tourism project, on the other hand, farmers have not only been faced with the problem of drought and “late rains,” but a dispute over what to do about grazing rights and practices on communal lands. While a traditional narrative might suggest that farmers were to blame for overgrazing the free “communal” lands, the reality is a much more complex story of sold communal lands, a lack of organization and enforcement of internal rules and a new climate regime which has reduced pasturelands. For example, through the years, a handful of ejidatarios have taken their communal rights and privatized them by fencing in large sections of land – which has been met largely by indifference. Then, as part of the reforms of Article 27 of the Mexican Constitution, some of these same ejidatarios proposed actually privatizing all land in the ejido by seeking “dominio pleno” – or plain dominion – to be able to buy and sell grazing land and fence it off. This effort was rejected by the community.

Thus, efforts to both “internationalize” the Sierra Tarahumara – through a biosphere reserve – or “privatize” lands through the Article 17 PROCEDE process have been proposed as ways to improve land management and thus help assure a better climate and Conchos river by some interest groups, but others – including the communities themselves – have rejected these approaches as counter to their interests.

As an alternative, CONTEC has been working with these communities to improve their internal regulations and regulations and promote alternative livelihoods.

The research shows how a crisis narrative – the drought in Chihuahua and loss of the river – led to increased attention on the upper watershed and land management practices, and a number of high profile efforts to improve them, but also how local communities have adapted their practices to this discussion through organization, conservation of native seeds and protection of soils. Thus, local communities are active participants in their development and impose their own practices and narratives.

Chapter Five: The Delicious Valley

Los fundadores de Delicias, como sus antepasados españoles, la ubicaron en el lugar preciso, no lejos del supremo milagro del agua. Delicias, obra del agua y trabajo, es hoy todo un ejemplo. (The founders of Delicias, like their spanish ancestors located it in the precise location, not far from the supreme miracle of water. Delicias, result of water and work, is today a complete example.)

--Jose Fuentes Mares, Prologue, Delicias: 50 Años (Delicias: Club Rotario, 1983).

"Before 1995, water was used politically, as demagoguery to secure votes in return for water and land."

-- Martin Echaanic Chavez, medium-sized pecan farmer near Saucillo, Delicias Irrigation District

"Las gallinas de arriba surren a las gallinas de abajo,…"
(The chickens above dirty the chickens below")

--Marciel Marquez, former Water User Association President, Module IV, Delicias Irrigation District, July 2003.

I. Overview

A. Introduction

Delicias – i.e. "delicious" – was founded on both the wonders of work and water. The water was courtesy of the Rio Conchos – which winds down the mountains of the Sierra Tarahumara toward the Valle de Zaragoza in Central-South Chihuahua and deposits its water in the immense La Boquilla Dam. Later, it is joined by the Rio San Pedro, which takes a more northerly course before depositing millions of cubic meters into the Francisco Madero Dam near Rosales and then meeting up with the Conchos near Julimes. With official boundaries of nearly 85,000 hectares, it is the second largest irrigation district in Mexico as well as the second district formed. Delicias, or Irrigation District 005, began operations in 1932, and was officially recognized in 1941 (Comision Nacional de Agua 2004A.)

The early years were built on wine and cotton, which through the 1950s was the area's bumper crop, and led to large-scale agricultural intensification in the area (Gándara Samaniego 2004: 79). When the second dam – known as both Francisco Madera and Las Virgenes – was completed in 1949, the total amount of land irrigated hovered between 40,000 and 60,000 – well below the 250,000 hectares of irrigated lands envisioned by Delicias founders of Carlos Guillermo Blake and General Ignacio Enriquéz– but still one of the country's major irrigation districts (Gándara Samaniego 2004: 25).

After drought, reduced worldwide prices, taxes and a cotton blight led to large-scale lay-offs in agricultural workers, profits and irrigated hectares in the cotton industry in the late 1950s and early 1960s, the district turned largely to wheat and corn, and the beginning of investment in pecans, and by the 1970s, to other crops such as alfalfa, sorghum and peanuts (Gándara Samaniego 2004: 79). The 1970s and 80s were an expansive time for the district, as high wheat prices, access to federal government credit and locally-supported credit unions, and the expansion of the district into new lands to the west – toward Chihuahua City – brought the total amount of land irrigated to more than 80,000 hectares (CONAGUA, Distrito de Riego 005, Information Provided to Author, August 30, 2005). While new, non-native pecan orchards began to show up along the Rio Conchos banks in the 1950s – led by local grower Mario Lopez Velarde – it was in the late 1970s that U.S. buyers began to convince growers from the Camargo, Saucillo and Delicias area to begin the southern expansion of pecans at larger scales. (Martin Echaanic Chavez, Pecan Grower, Saucillo, personal communication with author, September 2005).

By the high-rainfall 1992-1993 agricultural year, CONAGUA reports that some 82,956 hectares of land were irrigated by dam water within the confines of the district and many farmers were growing up to three crops in a year, with spring corn, summer/fall sorghum and then winter wheat being a common practice among farmers who had the land and resources. (CONAGUA, Distrito de Riego 005, Information provided to author, August 30, 2005)

Over approximately 15 years, fundamental changes in irrigation district management, land tenure, market forces and tariffs, water availability and access to monies for conservation has occurred. What has emerged has been a renewed emphasis on water conservation among farmers, a devolution of power from the state – i.e. the federal government and CONAGUA – to local user associations, and a gradual “shrinking” of the district – both through a specific program to buy back water rights from farmers as well as market and other forces which have promoted the sale of land and water rights, often from poorer to richer farmers. At the same time, the opening up of permits for groundwater drilling and other “alternative” sources actually has led to a fundamental shift away from “dam” water, leading to a more complex water management structure with user associations and ejidos taking a more prominent role over water management. These changes, in fact, support the notion that the Delicias Irrigation District – rather than a geographic space negotiated with the state – has become a “glocalized” community mediated between local farmers, their user association and market forces, influenced by world market prices, as well as investment by U.S. firms – and their representatives -- in the purchase of goods such as pecans and chiles intended for export (Swyngedouw 1997).

This chapter reviews district-level information on land tenure, water management and water use, crop irrigation, water conservation and other issues in the Delicias Irrigation District over the last 15 years, before providing further analysis of two of the 10 “Modules” – specific geographically-bound areas within the district where differing strategies have been made by the association, its users and governmental entities in an effort to “adapt” to the new realities and challenges.

B. Methods

The author traveled to the Delicias Irrigation District on three occasions. In July of 2003, for approximately two weeks, the author visited the central offices of Irrigation District 005 and then toured the district's main dams and physical infrastructures with officials from the Comisión Nacional de Agua, also known as CONAGUA. In addition, the author toured two Modules with the respective presidents of the Users Association – Module IV and V. In July of 2004, the author returned to the Delicias Irrigation District, interviewed the General Manager and Operations Manager of the Irrigation District in Delicias, and toured three Modules with the General Mangers of Modules II, V and XII, as well as conducting interviews with other officials from both the National Water Commission, Agricultural Ministry (SAGARPA), and Rural Development offices.

Finally, in 2005, the author lived in the Community of Ortíz, near Rosales, within the geographic confines of Module VI, during August and September of 2005, renting a house from a family that is usually used by migrant labor (Photo 5.1.). Over a period of six weeks, the author conducted 35 surveys with farmers in Module VI (Rosales) and 37 surveys with farmers in the nearby Module XII (Saucillo) on a variety of topics, including water use, drought, land inputs and organizational help. Farmers were located either in their homes or fields. In conducting the surveys, the author attempted to conduct approximately 10 surveys in each general area of the Module to obtain geographic variability. Thus, the surveys are in essence a cluster sample of farmers within the Module. While the present chapter presents an overall summary of the survey results, more detailed survey results are available from the author upon request. While not a statistical dissertation, the answers were illuminating to the general trends in the district, and helped the author compare and contrast issues between smaller and larger farmers and with the Lower Río Conchos Irrigation District.

In addition, the author conducted individual in-depth interviews with some farmers – particularly those with large land holdings -- as well as with the Presidents and General Managers of Module XII and VI. The author also conducted interviews with the presidents of several local agricultural communities known as ejidos. Moreover, interviews were conducted with government officials of the National Water Commission (CONAGUA or Comision Nacional de Agua) working at the Delicias Irrigation District 005, with officials from both the state Agricultural Ministry, and municipal Rural Development officials in Saucillo and Rosales, and a variety of others. In addition, representatives of three companies that have contracts to modernize canal and irrigation technology within the district, as well as representatives of companies that buy and sell agricultural products were interviewed (see Table 5.1).

Photo 5.1. "My" House in Congregación Ortíz, 2005.

Table 5.1. Surveys and Interviews Conducted for Present Study in Delicias, 2005

Category	Number	Type	Location
Farmers	37	Structured Survey with some open-ended questions	Module 12 (Canal de Saucillo)
Farmers	35	Structured Survey with some open-ended questions	Module 6 (Rosales)
Farmers	8	Open-ended interviews	Saucillo, Rosales, Delicias
Presidents of Ejidos	5	Open-ended interviews	Saucillo, Rosales
Officials from Comision Nacional De Agua	5	Open-ended Interviews	Delicias, Chihuahua
Presidents, former Presidents and General Managers from Irrigation User Associations	9	Semi-structured Interviews	Module 12, Module 6, Module 2 and Module 8
Agricultural Government Officials (JLSV, SAGARPA, Desarollo Rural)	7	Semi-structured interviews	Delicias, Saucillo, Rosales, Meoqui
Irrigation Technology Companies	3	Open-ended interviews	Delicias
Private Agricultural Companies	10	Open-ended interviews	Delicias, Saucillo, Rosales
LICONSA (government milk company)	2	Open-ended interviews	Meoqui and Saucillo
Agricultural Cooperatives	3	Open-ended interviews	Saucillo and Rosales
Bank Officials	2	Open-ended interviews	Rosales
Total	126		Various

II. Pre – 1992: A brief history of Delicias Irrigation District

The genesis of the Delicias Irrigation District lay not in irrigation but in electricity. Between 1910 and 1916 – during the height of the Mexican revolution -- CIA Agricola y Fuerza Electrica del Rio Conchos, a Mexican subsidiary of the Canadian company Bond and Sher constructed a mammoth reservoir for the expressed purpose of generating electricity for Mexico's growing northern populace. How mammoth is La Boquilla, more commonly known as Lago Toronto? With a total capacity of 2,903.4 million cubic meters and a sustainable capacity of 2,744.2 million cubic meters, it continues to be Mexico's second largest dam (CONAGUA 2004A).

When Chihuahua's revolutionary general Ignacio Enriquez stepped into power as the state's first post-revolutionary governor in 1916 – with demands by former agricultural workers for their own land high on his political plate-- visions of a large-scale agricultural revolution danced in his head, and the availability of water from the large dam presented an obvious solution (Gandara Samaniego 2004: 33). After stepping down in 1920, he asked the following governor – Abel Rodríguez-- to request a license for water from the Boquilla Dam (Lago Toronto) as well as the building of another dam on the Rio San Pedro to irrigate some 250,000 hectares of valleys in Central Chihuahua. When the Secretaría de Agricultura initially rejected the request, and after some back and forth with Mexican authorities over the district and negotiations with the electric company, the Chihuahuans hired the White Engineering Company – led by Mexican national Carlos Blake – to redesign the proposed district in 1927, and by 1929, plans were complete for a much smaller district of approximately 140,000 hectares.

In 1930, construction of the first 32 kilometers of the Conchos Canal were finished, and operations began in 1932, with Carlos Blake as the first manager of the Delicias Irrigation District, only the second irrigation district in Mexico. From his offices in the vacant central desert valleys, Blake also began “engineering” the streets and wide avenues of the city of Delicias which is today Chihuahua’s fourth largest, and a civil engineer – not a farmer – is recognized as the father of Delicias (Gandara Samaniego 2004: 36).

By 1936, all 104 kilometers of the Conchos Irrigation Canal had been finished – and approximately 48,000 hectares were in theory open for irrigation along the canal itself. These farmers were organized into a Sociedad Rural Limitada – a user association tied to the use of the canal itself and run by regional farmers – to whom the water concession was granted. By 1941, the final approval from the Mexican government arrived, which not only cemented the existence of the Conchos Canal, but confirmed a second concession to a second user association based upon water from a not-yet constructed second dam (CONAGUA 2004A).

With negotiations being cemented in 1943 between Mexico and the United States over the Colorado River and the tributaries from both sides to the Rio Grande, the Mexican government limited the size of the district from the two dams to approximately 80,000 hectares (CONAGUA 2004A). Mexico in fact had committed itself to a more limited irrigation district than leaders like Enriquez and Blake had originally envisioned when a much larger dam of 1,230 Million Cubic Meters was planned at Villalba, upstream of Francisco Madero. Blake himself was part of the Mexican negotiation team which negotiated the 1944 Water Treaty and was well versed in the needs and ultimate size of Irrigation District 005, now committed to the much smaller dam at Las Virgenes, some 10 kilometers northwest of Rosales itself. Construction began in 1942 and was finished in 1949. (Gandara Samaniego 2004: 23 -34).

When inaugurated, Las Virgenes was intended to provide a sustainable yield of some 425 million cubic meters over 80 years, though by 2003, CONAGUA was estimating its useful capacity at 320 million cubic meters due to sediment build-up (CONAGUA 2004A). In fact, in the late 1990s, CONAGUA authorized the construction of the “rubber dam” addition on the Dam – to increase its capacity by roughly 100 million cubic meters, an effort that was seized upon by some U.S. farmers and politicians as proof of Mexico’s intent to “steal” international waters. In Mexico, on the other hand, it was lauded, and the district was recognized by President Vicente Fox in a 2003 award ceremony because of the construction of the rubber dam. More recently, after considerable rains in 2006, the dam flowed over the rubber dam and there was concern about its safety (Fuentes 2006: A1.)

Table 5.2. Major Storage Dams Making up Delicias Irrigation District

Storage Dam	Construction Period	Water Source	Capacity (Million Cubic Meters)	Sustainable Yield
La Boquilla (Lago Toronto)	1910-1916	Río Conchos	2,903.4	2,744.2
Francisco Madero (De Las Vírgenes)	1942-1949	Río San Pedro	348.0	322.7
TOTAL			3,251.0	3,066.9

Note: The Francisco Madero dam’s capacity was expanded in 2003 with the addition of the “rubber dam” to 454.6 Million Cubic Meters.
Source: CONAGUA 2004A.

Then came 1952. In a year when rains were nearly non-existent in both the upper and middle sections of the watershed, farmers were told they would only be able count on 80 million cubic meters – a fraction of the sustainable yield of Boquilla – for the 1952-1953 irrigation season. Blake, city and district founder, was appointed along with a committee of district experts, to figure out what to do.

The solution was a “toma baja,” a lower perforation of the dam curtain so that water at a lower depth could flow to the catchment dam below and to the Conchos Canal itself (Fuentes Mares 1983).

Cited as a major political victory over the Energy Company – which opposed the new structure on the dam-- the decision among the user associations making up the district was “a long and stormy extraordinary assembly which ended in unanimous consent.” Ultimately these actions would help cement irrigation as king, as Blake requested and received a change in water concessions which put the needs of irrigation above those of electricity (Fuentes Mares 1983).

The 1980s were good to the farmers of the district. In 1982, another major infrastructure effort occurred – the raising and relining of the main Conchos irrigation canal – after years of neglect. It was also a time of physical expansion. Many of the lands which form Module 8 and portions of Module 7 were created through the Bachimba Ejido, established in the late 1970s. (Ramón Hernández Hernández, Ejido Bachimba, personal communication with author, 2005).

A number of local credit unions also emerged to lend money to farmers. One such bank was the Union Progreso de Delicias. Founded in 1976 by some of the largest wheat and cotton producers, the credit union used their huge yields as collateral to secure a $40 million credit from a private bank, which then could be used to lend out to other farmers. Because the credit union did all of the individual paperwork for individual loans, but only had a single line of credit with the private bank, the interest rates were significantly below what the private banks were landing to individual farmers (Enrique Verges, Farmer, personal communication with author, 2005). According to one of its founders, what began as an experiment of 32 farmers grew to more than 300 from all over the district. “Among us, we were producing 200,000 tons of grain,” noted founder Enrique

Verges. “We sold to the mills at a guaranteed price and our water was guaranteed as well in those years – there really was no risk for us or the bank.” (Verges, personal communication with author, 2005).

In fact, some farmers in the 1980s used the high profits to transition to pecan orchards. In addition to these “private” banks and credit unions – which tended to support farmers with private land -- the Mexican government – through Banco Rural – supported ejido farmers through collective projects during the 1970s and 1980s within the district. Of equal importance, many of the major crops were supported by price controls, even as imports were limited through quotas and tariffs (Manuel Guerrero, Distrito 013 Delicias, SAGARPA (agricultural ministry), personal communication with author, 2005).

III. Post-1992 to the Present

Beginning in 1992, the Delicias Irrigation District began to change, both through a major re-organization and then through climate and market forces.

A. Water Management and Use

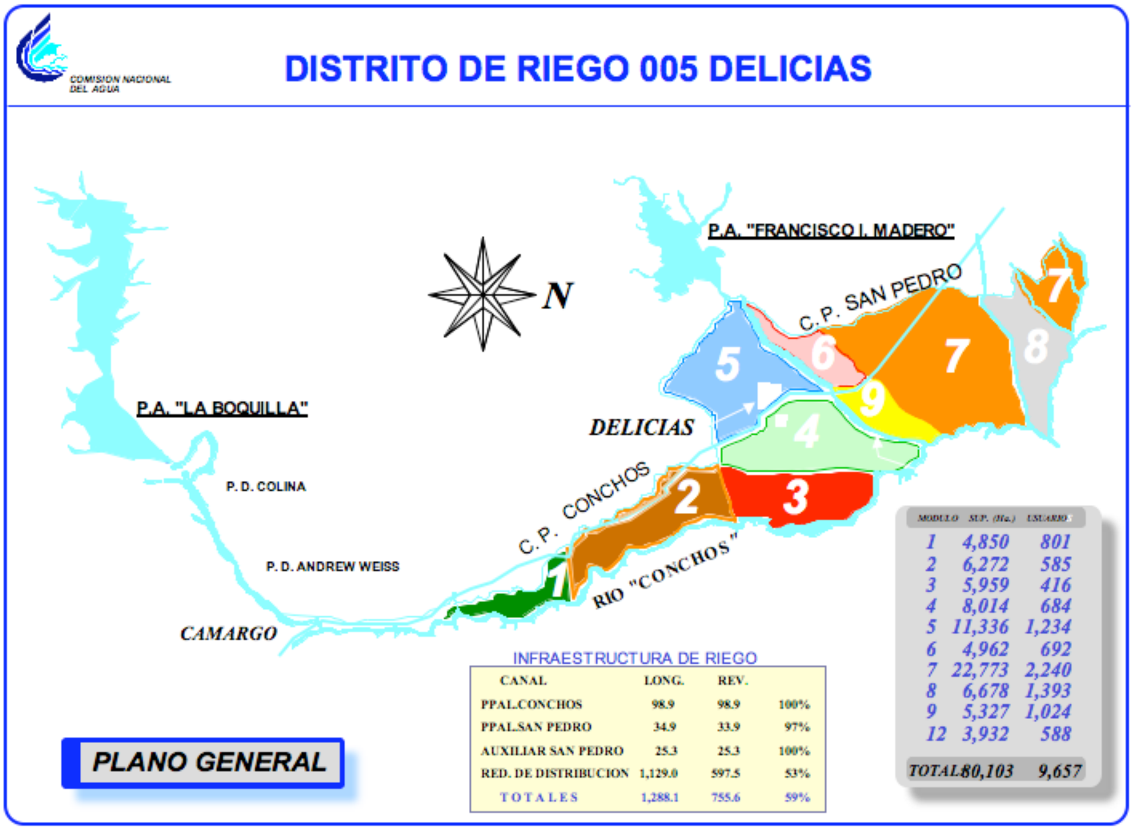
In an experiment in self-governance and privatization pushed by then-President Carlos Salinas and the World Bank, Delicias became the first district to “benefit” from the decision to turn the physical infrastructure of the district itself from the Comision Nacional de Agua over to a series of user associations in 1992.

Based largely upon both water delivery points, geography and ejido boundaries, the two larger user associations of the Rio San Pedro Canal and Rio Conchos Canal which operated the main canals were transformed at that time into nine individual “Modulos” (Modules), each of which was a separate user association with its own elected-president, vice-president, and treasurer among other positions. Each elected board then hired its own staff led by a general manager.

By 1995 each Module had its own separate water concession based on size and historical use (Map . Moderating between the individual modules and the Irrigation District itself, were two Sociedad Rural Limitadas – the old user association transformed into a kind of Supra-Module. They themselves were charged with assuring maintenance, improvement and management of the delivery system infrastructure – the main San Pedro and Conchos canals -- and the actual delivery of water to the individual Modules, even as the dams themselves, including release points – continued to be in the hands of the federal government, through CONAGUA, and its irrigation district offices.

Making up the Rio Conchos SRL were Module 1, 2, 3, 4 and 5 – covering roughly the Municipalities of Saucillo and Delicias while the Rio San Pedro SRL was made up of Modules 6, 7, 8 and 9, corresponding more or less to the municipalities of Rosales, Meoqui and Julimes. In 1999, a “new” Module – the Saucillo Canal Water User Association – or Module 12 an old style association with roots back to the 1880s– was added to the District Boundaries (see Section IV for more information). According to its first president as part of the Irrigation District, the inclusion of the Saucillo Canal area within the Irrigation District itself was a direct result of the lack of water available in the Rio Conchos itself following the 1995 agricultural season, and the desire of the more traditional user association to gain access to water conservation monies (Martin Echaanic Chavez, personal communication with author, 2005). In contrast, farmers from the other “labores viejas” – the “old works” canals in Camargo and San Francisco de Conchos which branch off from the Rio Conchos river also formalized their water rights from the Rio Conchos, but at least as of 2006 had not officially joined the district itself despite official encouragement (Ezequiel Bravo, Operations Manager, Distrito 005, CONAGUA, personal communication with author, 2005).

Map 7. Delicias Irrigation District, 1995



Note: Module 12 is not shown in the map as it became part of the Irrigation District later, but would be located next to Module 1 and Module 2.
Source: CONAGUA, Delicias, Distrito de Riego 005, information provided to author.

Working the district's 80,000 hectares of irrigable lands were more than 9,500 "users," which included private property, ejidal and colono farmers (see Table 5.3). The 10 Modules have a wide variation in total and average size of farms and types of users, as well as average water deliveries (see Table 5.4). Average farm size is most directly related to the number of "private" farmers. Thus, those

Modules with high numbers of ejido farmers – such as Modules 12, 8, and 6 – tend to have smaller farm sizes than those with large numbers of "private" and "colono" farmers such as in Modules 2, 3,4 and 7.

Table 5.3. Number of "Users" by Property Regime Type and Size of Farms, Delicias Irrigation District, 2001

Type of Land Tenure	Irrigated Surface	%	Number of Users	%	Average Size
	(HAS)				(HAS)
Ejido	24,076	30.3	4,500	47.3	5.4
Private Property	21,618	30.5	2,966	31.2	7.3
Colono	31,279	39.2	2,043	21.5	15.3
TOTAL	79,553	100.0	9,509	100.0	8.4

Source: CONAGUA, Distrito de Riego 005, Delicias "Caracteristicas Generales del Distrito," 2004.

Table 5.4. Number of Irrigable Hectares, Users, Average Farm Size and Total Water Use, Delicias Irrigation District by "Module"

Module	Hectares	Total Number of Users	Number of Ejido Users	Average Farm Size	Total Dam Water Distributed, 1993	Total Dam Water Distributed, 2004
1	4,850	801	230	6.05	120,740	26,350
2	6,272	585	140	10.72	158,282	25,054
3	5,959	416	74	14.32	132,261	25,437
4	8,014	684	227	11.72	171,061	34,033
5	11,336	1,234	531	9.19	200,761	45,765
12	3,932	588	212	6.69	NA	13,985
Rio Conchos Section	40,363	4,308	1,414	9.37	**783,105**	**170,624**
6	4,962	692	418	7.17	152,629	12,197
7	22,773	2,240	1,207	10.17	389,546	86,262
8	6,678	1,,393	1,383	4.79	68,217	23,945
9	5,327	1,024	78	5.20	69,541	22,400
San Pedro Section	39,740	5,349	3,086	7.43	**679,933**	**144,804**
District Total	80,103	9,657	4,500	8.29	**1,463,038**	**315,428**

Source: CONAGUA, Distrito de Riego, 005, Information provided to author, 2005.

Accompanying the new change in management was wholesale changes in the price of water, which rose significantly between 1988 and 1991. Previously, irrigators were required to pay CONAGUA a single payment for the entire irrigation season (Mendoza 1988: 75). Starting in 1988, CONAGUA began to charge by irrigation per hectare. The single largest jump in price was in 1994, when CONAGUA essentially quadrupled the price – due in part to the devaluation of the peso but also to the incredibly dry year in which for all intents and purposes the dams were closed. By the following year, the price again plummeted to approximately $33 per 1,000 cubic meters, only slightly above its 1993 price in real terms. The price – expressed in Mexico's Nuevos Pesos per 1,000 cubic meters of water – continued to rise through 2005, tripling between the 1995-1996 irrigation season and the 2004-2005 irrigation season, although compared to the value of the dollar, it only doubled. Thus, a farmer averaging seven irrigations of a single hectare of peanuts for two-and-a-half hours would have seen his water costs expressed in U.S. dollars rise from $27 dollars in 1995 to $54 dollars in 2005 (see Table 5.5). Still, from the perspective of local farmers, the increase in the price of water is cited as excessive and an important factor in decisions about which crops to grow (see Sections IV and V).

Table 5.5. Water Pricing in the Delicias Irrigation District.

Agricultural Year	Price Type	Price in Year	Estimated Price per 1,000 Cubic Meters Expressed in Nuevo Pesos (1)	Estimated Price to Irrigate a Peanut Field Seven Times In U.S. Dollars, adjusted for Exchange Rate (2)
1987-1988	Per Irrigation per Hectare Irrigated	$1,800	$2	$5.41
1988-1989	Per Irrigation per Hectare Irrigated	$3,000	$3.3	$8.70
1989-1990	Per Irrigation per Hectare Irrigated	$4,500	$5	$11.37
1990-1991	Per Hectare Irrigated (Medium Demand Crop of 7 Irrigation Cycles)	$77,000	$12.2	$25.70
1991-1992	Per Hectare Irrigated (Medium Demand Crop)	$133,000	$21.2	$42.74
1992-1993	Per Hectare Irrigated (Medium Demand Crop)	$133,000	$21.1	$41.36
1993-1994	Per Hectare Irrigated (Medium Demand Crop)	$150,000	$23.8	$44.63
1994-1995	Millar	$90	$90.0	$83.38
1995-1996	Millar	$33	$33.0	$27.53
1996-1997	Millar	$32.28	$32.28	$25.48
1997-1998	Millar	$45.00	$45.00	$32.97
1998-1999	Millar	$80.00	$80.0	$52.23
1999-2000	Millar	$75.00	$75.0	$50.27
2000-2001	Millar	$80.00	$80.0	$52.50
2001-2002	Millar	$80.00	$80.0	$55.45
2002-2003	Millar	$85.00	$85.0	$49.04
2003-2004	Millar	$90.00	$90.0	$50.27
2004-2005	Millar	$95.00	$95.0	$52.96

(1) Because water pricing was based on irrigated hectares before 1994 and not volume, an estimate of 6.3 thousand cubic meters per hectare – based on seven irrigations of 2.5 hours per hectare for an average peanut field – was used to convert the price per hectare to the price per 1,000 cubic meters. In addition, the Mexican government converted Mexican pesos to Nuevos Pesos in 1993 by dividing by 1,000.

(2) Because the peso has been devalued several times since 1989, average exchange rates for the beginning of the irrigation season (March) were used to convert the totals to

the average cost of water to irrigate one hectare of peanuts in U.S. dollars for that year. The numbers have not been adjusted for inflation, however.

Sources: CONAGUA, Distrito de Riego 005, Delicias, “Cuota por Concepto de Servicio de Riego,” September 2005 and Author Calculations. Exchange rates derived from information from Banco de México. Indicadores económicos. Tipo de Cambio del Peso Respecto al Dolar, accessed from website Banco de Datos Economicos

The rationale for the increase in water prices was to provide an income source for the Modules to run their operations and pay the machine operators, canal operators, valve turners and other employees, while also making the price of water service more reflective of its true cost. At the same time, after years of collecting monies based upon the number of hectares irrigated, the Modules began to collect the money *based on the volume of water used*, a significant change in culture and a precursor toward water conservation efforts. Under an agreement with CONAGUA, the modules collect the money, and then distribute the revenues among the Module, the governing Sociedad Rural Limitada and CONAGUA, with the split roughly 75/15/10 % of the revenues. It is important to note that while the water price is set by CONAGUA, individual modules do increase the price slightly to pay for special projects and also may sell non-district waters – whether from wells or from the river itself – at different prices than the official price (“Beto” Serrano, Module VI, personal communication with author, 2006).

As highlighted in Chapter Three, after several years of above-average water availability and use in the early 1990s, low rains in 1993 and 1994 drove CONAGUA to take the decision to seriously curtail – and in fact close the Boquilla Dam during the 1994-1995 irrigation season. That decision was soon followed by the decision to operate the two main dams only during the summer irrigation season (March to September), essentially eliminating dam water irrigation of winter crops. Thus, farmers only were using the main canals during the winter for distribution of local rains, not dam waters.

Now that power had been devolved to the Modules, many chose to augment their curtailed water rights from CONAGUA with communal water wells, while wealthier farmers within the district dug their own wells. In addition, hundreds of shallow wells – known as norias – as well as holes dug in shallow aquifers – known as tajos – were dug by individual farmers in an effort to save their crops in 1995 and assure future irrigation in the years following (see Sections IV and V). While many of the individual wells, norias and tajos were in some sense "illegal" when dug, most of them have been since regularized, and others in unauthorized areas shut down by CONAGUA (Ing. Hernandez, personal communication with author, 2005). In addition to these water sources, some farmers simply hooked up their tractor to the Rio Conchos itself, augmenting their individual water right with river water, again at times legal at times not.

Table 5.6 shows the "official" count of wells in the district, but interviews, surveys and personal observation make it clear that these numbers probably undercount the number of these alternative sources of water. Water accounting has also suffered as a result. Ten years after the Modules began drilling their communal wells to augment surface water supply, CONAGUA finally began collecting data on the amount of water used and crops grown using this alternative natural resource in the 2004-2005 growing season (Barrientos, CONAGUA, 2005). In fact, the Modules now keep more accurate records of water use than does CONAGUA itself. Even then, such data does not include "individual" water decisions, such as personal wells, tractors pumping river water or the poor man version of wells – tajos and norias – that now dot the fields within the district.

Table 5.6. Number of Wells in the Delicias Irrigation District by Module, 2005

Module	Official Module Wells	Individual Agricultural Wells	Total
1	0	10	10
2	0	54	54
3	5	59	64
4	11	40	51
5	2	86	88
6	13	6	19
7	59	31	90
8	25	3	28
9	25	6	31
12	0	7	7
Total	140	302	442

Source: Comision Nacional del Agua, Distrito de Riego 005, “Numero de Pozos Oficiales y Particulares,” 2005.

B. Market Changes: NAFTA and Agricultural Prices

The loss of water availability of the dams coincided with the ushering in of 1994’s North American Free Trade Agreement and the devaluation of the Mexican peso in January of 1995, which caused serious hardship for those farmers producing for the domestic market.

1. Basic Grains

“Our farms were producing 300,000 tons a year of corn and wheat that doesn’t exist anymore,” noted long-time Delicias farmer and political leader Enrique Verges. “The Free Trade Agreement helped industries like tortilla or corn oil makers but not the farmers – the prices fell out on us” (Enrique Verges, personal communication with author, 2005).

Between 1995 and 2005 the economics of price inputs and outputs caused a fundamental shift in the types of crops grown. Thus, Empresas Longoria, based in Mexico City, but with significant investments in the State of Chihuahua, was one of the main purchasers of wheat in the area. In the 1970s and 80s, the agricultural giant bought and sold wheat, peanuts, sorghum and soybeans as well as cotton and operated wheat mills in Ojinaga, Delicias and Camargo among other locations, but post-NAFTA, all wheat purchases and virtually every other crop, with the exception of cotton, stopped (Ing. Bolivar, Empresas Langoria, personal communication with author, 2005).

2. Cotton surviving?

Instead of wheat, Empresas Langoria has concentrated entirely on their cotton gyn production. Even then, in 2005, only two cotton gyns were running in Delicias and Meoqui, as other plants – such as their Ojinaga plant – shut down (Bolivar, Empresas Langoria, personal communication with author, August 2005). Helping the slight revival in cotton has been a government support program which makes up the difference in price if cotton does not reach the price of $65 per quintal.

“Even with the guaranteed price for growers, we have big disadvantages compared to U.S. growers,” noted local manager Bolívar. “They always have guaranteed prices – paid promptly – they have economies of scale; they have much better interest rates for commercialization. Finally, because cotton is different in each area, those buying cotton don’t want to change their mills for the specific cotton grown in Delicias.”

In 2003, Chihuahua joined southern U.S. status in a common front against the boll weevil and pink bollworm. Known as the *Programa Binacional de Erradicación y Supresión de Picudo y Gusano Rosado,* the program grew out of

U.S. concerns that the Boll Weevil and Pink Bollworm would not be eliminated from U.S. fields as long as there was not a southern front (EL-Lissy and Grefenstette 2006). Under the program, Mexican farmers are required to pay a fee to the Junta Local de Sanidad Vegetal, which oversees inspections and pesticide applications. Because most farmers can not afford to pay these fees, they often turn to private companies like Empresas Langoria to provide the money upfront. In return, Empresas Langoria keeps part of the cotton provided to their gyn or takes part of the government guaranteed price controls. However, Bolivar said the program had been difficult to manage and they chose not to offer credits to farmers during the 2005 growing season.

Photo 5.2. Cotton is unloaded outside cotton gyn owned by Empresas Langoria in Delicias

Still, cotton – once king in Delicias – has returned to some areas in the middle section of the district and to Chihuahua itself. In 2005, over 6,000 hectares of cotton were grown in the district and adjacent municipalities. The vast majority is now "transgénico" -- a genetically modified crop -- which in some crops Mexico has embraced even as it resists other transgenic products like corn (Nadal 2002). In 2005, some 90 percent of cotton grown in Central Chihuahua was genetically modified and an increasing number of hectares changed their production pattern and packed the crop rows of their cotton closer together – a change intended to decrease the use of water overall (see Table 5.7).

Table 5.7. Hectares of Cotton Planted in 2005 by Municipality and Type of Seed

Municipality	Number of Lots	Conventional Hectares	Transgenic Variety in Hectares	Total Hectares	Number of Hectares with Denser Planted Rows
Camargo	2	1.2	1.1	2.3	0
Julimes	10	11.1	51.2	62.3	22
Meoqui	153	26.5	1269.1	1296.1	43.6
Rosales	237	126.7	1409.4	1536.1	504.1
Delicias	179	77.5	2001.5	2079	4.4
Saucillo	75	3.1	499.6	502.7	72.3
La Cruz	1	0	2.3	2.3	0
Conchos	2	0	2.8	2.8	0
Jimenez	37	77.2	332.8	410	323
Valle de Ahumada	9	0	229.7	229.7	203.4
Villa Lopez	6	0	39.5	39.5	39.5
Aldama	20	0	164.2	164.2	0
Total	731	323.3	6003.7	6327	1212.3

Source: Comité Estatal de Sanidad Vegetal, Programa Binacional de Erradicación y Supresion de Picudo y Gusano Rosado, 2005.

Eliseo Nuñez is the Technical Advisor to the Local Sanitary Agricultural Board in Meoqui, Chihuahua, which oversees inspections, permits and pesticide applications on many of the district's most important crops. While farmers are required to pay the Board a nominal fee to support Board budget and staff, "most farmers do not pay the crop permit and pecan and alfalfa producers have never paid.” (Eliseo Nuñez, Junta Local de Sanidad Vegetal, Meoqui office, personal communication with author, 2005.)

Under the binational erradication program, farmers are required to pay $1800 nuevos pesos per hectare of cotton planted – about $150 – to cover the costs of inspections, insect traps – which are placed every two hectares apart -- pheromones and when necessary – aerial spraying – usually of “Ultra-Low Volume” Malathion. Some 70 percent of the farmers are covered by credit from the cotton gyns, private banks or credit unions, while 30 percent pay their own way (Nuñez, personal communication with author, 2005). Nonetheless, says Nuñez, “the number who have actually paid are very low and the subsidies from the government are often late.” The problem of payments has incensed the eight companies charged with providing aerial spraying, since they are often forced to eat costs as they wait for payments to trickle in.

3. Corn Hybrids

Corn – often cited as a symbol of Mexico – is an interesting example of the shifts in production. While wheat, sorghum and soybeans – once staples of the district – have largely disappeared, farmers in the district continued to grow corn in 2005. However, corn production has shifted from human consumption to growing corn for cattle. Today, farmers own or rent huge machines to “ensilar” – turn the plant – stalks and all -- into ground up feed, which is then mixed with other crops, such as oats, alfalfa, sorghum and other feeds depending on the livestock (see Photo 5.3).


Photo 5.3. Huge machines chop up corn -- stalks and ears -- for cattle feed.

SAGARPA data from the Delicias region and in nearby municipalities like Camargo and San Francisco de Conchos clearly indicates that corn production for feed has increased even as “ear” production has declined (see Table 5.8). Over time, the production per hectare has increased for both types of production, as has the value per hectare. While the value per ton is certainly more for corn for grain than for feed, the shear volume that can be generated by corn feed appears to make it much more economical for farmers.

Drive along any road in the district and you are likely to see signs with the number and code name for the latest hybrid yellow and white corn “species,” such as “Pantera” “Macanudo” and “Jaguar” (see Photo). Asgrow, a subsidiary of Monsanto, and Pioneer, a subsidiary of DuPont, have gone fully into the production of hybrid or “improved” seeds, which is the product of a cross among two or more families of the same plant (Nemecio Ramirez, Monsanto, personal communication with author, September 2005). While companies like Cargill, Asgrow and Pioneer have been in the Mexican market since the 1970s, sales of these improved seeds skyrocketed in the 1990s due to their higher yields, drought-resistance and the lack of available water. With less water came the need to concentrate yields in smaller plots of land. (Carlos Trejo-Pech 2003).

On a sunny day in August, 2005, there is music playing and beer flowing under a tarp on one private farmer's land. Sponsored by TreAgro – a local seed distribution company – and Monsanto's Mexican subsidiary, the event brings farmers to an up-close-and personal view of an experimental farm in which some ten different varieties of Monsanto-produced corn has been grown with careful supervision by Treagro within the confines of Modulo IV – on the outskirts of Delicias. Augmented with semi-treated wastewater from Delicias itself, each row of corn is fronted by a bright yellow "Asgrow" signs accompanied by the brand names – Macanudo, Puma, Jaguar, Oso, Bengala, Tigre and Pantera – while a second smaller sign advertises Solución Faena – the herbicide Roundup.

Table 5.8. Corn for Feed and Corn for Grain in Central Chihuahua, 1990, 1995, 2000 and 2005

Category	Corn for Feed	Corn for Grain
Hectares Irrigated, 1991	2,374	13,453
Hectares Irrigated, 1995	3,676	2,309
Hectares Irrigated, 2001	7,940	688
Hectares Irrigated, 2004	6,734	502
Tons/Hectare, 1991	39.2	3.1
Tons/Hectare, 1995	29.6	3.5
Tons/Hectare, 2001	35.36	5
Tons/Hectare, 2004	35.61	5.52
Value/Ton, 1991	48	713
Value/Ton, 1995	143	1100
Value/Ton, 2001	265.4	1336.4
Value/Ton, 2004	300.4	1488.8

Note: Price not adjusted for changing value of peso.

Source: SAGARPA, District 13 Delicias Office, 2005.

In 1996, Monsanto genetically engineered their soybeans to be resistant to their herbicide Roundup (glyphosate) and they have also developed genetically-modified cotton that is roundup ready. They have not, however, been authorized to sell genetically-modified corn in Mexico, either of the round-up or Bt variety (Nemecio Ramirez, Monsanto Mexico, personal communication with author, 2005)

Photo 5.4. Sign for A7573 Macanudo White Corn by Monsanto, Delicias Irrigation District, 2005

Holding up one of the “semi-erect” corn husks, local Treagro manager Jaime Treviño strips the Macanudo husk and tosses it to one of the farmers watching. “Pretty immense,” he laughs as the *mazorca* flies through the air. “One hectare could stand 120,000 plants –- they can tolerate such high densities with only 10 or 15 percent loss,” he notes. “This field is only at 75,000 plants per hectare, but we are trying to raise the average here in Delicias to 80,000 per hectare.”

Bengala is perfect “if you want volume” since it can produce 63 tons per hectare, while Pantera is “exceptional” and is being used in Durango to make tortillas, fetching “$1,300 pesos a sack.”

“Tigre, Pantera and Macanudo tolerate the drought better,” Ramirez adds.

Many in 2005 believed it is only a matter of time before Round-up Ready corn joins Round-up Ready Cotton and Round-up Ready Soybeans already sold in Mexico. In 2005, Monsanto’s genetically modified Roundup Ready alfalfa was approved for commercial sale by the U.S. Department of Agriculture (USDA). Nemecio Ramírez said it is likely the product will be sold and distributed in Mexico by 2006 by Monsanto’s subsidiaries (Ramírez, personal communication with author, 2005).

After the demonstration, it is party time under the tarp in the hot August sun. There is food, plenty of beer, a bingo-type contest for prizes from Treagro, and even an entertainer who does impressions of Vicente Fernandez and Juan Gabriel. The author won a bottle opener.

4. Green fields ……of alfalfa

The increase of feed corn production – as explored in Chapter Two – is in part related to the emergence of the Delicias area as a major milk production center. Much of the corn grown in the Municipalities of Delicias, Meoqui and Suacillo is earmarked for the Zaragoza Milk Production center, as is the huge amount of hectares which continue to be dedicated to alfalfa even in the face of less access to water. While the total amount of land dedicated to alfalfa production has dropped – at least compared to the late 1980s – the drop is less related to its productivity or value and more with the reduction in water rights. To compensate, farmers have been irrigating less.

In fact, the District has required special “permits” to grow alfalfa, since it is such a high water-demand crops and no one can increase alfalfa production unless another farmer agrees to stop growing it (Ezequiel Bueno, Operations Manager, Delicias Irrigation District, personal communication with author, 2004). At the same time, because of the limits and restrictions, some farmers have switched to other sources of water to grow alfalfa. For example, according to CONAGUA, communal wells run by the Modulos irrigated 1,875 hectares of alfalfa in the 2004-2005 agricultural season, the first year for which they had groundwater information for irrigation, meaning that the total amount of hectares irrigated between the two water sources – at 11,624 hectares – was only slightly less than the 1991 total of 12,059 hectares irrigated. Given that some farmers also have private wells, or pumped water directly from rivers, it is likely that the total amount of alfalfa grown in 2004-2005 was higher in 2004 than in the early 1990s.

5. Overall Crop Trends and Water Use

The crop production shift discussed in Chapter Two -- an increase in perennials, a virtual elimination of winter crops, and a slight decrease in summer crops – seem to reflect decisions based largely on the profits per unit of water consumed. (see Table 5.9). Basic data on hectares irrigated within the district USING WATER DELIVERED from the dams, the amount of water delivered, total production and the actual monetary gain from crops per 1,000 cubic meters in 1990, 1995, 2000 and 2005 clearly indicate that some crops have done better than others. Farmers have spent more water resources on products with higher profits – like pecans, peanuts, chile and alfalfa.

Table 5.9. Hectares of Crop Irrigated, Total Production, Water Used and Average Value-Added per 1,000 Cubic Meters for Selected Years, Delicias Irrigation District, Dam Water Only

Year	1990-1991	1994-1995	2000-2001	2004-2005
Total Hectares Irrigated	96, 399	11,187	25,158	31,148
Total Production in Tons	651,353	142,120.8	327,630.2	464,325.8
Production per Hectare	6.76	12.7	13.02	14.91
Total Water Delivered	1,264,901	134,888.2	444,828	351,351.7
Water Use Per Hectare	13.1	12.1	17.7	11.39
Total Production Value (Million Pesos)	557,988,438	107,673,208.2	600,203,009	1,098,006,005.6
Production Value Per 1,000 Cubic Meters	441.13	798.24	1,349.29	3,125.1

Source: CONAGUA, information provided to author, 2005.

Table 5.10. Hectares of Crops Irrigated by Type, 1991 and 2005

Year	Spring Onions	Chile	Peanuts	Alfalfa	Cotton	Wheat	Sorghum
Total Hectares Irrigated, 1991	1,270	3,849	8,933	12,059	6,264	26,457	7,268
Total Hectares Irrigated, 2005	1,004	4,508	2,849	9,749	4,363	0	45
Production in Tons per Hectare, 1991	35.0	21.0	1.5	12.1	2.5	5.2	5.6
Production in Tons per Hectare, 2005	35.7	24.8	2.5	12.0	4.2	0	4.2
Water Use per Hectare, 1991	13.05	21.93	6.1	22.98	6.97	15.22	7.20
Water Use (1,000 Cubic Meters) Per Hectare, 2005	15.04	15.17	7.15	13.54	7.51	0	12.88
Production Value per 1,000 Cubic Meters, 1991	12,070.79	766.02	473.21	106.87	198.77	204.92	352.71
Production Value per 1,000 Cubic Meters, 2005	3,407.10	5,214.96	1,696.46	912.12	3,090.57	0	374.94

Source: CONAGUA, information provided to author, 2005.

Overall the amount of water used per hectare increased over the period, although by 2004-2005 there was a decrease in the amount of water used per hectare as water conservation projects initiated in 2003 continued to be implemented throughout the district. Again, however, it is important to note, that the data only reflects the use of dam surface water, a fact that seriously undercounts, for example, the growth in pecan orchards, which in Delicias have overwhelmingly switched to groundwater use. Even with this data limitation, detailed information about irrigated hectares, water use and production value for several of the major crops grown for the four years, including chile, cotton, onions, alfalfa, wheat, soybeans and sorghum, indicate significant changes within the district.

C. Land Tenure and Policy

Because individual water user association membership lists – the members who make up the Modulos – were put together in 1992 in preparation for the transfer – and were still being updated in 2005 – it is difficult to surmise what changes have occurred in land ownership over the past 15 years. Nonetheless, the change in Mexico's Article 27 of the Mexican Constitution did begin a process which has impacted land tenure. Under Article 56 of the new Agrarian Law, ejidos can choose to measure and regularize their lands – through certificates or actual titles -- with Reforma Agraria, the Procuradoria Agraria and INEGI.

As highlighted in Chapter Three and Four, the Chihuahua version of PROCEDE – the above-mentioned process for regularizing ejido and communal lands – has been held up as example for the rest of the nation (David Cerecedes Fierro, Reforma Agraria, Chihuahua office, personal communication with author, 2005). Overall, the vast majority of ejidos and agrarian communities in Chihuahua have entered the PROCEDE process. (see Table 5.11).

Most ejidos in Chihuahua have gone the middle route – entering PROCEDE – but not seeking “dominio pleno” – plain dominion where every owner can buy and sell land to whomever they want without seeking the permission of the wider community (David Cerecedes Fierro, Reforma Agraria, Chihuahua office, Personal Communication, October 2005). Several communities have sought “dominio pleno parcial” – where some members of the ejido are “let go” to privatization while the rest of the community remains part of an ejido structure. This option is particularly relevant where some land in the ejido has already been sold off to non-ejido members, fractioning the ejido. Thus, in Chihuahua, each ejido has collectively been making decisions about to what extent they want to privatize their lands – including both individual parcels and farming land -- and make them available for full selling and buying.

Table 5.11. Results of PROCEDE in Chihuahua, October 2005

Category	Amount of Land in Hectares	Number of Ejidos/Agricultural Communities
Entered and Completed PROCEDE process	9,255,667	904
Still Completing PROCEDE process	688,109	57
Rejected PROCEDE	208,205	12
Legal Dispute that Prevents Application of PROCEDE	247,503	33
Total Social Property in Chihuahua	10,637,995	991

Source: Diario Oficial del Estado De Chihuahua, October 14, 2005, pages 29-34.

Within the Delicias Irrigation District, only one agricultural community – San Jose del Carrizo in Julimes – had a legal dispute that prevented the community from proceeding with PROCEDE. Most ejidos and agricultural communities have measured their lands, sought private household lots and agrarian certificates, rather than private titles through the process known as Dominio Pleno. Within the

Delicias Irrigation District itself, there were only three communities on the outskirts of the City of Delicias which chose at least partial privatization, three farmers from the Meoqui Ejido, and the Ejido Community of Las Varas, near Saucillo. There, some 23 farmers representing 29 titles privatized about 430 hectares of land.

Still, despite the relatively small amount of outright privatization in Chihuahua and the Delicias Irrigation District – most connected to urbanization -- there are several factors which suggest this data undercounts privatization. For example, while Table 5.12 shows that 23 former ejidatarios have sought "dominio pleno" in Ejido Las Varas– taking themselves and their land out of the ejido structure – 2005 ejido comisariado Rodolfo Parras says the total is actually higher. He estimates that out of 83 ejidatarios making up the ejido, between 30 and 35 have left by seeking dominio pleno. In addition, out of those remaining, approximately 10 have sold off their ejido rights to other outsiders, but without seeking "dominio pleno," meaning the ejido has essentially lost half its membership (Rodolfo Parras, Comisariado, Ejido Las Varas, Saucillo, personal communication with author, 2005).

For those that remain, the tendency is to "rent to the chile producers" since most ejidatarios do not have access to the capital needed to invest in chile farms, by far the most profitable crop in the area. In addition, because the ejido also has communal lands, several of those that have remained within the ejido have sought investors to mine the communal land as a quarry, or develop the land for urban housing. Thus, even though most ejidatarios have chosen to remain as an ejido, market forces are contributing to slowly fraction off the remaining ejido lands (Rodolfo Parras, Ejido Las Varas, 2005).

In the Ejido and agricultural community of Ortíz, near Rosales, farmers have decided to privatize all titles, but a bureaucratic hold-up in Mexico City had prevented final resolution of their collective decision. Here, there is little fear that the privatization of their land will lead to concentration of lands in large land holdings because the community has access to groundwater, making their land very profitable to rent to wealthier farmers for chile or onions. Instead, most farmers want the improved access to credit that comes with private land and to be able to legally split their lands between different offspring so that some will continue to farm as others choose to rent or leave the area ("Beto" Serrano, personal communication with author, 2005).

In addition, surveys and interviews with ejido leaders show that buying and selling of land has often occurred outside of the PROCEDE process and even outside of the ejido's own rules. Thus, the "Comisariada" of the Valle de Saucillo Ejido – whose boundaries can be found in Modulo 1, 2 and 12 -- said that she believes that up to 10 members in the past 10 years have sold their land to "outsiders" although they have not sought permission from the ejido. She said that there were 214 ejidatarios when the ejido came into existence in 1935, by 1996 there were only 192 registered ejidatarios, and today, "we don't have an accurate count." (Comisariada of Valle de Saucillo, personal communication with author, 2005).

Thus, the combination of the changes in Article 27 – which increased the likelihood of transfer of social to private lands – the lack of available water which accompanied the drought, and the rising costs of water and other land inputs – particularly for the most profitable crops like pecans, chile and onions -- have been a factor in this process since some farmers have preferred to sell their lands rather than pay the high costs of production. However as the case studies demonstrate, decisions about buying and selling ejido land are also influenced by a community's resources – including access to alternative water -- and according to survey respondents and interviews the vast majority of ejidatarios have opted to rent their land and water rights to wealthier farmers rather than a wholesale, more permanent sell-off.

Table 5.12. Ejidos in Chihuahua with partial or full "dominio pleno" through PROCEDE, 2005

Name of Municipality	Number of Ejidos/Communities	Number of Ejidatarios	Number of Titles	Total Land "Privatized" in Hectares
Chihuahua	13	370	1,144	11,200
Delicias	2	64	140	624
Santa Isabel	1	1	2	15
Hidalgo del Parral	2	62	76	370
Jiménez	3	32	32	573
Juarez	5	400	1,098	6,254
Matachi	1	1	2	6
Meoqui	1	3	3	17
Ojinaga	2	87	92	838
Guerrero	1	1	1	7
Rosales	1	9	9	51
San Francisco de Conchos	1	65	142	1,234
Santa Barbara	2	10	17	167
Saucillo	1	23	27	432
Total	35		3575	39,566

Source: Reforma Agraria Nacional, Chihuahua City Office, September 2005.
Note: Does not include communities in the process of seeking Dominio Pleno not yet granted by Mexico City.

D. Water Conservation

The availability of $40 U.S. million in grants from the North American Development Bank and $96 million from the Mexican federal government to make water delivery more "efficient" and water conservation more common on the fields making up the Delicias Irrigation District was a major change and issue between 2002 and 2006. While plans for a more concentrated investment had already been in the works, the crisis of limited inflows to the dams during the 1990s and the specific transboundary dispute with the U.S. over the lack of inflows into the Rio Grande was the catalyst which sent bureaucrats and politicians scurrying for some positive actions to relieve the crisis. Working feverishly, Chihuahuan state officials, CONAGUA and the staff of the Border Environment Cooperation Commission (BECC) put together a plan in 2002 that called for over 343 million cubic water savings in District 005 through the lining of canals, advanced irrigation technologies, leveling of lands and other delivery improvement (BECC 2002; IBWC 2003). Under the project certified by BECC, water deliveries would be reduced to farmers – and eventually water rights would also be reduced – thus freeing up water for other needs, including the need to comply with the 1944 Treaty with the U.S.

It is, of course, one thing to say there are 343 million cubic meters of water demand to be saved, and quite another to make it happen, but between 2003 and 2005, significant investments were made throughout the district, although not in the exact manner presented for certification before the Border Environment Cooperation Commission. Rather than a single district to invest in – and manage -- CONAGUA was faced now with 10 separate Modulos and two overarching main canal user associations that all wanted to determine how and where the money was spent.

According to the Irrigation District's "residencia" chief – Engineer Lauro Fernandez – akin to a public works and finance section – the presidents of the Modules, general managers and CONAGUA collectively made the decision to base the amount of money invested on the amount of land planted in each of the 10 Modules over the previous five years. Complicating the decision was that three of the Modules served by San Pedro's Las Virgenes Dam– Modulos 7, 8 and 9 -- initially decided they did not want to participate at all, which meant that some Modulos got more of a jumpstart on water savings than others. At issue? Each Module was required to sign a document stating that after the water conservation projects were implemented – and the water savings realized – their water rights would be reduced correspondingly. By late 2003, however, the Modules rejecting the agreement reversed course and signed the documents, giving them access to the project money (Manuel Carnero Valles, President, Modulo VIII, personal communication with author, 2005).

Over the first three years of the project, more than $820 million pesos – around $75 million dollars – was spent to reline some 395 kilometers of canals, level 9,846 hectares of agricultural lands to make them more efficient for irrigation, install low-pressure irrigation systems in 7,446 hectares of land and high-pressure "spray" systems in 5,716 hectares of land, while also rehabilitating seven wells (see Table 5.13). Between 2002 and 2004, certain Modules favored a more "technical" approach – low and high pressure irrigation systems – while other favored more low-tech approach, such as relining canals with cement (see Table 5.14). In general, those Modulos with a high number of private land owners with pecan farms tended to invest money in high pressure systems, while those with more ejido land tended to favor projects of a wider benefit, like low-pressure gated pipes and cement lining of canals. In fact, say Module managers, the *first year they felt pressured by CONAGUA and some of the larger farmers to spend money on high-pressure spray systems* – mainly for pecan producers. Once they observed that it only benefited individual farmers and cost more they began to look at simple relining of canals and low-pressure systems (Jose García, manager, Modulo 12, personal communication with author, 2005).

For the first two years of the project, Mexico's "experts" on water management – the Instituto Mexicano para la Tecnología del Agua – an autonomous, university-linked government agency -- were hired to measure the actual volumes of water being saved through these water conservation projects. While the volumes of water saved were less than had been anticipated – in part because of the failure of Modules 7, 8 and 9 to participate – they were still significant – about 54 million cubic meters in water savings in two years-- indicating the basic credibility of the investment. When upstream users in the Camargo and San Francisco de Conchos user associations outside the district but dependent on releases from La Boquilla Dam are included, the water savings re even more impressive.

Table 5.13. Investments made by type and amount in Sustainable Water Use Program, Delicias Irrigation District.

		Year 1	Year 1	Year 2	Year 2	Year 3	Year 3	Total	Total
Component	**Unit**	**Quantity**	**Amount ($Million Pesos)**	**Quantity**	**Amount ($Million Pesos)**	**Quantity**	**Amount ($Million Pesos)**	**Quantity**	**Amount ($Million Pesos)**
Relining of Canals	Km	146	128.2	118	140.3	131.3	136.8	395	405.3
Land Leveling	Ha	2,702	15.2	5,715	32.9	1,450	14.5	9,867	62.6
Low Pressure Irrigation Systems with Gated Pipes	Ha	2,450	29.9	3,801	82.9	1,195	26.2	7,446	139.0
High Pressure Irrigation Systems (Sprinklers)	Ha	2,500	62.4	2,060	52.4	1,156	32.0	5,716	148.6
Well Rehabilitation	Num	7	2.1	3	1.1	8	2.8	18	6
Studies and Main Canal Rehabilitation	Km	175	3.4	226	4.2	107.5	1.3	509	8.9
Supervision of Projects			14.6		15.8		15.8		46.2
Measuring Gauges	Num					94	7.6	94	7.6
Contracts		54		43		39		136	
TOTAL $s			255.8		329.6		237.0		822.4

Source: Gerencia Regional Rio Bravo, Residencia General Proyecto Delicias, Distrito de Riego 005, 2005.

In mid-2005, however, plans for the 2005-2006 fiscal year began to go array. A series of devastating hurricanes in September in southern Mexico caused the Federal Government to reduce the overall budget for the water conservation projects from $538 million pesos to $280 million pesos, meaning budgets had to be reduced by some 60 percent (Lauro Fernandez, Distrito de Riego 005, personal communication with author, 2005). In addition, costs for both cement – to line canals – and PVC pipes – which in some cases are replacing canals in the district – skyrocketed meaning 280 million pesos in 2005 wasn't buying what it was in 2004. "Basically with the price of oil doubling, the price of PVC pipes also doubled," noted Fernandez.

Table 5.14. Low and High Water Pressure Systems Implemented by Module, 2002-2004

Module No.	**Low Pressure Systems *(Multicompuertas* – Gated Pipes)**		**High Pressure Systems (Sprinklers, Drip, Central Pivot, Sideroll)**	
	No. of Systems	Surface Area (Hectares)	No. of Systems	Surface Area (Hectares)
1	0	0	0	0
2	0	0	20	375
3	20	807	30	604
4	12	740	27	950
5	7	86	43	682
6	4	1995	23	475
7	12	1227	18	587
8	8	691	15	90
9	1	416	0	0
San Francisco De Conchos	8	237	53	390
Camargo	0	0	2	43
12 (Saucillo Canal)	2	170	18	251
Total	74	6,366	246	5,419

Source: CONAGUA, Residencia General Proyecto Delicias, Distrito de Riego 005 Delicias, Programa del Uso Sustentable del Agua, Etapa 1 y 11, September 2005.

CONAGUA – in part because of the cost overruns – also made changes in the specifications in their contracts to try and reduce the costs, including a decision to reduce the width of canal lining from 7 centimeters to 5 centimeters, a decision which has been criticized by some of the contractors.

“I don’t know why they approved this change to reduce the thickness,” noted Pedro Mata, a civil engineer who runs a local irrigation canal design and construction contract company. “There is no actual paperwork stating why they made this change and it means that canals will only last five or ten years instead of 15 or 20.” (Pedro Mata, Obra Roma Civil, personal communication with author, 2005).

Table 5.15. Water Savings through Sustainable Water Use Project, Delicias Irrigation District, Millions of Cubic Meters

Modulo	1st Phase	2nd Phase	Total
1	6.195	6.557	12.754
2	1.834	3.737	5.571
3	0.233	0.408	0.642
4	0.148	4.515	4.663
5	4.142	9.746	13.887
12	0.077	2.984	3.062
Conchos River SRL	12.631	27.949	40.580
6	3.067	5.958	9.025
7	0	3.774	3.774
8	0	0.106	0.106
9	0	0.351	0.351
San Pedro SRL	3.067	10.189	13.256
Upstream “Old Works” in Camargo and San Francisco de Conchos Irrigation Units	3.984	4.229	8.213
Total	19.682	42.367	62.049

Source: Instituto Mexicano de Tecnología del Agua, “Volumenes Rescatados con el PUSASC en Distrito de Riego 005 Delicias,” 2005.

Fernandez’ staff also oversees the bidding and contract process. On a sunny day in September, about 15 male engineers mill about the district offices in downtown Delicias, waiting for the paperwork to be released to prepare the contracts. For any given contract, Fernandez says they will get 10 to 15 bids, ranging from smaller local companies to large companies based in other states, and at times, even international companies with subsidiaries in Mexico. The monies NADBANK monies undergo a more rigorous oversight and analysis.

“The NADBANK contracts require actual proof of liability insurance, financial accounting and even resumes” notes Hugo Candelaria, who runs the local Delicias offices of Plasticos Rex, one of the leading providers of irrigation equipment in the area. (Hugo Candelaria, Plasticos Rex, personal communication with author, 2005)

Fernandez rates the water conservation projects a success, since energy, water consumption and the number of irrigations per crop has been substantially reduced over the past few years. The negative factors, he states, have more to do with the expectation of users that such “subsidies” of basic irrigation equipment will continue and that some irrigation equipment has not been well-maintained or used correctly.

“The hoses (*cintillas*) that we have contracted for drip irrigation have not been used adequately, with farmers sometimes putting the drip away from the roots rather than toward the roots,” Fernandez notes. “And they may not realize that in a few years they will have to replace these systems or they won’t work properly.”

One of the firms benefiting from the water conservation monies – Obra Roma Civil based in Delicias – expresses the concern that too much money has gone into new technology. Ing. Pedro Mata says the eagerness within the district to replace canals with PVC pipes might be a mistake.

“They’re replacing canals with tubes all over the district, but after three or four years, the pipes will fail and replacing them will be very costly, because there will no federal program to support the farmer,” Ing. Pedro Mata stated from his simple office on the outskirts of Delicias. “We should be returning to more basic maintenance and operation rather than throwing up all this new technology.”

A similar concern is echoed by Plastico Rex's Candelaria, who says farmers have yet not adjusted to using the new technology properly, in part because of a lack of "culture of water." "They want to flood their fields with five liters of water per hectare instead of only needing two liters of water per hectare," he stated. "It's part of a change in the culture of water."

Both Candelaria and also Mata put some of the blame on CONAGUA itself, which they felt had not overseen all the projects properly. "They have hired these out-of-state contractors who come in, do a poor job in construction and leave, and those same companies keep getting the contracts," Mata stated.

Finally, while nearly everyone interviewed felt that the conservation projects have been a huge boon for the district, many felt the projects had been undercut by a lack of oversight. When the program was first implemented, an oversight committee composed of CONAGUA, the SRLs and the Modules was formed to report back on the project themselves. Nonetheless, in 2005, the committee had not been meeting regularly and instead during the normal "Comites Hidraulicos" project implementation issues are discussed. A 2004 report on the Delicias water conservation projects and BECC certification process noted the failure of the oversight committee to have regular meetings and follow-up (Kelly and Luján 2004).

Thus, while the water conservation projects have represented an important change within the district, in general improving efficiency, a number of challenges have impacted their implementation. These problems range from farmers implementing the new technologies correctly, a significant amount of the technology being used on "alternative" sources of water -- reducing the amount of savings of "district" water -- less-than-stellar work by contractors, cost overruns, budget cuts and in some cases, fights within Modules over how and where to spend the money, as is discussed further within the specific Module case studies.

E. Water Rights Sales

In addition to the water conservation projects – using water more efficiently -- CONAGUA began a project to actually buy back water rights from farmers in the two Modulos furthest away from the Las Virgenes dam – Modulo 7 and 8. In 2004, using federal monies, they began negotiating with the farmers – virtually all of them from the Ejido of Bachimba – and offered to buy back water rights of those lands that were poor in quality, far from the water source, rapidly urbanizing, and/or difficult to modernize through new irrigation systems (Ezequiel Bueno, CONAGUA, Distrito de Riego 005, personal communication with author, 2005).

"This was the first time we had ever considered actually changing the district boundaries to unincorporate part of the district and reflect the reality of a district with less surface, but without reducing the amount of water by concentrating the water where it made sense," Bueno explained.

Interestingly, these same farmers were from the Modulos who only a short time before – in September of 2002 – had rejected participating in the water conservation projects, concerned that the projects were really more about stealing their water rights rather than using water more efficiently (Manuel Carnero Valles, Modulo 8 President, personal communication with author, 2005). According to Manuel Carnero Valles, who became Modulo 8 president in January of 2005, at the beginning there was no established price for the "definitive" sale of water rights, but then a price of $29,600 pesos per hectare was published in the Federal Register, based on “some kind of study.”

The Modulo advertised the potential sale of water rights and received over 230 members of the Modulo who wanted to sell water rights back to the government.

“They were all ejidatarios in the areas where water delivery has always been difficult,” Valles explained from his office in Lazaro Cardenas. Valles said the first year, based upon the amount of money CONAGUA had been assigned, 121 members of the ejido with 745 hectares of land within Modulo 8 were able to sell off surface water rights, and in some cases, groundwater rights back to the state. Another 104 members – with 688 hectares – were approved for water rights but had yet to receive payments, a situation that led to protests in 2005 (Fuentes 2005). Approximately 100 more farmers had expressed some interest in participating in future sales, although they had yet to be accepted by CONAGUA and SAGARPA.

Ramon Hernandez Hernandez, an Bachimba ejido said “the only thing that we can do on the land is pasture animals or grow mesquite trees for barbecues.” (Hernandez Hernandez, personal communication with author, 2005).

He said the sell-off was to be expected. “The ejido boundaries were always a political question,” Hernandez explained. “They gave us land in return for votes. When the rains stopped and they began growing chile, vegetables and pecan trees by the rivers, the dam levels went down with the change in crops and the dams have never recovered. The only solution is really to shrink the district.” (Ramon Hernandez Hernandez, Bachimba Ejido, personal communication with author, 2005.)

In all, some 31 million cubic meters of water were "saved" through water right sales, reducing the district by some 400 hectares, although of course it was water largely "on paper" anyway since many of the lands had not been irrigated for the better part of a decade. A similar amount was expected in the 2005-2006 season (see Table 5.16).

Table 5.16. Definitive Water Rights Sales, Users, Volume of Water, Hectares and Amount Paid under PADUA program, 2004-2005.

Modulo	Surface (Ha)	Surface Water Volume (Mm3)	Amount Pesos (000s)	Ground water Volume (Mm3)	Amount Pesos (000s)	Total Volume of Water	Total Amount Pesos (000s)
VII	273	17,503	35,006	3,518	8,796	21,021	43,802
VIII	121	8,801	17,601	1,763	4,408	10,564	22,009
Total	394	26,304	52,607	5,281	13,204	31,585	65,811

Source: CONAGUA, Distrito de Riego 005 Delicias, "PADUA: Primera Etapa," 2005.

"Every water user has a water right, but we are concentrating the rights geographically," explained District Operation Manager Ezequiel Bueno. "The farmer who had two water rights for two different pieces of land is using the two rights in only one land so he has sufficient water and in this way we are concentrating the use of water…through the program." (Bueno, Distrito de Riego 005, CONAGUA, personal communication with author, 2005).

IV. Scaling In: The Old Saucillo Canal

A. A Little History

It doesn't look like much, the beginning of the ol' Suacillo Canal. The Río Conchos moves in a northerly direction and is suddenly interrupted by a small cement check dam, known locally as the Presa Tortuga – Turtle Dam. To the west, a small canal diverts water to one side of the check dam, and begins a 43 kilometer journey through a number of ejidos, downtown Saucillo, through a series of small rural communities on the old road to Delicias, and eventually back to the Rio Conchos itself (see Photo 5.5).

The users of the Saucillo Canal occupy some 3,725 hectares of land squeezed between the Rio Conchos and the Saucillo Canal itself. It is a thin slice of land that occupies the flood plain of the river, and some of the best alluvial soils, particularly well-liked by pecan trees. The roots of the Saucillo Canal Water Users Association goes back to 1717 – with the establishment of the Hacienda de San Marcos de Saucillo, a 125,918 hectare land tract – or “Mercedes” granted by Spain to Juan Antonio de Traviña y Retes, that would later become the heart of the municipalities of Delicias, Rosales, Meoqui and Saucillo. After the death of de Traviña y Retes in 1724, the land was passed onto his widow, and then his son-in-law, before being administered by “La Compañía de Jesús” – the Jesuits. While the first activities under de Traviña y Retes were related to mining, under the Jesuits, cattle and agriculture – through the renting of land to local inhabitants – became the dominant activities (Alvarado et al. 2003: 28).

After the Jesuits were thrown out by the Spanish regime in 1767, the Hacienda was turned over to the state, and constant attacks by the apaches and other indigenous tribes from the north placed the Hacienda in severe decay and semi-abandonment. Following the war of independence with Spain, Don Jose Antonio Uribe and his wife arrived from San Pablo (today known as Meoqui) and began farming a large portion of the land. The couple are considered founders of the City of Saucillo. In 1830, the Hacienda de San Marcos itself was sold to Esteban Courcier, a French investor, and agriculture reemerged along the banks of the Rio Conchos, as cotton, watermelon, wheat, oats and corn were grown in part to feed workers who were mining the nearby hills (Alvarado, et al. 2003: 31). In 1850, the population of Saucillo was officially recognized by the federal government as new families arrived to settle the area.

Photo 5.5. Presa "La Tortuga" on the Río Conchos. The beginning of the Saucillo Canal is to the right on the photo.

In 1878, Porfirio Armendariz, a wealthy agriculturist and merchant from nearby Rosales, purchased the Hacienda, and began to subdivide it and sell off each small track for 500 pesos. Small towns like Las Varas, La Cuadra, and El Orranteño -- which line the Rio Conchos between Saucillo and Delicias – known as the "Cordillera de Saucillo" -- originated in this period as new families came to grow crops and mine the hills to the east. These same families from Saucillo and nearby towns began construction of the Tortuga Dam and Saucillo Canal, which were begun in this period by "pico y palo" only to be destroyed by a series of floods in the late 1800s, leading the town of Saucillo to be relocated slightly down the river. The canal itself was rebuilt in the late 1880s (Alvarado et al. 2003:33).

Following the Mexican revolution, new lands were subdivided along the Cordillera de Suacillo and given to families and ejidos.

Photo 5.6. Downtown Saucillo, 2005

Martin Echaanic Chavez is a second generation farmer whose father arrived from the Basque country in Spain to Saucillo in the post-WW II era. Chavez served as president of the User Association from both 1979 to 1981 and 1991 to 1995. In the late 1970s, he said, pecan production was just beginning to take off, but the “entire 3725” hectares was continually planted and replanted by grains, vegetables and cotton. The canal – dilapidated and sinewy – was continually cleaned and maintained by local users and the diversion dam continuously diverted river water. (Martín Echaanic Chavez, Modulo XII farmer, personal communication with author, 2005).

“The drought arrived and it affected all the “labores viejas” – the old works – all of us who relied on canals connected to the river itself,” the middle-aged charismatic farmer remembered. “It was the downstream farmers against the upstream farmers and all the farmers against the government.”

Echaanic Chavez said that when he became president the second time he was concerned that his water user association did not have an actual piece of paper saying they could use the water. After finally securing an official concession from the river, he began to ask for even more water in late 1994.

“They announced they would close the dam, which meant none of the folks in the irrigation district would be watering and no releases from the dam down the river,” he noted. “I knew that we couldn’t just rely on the river concession.”
Chavez said that he paid visits to “Dr. Zedillo,” referring to the former Mexican president, and a number of political leaders. At first they proposed dividing the Old Saucillo Canal Water User Assocation into three sections, “split evenly between Modulos 1, 2, and 3.”

“We told them we would not be divided and that we needed both the river concession and a dam concession,” Chavez remembered. In the meantime, Chavez also began assuring that more water would get to the Saucillo Canal itself through “updating” the diversion dam (See Photo 5.5). The check dam’s stone “wall” – dating from the 1870s -- was replaced in 1994 with “cement, rather than the traditional stones which line the river.” (Chavez, personal communication with author, 2005).

“I didn’t ask for permission, I didn’t warn anyone, I just did it,” the proud Chavez stated matter-a-factly, who estimates he raised the wall about 20 centimeters.

His decision – while supported by most farmers in Modulo XII – did not sit well with other farmers who rely on “Federal” rights -- Derechos Federales -- from the government to use river water downstream from the diversion dam itself. For example, in the ejidal town of Parritas – the beginning of the Old Saucillo Canal – a number of the ejidatarios depend upon pumping the river water itself to irrigate their cropland.

Hector Talamantes, an older farmer in Parritas, is the current president of the Ejido. He said that when Parritas was first recognized in 1935 by the federal government, several of the ejido members who did not irrigate from the Saucillo Canal itself were granted a federal right to pump out river water. (Hector Talamantes, Ejido Las Parritas, personal communication with author, 2005).

While the ejido currently has 37 members with 2,856 hectares of farmland and 2,500 hectares of “common use” – basically scrub brush in the steep hills beyond the riverplain -- some 14 of those have relied on the federal rights to pump water from the river and send it into a small canal.

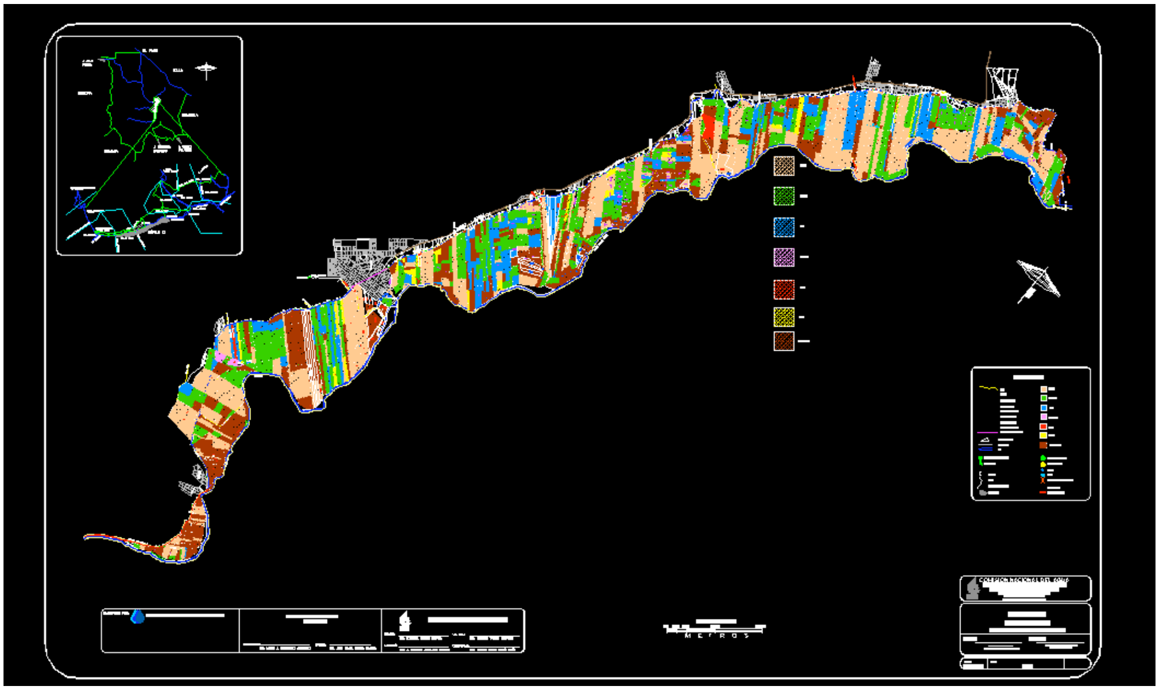
“We all used to grow six hectares of wheat and corn and now we grow nothing,” Talamantes states, holding up his ejido’s federal *concesión* outside his humble home in Parritas. “I wish the river would flow again so we would benefit and the pools would fill up again and the fish would come back.”

In 1999, after sever years of negotiation, and several years in which the Saucillo Canal farmers had to pay other Modulos to release water down drainage dams as the Rio Conchos ran dry, the old Saucillo Canal joined up with their brethren in the Irrigation District and became Modulo XII.

B. The Old Saucillo Canal Today

Today, the Saucillo Canal User Association, known as Modulo XII, gets its water from both sources – the river and the dam. “Section 1” of Modulo XII still gets all of its water from the river itself, using the river water concession from the Federal Government. Depending upon the amount of river water available, Sections II and III get water from the much larger Conchos Canal, passed through Modulo II down four drainage ditches, according to Modulo’s XII general manager, Jose García (see Map 8 and Photo 5.7). A slight man from Orranteño with an engineering degree and a young family, García can quote numbers of thousand cubic meters of brute and net water used by section from memory – even if it doesn’t seem to be written down anywhere.

Map 8. The boundaries of "Modulo XII": The Saucillo Canal Water Users Association



Source: Modulo XII, 2005.


Photo 5.7. The Conchos Canal, near Estacion Conchos, provides water to the Old Saucillo Canal through four drainage canals.

“We only had about 200 liters per second of water out of the river, and it would run a little ways and then there would just be nothing in the (Saucillo) canal,” García noted. (José García, Modulo XII, personal communication with author, 2005; see Photo 5.8).

Every October, the Modulo XII president and general manager meet with CONAGUA to determine how much water they will be granted from the dam in March. Based on the amount from the dam, they divide the amount of water in Sections II and III by the number of water rights users to tell farmers how much water will be available. In February that number is adjusted slightly based on rains accumulated over the period. In 2004, for example, García was given

13,390,000 thousand cubic meters of water, enough for each of the 535 users in Section Ii and III to get 25 “millares” or 25,000 cubic meters per user right.

Photo 5.8. The Suacillo Canal as it approaches the town of Saucillo.

“But our farmers don’t think in terms of millares – which is a term common in the wider district – but in terms of the number of hectares,” he explained. “So we told them that’s a little over 3 hectares of cotton, about 1.75 hectares of alfalfa or 1.25 hectares of jalapeños.”

Whatever the farmers in Section II and III get, García grants a similar amount from the river to the farmers in Section I, God willing. The Modulo charges the water user per millar used, although again, most farmers in the district express it in terms of hectare irrigated. “We put a hectare of corn at 800 pesos, a hectare of chile at 2000 pesos and hectare of alfalfa at 1400,” García notes.

There are 712 “users” of the Old Saucillo Canal, covering some 3,979 hectares, or an average of five hectares per user (see Table 5.17). It is important to note that the number of “users” does not necessarily equal the number of farmers since one farmer may have several water rights. Thus, CONAGUA reports a total of 588 users in Modulo XII, with 212 users being part of an ejido – and covering about 830 hectares -- and 376 “private” users utilizing 3102 hectares (see Table 5.18). García says the difference between their number of users and CONAGUA’s may be due to differences in Section 1, which relies on river water, shallow wells and direct pumping from the river, as well as the “fractionalization” of the ejidos, which has led to “new” users not recorded by CONAGUA.

Table 5.17. Number of Users of Saucillo Canal Water Association (Modulo XII)

Section	Number of “Users” (1)	Hectares
I	179	1227
2	297	1291
3	236	1461
Total	712	3979

Source: Jose García, Modulo XII, 2004.
Notes: (1) User signifies a distinct user right. Some farmers have more than one water right.

Table 5.18. Land Ownership in Saucillo Modulo XII

Category	Ejido	Private Owner	Total
Water Users	212	376	588
Amount of Land	830	3102	3932
Average Size Plot	3.91	8.25	6.68

Source: CONAGUA, Distrito de Riego 005, “Cuadro de Superficie Fisica y Riego General del Distrito,” 2004.

In addition to the river water from the Canal Saucillo in Section 1 and the dam water from the Conchos Canal which is “passed through” to Sections 2 and 3, there are a number of private wells, two communal wells and a number of farmers who have dug their own “norias” – shallow wells near the river itself. Finally, there are a number of farmers who pump directly from the river, legally or not. One such legal example is the already cited 14 ejidatarios in Parritas, who have a paper right to 420,000 cubic meters per year to irrigate 70 hectares, though they have not been able to use those rights since 1995 (Tribunal Superior Agrario 1996; Talamantes, personal communication with author, 2005).

Running the show for the Modulo is Rodolfo Parras, who became its president in January of 2005 (Rodolfo Parras, Modulo XII President, personal communication with author, 2005). He said the “Old Works” association decided to join the district because of access to water and to money that would be available for water efficiency efforts.

“Everything is costly now,” the burly, mustached farmer and local politico explained. “The machinery to clean out the canals, the diesel, the sediment, lime and other costs all keep increasing since we have to clean out the canal twice a year at least.”

To compensate, the Module has had to increase the price of water, from 100 pesos per hectare to about 1400 pesos to irrigate one hectare of alfalfa. Information provided by CONAGUA and Modulo XII since 2000 show that less than half of irrigable land in Sections II and III have been irrigated as water deliveries have been limited (See Table 5.19). The water delivered differs from the water programmed because Modulo XII is able to replace some of the dam water needed by increasing river water.

Table 5.19. Water Use, Cost and Delivery within Modulo XII, Sections II and III only

Category	2000	2001	2002	2003	2004	2005
Pesos per 1,000 Cubic Meters	75	80	80	85	95	100
Amount of Water Delivered (000s)	20,050,000	15,850,000	13,911,000	22,576,000	13,985,000	13,138,000 (1)
Number of Hectares per Water Right for Medium-Demand Crop	3	2.5	2	3	2	4
Total Hectares Irrigated with Dam Water	1,518	1,222	878	1,427	1,207	1,078
Alfalfa	457	422	360	505	294	230
Pecan	532	472	325	475	533	480
Corn	457	275	163	328	220	252
Cotton	0	0	0	25	93	23
Chile	35	29	12	19	38	31
Various (Oats, Sorghum, Peanuts)	37	24	18	23	33	62
Average 1,000 Cubic Meters per Hectare Irrigated	13.21	12.97	15.84	15.82	11.59	12.19

Note: (1) Does not include nearly 6,000,000 cubic meters transferred to other districts due to lining of Saucillo Canal which prevented some farmers from using irrigation water right.

Source: For 2000-2002, CONAGUA, Distrito de Riego 005 Delicias, 2005; for 2003-2005, Jose García, Manager, Modulo XII, 2005.

The information does not include land irrigated by the river itself – mainly in Section 1 – as well as by the individual and community wells and is thus incomplete. Still, the amount of hectares irrigated has closely followed the amount of water delivered to the Modulo over the last six years. It is clear that while the types of crops have not changed – typified by pecans, alfalfa, corn and a smattering of other crops – the amounts have, particularly with a slight rise in the growth of chile farms and a slight reduction in alfalfa, related again to the lack of available water. Overall, farmers in Saucillo appear to be using the dam water more "efficiently" over the last two years, which is related both to the reduction in hectares of alfalfa – a high water use crop – as well as efficiencies gained due to the cement lining of the Saucillo Canal. While the table suggests a slight reduction in hectares of pecans irrigated, it is related to the transfer of some pecan orchards to groundwater and even river water, rather than an actual physical reduction in pecan groves. If anything, observational evidence suggests that pecan orchards are increasing locally.

Table 5.20. Water Use and Cropland Irrigated by Section, Modulo XII, 2004-05 Irrigation Season

Crop	Section 1 Hectares Irrigated (River Water)	Amount of Water Delivered Section 1 (Thousand Cubic Meters)	Sections 2 and 3 Hectares Irrigated (Dam Water)	Amount of Water Delivered Sections 2/3 (Thousand Cubic Meters)	Total Hectares Irrigated	Total Water Delivered (Thousand Cubic Meters)
Alfalfa	131	1834	307	4298	438	6132
Pecan	245	3185	414	5382	659	8567
Corn	63	567	279	2511	342	3078
Chile	61	1220	28	560	89	1780
Cotton	12	108	0	387	12	495
Various	55	495	43	0	98	495
Total	567	7409	1071	13138	1638	20547

Source: Jose García, Manager, Modulo XII, 2005.

A much more complete picture of total irrigation in the Modulo includes information from Section 1, irrigated by the river water (See Table 5.20). The table shows that Section 1 –relying on river water – is heavily invested in pecan orchards, alfalfa, corn and chile. These four crops make up more than 90 percent of the lands irrigated and more than 98 percent of the water used overall. In particular, in recent years farmers have invested in new production in pecans and chile peppers, while corn and alfalfa have emerged as crops for the milk and cheese industries which operate in the area. Thus, trends in Modulo XII closely mirror trends within the district as a whole, with high water-demand cash crops like pecans and chile expanding, alfalfa fairly stable, even as the overall amount of hectares irrigated has declined (Photo 5.9).

Photo 5.9. A high water demand-crop, pecans, are slowly replacing crops like cotton.

C. Managing their Water More Wisely?

In 2002, Modulo XII signed the same “Convenio” as did most other Modulos pledging to reduce their water rights if and when water conservation projects were implemented and verified.

“We weren’t really in agreement with the Convenio – to give up our water rights but it was the only way to bring money and technology,” Parras explained.

The water conservation projects themselves have been a mixed blessing, according to García, Parras and the farmers of Saucillo. When the Sustainable Water Use program began in the 2002-2003 hydrological year, CONAGUA encouraged the Modulos to try all the new technologies available – from low pressure to high pressure irrigation systems to more traditional “lining” of canals.

“The problem is that at the beginning CONAGUA obligated that we had to do these other works,” Parras explained. “They told us, “put it all in” so that the (former) president took it as a green light. A year later we realized that there wasn’t much money and the benefits weren’t going to reach many farmers, so we put it all into relining the (Saucillo) canal.” (Rodolfo Parras, personal communication with author, 2005).

Information provided by CONAGUA on how Modulo XII has spent its allotment of the monies granted under the Sustainable Use Program reinforces Parras’ assertion (See Table 5.21). Thus, in the 2002-2003 period, there were three wells that were connected to a system of tubes, hydrants and “tuberia de multicompuertas” in an attempt to improve efficiency and in essence lessen the demand on the Saucillo Canal itself. Wells were dug and connected in El Indio, Bawanca and for one individual, potentially benefiting 180 hectares and 38 individuals.

Interviews with some of those benefiting from the system confirm, however, that not all of these beneficiaries were using the system in 2005. In El Indio, for example, a 130-meter deep well was dug and 20 members of the community – all members of Ejido Saucillo -- were switched to groundwater use (Photo 5.10 and 5.11). The wells were actually dug in 1995 according to current well manager José Esteban Lara Pino. In 2002 and 2003, as part of the conservation projects, each of the 20 farmers were provided with gated irrigation tubes to irrigate their lands using the well water and had a hydrant installed on the corner of their land. In 2005, only half of the beneficiaries were using the hydrants and gated pipes together. Some prefer to simply run the hydrants into the existing earthen canals on their land, while others are not using the well water at all, in part because the cost of the water is greater. Residents must pay for the electricity operating the pump (José Esteban Lara Pino, Los Indios, personal communication with author, 2005).

Table 5.21. Works Performed under Sustainable Water Use Program, 2002-2005, Module XII

Year	Kilometers of Main Canal Lined	No. of Low Pressure Systems (Gated Pipes) (2)	Number of Hectares on Low Pressure System (2)	Number of Farmers Served by High Pressure Sprinkler Systems (2)	Number of High Pressure Irrigation System (3)	Number of Hectares Covered by High Pressure Irrigation Systems (3)	Number of Farmers Served by High Pressure Irrigation Systems (3)
2002-2003	8 kms	3	180	38	16	208	9
2003-2004	8 kms	0	0	0	0	0	0
2004-2005	14 kms	0	0	0	0	0	0
2005-2006 (1)	5 kms	0	0	0	0	0	0
Total	35 kms	0	180	38	16	208	9

(1) The 2005-2006 is the estimate of the work that will be performed in Modulo XII based upon the amount of money earmarked and the cost of lining the main Saucillo Canal.
(2) Total capacity of the system. In some cases, not all hectares and beneficiaries are using the low-pressure irrigation system.
(3) Total capacity of the system. Not all systems are in operation and not all hectares are being irrigated using these high-pressure irrigation systems.

Source: Jose García, General Manager, Modulo XII, 2005 and CONAGUA, Residencia General, Distrito de Riego 005 Delicias, 2005.

Photo 5.10. Community Well, Los Indios is opened for business by manager José Esteban Lar Pino of Los Indios.

The high-pressure systems also enacted under the high-profile program in Modulo XII have been slightly more successful, and are all being used to irrigate pecan fields. According to García, six of the nine systems are operating, although he notes “these wealthier farmers were already investing in wells and high-pressure systems.”

Photo 5.11. Hydrant in Los Indios. Note that the hydrant has not been connected to multi-gated pipes.

The lining of the Saucillo Canal itself has been an amazing undertaking. In the 2004-2005 period, two different contractors were busy relining some 14 kilometers of the 43-kilometer canal (see Photo 5.12). According to Parras, the result has been mixed. On the one hand, the water has come more quickly down the canal, and is more efficiently delivered. On the other, a series of delays in construction and the simple fact that as the canal is lined some users do not have access to water for irrigations, has been problematic.

Parras said that there have been two types of reactions to the change. Those who are already efficient water users "can irrigate twice with the same amount of water," while those that irrigate more don't like it because there is physically less volume being released from the main canal, or “they have soils that are too sandy.”

Pedro Mata, who oversees the construction firm Roma Obra Civil, runs one of the companies lining the old Suacillo Canal and says they lined 3.5 kilometers of the canal in 2005.

“The folks from the Modulo want me to finish the whole canal because they know I have experience, but I have to compete against about 18 firms just to get the contract, and CONAGUA does it by points and cost,” Mata explained. He complained that the other firm currently doing work on the canal – DEUSA – from a neighboring state “uses people to do their work with no experience in cement.”

Photo 5.12. The lining of the Suacillo Canal turns an earthen canal into a modern irrigation canal.

“In the end constructing a canal is easy, simple,” Roma remarked. “The real test for these Modulos will be in preventative and maintenance work to make sure the works last more than a few years.”

Photo 5.13. Lining of the Saucillo Canal. Some have complained of shoddy work and said that improper base material has already caused break-ups of cement on the Saucillo Canal.

The interruptions in service and the high price of water have also led to a new market in water rights that didn’t exist before Saucillo’s entrance into the District. Those unable to irrigate due to the relining have often temporarily sold their water right to others for a sizable sum. Thus, in 2004, according to García, farmers in Saucillo were selling their 25,000 cubic meter water right for some 6,000 pesos, or more than twice what they were being charged by the Modulo. In 2005, García said that nearly 6 million cubic meters of water were transferred from users in

Modulo XII to users in neighboring Modulos when the lining of the canal in the middle section of the Modulo prevented them from irrigating.

'It's really simple economics," explained García. "When water is scarce and the price is high, there is a market to sell water rights. When water is more plentiful, there is less incentive for farmers to sell."

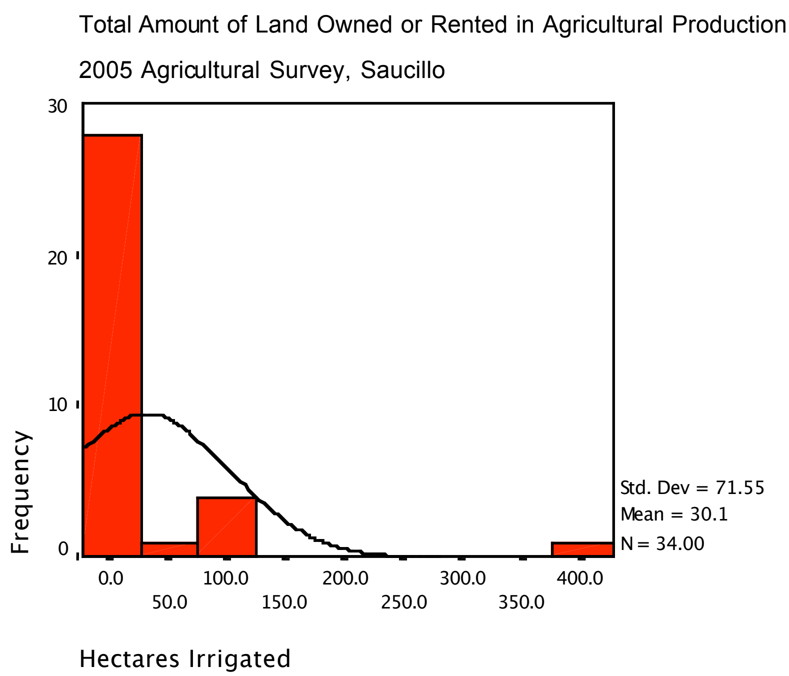
D. The Farmers

During September of 2005, 35 surveys were conducted with farmers in the Modulo XII region. In three cases the farmers were not official "users" of Modulo XII. Two were farmers who rented property in the Modulo but owned property in another area, while another had his land on the other side of the river outside the Modulo altogether, and was relying on pumping river water and local groundwater to irrigate a pecan field, corn and alfalfa. The first two cases were included in the survey because the farmers were using Modulo resources, while the final case was not. In some cases, the surveys were conducted on farms and at other times in residences. All of those interviewed were male, which is not surprising, given that the vast majority of both private land owners and ejido members are male. Appendix A contains a copy of the survey instrument used. This section will highlight several of the major factors related to the drought and its impacts, changing factors in agricultural production, the water conservation projects, and the organizations that assist the farmers. While the present chapter presents an overall summary of the survey results, more detailed survey results from Delicias are available from the author upon request.

1. Land Use

Overall, most farmers surveyed -- 22 out of 34 – planted on 10 hectares or less of land rented or owned in 2005. The information from the surveys indicate that ejidal land owners tended to be small with the hectares more or less normally distributed, with most private farmers also fairly small with a few outliers. (See Figure 5.1).

Figure 5.1. Distribution of Total Amount of Land Planted that is Owned or Rented In Agricultural Production, 2005, Saucillo Survey (N=34)



Source: Reed, Saucillo Survey, Respondents 1-34, 2005.

Based on these responses, the farmers were divided into different categories: ejidal farmers (n=13), small private farmers (n=9) and large farmers (n=12). While different respondents grew different crops, in general the larger farmers were more likely to grow pecans, alfalfa and corn, while smaller farmers whether ejidal or private tended to grow corn and alfalfa as inputs to dairy cows, as well as to a lesser extent pecans, peanuts and chile peppers. In general, larger farmers tended to have more established contracts for their products – be it growing pecans for Bimbo – or corn or alfalfa for large dairy operations, while smaller farmers either used the crops as inputs to their own cattle or sold their chile peppers, peanuts or pecans to the highest bidder, often waiting till the last minute, at least according to local observation.

A recent trend in the pecan industry has been the use of biological controls, itself partly influenced by the U.S. market (Herbert Gutierrez, Nueces Chihuahua personal communication with author, 2005). Part of this effort has been promoted by the local Junta Local de Sanidad Vegetal, which sells biological controls and even added a beneficial insect to its logo to emphasize biological control (Photo 5.14). While many of the smaller farms use "native" criollo pecan nuts –wild pecans which line the sides of the Conchos River – the larger farmers tend to be more mechanized and have larger, shinier "Western" or "Wichita" nuts, which fetch a higher price on the local and world market, not only because they are preferred but because they have more "meat." (see Photo 5.15).

Photo 5.14. Logo of local agricultural extension agency, Saucillo, 2005. The beneficial wasp was added in 2005 to the logo to emphasize biological control.

A recent entry into the local chile market is Rex Internacional, a U.S.-based company which built a chile processing and package center in 1992 in Chihuahua. In 1997, they moved the plant to Saucillo (see Photo 5.16). In 2005, the plant had over 80 contracts with growers in the Delicias area, many of them with private growers with access to well water. They also buy from local growers without guaranteed contracts. All of the chiles are turned into chipotle sauce or dried and exported to the U.S. for use in food, dyes or cosmetics (Javier Grajeda, Rex Internacional, personal communication with author, 2005).

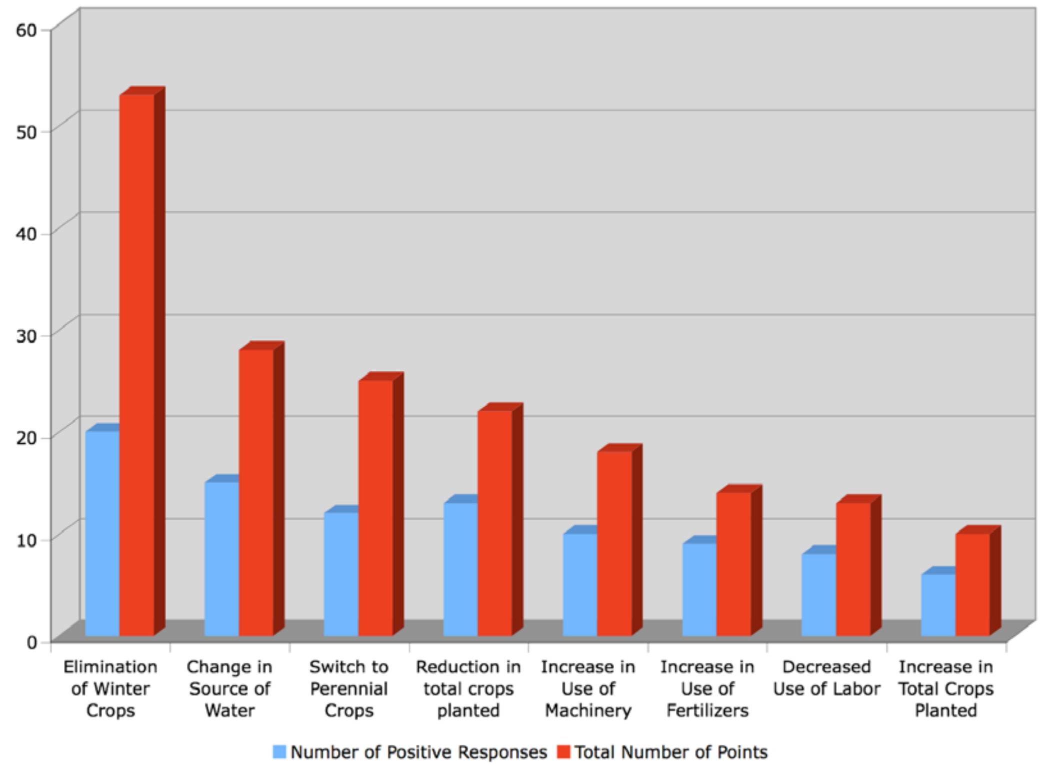
Photo 5.15. Farmers use a traditional way to shake the pecans down, 2005. Modern pecan mechanized tools have increased yields, and decreased labor costs, but are only accessible to farmers with larger “economies of scale.”

Photo 5.16. Trucks wait outside of Rex Internacional, one of the leading purchasers of chile peppers, Saucillo, Delicias Irrigation District, 2005.

2. Agricultural Change

Both large and small farmers were asked through the survey instrument the major changes that occurred on their farms since 1995 and why. Among the major changes cited by Saucillo farmers were the loss of winter crops like wheat, rye grass and oats; shifts in water source – from river water to alternative sources like "tajos" – holes dug near the river -- communal wells, district water and individual wells and in some cases, direct pumping of the river; the switch to perennial crops –virtually all related to pecan production -- the reduced amounts of hectares irrigated; the increased use of technology – both for pecans and chile peppers; the corresponding decreased use of labor; and the increased use of fertilizers (see Figure 5.2). A handful of farmers reported growing more hectares than previously, related to the buying or renting of other lands or use of new water sources. A few farmers reported using more pesticides – mainly those growing chile pepper and corn --- while some pecan farmers reported using less pesticides as they switched to biological controls.

Figure 5.2. Agricultural Changes reported by Saucillo Farmers in Total Responses (N=34) and Total Points (Maximum = 102)

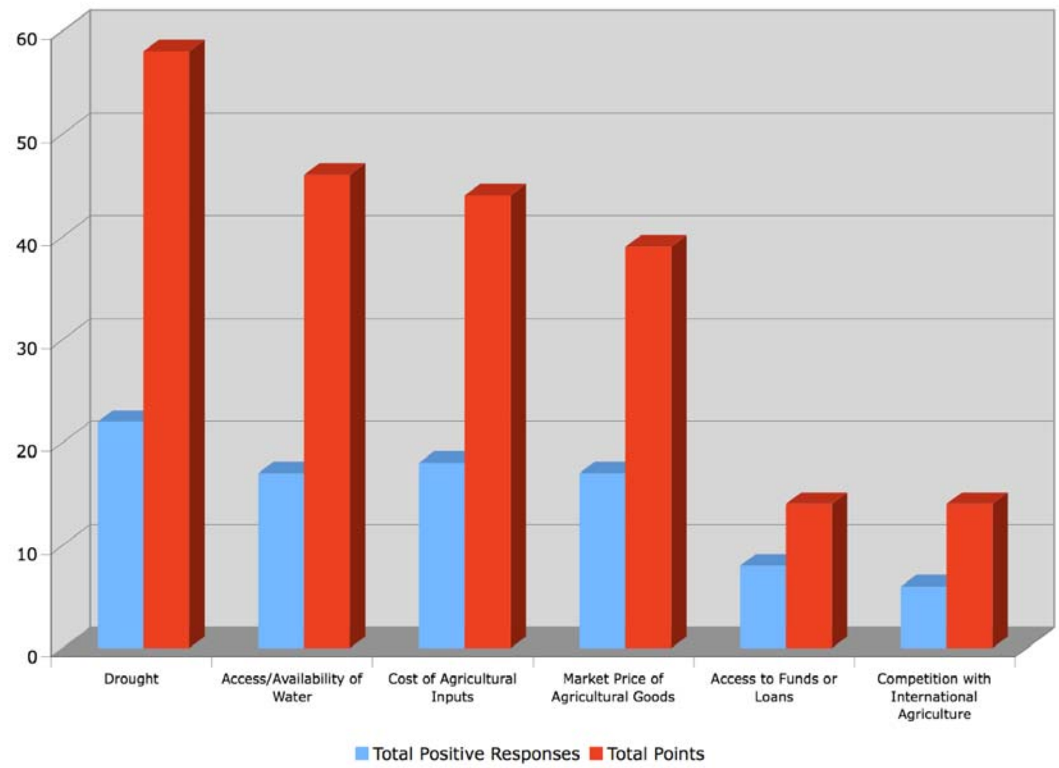


Note: One point was assigned for a "small" change, two points were assigned for a "medium" change and three points were assigned for a "large" change.
Source: Reed, Surveys 1-34, Saucillo 2005.

There were differences between large and small farmers. Thus, while all farmers cited the elimination of winter crops as a major factor, large farmers were much more likely to cite a change in water source and the increased use of machinery than smaller private or ejido farmers, and small farmers and ejido farmers were much more likely to say they had reduced the total amount of hectares irrigated than large farmers. Finally, of the six respondents who said they had increased the total number of hectares irrigated, five were “large” private farmers.

What caused farmers to make these changes? Again, not surprisingly, the major factors were both natural – the drought and lack of access to waters of the Saucillo Canal – and market-based – the change in the price of inputs and the profitability of some crops like corn, winter wheat, pecans and chile peppers. The first two had declined their profitability – though corn was still used as a dairy input -- while the last two had increased their market price in recent years. Unfortunately, these last two were also the biggest water users and tended to favor larger rather than smaller farmers. (See Figure 5.3). Other factors cited by respondents included access to funds or loans – the drying up of credit principally related to the government-backed Banco Rural – and competition with international producers, mainly related to corn and wheat production.

Figure 5.3. Factors Related to Agricultural Changes, Saucillo Farmers in Total Responses (N=34) and Total Points (Maximum=102)

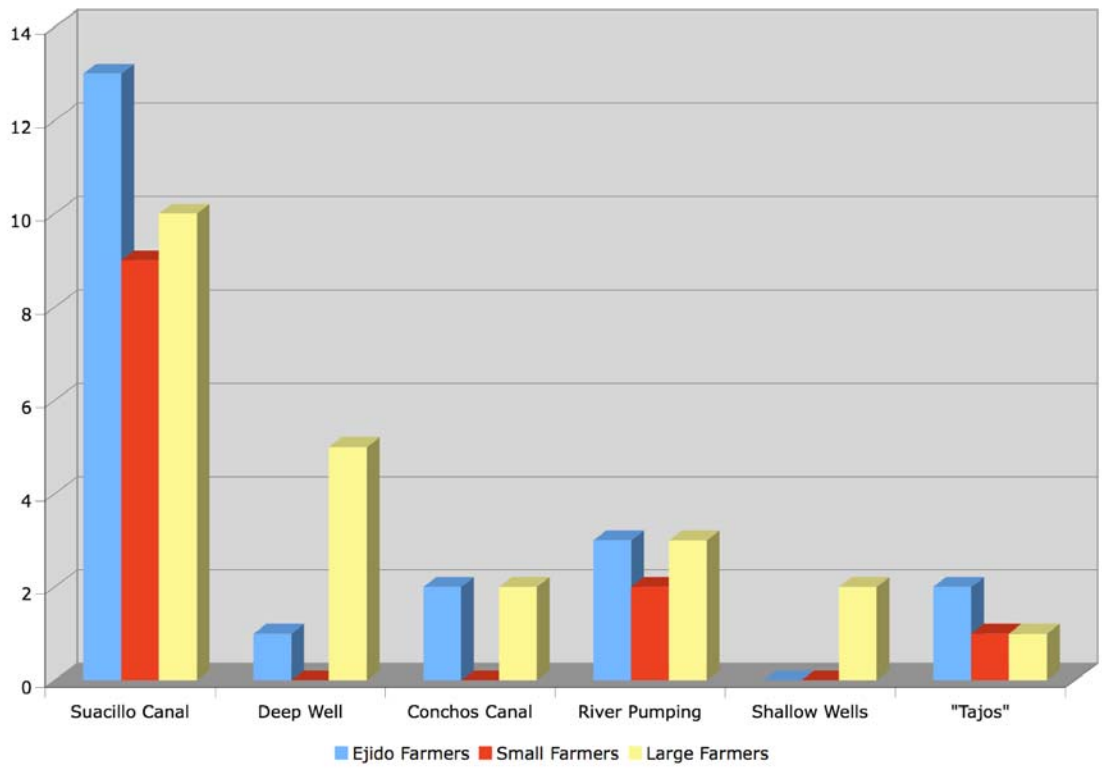


Note: One point was assigned for a "small" change, two points were assigned for a "medium" change and three points were assigned for a "large" change.
Source: Reed, Surveys 1-34, Saucillo 2005.

3. Water source and drought

Actual water use in the fields of Modulo XII is a complex, variable mosaic, as farmers use, buy and sell their "normal" water rights from the Saucillo Canal (and Conchos Canal), and augment that water with water from other sources. (see Figure 5.4). Thus, one ejido farmer said that he primarily uses the water from the Saucillo Canal, but at times he will augment it by pumping water from the river. A small private farmer said that he has water rights but often sells them for money, and then makes use of his tractor to pump water from the river directly to a drainage ditch surrounding his alfalfa field, which he then connects to gated pipes (see Photo 5.17). Some farmers also use "Tajos" a hole dug in the ground to collect rainwater, groundwater and runoff which is then pumped. In fact, 19 out of the 34 surveyed reported having made changes in their water source between 1995 and 2005, a stunning number.

Figure 5.4. Sources of Irrigation Water Used by Saucillo Farmers (N=32) by Category of Farmer in 2005



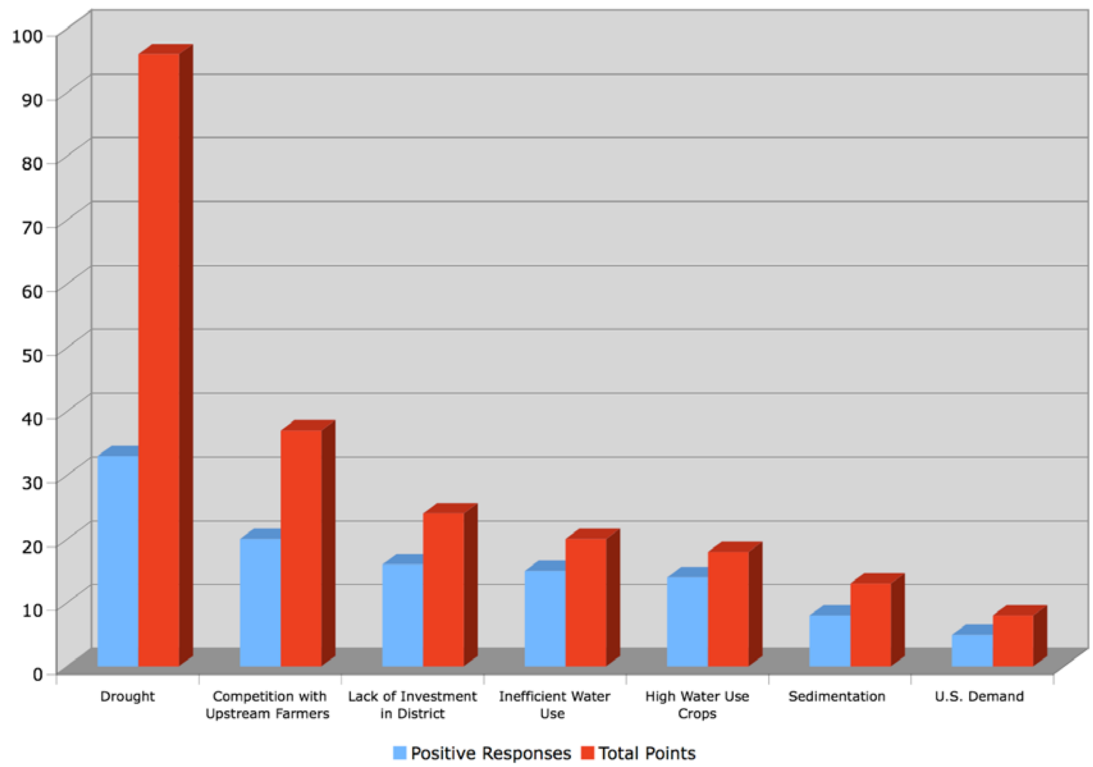
Source: Reed, Surveys 1-34, Saucillo 2005.

Photo 5.17. This field was irrigated by pumping water directly from Rio Conchos using a tractor and then irrigating his alfalfa field, using a combination of old and new technology, such as gated pipes.

The change is related to the sudden lack of access to river water in 1995, access to funds for water well drilling and more recently, water conservation projects, and the decentralization of water management which has allowed for more "creativity." All but one of the farmers surveyed in Saucillo agreed that there had been a severe drought. In terms of its causes, other than the obvious lack of rain and drought itself, farmers also cited the increased competition with other traditional farmers upstream which relied on old-style canals to pump the river water, the expansion of the irrigation district in the 1980s and lack of investment in the Saucillo area, poor water management and inefficient water use, and the expansion of high-demand water crops. Secondary factors included sedimentation of the rivers, canals and dams and the U.S. demand for water.

Thus, farmers in Modulo XII blamed nature – the drought – their government – for expanding the district and then not investing properly – the market – favoring high demand water crops -- and themselves – for wasting, stealing and pumping water – for the water management problems. Such responses belie a simple explanation and show that unlike U.S. and Mexican politicians – focused on a single explanation of declining flows – farmers recognized that the lack of flows involved economics, water management and natural causes.

Figure 5.5. Factors cited by Saucillo farmers related to the lack of available water since 1995 in total responses (N=34) and total maximum points (N=102)



Note: One point was assigned for a “small” factor, two points were assigned for a “medium” factor and three points were assigned for a large factor.

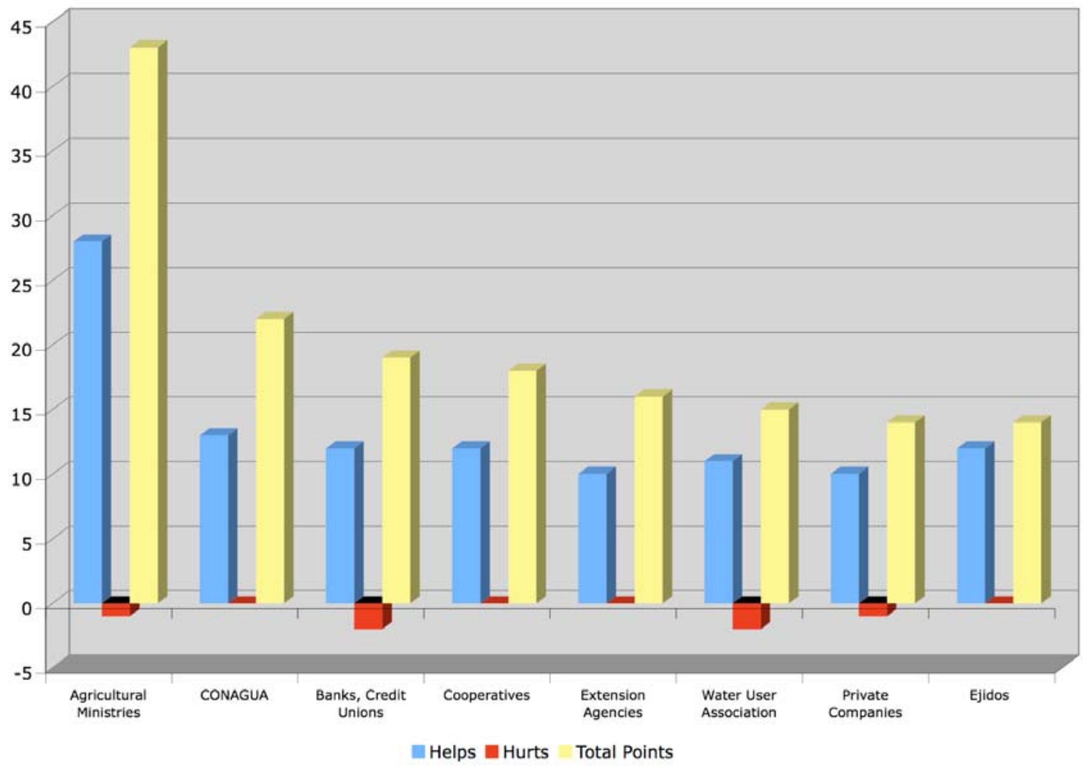
Source: Reed, Surveys 1-34, Saucillo 2005.

The water conservation projects were generally well received. Thus of the 26 respondents who chose to answer the question, 20 rated the conservation projects as good or very good, another 2 said they were “normal,” three said the conservation projects were poor and one ejido member said the project had been “very bad.” Virtually all farmers felt it made sense to conserve water, although most assumed that they could both use less water for the same amount of crops but also expand production. They generally believed the projects were benefiting all farmers in the region, with some exception for smaller farmers who felt they had been left out of its benefits, and virtually none felt the projects had been imposed upon them. Most – 21 out of 34 – agreed or strongly agreed that the projects were related to the dispute with the U.S., and that some of the benefits would flow to the U.S. They did not necessarily like this, or feel it was fair that Chihuahua was paying back the debt and not other states, but recognized the reality of the treaty.

4. Organizational Issues

Just who helps the farmers of the Saucillo canals? Unlike the relatively abandoned farmers of the upper Conchos watershed, there is a surprising number of government, cooperatives, associational and private organizations assisting farmers. Topping the list are the municipal and federal agricultural ministries, which provide the ProCampo subsidy payments, access to loans and grants for agricultural technology, and special projects, such as roofing, corrals and fences. CONAGUA – the water ministry – also received praise, most of it related to the new water conservation projects. Other support came from banks – including Credit Unions – the ejidos themselves, the water user association and private companies with contracts for farmers. These included Rex, the chile purchaser, and Bimbo, which purchases pecans. While there were some individual complaints about some of these organizations – such as private companies or banks had abused the terms of contracts or loans– there was also many success stories, such as a Saucillo Cooperative to buy inputs cheaply and a government-led milk processing center which purchased milk from small farmers at favorable prices (see Photo 5.18).

Figure 5.6. Who helps the Saucillo Canal farmers? Positive and negative responses (N=32) and Points (Maximum = 96)



Note: One point was assigned for a "small" help, two points were assigned for a "medium" help and three points were assigned for a "large" help. Negative points were assigned for organizations that "hurt" farmers.
Source: Reed, Surveys 1-34, Saucillo 2005.

Finally, farmers were asked questions about the water management association itself, and the transfer to the Delicias Irrigation District which occurred. Most – 22 out of 34 – felt the transfer had been of benefit, with eight saying it had been a disadvantage. The primary benefit was of course the access to dam water, as well as the increased access to water conservation monies. The big disadvantage was not surprisingly the increased cost of water as the Module began charging district-level prices.

Noted one unhappy ejido farmer “they charge double the price for water and there is no difference in the service. Before they charged less and if we needed something fixed we did it ourselves, now we have to pay them to do it.”

Photo 5.18. The Saucillo Cooperative was cited by 11 farmers has having assisted them by lowering input costs. Other cooperatives cited included the LICONSA milk cooperative.

E. Concluding Thoughts: Saucillo

In a 10 year period, the farmers dependent upon the Saucillo Canal witnessed a sudden transformation. An historic drought – coupled with hundreds of straws along the Rio Conchos itself – dried up their river to the point that they needed emergency “loans” of water from the Delicias Irrigation Districts as they pursued an actual water concession from the La Boquilla Dam. By the 1998-99 irrigation season, the small historic water user association had joined the District Itself, and rather than relying exclusively on their river water from the Tortuga Dam, they combined it with water from both the dam and larger Conchos Canal. In the meantime, farmers had found every way imaginable to get water when they needed, from wealthier pecan farmers using government, bank and their own resources to dig deepwater wells, to ejido and smaller farmers pumping water from the rivers, initiating “community” wells or digging shallow “noria” wells or “tajos” – holes in the ground -- along the banks of the Rio Conchos. In 2002-2003, the Rio Saucillo User Assocation signed the documents to participate in the “Sustainable Water Use” projects and began granting monies to pecan farmers to install sprinkler systems, while finally beginning to line most of the 100 year-old Saucillo Canal with cement. By the following year, when they observed how little monies were actually available, they abandoned the individual on-farm conservation project in favor of attempting to reline the entire 43 kilometer Saucillo Canal itself, a job which had fallen short of expectations due to budget cuts, the rising cost of cement and some problems with contractors hired to do the job.

Farmers blamed the lack of river water – and the need to turn to additional water sources and water conservation– on natural factors – the drought – along with management issues, which ranged from competition with upstream farmers for water, overextension of the Irrigation District in the 1980s, and water waste. In addition, farmers reported that economic conditions had led them to concentrate their water resources in higher water-demand crops like alfalfa, chile and pecans.

Thus, along with these changes in water use and conservation came changes in crop production. The winter crop – wheat – was abandoned in favor of basic grains and grasses – alfalfa and corn – for dairy cows, and more remunerative crops like chile and pecans. In general, wealthier farmers concentrated their efforts on pecan production, while land-poor farmers concentrated on inputs to their small dairy farms for domestic production. Inputs to the farm itself – pesticides, fertilizers and machinery – generally increased, although interestingly many farmers did turn to "organic" controls for pests or organic fertilizer for crops in an effort to meet consumer demands and reduce costs. The changes in crops and inputs were themselves related not only to changes in water availability, but also to larger changes related to markets and the entrance of Mexico into the North American Free Trade Agreement. The farm along the Saucillo Canal had become a "glocalized" community as farmers negotiated relationships locally, but with an eye on the larger economy. In these relations, local cooperatives, including government-supported efforts like the Milk Collection Centers, played an important role, even as the ejido structure itself appeared to weaken with land and water rights becoming more concentrated in the hands of wealthier farmers.

Farmers generally supported the need to join the larger Irrigation District, which gave them access to more water concessions and conservation projects, even as it increased the cost of water itself.

V. Nuts: The Peanut Fields and Pecan Orchards of San Pedro

A. History and Geography.

Franciscan missionaries settled the area of Rosales in 1649 to convert the Tapacolme Indigenous and take advantage of waters from the San Pedro river, and in 1714 " Nuevo Vizcaya" general Juan Antonio Tresviña y Retes donated the lands to the Franciscans to found what was then called the Santa Cruz, Tapacolmes Mission on the banks of the Rio San Pedro (Esparza Terrazas 2004: 52; Photo 5.19). In 1753, the mission and town moved to its present location, and it was named after Mexican insurgent leader Victor Rosales in 1831 (see Photo 5.20). Some 17 years later it would be the site of a major embarrassment for the Mexican Army, when Chihuahuan governor Angel Trías was seized by the forces of Sterling Price, just days after the Treaty of Guadalupe Hidalgo had been signed in 1848.

The roots of the present large-scale irrigation go back to the 1850s when wheat, corn and cotton were grown through make-shift diversion dams, earthen canals and river water flooding of the Río San Pedro. Most of this farming served the needs of the four large Haciendas in the area: Delicias, San Lucas, Casa Blanca and San Pablo (Meoqui). In 1882, the other major town in the area – Congregación Ortíz – began as a train station on the Chihuahuan Railroad and at the time was known as “Estación Ortíz.” Ortíz was the family name of the owners of the Hacienda Casa Blanca and one of the wealthiest families of the area. As workers of the Hacienda and outsiders drawn by commerce from the train station began to locate there, the locals began to organize and following the Mexican revolution, asked to be recognized as an ejido. They demanded approximately 1,000 hectares of farming land – taken directly from the Ortíz hacienda – which was granted officially in 1924 by the Governor (Esparza Terrazas 2004: 355).

The other large ejido in the area – Ejido Rosales – emerged in the early 1920s, as workers of the large Haciendas – Delicias, San Lucas and Casa Blanca -- and residents of Rosales itself began to demand their own land to irrigate, as well as land for ranching and cattle raising. In 1930, their demand was initially approved by the Chihuahuan Governor, although without the associated water rights. After six years of legal battles, in 1936, a presidential resolution created the Ejido

Rosales, granting 540 ejido members nearly 6,000 hectares, about 2,300 hectares of which was “susceptible” to irrigation (Esparza Terrazas 2004: 358). Today, ejido members live in Rosales or some of the smaller communities like Orinda.

A similar story is a much smaller ejido called Casa Blanca, which also formed as a result of the break up of the Casa Blanca Hacienda. The Ejido Casa Blanca was formed in 1936 and began with 27 ejidatarios, 100 hectares of farmland and 500 hectares of “common use” land, basically quarries and rangeland for cattle. By 1948 – with the arrival of the dam and San Pedro Canal, the ejido was expanded to 63 members – each with rights to four hectares of land, and for the most part there have been few changes in the 915 hectares of irrigable and communal lands. By 1968, the town of Loma Linda which still is “not on a map” had become a reality and electrical lights and a rudimentary water system were installed. (Ejido Casa Blanca Comisariado, personal communication with author, 2005).

“Here was just wilderness, and they decided to form a population center,” the ejido Comisariado explained. “At first they called it “La Morita” after a little place that sold food and goods – they say it was named after the lover of one of the Hacienda owners -- but then everyone began to call it Loma Linda (Beautiful Hill).”

Photo 5.19. Photo Municipal Palace, Rosales shows mural of Tapacolmes Indigenous along the San Pedro River.

With the completion of the Conchos Canal in 1932, which connected the waters from the La Boquilla Dam to the Rio San Pedro about 8 kilometers to the west of Rosales, "Conchos" water became available to the Rosales/Meoqui area, and some 20,000 hectares of irrigated land were added between 1932 and 1935 (Esparza Terrazas 2004: 322). This irrigation was thus the direct result of land tenure decisions – breaking up the three large Haciendas in the area – as well as the availability of more water (Esparza Terrazas 2004: 331).

Photo 5.20. Old Aqueduct marks the spot where water was carried and used in an old wheat mill in the 1700s just outside of Rosales near the former mission.

Irrigation expanded considerably in the area with the completion of the dam. Begun in 1941, but completed in 1949, the De Las Virgenes Dam, or more officially Francisco Madero Dam, lies about 15 kilometers to the southwest of Congregación Ortíz and 8 kilometers to the west of Rosales. Some 2,000 Mexican workers helped construct the immense structure, and for many years a town called "Las Virgenes" was located there and included stores, bars, schools and homes. It was at that time larger than Rosales itself. (Esparza Terrazas 2004: 324). The name "De Las Virgenes" refers to two rocks that supposedly resembled women that now lie beneath the water of the dam itself. Two giant statues of heroic looking women line either side of the dam's wall at the exit to the San Pedro River itself. Today, families from Rosales, Delicias and nearby towns flock to the reservoir. Mariachi musicians also congregate there, hoping for tips in return for songs. At the dam's outlet, other families and small children swim in the river to beat the hot summer days (Photo 5.21).

Photo 5.21. San Pedro River downstream of Madero Dam.

About a kilometer down, however, lies the real economic engine of Rosales and nearby communities: the San Pedro Canal, which diverts hundreds of millions of cubic meters from the San Pedro itself, and makes its way, snakelike, along the base of the local mountain range (Photo 5.22). Crops are varied, but near the canal, you are likely to spot peanuts, corn, chile, alfalfa and, more obviously, pecan orchards, young and old. About eight kilometers along the Canal, down in the valley below lies the town of Rosales, with its church steeples and adobe and concrete homes. Continue along agricultural fields, and you will pass a series of “ejido” towns, including Orinda, Loma Linda and in the distance, about 3 kilometers below, Congregacion Ortíz.

Photo 5.22. The San Pedro Canal runs below local mountain range above the valley of Rosales.

A very different perspective is gained by following the river. The San Pedro still flowed mightily after the dam was built, but between 1995 and 2005 lost much of its pizzazz. The river itself essentially dies after a few kilometers, becoming a trickle among a huge river bed, which is overgrown with grasses, lilies and cattails (Photo 5.23). Some agricultural land along its banks has been abandoned as farmers who relied on “federal rights” to pump river water were forced out of business, unless they had access to well or dam water. Pecan and pistachios trees long abandoned wilt in the summer heat. Huge pockmarks in the alluvial soils and sands just downstream of Rosales itself, toward Ortíz and along the highway near Delicias. Along the highway which runs from Rosales to Delicias are dozens of family pool areas so that families can escape the afternoon sun under umbrellas, or slide down a water slide into cool waters. By the time the “river” reaches Julimes, the official meeting of the Conchos and San Pedro, it is nonexistent, unless local rains have turned it into a river once again.

These are the lands of the Asociacion de Usuarios de Rosales, known more technically as Modulo VI, a small “module” which depends upon the San Pedro River waters, associated canals and some communal wells to irrigate its sloping, rocky terrains, and alluvial valley. Like the Suacillo Canal area, this geographic region has its own story, individually and communally, of what has happened since the availability of water was reduced in the mid-1990s.

Photo 5.23. The Denuded Rio San Pedro near Rosales is often used as a mining source for local roads.

B. Module VI (Rosales) 2005

Just outside Congregación Ortíz, on an early September morning, a group of farmers gather along the entrance road which connects to the larger country road going either to Rosales to the right, Meoqui to the left, or Delicias straight ahead. About 15 of them mill around the decaying stump of an old cottonwood tree. They say that before drought socked the area in the 1990s, this tree was alive and gave much needed shade. They are waiting for "El Canalero," the canal operator for this section of Modulo VI. A young and energetic sort, Jacinto pulls up in his Modulo-issued pick-up – complete with the User Association's emblem – representing an Indian, a Spaniard, crops and water – goes to the front and pulls out "the book of accounts," which is full of figures for each plot of land and farmer that has land in this section. This is the last month of the 2004-2005 irrigation season, and farmers are anxious to settle accounts.

Pedro, a middle-aged ejido farmer who lives in Ortíz, approaches him with a questioning gesture and Jacinto, leafing through the book, says "You have exactly 481 pesos of irrigation left – two irrigations from wells or four irrigations from the dam. How many more times are you going to irrigate?"

"Just once… Ok maybe twice, but I am going to see if it rains first," responds Pedro.

"Go to Chiapas or Veracruz, because it's not going to rain here," laughs Jacinto.

Irrigation in Modulo VI is a complex task in an a region which has been held up as the poster child for efficient irrigation and a region that has made the transition from water "overuse" to conjunctive use of well and dam water without – for the most part –losing productivity or abandoning agriculture. In fact, the reality is more varied, with some smaller ejido farmers abandoning agricultural, some outside wealthier farmers paying a premium to utilize the land and water abundant here, and many middle farmers doing both: using their land in the summer with their water rights and renting their land in the winter for use by “outside” onion and other winter crop farmers using the communal water wells (“Beto” Serrano, Modulo VI President (2001-2004), personal communication with author, 2004).

Photo 5.24. Dead tree stump outside Congregación Ortíz is the designated place to meet the “Canalero” to ask for water from communal wells or the dam and settle accounts.

At 5,062.58 hectares – virtually all of which are irrigable – Modulo VI is one of the smaller Modulos and is the first in line to get its water from the Francisco Madero

Dam (see Map 9). This irrigable land is divided nearly equally between "private" land and land owned by members of one of the three ejidos. A small portion of the land is "federal" lands, where 37 individual farmers have gained access to water rights outside of the water provided by the Irrigation District, either based on river water or other sources. This also includes approximately 70 hectares in the "Casa Blanca" ejido that does not have access to dam water – or for that matter any water – unless other needs are met first. In all, there are 692 "users" of water, including the 37 with federal water rights, 237 private farmers and 418 farmers who are members of ejidos. However, plots of land are often under various the names of various members of a single family, and in reality, the number of individuals who actually use the land is much lower than 692 (Beto Serrano, personal communication with author, 2005).

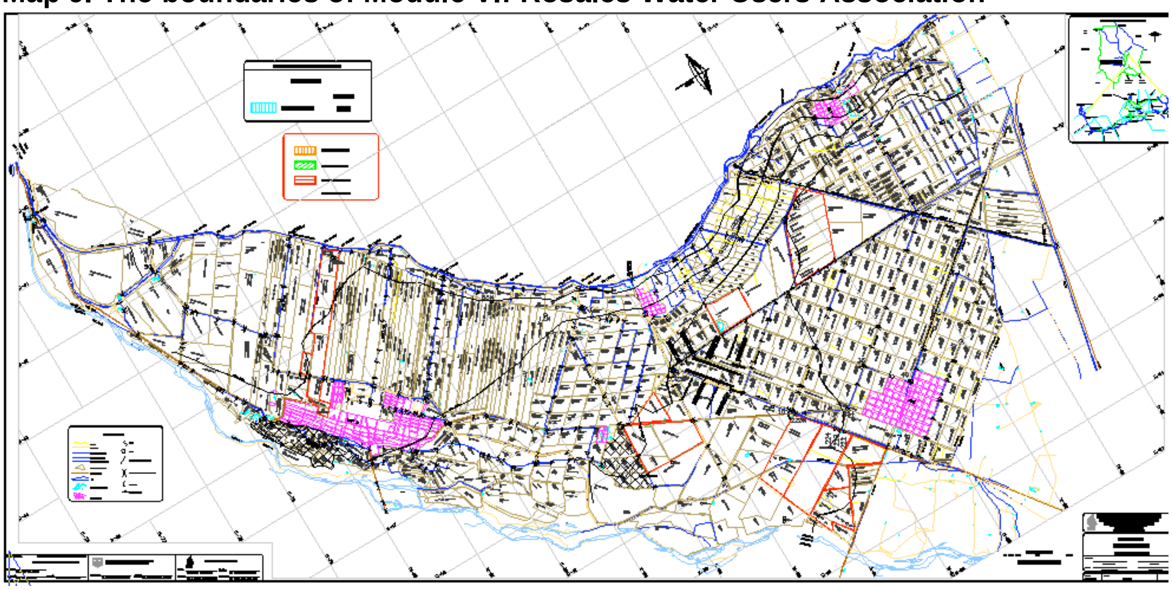
Not including the main San Pedro Canal itself – which is operated by the Sociedad Rural Limitada San Pedro -- there are some 77 kilometers of canals, approximately half of which had been relined with cement in 2004. In addition to the series of canals connected to surface water from Las Vírgenes, Modulo VI is also home to 21 deep wells, including 12 in the eastern half of the Modulo run by the Ejido Ortíz, three dug for the benefit of the Ejido Rosales – only one of which was operating in 2005 – and six individual wells, used to irrigate pecan orchards. Finally, over the last several years, many of the canals have been augmented or replaced with pipes and tubes for efficiency purposes (see Table 5.22).

Table 5.22. Basic Information about Modulo VI

Category	Sub-category	Amount
Area	Total Area	5,062.58
	Irrigable Area	4,961.26
	"Private" Irrigable Land	2,533.12
	"Ejido" Irrigable Land	2,290.53
	Federal Lands	137.61
Users	Total	692
	Private Farmers	237
	Ejido Farmers	418
	Federal Zone Farmers	37
Wells	Total Wells	21
	Private Wells	6
	"Communal" Wells	15
Canals	Total Kilometers of Secondary Canals	76.75
	Number of Miles of Canal that had been relined, 2004	31.295

Source: Modulo VI, information provided to author, 2005.

Map 9. The boundaries of Module VI: Rosales Water Users Association



Source: Modulo VI, 2005

C. Crops and Water Use

Data provided by CONAGUA about Modulo VI seriously undercounts the amount of water used and crops grown in the Module because it does not include information on well use. Data provided by Modulo VI also undercounts the amount of water used and crops grown because it does not include information on "private" well use but does provide information on communal well use.

Still, incomplete information provided by Modulo VI shows stunning changes in crop choice and water use between 1992 and 2005. In the 1991-1992 year, for example, Modulo VI reports that its farmers irrigated 3,578 hectares of crops, using 48,941 thousand cubic meters of water in the process. Two years later, that total – largely spurred by huge production in winter wheat – topped 5,663 hectares of irrigated cropland with 68,764 thousand cubic meters utilized. Farmers in Modulo VI split their land nearly evenly between perennials, winter crops, spring-summer crops and second summer crops, with each category having more than a thousand hectares planted.

Then came the drought. With Francisco Madero only releasing small amounts of rationed water, both winter and 2nd summer crops were largely eliminated, and only 498 hectares of crops were irrigated with 4,962 thousand cubic meters of dam water in 1995. While 1997 and 1998 totals matched the pre-1995 period, the total amount of cropland irrigated with *dam water* ranged between 1,185 and 2,180 hectares, while total dam water utilized hovered between 12,500 and 30,000 thousand cubic meters. However, while both individual and communal well water had been used in the area since 1995, in 1999, new well construction and the interconnection of all 12 Ortíz-owned wells suddenly gave the water users association a new source of water that could be managed, controlled and priced.

Beginning in 2000, the Module carefully measured and delivered this communal resource, in essence “replacing” dam water with well water. Thus, when this water is included, 2005 levels of irrigated crops, with 3,365 hectares irrigated and 37,421 thousand cubic meters of water used by Modulo VI farmers – and their renters -- was similar to 1992 levels.

Hidden in these overall totals, however, is a remarkable and varied history of changing crop patterns. Winter crops have all but disappeared, 2nd summer crops like sorghum, soybeans, fall corn and fall peanuts have been eliminated, perennial crops have stayed fairly steady and spring-summer crops like chile, onions, peanuts and cotton have actually increased.

Winter wheat is a case in point. With the exception of 1997, when winter waters were made available from Francisco Madero Dam for wheat producers, wheat had all but disappeared from Modulo VI by 2005, except for a few producers who use well water to grow a small amount to sell for seed production. Sorghum and soy production – which before 1995 were largely late summer/early fall crops – were no longer present in 2005, while corn is still prevalent, though considerably reduced. Perennials – alfalfa and pecan production – have seen ebbs and flows, though they appear to have stabilized between 2000 and 2005. It is important to note that while dam and communal wells appear to irrigate about 300 hectares of pecan groves, another 100 or so are irrigated by six private wells. In fact, information obtained from Modulo VI showed that in 2005, in addition to the 315 hectares of pecans irrigated by dam or communal well water, another 132 hectares were irrigated by private wells, meaning that the same number of hectares of pecans were being irrigated in 2005 as in 1992, although not necessarily the same groves (Modulo VI, Padrón de Cultivos, 2004-2005, information provided to author, September 2005).

Photo 5.25. Pecan groves irrigated by "rebombeo" water –water repumped as canal water passes in foreground.

Other crops have increased their presence, including spring onions, chile peppers, cotton – heavily subsidized in recent years – while peanuts have maintained their historical presence. Interestingly, both chile peppers and onions are generally high water-demand crops. As the survey results show, there are a number of factors for these changes, but several relate to the interconnection of communal wells that occurred in the 1999-2000 period, and the subsequent use of water conservation funds to move the well water by tube and low-pressurized PVC pipes with gates for on-farm irrigation. These changes allowed farmers in one geographic region greater and more efficient access to communal well water that could be used for their own crops or to rent their lands to wealthier outside farmers for chile and onion production (Photo 5.26).

Table 5.23. Irrigated Cropland from Dam and Communal Well Waters, Modulo VI, 1992-2005

	Wheat	Cot-ton	Pea-nut	Corn	Sorgh um	Soy	Chile	Onion	Alfalfa	Pecan	Total
1992	0	8	737	447	640	366	351	0	475	445	3,469
1993	1148	0	343	933	322	419	225	41	578	470	4,479
1994	1274	34	956	1028	150	220	207	20	662	476	5,027
1995	0	46	170	75	0	0	36	6	45	83	461
1996	20	238	428	261	30	2	108	42	28	375	1,532
1997	431	381	1551	588	54	95	321	62	377	636	4,496
1998	6	224	1809	183	38	35	273	13	394	595	3,570
1999	0	166	1188	166	10	0	77	7	255	313	2,182
2000	37	108	1645	201	33	5	251	51	352	433	3,116
2001	38	187	915	219	7	0	264	175	304	431	2,540
2002	0	26	649	143	17	0	297	274	308	398	2,112
2003	0	295	523	288	38	6	319	260	361	323	2,413
2004	23	501	459	90	26	0	242	274	232	275	2,122
2005	17	230	1105	450	11	0	394	354	393	315	3,269

Source: Module VI, Information Provided to Author, 2005.

In 2005, Modulo VI was staffed by a total of 14 permanent employees. Every three years, elections are held and a President, Vice-President, Treasurer, Secretary and a “Vigilance” committee are elected from the wider membership. From 2002 to 2005, Humberto “Beto” Serrano, a middle-aged ejido and private farmer from Congregación Ortíz served as President. A former government bank official charged with making agricultural loans, and currently a sales manager for one of the leading tractor manufacturer, Beto is a middle-sized major peanut and chile pepper farmer in the region, owning and renting both ejido and private lands within Modulo VI.

“I wanted to see if I had what it takes to lead Modulo VI,” Serrano explained. “I wanted to guide the association through this change to tecnification and efficiency of water.”

Photo 5.26. Winter onions were grown in this rented field outside of Congregación Ortiz, utilizing water from the communal wells.

D. Water Conservation

The "tecnificación" he says, actually began several years before, when Congregación Ortíz sought funding to interconnect its 12 deep water wells. "Rather than each well basically serving one area, we wanted to make it part of the actual structure of the Modulo," he said. He said that in 1999, the work was finished and suddenly 960 hectares of land owned by the ejido had the potential to use water from the 12 wells, although actual on-field interconnections and replacement of canals with pipes, "hydrants" and PVC tubing occurred after CONAGUA made the NADBANK and other monies available in the 2002-2005 period.

Even though Serrano recognized that "efficiencies" from water conservation projects could lead to reductions in their water rights, he said nearly everyone was in favor of the NADBANK and federal monies "as long as they (CONAGUA) could document the (water) savings."

"If they were going to reduce the (water rights) concession, the concession was still going to be able to cover our needs, and that (concession) isn't even real because we haven't ever used it or even had that much water," Serrano explained. "The real vision is how do we maintain agriculture and not lose people to migration," said Serrano, father of two college-aged boys.
"How do we keep the next generation?"

Photo 5.27. Model of Congregación Ortíz Conjunctive Use Irrigation System Sits Inside Module VI Offices

The answer, says the engineer, was to make sure there is water and it is well-distributed, particularly for a region "that needs more water than other areas because it is earth with a lot of rocks." Rosales earth – particularly as you move upslope toward the San Pedro Canal -- is rocky (see Photo 5.28). A 1967 soil survey conducted by CONAGUA describe the "Rosales" soil thus:

> *Suelos de abánicos aluviales al pie de las colinas con perfil uniforme de migajón arenoso con abundancia de material gravoso y permeable en casi todo su extensión. Subsuelo gravoso y arenoso, condiciones de drenaje buenas, color rojizo, situacion topografico: Faldas, lomas y pequeños aranico aluviales, mesetas.* Tiposo Migajo Arenosa F gravosa, Migajón Arenoso abónicos pedregosos, Franco. CONAGUA 1967

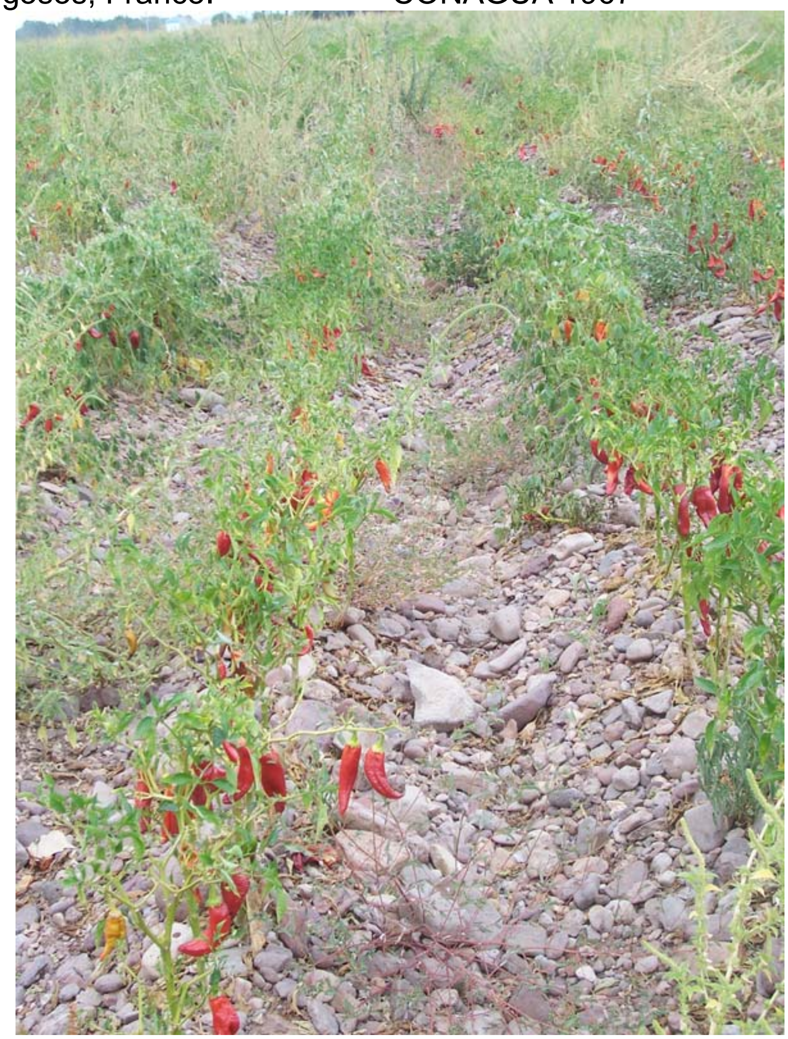


Photo 5.28. View of a typical chile pepper field on Rosales "rocky" soils.

The rocks mean that crops are often protected from freezes – the rocks maintain heat – and potentially from some evaporation – but it also means sometimes the water doesn't get down in the soil to the roots. Properly watered, crops – particularly peanuts and chile plants – appear to fourish in the rocky soils, and peanut yields in Rosales are sometimes one and a half to two times yields in the Saucillo area.

But that takes water, and Serrano jumped on the conservation monies. If the Modulo's own water accounting methods are correct, the Modulo VI did see a stunning transformation in terms of water efficiencies over the last five years as Dam Water went from 65 to 84 percent efficiencies and communal well water – the water that irrigates approximately 1,000 hectares within the Module – went from 65 percent to 92 percent over those same years (Table 5.24).

Table 5.24. Water Delivery Efficiencies in Modulo VI, AY 2001 – AY 2005

Agricultural Year	% of Surface Water Efficiency (Brute Volume of Water vs. Net Volume of Water)	% of Communal Well Water Efficiency (Brute Volume of Water vs. Net Volume of Water)
AY 2001	65.20%	65.00%
AY 2002	64.00%	78
AY 2003	66.00%	95
AY 2004	76.00%	90
AY 2005	84.00%	92

Source: Modulo VI, 2005.

To accomplish this transformation, Serrano says they started by insisting that every farmer in Ortíz have access to a "hydrant" and "tuberías de multicompuertas" (gated pipes) while also concentrating on the "18 pecan groves," to make sure "I benefited them with new technology." After those water users were satisfied, Serrano said the vision was to move upstream toward the dam to convert canals into pipes and bumpy lands into smooth lands with "tubos" de multicompuertas.

“It’s like a piece of birthday cake that you get to share each year, and the idea is that everyone gets a piece, piece by piece, not all at once,” he explained.

Still, he notes, “you can’t make everyone happy,” and so since the sections of the Modulo nearest to the dams did not benefit he also pursued the drilling of communal wells near Rosales itself. Using a “loan” from the government-subsidized Programa de Desarrollo Parcelario (PRODEP), Serrano says they took out more than 5 million pesos of loans for new machinery as well as another 3.5 million pesos to rehabilitate, drill and electrify three communal wells. “The trouble was we drilled five holes and only two provided any water,” he noted, somewhat sadly.

Thus, in the 2002-2003 period, there were outlays to 18 pecan farmers to install high-pressure sprinkler systems – based either on private wells or “rebombeo” – actually pumping surface water from a central water storage area for further distribution using spray irrigation– and two other systems including a “Side Roll” and drip irrigation system for large alfalfa farmers -- covering 475 hectares of land in all -- as well as the leveling and installation of “tuberia de multicompuertas” in Ejido Ortíz. Under Serrano’s leadership, the 2003-2004 period completed the northern section of the Modulo with leveling and tubing, “modernizing” another 700 hectares and 104 farmers with low-pressure systems. In the 2004-2005 agricultural year, under new leadership, the wealth was spread, with an additional nine farmers –mainly pecan groves – receiving high-pressure spray systems, another 17 farmers in the southern (Rosales) end with about 287 hectares of land having their lands “leveled” – in preparation for future systems – and about 70 farmers in the “middle” section with approximately 370 hectares of land switched to hydrants, tubes and gated pipes (see Table 5.25).

Photo 5.29. This secondary canal is replaced by underground tubing emerging at a hydrant as Modulo VI attempts to make water delivery more efficient, 2005.

Unlike the farmers in Ortíz, who were hooked up to their communal well water systems, the farmers in the middle section would rely on gravity pressure as former distributive canals were replaced with tubing just downslope from the San Pedro Canal itself (Photo 5.29). Thus, as part of the water distribution transformation, the secondary canals were replaced – or at least circumvented – with below-ground tubes, emerging at above ground hydrants.

Table 5.25. Investments and Benefits of "Sustainable Water Use Program," Delicias Irrigation District, Modulo VI, Rosales, Chihuahua

Category	Sub-Category	2003	2004	2005	Totals
High-pressure spray Systems	Number of Hectares	424	0	70	494
	Number of Users Benefiting	18	0	9	27
High-Pressure Drip Irrigation System	Number of Hectares	22.8	0	0	22.8
	Users Benefiting	1	0	0	1
High-Pressure Side Roll	Numbers of Hectares	28	0	0	28
	Users Benefiting	1	0	0	1
Total High Pressure Systems	Number of Hectares	475	0	70	545
	Users Benefiting	20	0	9	29
	Total Investment	$10,678,783	0	$1,814,766	$12,493,549
Tubing and Low-Pressure Irrigation Systems	Number of Hectares	313.6	687	359.5	1,360.10
	Users Benefiting	23	104	70	197
	Total Investment	$11,171,848	$18,392,646	$7,931,174	$37,495,668
Land Leveling	Number of Hectares	320.9	0	283	603.9
	Users Benefiting	50	0	17	67
	Total Investment	$1,296,684	0	$1,814,765	$3,111,449
GRAND TOTAL		$23,147,316	$18,392,646	$12,160,213	$53,700,175

Source: CONAGUA, Residencia, Distrito de Riego 005, Information provided to author, 2005.

New Modulo VI president Jaime Rodriguez (2005-2008) says that the decision to put most of the conservation funds – as well as the profits from their operations – into Ejido Ortíz and larger private farmers, rather than spreading the wealth to other areas, was partially necessary because of technical and geographic reasons. Still, he said that "Ortíz and the large private farmers" benefited more from the money, and he ran specifically on the idea "that everyone should be treated equally … and maybe we need to help the "fregado"[12] more." (Photo 5.30). Underscoring his theme to help "the fregado," his opponent in the race was one of the area's most successful private farmers from a family with historical roots in the area, dating back to before the Mexican revolution. (Jaime Rodriguez, Modulo VI, personal communication with author, 2005).

Among his charges, he believes, is not to focus so much on "tecnificación" but on the day-to-day work of the Modulo, such as maintaining the distributive canals and fixing the systems of dirt and cement roads. Still he says "we have to learn how to irrigate better – we have leaks, breaks of the tubes, robberies – we are still in a process of adaptation – at the farmer level, at the Modulo and in CONAGUA."

[12] Literally the "screwed."

Photo 5.30. Those who benefited the most from the water conservation monies are the Ortiz farmers with their hydrants and gated pipes and individual private farmers with systems like the Sideroll.

Rodríguez said one change is to make sure the actual beneficiaries of the new irrigation technology know how to use it. He will do this, he says, by insisting the companies have a meeting at the Modulo offices with all the farmers benefiting even before any work is done on their land. “I want the farmers to be present when they discuss installing their systems or when they level their land,” he explained, noting that in the past, some farmers – particularly the older ones--never communicated with the contracted companies and then never learned how to use the equipment properly. This view was confirmed with interviews with local contracted companies.

Like his counterparts in Saucillo, Rodriguez arrived to his presidential offices with some bad news. The original budget of $16 million pesos out of the total $433 million budget for the fourth year of the water conservation projects would be reduced to only $9 or $10 million out of $230 million (Lauro Fernandez, Delicias Irrigation District, CONAGUA, personal communication with author, 2005). With only 70 percent of the expected budget, their plan to complete the replacing of canals with pipes was put on hold. In addition, the price of the PVC tubing itself had risen astronomically – due to higher oil prices and transport costs.

E. Water & Land Markets in 2005

The other challenge for the Modulo is their own budget. To run the Modulo, the Modulo charges its users one amount for the dam water and another amount for the communal well water. Farmers have a right to buy a certain amount of water each year based on the concession from CONAGUA. The arrangement and pricing of water has changed over time (see Table). Before 1995, when no wells had been built, the Module sold water on a per-hectare basis, depending on whether a crop was high or low water, and there was no limit to the number of irrigations. In 1995, the Modulo switched to a price-per-volume basis, and began to impose an allotment on each farmer, depending on the overall concession given to them by CONAGUA. At the height of the drought – in 1996 – farmers were only given 16,000 cubic meters – enough to irrigate one to two hectares of land – while in recent years they have been given approximately 30,000 cubic meters – enough to irrigate three to four hectares per water right.

In addition, in 1995, some farmers in Ortíz gained access to well water, although at that time well water sales were very limited. With the interconnection of wells in 1999, however, the Modulo developed a unique system. While well water is officially sold for more than twice the value of dam water, the Modulo allows the farmers near Ortíz to pay the reduced dam rate and use the well water within their guaranteed allotment, so that more dam water can be sold to other areas. If farmers want to use more well water then they most pay the normal well water price. In 2005, well water sold at 220 pesos per 1,000 cubic meters, about double the surface water.

In Modulo VI, the availability of communal well water has led to a market in both water and land – as farmers from outside the Modulo rent land for alfalfa, chile and onion production (see Table 5.27). While the Modulo charges a set price for water, farmers are free to negotiate higher prices for their allotments. Before the well water became available as a shared management strategy, such transfers were rare. Now, when water is scarce, farmers frequently purchase water rights for inflated prices with local Ortiz farmers often utilizing well water, but selling their dam water allotment to outside farmers.

For example, in the 2002-2003 agricultural year, data provided by the Module revealed that out of 938 “lots”, 337 lots were rented at least part of the year. In terms of land, out of 5,651 hectares of land irrigated, 2,189 hectares were irrigated on rented land. While there were a large number of renters – in fact over 100 --- several rented multiple lands and were thus major agricultural players in the Modulo, even though they themselves did not own land there. Thus, out of the 337 lots, for example, one farmer rented 33 lots covering 186 hectares, another 19 lots and 105 hectares, and another 26 lots and 126 hectares. In fact, among only 10 “renting” farmers, more than 1050 hectares of land – about a fifth of the total area -- were rented.

Table 5.26. Water Pricing, Availability and Sales in Modulo VI, 1991 – 2005

Agricultural Year	Price per Hectare – Low Demand Crops	Price/Hectare, High Demand Crops	Price/Mm3 Dam Water	Price/Mm3, Communal Water Wells	Mm3 per water right	Sales in Mm3 Within District Between Farmers
1992	145.00	270.00			No Limit	
1993	145.00	270.00			No Limit	
1994	100.00	310.00			No Limit	
1995			36	90	22	
1996			90	135	16	
1997			32	none	54	
1998			55	none	32	
1999			75	160	24	
2000			75	160	60	2,100
2001			75	160	27	2,390
2002			80	220	24	4,760
2003			85	220	29	4,325
2004			90	220	31	3,150
2005			105	220	33	2,310

Source: Modulo VI, 2005.

Table 5.27. Land Rented in Modulo VI, 2002-2003 Agricultural Year

	Land Rented	Used by Owner	Total	% of Total Rented
Number of Lots	337	601	938	35.93%
Hectares Irrigated	2,189	3,462	5,651	38.73%
Hectares Irrigated with Groundwater	309	1,758	2,067	14.95%
Hectares Irrigated with Surface Water	1,880	1,704	3,584	52.45%
Number of "Owners" (1)	105	548	653	16.08%

Source: Modulo VI, 2005. Calculations by author.

Notes: (1) For land rented, the number of different names were used to calculate the number of individuals renting. For all lands, the number of different names were counted. It should be noted, however, that often times land is divided among several brothers, or between a husband and wife, but the "practical" owner may be a single individual. Thus, the total is probable an over-estimate of the total number of individuals in Modulo VI "operating" as farmers or renters of land. The "official" number of owners, according to the Padrón de Usuarios is 693.

F. Operations

In addition to the sale of water itself – some of which flows back to the SRL and CONAGUA – the Modulo also "rents" out its machinery to farmers interested in cleaning their canals, leveling their land or performing other maintenance and agricultural field work. Between October of 2003 and January of 2005, the Modulo showed a profit of $710,062, but Rodriguez feared the debts due on the new water wells and expected increases in the cost of oil and energy would quickly eat it away.

Still, Rodriguez is generally upbeat about the Modulo's future, due he said, to their ability to change. He pointed to new projects to "grow trees" and plant nopales – prickly pears -- as evidence that the Modulo can adapt to changes in water management.

"We knocked all the trees down and there is less rain now," he said. "Now we need to grow trees."

The "growing of trees" he refers to is a project which lies between the tiny towns of Orinda and Loma Linda. The project is to use 70 hectares of ejido lands with "federal water rights" along the San Pedro Canal to grow "cevite," a kind of quick-growing cedar tree that happens to be excellent as a slow-burning wood used in cooking "Chipotle," the specialty sauce that comes from slow-cooking jalapeños, which are grown in the region (see Photo).

The ejido lands were once the site of a failed experiment to grow grapes in the 1970s and 80s, and have lain dormant in the 1990s, since the water "rights" of the 14 owners are only guaranteed when there is sufficient water in the De Las

Virgenes Dam. Rodriguez said because of the gains in efficiencies, his Modulo can guarantee the water to these users for the unique project.

The project is supported by funding from CONASA – the National Arid Zones Commission – through the Rosales' Rural Development Department. According to Rosales Rural Development director Dr. Eleazar Torres, over 40,000 tons a year of mesquite, cottonwoods and oaks are used to "cook" jalapeños in modern and makeshift chile cookers throughout the region. (Dr. Eleazar Torres, Rural Development, Rosales, personal communication with author, 2005).

"In one generation, we have eliminated the ecosystem," Torres noted sadly. The project in Loma Linda is being funded with about 500,000 pesos, and will produce about 80 tons of wood per year in four to five years.

Table 5.28. Income Sources and Expenses, Modulo VI, October 2003-January 2005

Income Category	Amount	Expense Category	Amount
Water Sales, Dam Water	$2,362,994	Operation Expenses	$2,172,173
Water Sales, Well Water	$3,070,674	Water Conservation Projects (Cleaning, etc)	$964,135
Water Sales, Recovery of Debts	$1,245,307	Payments for Machinery Loan	$965,866
Sale of Two Trucks	$23,500	Payments to CONAGUA	$115,205
Income from Renting of Heavy Machinery to Farmers	$528,306	Payments to SRL	$287,802
Government Program – PROCAMPO	$11,300	Administrative Expenses (Payroll)	$1,869,564
Maintenance Reimbursements	$10,800	Loan Payments (Wells, etc)	$172,550
Other	$4,478		
Total	$7,257,358	Total	$6,547,296

Source: Modulo VI, Estado de Ingresos y Egresos, Asamblea Anual Informativa y Para el Cambio de Mesa Directiva y Consejo de Vigilancia, January 2005.

Down the slope from Loma Linda, on land owned by an Ortíz farmer sits six brand new chipotle ovens. The ovens – built by Meoqui-based chile farmer "Chuy" Prieto – use both oak wood – shipped from the Sierra in Madero – and natural gas to cook the chile peppers over several days, roasting them in the hot sun.

Photo 5.31. These "modern" chipotle ovens were built by a local farmer who rents land for chile production in Modulo VI, near Congregacion Ortíz.

Another new project is government support for the production of Nopales. Torres says the hope is that a market will develop for the desert prickly pear plant, especially "since it's good for those with diabetes." (Torres, personal communication with author, 2005).

Photo 5.32. Nopales (Prickly Pear) on this private farm – which sits on one of the original missions in the area -- were subsidized by the government in an effort to market new low-water crops in the area.

G. The Surveys

As part of the case study of Modulo VI, the author conducted 38 surveys in the fields and homes of the farmers of Modulo VI. To ascertain the views of both smaller and larger farmers, the author made a specific effort to contact some of the wealthier farmers who often work and live in Delicias, but operate their pecan groves or alfalfa fields through hired managers in the Rosales area. Thus, on two occasions, the author conducted surveys in Delicias itself with larger owners of land. However, in every other case, during August and September of 2005, the author was able to contact owners of land either in their homes or on the field.

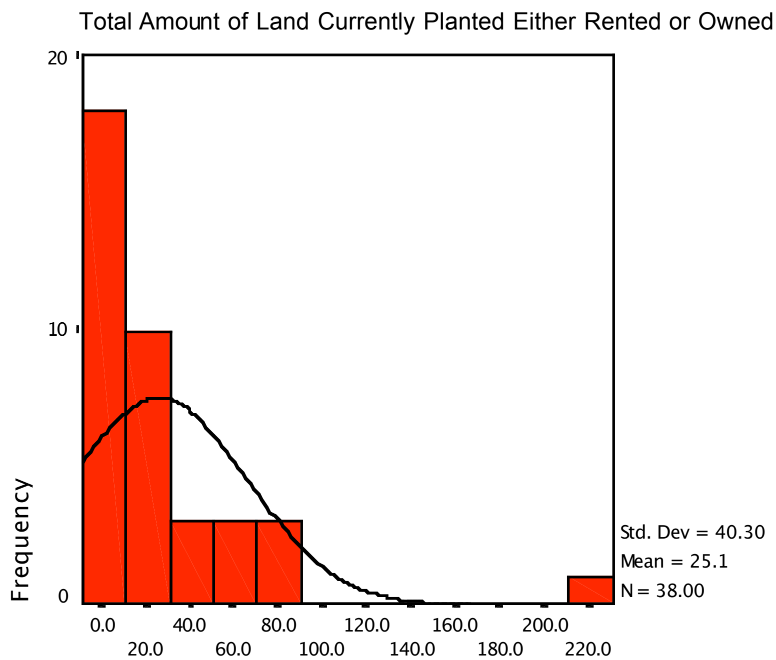
Again, because it is a relatively small simple – about 38 out of 693 "users" registered with the Modulo – about 6 percent -- the surveys were used to run simple descriptive statistics and cross-tabulations to compare small and large farmer practices– as well as to gather anecdotal information about crop choice and water use -- rather than trying to "prove" correlations or run regression analyses. Still, the surveys illuminate many of the decisions about natural resource use and crop selection faced by the farmers of the Rosales area in the post-NAFTA, drought time-period of 95-2005 and some of the key differences between larger and smaller farmers confronted by available options. They also help confirm many of the statements of Serrano, Rodriguez and other local leaders already noted above.

1. Land Use and Crop Choice

Nearly all farmers surveyed – 31 out of 38 --- had some ejidal land, although some farmers had both private and ejidal land. The 31 respondents who said they owned ejido land had relatively small plots, with 28 reporting having less than 10 hectares of land, while the seven land owners with private lands all reported owning more than 20 hectares of land. Overall, when adding up ejido, private and rented land irrigated in 2005, some 18 farmers reported irrigated 10 hectares of land or less, 13 between 10 and 50 hectares of land, and seven over 50 hectares of land. Thus, while most farmers in the district are "small" farmers, the survey suggests that both private and ejido farmers "increase" their ownership by renting additional lands from farmers who chose not to farm. Based on these sizes, farmers were categorized as small, medium or large farmers (See Figure 5.7).

Crop choice was varied, and the size of plots mattered. Thus, in terms of pecan production, while four of the 18 small ejido farmers did have small plots of pecan groves, large private farmers dominated this type of production, with seven of the eight private farmers possessing large pecan groves, ranging from 30 to 75 hectares. In terms of chile farming, on the other hand, while the smallest ejido farmers did not report growing chiles, medium-sized ejidatarios did, with eight of the 12 irrigating 122 hectares of different kinds of chile. Two private farmers also reported irrigating 26 hectares of chile peppers. In addition to the pecan and chile peppers, private farmers grew other products such as onions (1 farmer), corn (2 farmers), alfalfa (2 farmers) and peanuts (1 farmer). Small ejido farmers, on the other hand, mainly grew alfalfa (6 farmers) and peanuts (7 farmers). Medium-sized farmers, in addition to their association with chile irrigation, also irrigated corn fields (5), alfalfa (4) and especially, peanuts (10 farmers irrigating 98 hectares).

Figure 5.7. Distribution Curve of Hectares Planted in Rosales, 2005



Source: Reed, Rosales Survey, Respondents 36-73, 2005.

In the Rosales area, there are several companies that buy peanuts from local producers, but one of the most important is Montagro Industries. According to owner Ing. Hector Coluga Esparza, the nut buyer began purchasing both pecans and peanuts in 1992 but over time has come to specialize in peanuts. He said that because Mexico imports most of its peanuts from the U.S., Argentina, Chile and Uruguay, all Mexican production goes to the domestic market and the price is determined by the U.S. price. The seeds themselves are largely imported from the U.S. and in most cases, Montagro provides the seeds, fertilizers and herbicides to the farmer – but the farmer provides "the land and water." Montagro said the big change in peanut production in the Delicias area has been the reduction in hectares, but a recent increase in yield due to "water efficiencies." The big determinant in peanut production is availability of water and for the peanut-growing farmers of Ortíz, the availability of communal groundwater has allowed them to continue to grow peanuts on the rocky, high-water demand but productive soils (see Photo 5.33)

2. Agricultural Changes and Factors

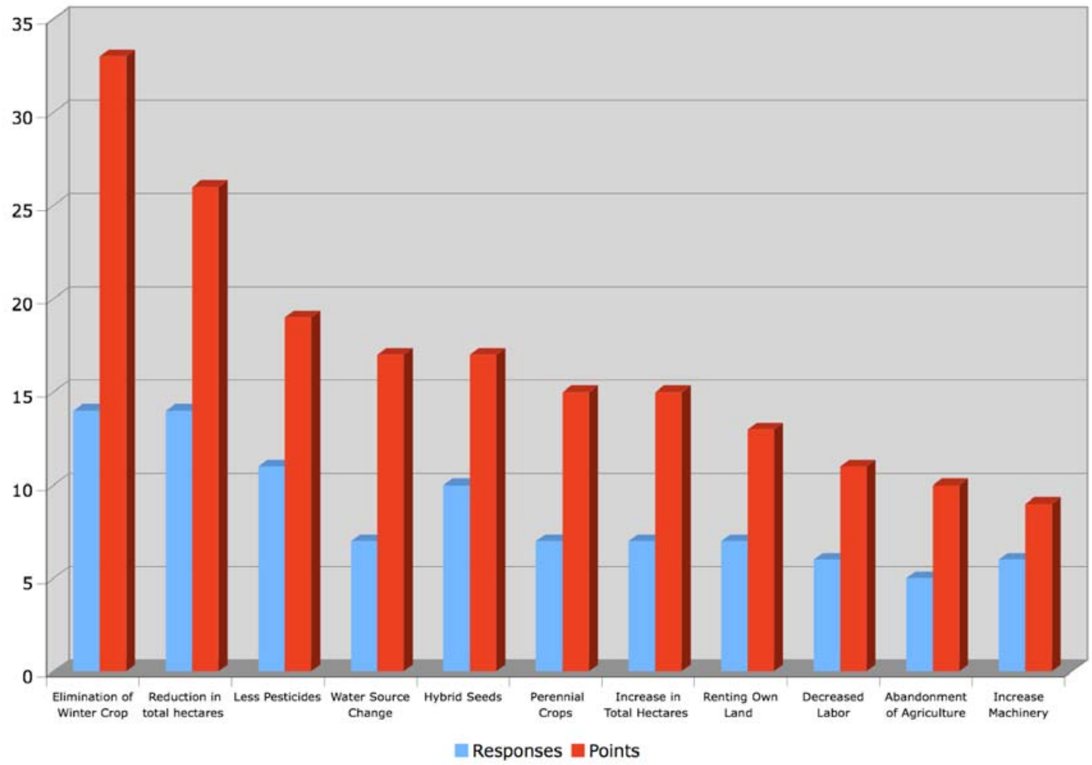
What did those surveyed say had changed over the last 10 years? (see Figure 5.8) Topping the list with 14 "positive" responses was the elimination of winter crops, the winter wheat, rye grass and winter onions that are for the most part no longer grown in Modulo VI, while 14 farmers also cited the reduction in the total amount of hectares irrigated. Still, seven farmers actually reported increasing the amount of land irrigated over the last ten years. Other factors receiving multiple responses included a "decreased use of pesticides(11 responses)," "use of hybrid seeds (10 responses)", "change in source of water" (7 responses)," "switch to perennial crops (7 responses)," "renting land to others (7 responses)," while the decreased use of labor and increased use of machinery each garnered

6 positive responses. Thus, the responses were similar to those in Saucillo though with perhaps less intensity.

Photo 5.33. *Tubería de Multicompuertas* irrigates a peanut field with well water near Ortíz, Modulo VI

There were categorical differences. While all farmers were impacted by the loss of winter crops, the smaller ejido farmers were more likely to cite reduction of their total land cultivated, of renting their own land or abandoning agricultural altogether, while medium and large private farmers were more likely to increase hectares, change their water source, switch to perennial crops, and increase the use of technology. Rather than perhaps a clear case of winners and losers between ejido and private farmers, the survey results actually demonstrate that some ejido farmers were able to adapt and become “medium” players through renting of land and access to credit and alternative water, while others abandoned or eked out a living, sometimes by relying more on dairy farms and less on “pure” agriculture.

Figure 5.8. Post-1995 Changes cited by Rosales farmers in total responses (N=33) and total points (Maximum=99)

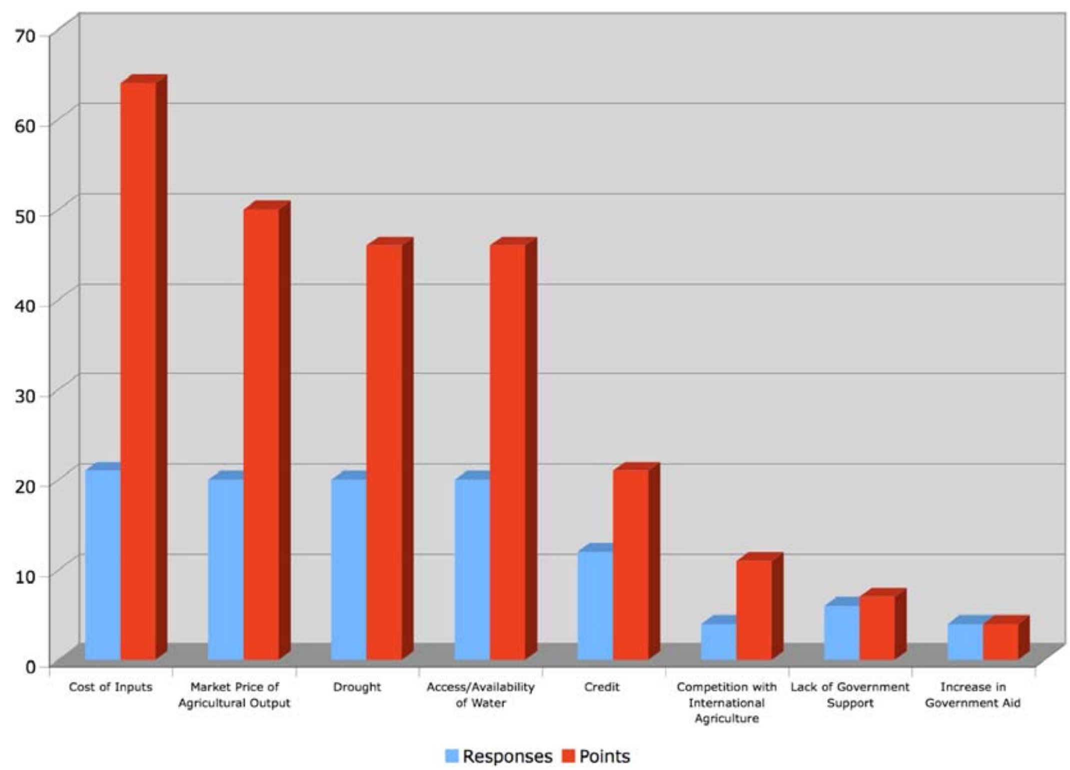


Note: One point was assigned for a “small” change, two points were assigned for a “medium” change and three points were assigned for a large change.

Source: Reed, Surveys 35-73, Rosales 2005.

What caused these changes? Perhaps of greater importance than the drought were changes in the cost of inputs and market prices (see Figure 5.9). This is probably related to the fact that many farmers were able to access groundwater and thus avoid the most profound impacts of the drought, which was not the case in Saucillo, dependent much more heavily on surface water. The responses once again indicate the importance of geography. Secondary factors included credit – either its lack or availability -- competition with international producers or government support or lack of support.

Figure 5.9. Post-1995 Factors Related to Agricultural Change cited by Rosales farmers in total responses (N=33) and total points (Maximum=99)



Note: One point was assigned for a "small" factor, two points were assigned for a "medium" factor and three points were assigned for a "large" factor.

Source: Reed, Surveys 35-73, Rosales 2005.

3. Water, water everywhere?

The survey asked additional questions about water practices, their perceptions of the "drought" and of water conservation projects which began in the Modulo VI in 1999 with the interconnection of the communal wells in Ortíz and the wider conservation projects begun in 2002 following certification of the "Sustainable

Water Use" project by the Border Environment Cooperation Commission (BECC 2002).

First of all, water management and water sources were complex according to farmers and 18 out of 38 said they had changed their primary water source since 1995. By 2005, farmers were getting water from the San Pedro Canal, from private deepwater wells, from the communal wells in Ortíz, and even by "repumping" the San Pedro Canal water from the canal to a container to then be distributed in pecan groves through modern irrigation systems. It should be noted that in addition to these methods, some farmers put a "straw" directly into the San Pedro Canal itself and pumped it out with tractors if they were unable to get water directly due to the location of their land or if there was "agua rodada" – rainwater which entered the canal during the winter off-season.

Thus, seven of the 38 respondents were using private water wells for most of their water – all of them pecan farmers – while another 12 reported using at certain times of year the communal wells of Ortiz, most of whom were peanut farmers (see Photo 5.33). Only four were not using the San Pedro Canal and dam water as a primary or secondary source. The changes in water management over the last 10 years are complex, spurred both by the changes in water rights management and ownership and the technological changes, including grated pipes and hydrants and the interconnection of deepwells.

Water rights sales are common, with 21 of the 38 surveyed saying they had bought additional water rights from some farmers or from the water user association in the last five years, purchasing 60 additional water rights in 2005 alone, a significant number in such a small sample. Eight farmers said they had sold their water rights within the last five years, including four in 2005.

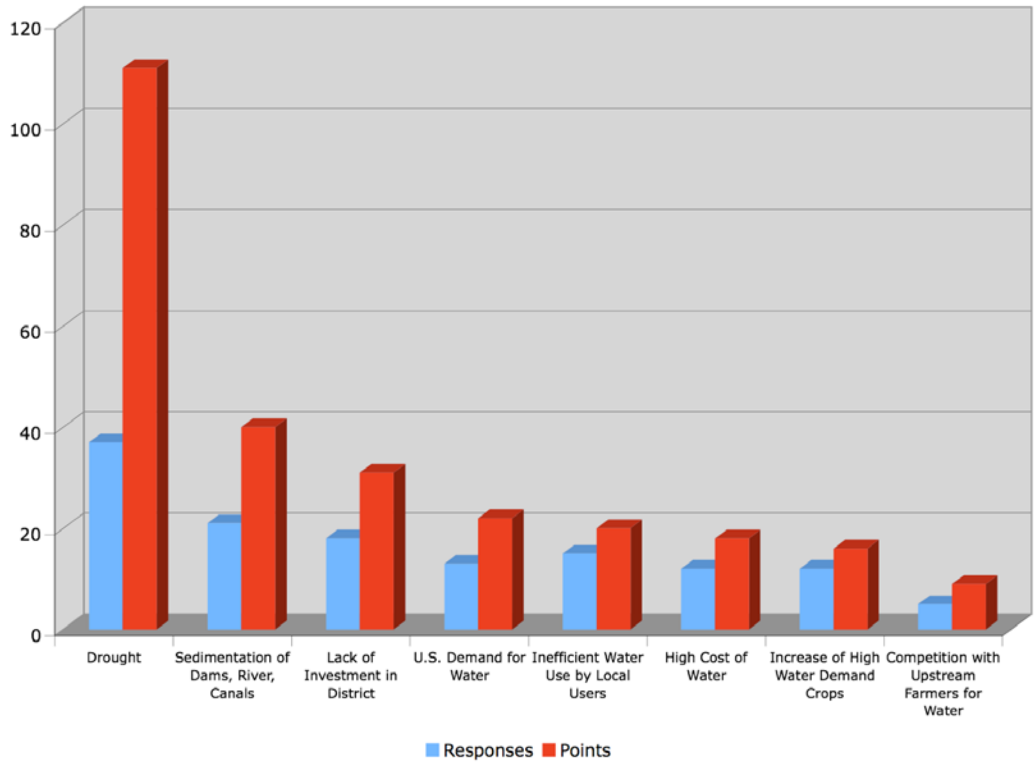
Water irrigation strategies were varied among the 38 respondents in Modulo VI. Thus, among peanut growers, “zurcos” – small ditches in which the water runs down the rows of peanuts -- was an accepted strategy – but the delivery of the water might come from the “hydrants” with gated pipes, from earth-laden canals, or “acequias revestidas” – concrete-lined canals. Those without access to the gated pipes would build little dams – presillas – to guide the water from the canals to one end of the field and then either knock the dams down or use small metal hoses to push the water by suction to the “zurcos.” One enterprising large private farmer was using drip irrigation “cintillas” – small plastic black tubes – for his alfalfa field – which he had planted first – and using “microaspersion” – a kind of minispray system aimed at tree roots for his pecan grove (Photo 5.34).

Photo 5.34. Irrigation system “a la mexicana” combines spray and drip irrigation on this pecan grove using well water.

Not surprisingly, most farmers were supportive of the water conservation and efficiency programs which have in part led to these changes. Thus, out of the 25 farmers who participated in the water conservation projects, 20 rated the projects as good or very good, and only three as being poor. When asked to respond to a series of statements about whether water conservation projects improve efficiencies, increased production and helped to share the resource, support for water conservation was widespread, even if some might disagree with particular aspects of its implementation. Only seven out of the 38 felt the projects had been imposed upon them, and only five thought they were designed to only benefit some farmers over others. There was widespread agreement – 20 out of 38 – or no opinion on the idea that the conservation projects were designed to benefit the U.S., which is of course a true statement.

In terms of the drought itself, farmers in Modulo VI overwhelmingly blamed the lack of water accessibility on the lack of rainfall – the drought. In fact, all 38 respondents not only said there had been a drought over the previous decade, but 34 said the drought had been the worst they had ever experienced. And 37 said the drought had caused the lack of available water "to a great extent." But in addition, a variety of other secondary factors – including the sedimentation of the dam and San Pedro Canal, the lack of investment in the district, the U.S. demand for the same water, some water inefficiencies by users and the rise in high-demand crops – also received a significant number of responses. When asked to elaborate on these responses, many also cited the "expansion of the district" – a factor not listed on the survey itself – as a cause, referring to lands added to the district in the 1980s downstream of the San Pedro Canal.

Figure 5.10. Factors cited by Rosales farmers leading to lack of access to water by responses (N=38) and total points (Maximum=114).



Note: One point was assigned for a “small” factor, two points were assigned for a “medium” factor and three points were assigned for a large factor.
Source: Reed, Surveys 35-73, Rosales 2005.

4. Organizational help

While farmers often complained that the government had deserted them, when asked about specific organizations, farmers did say they had been helped. Topping the list were SAGARPA – the federal agricultural ministry – and CONAGUA, the National Water Commission. As in Saucillo, the positive responses directed at SAGARPA were related to direct support from the agricultural agency, including Alianza para el Campo (Alliance for the Fields), which nine farmers cited as providing credit or grants for tractors and other machinery, PROCAMPO – the subsidy payments to former grain producers – cited by 12 farmers, ProDiesel –sometimes called “cheap diesel” – which was cited by 12 farmers, and “objective” price supports for cotton crops, cited by two farmers. In terms of CONAGUA, they largely cited the water conservation projects.

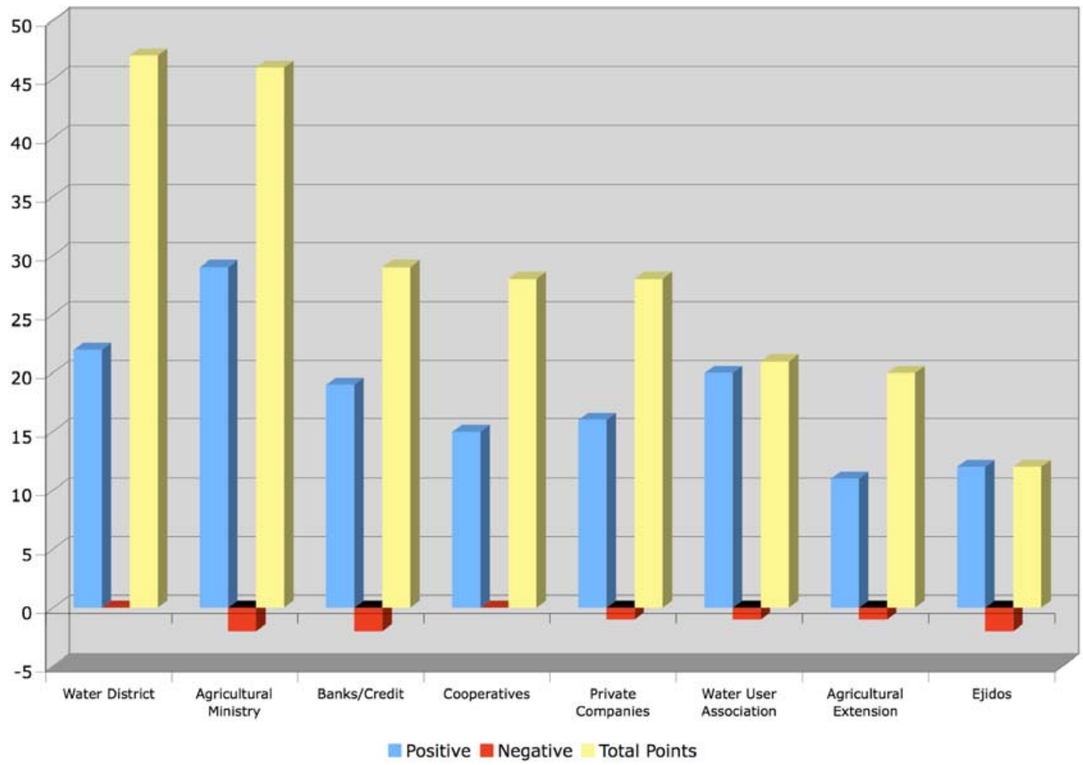
Besides these two large federal agencies, however, farmers cited a surprising number of other organizations, including banks and credit unions, cooperatives, private companies, the ejidos, agricultural extension agencies and the water user association itself. Thus, many smaller farmers cited the existence of the Milk Collection Center created with cooperative and government help (Photo 5.35), while some larger farmers spoke of ALPURA, the large cooperative dairy producer and ALCODESA, a private company started to provide inputs – cattle feed -- to large dairy operations (Photo 5.36). While there were some examples of farmers being hurt by either private companies, banks, or ejidos which had committed contract abuse or fraud, in general farmers were positive about the organizations that supported them (Figure 5.11).

Farmers were slightly negative in their opinion of the transfer of the irrigation district from the government to the water user association, with 10 citing it as beneficial, eight neutral and 17 saying the transfer represented a disadvantage. That being said, many of the negative comments were related to the idea that the cost of water had increased exponentially since the district was transferred in 1995, and there had been less water, factors which can not be “blamed” on the Modulo itself. That being said, others also felt there were too many staff members to pay for and it had become politicized with certain geographic areas benefiting more than other. Others had a more positive view, saying decentralization had led to more direct control and responsiveness, and citing the implementation of new technology and water conservation as related to the decentralization. Overall, farmers felt however that the district had been decentralized and transferred with little oversight or training by CONAGUA.

Photo 5.35. The "Centro de Acopio" in Meoqui has become an important facility for the farmers of Modulo VI, especially the small ejido farmers of Orinda and Loma Linda, who sell their milk to the state-sponsored milk collection center.

Photo 5.36. The 200 dairy cows of this private dairy farm are associated both with ALPURA, a national cooperative which buys the milk, and ALCODESA, from which he buys feed for his dairy cows.

Figure 5.11. Organizations that helped or hurt farmers in Rosales by Number of Responses (N=38) and total points (Maximum=114).



Note: One point was assigned for a “small” help, two points were assigned for a “medium” help and three points were assigned for a “large” help. Negative points were assigned for organizations that “hurt” the farmer.
Source: Reed, Surveys 35-73, Rosales 2005.

VI. Conclusions

Using in-depth interviews, personal observations and semi-structured surveys with farmers in two geographically-bounded areas within the Delicias Irrigation District, this chapter presented a case study of changes occurring in the district over the last 10 or 15 years. The chapter found that in the district as a whole, as well as in Saucillo and Rosales, profound changes had occurred in water use, crop choice and other farming practices since the mid-1990s. First of all, the overall view promoted by Mexican officials that because of an historic drought farmers in the district had been forced to make major reductions in crop acreage and water use was belied by a much more complex picture of adaptation to a changing water environment. Thus, while farmers were forced to curtail water use and acreage in both areas surveyed, data from the local Modulo leadership reveals that a major change was a shift in the period from surface water – whether from the dam or the Río Conchos – to other sources of water. In the "Old Saucillo Canal Water User Association" Modulo, this meant not only the change from pure river water to dam water through the garnering of a federal water right concession, but also to individual water wells, communal water wells, river water directly pumped onto fields, shallow "noria" wells and "tajos" – literally holes in the earth in which water percolated up to the surface for further pumping to fields. These alternative sources were often informally managed depending upon water availability.

In Rosales, on the other hand, the digging of communal wells in Congregación Ortíz became an official water management policy of the Rosales Water User Association Module itself, using Ortíz Ejido water rights to augment the dam water and use it conjunctively. The interconnection of the 12 water wells in 1999 fundamentally changed water management strategies in the Module. In addition, wealthier farmers sought and gained permits to dig water wells of their own in the post-1995 period, and several pecan groves – the largest water users but also the most profitable crops – made the switch to private well water. The opening up of alternative sources of water allowed farmers – particularly the larger farmers – to keep and in some cases expand production of perennials like pecans and alfalfa at a time when these crops were "officially" being discouraged through a permit and cap system.

Furthermore, these "alternative" water sources were usually not reflected in CONAGUA data on water use and crop irrigations, meaning the "official" story presented to U.S. diplomats, press and others was – if not deliberately misleading – partial at best.

Still, in addition to the finding of the expansion of water sources, interviews, observations and surveys found that the lack of available water and changing market conditions did lead to painful changes for farmers. Thus, the efforts to grow some grains – such as wheat, sorghum and soybeans –all but disappeared in both regions as farmers abandoned or were forced to abandon winter crops. Corn – while still a major production crop in the area – had also seen major changes, with farmers more likely to turn to “modern” hybrids produced by subsidiaries of Monsanto and DuPont, mainly as cattle feed. In fact given the rising costs of water and other inputs, many farmers used both alfalfa and corn not as a cash crop, but as an input into their dairy farms.

For many crops – such as peanuts, cotton and pecans – mechanization had increased yields, but also increased the costs of inputs. Farmers increased the use of machinery whether through purchase, loans or subcontracts.

Farmers in the region had no doubt that one of the major causes of their woes was the drought itself, which was cited by virtually all farmers as the cause of loss of water and productivity. Nevertheless, in Saucillo, there was the recognition that competition with upstream users – from the other traditional farming communities – sedimentation of the river and canals – and inefficiencies in water use had also played a role. In Rosales, farmers did not on the whole blame their own management practices, but instead the lack of investment in the district and the decision – for purely “political” reasons– to expand the district downstream to “bad” lands near Julimes and Lázaro Cardenas.

Concern or anger about potential “stealing” of their water by the government or the U.S. was surprisingly mute. Farmers did not feel that they were being coerced into conservation, but recognized that they had to adapt to a new reality. They had, in fact, a much more “binational” focus than one would expect, while feeling that given new realities the water treaty should be renegotiated. Thus, the “coerced” conservation thesis espoused by Peluso and others did not appear to be a factor for farmers in Suacillo and Delicias, perhaps because of the participatory aspects of the water conservation projects, which were run through the Modules and not directly by CONAGUA (Peluso 1993).

The water conservation projects were not without controversy. In Saucillo, initial efforts to reline the old Saucillo Canal – which all users share – were scaled back to also support the interconnection of communal wells with more modern irrigation equipment and “repumping” spray irrigation systems in private pecan wells. Smaller ejido farmers generally viewed these efforts with suspicion. Subsequently, the user association has focused solely on relining the Saucillo Canal, but was beset by delays, poor construction and decisions by CONAGUA to lessen the requirement for the thickness of the lining. Still, farmers felt the efforts were worth it and it made sense to reduce water rights so long as they could continue to water their fields – or even expand production.

In Rosales, the improved efficiencies and availability of groundwater appeared to favor the larger farmers and “medium”-sized ejidatarios of Ortíz, who took advantage to expand production or rent land or water rights to larger-scale farmers for chile, onion or peanut production. Benefiting less – at least at the time when the surveys were conducted – were smaller farmers in the hills above the Ortíz fields. Often forced to abandon agricultural lands, or reduce irrigated surfaces, many were forced to in essence turn their efforts toward dairy production. Some farmers from Loma Linda couldn’t irrigate at all since their rights were based on a “Convenio Precario” which only allows irrigation when water is plentiful. Several began experimentally with government assistance to grow nopales and Sivetre trees as an input to the brewing of chile chipotle sauce.

The chapter also supports generally the glocalization thesis. While the state – whether through funding for water conservation projects, support for nopal or tree-growing, SAGARPA payments to farmers and some continued government bank support – continues to play a huge role in farmers lives, local associations and organizations had become the method to negotiate with the larger market economy and U.S. investors. Thus, smaller farmers in both locations used diary cooperatives and associations to collect and transport their milk to local milk collection sites, while other farmers signed contracts with private chile companies. Ejidos – long the association that helped hold farming communities together and an important actor in negotiating political solutions – no longer appear to be the social organization of choice. In nearly all ejidos visited, members and leaders complained that even organizing a meeting was difficult. Most ejidos in the area – following the change in Article 27 – had undergone the PROCEDE process. But even before, some ejidatarios were selling off both agricultural parcels and communal land rights – legally or not. In Ortíz, they collectively made the decision to seek full private land rights through dominio pleno, although with both water and land resources, there did not seem to be a general desire or fear that long-time farmers would suddenly sell off their water and lands, but more likely continue to use and/or rent them.

Instead of the ejido structure, farmers across geographic boundaries had joined collectives like the Saucillo Cooperative, or become members of ALPURA, the milk cooperative. In addition, the Water User Associations themselves had become the defacto governing bodies for water management decisions – albeit with input from CONAGUA. These user associations were making collective decisions about water conservation funds, crop choices and water use permits, alternative water supplies like communal wells and support for new crop choices. They had hired canal operators and engineers, implemented a water rights market, purchased their own machinery to clean canals and level lands, made roads and sought loans on behalf of ejido members. While CONAGUA appeared to have no funding or made little effort to monitor and assess the multiple wells that had been dug as a result of the 1995 drought, the Rosales Water User Association was paying for a technician to keep tabs on water well levels. Thus, they were not only assuming management but planning and assessment, usually a role reserved for CONAGUA.

What this mean for water use and natural resource management is more complex. While the water conservation efforts have reduced water use on a per-hectare and irrigation level, the increased use of other sources of water – both pumping of the river itself and groundwater – counteract the more sustainable use of water that had been achieved. In addition, with a focus on "new technology" – the drip irrigation, sprayers and tuberia de multicompuerta – suddenly so present in the district, there is widespread concern about what happens when the technology begins to fail. The adoption of more efficient conservation measures – against the backdrop of the drought and the conflict with the U.S. over transboundary water resources – has been supported by nearly $140 million in government funds. Even in late 2005, the ironclad plans fell by the wayside as rising prices in oil and materials and a government decision to shift some resources to the hurricane-ravaged fields of Southeastern Mexico led to a slashing of the project budget and expected results. Thus, the farmers in Delicias continue to adapt to the vagaries of the market, government programs and the climate.

Chapter Six: Pearl of the Desert or Gateway to Hell? Agricultural Change in the Lower Río Conchos (Ojinaga) Irrigation District, 1990-2005

> The verdant valley that lies alongside the Río Grande where the Río Conchos flows into it is probably the oldest continuously cultivated land in what is today the United States. It was called "La Junta de los Ríos."

Cecilia Thompson. History of Marfa and Presidio County, 1535-1946. Volume One, 1535-1900. (Nortex Press: Austin, 1985), Page 1.

> Before we had wheat, sorghum, corn and CONASUPO bought it, and we had cotton, and cotton gyns and credit from the Rural Bank. Now, Langoria and Perla del Desierto have closed, except for Fibras del Norte, which gives only bad credit and there are no large buyers of corn, sorghum or wheat. If we haven't totally lost, it is only because of one word: cattle.

Farmer in Lower Río Conchos Irrigation District, Age 52, Survey No. 50, Lower Río Conchos Irrigation District, 2005, from Cyrus Reed. Agricultural Land and Water Use Survey. 2005.

> God didn't charge us for water, but now they sell it and then resell it.

Señora Niño, 89, from Esmeralda, Ojinaga, personal communication with author, 2005.

> There was a farmer who went straight to hell after his death. As he sat on the fiery floor waiting to meet the Devil, he put his arms around his body, shivering. When the devil arrived, the farmer asked him for a blanket. The devil, surprised, asked him where he was from. "Ojinaga, Chihuahua, Mexico" answered the farmer.

-- Popular joke in Ojinaga, sometimes referred to locally as "The Gateway to Hell"

I. Overview

Lying at approximately 840 meters above sea level, the two most prominent topographical features in the Municipality of Ojinaga are the Sierrita de Santa

Cruz to the east, near La Estación, and the Cerro Alto (the High Hill), which overlooks the Río Grande, about 10 kilometers west of the Municipal Capital (Photo 5.1). Legend has it that the devil liked to dance on a cord, or swing on a swing, that stretched between the Sierrita de Santa Cruz (Photo 5.2) and the Cerro Alto, often carrying a fiery metal ball. However, on occasion he would slip and drop the ball, burning large swaths of land in the alluvial valleys formed by the Río Conchos and Río Grande, which were once verdant and full of trees. At some point, it is said, he tired of his game and disappeared somewhere in the Sierrita de Santa Cruz. The arid landscape is thus the product of the devil's clumsiness or malfeasance. One of the metal fiery balls he dropped for a time was actually discovered near the present location of the municipal library, although it was most likely a mortar from the many violent encounters that occurred in the region in the last century (Administración Municipal de Ojinaga 2004: 19).

In the 2004-2005 agricultural year, most of the agricultural lands that make up the Bajo, or Lower Río Conchos Irrigation District – often called the Ojinaga Irrigation District -- lay dormant and much of the terrain looked indeed like it had been scorched by the devil. That year, only 28 percent --about 3,000 hectares -- of the 10,834 hectares of total irrigable lands were under irrigation at one time or another. Truth be told, 10,834 hectares of irrigable land is more wish than a reality. For one, a considerable swath of those lands have high saline contents, and are more like slate – "pizarra" as the locals call it – than soil. For another, the dimensions of the irrigation district are being recalculated, to reflect the recent sale of nearly 19.7 million cubic meters worth of water rights, enough water to potentially irrigate 2,515 hectares of land which has now been permanently removed from the district's rolls (Elías Calderón 2005: 8).

Photo 6.1. Cerro Alto, which overlooks the alluvial valleys formed by the Río Grande west of Ojinaga.

At the same time, the five “Modules” –water user associations in defined geographic areas – that make up the district were in their third year of an aggressive water conservation campaign designed to reduce water use. The program began in the fall of 2002 and was intended to help Mexico reduce water use in part to allow more water to flow down the Río Conchos and make its way to the Río Bravo/Río Grande (BECC 2002). Between 1993 and 2005, the river had become a pale shadow of its former glory, providing less than eight percent of the daily flow, averaged between the 1940s and 1993 (see Chapter Three).

It wasn’t always so difficult. For decades, in fact, the 1000 or so farmers with lands in the Lower Río Conchos Irrigation District produced some of the world’s best cotton – helped by the dry climate and sandy soils – as well as prolific amounts of corn, sorghum, and winter wheat. About four kilometers east of town, in La Estación, the railroad would carry tons of milled wheat from a warehouse owned by Empresas Langoria off to Chihuahua. Langoria also ran a local cotton gyn, while a farmer-led collective called Oasis del Desierto and even a third cotton gyn supported farmers in bringing their product to market, often competing for the best cotton. El Banco Rural -- the Rural Bank -- provided a government-supported line of credit to farmers, including ejido farmers without titles to private property. The credit allowed farmers to invest in the seeds, technology, water, fertilizers and pesticides needed to bring product to market, and the market – the cotton gyns, the wheat mills, the railroad, the bridge to the U.S. – came to them.

Photo 6.2. The Sierrita Santa Cruz, east of Ojinaga, looks over the Río Grande and the town of La Estación.

But change happens. Water levels in the Luis León Dam – finished in 1968 – began to drop after 1994. Locals say that the enactment of the North American Free Trade Agreement in 1994 fundamentally changed the competition faced by Ojinaga farmers, as wheat, corn, soybeans and sorghum from the U.S. provided Mexican bread, tortilla, livestock feed and other agro-industrial processors with other cheaper options. Others maintain that physical changes in the land – the invasion of salt cedar in some lands, the rise in salinity – the continued silting and sedimentation of diversion dams, canals and lands, took their toll as well. Many farmers chose with their feet, sending themselves, or their sons, to look for a different life in the U.S. As this chapter will demonstrate, whole communities and ejidos were virtually abandoned in the late 1990s.

This final case study chapter reviews and discusses these changes in the context of the attempt to improve water use and conservation in the district as part of the proposed solution to the low outflow levels of water from the Río Conchos into the Río Grande. After reviewing some basic features of the history of the area and the irrigation district itself, the chapter looks in-depth at changes that have occurred and the reactions of the farmers in two of the five “Modules” that make up the Lower Río Conchos Irrigation District, including “Modulo IV” – which lies in the desert hills south of the city and has been typified by cotton production – and Modulo V – the strip of land that lies upstream of the joining of the two rivers along the banks of the Río Grande.

II. Desert Agriculture in Ojinaga

Agricultural did not begin in the Municipality of Ojinaga with the official decree establishing the rules of operation of Irrigation District 090 in 1976. If local historian Cecile Thompson is correct, Spanish explorer and Conquistador Alvan

Nuñez Cabeza de Vaca probably visited the area of the "Junta de los Ríos" in 1535, writing in his Relaciones of a "river that flows between mountains and a village where there was the first adobes we saw that were like 'real houses." (Núñez Cabeza de Vaca as quoted in Pupo-Walker 1993: 101). He wrote of corn, squash and beans lining banks of the river, a kind of flood agricultural.

La Junta – as the region became known – had in fact been settled for a long time, with Archeologist J. Charles Kelley finding artifacts – rock shelters and crude weapons – that date back to 4,000 B.C. (Thompson 1985: 2). Kelley and others surmise that it was often inhabited by nomadic cultures and became a center for trading with the Paquimé cultures to the southwest in Nuevas Casas Grandes as well as Texas and New Mexico-based cultures between 1200 and 1400 (J. Charles Kelley 1992: 138). With movements by both the Anasazi cultures from Northern New Mexico and Pueblo cultures from Southern New Mexico, La Junta may have been an important link in the spread of corn and beans from present-day Mexico into the American Southwest. There are indications La Junta became a melting pot between the Anazasi, Mogollan, and Puebla tribes. Later, the Jumanos, who are thought by some as a precursor of the apaches, but by others as a distinct culture, probably arrived in the late 1400s or early 1500s, and came under the influence of the Conchos to the South (Kelley 1992: 136; Robert Mallouf 1992: 162) (see Photo 6.3).

Photo 6.3. Mural rendering of the Jumanos Indians that once farmed the alluvial valley near the outflow of the Río Conchos into the Río Bravo. Accessed from http://www.jumanos.net/jumanos/.

In 1582, Fray Fernando Beltran traveled with adventurer Antonio de Espejo, and chronicler Diego Luján, who spoke of a smaller indigenous pueblo which they called Santo Tomas, which was later renamed San Francisco de la Junta de los Ríos, as well as a larger pueblo downstream of the Junta, which they called Santiago. He wrote of damp lands, islands and bays downstream of La Junta, and people living in flat-roofed long houses, along the edges of fields that they farmed with corn, bean, squashes and even types of melons (Thompson 1985: 15). While they write of some 10,000 people living along the river in the La Junta area, it is probably an exaggeration meant to aggrandize the importance of their expedition. (Jordan 1956: 49).

Photo 6.4. Mural in Ojinaga Municipal Palace depicts Cabeza de Vaca and his three companions along the Rio Grande near Cerro Alto as a “future” Conquistador looks on.

Other tribes inhabiting the area – slightly to the south of the outlet itself -- may have included the Conchos, Sisimbres, Cacalotes and Mezquites, all of whom would have farmed the alluvial river lands along the Río Conchos, principally with corn (Residencia de Agrología 1965: 70).

In 1715, the Misión de San Francisco de La Junta de los Ríos was founded for evangelization purposes (Administración Municipal de Ojinaga 2004; see Photo 6.5). However, the indigenous population had already plunged by that point. The Guadalupe-Hidalgo Treaty of 1848 would convert the Río Bravo from a river shared by many communities into the natural frontier between two nations, and thus also convert water management from a local to a regional issue. In 1865, following the defeat of the Napoleanic forces in Mexico led by Maximiliano, President Benito Juarez renamed Presidio de Belen “Ojinaga,” in remembrance of Manuel Ojinaga, the young general who had led Chihuahua’s forces against the French invaders in 1864.

Photo 6.5. Church of San Francisco de La Junta de los Ríos in the Ejido of the same name. While this particular chapel was built in the early 1900s, the Mission, established by the Jesuits, dates from 1715.

Following the revolutionary battles between Pancho Villa and the Federales – including the capture of Ojinaga by Villa himself in 1913 -- new lands were opened for farming along the Río Conchos in towns like Mesquite, Valverde, San Juan, El Ancon, and Paradero as part of the government land distribution programs of the 1920s and 1930s. Many of these farmers began to grow corn, winter wheat and especially cotton, dedicated to support national industrialization schemes (Jiménez González 2003; see Photo 6.6).

“We built the canals,” remembered Natividad Lujan, an elderly farmer who lives among the dust, mesquite and cactus fields of Valverde, south of Ojinaga. “We built them with shovels and picks, and when the river flooded and destroyed the canals we would meet as an ejido, and build them again.” (Natividad Lujan, Valverde, farmer, personal communication with author, 2005).

Photo 6.6. Wheat Mill, long abandoned, San Juan de la Colmena

By the 1950s, the farmers began to petition the government for the creation of more permanent infrastructure to support their development. In 1955, the

Secretaria de Recursos Hidraulicos responded to their petition to create a new irrigation district between the Cañon del Peguis which overlooks the Río Conchos and its outflow into the Río Grande, and began a series of studies (Residencia de Agrología 1965: 2). The drought of the mid-1950s, followed by the sudden flooding of the Río Conchos in 1958 – due in large part to the flooding of the Río Florido in Durango and southern Chihuahua – was another impetus to control flooding and irrigation in the Valley of Ojinaga (Residencia de Agrología 1965: 3). Still, it was not until 1968 that the Luis León Dam was built, and not until 1976 that the Irrigation District became official (Jiménez González 2003: 3).

III. The District Today

A. Infrastructure

The Lower Río Conchos Irrigation District consists of a water supply dam, two distribution dams, 730 kilometers of primary and secondary cement and dirt canals, roads and drains, four electric pumps which move water from lower to higher grounds and some 10,800 hectares of irrigable lands – at least until recent water rights sales (see Table 6.1).

Located 130 kilometers south of the Irrigation District itself, Luis León Dam – more commonly known as El Granero – began its operations in 1968. With a capacity of 850 million cubic meters, including 90 million for sediment control, 500 for flood control and 260 for agricultural use, the dam has fundamentally changed agricultural – both in the Lower Río Conchos Irrigation District – but also in the 18 “Unidades de Riego” – irrigation units which operate south of Ojinaga along the banks of the Río Conchos between the Dam and the beginning of the District.

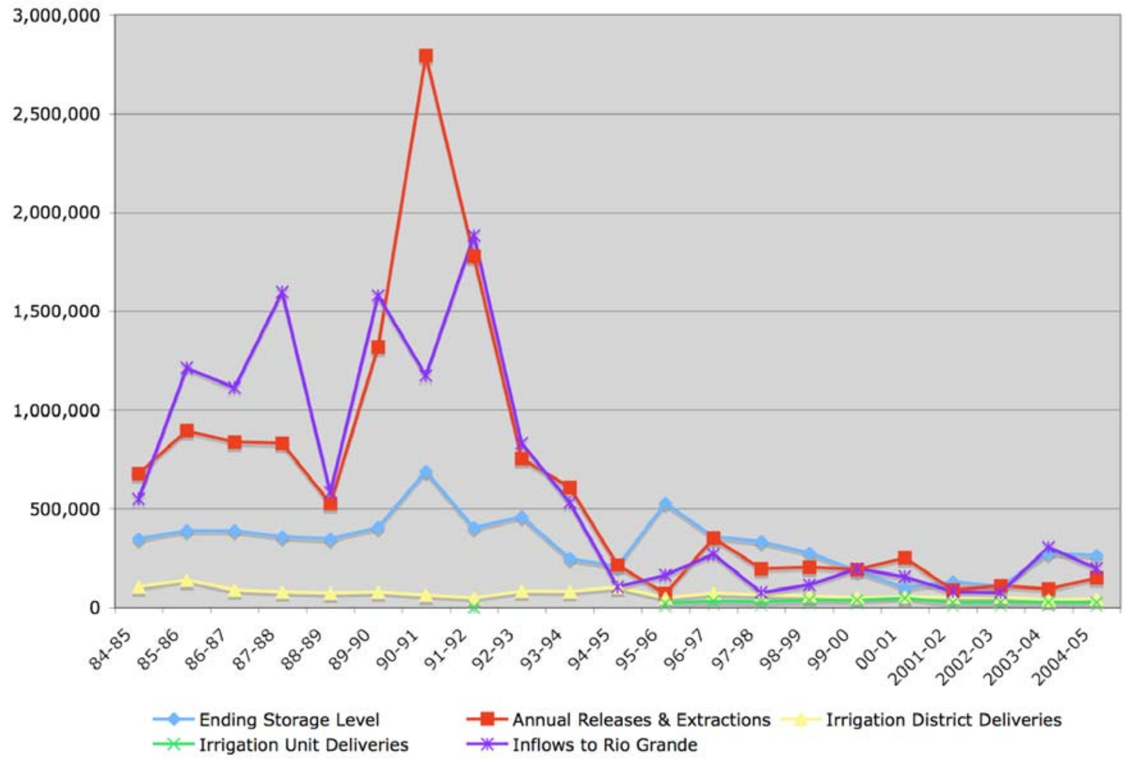
Table 6.1. Characteristics of the Lower Río Conchos Irrigation District, Dams and Pumps

Name of Infrastructure	Capacity or Size (Hectares or Million Cubic Meters)	Useful Capacity (Million Cubic Meters or Hectares)	Cubic Meters per Second Capacity	Actual Water Releases for Irrigation Use, 1994-2005
Lower Río Conchos Irrigation District 090	11,134 hectares	10,834 hectares		
Luis León Dam	850	320		100
Fernando Miramontes Distribution Dam (Peguis Chico)	227	43	7.3/sec	22.1
Gral. Toribio Ortega Distribution Dam (Tarahumara)	301.7	35.28	4.5/sec Right Canal 5.2/sec Left Canal	33.5
Pump Stations (12 pumps at 4 stations)	34.5		5.25/sec	

Source: CONAGUA, Distrito de Riego 090 Bajo Río Conchos, Características Generales del Distrito de Riego 2004.

Figure 6.1 shows the annual storage, total releases, and Lower Río Conchos Irrigation District deliveries from the Luis León Dam as well as outflows into the Río Bravo between 1984 and 2005. Beginning in 1995, the graph also shows Irrigation Unit water deliveries as CONAGUA began to estimate water use for these less regulated irrigation entities. Table 6.2 shows the average of this information for the 21 year period, as well as the average for the first 11 years and the last 10, clearly indicating a rapid decline in storage capacity, releases, irrigation district use, and inputs into the Río Grande. Interestingly, the estimated water deliveries to the irrigation units appear stable during this period, indicating that they were less affected by the reduced releases from Luis León, courtesy of their geographic proximity and perhaps less regulation by CONAGUA. For the irrigation district itself, on the other hand, the curtailment of water deliveries is obvious over the latter portion of the period.

Figure 6.1. Luis León (El Granero) Dam Storage Levels, Releases, Irrigation Water Use and Outflows to Río Grande, HY 1984-2005 in 1000 Cubic Meters per Second



Source: CONAGUA, Distrito de Riego 090, information provided to author, 2005.

Table 6.2. Annual Storage Levels, Releases, and Deliveries from the Luis León Dam and Inflows to the Río Grande from Río Conchos, HY 1984-2005

	Ending Storage Level, Luis León Dam	**Annual Releases & Extractions**	**Irrigation District Deliveries**	**Irrigation Unit Deliveries**	**Inflows to Río Grande**
Average HY 1984-2005	324,363	616,555	71,237	30,640	609,488
Average HY 84-95	386,471	1,021,540	86,587	Not Reported	1,014,757
Average HY 96-2005	256,044	171,071	54,352	30,640	163,692

Source: CONAGUA, Distrito de Riego 090, information provided to author, 2005.

According to CONAGUA officials, there has been much less direct regulation and measurement of the Irrigation Units as compared to the irrigation district itself (Oscar López, Operations Manager, Distrito de Riego 090, CONAGUA, personal communication with author, 2003). Nonetheless, in the last several years, as part of the larger "Sustainable Use" project, these irrigation units have been placed much more directly under the supervision of CONAGUA.

Today, the 18 irrigation units that dot the banks of the Río Conchos between Luis León Dam and the irrigation district collectively enjoy water concessions for some 24.8 million cubic meters to irrigate some 3,560 hectares (see Table 6.3). While there is still not an accurate estimate of actual water use, since the 1995-96 agricultural year, CONAGUA estimates water deliveries of between a low of 21.3 million cubic meters in 1995-96 to a high of 46.9 million cubic meters in the 2000-2001 agricultural year, indicating that water use has often exceeded concession levels. Interestingly, these irrigation units range from large communities with small ejido tracts of land, to individual landowners, one of which – El Consuelo – is a single pecan orchard of 130 hectares (Photo 6.7). Recent activities on behalf of the Irrigation Units have included a rehabilitated diversion dam (Photo 6.8).

Table 6.3. Irrigation Units, Number of Users and Total Hectares

Municipality	Name of Irrigation Unit	Number of Registered Users	Total Irrigable Hectares
ALDAMA	Maclovio Herrera I & 2	107	615
	Colonia Pueblito	86	693
COYAME	Bufalo	1	70
	Francisco Portillo	19	225
	La Suaceda	28	80
	El Consuelo	1	130
	El Peñeno	1	46
	Las Garzas	1	30
	El Ahogadero	1	28
	San Pedro	34	236
	Bajios San Pedro	13	160
	La Paz de Mexico	68	281
	El Diamante	1	100
	Cuchillo Parado	65	630
	Fortin II	1	7
	Cañon de Barrera	22	210
Total		450	3,561

Source: CONAGUA, Distrito de Riego 090, information provided to author, 2005.

Photo 6.7. “El Consuelo,” a pecan farm of 130 hectares lines the banks of the Río Conchos approximately 40 kilometers south of Ojinaga and is owned by a former state government official.

Some 130 kilometers down from the release of Luis León Dam, after passing through the spectacular Canyón Peguis (Photo 6.9), the Río Conchos arrives at “El Peguis Chico” Distribution Dam, as the river emerges from canyon walls into a small river plain (Photo 6.10). The irrigation district itself has begun. On the edge of the dam, the district’s primary canal travels northeast toward El Mesquite, a desert community that once produced thousands of tons of cotton and wheat and makes up the lands of “Modulo III.” Northeast of El Mesquite, the canal splits: part of the canal continues parallel to the river itself, while a series of pumps actually sends a portion of the water up above the river floodplain along the desert mesas of “Llano de Dolores,” irrigating the ejido fields, until 2005, when water rights sales ended irrigation of Llano de Dolores.

Photo 6.8. This Diversion Dam Structure was rebuilt in 2003 as part of the "Sustainable Water Use" projects for the benefit of the Ejidos of San Pedro, La Paz de Mexico and a private pecan farmer among others.

A few kilometers later, the canal splits again, part following the eastern path of the Río Conchos until it flows into a second distribution dam, while another part of the canal actually turns northwest, pumped under the Río Conchos itself, to emerge near the community of Santa Teresa. These are the arid lands of "Modulo IV," which includes the communities of Santa Teresa, San Juan, Valverde and El Ancón.

Photo 6.9. The spectacular view of "El Peguis" Canyon north of Ojinaga.

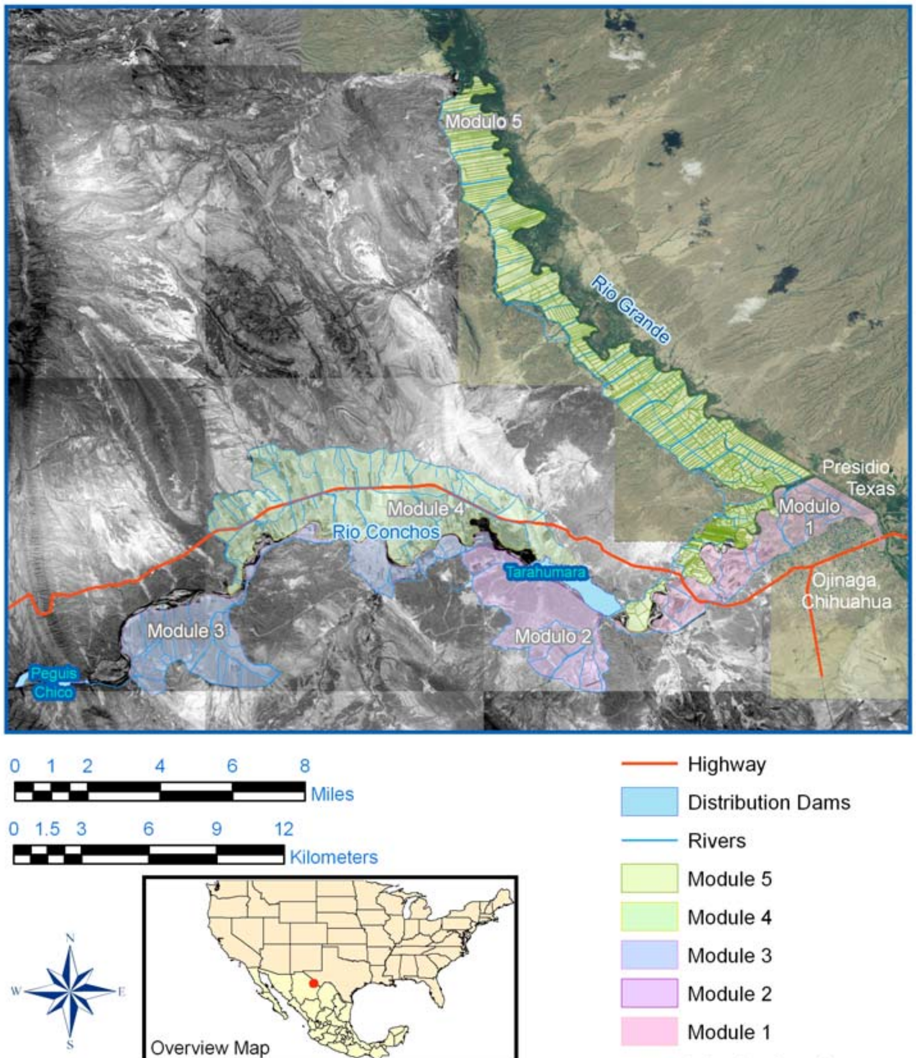
The Presa Derivadora Gral. Toribio Ortega – universally referred to as *El Tarahumara* – is larger but less panaromic than its counterpart (Photo 6.12). Serving the lower part of the irrigation district, and located about 10 kilometers due west of the Ojinaga bridge to Presidio, El Tarahumara at present has a large swath of vegetation – much of which is salt cedar or tamarisk growth on a sand bar island in its middle (Lujan 2005: 13). There are two canals which emerge on either side of the diversion structure. One serves "Labores de Ojinaga -- Modulo I – which is dominated by larger private farmers, some of whom have begun growing pecan orchards in recent years. The other canal travels nearly due north of the river, through Tocolote, and then further northwest past San Francisco, La Esmeralda, El Paradero and Cerro Alto, parallel to the Río Grande itself. In El Paradero Alto, the canal stops at a series of electric pumps, which sometimes pump the water above to irrigate fields in El Paradero de Arriba and Cerro Alto. This area – the largest in the district -- is Modulo V -- Paso del Norte. Map 10 shows the outlines of the five Modules making up the Irrigation District and the location of the dams and canals.

Photo 6.10. The El Peguis Chico distribution dam, which serves three of the five "Modulos" which make up the Bajo Rio Conchos Irrigation District.

Photo 6.11. The Lands of Llano de Dolores, Module II, have been abandoned, with its owners selling off their water rights. The ejidal house is in the background.

Photo 6.12. The Tamarisk-choked Distribution Dam of "El Tarahumara", Lower Rio Conchos Irrigation District.

Map 10. Bajo Rio Conchos Irrigation District



Source: Miguel Pavón, Borderlands Information Center, Texas Natural Resource Information Service, 2007.

B. The Farmers, Irrigated Land & Water Use

In 1994, the water district was divided into five “Modulos” or water user association areas (see Table 6.4). According to information provided in 2004, 1,156 water users had rights to irrigate up to 10,884 hectares of land. There was slightly more private farmers – 582 – than “communal farmers” and a slight majority of the land was “private” property (see Table 6.5).

Since four of the modules have part of their irrigated area served by pumps which send the water to higher ground, a significant amount of land in the district – some 40 percent – depends upon the electric pumps. While the now extinct Module II depended completely upon water that is pumped to lands above, and Module IV has slightly more irrigable land dependent upon “pumped” water, the other modules rely mainly on the magic of gravity to irrigate their lands.

Water deliveries have been well below the volume of the water concessions for the individual Modules, with the exception of Module I. There is an explanation. Module I is the irrigation association unit most dominated by private landowners, has the least problems in terms of water deliveries because its canals are located near the point of control, and all of its lands are irrigated by gravity. In contrast, Module II – which depends entirely upon pumping – actually “went out of business” in the 2004-2005 agricultural year as ejido farmers chose to sell off their water rights in a government buy-back program (see Photo 6.11). In fact, Module I had water use volumes above its official concessions in several years, as farmers who had lands in more than one module “transferred” their water rights into Module I, or private farmers in Module I transferred water rights through water rights purchases from other areas within the district. All of the other modules experienced significant curtailments in water use and irrigated lands between 1994 and 2005.

Table 6.4. Farmers by Type and Module, Lower Rio Conchos Irrigation District

Module	Total Hectares	Total Irrigable Hectares	Total Ejido and Colono Irrigable Hectares	Total Private Property Irrigable Hectares	Total Users	Total Ejido and Colono Users	Total Private Property Users
Modulo I "Labor de Ojinaga"	1,422.3	1,397.8	24.0	1,373.8	193	3	190
Modulo II "Llano de Dolores y San Juan"	863.8	831.6	821.6	10.0	96	95	1
Modulo III "El Mezquite y la Colmena"	1,758.7	1,669.4	1,365.8	303.6	146	124	22
Modulo IV "Santa Teresa – El Ancón"	2,879.9	2,832.0	1,314.3	1,517.7	291	138	153
Modulo V "Paso del Norte"	4,209.4	4,102.8	1,609.6	2,493.2	430	212	218
Total	11,134.1	10,833.6	5,135.3	5,698.3	1,156	572	584

Source: CONAGUA, Distrito de Riego: 090 Bajo Río Conchos, Características Generales del Distrito de Riego 2004.

Table 6.5. Irrigable Lands, Gravity-Fed and Electric-Pumped, Water Rights and Water Use by Module, , Lower Rio Conchos Irrigation District

Modulo	Irrigable Lands (Ha)	Irrigable Lands Served by Gravity	Ejido Irrigable Lands Served by Gravity	Irrigable Lands by Pump	Ejido Irrigable Lands Served by Pumps	Volume of Water Rights, Thous. Cubic Meters	Actual Average Water Delivery, 94-2005 (1)
I	1,398	1,397.8	24.0	0.0	0.0	11,168	**13,599**
II	832	0.0	0.0	831.6	821.6	6,647	**1,466**
III	1,669	1,041.3	626.9	628.1	515.9	13,841	**7,447**
IV	2,832	1,487.8	327.3	1,344.2	987.0	21,448	**13,163**
V	4,103	2,481.6	1,303.7	1,621.2	305.9	31,886	**20,054**
Total	**10,834**	**6,408.5**	**2,281.9**	**4,425.1**	2,630.4	**84,990**	**55,648**

(1) Actual water releases at point of control. Efficiencies of water deliveries to actually users vary, but generally average 80 to 85 percent for the district as a whole, although within individual Modulos, efficiencies can be as low as 55 percent.

Source: Comision Nacional del Agua, Distrito de Riego 090, Funcionamiento Hidraulico de las Obras (Anexo 3), information provided August of 2005.

C. Land Distribution

Most of the ejidos of the Lower Río Conchos Irrigation District – including San Juan, San Juan de la Colmena, La Esmeralda, and El Paradero -- were formed in the late 1920s and early 1930s as part of the land distribution reforms following the Mexican revolution. Another – San Francisco -- formed after the Río Grande changed course in the late 1960s and early 1970s (IBWC 1970; IBWC 1968). The changing of the river's course following significant flooding led to the creation of a swath of land known as La Cruz – the cross – which today is occupied mainly by members of the San Francisco ejido, in essence an off-shoot of the larger "Esmeralda" ejido (Guadalupe Torres, Ejido San Francisco, personal communication with author, 2005). Other ejidos – Tierra Nuevas, Llano de Dolores and El Agrillal – were successful attempts by farmers to organize collectively and open up additional lands for irrigation in more recent decades.

A small number – 19 – of users are "colono" farmers – who farm 223 hectares of land in Module III, while the rest of the communal ejidal farmers – 584 users with 713 water rights – have rights to farm some 5,700 hectares of land. In reality, there is no difference in how these different farmers are treated by the Modules or irrigation districts. They receive the same amount of water per water right, they rent their land and corresponding water rights when they want, and they choose which crops to grow. It is interesting to note that while ejido farmers generally only possess a single tract of land and one water right, a significant number of small private property owners have several water rights to cover more than one tract of land, since they purchased land at different times. On the other hand, there are private land owners with a large tract but only one water right.

CONAGUA's official numbers were not reflective of the reality of Ojinaga's ejidos in 2005. Llano de Dolores disappeared in 2004 with the sale of all of their water rights; only a few farmers in El Paradero still farm, the majority of whom have emigrated to the U.S. and "traditional" ejidos like San Juan de la Colmena and La Esmeralda are a pale reflection of their former glory, as some ejidatarios have sold their land – legally or not – and other have emigrated and only return for special occasions(Reed, Chihuahuan Land and Water Use Survey, 2005). Thus, while the number of registered ejidatarios district-wide may be close to 600, the number actually residing and farming their lands is much lower, perhaps about half. While none of the Ojinaga ejidos that make up part of the Irrigation District have officially privatized their lands through the PROCEDE process, many ejidatarios sold off their land and moved away, according to local agricultural officials ("Pepe" Corrales, Desarrollo Rural-Ojinaga, personal communication with author, 2005).

Table 6.6. Ejidos with lands in the Lower Río Conchos Irrigation District

Name of Ejido	Number of Water Rights	Number of Users	Total Hectares Owned within District	Total Irrigable Hectares
San Juan de La Colmena	198	185	2,214.6	2,156
El Agrillal	57	46	295	295
San Juan	30	27	255.5	251.5
Llano de Dolores	77	68	579.2	576.0
Tierras Nuevas	137	79	488.1	488.1
San Francisco	2	55	362.4	362.0
La Esmeralda	22	21	85.4	85.3
El Paradero	90	72	709.1	698.1
Colonos	19	19	223.0	223.0
Private Property	713	584	5,921.7	5,698.4
Total	1,345	1,156	11,134.1	10,833.5

Source: Comision Nacional de Agua, Distrito de Riego 090, "Resumen de Derechos y Numeros de Usuarios, 2004," June of 2004.

Overall, about 73 percent of ejido farmers in the Lower Río Conchos Irrigation District own 10 or less hectares of irrigable land, and 97.5 percent have 20 hectares or less (Table 6.7). Among private farmers about 63 percent also have 10 hectares of land or less, about 26 percent have between 10 and 20 hectares, seven percent – about 41 farmers – have between 20 and 30, and 19 farmers have 30 or more hectares. It is important to note that these percentages probably undercount the consolidation of lands, since lands may be registered in different family member names but may be controlled by a single individual. Thus, ejido land distribution in the Lower Río Conchos Irrigation District can be said to be more "equitable," with most farmers having a similar amount of land. Yet some say this is precisely the problem: the small sizes of lots make it inefficient to farm commercially (Alonso Valenzuela, Fibras del Norte Cotton Gyn, personal communication with author, 2005). In recent years, some private farmers, particularly in the gravity-fed lower part of the district have bought up smaller tracts of land to gain access to water rights that go along with the land and thus have more flexibility in crop choice. (Alonso Valenzuela 2005).

Table 6.7. Property by Size and Category in the Lower Río Conchos Irrigation District, 2004

Private Property Owners	Number of Owners	% of Owners	Irrigable Land (Hectares)	% of Land
0.0 to 5.0	230	39.38%	608.4	10.68%
5.1 to 10.0	140	23.97%	1,021.3	17.92%
10.1 to 20.0	154	26.37%	2,267.8	39.80%
20.1 to 30.0	41	7.02%	972.6	17.07%
30.1 to 40.0	7	1.20%	229.9	4.03%
40.1 to 50.0	7	1.20%	315.7	5.54%
50.1 to 100.0	5	0.86%	282.7	4.96%
Greater than 100.0	0	0.00%	0.0	0.00%
Totals:	584	100.00%	5,698.4	100.00%
Ejido Land Owners				
0.0 to 5.0	101	18.26%	349.9	7.12%
5.1 to 10.0	300	54.25%	2,248.0	45.76%
10.1 to 20.0	138	24.95%	1,923.3	39.15%
Greater than 20.0	14	2.53%	391.1	7.96%
Totals:	553	100.00%	4,912.2	100.00%
All Lands:	1,156	100.00%	10,833.5	100.00%

Source: Comision Nacional de Agua, Distrito de Riego 090, Clasificación de Tierra Agricólas, Sumario del Distrito, 2004

D. Irrigable Land and Crop Productions

1. Summary

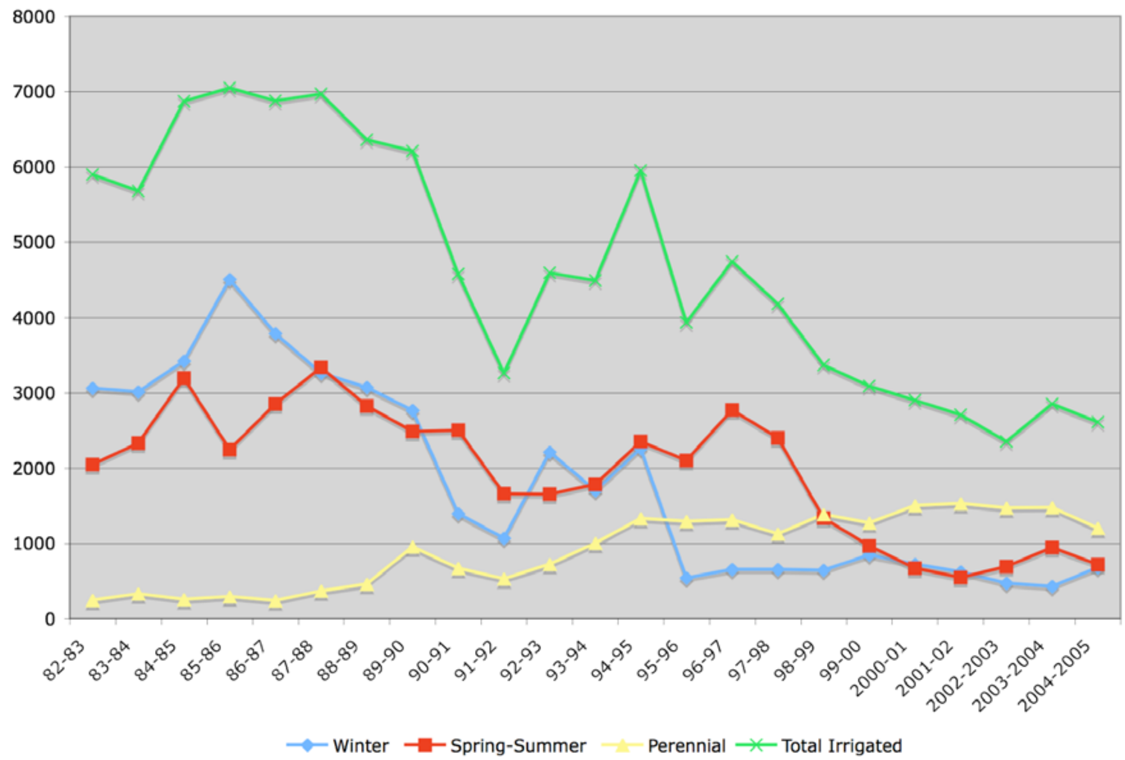
Irrigation of lands in the Lower Río Conchos Irrigation District rose throughout the early and mid 1980s, fell significantly in the early 1990s, and rose again in 1995. Thereafter, significant curtailments began– both in water deliveries and irrigated lands (see Figure 5.1, Table 6.8). However, this simple statement – that water use and irrigated lands have shrunk in the Lower Río Conchos Irrigation District significantly since 1995 masks a more complex reality, with significant changes in the geography of production, the types of crops grown, and the growing season. There has been a gradual shift away from cotton, and grain production (for human consumption) toward feed production (for livestock) and even a slight increase in pecan production. Thus, in some cases, the decrease in irrigated lands has represented a shift to higher water-demand crops like alfalfa, pecans and rye grass (see Figure 5.2). In essence, the number of irrigations have gone up to meet the demands of these new crops – increasing the amount of water used per hectare -- while the total amount of land irrigated and total volume of water used has gone down substantially over the period. Thus, while only some 500 hectares of perennial crops were grown in 1992, by 2004, some 1500 hectares of these crops were grown throughout the district.

Table 6.8. Total Lands Irrigated, Lower Río Conchos Irrigation District, 1974-2005

Agricultural Year	Physical Hectares Irrigated	Total Hectares Irrigated	Average Number of Irrigations	Millions of Cubic Meters of Water Used
1974-75	1,914	9,953	5.2	28.1
1975-76	1,418	7,799	5.5	22.4
1976-77	4,075	22,413	5.5	62.9
1977-78	3,376	17,893	5.3	51.0
1978-79	3,677	18,753	5.1	56.6
1979-80	4,013	22,072	5.5	62.7
1980-81	4,414	24,718	5.6	69.7
1981-82	6,907	35,362	5.1	110.4
1982-83	6,222	35,275	5.7	99.5
1983-84	6,551	36,420	5.6	100.0
1984-85	7,037	38,743	5.5	117.1
1985-86	7,344	39,810	5.4	132.2
1986-87	7,008	33,366	4.8	104.5
1987-88	7,010	35,775	5.1	104.9
1988-89	6,760	36,913	5.5	110.8
1989-90	6,802	38,153	5.6	125.9
1990-91	5,410	24,283	4.5	138.7
1991-92	3,306	16,414	5.0	101.7
1992-93	4,374	28,327	6.5	123.8
1993-94	4,444	30,911	7.0	111.3
1994-95	5,513	40,994	7.4	145.4
1995-96	3,142	17,034	5.4	52.0
1996-97	4,730	33,884	7.2	90.5
1997-98	4,332	30,475	7.0	78.5
1998-99	3,650	26,812	7.3	72.3
1999-00	3,664	23,132	6.3	62.9
2000-01	2,762	19,125	6.9	55.9
2001-02	2,292	12,734	5.6	51.4
2002 - 2003	2,559	13,324	5.2	52.1
2003 - 2004	2,825	13,082	4.6	38.2
2004 - 2005	3,006	NA	NA	NA
Average, 1974-2005	4,809	27,586	5.7	88.6
Average, 1995-2005	3,847	25,622	7.0	77.7

Source: CONAGUA, Distrito de Riego, information provided to author, 2005.

Figure 6.2. Crops grown in the Lower Río Conchos Irrigation District, 1982-2005 by Growing Season



Source: SAGARPA, Ojinaga District, Information Provided to Author 2005.

2. Winter Crops

The studies supporting the creation of the Lower Río Conchos Irrigation District listed winter wheat as the region's most important crop, stating that over 2,100 hectares of winter wheat were irrigated in the mid-1960s, or about 30 percent of the land irrigated in that period (Residencia de Agrología 1965: 70). By the mid-1980s, over 4,000 hectares of winter wheat were being irrigated, yet by 1995 there was only twelve hectares irrigated. Things didn't change much over the next decade.

Before the bottom fell out, three different large buyers served the Ojinaga district, including Empresas Langoria, Harinas de Chihuahua and Industrias E.M.A

(Table 6.9). By the mid-1990s these businesses no longer had mills and storage centers located in Ojinaga, as they consolidated their efforts in a few places, or chose to import wheat from the U.S. (Bolivar, Empresas Langoria, personal communication with author, 2005).

Table 6.9. Thousand tons of wheat from Ojinaga-area farmers purchased, 1989-1993

Name of Business	Tons Purchased, 89-90	Tons Purchased, 90-91	Tons Purchased, 91-92	Tons Purchased, 92-93
Empresas Langoria	1,669	1,799	2,410	3,450
Harinas de Chihuahua	1,370	1,360	0	754
Industrias E.M.A	577	827	526	44
Seed Production	80	0	30	120
Local Consumption	574	156	195	76
Contracted with Outside Buyer	394			
Total	4,664	4,142	3,161	4,444

Source: SAGARPA, Distrito de Desarrollo Rural 009, Bajo Río Conchos, 1993.

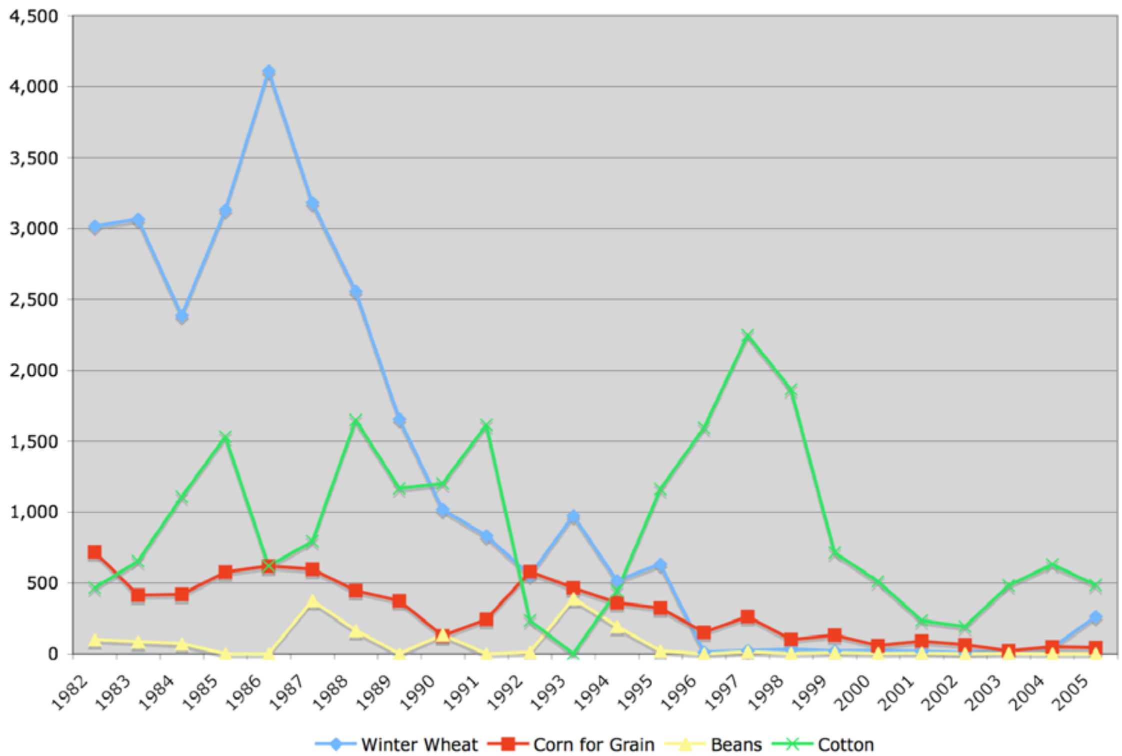
In 2003, SAGARPA began a price-support program to pay producers to irrigate wheat with the hope of reactivating this traditional sector of the economy. After some initial problems related to payments, by the 2004-2005 growing season the project had some success, with 33 farmers in the Municipality of Ojinaga planting over 340 hectares with winter wheat, including approximately 25 farmers in the Irrigation District, virtually all of whom are private farmers, mainly in Modules I and V (SAGARPA, Distrito de Desarrollo Rural 009 2005). Still, these growers must send their production all the way to Chihuahua City, signifying high transportation costs.

3. Summer Crops

Summer crops have continued to be important in the district, but there have been changes. First, the so-called “Segundo Cultivo” – literally a second summer crop – for the most part no longer exists. A large factor in this abandonment of the “Second Crop” was the difficulty in accessing water in the late 1990s, which forced farmers to consider where best to “spend” their water rights. Summer grains intended for human consumption – corn, soy beans, beans, sorghum for grain –witnessed large declines between 1990 and 2005. (see Figure 6.3).

The sudden contraction in summer crops irrigated in the mid-1990s has little to do with water deliveries – which at the time were still available -- and everything to do with the sudden failures in credit, pests, and falling worldwide cotton prices in 1992 and 1993, which caused farmers to leave cotton fields unattended, according to local observers Following the sudden fall in market price, farmers reacted, with both ejido and private property leaders forming not one but two cooperatives intended to reactivate the cotton-growing region of Ojinaga. Perla del Desierto – Pearl of the Desert – was a kind of security fund intended to channel credit and insurance to cotton-growing farmers, while Ultimo Esfuerzo – literally the Last Effort – was a productive cooperative which obtained credit and for several years operated a cotton gyn at the “curve” – a curve in the road between Ojinaga and Valverde, not far from where the Río Conchos crosses under the old highway (Natividad Luján, Valverde, personal communication with author, 2005).

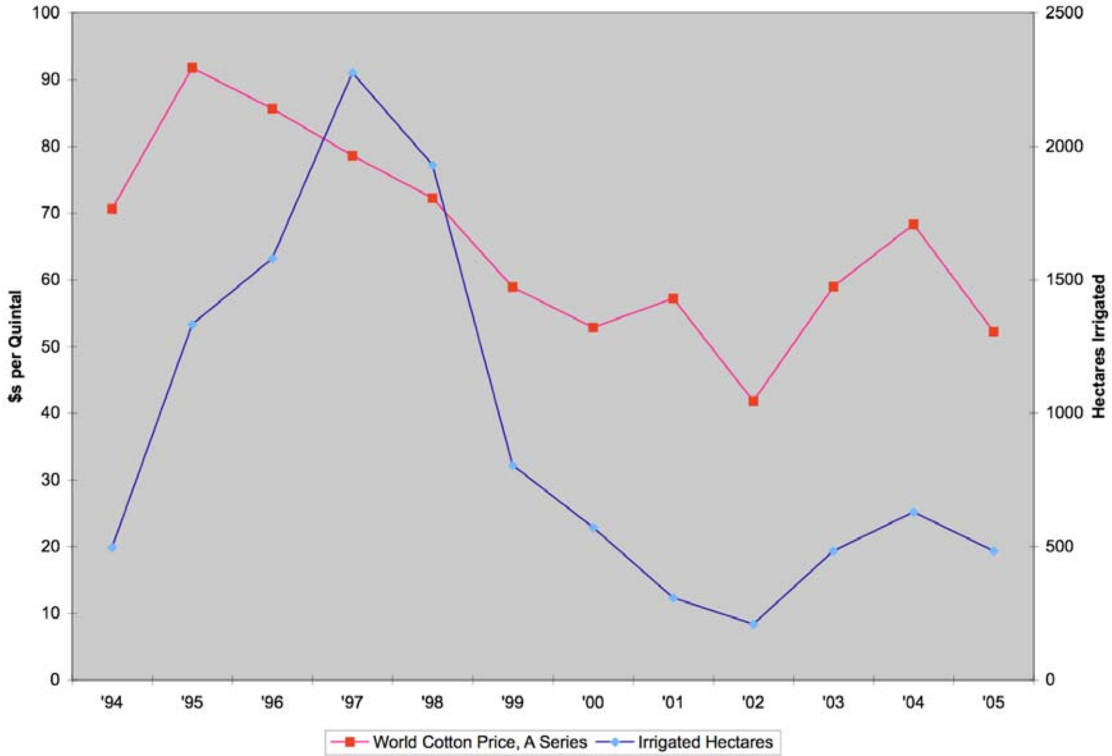
Figure 6.3. Number of Hectares of Basic Grains and Cotton Irrigated in Lower Río Conchos Irrigation District 090, 1982-2005



Source: SAGARPA, Ojinaga District, Information Provided to Author 2005.

By 1994 and 1995, with credit again offered, and cotton gyns operating, Ojinaga farmers reestablished cotton in the upper part of the district. In fact, 1997 was a bumper year for the crop, with over 2,000 hectares irrigated. Yet both rural associations ultimately failed and by the turn of the century, the cotton gyn run by the farmers – as well as another run by Empresas Langoria – had closed up shop, and cotton production plummeted (Ing. Juan de Dios Guardarrama, SAGARPA, Ojinaga District, personal communication with author, 2005; Photo 6.13). While water availability from the dams was clearly a factor, as a relatively low-water demand crop, it was not the major one. Cotton again virtually disappeared in the early 2000s, but again, rose slightly in 2003 and 2004 with the advent of a government-price-support program, the opening of a new privatelyrun cotton gyn in Tocolote, just south of Ojinaga, and a rise in world prices (Figure 6.4; Photo 6.14).

Figure 6.4. World Cotton Prices (Series A) per Quintal and Total Hectares Irrigated, Lower Río Conchos Irrigation District, 1994 – 2005.



Note: The ***COTLOOK A INDEX*** is intended to be representative of the level of offering prices on the international raw cotton market. It is an average of the cheapest five quotations from a selection (at present numbering nineteen) of the principal upland cottons traded internationally.
Source: Cotlook Daily Internet Service, Available at www.cotlook.com and SAGARPA, Ojinaga District, Information provided to Author, 2005.

Photo 6.13. Abandoned Cotton Gyn at "La Curva" once run by the Ejido Cooperative "El Último Esfuerzo" (The Last Effort)

In addition to a government price-support program, since 2002 the State of Chihuahua has worked with the U.S. and Texas Department of Agriculture on a Binational Boll Weevil and Pink Bollworm Eradication Program. As a member state, all cotton producers in Chihuahua must join the program, and there are frequent meetings between government officials in both countries to review progress made under their compact.

Charged with implementing the *Programa Binacional de Erradicacion para Picudo del Algodonero y Gusano Rosado* is the Local Agricultural Safety Board – La Junta Local de Sanidad Vegetal. By 2000, officials from Texas, Chihuahua and New Mexico proposed and signed a joint agreement to standardize the use of hormones, insecticides, sterilized pests and other methods to help lower the use of pesticides and eliminate the boll weevil and pink bollworm from cotton crops (Dirección General de Sanidad Vegetal 2001: 7).

Photo 6.14. "Fibras del Norte" Cotton Gyn in Tocolote began operations in 2001 and is the only cotton gyn operating in the Lower Río Conchos Irrigation District

In Ojinaga, between 2002 and 2005, the Junta Local was busy implementing the program. As a first step, all fields were globally positioned through hand-held GPS units and put in a GIS mapping system. "Scout" traps – impregnated with "grandlure" pheromones -- were placed approximately one trap per 15 hectares of cotton to detect boll weevils as a first step, although the density of traps was later increased to a trap per every six hectares. If significant populations are detected through the traps, or random testing, then additional traps are located around heavily-invested lots. In addition, those lots with significant boll weevil populations also receive an order to be sprayed with “ultra-low volume” Malathion, a kinder and gentler version of past Malathions.

Photo 6.15. Pheromone Trap found on Cotton Field, Lower Río Conchos Irrigation District, 2005

The techniques for controlling pink bollworms are similar, with mapping, trapping, detection and controls, mainly through the use of traps and sex pheromones (“Gossyplure”) to disrupt their mating patterns, and potentially an organophosphate insecticide when traps and spot checks reveal high levels of the worm (above 5 percent of plants in field). The program also recommends the use of transgenic cotton (El-Lissy and Hill 2006).

Still, cotton farmers have been faced with a severe credit crisis. Under the program, farmers were expected to pay $1,800 Mexican pesos (about $160 in 2005) for each hectare of planted cotton to the Junta Local de Sanidad Vegetal. Essentially, farmers in Chihuahua were forced to participate, but in return, costs per hectares would decline since there is less reliance on pesticides and a higher use of pheromones, cultural controls like row harvesting and traps. Even so, most farmers must rely on some type of credit.

At one time, ejido farmers in Ojinaga would have relied on the Rural Bank to pay for these inputs. But after the peso collapse and subsequent banking crisis, the Banco Rural –today called Financiera Rural -- no longer offered credit to any farmer with outstanding debt, which is the situation of most small cotton farmers in the district (Ing. Juan de Díos Gaurdarrama, SAGARPA, personal communication with author, 2005). Farmers also relied on the local cotton gyns -- Empresas Langoria and Perlas del Desierto -- for credit, but they both closed their doors in the late 1990s (Alonso Valenzuela, Fibras del Norte, personal communication with author, 2005).

According to local agricultural officials and newspaper reports, the eradication program has been inefficient due to a problem of payments in the Irrigation District and surrounding area. Thus, farmers are often waiting for the proceeds from the sale of their crops, as well as the new government price-support "Objective Price" payment to pay back the costs of the inputs they put on their crops six months earlier. Officials at the Junta Local de Sanidad Vegetal report that in the Ojinaga Municipality there were over 130 hectares of land "in debt" in the 2003-2004 agricultural season and even more – 392 – in the 2004-2005 season (Ing. Soto, Junta Local de Sanidad Vegetal, Ojinaga, personal communication with author, 2005).

Table 6.10. Debt on Cotton Pest Eradication Payments, 2003-2004, Ojinaga Municipality

Agricultural Year	Hectares	Amount in Debt in Pesos	Average Debt per Hectare
2003-2004	136.68	$177,684	$1,300
2004-2005	392.07	$627,312	$1,600

Source: SAGARPA, Ojinaga District, information provided to author, 2005.

In 2005, only one cotton gyn – Fibras del Norte – was offering any credit to cotton farmers within the Irrigation District, while several banks also had credit available – to farmers with good credit histories. “Fibras del Norte” – Fibers of the North – is a private enterprise formed by several U.S. and Mexican investors, but run by the local Valenzuela family, an important local agricultural family. Current manager Alonso Valenzuela said the cotton gyn began operations in 2000 on a “very small scale” but really took off in 2001. By 2004, they were providing credit to 48 farmers within the irrigation district, but the problem of payments became so severe that they only worked with 30 farmers in 2005 (Table 6.11).

Table 6.11. Number of farmers receiving credit from Fibras del Norte Cotton Gyn, 2001-2005 and Production Totals

Year	Number of Producers	Services	Packs of Cotton	Losses because of Floods, Hail, Plagues, etc	Total Production in Tons
2001	10		410		84
2002	24		1,280		1,280
2003	40	15	2,379	400	2,379
2004	48	18	3,290	600	2,390
2005	30	18%			

Source: Alonso Valenzuela, Fibras del Norte, August 2005.

Valenzuela said that many farmers use their own money or receive credit elsewhere. In the case of Fibras del Norte itself, the cotton gyn receives credit from a private bank – Banco Rural de Ojinaga – but they have had difficulty meeting payments because of the "lack of culture of payments" from the farmers themselves. To "protect" themselves, the cotton gyn only provides credit "a medias," about $700 pesos per hectare in 2005, or only about 40 percent of the requirement imposed by the eradication program, which itself does not include the costs of fertilizers, machinery or water.

Valenzuela said the cotton produced in Ojinaga is still among the best, and that a private cotton broker in 2004 had tested the cotton and certified it was "10 percent better than Arizona cotton." Still, local farmers surveyed complain that the cotton testers always subtract points, and that the cotton gyn undervalues the cotton they provide credit for, a charge Valenzuela denied.

"Producers are never happy, but I give them the options to produce," he explained. "This year we sent packs of cotton to Phoenix, Delicias and Las Bombas to classify them to avoid the problem of under classifying the cotton."

Valenzuela said the real problem of cotton production in Ojinaga is not credit or but good quality, contiguous plots of land.

"The lots of land here are too small," he explained. "A farmer with five lots of one hectare each spends much more than a farmer with a single five-hectare lot of land, and we need more agrarian reform so it is easier to buy and sell land." (Alonso Valenzuela, personal communication with author, 2005).

Valenzuela said you need at least 10 hectares of continuous land to make a profit and large tracts of land in the district are hard to find. For one, insurance companies will not provide insurance to lands that are too close to the Río Conchos, because of the constant risk of sudden desert flash-floods, which is one of the reasons that these lands have become pecan and alfalfa fields, more resistant to flooding damage than cotton, easily uprooted. Secondly, he said because of the slow legalization of ejido titles, buying and selling ejido land is too risky and time-consuming. Finally, he noted that because some of the cotton lands were in areas where water had to be pumped – adding an expense – many farmers chose to sell their water rights, most notably in Llano de Dolores, the ejido which decided in mass to sell off their water rights, ceding once productive cotton land back to desert hares and cactus.

Photo 6.16. Cotton field in Las Oasis, a Mennonite community founded in 1995, which now produces more cotton than the Lower Río Conchos Irrigation District.

He compared the situation in the district with that in the nearby communities of El Oasis, Nueva Holanda and Las Bombas, three communities of German-speaking Mennonites which have arisen out of the Chihuahuan Desert in the last 10 or 15 years to the east. Using ranchland and huge deep-well pumps, the communities have plunged into cotton farming, irrigating thousands of hectares in 2004 and 2005.

"They know how to take advantage of the government programs and they have the extensions of land to do it," Valenzuela explained.

Cotton farming is more productive and the farmers are receiving more government support in the Mennonite communities, which only began 10 years before. While the Mennonite farmers have embraced the more expensive genetically-modified cotton known as bT cotton, at least in 2004, irrigation district farmers for the most part rejected the higher priced, imported seeds (Ing. Juan de Dios Gaurdarrama, Ojinaga Rural Development District 009, personal communication with author, 2005). The eradication program itself for the pink bollworm is based partially upon the use of Bacillus thuringiensis (Bt) cotton, whose primary benefit according to promoters is its resistance to pests and the reduced use of pesticides. While Mexico has resisted the use of genetically-modified crops – particularly corn – for human consumption, there has been a slow and steady increase in the use of cotton, soybeans, alfalfa and other crops not intended for human consumption in Mexico (Dirección General de Sanidad Vegetal 2001: 11).

Table 6.12. Cotton production in the Ojinaga Rural Development District, Coyame and Ojinaga Municipalities, 2003-2004

Area	Number of Plots	Bt Cotton Planted (Hectares)	Conventional Cotton Planted (Hectares)	Total Hectares Planted	Average Hectares per Plot
Lower Río Conchos Irrigation District	41	0	507	507	12.36
El Mulato	3	0	44	44	14.66
Coyame	4	0	42	42	10.5
El Oasis	36	866	737	1,603	44.5
Nuevo Holanda	14	422.5	473	895.5	63.96
Total	98	1288.5	1803	3,091.5	31.55

Source: Ing. Juan de Dios Guardarrama, Rural Development District 009, SAGARPA, 2005.

Table 6.13. Cotton Price Support Program, Ojinaga Rural Development District, 2004

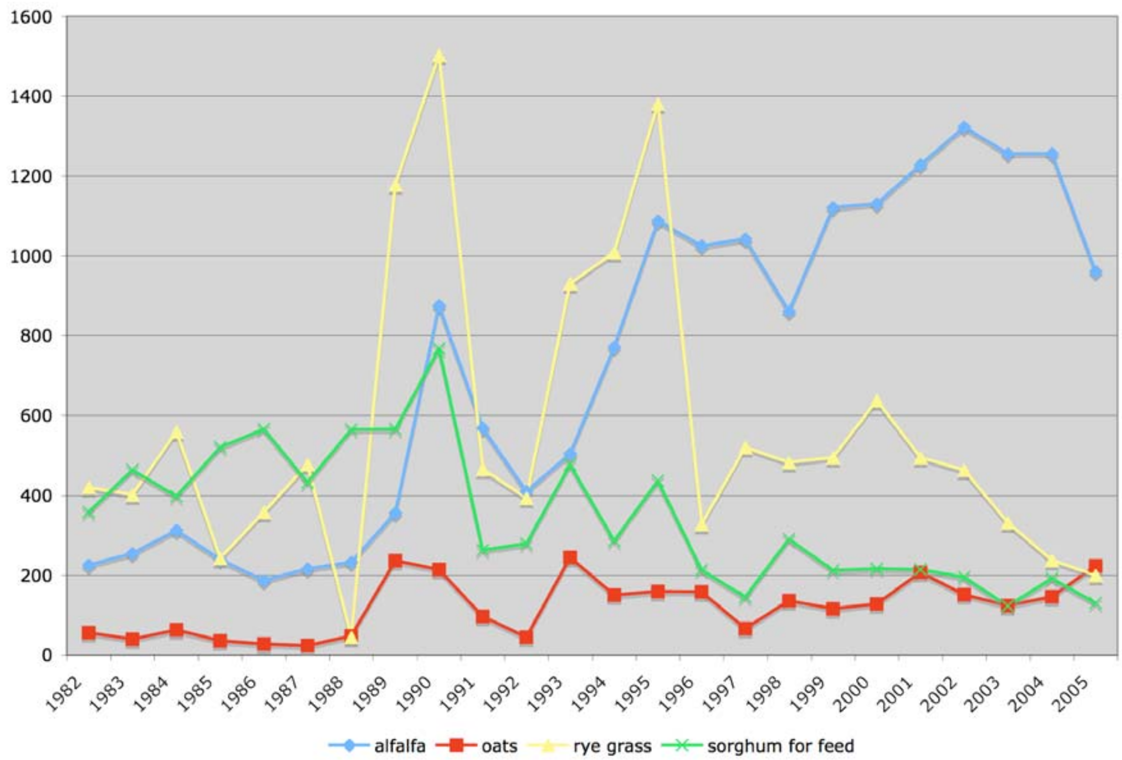
Category	"Mennonites" (Nueva Holanda, Las Bombas, Nueva Holanda)	"Mexicans" (Lower Río Conchos Irrigation District, El Mulato, Coyame)
Number	79	31
Hectares Planted	5,843	426
Tons of Cotton Sewn	7,452	532
Total Payments in Mexican Pesos	44,979,386	2,638,459
Payment per ton	$6,036	$4,960

Source: Ing. Juan de Dios Guardarrama, Rural Development District 009, SAGARPA, August 2005.

4. Perennials

What are the farmers of Ojinaga actually growing? The answer is simple: feed crops and pecans. The huge increase in "perennial crops" – those crops which must be watered throughout the year – is due almost entirely to increases in alfalfa, and to a lesser extent to pecans. At the same time, sorghum for feed, oats for feed and rye grass have also maintained an important presence in the district – with declines and increases depending on prices and access to water -- even with severe water restrictions due to the low storage water levels in the Luis León Dam (Figure 6.5). In addition to pecan nuts, the only other "fruits" grown in the district are a smattering of watermelon and melon crops, but despite the existence of local demand in Ojinaga and nearby towns like Mulato, only a few farmers – mainly larger private farmers – have dared to enter into production of these risky crops, which are susceptible to pests, coyotes, wild pigs, hails, rains, droughts and freezes (Figure 6.6; and Photo 6.17). (Armando Valenzuela, Modulo V President, personal communication with author, 2005).

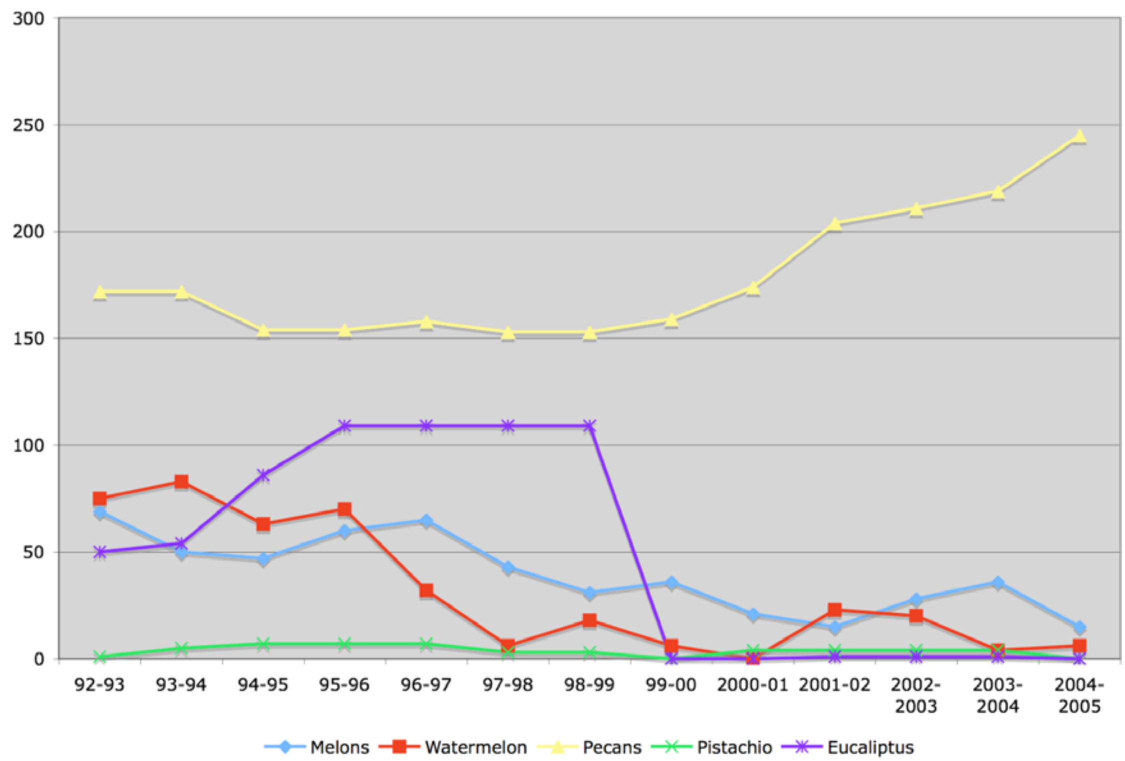
Figure 6.5. Irrigated Hectares of Feed Crops, Lower Río Conchos Irrigation District 090, 1982 - 2005



Source: SAGARPA, Ojinaga District, information provided to author, 2005.

There have also been a few attempts to grow pistachio crops and one major effort – supported by the government – to grow eucalyptus trees on lands where crops had been abandoned. At one point, over 100 hectares were planted with the Australian arbust, but the supposed market for paper never took off, and the trees themselves never received the needed care. There are still groves of the trees which emerge suddenly out of the desert floor, but they look sickly and in fact have not been irrigated in years. Thus, put simply, the majority of farmers still operating in Ojinaga have put their faith in growing crops to feed cattle, or have moved into pecan production, while a few farmers – most of them ejido in portions of the district far away from the more productive alluvial soils– continue to grow cotton or winter wheat, supported by new government price-guarantee programs.

Figure 6.6. Irrigated Hectares of Tree and Melon Crops, Lower Río Conchos Irrigation District 090, 1993-2005



Source: SAGARPA, Ojinaga District, information provided to author, 2005.

Photo 6.17. Watermelons face a difficult time in the Ojinaga region due to freezes, livestock, coyotes and feral pigs

E. The Geography of Production in the Lower Río Conchos Irrigation District

The shrinking of the district has not occurred equally between small and large farmers, nor equally among the modules. Indeed, the most startling change in the district is perhaps the abandonment of much of the land in those areas where water has to be pumped up by electric pumps, much of it in the area occupied by ejidos like San Juan, Paradero and Llano de Dolores. Thus, the amount of land that is irrigated that is “covered” by canals which rely on pumps to carry the water from low to higher lands has shrunk much faster that land that is irrigated by canals which rely on gravity. There are geographical consequences of the shrinkage of agriculture in the Irrigation District. Thus, in the 1993-1996 four-year period, an average of 72 % of the irrigated lands occurred with standard gravity canals, but in the 2002-2005 period, nearly 88% of the irrigated lands were served by gravity canals (Table 6.14).

Table 6.14. Irrigated Hectares by Type of Canal in Lower Río Conchos Irrigation District, Agricultural Years 1993-2005

Year	Hectares Irrigated by Gravity Canals	Hectares Irrigated by Canals relying on Pumps	Total Hectares Irrigated	% of Hectares Irrigated by Gravity Canals
1993	3,425	1,170	4,595	74.54%
1994	3,372	1,118	4,490	75.10%
1995	3,909	2,042	5,951	65.69%
1996	2,897	1,037	3,934	73.64%
Average 1993-96	**3,401**	**1,342**	**4,743**	**72.24%**
2002	2,458	248	2,706	90.84%
2003	2,353	287	2,640	89.13%
2004	2,371	484	2,855	83.05%
2005	2,312	298	2,610	88.58%
Average 2002-2005	**2,374**	**329**	**2,703**	**87.90%**

Notes: Statistics from 1997 to 2001 provided did not break down irrigated hectares by type of canal. 2005 are unofficial data. Calculations by Author.
Source: Rural Development District 009, Ojinaga, SAGARPA, 2005.

Which crops were still being irrigated with pumped water? The answer for the present period is really only cotton and alfalfa. Between 2002 and 2005 when full Module-level statistics were available, most production in Ojinaga occurred in gravity-fed canals in Modules I and Modules V, although significant cotton-growing still occurred in Modules III and IV, including some with pumped water. These figures suggest that along with the overall shrinkage of hectares irrigated in the district was a concentration of production in the private lands of Module V and Module I along the river corridors of the lower Río Conchos and Río Grande, upstream of the entrance of the Conchos. Thus, while only about 25 percent of the district lands were “irrigated” in 2005, over 55 percent of the gravity-fed lands of Module I and some 35 percent of gravity-fed lands in Module V were used.

Table 6.15. Changes in Hectares Irrigated by Module, Lower Río Conchos Irrigation District, 2002-2005

	Irrigable Lands	2002	2003	2004	2005	Change, 200-2005	% of Irrigable Land In Production, 2005
Module I-Gravity	1,398	757	590	717	794	4.89%	56.80%
Module II-Pumped Water	832	19	57	115	0	-100.00%	0.00%
Module III-Gravity	1,041	402	410	372	332	-17.41%	31.89%
Module III-Pumped	628	0	0	0	0	0.00%	0.00%
Module III-Total	1,669	402	410	372	332	-17.41%	19.89%
Module IV – Gravity	1,488	449	458	428	349	-22.27%	23.45%
Module IV – Pumped	1,344	158	158	235	187	18.35%	13.91%
Module IV Total	2,832	607	616	663	536	-11.70%	18.93%
Module V-Gravity	2,482	850	907	854	837	-1.53%	33.72%
Module V-Pumped	1,621	71	72	134	111	56.34%	6.85%
Module V-Total	4,103	921	979	988	948	2.93%	23.11%
District-Gravity	6,409	2,458	2,353	2,371	2,312	-5.94%	36.07%
District-Pumped	4,425	248	287	484	298	20.16%	6.73%
District - Total	10,834	2,706	2,640	2,855	2,610	-3.55%	24.09%

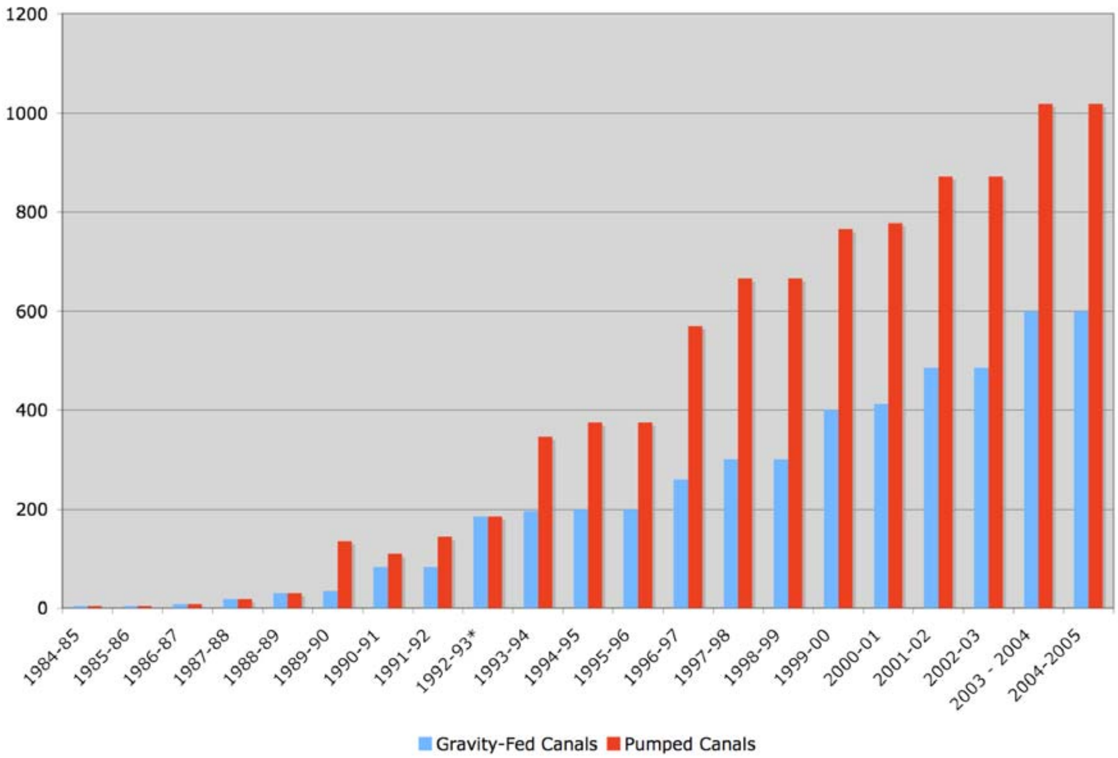
Note: Percentages calculated by author.
Source: Rural Development District 009, Ojinaga, SAGARPA, 2005.

F. Why the abandonment?

Physical, managerial and economic factors caused the abandonment of agriculture in some areas of the district according to local farmers and officials. First of all, the cost of water increased in the Lower Río Conchos Water District since the district was turned over to its users, and in particular, the cost of pumped water has soared. Between 1984 and 1992, prior to the transfer of the district over to its users, CONAGUA charged water users based on the hectares irrigated and whether the crops being irrigated were high or low-water demand crops as well as other factors. In 1989, CONAGUA also began charging a separate price for irrigating lands using pumped water. Thus, by 1990, CONAGUA was charging those growing alfalfa – a high water demand crop -- in pumped canals 136,150 old Mexican pesos, about 10 times the cost they were charging for low-water demand crops in gravity-fed canals.

When the district – or at least its infrastructure—was turned over to the Modules in the 1993-1994 period, the modules eliminated the tiered system of high, medium and low-water demand crops in favor of one price for gravity-fed lands and another price for those served by pumps. Expressed in U.S. dollars, adjusted for the exchange rate, the real price of gravity-fed water rose from a low of about $7.50 per hectare in the 1985-86 agricultural season to approximately $56.00 in the 2004-2005 season, while the price of pumped water rose from about $25.00 in 1990 to over $100.00 in 1993-1994 – when the Modules suddenly realized the high cost of maintaining and operating the pumps. The price has remained there since. Clearly, given a choice, few farmers were willing to spend an extra $40.00 per hectare to irrigate their crops in 2005 with small cotton farmers – low water users -- being the exception.

Figure 6.7. Average Cost in Mexican Nuevos Pesos Per-Hectare for Gravity-Fed Canal and Pumped-Fed Canal Irrigations, Lower Rio Conchos Water District, 1984-2005



Note: To convert to New Mexican Pesos, values before 1992-1993 were divided by 1,000.
Source: CONAGUA, Distrito de Riego 090, Cuotas Históricas de Agua, 2005.

In fact, the real price of pumped water is not reflected in the figure. In recent years, as the number of hectares of land irrigated with pumped water has plummeted, the Modules have adopted a system where those users that actually make use of the pumped water pay the cost of electricity of the pumps. Thus, in 2005, users paid $1,000 new pesos per hectare for the use of the water plus approximately $20 pesos for each hour of irrigation. It is thus not surprising that with the exception of cotton, few farmers used pumped water by 2005. The transfer of the district's operation from CONAGUA to the Module system in 1992 led to a wholesale increase in the cost of water overall, and particularly of pumped water as the Modules were placed in charge of paying for and operating the pumps and corresponding canals.

Beyond the rise in the actual cost to the farmer to irrigate his lands with pumped water, the pumps – which were constructed decades ago – have had a series of failures and problems which have been also been inherited by the Modules as CONAGUA turned them over to the user associations. The pumps continually fill up with muck, silt, sand, garbage and vegetation, particularly after heavy rains, and need continual maintenance and cleaning. In Module IV, for example, in 2005, only one of its three pumps was working properly (see Photo 6.18).

Then there is a simple reality: many of the lands relying on pumped waters have inferior soils, problems of saline soils and invasion of vegetation, decreasing their viability as agricultural lands. This reality was recognized by the hydrologists, soil scientists and agricultural officials who studied the Valley of Ojinaga in the mid-1960s when Luis León Dam was being built.

In describing the proposed district, these soil scientists contrasted the “Ojinaga” soils lining the river valleys with the “Mezquite” and “Divisadero” soils on the small hills and mesas above the river valleys. Thus, the report states:

> The highest quality soils belong to the Ojinaga Series, which is also the most extensive. The Soils with the highest internal drainage deficiency are those of the Esmeralda and Mezquite series, which are formed by very compact clays of a yellow color…. The only soils affected by soluble salts and sodium in high levels were the Esmeralda Series in all its horizons and the Mezquite soils in its lower horizons. (Residencia de Agrología 1965: 1D.author translation.)

Photo 6.18. Members of the Module IV Water User Association clean out Pump No. 3, Santa Teresa Pump, Lower Río Conchos Irrigation District

In fact, the report states, the approximately 3,500 hectares that could be farmed through pumping water up to canals located three or five meters above the regular gravity canals:

> belong to the Mezquite Series, and are poor in organic content and very compact in its horizons, making their internal drainage difficult. Currently, they are affected by salts and sodium in their lower horizons, so that when putting these lands under cultivation, it is vitally important to grant them artificial drainage and manage the irrigation carefully to prevent salinization. (Agrologia 1965: 2C). (author's own translation).

Thus, some of the physical issues faced by farmers in the lands served by pumps were recognized even before the district was formed.

Another "physical" problem faced by farmers – which in part explains the abandonment – is the sudden arrival of flood waters, which can cut through a planted field in minutes. You wouldn't know it most days – with only about 25 centimeters of rain per year – but the smallest downpour in the hills surrounding Ojinaga can cause a huge amount of water to flood fields – either on the banks of the Río Conchos itself – or even in desert lands above the river valley.

In Modulo IV, on a bright sunny day, one passes a creek bed to get to a farmer's land planted with sorghum and alfalfa on the banks of the Río Conchos. There is a rumbling of sorts which breaks the sound of the occasional fly. Is it a truck coming down the creek bed, one might wonder? No, laughs the farmer, it is water – it rained that morning in the mountains to the west of the district and the water rushes by, changing a once dry bed into a ravaging river. We will need to wait about an hour until the muddy water goes by to be able to cross with my Honda CRV, at which time the river dissipates back into the sandy soils (see Photo 6.19).

Photo 6.19. Rumbling Tributary to the Río Conchos Fills Up Quickly Due to Local Rains, as farmer looks on. At times, local floods can move overbank and ruin agricultural fields.

The water – and desert wind – create other problems – huge amounts of sediment and silt, carried both by the Río Conchos into the derivation dams as well as into the canals themselves if local observation is any indication. Go by any canal and unless one of the Water User Association back-hoe operators has just cleaned out the muck, there will be inches or even a foot of sand, silt, rocks, vegetation and garbage impeding the free flow of water. In those canals which have not been cleaned for a long time, there also will be "tule," a kind of cattail which shoots up unexpectedly from the desert floor in a scene more reminiscent of Florida than Ojinaga.

Photo 6.20. Muck and vegetation can take over canals (left) in a matter of weeks say local farmers.

“It is a very particular problem here that affects efficient conduction of the water,” explained Lower Río Conchos Irrigation District manager Eliseo Calderón, an engineer who first came to run the district in 2002. “Enormous amounts – exaggerated amounts of sediment accumulate so that in just one year the distribution dams get silted up.” (Elías Calderón, Irrigation District 090, personal communication with author, 2005). Module IV President Domingo Rey (2002-2005) confirms this view, stating “the real problem is not water but the silt – it is what affects irrigation.” (Domingo Rey, Module IV, personal communication with author, 2005). Rey said a significant amount of their outlays are merely cleaning out the canals so the water can run (see Photo 6.21).

Photo 6.21. Back-hoe operator cleans out primary canal in Lower Río Conchos Irrigation District as silt, sands and vegetation fill canals up quickly, local officials say.

G. Water Use, Conservation and Water Right Sales

During the time period of the present study, two new unique programs spearheaded by CONAGUA were being implemented in the district. On the one hand, CONAGUA began to receive federal support for the district to implement water conservation projects intended to improve the conduction efficiency of the canals, as well as for on-farm irrigation systems, either through leveling of land, relining or lining of distributive canals, as well as some more advanced irrigation systems for individual farmers. At the same time, in 2003, CONAGUA began exploring the resizing of the district through a program of the buy-back of water rights (Elías Calderón, Irrigation District 090, CONAGUA, personal communication with author, 2004).

Known as the "Sustainable Water Use Program in the Río Conchos Watershed," the efforts to conserve water – at least in a more coordinated sense – came out of, in part, the dispute between Mexico and the U.S. over the lack of flow from the Río Conchos (IBWC 2002; IBWC 2003, see Chapter Two). As part of these binational efforts, dozens of meeting occurred throughout 2002, as state, federal and CONAGUA officials – in coordination at times with the Border Environment Cooperation Commission – met with the farmers and their representatives in the Water User Associations, including in Ojinaga itself (Gonzalo Bravo, BECC, personal communication with author, 2005).

In return for the promised investments of monies into the district to improve their efficiency and the productivity of the lands, each water user association was asked to sign a document, obligating them to give up part of their water rights after the water conservation projects were completed in 2007. In Ojinaga, despite some initial opposition, all of the association members approved the agreements and all of the local officials signed the document.

Modulo V president Arnaldo Valenzuela (2002-2005) noted that "there were many opposed to signing the document, but we pointed out that the reduction in the water concession was only in return for the saved water, and we had the hope that they would also make the concession more favorable (Arnaldo Valenzuela, Module V, personal communication with author, 2005).

Whereas Delicias was given approximately 15 thousand cubic meters per hectare, the Ojinaga Water District's water concession is only 7.8 thousand cubic meters per hectare, according to Valenzuela, a profound difference.

Valenzuela said the benefits of the water conservation efforts have been notable, but have fallen well short of expectations. In Module V, the main benefit has been the relining of the main canal, as well as the laser-guided leveling of hundreds of hectares to be able to more efficiently irrigate. Nonetheless, he noted, the promised money has not covered the need, and many farmers, rather than wait for the promised leveling of their land to arrive, "became desperate and went ahead and planted before the leveling arrived."

The other major problem is that instead of the money being used in the irrigation district itself, much of it has flowed instead to the Irrigation Units above the district, spreading the wealth but decreasing the effectiveness of the program within the district itself.

"They are still leveling lands in the irrigation units upstream, even though we have two years without leveling here," he complained.

The data confirms the story. The total planned investment for the area is $168.5 million pesos over a four year period, but approximately 40 % is being invested in the irrigation units above the district itself (see Table 6.16). Through 2005, a total of $97 million pesos had or was being invested as part of the conservation efforts, with about $57 million going to the Irrigation District. Interestingly, in 2005, only about $4.2 million out of $25.8 million being spent was flowing to the district itself, with the vast majority being used to reline main canals in the irrigation units in Aldama and Coyame.

Table 6.16. Amount of Monies Invested in Lower Río Conchos Watershed in Conservation Programs, 2002-2005

Year	Irrigation District (Ojinaga)	Irrigation Units (Aldama and Coyame)	Total
Relining of Main Canal, and Gates to Derivation Dams	10,268,164	17,443,615	27,311,844
Relining of Other Canals	21,511,319	0	21,511,319
Rehabilitation of Derivation Dam "San Pedro"	0	11,385,559	11,385,559
Rehabilitation of Canals, Joints and Seals in Canal System	9,103,069	0	9,013,069
Leveling	7,157,458	0	7,157,458
Executive Projects	1,125,111	1,977,710	3,102,822
Supervision	5,060,502	3,804,083	8,864,585
Total	57,617,698	37,227,510	94,845,208

Source: CONAGUA, Distrito de Riego No. 090, information provided to author, 2005.

According to CONAGUA, part of the rationale for devoting so much of the water conservation budget to the irrigation units is that they have not been regulated by CONAGUA, and have therefore had significant water efficiency challenges. Thus, the single largest investment in the period was the rehabilitation and construction of a new, modern derivation structure to serve the communities of San Pedro and La Paz de Mexico, as well as the large pecan grove (El Consuelo) owned by one individual (Oscar López, Operations Manager, CONAGUA, Distrito de Riego 090, personal communication with author, 2005; See Photo 6.8).

In the district itself, the largest project was the relining of the first 3.8 kilometers of the main canal from the Tarahumara Derivation Dam – located in Module I --

as well as significant investments in new structures, valves and the main gates from the two derivation dams (see Photo 6.22 and Photo 6.23). In terms of the leveling of land, the wealth has been spread around, with each Module – with the exception of Module II where only limited leveling was done – having between 400 and 500 hectares of land leveled as well as distribution canals relined.

Photo 6.22. The Newly Lined Main Canal, which serves Module I and Module V.

Photo 6.23. New gates to guide the water from the Peguis Chico and Tarahumara diversion dams to the main canals were bought for the district in 2003 and 2004.

While it is difficult to ascertain who particularly has benefited, the relining of the main canal from the Tarahumara Dam, and the replacements of its doors, seals, the higher rate of rehabilitation of other canals seem to suggest that there has been more work accomplished and more funding earmarked to Modules I and V – the lower portion of the district dominated by larger, private farmers.

For Lower Río Conchos Irrigation District manager Elías Calderón, the effort to conserve water did not arise out of the drought and failure to meet the terms of the treaty, but "the need to achieve a sustainable use of water." CONAGUA initiated a policy change in 1993, he noted, as part of the National Water Law and began to look at the water needs on a watershed basis, including the increasing needs of the urban areas.

"The new (water) Law of 1992 initiated the concession of water by use and by volume – instead of just the number of hectares – which forced us to recognize over time that our concessions were exceeding the availability of water – particularly in drought years – as well as other needs in the watersheds." (Elías Calderón, CONAGUA, Irrigation District 090, personal communication with author, 2004).

Once, Calderón said, this "disequilibrium" was recognized, CONAGUA began to consider programs to reduce the use of water by the agricultural sector, in part by reducing concessions, and in part by conservation infrastructure. The way to do that he said was to buy back water rights from some unproductive farmers, while reducing water use by those who were still productive.

According to Oscar López, CONAGUA's operations manager for the district, the "Programa de Adquisicion de Derechos, Uso de Agua y Redimensionamiento de los Distritos de Riego (PADUA)" was a water right buy-back program that really began in Ojinaga. It was a test case – a pilot project -- for other larger districts.

"We needed to reduce the pressure in the district and the Irrigation Units above," explained López, who said the drought had contributed to but not caused the need to consider buying back water rights. "We had given concessions for 150 million cubic meters when only about 115 million cubic meters are sustainable." (Oscar López, Operations Manager, personal communication with author, 2004).

Therefore, both the buy back of water rights and the attempt to make water use more efficient are part of the same program – the *sustainable* use of water. As a first step, he said, they began identifying those areas that because of high costs to pump water, bad soils, or infrastructure problems would be subject to buy backs. At the same time, they began to discuss the program with the five modules. While they first proposed prices based on the suitability of the land for production, with more productive lands receiving higher payments, they later based the water rights price on the average use of water over a five-year period.

While some Modules accepted an offer of $12,864 per hectares – based on the price of $1,643 pesos for a thousand cubic meters -- others – like Modulo IV – declined. Eventually, however, all five Modules joined the program, and in its initial phase, over 2,500 hectares were eliminated from the district through the sale of water rights – including the total disappearance of Module II, which only the year before had grown more than 115 hectares of cotton. (Calderón 2005).

The Module officials charged with negotiating the payments and determination of which lands would be eligible remember it differently. Thus, Domingo Rey, Module IV president (2002-2005), said the initial offers ranged from only $3,000 to $8,000 Pesos per hectare, later raised to $8,000 to $12,000 depending again upon the terrain – how far it was from the main canals and whether the land was saline. It was the farmers, he explained, not CONAGUA, which insisted on a single price for the water rights, and while the farmers first held out for $16,000 per hectare, they eventually agreed to the lower $12,864 per hectare price.

In Module II, Llano de Dolores, Module President Federico Garza (2002-2005) said the process was also conflictive, but that most farmers were happy to sell since many owned or rented lands in other modules and had not farmed the ejido lands for many years. Still, he said, there were a few who wanted to hold onto their lands, with the hope that CONAGUA would invest monies in the pumps and relining of the main canals and that the land would once again become productive. But, he said, the temptation to sell was simply too much for most ejido members. Once the majority signed on, the rest saw the possibility that CONAGUA would invest for just a few farmers as minimal (Federico Garza, Llano de Dolores, personal communication with author, 2005).

For their part, CONAGUA officials say the emergence of PADUA forced them to change plans for the Water Conservation Program. They put off investments into the lands served by “pumped” water because they were still determining which lands and which farmers were selling off their water rights. It just didn’t make sense to fix up canals or reline them or level lands if the areas might never be farmed. For another, the shrinking of the district – and contraction of water rights – meant they had to reconsider where to invest the monies. Thus, in 2005, they decided to put much of their effort into the Irrigation Units south of the district and in essence stopped investing major funds into the district.

In Module V, many farmers who relied on the pumps in Paradero and Cerro Alto had quit farming years before, many emigrating to the U.S., and most agreed to sell off their water rights. Nonetheless, several ejido and private farmers who rely on the pumps – including President Arnaldo Valenzuela (2002-2005) -- decided to hold onto their water rights, hoping that at some point, the federal government would invest in updating the pumps and infrastructure.

“I am a friend of Dr. Rendón from Mexico City from CONAGUA,” noted one elderly farmer – referring to a high-ranking CONAGUA official charged with overseeing the buy-back. “He told me that if enough of us held onto our land, they would invest money in the pumps to make it profitable to farm again.”

Module V president Valenzuela confirmed the statement, saying that based on the first round of the sale of water rights, there was approximately 50 hectares between Paradero and Cerro Alto that would be “modernized” and a single more modern pump would replace the existing dilapidated pumps. Valenzuela himself has significant hectares irrigated here, growing alfalfa, melons and watermelons.

“Money ends, but land can sustain generations,” Valenzuela noted. “After the drought we were doing badly and here comes a program that has easy money, but it hurts to see good lands sell off their water rights for a pittance.”

Thus, in the Lower Río Conchos Irrigation District, the two main programs – PADUA and the Sustainable Use of Water – have served to reduce the amount of water used by farmers, and in fact, to reduce the actual amount of land that can even be considered for irrigation purposes. In addition, it appears that the programs have mainly benefited the private farmers of Modules I and V that have gravity-fed lands. This is again related to the fact that modules with large amounts of lands previously served by the pumps have not received significant investments from the Sustainable Use monies as CONAGUA made efforts to get those farmers to sell off their water rights. Thus, the programs have primarily benefited the larger, private farmers, a significant equity issue.

IV. Ojinaga Close-up: Module IV – the King of Cotton?

A. Overview

Created when the Lower Río Conchos Irrigation District was turned over to the farmers in 1993, Module IV is about 2,700 hectares of desert hills, mesas and river valleys. Known as "Santa Teresa – El Ancón A.C." after the southern and northern-most communities within its area, Module IV is served both by the Santa Teresa pumps and gravity-fed canals which originate at the Peguis Chico Diversion Dam. About 290 farmers – equally split between ejido and private – are on the "rolls" of the users directory, although in reality, says President Domingo Rey, "much less than half are farming." (see Table 6.17). Of some importance in the district are winter crops – wheat, oats and rye grass – as well as alfalfa, and especially cotton. Other summer crops – sorghum, chile, vegetables – are grown in only small quantities, and only two farmers began to grow pecan trees –one in 2004 and one in 2005, hoping that in 8 or 10 years the trees will provide productive yields. The only crop that is grown in substantial amounts in the area served by pumps in 2005 was cotton, with 156 hectares (see Figure 6.8).

Table 6.17. Basic Data on Module IV, 2005

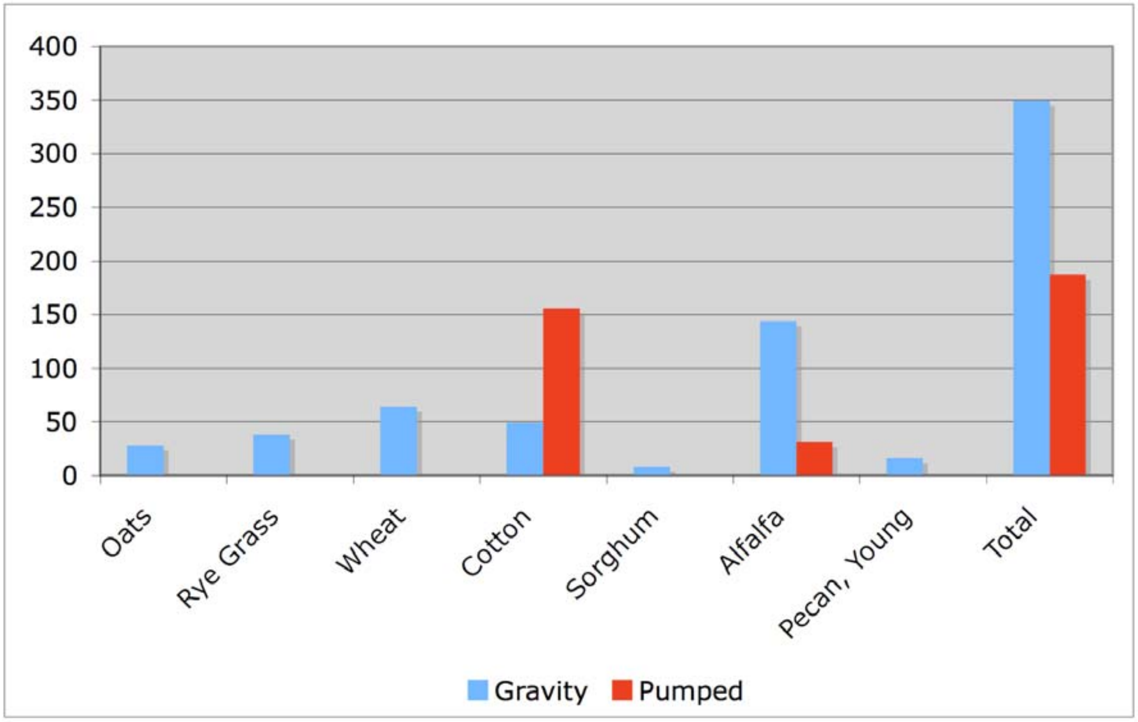
	Ejido Farms, Hectares	Private Farms, Hectares	All Hectares	Number of Water Rights
Hectares Served by Pumps	987	357	1,344	157
Hectares Served by Gravity	327	1,161	1,488	249
Farmers	138	153	291	
Total	1,314	1,518	2,832	406

Source: CONAGUA, Distrito de Riego 090, information provided to author, 2005.

Photo 6.24. These fields in Module IV were abandoned several years ago, due to the high cost of pumping water here and the nature of the soils, full of "pizarra," literally slate.

The Water User Association – now 12 years old – is run on a shoe-string budget. As the number of hectares of irrigated land has shrunk, the Water User Association has been forced to increase the cost per-hectare for providing water. In addition, because the cost of electricity has also increased, the amount they must collect from those farmers using the pumps has also increased. Interestingly, even though there were slightly more hectares irrigated in 2004 than in 2003, increasing the income from sales of water, expenses went up even more, because of the price of gasoline, as well as the increased cost of electricity on a per-hour basis (see Table 6.18). Thus, says Domingo Rey, the association actually ran in the red in 2004, and as a result, in 2005, they let one of their two canal operators go, forcing Domingo's cousin, Sarmiento, to be the water distributor of both the gravity-fed and pumped area. In 2004, the Association also spent about $50,000 pesos – or $5,000 – performing routine maintenance of the pumps and cleaning out the canals that come from the pumps (Domingo Rey, Modulo IV, personal communication with author, July 2004).

Figure 6.8. Hectares of Crops Irrigated in Module IV by Gravity-Fed and Pump-Fed Canals, 2005



Source: SAGARPA, Ojinaga District, information provided to author, 2005.

According to “El Canalero,” the spindly, fast-talking middle-aged Sarmiento, who hails from the dusty town of Valverde, his salary has stayed largely the same even as he travels from one end of the district to the other, listening to complaints, attempting to avoid conflicts, relieving flood waters that fill up the canals due to local flash floods, and generally trying to respond to the demands of alfalfa farmers near the river and cotton farmers in the areas west of the main highway.

“They are always asking me for a little more water, and I just tell them the day they are allowed to get it,” Sarmiento says matter-a-factly. (Sarmiento Rey, personal communication with author, 2005)

Table 6.18. Expenses and Income of Module IV, Lower Río Conchos Irrigation District, 2003-2004 in Nuevo Pesos

	2003	2004
Cost of Electricity (Pumps)	134,965	79,013
Payments to CONAGUA for Water	69,500	92,000
Salaries	109,900	127,895
Fuels for Vehicles	113,482	138,777
Conservation and Maintenance of Gravity Canals	58,371	17,983
Conservation and Maintenance of Pumps and Canals	24,535	49,872
Total Expenses	517,061	617,666
Hours of Electricity Sold for Water Pumped	155,048	81,412
Regular Water Sales	263,544	371,605
Renting of Heavy Equipment	152,431	121,485
Total Income	584,657	578,544

Source: Modulo IV Santa Teresa El Ancon A.C., “Resumen de Ingresos y Egresos y Gastos de Conservación,” Lower Río Conchos Irrigation District, 2004.

B. The Farmers

In July and August of 2005, 31 farmers from Valverde, San Juan, Santa Teresa and El Ancón were surveyed as part of the present work. Approximately a third were from Santa Teresa and Valverde in the upper part of the Module, a third from San Juan in the middle section and a third from the “private” lands near El Ancón at the lower end of the Module. All farmers reported having been born in the Municipality of Ojinaga, including Valverde, San Juan, La Loma and Ojinaga itself. All 31 farmers were male. The average age of the respondents was 53, with a maximum age of 85 and a minimum of 31. The present chapter presents an overall summary, more detailed survey results are available upon request.

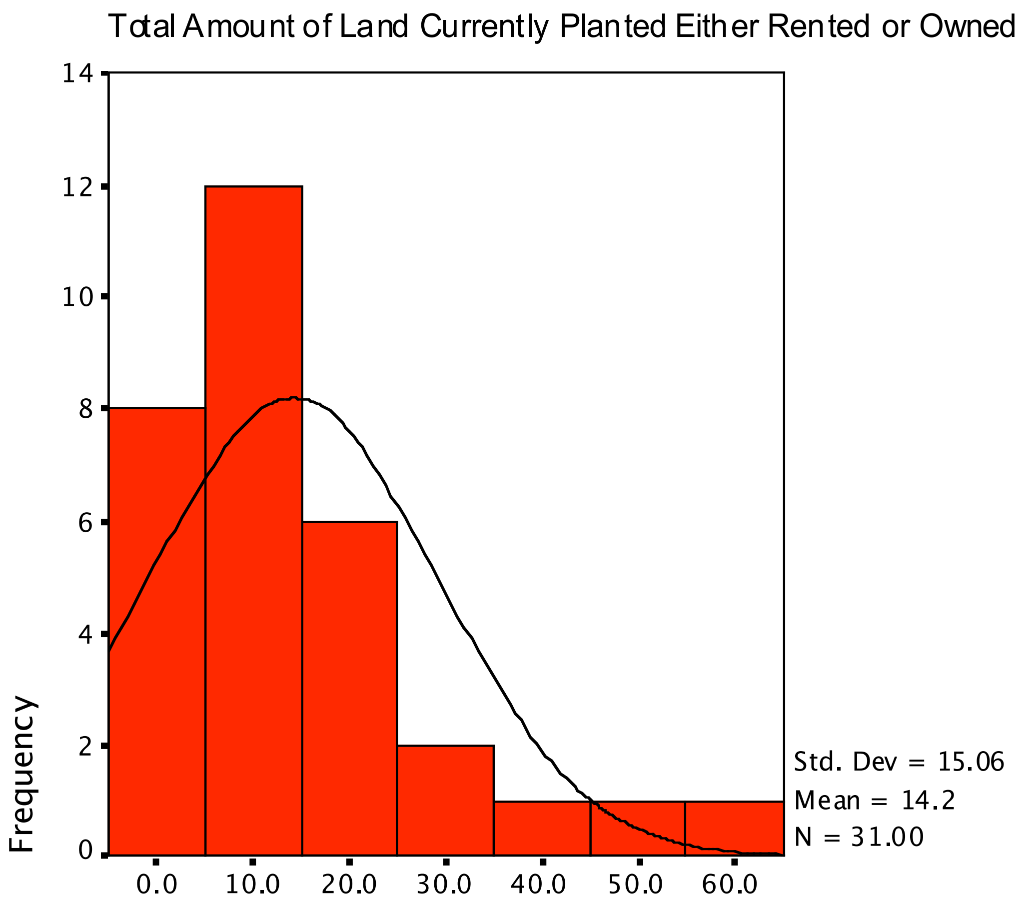
1. Land Ownership

About 2/3rds of the surveyed farmers were ejido farmers, while 12 were private farmers. On average, the private farmers had larger lots than the ejido farmers. Thus, the average size of ejido farms were 10 hectares, while the average land owned by private farmers was 16 hectares. Finally, 13 out of the 31 farmers were also renting some land for irrigation purposes. When the amount of owned land and rented land that is irrigated is added together, overall the 31 farmers irrigated between 0 and 63 hectares in 2005, with an average of 14.20 hectares.

Based upon this distribution of land, farmers were classified into three categories: small ejido farmers (16), small private farmers (7), and medium-sized farmers (8), which included five farmers with some ejido lands. The small private and ejido farmers all irrigated 20 hectares or less while the medium-sized farmers irrigated more than 20 hectares in 2005.

The surveys supported the information collected by the agricultural authorities of Ojinaga: the only crops of consequence in Module IV in 2005 were cotton, alfalfa and rye grass. Connected to the growing of these crops was the raising of cattle, which in itself was an agricultural “crop” reported by 18 of the 31 farmers. All three groups of farmers grew these crops, regardless of the size of their plots. All those growing cotton were growing it for the domestic market, selling to the local cotton gyn. All of the farmers grew rye grass to feed to their own cattle exclusively, letting the cattle graze there at times, while alfalfa and sorghum were grown to partially feed their own cattle, and partially to sell to the domestic market, which itself is connected to the meat export market.

Figure 6.9. Distribution of Land Owned or Rented that Was Currently Planted, 2005, among Surveyed Farmers (N=31)



Source: Reed, Ojinaga Agricultural Water and Land Use Survey, 2005, Respondents 1-31.

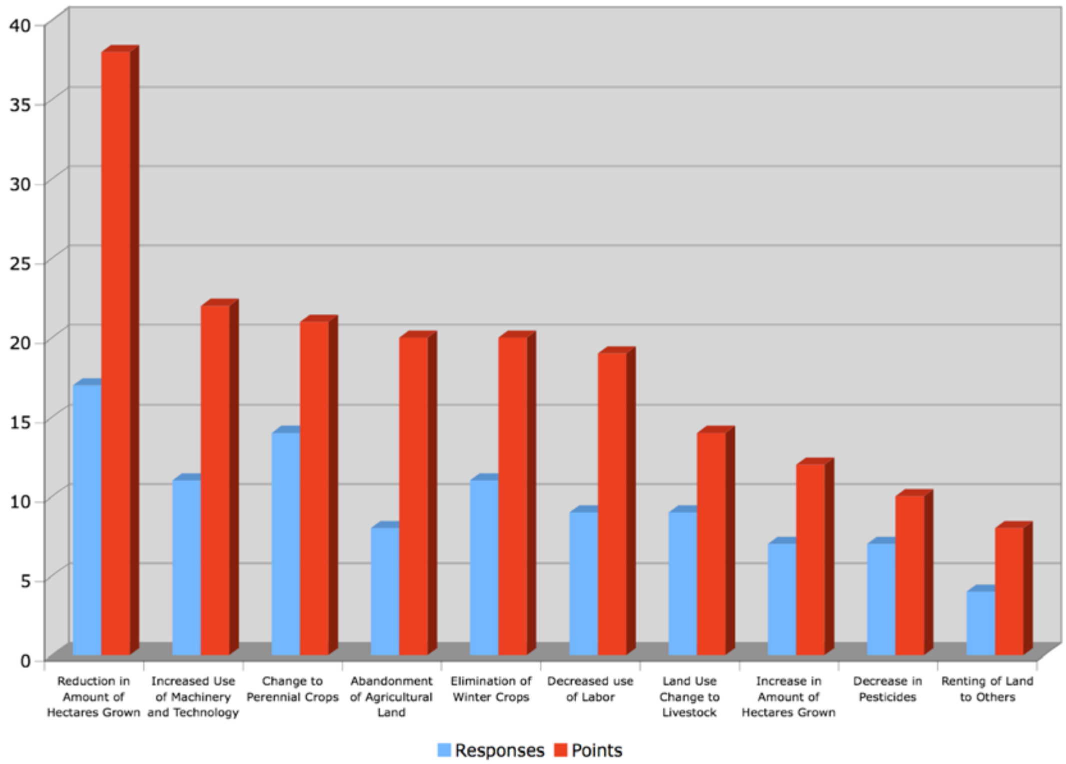
2. Changes, changes

The single biggest change mentioned by respondents was *the reduction in the amount of hectares irrigated*. Thus, 17 out of the 30 respondents mentioned it as a change, with nine of them saying it had been a change to a medium extent and six to a great change. Eight respondents also mentioned the abandonment of agricultural lands, seven mentioned the conversion of agricultural lands to livestock raising and four mentioned renting their land to others. In terms of crop choice, 14 respondents mentioned a switch to perennial crops, while 11 mentioned the elimination of winter crops. While there did not seem to be a real pattern in terms of changes in inputs to the land – with nearly an equal number saying they either increased or decreased pesticide and fertilizer use – 11 respondents specifically mentioned the increased use of technology and machinery, and nine cited the decreased use of labor. Many of these comments were related to cotton and the change in cotton from a hand-picked product to one relying nearly exclusively on machinery over the last ten years, a transformation also mentioned in interviews with the manager of Fibras del Norte and local agricultural officials (Alonso Valenzuela, Fibras del Norte, 2005).

Based on cross-tab analysis by category, smaller farmers were more likely to state that there had been a decrease in the number of hectares irrigated, as well as related changes, such as the conversion of some of their land to livestock production, or the renting or partial abandonment of their agricultural land. Increases in the number of hectares irrigated, on the other hand, showed the opposite tendency, with a greater number of large farmers responding positively than would be "expected." It is somewhat of a self-fulfilling prophesy since small farmers were precisely those that may have abandoned or rented their own land.

When asked why these changes had occurred, the focus was on rain that had not fallen, a market which had abandoned them, banks that no longer lent them money, and the high costs of inputs (See Figure 6.11). Topping the list of factors responsible for changes on their land with the highest number of responses was the "presence of drought," with 23 out of the 27 farmers responding that drought had been a contributing factor in changes on their land, although most farmers said it was a medium or small factor and not a major one. When adjusted by scale – with "major" factors weighted more than "small" factors -- the single most important factor mentioned by *farmers was the change in the costs of inputs to agriculture*. Thus, 22 out of the 27 listed it as a factor, with 12 saying it had been a major factor. Also receiving 22 responses were changes in prices for agricultural goods, with twenty out of 22 calling it a major or medium factor. In essence, many of the crops that farmers in the region once grew no longer offered them favorable prices compared to the costs of inputs – the fertilizers, pesticides and the water that now cost more. Thus, both the presence of the drought, and the related access or availability of water – which received 17 positive responses – were for the most part seen as secondary factors compared to changes in the cost of inputs and the prices of agricultural goods.

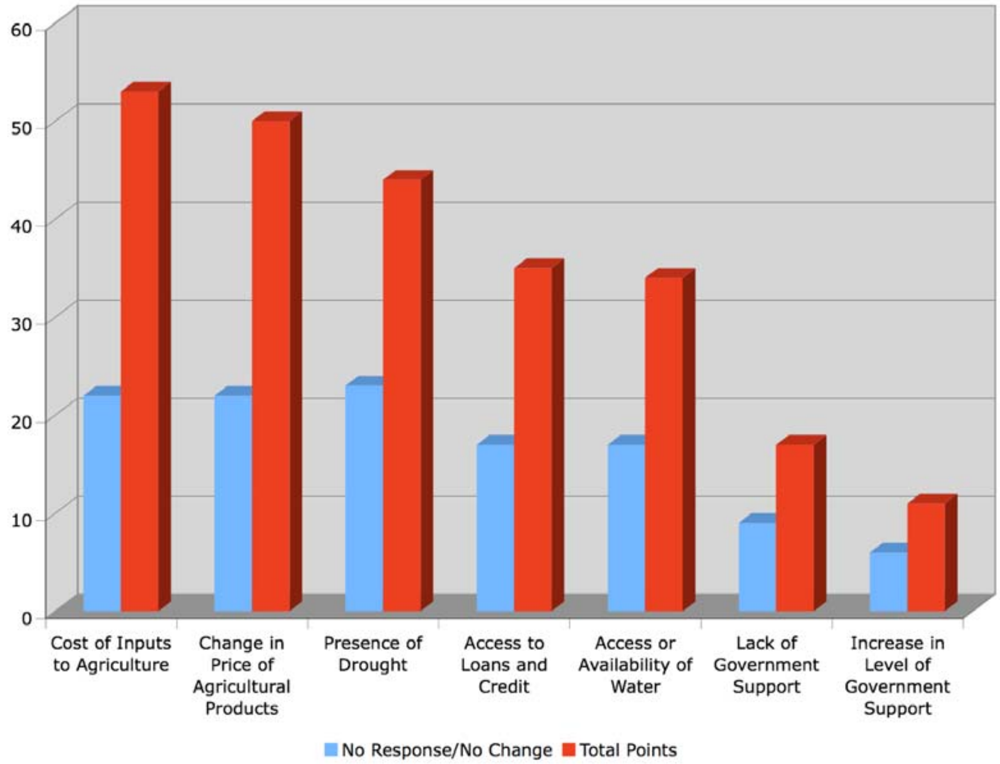
Figure 6.10. Changes cited by farmers in Modulo IV (Valverde-El Ancón) by Number of Responses (N=31) and Number of Points (Maximum =93)



Note: Changes were assigned one point for a "small" change, two points for a "medium" change and three points for a "major" change.
Source: Reed 2005, Ojinaga Survey, Surveys 1-31.

The other factor mentioned by a majority of farmers had to do with access to credit and funds for the purchase of inputs. Thus, 17 of the 27 farmers who responded cited access to credit as a major change over the previous 10 years, with 14 of them saying it had been a major or medium factor. Ejido and small private farmers were more likely to cite the cost of inputs as a greater factor than larger farmers, as well as the lack of government support and access to credit. Moreover, five of the six respondents who said that an increase in government support had been a factor were larger farmers. The responses suggest that smaller farmers had been impacted more negatively by the changes than larger farmers, or put another way, some farmers were able to adapt through access to credit and land and transition to new crops, while smaller farmers were less successful.

Figure 6.11. Factors cited by Module IV farmers in agricultural change in responses (N=27) and responses (N=81)



Note: Factors were assigned one point for a “small”, two points for a “medium” and three points for a “major” factor.

Source: Reed 2005, Ojinaga Survey, Surveys 1-31.

In addition to these standardized responses, a total of 25 of the 31 farmers listed additional factors. Thus, the disappearance of the cotton gyns in the late 1990s not only wiped out – or severely reduced -- a market for their product, but also wiped out access to credit and several farmers expounded on this factor.

Similarly, several mentioned the closing of the wheat mills and cotton gyns, and the organizational problems inherent in these ventures. Two different respondents put the problems and changes in agriculture in the region as due to the lack of markets. There simply was no where to sell many kinds of crops. No one to take the place of the gyns and mills that had closed. Several specifically mentioned the North American Free Trade Agreement and the competition in wheat, corn and beans as a negative factor in the changes that had occurred. On a positive note, many farmers mentioned the continued healthy price of alfalfa in the market, which even though a large water user, continued to provide income to farmers in the area, as did meat from cattle raised on the alfalfa, sorghum and rye grass in the area. Thus, it was not all bad news for Ojinaga farmers. In terms of cotton, several farmers mentioned the existence of the government price-support program as a key factor in its continued presence in the area.

Several farmers also mentioned physical challenges, including land which was so distant that it was hard to irrigate properly, as well as lands that were highly salinized or contained “pizarra” and were no longer productive. An additional factor was the high rains and flooding between 1991 and 1992, which destroyed many of the irrigable lands near San Juan, Valverde and El Ancon. After some years of neglect, these lands were invaded by woods of tamarisk, mesquite and other shrubs, changing the terrain and characteristics of the soils. Farmers chose to leave them alone, and with help from the irrigation district and Module, built a perimeter of raised land around them to prevent further incursions from new floods. The woods now serve as a barrier between their irrigable lands and the river, but are often inhabited by livestock searching for forage (see Photo 6.25).

Photo 6.25. These "woods" arose after the 1991 and 1992 floods, and since are used only to provide shade and space for livestock, the area long abandoned for farming.

In a recent work, local science teacher Humberto Lujan contracted with U.S. environmental organization Environmental Defense to survey the vegetation and study landsat maps for the presence of tamarisk along the Río Conchos, particularly upstream of the Tarahumara Diversion Dam. His conclusion? Tamarisk did not really exist in the area until after releases from Luis León dam were severely curtailed after 1992 (Lujan 2005: 16-17). Based on sampling sites, Lujan found 62 fields affected by tamarisk invasion within the district, most of it just upstream of the Tarahumara dam near El Ancón along the banks of the Río Conchos (Table 6.19).

Table 6.19. Surface area affected by Tamarisk invasion, Lower Río Conchos Irrigation District

MODULO	No. of Fields Affected	Total Surface Area of Fields	Total Surface with Presence of Tamarisk	% Affected
I – Labor de Ojinaga	4	83.92	21.55	25.69%
III- El Mezquite	10	153.99	68.13	44.24%
IV-Santa Teresa-El Ancon	42	347.34	101.69	29.27%
V-Paso del Norte	6	57.30	20.06	35.01%
Total	62	642.56	211.46	32.9%

Source: Humberto Lujan, "La Invasion de Tamarisk (Cedro Salado) en el Bajo Río Conchos, Aguas Arriba de la Presa Derivadora "Tarahumara," (Austin, Texas: Environmental Defense, March 2004).

3. Water, drought and conservation

There were two major sources of water for Module IV farmers. Some 25 of the 29 farmers who responded said their major source of water was the irrigation canals, with four reporting water from the canals served by the pumps as being their major source of water. One respondent said they had dug a "noria" – a shallow well near the Río Conchos to augment their supply. This respondent was the only farmer who said they had "changed" their source of irrigation water, a significant difference with the farmers surveyed in Delicias (see Chapter Five), where surveys showed that the majority of farmers switched water sources.

All those who provided detailed information relied on a main canal, connected to a secondary canal, connected to individual canals on their land, whether or not the water was pumped. What differed to some degrees is whether these secondary and individual canals, known as "acequias" were earthen or cement. In addition, while many farmers reported using "mangueras" – small plastic hoses – to carry the water onto their rows of crops, others used "presillas" – small earthen dams to irrigate one section – or one row of crops -- of the land at a time.

In general, those growing cotton used the more precise “mangueras” while those growing alfalfa, rye grass or sorghum – which are not planted in precise rows -- used “presillas.” Four different cotton farmers also said in recent years they had changed to planting the rows of cotton to 30 or 32 inches apart, rather than 38 or 40 inches as part of an effort to make better use of water and increase production, a change that has been promoted by the local agricultural extension office (see Photo 6.26).

Photo 6.26. Typical Cotton Field near San Juan in Modulo IV. Note Plastic “Mangueras” coming From Acequías and foraging cow.

While the survey size is probably too small to make any definitive conclusions, it appears that the number of irrigations has gone down compared to years when water was more easily accessible, but the number of hours has remained about the same.

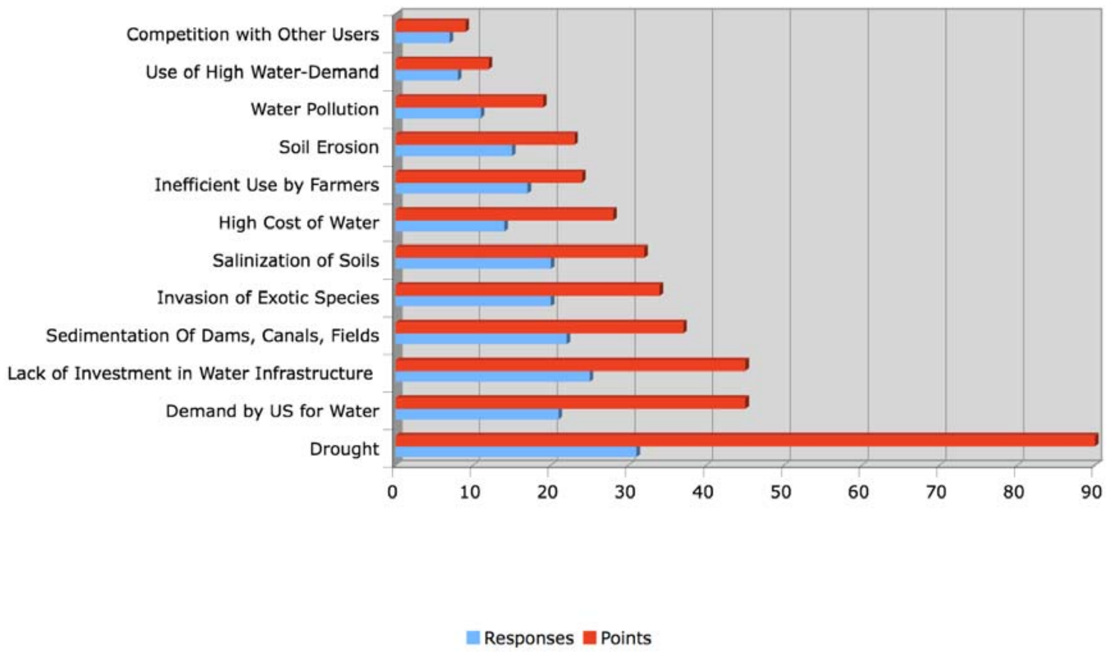
Some of the changes in water use per hectare are related to participation in the water conservation projects recently enacted in Module IV, including both the lining of secondary canals and the leveling of some lands for more efficient irrigation. A full 20 out of the 31 surveyed farmers said they had participated in a water conservation project either at the communal or individual level.

Farmers were supportive of the water conservation projects, though disappointed with some of the results to date. While most recognized that part of the reasons for the programs was precisely to assure more water to the U.S., few felt it had been imposed, although more – particularly small farmers -- felt it was benefiting some more than others. Thus, the disagreements with the programs were not related to the need for water conservation and water efficiency, but to how it was being implemented, and who it had benefited.

All the farmers surveyed believed there had been a drought that had affected the District, and 24 of the 31 saying it had been the worst drought they had experienced. There was little doubt among farmers that the principle factor in less water being available was the drought itself, although other factors were also cited (see Figure 6.12).

Thus, 21 out of the 31 respondents felt that the U.S. demand for water from the Río Conchos was a factor in the lack of access to water for irrigation over the last 10 years. A common feeling among respondents was, in fact, the sense that their share of water from Luis León had been directly limited by the need to release water to the U.S. Not only did they know it to be true from reports, but they had actually seen releases during dry spells go down the Río Conchos past their dry and thirsty fields.

Figure 6.12. Factors in the lack of water cited by Module IV farmers by affirmative responses (N=31) and points (Maximum=93)



Note: Factors were assigned one point for a "small", two points for a "medium" and three points for a "major" factor.

Source: Reed 2005, Ojinaga Survey, Surveys 1-31.

Similar to this belief, was the idea expressed by several farmers that water that fell locally and fed the river "did not count" toward meeting Mexico's water treaty obligations. While untrue, this common myth among the farmers led to the belief that only water specifically released from Luis León that bypassed their own irrigation system counted, and led in part to the widespread belief that the lack of water was in part due to water demands by the U.S.

Most – 25 of the 31 farmers surveyed in Modulo IV – also felt that their access to water had been severely curtailed by the lack of investment in basic water delivery infrastructure. There was too much sediment in canals and too little effort to clean it, and the pumps intended to irrigate the lands above the river valleys were old, ill-equipped and had frequent problems. Young, old, rich and poor farmers all felt that rather than small distribution dams and a major reservoir – El Granero – located 140 kilometers upstream, the Mexican government should build a storage and distribution reservoir somewhere near El Peguis – the stunning canyon about 20 kilometers south of the district – or increase the size of the existing diversion dams.

"It doesn't make any sense to lose all the local rains because our diversion dam is too small," noted Modulo IV president Domingo Rey. "We could store more and give more water to the U.S. and our farmers." (Rey 2005).

A similar factor is the large amount of silt, sand and sediments that washes through the riverbed, diversion dams and irrigation distribution system, which 22 of the 31 farmers cited. Some of the comments related to the lack of investment were directly related to the high amount of silt and sand common in the district.

In addition, 20 out of the 31 farmers said that invasion of vegetative species – primarily salt cedar – had been at least a minor factor in the loss of water – or really the reduction in irrigable land – while the same number said highly salinized soils – literally salt accumulating into the soils -- had been a factor. Often of course the two factors appeared to be related with invasive species increasing the saline content of their lands.

Other factors receiving comments included inefficient use of water by farmers, as well as the use of high-demand crops. Other factors – such as water pollution and the high cost of water itself – also received multiple positive responses, while "competition with others" – notably competition with the upstream irrigation units received much more limited replies.

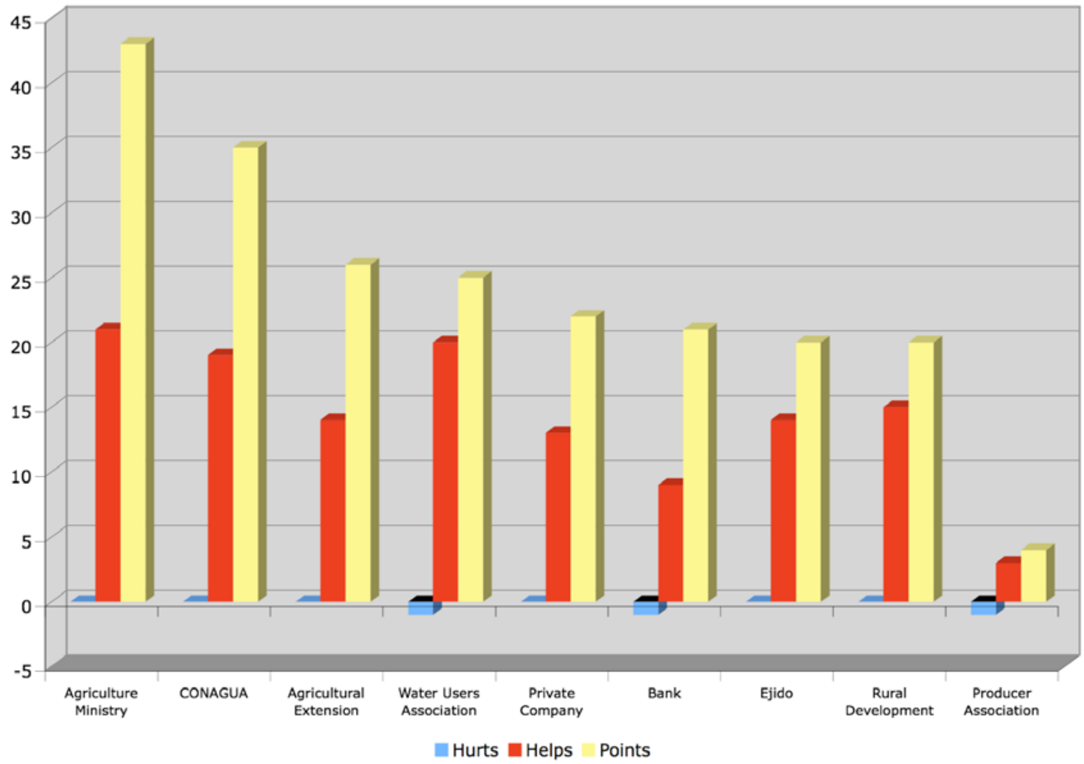
4. Organizational help

Farmers were asked about the organizations that assisted them (see Figure 6.13). Topping the list was the agricultural ministry – SAGARPA. Interestingly, eight of the nine larger farmers who said the ministry had supported them said they had done so at a medium or high level, and a cross-tabs analysis indicates larger farmers said they received more help than smaller farmers from the federal agricultural commission.

CONAGUA also received multiple positive responses, mainly related to the water conservation projects, with most citing the land leveling projects as the major help. Sanidad Vegetal – the local agricultural extension agency – received significant positive response, related to the Boll Weevil and Pink Bollworm Eradication Program.

Farmers were decidedly mixed in their opinion of the water user association, which runs Modulo IV, including the distribution of water. While 15 users did say it provided a small amount of help, and five respondents said they received even greater levels, four said the water user association had been no help at all, and one respondent claimed he had been hurt by the association – due to high water prices and poor response.

Figure 6.13. Organizations cited by Module IV farmers as helping or hurting them in number of responses (N=31) and points (Maximum =93)



Note: Organizations were assigned one point for “small” help, two points for “medium” and three points for “major” help. Negative points were assigned if an organization “hurt” the farmer.
Source: Reed 2005, Ojinaga Survey, Surveys 1-31.

Farmers were asked whether the major policy change that occurred with the 1992 National Water Law – the transfer of the irrigation districts from CONAGUA to individual water user associations – had been of benefit. Farmers have a mixed feeling about taking over the district for themselves. Of the 23 farmers who answered the question, 11 considered it a disadvantage, eight an advantage and four were neutral.

On one side, many felt that because the management of the district was now their affair, they had a better sense of how to manage it. On the other was the opposite view, that while in theory it might be a good thing to administer your own resources, it had been poorly managed. In general, farmers had the view that CONAGUA had turned over the district, but without the oversight – or the funding – needed for the farmers themselves to improve service. Thus, farmers waited around depending on the local water user association to clean canals or respond to problems, but these water user association had neither the training or the funds to properly respond. As one farmer noted, “the price has gone up, but not the service.”

Less than half of those surveyed mentioned private companies. Most of these either mentioned the only cotton gyn operating in 2005 – Fibras del Norte – or mills or cotton gyns no longer operating. Most were referring to help in previous years, when mills and cotton gyns gave farmers an outlet for their products. There was a dearth of private companies in 2005, a stark contrast to Delicias.

The 16 respondents who were members of ejidos gave some credit to the ejido structure itself for providing help. However, all of the comments were not so much related to the organization of the ejido, but to the fact that several government programs are geared toward helping communities at the ejido level. Others mentioned the credit they had received in the 1980s and early 1990s from Banco Rural, again credit provided through the ejido structure. Thus, there was not overwhelming support for the ejido as an organizational entity.

Similarly, out of 31 respondents, only 10 said they had received credit or help from banks, one saying it had actually hurt due to high interest rates. Nine out of the 10 respondents were in fact referring to credit provided in the past by Banco Rural, most of which ended in the late 1990s.

Only six farmers reported having been involved in some kind of producer association. Of these six, one reported having been actually harmed by his membership and two said the association had provided no benefit whatsoever. Two of those responses were related to the previous cooperative efforts to run and finance cotton gyns, knows as Sociedad Ultimo Esfuerzo and Sociedad Perla del Desierto, both of which ultimately failed.

The final organization that provided some assistance was the Rural Development division of the local Ojinaga Municipality. Here, most farmers credited the division with providing needed assistance, particularly during drought years when access to cattle feed was difficult. Still, several respondents faulted the agency saying that they had applied for benefits they never received, such as one heard there were goats available but never received a response.

The answers to this part of the survey reveals a farming population which depends heavily on support from government programs such as PROCAMPO, and to a lesser extent from Desarrollo Rural, which previously had support from banks and private companies – most of which has dried up -- and which does not have significant organizational support through either its ejido structure or producer associations. Thus, the credit, private company contracts, producer associations bank loans and cooperatives which pepper the Delicias Irrigation District are in short supply in Ojinaga, leaving farmers to depend on the government for help.

V. Module V: Cow Feed

A. Overview

Modulo V – officially known as “Paso del Norte, Asociacion Civil” (North Pass Civil Association) – is the Lower Río Conchos Irrigation District’s largest in terms of land area of the five water user associations. Officially created in January of

1994, Modulo V expands over 4,200 hectares and includes kilometers of alluvial fields along the banks of the Río Grande, stretching from just below Cerro Alto – the highest peak in the area – to the banks of the Río Conchos itself, just above its meeting with the Río Grande. Further south, the Module also includes some desert hills in small communities like La Esmeralda, San Francisco de la Junta de los Ríos, Tierras Nuevas and Tocolote. It is a big and expansive area, with hills, mountains, alluvial fields and small towns lying just south and west of the City of Ojinaga itself. Some 430 farmers in the Module own 501 water rights to farm the area – at least on paper -- but many of the towns and fields have been partially abandoned, say local officials (Arnaldo Valenzuela, Modulo V, personal communication with author, 2005 -- see Table).

Ejidos with lands in Modulo V include La Esmeralda, San Francisco, El Paradero and Tierras Nuevas. Farmers living in San Francisco – largely blood relations to the farmers from Esmeralda -- wanted their own lands separate from Esmeralda, and a new ejido was also born in the early 1980s once the river changes course (Guadalupe Torres, San Francisco de la Junta de los Ríos, personal communication with author, 2005). According to one ejido official, however, the unity farmers displayed in the early 1980s to win the land has largely dissipated and “only about 12 of us are still active.” He said that some 15 ejidatarios had sold off their lands, and many had migrated to the U.S. (“Jose,” Ejido Official, San Francisco, personal communication with author, 2005).

According to local Esmeralda resident “the Widow Niño“, her family founded the town of Esmeralda in the 1920s, coming from San Luis Potosí “in search of land in a cart with mules.” Using little ditches from both the Río Grande and Río Conchos, they began to grow corn, and increasingly, cotton. Others also arrived, and by the late 1920s, the town was already part of an ejido structure.

“There were trucks loaded with cotton and bushels and bushels of corn,” she remembered, and said the residents of the ejido would often irrigate light at night using kerosene lamps to save water. “God didn’t charge us for water, but now they sell it and then resell it.”

If you travel northwest parallel to the Río Grande past San Francisco and Esmeralda, and past the private lands known as the “Pequeñas Propiedades,” you come to the Paraderos – Paradero de Abajo and Paradero de Arriba, twin dusty towns which have for the most part been abandoned (see Photo 6.27). With water scarce and incomes from farming reduced, most here have let their feet to the walking, emigrating either to Ojinaga itself or crossing the border to the U.S.

One elderly couple who have stayed live in a dilapidated house at the end of a street full of abandoned homes. They grow a tiny amount of vegetables around their home, irrigating a few dirt canals from the main canal about a hundred yards away. They have long ago abandoned the agricultural fields. They say the ejido no longer meets, and many members took advantage of the recent government program to sell off their water rights.

Photo 6.27. Homes, church and streets in Paradero de Abajo, largely abandoned.

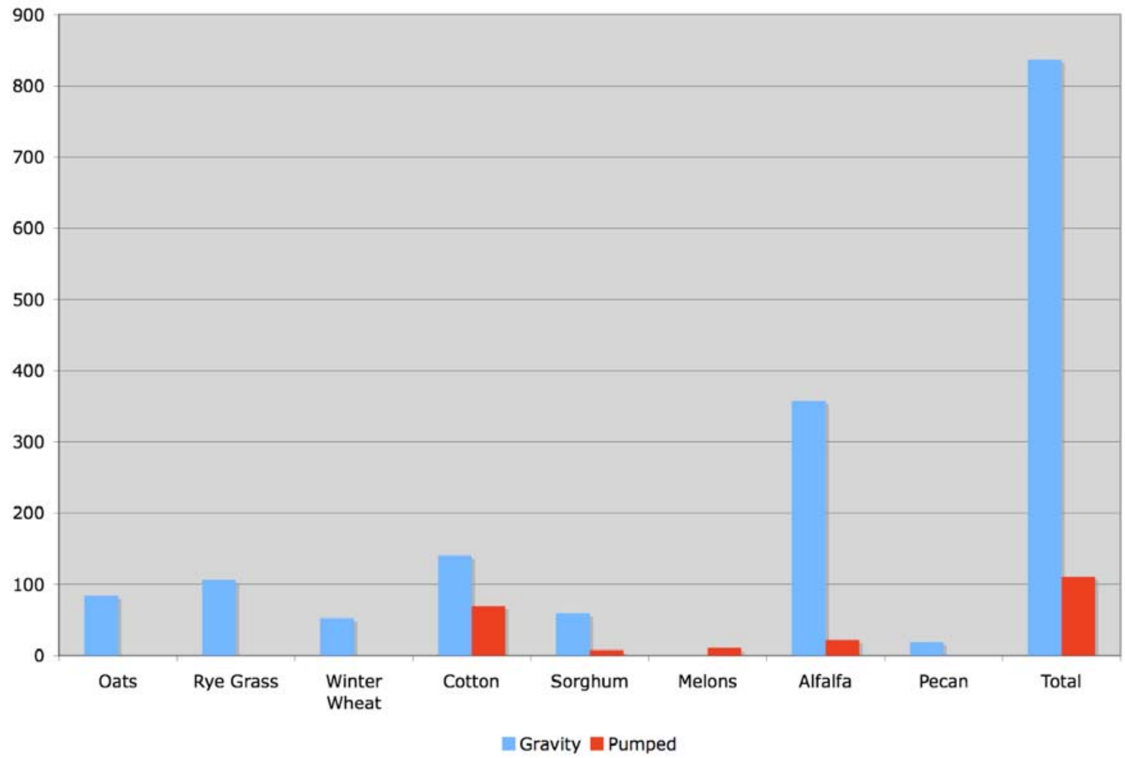
The land in Module V is divided between those served by the main irrigation canal and its secondary distribution canals which provides access to water to about 60 percent of the Module, and three pumps in Paradero de Arriba, which pumps the canal water to the lands between Paradero de Arriba and Cerro Alto (Photo 6.28). Here they also take advantage of supplementing the pumped water with local “wild” waters from the Río Grande when it rains. A diversion device was built in 1957 and some farmers have rights to half of the flow. While suffering from years of neglect, the diversion device still “works” and serves as an important resource to local farmers whose cost of water has risen along with the cost of electricity from the pump.

According to statistics from the local rural development district of SAGARPA, the federal agricultural ministry, as of July, 2005, only about 950 hectares had been irrigated that agricultural year, with only slightly more than 100 hectares being in the area served by the "pumps." In fact, since 2002, very little has changed in the number of hectares irrigated in the district as only a handful of farmers – approximately 100 of the 430 – are still making a living off the land. Overall, the farmers of Modulo V were only farming about 25 percent of the irrigable area, including about of a third of the lands served by "gravity" and only some seven percent of the land served by pumps (see Figure 6.14).

Photo 6.28. The Pumps of Paradero de Arriba

In 2005, the leading crops were alfalfa (380 hectares), cotton (211 hectares), rye grass (106 hectares), oats (84 hectares), sorghum for feed (51 hectares) and winter wheat (53 hectares). Only two farmers were growing pecans in the Module (see Figure 6.14).

Figure 6.14. Hectares of Crops Irrigated in Module V by Gravity-Fed and Pump-Fed Canals in 2005



Source: SAGARPA, Ojinaga District, information provided to author, 2005.

Modulo V had hired a single canal operator to serve the 4,200 hectares. The canal operator received about $3,000 U.S. per year plus gas money as he traversed the district in a beat-up sedan. As the number of hectares of irrigated land has shrunk, both CONAGUA and by extension the Water User Association has been forced to increase the cost per-hectare for providing water. In fact, in 2004, the Module actually spent more money than it took in, due in part to failures in some of the machinery and the need to invest more money in the pumps. Thus, the “taking over” of the district’s infrastructure has been a difficult prospect for the water user association, due to decreasing water sales.

Photo 6.29. Alfalfa field in La Esmeralda. Alfalfa has become by far the dominant crop in Module V in recent years; Note the Secondary Canal has been Relined with Cement making Irrigation more Efficient

Adrian, the 30-something canal operator of Module V – “El Canalero” – said it is difficult work. “There is always canals that need cleaning so that the farmers can irrigate,” he said on a hot afternoon in 2004, indicating Lateral No. 10, which at that moment was being cleaned out. He said there are problems with the users, who sometimes break the locks on the little valves so they can sneak in a nightly irrigation. “They sometimes take water without asking.” (Adrian, Canal Operator, Module V, personal communication with author, 2004).

The farmers are supposed to ask him for water for the upcoming week by Tuesday, and he then is supposed to report it to his bosses, who in turn report it to CONAGUA every Wednesday. Sometimes, however, the farmers ask for the water "out of turn," forcing the Module and canal operator to juggle around scheduled deliveries to meet farmers' demands.

"When there is water no one wants it and we sometimes just let it flow. When there isn't any water is when suddenly the people ask for it," he noted (Adrian, Canal Operator, Module V, 2004).

At a local meeting of the Modulo V on July 20th, 2005, Adrian, Modulo V president Valenzuela, members of the local "Comité de Vigilancia " (Watch Committee) and members of the Esmeralda Ejido gathered at the local primary school to discuss issues. These types of meeting – where a "section" of the Module reviews progress and registers complaints – is common in the Module during the irrigation season.

The meeting – with approximately 30 farmers crammed comically into children's desks – is part information session and partly the vetting of complaints. Valenzuela notes that they have cleaned most of the laterals and the main canal, but "while we are full of eagerness, we lack money." He lays out the schedule for cleaning canals for the rest of the year as well as emphasizing the need to get their irrigations schedule in order "so that we can make sure there will be enough water from CONAGUA for the rest of the summer."

Part of the discussion revolves around how to actually keep the module running properly since, as Valenzuela states, "it would take 600,000 pesos to clean all the secondary canals for the 1,000 hectares that are being irrigated," money the Module clearly doesn't possess (see Table 6.20). Problems discussed include the sedimentation of the canals, the frequent problems with the dirt roads, which can become impassable during intense rains, the garbage which flows into the canals, and poorly installed or broken canals and valves. He also says that while they have sufficient monies to clean out the main secondary canals before the end of the year, there is no money from CONAGUA for more land-leveling as part of the water conservation efforts “until 2006.”

There is then a frank and open discussion about the robberies, violence and distrust that exists among some farmers in the Module. Apparently, fights between farmers over water have occurred, and the canal operator has been threatened several times over misunderstandings about the water schedule. Of particular concern are the scattered incidents of robbery – where locks have been cuts or valves opened illicitly without the knowledge of the canal operator or the module. The question to the farmers is what should they do?

The farmers agree that after a first offense, the farmer committing the violation and the other farmers downstream impacted should sit down with the leadership and remedy the situation, but that future problems should lead to actual sanctions against the farmer. As one farmer puts it, using a soccer analogy, a “yellow card” for a first offense – a warning – and a “red card” – expulsion -- for a second.

Finally, looking to the future, Valenzuela discusses the need to take water conservation and the orderly delivery of water more seriously. “The entrance of water from the Conchos is charged to us by CONAGUA in millares (thousand cubic meters), not hectares and we have paid over 100,000 pesos through June,” he said. “But here in the Module we pay the same amount – whether for oats, or pecans – by hectare.”

Adrian, the “Canalero” also reminds the farmers to cut off the flow when they finish irrigating so that water is not wasted. The solution, say both Valenzuela and other farmers, is to charge by the “volume utilized” and “not by hectare,” although Valenzuela says it will be up to future administrations. Such a change would represent a major change in the local culture but one that Delicias undertook ten years earlier.

Table 6.20. Income and expenses for Modulo V, Lower Río Conchos Irrigation District, 2002-2004 in Nuevos Pesos

	2002	**2004**
Cost of Electricity (Pumps)	NR	59,395
Payments to CONAGUA for Water Delivered	153,706	135,273
Salaries (Canal Operator, Manager, Administrators)	101,527	84,841
Fuels for Vehicles	55,487	75,270
Loan Payments for “Back Hoe” heavy machinery	49,035	54,168
Maintenance and Repair of Vehicles	40,393	98,576
Conservation and Maintenance of Gravity Canals	18,180	16,870
Conservation and Maintenance of Pumps	6,264	39,462
Total Expenses	471,105	649,386
Hours of Electricity Sold for Water Pumped	NR	50,221
Regular Water Sales	421,384	547,677
Renting of Heavy Equipment	60,963	12,650
Total Income	493,588	629,827

Source: Modulo V Paso del Norte A.C., “Resumen de Ingresos y Egresos Correspondientes Al Ciclo de Octubre de 2003 a Septiembre de 2004,” Lower Río Conchos Irrigation District, 2004.

B. Survey: The Farmers of Modulo V

1. The Farmers

In July and August of 2005, 34 farmers from Modulo V were surveyed in Esmeralda, San Francisco de la Juntas, “Las Pequeñas Propiedades”, Paradero de Arriba and Paradero de Abajo, Cerro Alto, Tierras Nuevas and El Tocolote. Approximately a third were from San Francisco and Esmeralda near the meeting of the Río Grande and Río Conchos, a third from lands in “Los Pequeños” and El Paradero – in the bluff above the Río Grande -- and a third from the southern part of the Module in Tierras Nuevas and El Tocolote.

Not surprisingly, all 34 were male, since the owners and workers of land were sought. Land distribution of those surveyed clearly shows most farmers are small farmers, with 15 out of the 34 farmers surveyed irrigating 10 hectares or less of owned or rented land in 2005. Most of the farmers – 12 of the 16 -- who were renting additional lands were private farmers. Based upon this distribution of land irrigated, farmers were classified into three categories: small ejido farmers (15), small private farmers (13), and medium-sized farmers (6). All the “small” private and ejido farmers were irrigating less than 20 hectares in 2005.

While ejido lands were found near the communities of San Francisco and Esmeralda, private lands were contained in the Pequeñas Propiedades and El Tocolote (see Photo 6.29). While the majority of private farmers had relatively smaller tracts of 10 or 20 hectares, a number of individuals and families did buy up properties during the 1990s and early 2000s (Arnaldo Valenzuela, President, Modulo V, personal communication with author, August 2005). Thus, there was a concentration of land ownership, particularly in Pequeñas Propiedades, a series of long rectangle strips of land which extend from the main canal to the banks of the Río Grande.

Photo 6.30. The lands of the Pequeñas Propiedades have been bought and sold with frequency.

With the exception of some cotton – most of it grown by one large grower -- most farmers surveyed were growing crops for cattle feed, including sorghum, oats, rye grass and especially alfalfa. Alfalfa was grown by large and small farmers nearly equally. In addition to these crops, farmers were also growing "cows," either for meat or more often for dairy intended for local, home cheese production. Thus, one ejido respondent said they made homemade cheese, one said he raised goats for meat, and two others reported selling off calves, while three private small farmers also reported making "asaderro" cheese (Photo 6.31). Another respondents said he had begun raising sheep for meat. Finally, among larger farmers, two reported raising dairy cows and one was raising and exporting calves (Photo 6.32). There was a smattering of cotton grown by some farmers surveyed, one farmer reported growing melons of various types, and only farmer had a pecan farm – along the banks of the Conchos.

Photo 6.31. Farmer and sons make asaderro cheese in their home in Tierras Nuevas.

Production thus was either for use primarily as an input to cows for cheese making, or to sell to the domestic market for calves being exported to the U.S. With the local one-stop cattle export shop some four kilometers west of Ojinaga in El Mulato, it is a short trip for most local farmers, and provides some needed profit to their farming operations for those selling to the buyers and sellers of cattle awaiting export to the U.S.

Photo 6.32. Cattle await export to the U.S. from La Estación, which serves as a destination for locally grown alfalfa, oats, corn and rye grass.

Other than cattle and in one case pecans, the only exports across the river were local cheese makers which sold small quantities to shops and individuals across the bridge in Presidio.

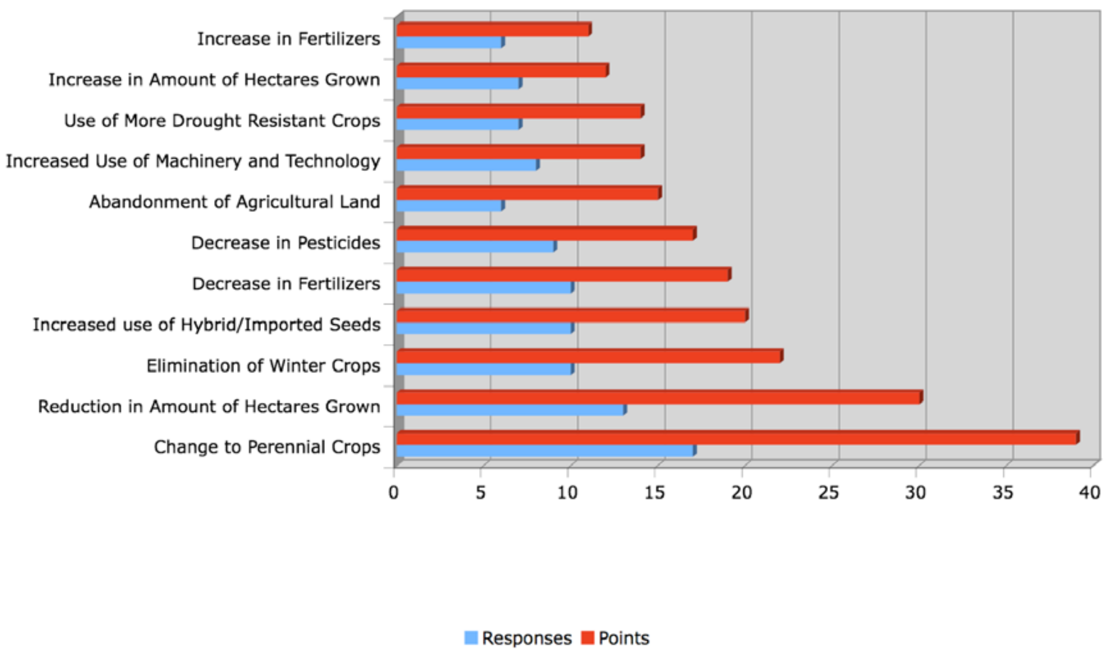
2. Changes

Nearly all – 32 out of 34 -- of the farmers reported that their had been changes to the way in which they used their land over the last 10 years (Figure 6.15). The single biggest factor mentioned by respondents was the switch to perennial crops. In terms of total hectares irrigated, 13 respondents said there had been a reduction in the total number of hectares they were irrigating – mainly a "medium-level" change – and seven said there had been an increase. Some 10 respondents mentioned the elimination of a winter crop as a change over the last 10 years, referring to winter wheat. Seemingly related to the increase in the irrigation of cattle feeds like sorghum, rye grass and alfalfa, more respondents said they had decreased pesticide and fertilizer use than increased it, as well as increasing imported seeds. Because only a few respondents were growing cotton – where the use of machinery has increased – there were few responses related to the use of technology. Only six respondents mentioned the complete abandonment of agriculture – still a high number considering the small sample -- only two said they had switched their land to livestock production while three said they had been renting more of their land to others. These tended to be smaller farmers.

Smaller farmers were more likely to answer positively to the statement that there had been a decrease in the number of hectares irrigated, while larger farmers were more likely to say there had been an increase in the number of hectares irrigated. Similarly, all three who responded that they had been renting their land to others were ejido farmers. There did not appear to be other major differences between the categories of farmers in terms of crop choice or input use.

Just why did theses changes occur? Farmers were asked to "rate" a series of factors which might have influenced the changes that had occurred on their land, including both physical, economic and climactic changes. Not surprisingly, for most farmers, it appeared that a combination of new market realities and to a smaller extent drought conditions had influenced changes in the volume of land and crop choice. As in Module IV, topping the list of factors responsible for changes on their land with the highest number of responses was “changes in market prices” and “costs of inputs.”. Thus, while drought and access to water might have been a factor – particularly in the amount of land irrigated – the major changes were related to the cost and prices of good.

Figure 6.15. Changes cited by farmers in Module V by Number of Responses (N=32) and Total Points (Maximum=96)

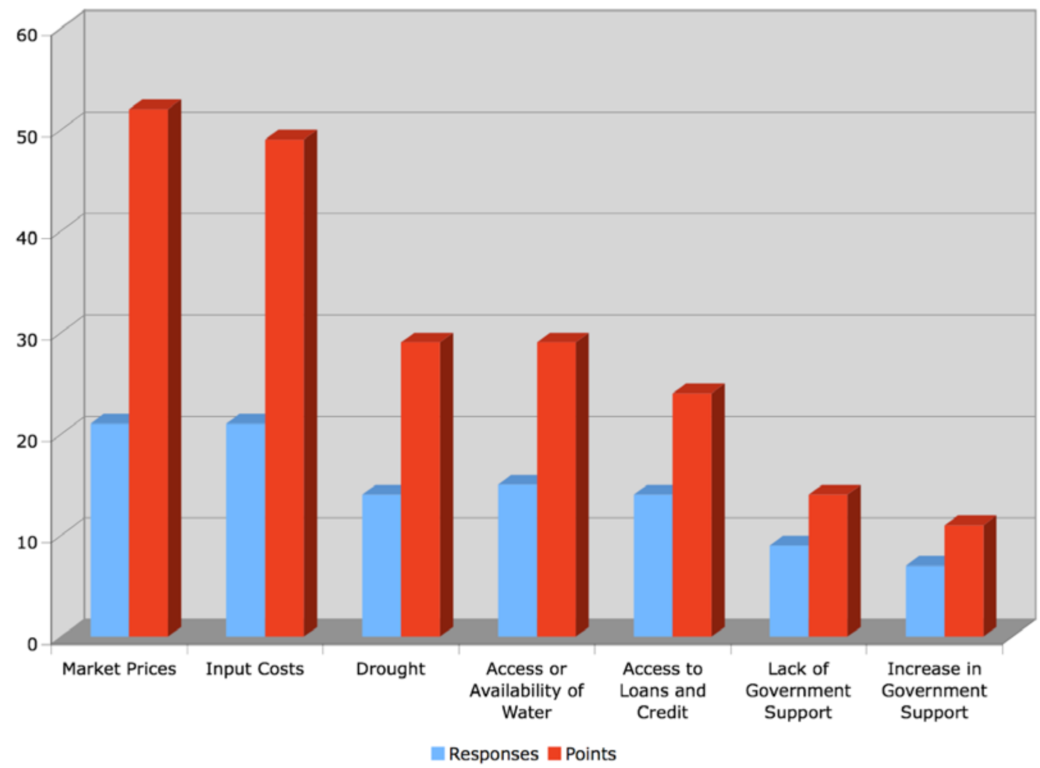


Note: Factors were assigned one point for a “small”, two points for a “medium” and three points for a “major” change.

Source: Reed 2005, Ojinaga Survey, Surveys 32-66.

When asked about additional factors not listed on the survey, nearly all of the responses were related to market conditions and organizational issues. Thus, several mentioned the closing of the wheat mill and the difficulty and near impossibility to grow wheat again given the high transport costs to send the product all the way to Chihuahua City. Similarly, others mentioned the lack of credit for farmers in the area, while several others put the problem as organizational – there was no good mechanism or association to market their products. Finally, one respondent mentioned a very important market force in the area – emigration to the U.S. as an option for Ojinaga farmers. As one farmer remarked, “we don’t export crops, we export labor.”

Figure 6.16. Factors related to agricultural change cited by farmers in Module V, by number of responses (N=32) and Points (Maximum=96)



Note: Factors were assigned one point for a “small”, two points for a “medium” and three points for a “major” change.

Source: Reed 2005, Ojinaga Survey, Surveys 32-66.

3. Water Issues

While drought and access to water were not cited by farmers as the major causes of changes in their crop selection, they were nonetheless important. Of the 32 farmers who responded to the section of the survey on water use – two farmers were renting their land to others – all said their primary source was the irrigation canal itself, with two farmers saying they augmented it with pumped water from the main pump, two mentioning they used a tractor at times to pump from the canal, and two others saying they used Río Grande water on occasion (see Photo 6.33 and 6.34).

Photo 6.33. Some farmers pump directly from the irrigation canal using tractors.

Farmers in Modulo V irrigated their crops in much the same way that those in Modulo IV did. Thus, there was no mention of spray or pivot irrigation systems, but there was talk of “acequias” – earthen canals connected to secondary canals -- which themselves came off of either the primary canals or secondary lateral canals. There were differences. For example, some farmers irrigated their fields with “presillas” – little mounds of dirt creating a mini-dam which was then opened between raised earth mounds – melgas – to irrigate alfalfa fields. Others – particularly the few irrigating cotton – used “mangueras,” little rubber hoses that carried water into individual ditches. There were several farmers – four in all – who specifically mentioned that they had changed from “presillas” to “mangueras,” even when irrigating alfalfa fields. There were also some farmers – 13 in all -- who reported now having a cement-lined individual canal, while most continued to irrigate with earthen canals on their land.

Photo 6.34. Diversion device in Río Grande provides some farmers in Modulo V with additional rights to irrigate crops.

Most of those surveyed –23 – reporting owning only a single water right, three small private farmers reported having two water rights, and four other private farmers reported having between three and five water rights. No farmer reported buying additional water rights in 2005, and only two reported selling their water rights, including one who participated in the government buy-back program.

There did not appear to be major changes in irrigation schedules, although for winter crops there had been severe curtailments. Several farmers mentioned that the lining of canals and the leveling of fields – part of the major water conservation efforts – had allowed them to lessen the number of hours needed to fully irrigate their fields since the water flowed more evenly and quickly.

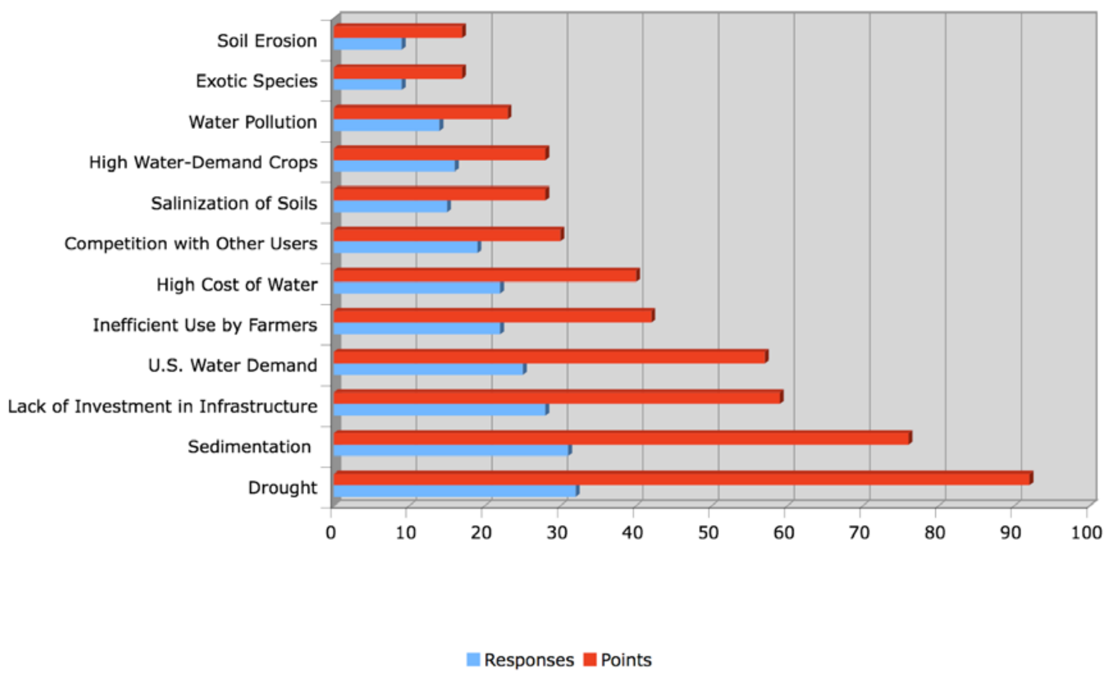
All of the farmers surveyed that were actively farming were aware of the new investments being made in the Lower Río Conchos Irrigation District to help "save" water and most of them had been involved in one project or another. While 21 were involved in water conservation projects, they felt their level of participation in the projects was fairly limited, largely "watching" the experts level fields and line canals. Virtually all who participated in projects were involved in some kind of leveling of their lands for more efficient irrigation practices or lining of canals. Nonetheless, in many of these cases, the farmers said the project had not lived up to their expectations, either because the project was not properly completed, they had been unable to farm that particular plot of land, or it was too little of an area to make a difference in total water use.

Farmers –no matter whether larger or small – believed water conservation projects not only were of benefit because they could reduce water use, but because they could also potentially be used to increase the amount of land irrigated. About a third did believe the water conservation projects were benefiting some farmers more than others, but few felt they had been imposed. Most – 23 out of 32 -- did recognize that part of the benefit would flow to the U.S., though they did not necessarily think that was fair. Thus, two farmers mentioned that it was unfair that Chihuahua was "paying for other states."

“We can’t pay it when there is no water. I am not going to take away a glass of water from my own son to give it to a neighbor,” another farmer explained simply.

All farmers replying said there had been a drought and 26 out of the 32 said it had been the most severe in memory. Who exactly was to blame? The farmers of the lower part of the Lower Río Conchos Irrigation District believed the lack of rain was the major factor. But there was plenty of blame to go around.

Figure 6.17. Factors cited by farmers in Module V, Lower Río Conchos Irrigation District, related to lack of water in responses (N=32) and points (Maximum=96)



Note: Factors were assigned one point for a “small”, two points for a “medium” and three points for a “major” factor.
Source: Reed 2005, Ojinaga Survey, Surveys 32-66.

The majority of farmers blamed sedimentation of the river, dams and canals as a major factor in their lack of access to water. They were more likely to cite this factors as compared to the farmers upstream in Module IV, which is likely due to their geographic position at the bottom of the Irrigation District. Thus, the physical reality of continual sedimentation of canals and the distribution dams – and for the few farmers utilizing the Río Grande waters the river itself – was a major constraint to irrigating their fields.

Also cited by a majority of respondents – 28 out of 32 – was the “lack of investment in water infrastructure.” Many farmers felt that improper maintenance of the dams and canals had allowed them to frequently silt up. There was a litany of complaints about the silting of the dams themselves, about the failure to upgrade the pumps, the grade of the canals to make water flow properly and in more than a few cases – a particular call for a new dam that would increase access to water in the district.

Also receiving a high number of positive responses – 25 out of 32 – was the demand for Río Conchos water from the U.S. Farmers were acutely aware that their water was subject to an international treaty and therefore U.S. demands for water. Farmers also blamed themselves. First, 22 of the 32 farmers blamed inefficient water use as being part of the problem. The recognition that the move to higher-demand water had been a factor in limiting total water use was cited by half of the respondents.

The high cost of water itself – the $630 new pesos per hectare farmers were paying in 2005 to irrigate their crops was another factor which farmers felt had limited their access to water.

Thus, the answers provided by farmers in Module V were similar to those in Module IV, indicating that while the drought was the main culprit of reduced access to water for farmers in Modulo V, the release of water to the U.S., sedimentation and vegetative invasion of dams and canals, the lack of investment in the district itself and a variety of other physical and social management issues had also plagued the district and its water user association in recent years.

4. Help on the way?

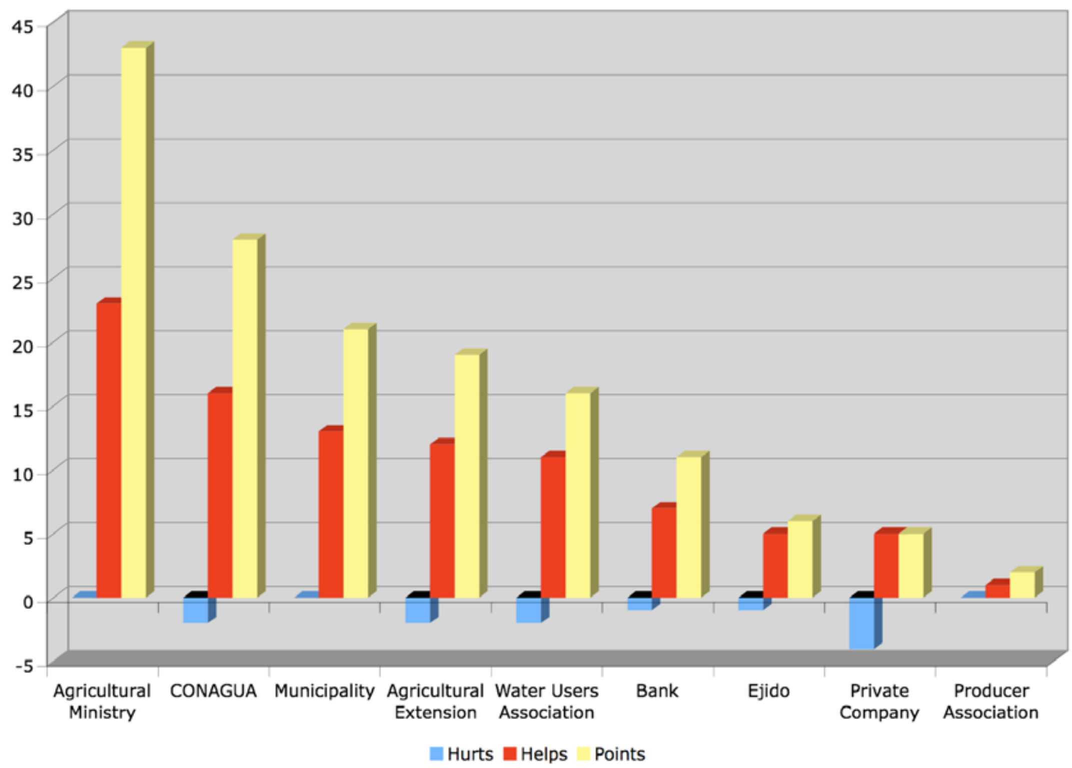
Farmers in Modulo V were asked about the organizations and government agencies that assisted them (see Figure 6.18). The answers were very similar to those in Module IV. Topping the list in Modulo V among respondents was the agricultural ministry – SAGARPA. While virtually all the support for ejido farmers were the direct production payments of PROCAMPO, private farmers were more likely to mention Alianza para el Campo, suggesting they had more access for such programs that allowed them access to machinery and other inputs.

CONAGUA also received significant responses, with 16 farmers saying they had been helped by the National Water Commission and two saying the “help” had actually hurt them. Most – seven in all -- cited the land leveling projects as the major help they received, while others said more generally “water conservation projects” and “relining of canals.” The two negative responses were related to water conservation and land leveling projects that “were badly done.” There were much fewer positive responses to Sanidad Vegetal – the local agricultural extension agency – in Modulo V than in Modulo IV, simply because most of the quasi-governmental agency’s work is related to the cotton boll weevil eradication program and pecans, neither of which is grown to a great extent in Module V.

Also receiving generally good marks was the local municipality’s Rural Development agency, with 13 farmers saying they had received assistance. Three of the six larger private farmers said the agency had helped them secure funding to build a “Tejabán” – literally an open-air roofed structure to store alfalfa, oat and rye grass hay. Farmers were decidedly mixed in their opinion of the water user association. While 11 users said it provided a small or medium amount of help, several said it was no help at all, and two respondents claimed they had been hurt due to high water prices and poor maintenance of canals.

When asked to comment on the transfer of the irrigation districts from CONAGUA to individual water user associations -- eight of the respondents chose to provide additional, largely, negative comments. There was a general feeling that the district had been transferred with little oversight, little training and little power. As one larger private farmer noted, “the water was so much cheaper and more plentiful when CONAGUA ran it, now they only give us a percentage.”

Figure 6.18. Organizations cited by farmers in Module V, Lower Río Conchos Irrigation District, that helped or hurt farmer by responses (N=32) and Points (Maximum=96)



Note: Organizations were assigned one point for “small”, two points for “medium” and three points for “major” help. Negative points were assigned for organizations that “hurt” the farmer.
Source: Reed 2005, Ojinaga Survey, Surveys 32-66.

Very few farmers cited help received from private companies, with only 10 individuals mentioning specific companies. Four of these individuals said their association with the private company had "hurt a little bit," which was related to problems of payment with the local cotton gyn. Most farmers seemed to scramble to sell their products – be it cheese, alfalfa, cattle or cotton – rather than enter into long-term contracts with particular companies.

Similarly, out of 34 respondents, only 10 said they had received credit or help from banks, six of which were referring to credit from Banco Rural from the previous decade. Thus, credit appeared to play only a small role in the district since the collapse of the agricultural government-supported banks in the 1990s.

No farmer reported having received help from a non-profit, non-government organization. Only one reported having been involved in some kind of producer association -- a local sheep production association – which opened a new chapter in Ojinaga in 2004.

V. Conclusions

The Lower Río Conchos Irrigation District faced special challenges throughout the 1990s and early 2000s. Rather than a simple tale of reduced rainfall, water delivery curtailments and a shrinking farming base, farmers reported that a new market reality – the elimination of wheat, cotton and corn beginning in the mid-1990s and the rise of cow-feeds like oats, rye grass and especially alfalfa – was the key to changes in the district. Thus, while irrigated hectares were reduced substantially, there was also a fundamental shift in crop choice. This crop choice favored those crops that were inputs to cattle and other livestock, some of which were exported for meat, and others which were used for local cheese production.

Drought did cause water curtailment in the district, a fact supported by both factual information from CONAGUA as well as survey data, but this fact was also complicated by the “transfer” of the district from CONAGUA – the National Water Commission – to five local water user associations known as Modulos. These Modulos began to hire their own administration and canal operators and charge farmers for hectares irrigated. While farmers are generally supportive of running the district themselves, they complained of mismanagement, favoritisms, but especially of the lack of support for basic infrastructure and training to better manage water and land. Essentially they felt CONAGUA had set them free without a parachute.

Compounding these issues were organizational and credit issues. Unlike Delicias – with a more integrated and organized market – farmers in Ojinaga had few options for credit, had largely failed in their attempts to organize collectively, and had seen private companies that previously provided support and credit fail, including both wheat mills and cotton gyns. While a new cotton gyn did open up in the early 2000s – in part responding to new government price-support programs – farmers complained that the gyn was not providing the credit or assistance to make cotton profitable. Still, cotton enjoyed a rebound in 2003 and 2004 due to the presence of the gyn and the government-support program.

The other organizational entity --- the ejido – seemed to have lost much of the communal spirit that may have once existed in the district. While recognizing that the ejido structure was still useful in securing support from government programs, most ejidos in the district were largely inactive; communal lands were largely unused; and many ejidataríos had simple left their lands abandoned, long having moved to the U.S. or to other parts of Chihuahua.

Indeed, there was a general concentration of farming in private hands in the lower part of the district in Module I and Module V, while pump-fed canals in the upper and western part of the district were abandoned. The reason was related to salinity and poor soils in these lands, the increasing costs of electricity to pump the water and the infrastructure itself – which received limited investments from the Module and CONAGUA during the period. Faced with these issues, many farmers in 2004 and 2005 chose to abandon these fields and even permanently sold off water rights to the government, a program that was both lauded and criticized by local farmers. In fact, one of the five “modules” disappeared in 2005, as the Llano de Dolores ejido collectively chose to sell off their water rights rather than face an uncertain future of pumping expensive water over desert hills.

Thus, the case study supported the notion that in the context of reduced water flow and releases to farmers, and the buy-back, privatization and decentralization of water rights, larger farmers benefited more. With more flexibility in land ownership and water rights, they seemed to adjust to the challenges of the late 1990s better and were able to buy up lands and water rights and gain access to programs like Alianza del Campo to acquire machinery.

The conflict over the lack of outflow of the Río Conchos between the U.S. and Mexico was recognized by local officials and farmers, as was the general need to use water more wisely and share the resource. Farmers did not generally feel that the conservation programs had been imposed upon them, nor that they benefited one class of farmers more than another, although there was a significant number surveyed who did feel there had been mismanagement of funds to benefit certain farmers. They did, however, feel that part of the impetus was to assure that more water flowed to the U.S. – and were generally critical of the Water Treaty. A significant number in both the upper and lower district felt that part of the reason for the lack of water were the “releases” to the U.S. during winter months from Luis León Dam – a generally true statement – but also blamed the water debt on the fact that local flood waters falling into the Río Conchos didn't count toward meeting treaty obligations – a myth repeated by both large and small farmers.

The curtailment of water did lead to changes on the land. Many farmers had participated in the water conservation projects, lining distribution canals and leveling their land to improve water management. Generally, most farmers reported reducing either the number of irrigations or the number of hours they irrigated, although not to a large extent. Many changed the irrigation practice itself – for example using small hoses rather than earthen "dams" to distribute the water among rows of crops – or using "corrugados" – similar to a corrugated tin roof for the water to flow more smoothly from higher to lower ground. Cotton farmers often increased the densities of their crops to increase yields and take advantage of less water availability. Still, local leaders complained that farmers often did not participate in the implementation of the local water conservation projects, or had not adopted irrigation practices that took advantage of the newly leveled-lands and lined canals.

As a border community, farmers in the Lower Río Conchos Irrigation District often had an option to leave the area – legally or not – and from local discussions it was clear that in the 1990s and 2000s given the uncertain future of water and markets, many farmers – and sons of farmers – did choose to leave. Thus, in San Juan, in 2005, a family returned from Odessa Texas to celebrate the 15th birthday of their daughter with the family that had remained. They rented out a local center in Ojinaga, provided music, while the local farmers killed and bled cows and pigs for the occasion. The sleepy town of San Juan came alive for a week-end and the only two-story house – built with money earned in the U.S. – came alive again. It was a reminder how life once was in the Lower Río Conchos

Irrigation District, when credit, local mills and cotton gyns, plenty of water at a cheap cost and no direct competition with U.S. imports gave local farmers a more sustained livelihood. It was the pearl of the desert.

In 2005, on the other hand, farmers faced a more challenging existence, and farmers either responded by buying up or renting land and water rights, and largely converting their farms into crops for cattle feed, or selling or renting their land and water rights, and abandoning farming altogether.

There have been some attempts provide new opportunities for these farmers. On July 24, 2005 at the Asociación Ganadera No. 3 – the local offices of the Chihuahan Cattle Association -- approximately 100 farmers from Ojinaga, Manuel Benavides and Coyame listened and approved plans to create a new cooperative. The attempt to create from scratch such a cooperative of ejido and private farmers and cattleman is ambitious and is modeled on some successful efforts in recent years throughout Mexico. Officially dubbed as the “Centro de Abastos de Insumos del Agropecuario del Semi-Desertico,” (Agriculture and Cattle Supply and Input Center of the Semi-Desert), the promoters described it as “new kind” of cooperative.

“Before people would together and try to collectivize work, so that if one person didn’t produce, everyone was affected,” explained José Castillo, the coordinator of the statewide efforts. “But with this cooperative, the work is individual, but the benefit is for everyone who works.”

Castillo told the crowd that the model was already working successfully in three other areas of the state, and while it was not a government program, the federal government could put up to $10,000 Mexican new pesos per associate as “working capital” for specific projects, such as creating a factory for producing feed. He also explained that unlike purely producer-led cooperatives, they would have a manager and administrative staff to run the cooperative, while the producers would form the board of directors to “avoid corruption and conflicts that have occurred.”

One member of the audience from Coyame agreed. “When it’s run by the producers, it never works because they always take action to favor some relative.”

The crowd endorsed the formation of the new association, electing Santiago Ortiz, a local cattleman, as its president. In 2005, the plan was to begin with surveys and a diagnostic of the region to determine which inputs might benefit from purchase in bulk and what products might benefit from a joint marketing strategy.

For his part, local Rural Development director “Pepe” Corrales said that the “Centro de Abasto” would be a welcome addition locally due to the low level of commercialization in the area. He said he would like to create marketing opportunities for local producers through cooperatives and government support (Pepe Corrales, Rural Development, Ojinaga Municipality, personal communication with author, 2005). He said of utmost importance to the region would be increase the price of milk and cheese sales, perhaps by opening a LICONSA milk collection center to provide local dairy producers a local sales option, as well as moving more heavily into goat and sheep production through local associations.

“We need to organize the milk producers so they can either sell directly to Chihuahua, Saucillo or Camargo or we can bring milk production here – bring a milk bottler here or a collection site for the government program," Corrales explained.

The farmer in Ojinaga cuts a lonely figure against the desert sky, with only his extended family to aid him. The ejidos are largely dormant, the public and private banks have abandoned him and private industry has not stepped in to support him. Imports from the U.S. in basic grains have fundamentally changed his crop options. Still, it would be wrong to paint a totally pessimistic picture. Some farmers have managed to survive by changing to more of a cattle-based economy, often renting or buying up abandoned land, while others have sought other alternatives, including broom sorghum production, honey production, sheep and goats and rabbit meat. While some of these experiments – including a brief attempt to grow eucalyptus trees – have failed, the presence of farming despite all the obstacles encountered throughout the 1990s is a testament to the perseverance of farming itself in an arid region of Mexico, scorched by the Devil himself.

Chapter Seven: Droughts, Disputes, Discourse, Decentralization and Natural Resource Use in the Río Conchos Basin

I. Introduction

Droughts have been recorded as a problem for farmers in Texas and Mexico since Spaniards explored the area. When Spanish explorer Álvar Núñez Cabeza de Vaca made his westward journey from Galveston across the Chihuahuan desert, he is believed to have stopped near present day Ojinaga, where the Río Conchos meets the Río Grande at the Junta de los Rios.[13] There, the natives were restless.

As related by Cabeza de Vaca:

> It is a heavily populated land. We asked why they did not sow maize; they replied that they were not doing so in order not to lose the crop, for during two consecutive years the rains had failed and the weather had been so dry that all had lost their whole crop of maize, and they did not dare sow it again until first there had been copious rain. And they begged us to tell the heavens to rain, to implore them to do so, and we promised them that we would do this. We also asked them from where they had brought that maize, and they said from the direction the sun set, and in that land there was maize everywhere; but the maize closest to us was in that direction. **(Cabeza de Vaca, as cited in Pupo-Walker** 1993: 101.)

Back in the 1530s, communities such as those described by Cabeza de Vaca in the Chihuahuan desert were facing drought, impacting their agricultural production, forcing them to trade with other communities less affected by the

[13] There is disagreement about the exact route Cabeza de Vaca and his remaining cohorts took across Texas, Mexico and the West. Thus, Enrique Pupo-Walker puts the voyage to the north of present day Presidio and suggests that the meetings of rivers discussed was actually along the Pecos. Instead, the travelers did not meet up with the Río Grande until near El Paso, before heading to the south. See page 137 for a discussion of the Jumanos and Conchos Indians likely encountered by Cabeza de Vaca. (Pupo-Walker 1993:137).

vagaries of climate. They asked for help from outsiders – albeit in spiritual intercession rather than material goods – and awaited climate change. What then, has really changed in 500 or so years?

In one sense, not a whole lot. Drought in northern Mexico and Southwestern U.S. continues to be common, both locally and regionally (Liverman 1999; Goodrich and Ellis 2006). Farmers continue to make decisions about natural resource use based on climactic, supply and demand conditions, and continued to look to the world outside their immediate soil, land and watersheds for markets, assistance and new technologies.

On the other hand, as this dissertation has shown, conditions in the Río Conchos watershed changed significantly from previous drought-like conditions, at least in the period of record, with significantly less flow in the river and significantly greater populations, interest and demands on the water resources. In addition, if indigenous farmers in the 1500s traded with nearby indigenous communities and asked for help from other cultures during times of drought, they did so without the benefits or drawbacks of a water governance structure, trade regime and land tenure system. As part of an international boundary and international water treaty – not to mention an international trade treaty which created new rules on investments, imports and tariffs beginning in 1994 -- farmers in Chihuahua were also subject to much larger “outside” interests in decision-making about their resource use, from large environmental organizations, to grain importers, to cities like Chihuahua to U.S. interests like South Texas farmers and the politicians that supported them, to the larger scale of world markets, which often set the prices of the products they were growing (IBWC 1944; NAFTA Secretariat 1994). They were part of a much larger network of relationships across different geographic scales, and not just a chance meeting with some lost Spanish explorers. In fact, significant differences would be found even comparing farmers of the 1970s and

1980s and present-day farmers in these areas, as the pressures and realities facing them were very different, as well as the connections to international markets and governance regimes.

This final chapter reviews the key findings of the study, as well as how these findings contribute to the larger literatures within differing strains of geography and natural resource studies. Finally, the chapter outlines future areas of research related to this region and topic and considers if the physical and institutional architecture now exists to resolve future binational disputes over water, or to utilize water in a sustainable fashion.

II. Some Key Findings: Dispute and Discourse over an International Resource

While presenting case studies of natural resource use by farmers in specific geographic locations in a time of drought, the dissertation began by reviewing the causes, real and imagined, consequences and proposed solutions of the dispute between the U.S. and Mexico over low inflows coming from Mexican tributaries to the Río Grande, the international boundary between El Paso and Brownsville. Because the Río Conchos has been the major hydrological “input” to the Río Grande below the Elephant Butte reservoir in New Mexico, there was particular attention in the media, among politicians and interested parties in what was happening in this watershed that had caused such low outflows (see Chapters Two and Three). There were two major findings.

First of all, the research found that a number of explanations were offered by interested parties for the low flows from Mexico into the Río Grande. Mexican officials and academics pointed to an “historic” drought which while not as intense as droughts of the 1950s and 1960s had been much more extensive geographically and temporally. The intense drought of the late 1950s had been replaced by an extended period of low rains and low inflow into the dams throughout the basin (Reyes Gómez et al. 2005). U.S. officials, farmers, academics and consultants pointed instead to dam management decisions and the expansion of agriculture in the Delicias Irrigation District as either the primary or secondary causes of the lowflow. Thus, on the one hand, Mexican officials claimed there simply was not sufficient water to meet basic needs and allow water to flow into the Río Grande, while U.S. farmers and officials said that there was, and that Mexico was "stealing" this natural resource by hoarding the water at Mexican dams for the benefit of the expansion of Mexican farmers.

A third narrative emerged from environmental organizations and to some extent entities like the Drought Center in central Chihuahua which focused not only on the lack of rainfall, the change in timing of rainfall – potentially related to global climactic changes – but also on land use changes, in particular deforestation in the uplands, contributing to lower rains, filling dams with sediment and impacting base flows.

Without necessarily assigning a single cause, the research noted that much of this discussion utilized differing data sets to bolster their case. Thus, Mexican officials focused on dam releases, overall rainfall patterns and the number of hectares under irrigation, as reported by "official" sources – the National Water Commission or CONAGUA – while U.S. officials and their consultants relied on overall and average dam levels, the total quantity of water in the dams – cumulatively added over time -- the timing of releases and the total amount of hectares irrigated in the Conchos irrigation districts, culled from satellite imagery and other sources (Brandes 2000; Center for Space Research 2003). Data from the Drought Center focused on rainfall differences regionally and runoff coefficients, influenced by fire and deforestation (Reyes Gómez et. al. 2005; Rodríguez Piñeda et. al. 2005).

The research then looked at the data on many of these issues, and again, without necessarily assigning an essential “cause” found that there was evidence that several of these factors did contribute to the lowflows. Thus, there was little doubt that rainfall decreased in the 1990s in the Conchos watershed, although the lack of rainfall and stream gauges in the upper Río Conchos made precise conclusions difficult. At the same time, while overall irrigation of hectares did decline in the three major irrigation districts– along with overall water use – there appeared to be a slight increase in the amount of water used per hectare throughout the mid and late 1990s. In addition, while the number of hectares that relied on “official” water from the irrigation district dams declined precipitously, many farmers began to rely on alternative sources, and statistics from the agricultural ministry – SAGARPA -- demonstrated much greater levels of hectares irrigated and production than from the data provided and continually cited by Mexican politicians from CONAGUA, the National Water Commission. Thus, in response to the drought – which lowered hectares of land irrigated and overall water use – farmers often turned to other water sources, which themselves could have impacted the flow of the river. These findings were confirmed throughout the case study chapters.

At the same time, CONAGUA and irrigation representatives did make decisions to change the timing and release of water from some of the major dams in Chihuahua, in essence turning off the dams in winter months due to the drought-like conditions. This probably changed the “normal” flow of the Conchos River which in previous decades had received significant runoff from irrigation of winter wheat, alfalfa and oats grown in the winter as well as more frequent fall rains.

Another obvious factor was the very existence of the dams themselves. In previous droughts in the 1960s, Luis Leon dam – downstream of Delicias Irrigation District -- did not exist, meaning rainfall and return irrigation flow flowed downstream and was not captured at Luis Leon. The completion of the dam potentially aggravated lowflow conditions, due to curtailed releases, silting and evaporation during drought-like conditions.

The study presented no definitive evidence on how deforestation and land use change might have impacted flow, but observations and interviews suggest that local impacts in the upper watershed both from deforestation and mining of materials in riverbeds led to substantial tributary blockage and observed sedimentation which may have reduced runoff to the larger river and the downstream dams. Thus, the research suggests a multi-faceted cause of low inflows into the Río Grande, from increased overall water use – including groundwater pumping from alluvial aquifers and direct pumping of the river – to low rainfall, to new dam management to local land use changes. This multi-scaled explanation stands in stark contrast to the "essentializing" tendencies of the major narratives explaining lowflow among interested parties in the U.S. – Mexico conflict (Ellis 1996). Furthermore, the research also looked at how changes in water and land policy, as well as the North American Trade Agreement were also part of the story, because of their influence on which types of farmers might have benefited and which types of crops were thus more likely to be grown. This approach, influenced by the field of political ecology, suggests that part of the cause in natural resource use change can be attributed to market forces and changes in policy which decentralized and privatized the use of water and land, influencing production and use patterns.

Another major finding was how the transboundary conflict was changed from a narrow technical discussion over water quantity to a more comprehensive discussion of water and river shed management. Groups and interested parties – including the governments themselves -- used the conflict to promote water conservation and efficiency as well as land stewardship as viable solutions to the lack of water flowing into the Río Grande.

Thus, a group of 20 environmental groups from both sides of the border called on the two governments to change the focus from water scarcity issues to water management (Texas Center for Policy Studies 2001). The water conservation option – advocated among other recommendations by the groups – was incorporated into the official “minutes” or agreements by the International Boundary and Water Commission in both Minute 308 and Minute 309, becoming the basis for a unique financing agreement through two new binational organizations, the Border Environment Cooperation Commission and North American Development Bank (IBWC 2002; IBWC 2003: BECC 2002). Although originally focused on potable municipal water supply issues, wastewater treatment and solid waste management, these new institutions expanded their mandate to also include a focus on agricultural water use and irrigation practices, a change that was also pushed in part by environmental groups working on issues along the U.S.-Mexico border (Kelly, Reed and Taylor 2001:19; NADBANK 2000). Thus, the recent dispute utilized new actors – from environmental organizations to farmers to new binational institutions – and new solutions – water conservations and land management practices – to help resolve an environmental conflict (Browning-Aiken et. al. 2004).

Similarly, while the eventual resolution of the conflict occurred largely through releases of stored dam water in Tamaulipas – flush with water from the hurricane-related storms of 2005 – and was conducted chiefly by the state departments of both countries with technical advice from CILA and IBWC, the presence of officials from the State of Texas – representing in some sense the vocal farmers of South Texas – was a unique change from previous more narrow resolutions of transboundary environmental conflicts between the U.S. and Mexico at higher national levels.

The proposed solution was not uncontroversial since it in essence invested monies into Chihuahua's irrigation districts in return for a promise to reduce total water rights to the water user associations making up the irrigation districts. Still, ultimately all water user associations signed a document pledging to implement the water conservation projects and –if there were confirmed water savings – give up a portion of their water rights. Whether or not these agreements served to help reduce overall water use and increase the flows of the Río Conchos, these projects did result in part from the binational crisis and along with the buy-back of water rights from farmers became major investments at a time of great transitions for Mexican farmers.

Beyond the more narrow focus on water conservation in Chihuahua's irrigation district, other organizations with projects within the Río Conchos watershed "sold" their projects to funders as ways to increase water flows in the river, again an effect of the focus on resolving the transnational natural resource conflict. Thus, in the upper catchment – where it all begins – the water dispute and the lack of water coming from the Río Grande – was highlighted in a number of local projects at the community and regional level. In particular, World Wildlife Fund began a watershed project which included not only salt cedar removal along the Río Grande, but also contracting "local" NGOs to work on community-level resource management projects in Bocoyna and Carichí counties in an ultimate effort to restore riparian and reduce deforestation, purported to have contributed to the low rainfalls in the first place (WWF 2004). The project involved funding from major international corporations and banks as well as the U.S. Agency for International Development.

Similarly, a region-wide effort to declare the Sierra Tarahumara a UN biosphere reserve was expanded to include the Río Conchos watershed in 2004, in part because of the rationale that it would protect the upper watershed from deforestation, impacting river flows. Led by the Mexican government, and supported by a coalition of environmental and indigenous-groups, the effort was mired in controversy because of the fear it would create a new level of control over decision-making among farmers and other interest groups – including miners, loggers, farmers, indigenous communities and local governments. At the same time, the Mexican government also created new programs – including Environmental Service payments for "hydrological" services – to help increase flow – as well as one for decreasing carbon dioxide emissions largely through reforestation and preservation, both of which were potentially made available for communities in the Upper Río Conchos. Thus, again, these can be seen as examples of how impacts on local communities due to climate change become part of a much larger debate over resource use in a binational and even international – i.e. global climate change – context.

In addition, local groups like CONTEC began working with local ejidos on their own community management plans, but with a particular focus on legal strategies, preservation of communal land rights and democratization of decision-making. These efforts would have existed with or without the international water dispute, but the projects themselves became more focused on the connection to river flows and to conservation of natural resources as donor interest was peaked.

Thus, both the emphasis on water conservation in the Chihuahuan irrigation districts, as well as the development of projects aimed at improving land management in the Upper Río Conchos among indigenous communities and ejidos owe part of their impetus to the debate over low-flows from the Río Conchos. Conservation– be it water or land resources – was presented as part of the solution to overcome "inefficiencies" in the use of resources by farmers.

III. Agriculture Change and Solutions

A. Changing Land and Water Policies and their Impacts

Information about three agricultural areas, and specific agricultural communities were presented in the middle chapters. Chapter Four addressed several communities within the Municipalities of Bocoyna and Carichí – the forested uplands of the Río Conchos waterbasin -- while Chapters Five and Six looked at water and land use within the Delicias Irrigation District and Lower Río Conchos Irrigation District, located within the Municipality of Ojinaga, as well as particular communities within them.

The chapters revealed the complex economic and policy changes facing the natural resource users of the Río Conchos. On one level, a major agricultural shift took place in the mid and late 1990s as many of the crops grown in the previous decade declined in terms of the area planted and harvested – including corn for grain, sorghum, beans and winter wheat – while new crops – notably pecans, alfalfa and chile peppers – were increasing. Part of this downturn is related to the fall in world prices for the former goods, as well as changes in tariff, quota and investment policy related to the North American Free Trade Agreement. The research contributes to the long tradition within geography to study the impacts of world systems and markets on local resource users.

Nonetheless, rather than a simple story of markets shaping resource actors, other changes, including water policy changes, also contributed to this shift. As water management and pricing was decentralized to the irrigation water user associations, the price of water increased, becoming a factor in the decision taken by many farmers to grow crops that on a per-unit of water were the most economical. Thus, even though high-water demand crops like pecans, chile peppers and alfalfa were more expensive, and required more frequent irrigations, these crops were ironically the ones that increased their presence over the time period. The change in ownership of the irrigation districts also helped spur creation of a new market in the buying and selling of water and water rights, which provided both an opportunity for some farmers, as well as some pressure for others to sell those rights. These changes may also have had important equity and indeed geographic implications.

Both forested and other “ejido” land were also subject to new “opportunities” and pressures to change basic property management within the Río Conchos watershed. Thus, following the major changes to the National Forestry Law and Article 27 of the Mexican Constitution, private owners could legally increase holdings within forested lands, and ejidos could voluntarily enter a complex process known in Chihuahua as PROCEDE to legalize and potentially privatize their own land. This process included federal and state agencies, communities and some organizations assisting them. Despite dire warnings from some interested parties of the impact of changes to the Mexican constitution and Mexican land tenure law and regulations, most ejidos *in Chihuahua* rejected total privatization of ejido communal lands, while titling and in some cases privatizing individual parcels and household lots.

In the upper watershed, several indigenous communities and ejidos did enter the PROCEDE process in an attempt to clearly define their ejidos’ boundaries but rejected calls for privatization either of individual plots or communal lands. Thus, Bacabureachi – working with the non-governmental organization CONTEC –

decided as a community that it was better to develop and enforce internal rules on the use of communal lands, rather than let lands become divided legally, even if it practical terms it was already happening. In essence, they were rejecting the notion that the lands would be better managed through privatization than as communal property and instead believed that a clear management scheme was needed to prevent the "tragedy of the commons" that those in favor of privatization argued had occurred in the region.

In the Irrigation Districts of Ojinaga and Delicias, ejidos adopted differing strategies toward privatization of lands in Mexico. While ejidos near major cities like Delicias did undergo a process of privatization – as urbanization drove up the cost of land -- other ejidos maintained their more traditional scope. One ejido covered in a case study – Congregación Ortiz near Rosales in the Delicias Irrigation District – chose to seek complete privatization. This should be viewed as a unique case. The ejido does not possess communal lands, access to credit was limited without private title to land, and the community possessed a resource which was managed communally: deep, interconnected water wells. In essence, the social ownership and management of water was more important to the community than any social ownership of land and helped belay any fears of communal loss.

In Ojinaga, ejidos maintained their relevance, but only nominally. Ejido leaders complained of the difficulty in even meeting to discuss issues related to ejido management or access to communal lands. More than privatization itself, the apparent weakness of the ejido as a socially relevant unit was often related to the obstacles facing small-scale agriculture, not the "threat" of privatization. Thus, in Ojinaga, while many ejidos were still officially on the books, and still "possessed" communal lands for grazing or mining, their members had emigrated, leaving behind virtual ghost towns, or in the case of Llano de Dolores, selling off their water rights – in essence their livelihood – back to the government.

B. Regional Differences: Markets, Governance and Use of Natural Resources

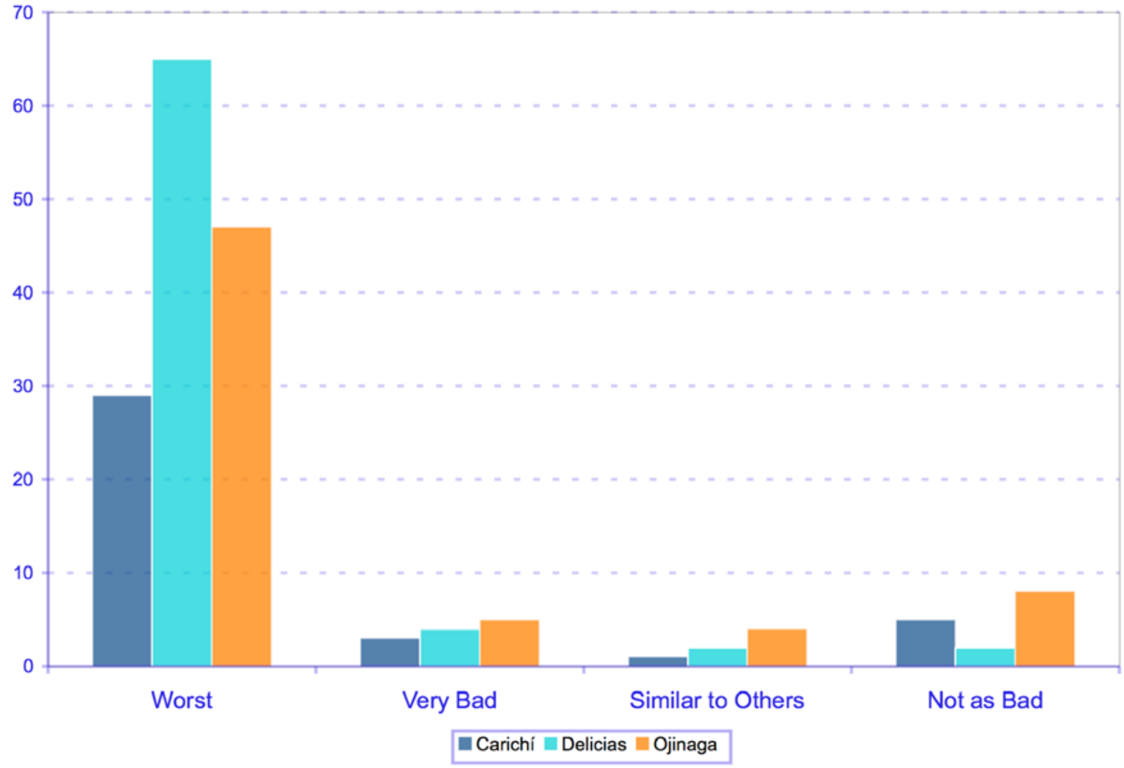
In addition to interviews with officials, farmers and representatives of agricultural companies and banks, some 175 surveys were conducted with farmers in three agricultural areas (see Table 7.1 and Appendix A for survey instrument). Throughout the basin, farmers interviewed and surveyed believed that the mid-1990s and early 21st century were marked by a region-wide drought which impacted their ability to produce high agricultural yields. The vast majority of these farmers believed that the drought was severe and these responses did not depend on whether the farmer owned private or ejido land or how much land they owned (Figure 7.1).

Table 7.1. Surveys Conducted in Present Study, 2005

Municipality	Community or Area	Number of Surveys Conducted
Carichí	Bacabureachí	18
Carichí	El Consuelo/Arroyo del Agua	20
Saucillo	Modulo XII (Saucillo Canal)	34
Rosales	Modulo VI (Rosales)	38
Ojinaga	Modulo IV (Valverde)	31
Ojinaga	Modulo V (Labor del Paso)	34
Total		175

Source: Reed, Chihuahua Land and Water Use Survey, 2005.

Figure 7.1. Farmer (N=175) Opinion on Severity of Drought Post-1995 by Area Surveyed

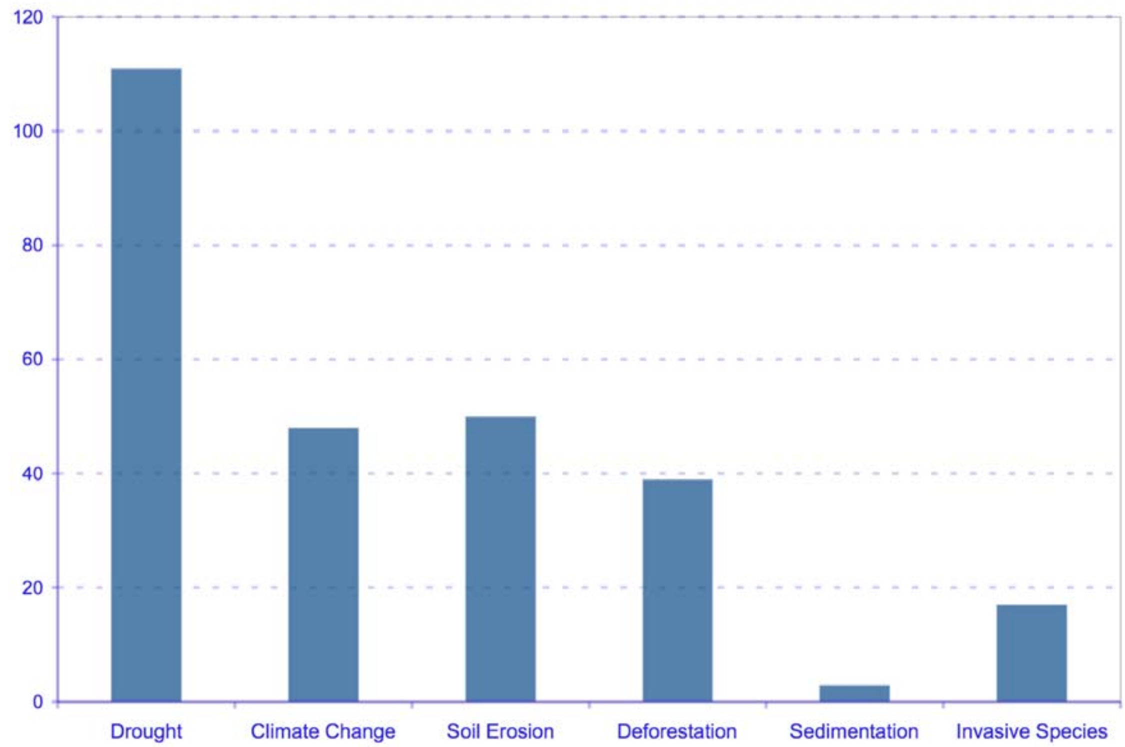


Source: Reed, Chihuahua Land and Water Use Survey, 2005.

Nonetheless, when asked what factors contributed to the low moisture content for those that relied on direct rain or lack of access to water for those who relied on irrigated water, responses varied. While all farmers obviously cited the lack of rain, farmers in the upper Río Conchos cited such factors as “climate change” – it was hotter and the rains arrived later in the agricultural season -- deforestation, invasive species and soil erosion (see Figure 7.2).

Middle-basin farmers in Delicias, on the other hand, cited drought, water use by upstream farmers, dam sedimentation and expansion of the district in the 1980s as causes of the drought. Lower-basin farmers in the Lower Río Conchos Irrigation District blamed the drought, but also sedimentation of the dams and canals, U.S. demand – and Mexican releases – of the water, the lack of investment in the district itself, invasive species like tamarisk and salinized soils, along with the high cost of water, particularly when water had to be pumped up to irrigation canals (Figure 7.3).

Figure 7.2. Farmer Responses to Contributing Factors of Lack of Humidity in Soils, Lack of Access to Water in Carichí by Total "Points" (Maximum=114 points)

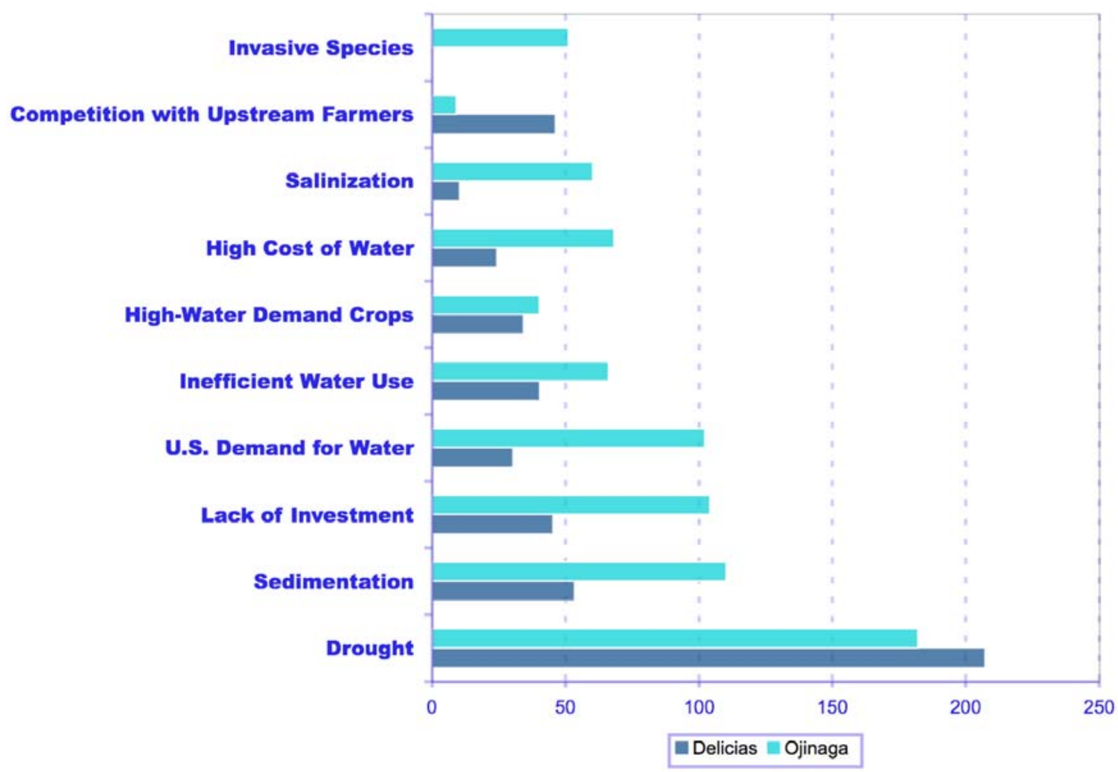


Note: Three points were assigned for a "major" factor, two for a "medium" and one for a small "factor."

Source: Reed, Chihuahua Land and Water Use Survey, 2005.

To a more limited extent, farmers in all three areas recognized that a partial factor was their own use of natural resources, from poor soil management in Carichí to water waste, overuse and the growth of high-water demand crops in Delicias and Ojinaga (see Figure 7.3). Place and location mattered in terms of attributing causes to the drought. Even within regions, there were substantial differences among farmers in their opinions. Thus, farmers in Saucillo were much more likely to blame competition with other upstream farmers for the lack of access to water, as they gain part of their water from the river itself, competing with farmers from Camargo, while in Ojinaga, farmers in Modulo IV with lands along the Rio Conchos near the diversion dam were most likely to cite the impacts of invasive species – Tamarisk, or salt cedar.

Figure 7.3. Farmer Responses to Contributing Factors in Lack of Access to Water in Delicias and Lower Río Conchos Irrigation Districts, Total "Points" (Maximum in Ojinaga=195; Maximum in Delicias =216)

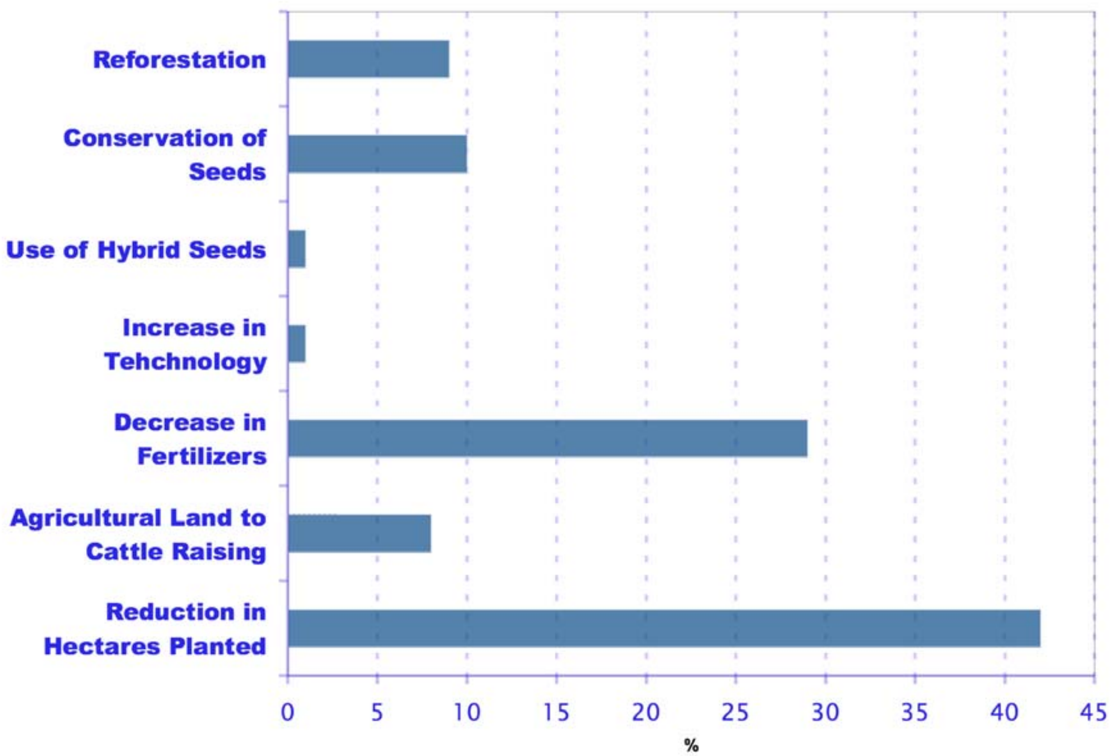


Note: Three points were assigned for a "major" factor, two for a medium and one for a small "factor."

Source: Reed, Chihuahua Land and Water Use Survey, 2005.

Similarly, farmers had varying responses to questions about changes over the previous decade. Thus, in the upper basin, low yields, a reduction in hectares planted and some crop change – particularly the lack of bean production – was cited by many farmers. Much of this change was directly related to low rains and the change in timing of rains which had thrown off their ability to plant additional crops. To compensate, farmers said they were changing their pre-planting cycle, often tilling twice rather than once to increase humidity in their soils and increasing the use of natural fertilizers, while decreasing commercial fertilizers, particularly as the cost of commercial fertilizers increased. Other wealthier farmers – the few surveyed in the communities – were raising more cattle, often utilizing communal lands for grazing purposes (see Figure 7.4).

Figure 7.4. Major Changes Cited by Farmers in Carichí as a Percentage of Total Points



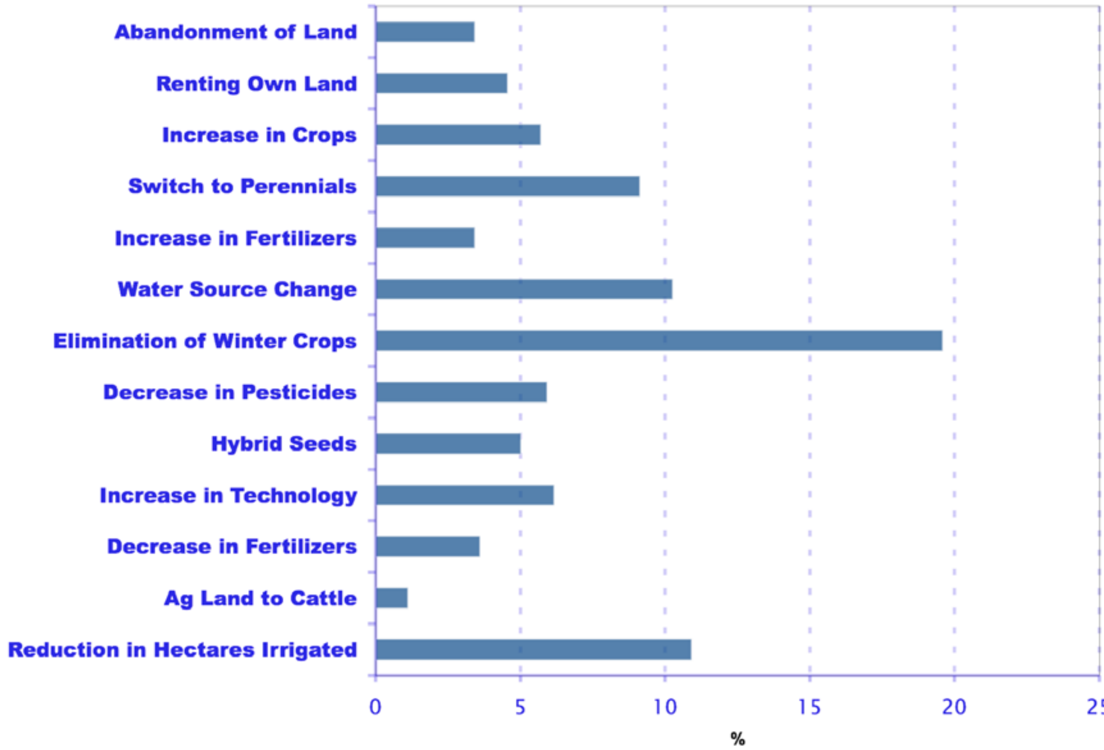
Note: Three points were assigned for a "major" factor, two for a medium and one for a small "factor."

Source: Reed, Chihuahua Land and Water Use Survey, 2005.

In the middle basin, in the Delicias Irrigation District, the major responses indicated that major changes were the elimination of winter crops like winter wheat, a move toward perennial crops, in particular alfalfa and pecans and a reduction in hectares irrigated, though some respondents mentioned they had increased the number of hectares irrigated. The other major change cited by a large number of respondents was the shift in water source. In Rosales, survey respondents indicated that larger private farmers dug their own groundwater wells, while smaller ejido farmers used either communal wells or “norias” – shallower wells which rely on shallow aquifers. Another area surveyed – the Old Saucillo Canal – had similar reactions, although instead of deeper wells, farmers were either digging norias or tajos – essentially a hole in the ground which also taps shallow wells or even runoff – or pumping directly from the Río Conchos, often using their tractors as pumps.

This fact – that farmers during the drought had turned from “dam” water covered under the 1944 Water Treaty with the U.S. – to alternative sources of water communally or individually – is a major finding, at least for this portion of the watershed and helps explain how Mexico could insist that agricultural water use had been reduced substantially even as the U.S. was producing satellite photos showing expansion of agricultural lands. The water source changed (see Figure 7.5). A number of respondents – virtually all small farmers – also mentioned abandoning some land, renting out their land and/or converting agricultural land to cattle grazing.

Figure 7.5 Major Changes Cited by Farmers in Delicias Irrigation District as Percentage of Total "Points"

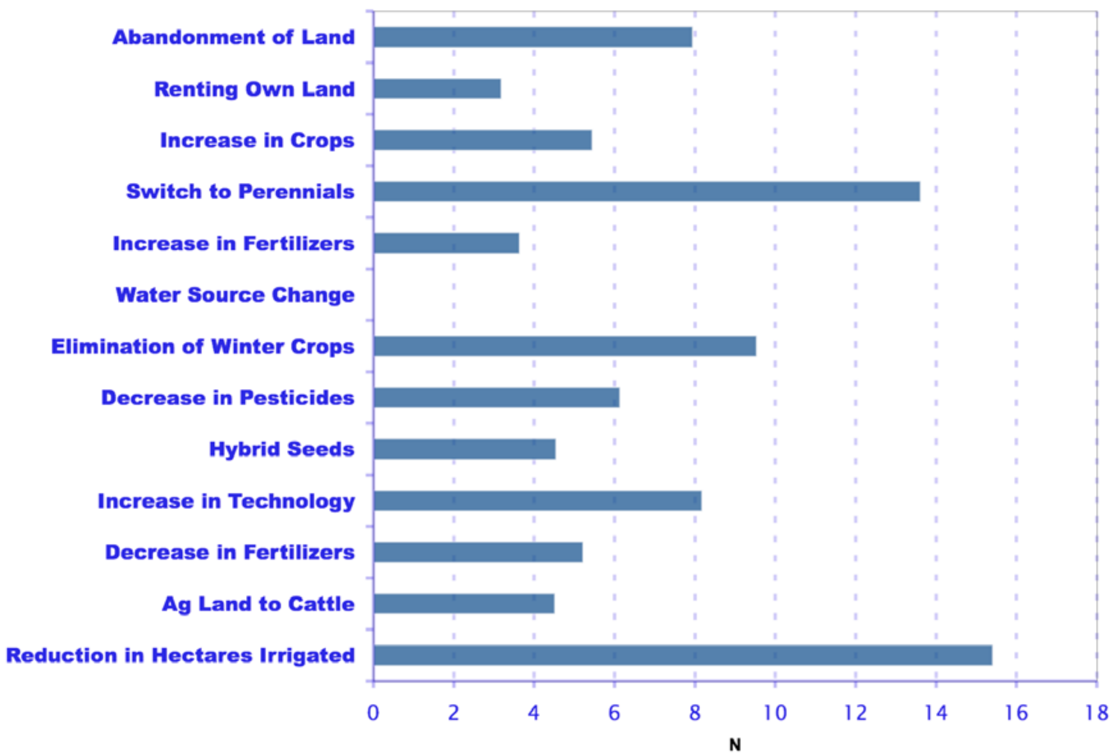


Note: Three points were assigned for a "major" factor, two for a medium and one for a small "factor."

Source: Reed, Chihuahua Land and Water Use Survey, 2005.

In Ojinaga, respondents also pointed to a reduction in hectares irrigated, the elimination of winter crops – principally winter wheat -- as well as upon a shift toward perennials related to cows and cattle – notably alfalfa. Whether for local cheese or milk production – or more likely – to grow crops for young cattle destined for export to the U.S. – the Lower Río Conchos Irrigation District changed from a producer of winter wheat, cotton and corn to one of cows, and the feed – sorghum, alfalfa and oats – needed to feed them. A particular boost to local producers – highlighting to the connection between the local natural resource use and the wider "global" economy – was provided by the cattle export station located just kilometers from the district boundary itself, as young cattle made their way to fattening stations in Kansas, Texas, or Oklahoma. While some areas continued to grow cotton, such production relied heavily on the promise of government subsidies and problems related to payment and credit with the one local cotton gyn were major obstacles for local farmers. A few farmers began the slow but profitable process of planting pecan orchards.

Figure 7.6. Major Changes Cited by Farmers in Ojinaga, as a percentage of total "points"



Note: Three points were assigned for a "major" factor, two for a medium and one for a small "factor."

Source: Reed, Chihuahua Land and Water Use Survey, 2005

While the survey did not reveal major shifts in input, a few trends were apparent based on the limited survey details as well as interviews with farmers and government officials. One is that in both Delicias and Ojinaga, as probably could be expected, technology had begun to replace labor for some crops. Thus, wealthier pecan farmers began to use “shakers,” “sweepers” and “harvesters” to gather pecans in October, even while smaller ejido farmers with pecan orchards continued to use more traditional methods. Peanut farmers in Congregación Ortiz also invested in machinery to pull the peanut roots out of the ground, while leaving the plant behind for cattle feed more efficiently. As more farmers grew corn for feed rather than for “ears” or grain, huge stacks of corn were mashed up and sold as cattle feed through the use of rented or owned “harvesters”.

Cotton was also an example of this transformation, with “pickers” and “polishers” replacing manual labor among virtually all Ojinaga cotton farmers. Many farmers complained that technology – while more “efficient” – had impacted the quality of the product since individual pickers could be more careful in selecting and sorting cotton from cottonseed, or had priced them out of the market. Some farmers with smaller extensions of land had neither the funds nor the access to government programs or credit to purchase such machines.

This is not to say labor – particularly day labor – did not continue to be an important part of labor inputs. But it was clear that more and more farmers – particularly larger ones – found it more economical to invest in machinery rather than people. This decreased the ability of local farmers to supplement their income from their own land by helping their wealthier neighbors work theirs.

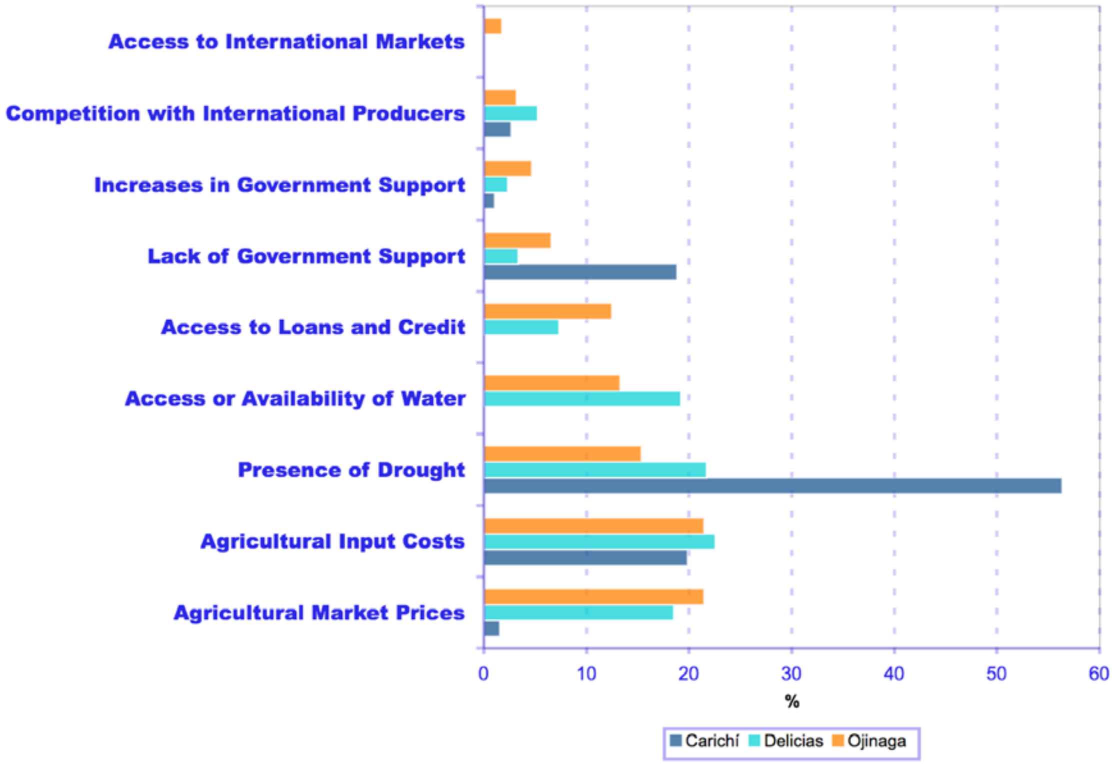
Furthermore, while the study did not detail use of pesticides and fertilizers in any kind of systematic way, there was some indication that while short of going “organic,” pecan farmers in Delicias had begun to reduce their use of insecticides and use natural “pest” killers – wasps and ladybugs -- to control damage to pecans. Local officials and academics at the Agricultural Extension Service in Rosales and the local extension agencies in Meoqui, Saucillo and Ojinaga were assisting in this transformation as were U.S. demands for pesticide-free pecans.

In terms of cotton, the binational eradication Program being implemented in Chihuahua – while a target of many Chihuahuan farmers wrath for credit and payment problems – was cited as having reduced the indiscriminate spraying of dangerous pesticides.

In addition, while far short of a movement, many farmers reported using natural fertilizers from their animals, to boost production on a wide variety of crops, in many cases as a replacement of chemical fertilizers. Part of this initial transformation was also supported by the high costs of fertilizers and pesticides. This was particularly true in the upper Conchos.

The changes that occurred in production, crops and inputs in the agricultural areas examined in this study were related to many factors. While the lack of access to water in the irrigation districts was clearly cited as a factor – particularly in regards to reductions in hectares irrigated as well as the major shift in water source to non-dam water-- the major causes of these agricultural changes were also the rising cost of agricultural inputs and the market prices offered for agricultural products. Thus, at the field level, prices and costs were the major factors cited for agricultural change rather than the drought itself, although with local variation. In addition, problems related to lack of credit in all three areas – particularly compared to previous decades when credit was more available – also had played a major part in decision-making. These answers – supported as well by interviews and observations – also revealed how much world and regional prices of goods – from the price of pecans set in the U.S. – to cotton, corn and even meat prices from cattle – played into the decisions being made at the local level (Figure 7.7). Not surprisingly, in Carichí, the changes in non-market sustenance farming practiced by local indigenous farmers was mainly due to the drought and climate change, not market conditions.

Figure 7.7. Factors Cited by Farmers as Causing Changes in Agricultural Practices by Region, as % of Total Points



Note: Three points were assigned for a "major" factor, two for a medium and one for a small "factor." Source: Reed, Chihuahua Land and Water Use Survey, 2005

C. Conservation and Governance of Natural Resources

The present study was conducted at a time when policies first developed in the early 1990s were being fully implemented as part of Mexico's embrace of neo-liberal policies and decentralization of its governmental responsibilities. Thus, the decentralization of government control over water, forestry, agricultural and environmental programs since 1992 were all being enacted at the municipal and regional levels. In terms of water management, one of the key policy changes in terms of water was the decision to "transfer" the irrigation districts from the CONAGUA to individual water user associations, geographically known as Modulos, a process which occurred rapidly in both the Delicias and Lower Río Conchos Irrigation Districts. (Elías Calderon, General Manager, CONAGUA, Lower Río Conchos Irrigation District, personal communication with author, 2005).

In addition, legislative changes to forestry laws in 1992, 1997 and 2005 reemphasized the communal ownership of forested ejidos, while also allowing for privatization of some forested lands (Guerrero, Kelly, Reed and Vegter 2002). In the meantime, the 1992 changes to the Mexican Constitution, Article 27, and eventually to the "Rural Development Law" in 2001 allowed ejidos to begin a process of regularization and in some cases privatization of individual plots and communal lands (SAGARPA 2001 Finally, agricultural government programs were in a process of decentralization, with both state and local municipal rural development departments taking a more active role in decision-making and distribution of agricultural subsidies (SAGARPA 2001).

There is an established literature on the benefits of decentralization toward more efficient, and conservation-minded natural resource use, as well as more equitable distribution of resources, a view that has been supported in Mexico by the World Bank and other development organizations (Asad, Seroa da Motta, Azevedo, Simpson & Kemper, 1999; Briscoe, Anguita Salas & Peña 1998). Others have argued that such a process can have the opposite effect by allowing wealthier individuals within a county to increase control and used of natural resources, in concert with global interests, in essence seizing control of natural resources (Wilder 2002; 2006).

Recent literature based on field research in Sonoran irrigation districts found a decidedly mixed result of this transformation, with transfer of the irrigation district not being used for improving efficiency or equity, but "as …channels for preferred treatment for capital accumulation by private entities as well as a legitimized way for the state to transfer the financially and politically charged burden of water management to non-state institutions." (Wilder and Romer Lankao 2006; see also Martínez Rodríguez and Reed 2002). In essence, these authors argue, the transfer was an expedient way for the government to rid itself of the headache of managing and facilitating natural resource use, although there were some benefits as well, mainly in democratization of decision-making, and the acceptance of a conservation "ethos," although focused on short-term need to conserve water rather than long-term management. Thus "producers believe that the transferred districts are more democratic and have streamlined processes that facilitate issuance of permits and other transactions (Wilder 2002)" although smaller farmers were less likely to have such a view.

The study also found that the increase in water prices – reflective of the move to make water more of a commodity – had been – in combination with other changes in market prices, access to credit, and the increasing costs of inputs – a factor in squeezing out smaller, ejido farmers.(Wilder 2002; Wilder and Romero Lankao 2006).

The present study supports the view that decentralization has been a mixed blessing for Mexico's irrigation-based farmers, and that it has had equity consequences which tend to hurt smaller rather than larger farmers. Farmers in the two irrigation districts in the district were asked to rate the help they received from their local water user association as well as to rate the transfer and provide comments on the benefits and drawbacks. Many farmers supported the idea of the transfer – and believed that they could theoretically manage the water more fairly than CONAGUA had – but believed the transfer had been enacted without the financial, managerial or oversight needed to make the "Modulos" run efficiently and fairly.

This was particularly true in Ojinaga, where the much smaller geographic entities known as Modulos had little access to funds to hire or train competent managers or canal operators, and where the high costs of operating the Modules was not fully supported, even by the increasing costs of water. The fact that there were fewer farmers farming and fewer thousand cubic meters of water being paid for made the situation that much more difficult for farmers and the associations running the irrigation districts. There were complaints – though not widespread – that the leadership of the water user associations had benefited certain classes of farmers, or more frequently, certain "geographies" – particular ejidos or areas, such as Congregación Ortíz in the Rosales User Water Association in the Delicias Irrigation District. This was not a universal feeling, however, and overall farmers supported the transfer – they just felt it was unfortunate it had happened at a time when market and climactic transformation had conspired against them. Indeed, the Module in Delicias on the whole appeared to be run efficiently and professionally with sophisticated managers and equipment.

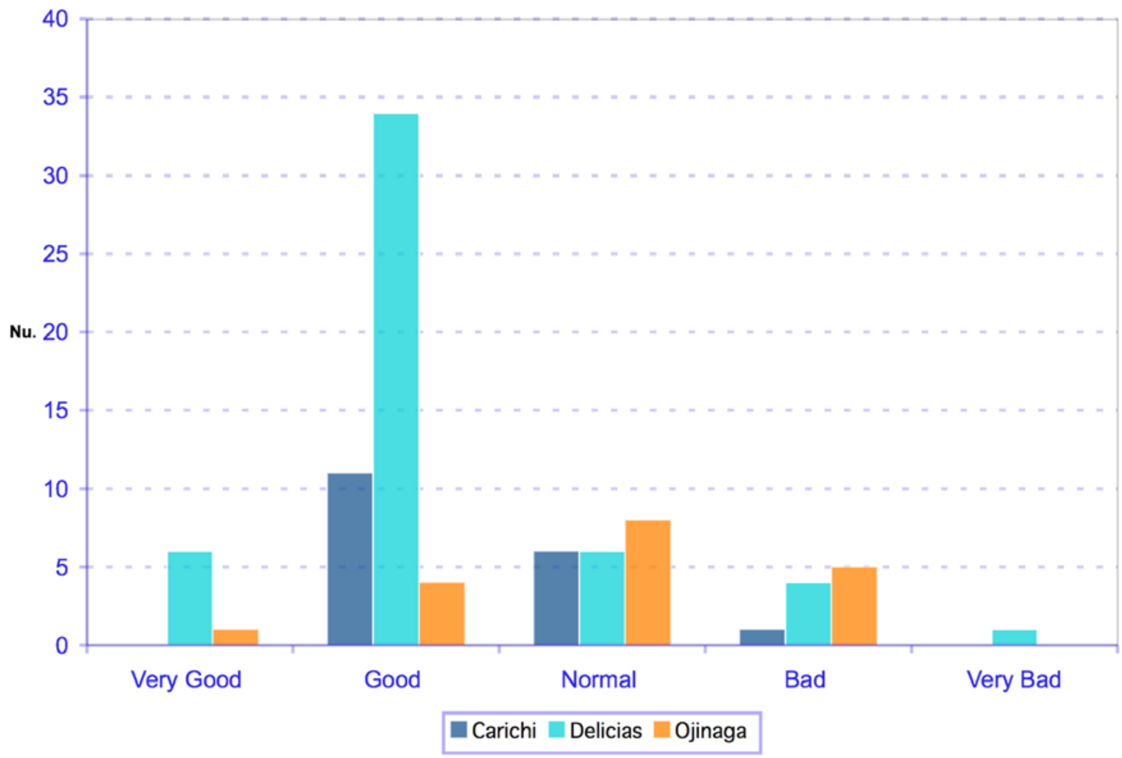
In terms of water conservation, water use data, survey results and observation of projects support the view that Mexican farmers embraced water conservation and that its benefits have been for the most part equitably distributed – at least among farmers still working the land. Thus, per-hectare water use – when comparing the same crops – fell, although some of these benefits did not translate into large overall water savings as farmers turned from low-water to high-water demand crops like pecans, alfalfa and chile peppers because of market forces. Still, as a response to drought and less access to water, and access to new monies for conservation projects, farmers did reduce hectares irrigated from dam water.

The savings in Delicias seem to be more widespread than in Ojinaga. There was evidence in both official water numbers as well as in responses to the survey that individual farmers had reduced their water use on a per-hectare basis for particular crops. Thus, many pecan farmers in Delicias had changed irrigation systems – adopting drip or spray irrigation systems rather than flood irrigation – either as part of the conservation projects or using their own resources. Cotton farmers in Ojinanga – largely on advice from local vegetation control boards – began to grow rows of cotton closer together to get a higher yield per-unit of water, while some alfalfa farmers had leveled their lands for quicker and more efficient irrigations.

In the upper basin, the participants in soil conservation projects in the communities of El Consuelo and Bacabureachi were optimistic about the projects even though results had been less than spectacular – due in large part to the continued lack of timely rain – but did not feel they were "coerced" into adopting conservation methods or that the projects were designed only to benefit particular members of the community. This is due in large part to the careful implementation of the projects by CONTEC hand-in-hand with the community. "Outsiders" in the community who did not participate in the projects were more pessimistic about the worthiness of such project, often believing that their own soil conservation and planting techniques were superior.

In the Municipality of Bocoyna, leaders interviewed were similarly positive about WWF-funded efforts to better manage their natural resources, but were uncomfortable with the lack of funding available to actually implement the projects and unclear about the future directions of the projects, including the relationship between WWF, local non-governmental organizations charged with overseeing the projects and the communities themselves. There was considerable fear and concern over discussions of a biosphere reserve, with many community leaders concerned that decisions over land and resource use would be controlled by government or non-governmental entities outside the control or “scale” of community structures.

Figure 7.8. Farmer Opinion of Soil and Water Conservation Projects by Area by Number of Responses



Source: Reed, Chihuahua Land and Water Use Survey, 2005.

Support for conservation and sustainability of water resources was focused more on the short-term need to reduce water use from the dams in a time of reduced supply, rather than an overall plan to live sustainable within the confines of all water sources – the dams, the rivers, and the shallow and deep aquifers in the area. The move toward sustainable use of water on the part of the government was complicated in Delicias by the large number of both “legal” and illegal wells, norias, pumping of river water and other water management strategies, with virtually no actual oversight or measurements of aquifer water levels. Thus, assuming that the crisis in water supply led automatically to a new conservation ethos is a fallacy.

In fact, the farmers themselves – again while nearly universally endorsing the need to stretch water supplies through more efficient water use by relining canals, installing low and high-pressure irrigation stystems and leveling farms– organized themselves in Ojinaga to ask for a new, bigger and better diversion dam to capture local rains, while farmers in Delicias – particularly wealthier farmers with better access to credit and government subsidies – rushed in the mid-1990s to dig new wells and develop new supplies when the government restricted access to dam water and turned off the spigot in the winter. In addition, farmers relying on the Francisco Madero Dam – Las Virgenes – pushed and supported the construction of a "Rubber Lip" – adding height to the dam outlet to increase total capacity.

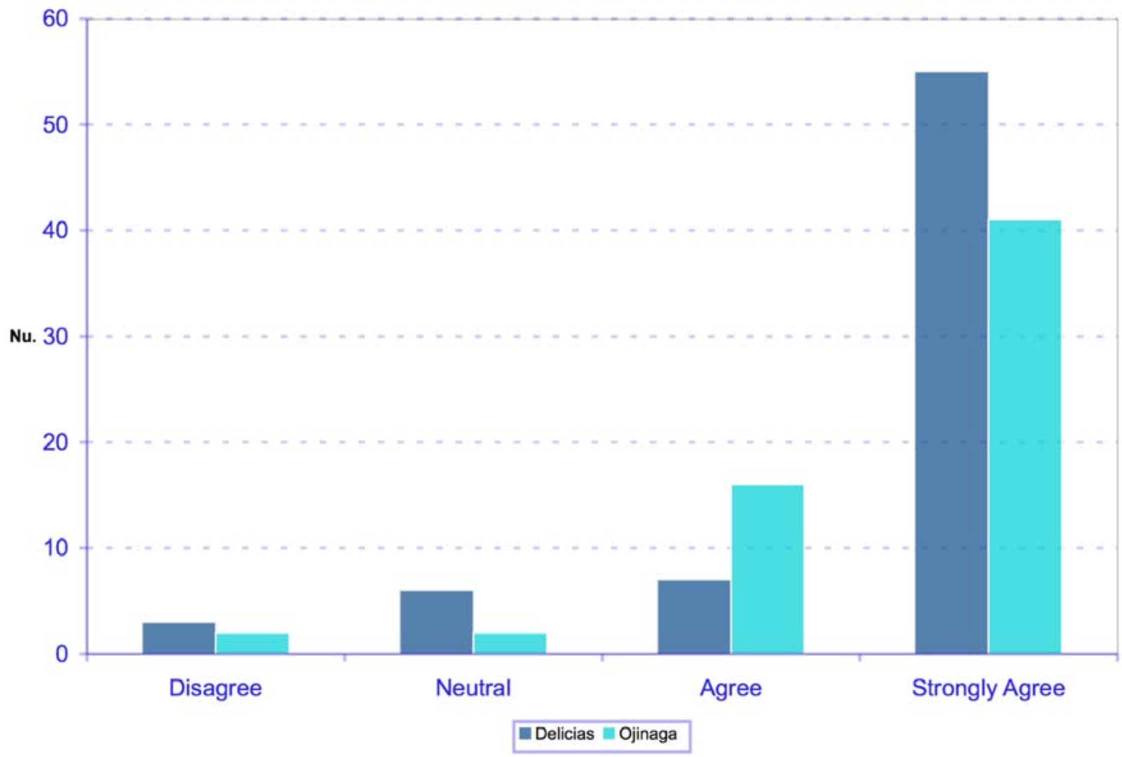
Farmers in all four surveyed areas in the two irrigation districts did not generally believe the water conservation projects were benefiting certain farmers rather than others. Nonetheless, equity concerns clearly weighed on individual farmers and leader's minds. Thus, in both the Old Suacillo Canal as well as Rosales region, after initially approving plans to implement a wide variety of irrigation systems in the first year, farmers and their water user association representatives noted that such variety was benefiting the few at the expense of the many, and instead worked on more communal approaches to water conservation.

It is clear that certain farmers benefited more overall from water conservation projects, and government projects in general. Those with private land had an easier time accessing credit. Government programs such as "Alianza para el Campo" rely on both government support and private participation so that only farmers with either their own funds or access to credit can afford to participate in projects like individualized irrigation system. By using their water more efficiently, private farmers were able to either expand production or often get off of the "communal" water supply altogether and move toward private groundwater sources. In essence, the opening up funds and projects for water conservation helped wealthier farmers privatize water resources by tapping into deep wells and make their farms run more efficiently. At the same time, this move toward privatization was counteracted by the presence of funds for the water user associations to increase technology and efficiency at the communal level. Examples include the transformation of canals to pipes, hydrants and "tubos de multicompuertas" in Congregacion Ortiz, or the lining of the Old Suacillo Canal, which improved efficiencies for the majority of farming residents – large and small – in Modulo XII in the Delicias Irrigation District. Thus, benefits did not correspond only to larger farmers.

In the Lower Rio Conchos Irrigation District, on the other hand, the water conservation projects seemed to favor those farmers with gravity-fed lands nearest the Río Conchos itself, and in particular the larger private farmers of Modulo I, the land along the highway leading into the municipality of Ojinaga. The transformation of this land into pecan orchards and alfalfa fields – while ongoing since the mid-1990s – was clearly aided by the water conservation project money. At the same time, the selling off of water rights back to the government in Modulo II – the Llano de Dolores Ejido that in essence disappeared between the 2004 and 2005 growing seasons – as well as in "pumped" water areas of Modulos IV and V –impacted smaller ejido farmers more than larger farmers. Thus, the transformation of the Lower Río Conchos Irrigation District into a land of pecan farms and cattle feed clearly had equity implications with private farmers with lands near the major rivers benefiting the most.

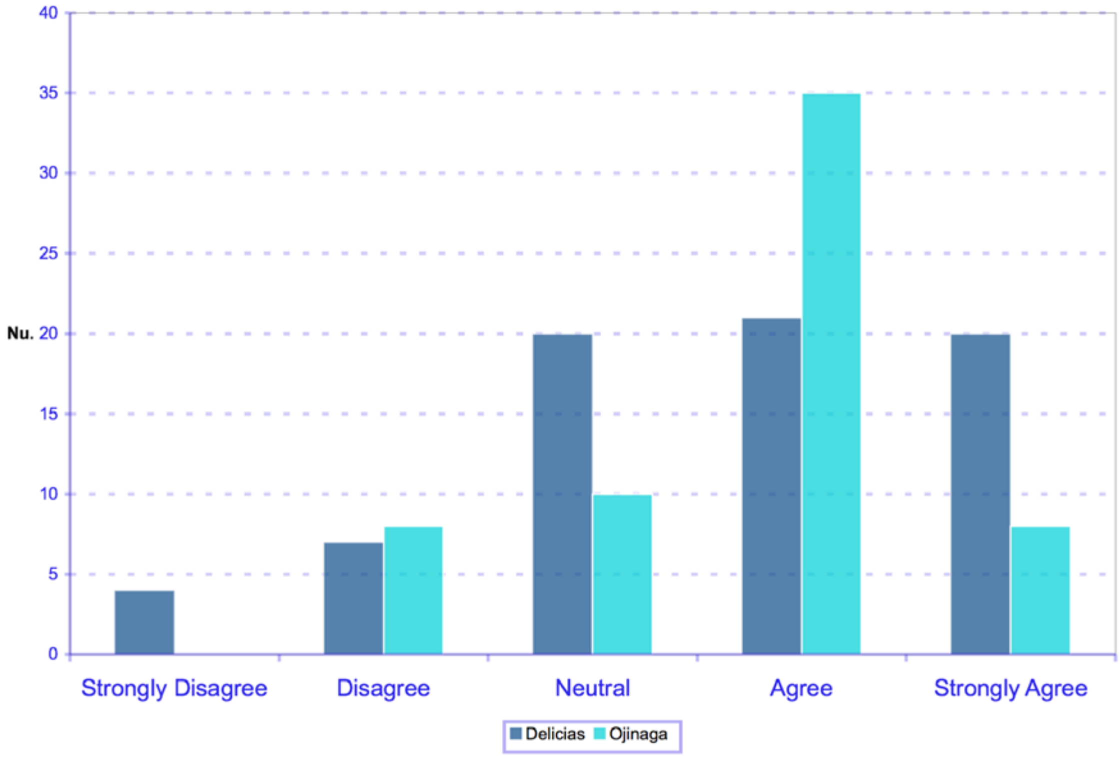
Finally, in terms of governance and water conservation, while all of the Modules signed documents stating their willingness to give up water rights in return for water savings from conservation investments, they were clearly focused on saving water for their own needs, rather than to augment flows to the U.S. or to municipal users. They signed the documents, and knew it was intended to flow partially to the U.S. (see Figure 7.9), but they just didn't necessarily believe that the promised water savings would materialize, and they generally felt they could use the saved water to increase production not just decrease water use (See Figure 7.10)

Figure 7.9. Farmer Opinion on Statement that Water Conservation Projects Were Intended to Benefit the United States Through Increased Flows to Río Conchos (number of responses by category)



Source: Reed, Chihuahua Land and Water Use Survey, 2005.

Figure 7.10. Farmer Opinion on Ideas that Water Conservation Projects Could be Used to Expand Production (number of responses by category)



D. Social organizations, market networks and government aid: Glocalization revisited

The research also revealed the power – or lack thereof – of social and market organizations. While each family farmer made decisions on their own – where and when to grow based upon access to land and water inputs – these decisions were made and influenced by networks of decision-makers. The research, while viewing farmers as independent actors making choices, also recognized they were part of larger networks which influenced and could curtail those decisions, as well as a "structure" – government programs, market forces and rules of trade. In fact, their decisions were influenced both by global and local issues and actors, a kind of "glocal" network of decision-makers (Swyngenouw 1997).

Thus, on one level, farmers who were part of an ejido might collectively make decisions about access to communal lands – including privatization -- or apply collectively for government aid. Nonetheless, other networks and decision-making were being formed outside of this traditional structure. First of all, the devolution of power from CONAGUA to the Water User Associations, also known as "Modules" of the Irrigation District, meant that these elected bodies were involved in decisions affecting local farmers, including implementation of the water conservation projects. This created new relationships and networks through the Water User Association presidents and other board members with individual farmers interested in installing more efficient water systems. Similarly, the federal water rights buy back programs were organized through this structure of the water user associations.

In Saucillo, the investment by a U.S. chile processor created new networks with farmers and the water user association, while a local cooperative allowed members to pool their resources and lower prices. The at least initial success of SEDESOL's federal milk program was a new kind of networking approach which went beyond either individual farmers or ejido networks toward collective action. The government worked with the local cattle or dairy association to help bring milk to milk collection centers, bypassing the normal government-ejido relationship through a new private-public partnership.

Most other relationships – such as the networks of chile and pecan buyers and sellers who contracted with individual farmers – were more fluid and dependent upon market conditions. It should be noted that while there were some examples of mutually beneficial agreements between buyers and sellers, many farmers felt they were at a disadvantage in the relationship. For these small farmers, they were often competing against a world price for their products, each other – both locally and regionally -- and buyers who had the ability to pick and choose when and where to purchase their products. It was essentially every farmer for himself.

Other farmers signed specific, longer-term contracts with companies, from the largest pecan producer of the Saucillo region signing a long-term contract with Mexico's huge agricultural conglomerate Bimbo, to contracts between peanut farmers and several local peanut distributors. Several local pecan farmers also revealed that they had formally or informally received advice or contracts with U.S. growers to help them reach the export market. Farmers – usually relatives – also sometimes shared machinery as the district move toward technology and machinery. Several U.S.- connected chile importers were also forging alliances with local growers.

The success in Delicias of local credit unions was still evidence of local farmers coming together to create relationships with larger market forces, while cooperatives like ALPURA and ALCODESA that had turned into major purchasers of crops in the area helped medium-sized and larger farmers maintain livelihoods in a time of scarcity and significant competition from U.S. imports.

In Ojinaga, these networks were less successful. Experiments throughout the period with cotton production, eucalyptus trees, pistachios, various new breeds of cattle and goats had ended in failure, either through local associations or existing ejido structures. A nascent experiment to begin a new kind of cooperative modeled on other successful experiments within Mexico – and with governmental support – was evidence that some farmers had not given up hope on working through producer associations. Still, with the rise of cattle in the region, new relationships were being formed between local farmers and the cattle export center as demands for oats, sorghum and alfalfa increased.

In the highlands of Carichi and Bocoyna, local NGOs like CONTEC, WWF and Fuerza Ambiental – and local Catholic missionaries -- worked both within and outside of the local ejido structure, attempting to balance the need to respect traditional forms of social organization with the need to avoid working with "entrenched" leaders. Some of these relations were not focused on markets per se for agricultural products but on the promise of environmental services, the idea that by taking care of the land, downstream users like the irrigation districts could be convinced to support local farmers and their incomes.

The promise of this vision, however, did not necessarily match the reality of day-to-day decisions or structures, and there was understandable suspicion of these possibilities, as well as with a proposal to create a biological reserve. Some local NGOs like CONTEC were also suspicious of such schemes, and were faced with the difficult reality facing local farmers in a time of limited rainfall. Attempts to utilize local resources like organic pesticides and fertilizers – and preserve native corn seeds as well as the local eco-tourism project in Bacabureachi were all attempts to preserve cultural and economic livelihoods in a respectful way. What is apparent through the case study approach is that it is unlikely that new international actors like environmental organizations will abandon areas like the upper Río Conchos watershed, due to its importance both in terms of biodiversity as well as a catcher of rains. These communities – whether they wish it or not – have become linked with the ongoing debate over environmental services, climate change and biodiversity, forming new glocalized communities.

IV. Afterthoughts: Water Management post-2005

The resolution of the Texas-Mexico water dispute – thanks in large part to hurricane-aided rains in Tamaulipas and Mexico's willingness to release waters from upstream dams– did not end discussion of water management issues along the Río Grande. Indeed, “activity” by interested groups has continued and intensified since the official resolution of the treaty dispute in September of 2005 (IBWC 2005C). While the rhetoric from the politicians has died down, the water conservation projects dreamed up as a solution have gone forward and were being implemented between 2002 and 2006 if at a reduced and less glamorous pace than initially contemplated and approved (IBWC 2003; BECC 2002). While some of the expected “gains” in water savings have not materialized, they are now part of a larger program being implemented by CONAGUA to make the irrigation districts in Mexico more “sustainable,” and find a way for the growing industrial and municipal water needs to meet their demands (Elías Calderon, Lower Río Conchos Irrigation District, personal communication with author, 2005).

In 2004, CONAGUA contracted with analysts from the decentralized Instituto Mexicano de Tecnología del Agua (IMTA) (Mexican Water Technology Institute) to assess the water conservation projects, but also to make recommendations on how best to manage irrigation districts in a more sustainable fashion, including the districts in Chihuahua. While the seeds to begin to look at water use and management clearly predate the water dispute with the U.S., the political capital to go forward with the IMTA analysis were given impetus from the dispute over the lack of water, as was the government program to buy back water rights from farmers as a means to “shrink” the amount of land that could be irrigated (Calderón 2005). Thus, as a result of the decision to invest monies in the irrigation districts of Chihuahua to “save” water to help assure flow back in the Conchos, CONAGUA and other officials have taken a much broader and active look at sustainable water use in the irrigation districts.

As such, following the decision in the mid-1990s to decentralize the irrigation districts through the creation of the water user associations, favoring local control, CONAGUA in a sense is attempting to reassert its "control" over overall water use and water management through implementation of water management plans, conservation projects and buy-back schemes. In some sense, more research and attention needs to be devoted to studying the benefits and drawbacks of decentralization and privatization of water resources in the irrigation districts of Northern Mexico and the appropriate role of government oversight. Clearly, the present research suggests the experiment has been a mixed success, with more attention to short-term conservation and more equitable distribution of the resource and democratic decision-making, but considerable difficulty in obtaining sufficient resources or training to more efficiently run the districts. This research also clearly suggests that larger farmers have benefited more from decentralization.

The attention of academic and environmental organizations on the Sierra Tarahumara and wider Conchos watershed has also continued. WWF's Chihuahuan office continued to look at watershed restoration both at the local scale of individual ejidos but also at the larger dream of having irrigation districts and municipalities downstream pay upstream land managers to keep the forests and soils intact. In 2006, the Mexican arm of WWF worked on passage of a new state-level water law in Chihuahua that would more explicitly recognize the water needs of the environment and allow for more flexible programs to protect upstream land as a fundamental part of water management, as well as an effort to have the Government of Mexico sign the United Nation's *Convention on the Law of the Non-navigational Uses of International Watercourses*, which similarly recognizes the ecological role that transnational rivers like the Río Conchos and Río San Pedro play (WWF 2006).

The minutes – amendments to the 1944 Water Treaty -- passed through the IBWC to help resolve the water dispute continued a push for the IBWC to consider binational water management policies and move beyond their more technical, legal role (Browning-Aiken et. al. 2004). In particular, the call in Minute 309 for a drought management plan and for a panel of “experts” on water management led directly to the Río Grande Binational summit held in McAllen in November of 2005 (IBWC 2003; IBWC 2006). The summit was not the first or last conference on water management issues on the Río Grande sponsored by official government sectors, nor did it lead to major policies decisions or shifts, but the sponsorship and presence of high-level IBWC, CILA, CONAGUA, State Department and other officials so immediately after resolution of the water dispute indicated a new willingness to engage civil society on these issues. The participation of large and small farmers from Chihuahua to Tamaulipas allowed these farmers to view their water management policies and practices not as a local decision-making process, but part of a wider management issue that impacted farmers throughout the Rio Grande basin.

The water dispute also created the expectation for more funding and attention on water management issues between the two countries. While expectations have been tempered against the very real drain of political attention and monies to the “War on Terror,” a number of projects throughout the wider Rio Grande basin have begun to assess and implement better water management practices.

Thus, in 2000, the U.S. Congress passed the Lower Río Grande Conservation Act, which provided $10 million in grant funding to help local irrigation districts in South Texas to make their management and use of Río Grande water more efficient, an effort that was coordinated with the Irrigation District Engineering and Assistance Program (IDEA) at Texas A & M. These funds helped bolster the monies also provided by the North American Development Bank to improve efficiencies on the U.S. side of the border in irrigation districts (Dr. Guy Fipps, Texas A & M, personal communication with author, 2006). Congress also funded the Río Grande Basin Initiative in 2001, which is run by the Texas A&M University Agriculture Program and the New Mexico State University College of Agriculture and Home Economics Department. The RGBI, which involves a variety of agricultural extension programs and universities in Texas and New Mexico, is divided into nine "tasks" – ranging from basin wide hydrology and the design of GIS layers for the basin and even on-farm irrigation technology – and the project received funding every year from the U.S. Congress between FY 2001 and FY 2006, enacting a number of projects (Texas Water Resources Institute 2007). While focused mainly on the U.S. side of the border, they have involved collaborations with Mexican academics.

A separate but related effort has been the "Sustainable Agriculture Water Conservation in the Río Grande" Project operated through the Texas State University System. Funded by the U.S. Department of Agriculture, the SAWC is a dizzying number of project which range from physical assessments of the Río Grande's middle section – sometimes called the Forgotten River – to characterizations of groundwater to surveys of ecologies and land use (River Systems Institute 2006).

Somewhat related to this effort is another project led by universities, NGOs and some governmental entities. Known as the "Physical Assessment Project," the Natural Heritage Institute in California describes it as "a collaboration among non-governmental organizations and universities on both sides of the border to illuminate the potential for solutions that transcend the boundaries of the management units into which the basin has been traditionally divided." (Natural Heritage Institute 2001).

Finally, in 2005, UNAM – Mexico's largest university – developed a project with Texas State University and Mexico's federal water authorities – CONAGUA – to seek funding from the United Nations Development Program's Global Environment Facility (UNDP GEF), an arm of the United Nations which was created in 1991 as a means to fund "sustainable" environmental projects. Because one of their project categories is "International Waters," the proposed projects seeks to create the institutional means to implement transboundary solutions that move beyond the narrow confines of the 1944 International Water Treaty and IBWC's traditional role (River Systems Institute 2006).

While the initial application asked for only $50,000 to create a background document and convene a region-wide meeting, which was held in 2006, the ultimate goal of the UN-funded project is much greater and would require greater funding. According to the initial 2005 application:

> To this end, this proposal seeks to develop a framework for the coordinated management of the entire Río Bravo drainage basin in a sustainable manner, based upon an agreement between the two countries, and establishment of an appropriate institutional framework. It is viewed as the necessary initial step for the joint development, elements and implementation of a long-term binational plan to meet future human and ecosystem water demands on both sides of the border in the Río Bravo drainage basin in a sustainable manner, as well as for development of possible short-term, interim measures and actions to meet current and near-future water shortages. (Rivers Systems Institute 2005).

V. Institutional Framework for Future Disputes

Whatever the worth or ultimate outcome of these various efforts, it is clear that the water quantity dispute raised awareness, funding and interest in water management issues along the U.S.-Mexico border. The Rivers Systems Institute/UNAM application, whether ultimately fully funded or not, as well as the

Rio Grande Basin Initiative and Sustainable Agriculture Water Conservation in the Río Grande all have the ultimate goal of moving to a watershed approach to resolve issues of water management that would move beyond the more legalistic role of the IBWC.

They also raise the question of whether the institutional mechanisms currently exist to “handle” future droughts and disputes between the two countries over water quantity. They clearly propound that the current institutional regimes and mechanisms do not. The projects are aimed at regionalizing decisions about water management or at least considering more scientifically how individual management decisions affect the wider river and riverbasin. In some sense, they suggest a further regionalization of decision-making may be necessary and inevitable as individual decisions are put through the microscope of the wider watershed and treaty compliance, and may result in a further layer of control over natural resource use.

Thinking historically, natural resource decisions made in the Río Conchos watershed were once primarily local in nature; became more regional with the building of dams, the creation of irrigation districts, and the implementation of the 1944 International Water Treaty; and finally the more recent efforts are aimed at creating a kind of supra-regional network of decision-makers mutually reinforcing and influencing water management decisions. Even the decision to involve the treaty compliance agencies in an effort at drought management and water conservation – if only in an oversight capacity – is truly historic and represents an emerging role.

Still, the resolution of the transboundary environmental resource between the U.S. and Mexico in 2005 was partial at best. Indeed, even with more releases in the 2005-2006 period, and the water savings from water conservation projects, Mexico was still slightly behind meeting the five-year 2002-2007 cycle in mid-2007, and a conscious effort to release waters was needed to meet the 2007 water debt. Ultimately, even contemplating a more regional water management plan is difficult to imagine given the competing local interests of the Rio Grande and its tributaries, and the decentralized nature of water management in both countries, as well as the apparent realization that global and regional climate change is likely to stress the watershed even more no matter what local entities do in terms of water use.

For the moment, decisions about natural resource use can still be thought of neither local, regional or international, but a continual process that stretches among these geographic scales of production. The slow recognition of a riverbasin as a distinct geographic space for decision-making will still operate within this “glocalized” sphere, where networks of producers influence and are influenced by government subsidies, market prices, international investors, export opportunities, and local biophysical processes, including rainfall, itself impacted by wider climactic change. At the end of the day, it is still the individual farmer deciding which crop to plant, or whether to pack up and leave for a different kind of life.

Still, the basic contradiction between local decentralized decision-making and the wider “needs” of the entire watershed – particularly in drought-like conditions – are not unattainable. The attention to water conservation, infrastructure improvements and efficiencies and land use changes are all a welcome addition to the discussion over water use. Yet without proper oversight and training and assurance of proper and appropriate technology – culturally, technically and economically – such projects may not offer long-term solutions. Thus, the reality of a growing municipal population with municipal needs would require that water management solutions must involve the urban sector as well. In addition, a new institutional framework to respond to future droughts would need to take into account the economic and market realities – and social networks that underpin such realities – and thus have significant flexibility. Farmers can not be expected to grow low-water demand crops if neither the markets nor the social and economic relations exist to make such crops work for their livelihoods.

It is also clear that the failure of either local management plans – including the recent IMTA efforts to come up with management plans for the Mexican irrigation district – as well as the IBWC management framework essentially ignore half the problem – the local and transboundary aquifers which are hydrologically connected to the Rio Grande and its tributaries. Thus, water management decisions must incorporate the existence and proper management of groundwater as well, a task for which the present institutional framework simply does not exist though recognition and initial analysis and studies of aquifers have occurred (Mumme and Aguilar Barajas 2003).

Other issues that the present framework does not adequately address in a wholesale fashion are the non-traditional users of water – the ecological habitat formed by the river that as WWF states is the lifeblood of the Chihuahuan desert (WWF 2004), as well as water quality. That is not to say there has been no action on these issues, including a major effort to restore flows in the so-called "Forgotten River" stretch between Fort Quitman and Presidio, where the Rio Grande is a denuded, tamarisk-infested shade of its former glory, as well as a series of studies throughout the 1990s looking at water quality of the Río Grande and of course, through the BECC/NADBANK framework, hundreds of millions of dollars spent for new wastewater treatment plants throughout the Border, responding to concerns about both health and water quality (Kelly, Reed and Taylor 2002). But neither the 1944 Treaty and subsequent minutes through the IBWC/CILA framework nor the BECC/NADBANK framework adequately address in any fundamental way such “sustainable” concepts as water quality or non-traditional uses of water as part of overall water management (Mumme and Barajas 2003: 69-73).

Thus, this work’s title. For the efforts at water conservation in the irrigation districts of the Río Conchos watershed as well as the efforts at land stewardship in the upper Río Conchos watershed were always only partial resolutions, more products of the reaction to a temporal climate crisis than a fundamental change in land or water use toward sustainable development or drought management planning or a response to the political demands of the natural resource users. The willingness of farmers in all three areas surveyed to initiate and adapt to changes involving resource use is a hopeful sign. Nonetheless, to get to a more fundamental change, than the users themselves – the farmers of the Río Conchos – must be given the tools and markets to make the changes work for their needs as well as those of the wider basin, while the institutional framework must be expanded to deal with extended drought, groundwater, non-traditional uses of water and water quality and initiate a longer-term drought management regime. Only then could true “resolution” of disputes between the two countries sharing an international resource occur.

Appendix A: Copies of Survey Instrument Used in 2005 (Spanish only)

Encuesta sobre el uso del agua y la tierra en Chihuahua, 2005

Gracias por participar en esta encuesta sobre el uso del agua y la tierra en Chihuahua. Como queda de manifiesto en la página adjunta – el documento en el que nos da su consentimiento – el propósito de este estudio es terminar una disertación para el Departamento de Geografía de la Universidad de Texas en Austin. El tema de la disertación es el cambio en el uso de la tierra y el agua en la cuenca del Río Conchos, particularmente en respuesta a la reciente escasez de agua, problemas con el manejo del agua y la disputa entre los Estados Unidos y México por el agua. Si bien yo le invito a que participe en esta encuesta, la decisión es suya. Si decide participar, puede contestar sólo las preguntas que desee. En todos los casos, su nombre individual no será usado en relación con la encuesta, y sus respuestas serán completamente confidenciales. Sólo se presentarán resúmenes de las respuestas a la encuesta en conferencias y en la disertación. Esta encuesta podrá tomar aproximadamente una hora para ser contestada.

1. ¿Es usted dueño o usuario de algún terreno en el que se hayan cultivado productos agrícolas en los últimos 10 años?

   Sí ____ No_________

Si no, gracias por su tiempo. No es necesario continuar.

Si contestó que sí, prosiga.

Sección A. INFORMACIÓN DEMOGRÁFICA BÁSICA

1. Sexo: M_____ F_____

2. Año de nacimiento: ___________________

3. Lugar de nacimiento: Chihuahua____ (Si es Chihuahua, vaya a la sección B)
Otro ___ (Si es otro, proceda al 4)

4. Si no nació en Chihuahua, ¿en dónde nació?

Otro estado de México ______
Por favor anote el estado _____
Otro país _________________
Por favor anote el país_______

5. Si no nació en Chihuahua, ¿cuándo se mudó al estado de Chihuahua?

Año aproximado _________

6. ¿Ha permanecido aquí desde que se mudó? Sí _________ No ________ Por favor explique.

SECCIÓN B. PROPIEDAD DE LA TIERRA

7. ¿Es usted dueño de propiedad PRIVADA en Chihuahua? Sí _______ Si sí, proceda al 8.
No _____ Si no, proceda al 17.

8. Si contestó que sí, ¿cuándo adquirió la propiedad? Año aproximado _________
9. ¿La propiedad se encuentra dentro de los límites de un distrito de riego? Sí ____ No____
10. Si contestó que sí, ¿cómo se llama el distrito de riego así como el módulo?
Distrito ______________ Módulo _________________
11. ¿De qué cantidad total de terreno es usted dueño en Chihuahua? Cantidad en hectáreas ______

12. ¿Qué cantidad de la propiedad se usa actualmente para producción agrícola? Cantidad en hectáreas___
13. ¿Qué cantidad de la propiedad se usa actualmente para producción ganadera? Cantidad en hectáreas___

14. ¿Toda su tierra está en un solo terreno, o está separada en diferentes áreas o lotes?
Un solo terreno _____ En diferentes lotes _____
15. Si está localizada en diferentes áreas o lotes, por favor describa ____________

16. ¿Es usted miembro de un Ejido? Sí ______ Si contestó que sí, vaya al 17
No _____ Si contestó que no, vaya al 22

17. ¿Cómo se llama el Ejido? _____________________
18. ¿En que año se hizo miembro del Ejido? ________________
19. Dentro del Ejido, ¿qué cantidad de la propiedad total usa usted individualmente?
Cantidad en hectáreas ______
20. Dentro del Ejido, ¿qué cantidad de la propiedad total usa usted comunalmente?
Cantidad en hectáreas ______
21. ¿Qué cantidad de la tierra ejidal total está actualmente en producción agrícola?
Cantidad en hectáreas ______
22. ¿Qué cantidad de la propiedad se usa actualmente para producción ganadera?
Cantidad en hectáreas ______

23. ¿Es usted miembro de una Colonia/Colono? Sí ______ Vaya al 24
No _____ Vaya al 30
24. ¿Cómo se llama la Colonia/Colono? _____________________
25. ¿En que año se hizo miembro de la Colonia? ________________
26. Dentro de la Colonia, ¿qué cantidad de la propiedad total usa usted individualmente?
Cantidad en hectáreas ______
27. Dentro de la Colonia, ¿qué cantidad de la propiedad total usa usted comunalmente?
Cantidad en hectáreas ______
28. ¿Qué cantidad de la tierra total de la Colonia está actualmente en producción agrícola?
Cantidad en hectáreas ______
29. ¿Qué cantidad de la propiedad se usa actualmente para producción ganadera?
Cantidad en hectáreas ______

SECCIÓN C. USO DE LA TIERRA

30. Actualmente, ¿usted arrienda o renta tierra de otro dueño para uso agrícola? Sí ___ No ___
Si Sí: Cantidad de tierra: _____ Hectáreas
31 ¿Cuánto tiempo tiene rentando tierra de otro dueño? ______________________________
32. ¿Cuál es el costo aproximado de arrendar la tierra de otra persona? _____________________
33. En el pasado, ¿ha arrendado tierra de otro dueño para usos agrícolas? Sí ___ No ___
Si Sí: Cantidad de tierra: _____ Hectáreas
34. ¿En qué años usted arrendó la tierra? ___________
35. ¿Cuál fue el costo aproximado de arrendar la tierra? _____________________
36. Actualmente, ¿está usted arrendando su propia tierra a otro usuario agrícola para producción?
Sí ___ No ___
37. Si sí, ¿cuál es la cantidad total de tierra que está arrendando a otro usuario?
Cantidad en hectáreas _____________
38. ¿Cuándo comenzó a arrendar esta tierra al usuario actual? ________
39. ¿Cuál es la ganancia aproximada que usted obtiene por arrendar su tierra? __________
40. En el pasado, ¿ha usted arrendado su tierra a otro usuario para uso agrícola? Sí ___ No ___
Si sí, cantidad de tierra ___________
41. ¿En qué años arrendó su tierra? ______________
42. ¿Cuál fue su ganancia aproximada por arrendar su tierra? _______
43. En la tierra de la que usted es dueño o que usted trabaja, ¿qué cultivos tiene actualmente o planea tener en esta temporada agrícola? Por favor anote en esta lista.

Nombre del cultivo	Tierra privada, en hectáreas	Tierra ejidal, en hectáreas	Tierra ejidal comunal, en hectáreas	Tierra de la Colonia, en hectáreas	Tierra comunal de la Colonia, en hectáreas	Tierra que usted arrienda **a otra** persona	Tierra que usted arrienda **de otra** persona

44. De los cultivos que usted tiene, ¿qué porcentaje es para consumo personal, cuánto para consumo directo del ganado, cuánto para el mercado doméstico y cuánto para exportación?

Nombre del cultivo	Consumo personal	Consumo de ganado	Mercado doméstico	Mercado de exportación

45. Para la presente temporada agrícola, ¿qué opina usted que será su producción total, comparada con años anteriores?

Muy buena ______ Buena _____ Regular _____ Mala _______ Muy mala _________

46. Para la presente temporada agrícola, ¿qué opina usted de su producción total, **por cultivos individuales**, comparada con el año pasado?

Cultivo	Muy buena	Buena	Regular	Mala	Muy mala

47. Durante los últimos 10 años, ¿han habido cambios significativos en las cantidades y tipos de cultivos que tiene?
Sí ______________ Por favor llene 48, 49, 50 y 51
No _____________ Vaya a la siguiente sección

48. Voy a mencionar cambios que podría haber occurido en sus terrenos. Por favor marque y califique hasta qué grado han sido importantes los siguientes cambios en los últimos 10 años. Responda a toda los factores.

	A un grado alto	A un grado mediano	A un grado bajo	Sin cambio/sin importancia	No se aplica
Reducción de la cantidad total de tierra de cultivo					
Aumento de la cantidad total de tierra de cultivo					
Reducción de la cantidad de tierra de cultivo, pero aumento de la producción en el mismo terreno					
Abandono de los terrenos de cultivo y de agricultura					
Renta de terrenos a otros					
Cambio de granos a frutas y verduras					
Cambio a cultivos de exportación					
Cambio a cultivos perennes					
Eliminación de la segunda temporada agrícola (invierno)					
Uso de cultivos más resistentes					

a la sequía					
Uso de cultivos modificados genéticamente					
Aumento en el uso de fertilizantes					
Disminución en el uso de fertilizantes					
Disminución del uso de pesticidas					
Uso de semillas importadas					
Aumento en el uso de pesticidas					
Uso de cultivos más resistentes a los pesticidas					
Cambio en fuente de agua					
Cambio en el uso de la tierra, de producción agrícola a producción ganadera					
Utilizacion de nueva maquinaria/ tecnologia					
Uso de Menos Mano de Obra					
Uso de Mas Mano de Obra (Jornaleros)					

49. Por favor mencione otros factores ____

50. ¿Cuáles han sido los factores más importantes para los cambios en los tipos y cantidades de sus cultivos que ha hecho? Por favor marque todos los que sean aplicables.

	A un grado alto	A un grado mediano	A un grado bajo	Sin cambio/sin importancia	No se aplica
Precio de los productos agrícolas					
Acceso/entrega del agua					
Sequía					
Falta de apoyo del gobierno					
Incremento en Apoyo del Gobierno					
Acceso a mercados internacionales					
Competencia con otros productores agrícolas domésticos					
Competencia con productores agrícolas internacionales					
Acceso a préstamos y fondos para suministros o insumos agrícolas					
Costo y disponibilidad de los suministros o insumos					
Problemas de tenencia de la tierra/acceso a la tierra					

51. Por favor mencione otros factores relacionados con los cambios ______________

SECCIÓN D. DERECHOS Y USO DEL AGUA

52. ¿Actualmente riega usted sus cultivos con agua (además de sólo agua de lluvia)?
Sí ___ Vaya a la siguiente pregunta.
No ____ Pase a la pregunta 66

53. Si sí, ¿de dónde viene el agua? Marque todas las que se apliquen, dando le prioridad de más importante a menos importante.

Subterránea de un pozo privado o comunal __________________
Agua de la superficie, por un canal o por tubería de irrigación ________
Almacenamiento del agua de lluvia en la superficie ___________
Canal directo de un río/presa _________________________________
Otro_________________________

54. Por favor describa cómo hace llegar el agua a sus terrenos actualmente.

55. En la última década, ¿ha cambiado la fuente de suministro de su agua? Sí _____ No _____
56. Si contestó que sí, por favor describa __________________________________
57. ¿Actualmente es usted propietario de derechos sobre el agua? Sí _____ No ______
58. Si contestó que sí, ¿cuál es la cantidad total de derechos sobre agua que usted tiene? __________
59. ¿cuál es la cantidad total de millares que le correspondía por derecho este año agrícolo?
60. ¿Cuál es la mayor cantidad de derechos sobre el agua que le han proporcionado en los últimos 15 años, en Millares? _____________________ Millares
61. ¿Aproximadamente en qué año ocurrió eso? Año _________________
62. ¿Cuánto le cobran actualmente por cada Millar/derecho de agua que recibe?
_____________________Pesos
63. ¿Cuánto es lo menos que ha pagado por Millar? ______________Pesos
64. ¿En qué año ocurrió eso? Año ______________
65. ¿Cuánto es lo más que ha llegado a pagar por Millar? ______________Pesos
66. ¿En qué año ocurrió eso? Año ______________
67. ¿Alguna vez ha comprado derechos de agua de otros agricultores? Si ______ No______
68. Si si, ¿en que año? Año ______________
69. ¿Cuanto pagó?
70. ¿Alguna vez ha vendido derechos de agua a otro? Si ________ No__________
71. Si si, ¿en que año? Año ______________
72. ¿Cuanto pagó? ___________________
73. ¿Qué tecnologías usa actualmente para hacer llegar el agua a sus campos?

74ª. ¿Cuántas veces durante al año agrícola regó o va a regar sus cultivos este año? Llene lo siguiente

Cultivo	Num de Aplicacíones de Agua	Cantidad de Agua por Aplicación	Num de Aplicaciones de Agua en Año en que Mas se utilizó agua	Cantidad de Agua por Aplicación

75. Para los que sólo usan agua de lluvia para regar sus campos, por favor describa lo que hace en su tierra para asegurarse que sus cultivos reciban el agua adecuada.
76. ¿Ha hecho usted algún cambio en años recientes para asegurar que el agua de lluvia llegue a sus cultivos?

SECCIÓN E. IMPACTOS DE LA SEQUÍA

77. Es su opinión, en los últimos 15 años, ¿ha habido una sequía en su área?

Sí _____ No _____

78. Si contestó que sí, ¿cómo calificaría la severidad de esta sequía?

La peor Muy mala Similar a otras sequías
No tan mala como en otros períodos No fue un gran problema

79. Por favor asigne el grado de importancia de los siguientes factores respecto a la falta de acceso al agua.

Factor	A un grado alto	A un grado mediano	A un grado pequeño	Sin importancia	No se aplica
Sequía					
Uso ineficiente del agua por parte de los productores agrícolas					
Contaminación del agua					
Falta de inversión en presas y canales de irrigación					
Salinización/ Erosión de los suelos					
Sedimentación en las principales canales, presas y ríos					
Competencia con otros usuarios, urbanos y de otros tipos					
Uso de cultivos que requieren de mucha agua					
El alto costo de la agua					
Los Estados Unidos exigen más agua					
Cedro Salado					

80. Por favor mencione otros factores.

SECCIÓN F. PROYECTOS DE CONSERVACIÓN

Esta sección incluye una serie de temas relacionados con el uso del agua y la participación en proyectos dirigidos a la conservación del agua.

81. ¿Usted está participando actualmente, o ha participado, en algún proyecto de conservación del agua?

Sí ________________ No ________

82. ¿El proyecto de conservación del agua se está implementando en su campo/terreno, dentro del módulo o en un distrito completo? Marque todas las que se aplican.

Distrito _________Módulo_____________Terreno individual___________

83. En los proyectos de conservación del agua para el módulo o distrito, ¿qué tanta participación tuvo usted?

Mucha, yo lo determiné
Una poca; me dijeron qué hacer, pero cambié algunas cosas
Muy poca, básicamente tuve que hacer lo que me dijeron
Ninguna

84. Si el proyecto de conservación del agua está en su terreno, ¿qué tanta participación tuvo usted?

Mucha, yo lo determiné
Una poca; me dijeron qué hacer, pero cambié algunas cosas
Muy poca, básicamente tuve que hacer lo que me dijeron
Ninguna

85ª. Hicieron bien el proyecto?

Muy Bien Bien Normal Mal Muy Mal

Por favor describa el proyecto de conservación del que usted forma parte.

86. Por favor dé su opinión sobre qué tan eficientemente se usa el agua en su área.

	Uso del agua muy eficiente	Uso del agua eficiente, pero se puede mejorar	El uso del agua no es eficiente ni es ineficiente	Uso del agua ineficiente, pero ha mejorado	Uso del agua muy ineficiente
Califique hasta qué grado **usted** usa el agua eficientemente					
Califique hasta qué grado **sus vecinos** usan el agua eficientemente					
Califique hasta qué grado **el módulo** usa el agua eficientemente					
Califique hasta qué grado **el distrito** usa el agua eficientemente					

87. Por favor califique hasta qué grado está usted de acuerdo con las siguientes declaraciones.

	De acuerdo en grado alto	De acuerdo en grado mediano	No estoy de acuerdo ni en desacuerdo—Neutral	En desacuerdo en grado mediano	En desacuerdo en grado alto
Usar menos agua pero lograr las mismas cantidades de cosecha me beneficia personalmente					
Los proyectos de conservación del agua nos ayudarán a usar el agua más eficientemente, para poder tener más cultivos					
Los proyectos de conservación del agua tienen sentido, ya que todos debemos compartir este recurso					
Se nos impusieron los proyectos de conservación del agua					
Los proyectos de conservación del agua van a beneficiar solamente a algunos agricultores, no a todos					
Los proyectos de conservación del agua tienen como fin darle más agua a los Estados Unidos					

88. ¿Hay actualmente una disputa entre los Estados Unidos y México acerca del agua que fluye de los Estados Unidos hacia México?

Sí _____ No _____ No sé _____

89. ¿Qué entiende usted sobre la disputa que hay actualmente entre los Estados Unidos y México por el agua? Por favor encierre en un círculo sus respuestas que sean aplicables.

La deuda del agua ha sido pagada. No se ha llegado a ningún acuerdo.

La deuda del agua no ha sido pagada, pero se ha llegado a un acuerdo.

No tengo conocimiento sobre la disputa.

SECCIÓN G. LOS IMPACTOS DEL LIBRE COMERCIO

90. Desde que entró en vigor el tratado de libre comercio con los Estados Unidos y Canadá en 1994, algunos analistas dicen que ha habido cambios importantes en los precios, acceso y propiedad de la tierra.

¿Cree que el TLC ha sido un beneficio para usted como productor agrícola?

Un gran beneficio
Un pequeño beneficio
Neutral
Una pequeña desventaja
Una gran desventaja

91. Por favor mencione cualquier factor, positivo o negativo, que el TLC ha traído a usted o a otros productores agrícolas.

92. ¿Usted exporta algún producto agrícola **a** los Estados Unidos? Sí_____ No _____

93. ¿Usted importa insumos o materiales agrícolas **de** los Estados Unidos? Sí_____ No _____

SECCIÓN H. OPINIÓN SOBRE LAS ORGANIZACIONES, GOBIERNOS

94. En sus campos agrícolas, ¿cuáles organizaciones le han dado ayuda, consejos o financiamiento a hacer cambios a sus terrenos? Por favor encierre en un círculo las que sean aplicables.

Comisión Nacional de Agua
Sanidad Vegetal
Secretaria de Agricultura
SEMARNAT
Comisión para la Cooperación Ambiental para la Frontera
Banco Norteamericano de Desarrollo

Otra organización gubernamental	Nombre ____________________
Organización no gubernamental	Nombre ____________________
Compañía privada	Nombre ____________________
Banco privado	Nombre ____________________
Asociación o módulo de irrigación	Nombre ____________________
Ejido	Nombre ____________________
Organización del gobierno de los Estados Unidos	Nombre ____________________
Organización no gubernamental de los Estados Unidos	Nombre ___________________
Otro	Nombre ____________________

95. Para cada una de estas organizaciones, por favor califique la medida en que le han ayudado, o no.

Nombre	En gran medida	En grado mediano	Un poco	Nada	Me han perjudicado un poco	Me han perjudicado mucho

96. Por favor describa cómo le han ayudado, o no, estas organizaciones.

97. Ha sido un beneficio la transferencia del distrito de CONAGUA a los Modulos? Porque?

Gran Beneficio
Pequeño Beneficio
Neutral
Pequeño Desventaja
Gran Desventaja

Appendix B: Letter of Informed Consent to Participate in English and Spanish

Informed Consent to Participate in Research

The University of Texas at Austin

You are being asked to participate in a research study. This form provides you with information about the study. The Principal Investigator (the person in charge of this research) will also describe this study to you and answer all of your questions. Please read the information below and ask questions about anything you don't understand before deciding whether or not to take part. Your participation is entirely voluntary and you can refuse to participate. Any answers or information you provide will be confidential and anonymous and no statements will be attributed to you. .

Title of Research Study: Changing Land and Water Practices in the Agricultural Fields of the Rio Conchos (Chihuahua) Watershed: Conservation, Water Rights and Communal Lands in a Time of Drought and Free Trade

Principal Investigator(s) (include faculty sponsor), UT affiliation, and Telephone Number(s):
Cyrus Reed, a P.H.D student in the Department of Geography at the University of Texas in Austin, Texas, is the Principal Investigator of this study. His home address is 4205 Ave. F, Austin, Texas 78751. His home number is 512-419-7260.

Professor Gregory Knapp is the supervising sponsor. He is the Chairman of the Department of Geography at the University of Texas in Austin.

His address is: University of Texas at Austin, Department of Geography, 210 W. 24th St. Austin, TX, 78712. His phone number is: (512) 232-1589

Funding source:

The study is being funded by personal finances as well as some funding from the University of Texas, including a grant from the Mexico Center (E.D. Farmer Research Fellowship). It is not receiving funds from any private business or foundation.

What is the purpose of this study? *[Please include the number of subjects]*

Cyrus Reed is conducting research for his PHD. He will be conducting research on land use, water use, water conservation and crop production along the Rio Conchos. The study has four basic objectives:

(1) Analyze basic hydrological and meteorological data over the last ten to fifteen years within the Rio Conchos Basin; (2) Analyze ownership and use of land and water over the last 10 years within the Rio Conchos Basin; (3) Investigate how the reduced amount of water available has impacted the ownership, control and use of water and land resources within particular agricultural communities; and (4) Investigate how local resource users have responded to new conservation and irrigation modernization programs.

What will be done if you take part in this research study?

Your answers will help determine the findings of this study. However, no individual answers will be made publicly available. Instead, answers will be summarized and analyzed without attributing them to an individual.

What are the possible discomforts and risks?

There are no known risks for participating in this study.

What are the possible benefits to you or to others?

The benefit of this study will be to learn to what extent the efforts to improve production and lower water use are working. This information will be presented at conferences and to policy makers.

If you choose to take part in this study, will it cost you anything?

No. There is no cost to take part in this study.

Will you receive compensation for your participation in this study?

No. There is no compensation for participating in this study.

If you do not want to take part in this study, what other options are available to you?

Participation in this study is entirely voluntary. You are free to refuse to be in the study, and your refusal will not influence current or future relationships with The University of Texas at Austin.

How can you withdraw from this research study and who should I call if I have questions?

You are free to withdraw your consent and stop participation in this research study at any time. You are free to refuse to answer any questions you do not want to answer. Throughout the study, the researchers will notify you of new information that may become available and that might affect your decision to remain in the study. If you wish to stop your participation in this research study for any reason, you should contact: Professor Gregory Knapp at the University of Texas at (512) 232-1589.

In addition, if you have questions about your rights as a research participant, please contact Clarke A. Burnham, Ph.D., Chair, The University of Texas at Austin Institutional Review Board for the Protection of Human Subjects, 512/232-4383.

How will your privacy and the confidentiality of your research records be protected?

Authorized persons from The University of Texas at Austin and the Institutional Review Board have the legal right to review your research records and will protect the confidentiality of those records to the extent permitted by law. If the research project is sponsored then the sponsor also has the legal right to review your research records. Otherwise, your research records will not be released without your consent unless required by law or a court order. If the results of this research are published or presented at scientific meetings, your identity will not be disclosed.

Consentimiento para participar en un estudio académico de investigación

The University of Texas at Austin (Universidad de Texas en Austin)

Le está pidiendo ser participante en un estudio de investigación. Esta forma le provee información sobre el estudio. El Investigador Principal (el encargado del estudio) también describirá el estudio y responderá a cualquier pregunta o duda sobre el estudio. Favor de leer la información abajo, preguntar sobre cualquier duda que se tenga antes de decidir a participar o no. Su participación es voluntaria y puede rehusarse a participar. Cualquier respuesta o información que provea será confidencial y anoníma y no se atribuirá ninguna palabra a su persona.

Nombre del Estudio de Investigación: Prácticas de Uso de Suelo y Agua en la Agricultura de la Cuenca del Río Conchos: Conservación, Derechos de Agua y Tierras Comunales Durante Sequía, Libre Comercio y la Disputa de Agua entré Estados Unidos y México

(Changing Land and Water Practices in the Agricultural Fields of the Rio Conchos (Chihuahua) Watershed: Conservation, Water Rights and Communal Lands in a Time of Drought, Free Trade and Water Dispute

Investigador Principal, Afiliación e Teléfono:
Cyrus Bayard Hutchins Reed es un estudiante de doctorado en el Departamento de Geografía y Ambiente en la Universidad de Texas en Austin. Es el investigador principal del estudio. Su dirección en Austin es 4205 Ave. F, Austin, Texas 78751. Su número de telefóno es el 512-419-7260 y su celular es el 512-740-4086. Su e-mail es cyrus_reed@mail.utexas.edu.

El Dr. Gregory Knapp es el supervisor del proyecto. Es profesor del departamento de Geografía en la Universidad de Texas.

Su dirección es: University of Texas at Austin, Department of Geography, 210 W. 24th St. Austin, TX, 78712. Su número de teléfono es: (512) 232-1589. Su e-mail es el gwk@mail.utexas.edu.

Fuente de Financiamiento:

El estudio es financiado con una beca (E.D. Farmer Research Fellowship) del Centro Mexicano de la Universidad de Texas en Austin y finanzas personales. No hay fondos de fundaciones o negocio privado.

Cual son los objetivos del estudio?

Cyrus Reed está emprendiendo una investigación para su doctorado en geografía. El estudio se centra en un estudio del uso de suelo, agua, conservación de agua y producción de cosechas durante los últimos 10 años en la Cuenca del Río Conchos. Tiene cuatro objetivos básicos:

(1) Analizar datos hidrológicos y meteorológicos de los últimos 10 a 15 años en la cuenca del Río Conchos: (2) Analizar tenencia y uso de tierra y agua en los últimos 10 a 15 años en la cuenca del

Río Conchos; (3) Investigar como la escasez de agua ha impactado la tenencia, control y uso de agua y tierra adentro de comunidades agrícolas particulares; (4) Investigar como los usarios de agua y tierra han respondido a los programas de conservación de agua y suelo.

Que pasa si participa en el estudio?

Sus respuestas ayudarán a determinar los resultados del estudio. Sin embargo, ninguna participación o respuesta individual será disponible al público. En cambio, las respuestas serán analizadas sin atribuirlas a alguien en particular.

Hay riesgos en participar?

No hay ningun riesgo en participar que se conozca como sus respuestas serán anónimas.

Cuales son los beneficios?

El beneficio es entender hasta que punto los intentos de mejorar la producción y bajar el uso de agua están dando fruto y cuales han sido las experiencas de los agricultures en estos años de cambio. La información podrá ser presentada en conferencias y a los políticos.

Y si no quiere participar uno en el estudio que opciones hay?

Su participación es completemente voluntaria.

Y si empieza uno a participar y después no quiere participar?

En cualquier momento puede uno retirar su participación en el estudio. Uno también puede negarse a responder a una pregunta en particular pero si participar en las otras preguntas. Si tiene algun problema con el investigador principal o quiere platicar directamente con el supervisor del proyecto, siempre puede comunicarse con el Professor Gregory Knapp en la University of Texas al teléfono (512) 232-1589.

Además si tiene preguntas sobre sus derechos como participante en esta investigación, puede comunicarse con el Clarke A. Burnham, Ph.D., The University of Texas at Austin Institutional Review Board for the Protection of Human Subjects, 512/232-4383.

Como se mantendrá la confidencialidad de los resultados de la investigación?

Los resultados de esta investigación no serán entregados a nadie sin su consentimiento, o a no ser de que una corte o ley lo requieran. Si los resultados del estudio son publicados o presentados en una reunión científica, su identidad quedará en forma confidencial como los datos serán presentado en un sumario, no por individuo.

Bibliography

Abella, Gloria. 2001. Interview with Alberto Székely: El problema del agua en la frontera México-Estados Unidos. Universidad Nacional Autónoma de México Radio, transmitted October 23, 2001. Available at http://www.sre.gob.mx/imred/difyext/transcripciones/radio01/aszekely.htm.

Administración Municipal de Ojinaga, 2001-2004. 2004. *Datos Básicos de Ojinaga*. Ojinaga, Chihuahua: Municipio de Ojinaga.

Agnew, John. 1999. The New Geopolitics of Power, in *Human Geography Today*, eds. Doreen Massey, John Allen and Philip Sarre, eds.,174-193. Cambridge, U.K: Polity Press, 1999.

Alcalá, Jorge. 2002. *Determinación de criterios e indicadores ambientales y de sostenibilidad en la región Bosque Modelo Chihuahua*. Chihuahua, Chih.: Unpublished Master's Thesis, UACH.

Alvarado, Carlos Mario, Juventino Eduardo González, Francisco Xavier Ortiz and Francisco Muñoz. 2003. *Suacillo: Mi Pequeña Gran Patria*. Chihuahua: DINTEL.

American Rivers. 2003. *America's Most Endangered Rivers of 2003: Ten Rivers Reaching The Crossroads in the Next 12 Months*. Washington, D.C.: American Rivers.

Arriaga, L., Espinoza, J.M., Aguilar, C., Martínez, E., Gómez, L and Loa, E. 2000. *Regiones terrestres prioritarias de México*. México: Comisión Nacional Para el Conocimiento y Uso de la Biodiversidad (CONABIO).

Asad, M., R. Serroa de Motta, L.G. Acevedo, L.D. Simpson & K.E. Kemper. 1999. Management of water resources: bulk water pricing in Brazil. *World Bank Technical Paper 432*. Washington, D.C. : The World Bank.

Batisse, Michel. 1986. Developing and Focusing the Biosphere Reserve Concept. *Nature and Resources* 23: 2-11.

Batterbury, Simon, Timothy Forsyth and Koy Thomson. 1997. Environmental Transformations in Developing Countries: Hybrid Research and Democratic Policy. *The Geographical Journal*. 163 (2): 126-132.

Batterbury, Simon and Jude Fernando. 2006. Rescaling Governance and the Impacts of Political and Environmental Decentralization: An Introduction. *World Development* 34(11): 1851-1863.

Bebbington, Anthony. 2004. NGOs and uneven development: geographies of development intervention. *Progress in Human Geography*. 725-745.

Bebbington, Anthony. 1997. Social Capital and Rural Intensification: Local Organizations and Islands of Sustainability in the Rural Andes*. Geographical Journa*l 163:189-197.

Bennett, John. 1976. *The ecological transition: cultural anthropology and human adaptation* (New York: Pergamon Press).

Blaikie, Piers and Joshua Muldavin. 2004. Upstream, Downstream, China, India: The Politics of Environment in the Himalayan Region*. Annals of the Association of American Geographers* 94 (3): 520-548.

Blaikie, Piers. 1999. A Review of Political Ecology, Zeitshcrift fur *Wirtschaftsgeographie* 43: 131-47.

Blaikie, Piers. 1985. *The Political Economy of Soil Erosion in Developing Countries*. New York: Longman Scientific and Technical.

Blaikie, Piers and Harold Brookfield. 1987. *Land Degradation and Society*. London and New York: Methuen and Co. Ltd.

Blake, Carlos. 1983. Historia del Sistema Nacional de Riego, No. 5, *in Delicias: 50 Años*. Delicias, Chih.: Club Rotario.

Border Environment Cooperation Commission. 1993. *Agreement between the Government of the United States of America and The government of the United Mexican States Concerning the Establishment of a Border Environment Cooperation Commission (BECC) and a North American Development Bank (NADB), 1993.*

Border Environment Cooperation Commission. September 2002. *Project for Modernization and Technical Improvements to the Conchos River Irrigation Districts: BECC Certification Document*. Ciudad Juárez, Chihuahua: BECC.

Boserup, Ester. 1965. *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. London: Earthscan Publications (1998 Reprint).

Boserup, Ester. 1981*. Population and technological change : a study of long-term trends*. Chicago: University of Chicago Press.

Bowden, Charles. 1977. *Killing the Hidden Waters: The Slow Destruction of Water Resources in the American Southwest*. Austin, Texas: University of Texas Press.

Brandes, R.J.. February 17, 2000. *Preliminary Analysis of Mexico's Rio Grande Water Deficit Under the 1944 Treaty*. Austin, Texas: RJ Brandes Company.

Brandes, R.J. April 2002. *Update of the Hydrologic, Climatologic, Storage, and Runoff Data for the United States in the Mexican Portion of the Rio Grande Basin: October 1992-September 2001, Technical Annex*. El Paso: International Boundary and Water Commission.

Briscoe, J., P. Anguita Salas & H. Peña. 1998. Managing water as an economic resource: reflections on the Chilean experience*. World Bank Environment Department Working Paper 62*. Washington, D.C.: The World Bank.

Brock, Laura, Karen Chapman and Mary Kelly. 2001. *Legal & Institutional Framework for Restoring Instream Flows in the Rio Grande: Fort Quitman to Amistad*. Austin, Texas: Texas Center for Policy Studies.

Bromley, Daniel W. 1989. Property Relations and Economic Development: the Other Land Reform. *World Development* 17(6):867-877.

Brookfield, H. C. and Paula Brown. 1963. *Struggle for land; agriculture and group territories among the Chimbu of the New Guinea highlands*. Melbourne: Oxford University Press.

Brown, Christopher and Stephen Mumme. 2000. Applied and theoretical aspects of binational watershed councils in the US-Mexico Borderlands*. Natural Resources Journal* 40 (4): 895-929.

Browning-Aiken, Anne, Holly Richter, David Goodrich, Bob Strain and Robert Varady. 2004. Upper San Pedro Basin: Fostering Collaborative Binational Watershed Management. *Water Resources Development* 20 (3): 353-367.

Buttimer, Anne. 1995. Home, Reach and the Sense of Place. *In The Human Experience of Space and Place*, eds. Anne Buttimer and David Seamon, 166-187. New York: St. Martin's Press.

Butzer, Karl. 1992. The Realm of Nature and Society: Adaptation and Change in Historical Perspective. In The Earth Transformed by Human Action, ed. B.L. Turner II et a, 685-701. New York: Cambridge University Press.

Calderón, Elías. 2005. *El Redimensionamiento del Distrito de Riego 090 Bajo Río Conchos, Chihuahua*. Paper presented at León, Guanajuato México, Comisión Nacional de Agua conference, August 12, 2005.

Cardenas Jiménez, Alberto. 2004. *Aviso de Estudios del Decreto de la Reserva de Biosfera Sierra Tarahumara*. Mexico: SEMARNAT.

Castree, Noel and Bruce Braun. 2001. *Social Nature: Theory, Practice and Politics*. Oxford: Blackwell Publishers.

Center for North American Studies. 2003. *Estimated Irrigation Water Use in Chihuahua, Mexico, 1980-2001*. College Station, TX: CNAS.

Center for Space Research. 2003. *An update of surface water availability in the Rio Grande basin of Mexico*. Austin, TX: Center for Space Research, University of Texas at Austin.

Centro de Investigación Sobre Sequía. 2004. *Sequía en Chihuahua, Boletín No. 1*. Cd. Aldama, Chihuahua: CEISS.

Chowdhury, Rinku Roy and Turner II, B. L.. 2006. Reconciling Agency and Structure in Empirical Analysis: Smallholder Land Use in the Southern Yucatán, Mexico. *Annals of the Association of American Geographers* 96 (2): 302-322.

Club Rotario de Delicas. 1983. *Delicias: 50 Años*. Delicias, Chihuahua: Club Rotario.

Collier, Michael, Robert Webb and John C. Schmidt. 1996. *Dams and Rivers: Primer on the Downstream Effects of Dams.* Tucson, Arizona: U.S. Geological Survey.

Comisión Nacional de Agua (CONAGUA). 2004a. *Características Generales del Distrito de Riego 005*. Delicias: CONAGUA.

CONAGUA. 2004b. *Características Generales del Distrito de Riego 090*. Ojinaga: CONAGUA.

CONAGUA. 2002. *Convenio de Concertación que Celebran el Ejecutivo Federal; el Gobierno del Estado Libre y Soberano de Chihuahua, Y Asociacion Civil de Usuarios del Río Conchos Canal Saucillo Para Llevar a Cargo las Acciones de Modernización de las Obras de Infraestructura Hidroagrícola y Tecnificación del Riego con el Objeto de Ahorrar Volúmenes de Agua*. Chihuahua, Chihuahua: CONAGUA.

CONAGUA. 2000. *Comentario al Documento Estadounidense Análisis Prelimaria del Déficit Mexicano de las Aguas del Río Bravo, bajo el Tratado de 1944*. Monterrey, México: CONAGUA.

CONAGUA. 1997. *Programa Hidraulico de Gran Visión, Estado de Chihuahua (1996-2020)*. México: CONAGUA.

CONAGUA. 1967*. Perfiles de los Suelos en Las Series Determinadas del Distrito de Riego 05* (Mexico: CONAGUA).

Comisión Nacional de Áreas Naturales Protegidas. 2005. *Convocatoria: Servicios de Consultoria Para el Desarrollo de Estudios y Actividades Logisticas para la Conservacion y Manejo de los Recursos Naturales de la Reserva de l Biosfera Sierra Tarahumara*, *CONANP-28-09-2005.02*. México: CONANP.

Commission for Environmental Cooperation. 2001*. Strategic Directions for the Conservation of Biodiversity*. Montreal: Commission for Environmental Cooperation.

Consejo Civil Mexiciano Para La Silvicultura Sostenible. 2005. Proyecto de la Nueva ANP en la Sierra Tarahumara. *Boletín Informativo* 3: 3-4.

CONTEC. 2004. *Diagnóstico Comunitario del Ejido El Consuelo*. Chihuahua: CONTEC.

Contreras-Balderas, S and M.L. Lozano-Vliano. 1996. Water, endangered fishes, and development perspectives in arid lands of Mexico. *Conservation Biology* 8:379-387.

Cornelius, W. & Myhre, D., eds. 1998*. The Transformation of Rural Mexico: Reforming the Ejido Sector*. La Jolla, California: Center for U.S.-Mexican Studies. University of California at San Diego.

Denevan, William. 1992. The Pristine Myth: The Landscape of the Americas in 1492*. Annals of the AAG* 82(3): 369-385.

Denevan, William. 1983. Adaptation, Variation, and Cultural Geography. *Professional Geographer* 35: 399-407.

Dirección General de Sanidad Vegetal. 2001. *Propuesta del Programa de Supresión-Erradicación para Picudo del Algodonero y Gusano Rosado en el Estado de Chihuahua*. Cd. Chihuahua: Dirección General de Sanidad Vegetal.

Doolittle, William. 2000. *Cultivated Landscapes of native North America*. Oxford: Oxford University Press.

Doolittle, William. 1989. Arroyos and the Development of Agriculture in Northern Mexico. In *Fragile Lands of Latin America: Strategies for Sustainable Development*, John Browder, Editor. Boulder, Co: Westview Press.

Doolittle, William. 1984. Agricultural Change as an Incremental Process*. Annals of the Association of American Geographers* 74: 124-137).

Dowie, Marc. 1996. *Losing Ground: American Environmentalism at the End of the Twentieth Century*. Cambridge, Mass: MIT Press.

Eckholm, E.P. 1976. *Losing Ground: Environmental Stress and World Food Prospects*. New York: W.W. Norton.

Edwards, R.J., G.P. Garrett, and E. Marsh-Matthews. 2002. Conservation and status of fish communities inhabiting the Río Conchos basin and Middle Río Grande, Mexico and U.S.A. Review. *Fish Biology and Fisheries* 12:119-132.

Ehrlich, Paul and Amy Ehrlich. 1990. *The Population Explosion*. New York: Simon & Schuster.

Ellis, J. 1996. On the Search for a Root Cause: Essentialist Tendencies in Environmental Discourse. In *Uncommon Ground: Rethinking the Human Place in Nature*, ed. William Cronon, 256-268. New York: W.W. Norton.

EL-Lissy, Osama and Hill Grefenstette. 2006*. Boll Weevil Eradication: Spring 2006 Update*. Riverdale, MD: United States Department of Agriculture.

Environmental Law Institute. 1998*. Legal Aspects of Forest Management in Mexico*. Washington, D.C.: Environmental Law Institute.

Escobedo, Tania. 2005. Inviable, proyecto de traer agua de Delicias. *El Heraldo de Chihuahua*, September 8, 2005: 4B

Espach, Ralph. 2006. When is Sustainable Forestry Sustainable? The Forest Stewardship Council in Argentina and Brazil. *Environmental Politics* 6 (2): 55-84.

Esparza Terrazas, Eduardo. 2004. *Santa Cruz, Antigua región de los tapacolmes: Historia de la Villa de Rosales*. Chihuahua: Solar Colección.

Everitt, B.L. 1998. Chronology of the Spread of Tamarisk in the Central Rio Grande. *Wetlands* 1 (4): 658-668.

Everitt, B.L. 1993. Channel Responses to Declining Flows on the Rio Grande Between Fort Quitman and Presidio, Texas. *Geomorphology* 6: 225-252.

Fairhead, James and Melissa Leach. 2003. *Reframing deforestation: global analyses and local realities: studies in West Africa*. London; New York: Routledge.

Fairhead, James and Melissa Leach. 1996. Rethinking the Forest-Savanna Mosaic. In *The Lie of the Land: Challenging Received Wisdom on the African Environment*, eds. Leach and Mearns, 105-122. London: Vilier Publications.

Feagin, Joe, Anthony M. Orum, and Gideon Sjoberg.1991. *A Case for the case study*. Chapel Hill : University of North Carolina Press.

Felger, Richard and Michael Wilson. 1995. Northern Sierra Madre Occidental and its Apachian outliers: A neglected center of biodiversity, Biodiversity and Management of the Madrean Archipelago: the Sky Islands of Southwestern United States and Southwestern Mexico. *USDA Forest Service General Technical Report RM-GTR-264.* September 19-23, 1994 Meeting in Tucson, Az.

Fisher, Robert and Ury, W. 1981. *Getting to Yes: Negotiating Agreement without Giving In*. Boston: Houghton Mifflin.

Fischhendler, Itay, Eran Feitelson and David Eaton. 2004. The Short- and Long-Term Ramifications of Linkages Involving Natural Resources: The U.S.-Mexico Transboundary Water Case. *Environment and Planning C: Government & Policy* 22 (55): 633-650.

Flores, Mike, Fernando Valentine, Gary Paul Nabhan. 1990. Managing Cultural Resources in Sonoran Desert Biosphere Reserves, Land and Resources: The Finite Frontier. *Cultural Survival Quarterly* 14 (4): 26-30.

Food and Agriculture Organization of the United Nations (FAO). 2005. *2005 Forest Resources Assessment*. New York: United Nations.

FAO. 1997. *1997 State of the World Forests*. New York: United Nations.

Fox, Vicente. 2001. *Cruzada Nacional por los Bosques y el Agua, March 7, 2001*. Available at http://cruzadabosquesagua.semarnat.gob.mx/palabras_presidente.html.

Friedmann, John. 1992. *Empowerment: The Politics of Alternative Development* Cambridge, U.K.: Blackwell.

Fuentes, Evangelina. 2006. Falla el Rubber Dam. *El Diario de Chihuahua*, September 8, 2006, A1.

Fuentes, Evangelina. 2005. Presionaron Para agilizar pago de derechos de agua. *El Diario de Chihuahua*. September 2, 2005, AI, A3.

Fuentes Mares, José. 1983. *Delicias: 50 Años*. Chihuahua, Chih: Club Rotario.

Fuerza Ambiental. 2005a*. Plan de Acción Comunitario del Ejido Arroyo de la Cabeza*. Chihuahua, Chihuahua: Fuerza Ambiental.

Fuerza Ambiental. 2005b. *Plan Rector Comunitario de la Comunidad La Laguna*. Chihuahua, Chihuahua: Fuerza Ambiental.

Gadsden, H., Rodríguez, J., Muñoz, C., Núñez D. y Hinojosa, O. 2003. Monitoring Drought in Chihuahua. *Voices of Mexico* 63: 102-108.

Gallagher, Kevin. 2004*. Free trade and the environment: Mexico, NAFTA, and beyond*. Stanford, California: Stanford Law and Politics.

Gándara Samaniego, Manuel. 2004. *Delicias: Apuntes para su Historia*. Chihuahua, Chih: Doble Hélice Ediciones.

Gerez Fernández, P., Alatorre-Guzmán, E., 2005. Challenges for forest certification and community forestry in Mexico. In: Merino Pérez, L. (Ed.), *The Community-Managed Forests of Mexico: The Struggle for Equity and Sustainability*, ed, Merino Pérez, L, 71-87. Austin, Texas: University of Texas Press.

Geertz, Clifford. 1973. Thick Description: Toward an Interpretive Theory of Culture. In *The Interpretation of Cultures*: *Selected Essays*, 3-30. New York: Basic Books.

Gingrich, Randall. 2007. *The Life, Death and Resurrection of the Sierra Tarahumara Biosphere Reserve.* Chihuahua, Chihuahua: Sierra Madre Alliance, available at http://www.sierramadrealliance.org.

Gingrich, Randall. 2005. Building Effective International, Multicultural Alliances for Restoration of Ejido Forests in the Sierra Madre. In *Connecting mountain islands and desert seas: biodiversity and management of the Madrean Archipelago II Proceedings RMRS-P-36*, eds. Gottfried, Gerald J.; Gebow, Brooke S.; Eskew, Lane G.; Edminster, Carleton B., 364-370. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Glesne. Corrine. 1984. The Impossibility of Doing Good. *Culture and Agriculture* 23: 1-6.

Goodrich, Gregory and Andrew Ellis. 2006. Climatological Drought in Arizona: An Analysis of Indicators for Guiding the Governor's Drought Task Force*. The Professional Geographer* 58 (4): 460-469.

Goudie, Andrew. 1982. *The Human Impact: Man's Role in Environmental Change*. Cambridge, Mass: MIT Press.

Green, Donald. 1973*. Land of the Underground Rain: Irrigation of the Texas High Plains, 1910-1970*. Austin, Texas: University of Texas Press.

Guerrero, María Teresa, Mary Kelly, Cyrus Reed, Brandon Vegter and Francisco Villa. 2002. The Forestry Industry in the State of Chihuahua: Economic, Ecological and Social 2002 Impacts Post-Nafta. In *The Environmental Effects of Free Trade*: *Papers Presented at the North American Symposium on Assessing the Linkages between Trade and Environment*. Montreal, 27-77. Montreal, Canada: North American Commission on Environmental Cooperation.

Hardin, Garnett. 1968. The Tragedy of the Commons. *Science* 162: 1243-1248.

Hecht, Susanna and Alexander Cockburn. 1989. *The Fate of the Forest: Developers, Destroyers and Defenders of the Amazon*. London: Verso.

Herman, Ken. 2003. Governor: If Mexico Won't Pay, Close Tap*. Austin-American Statesman,* August 15, 2003.

Horgan, Paul. 1954. *Great river: the Rio Grande in North American history*. New York: Rinehart.

HSBC. February 21, 2002. *Investing in Nature Press Release*, Available at http://www.hsbc.com/hsbc/news_room/news/.

Hudson, P.F., Hendrickson, D.A., Benke, A.C., Rodiles-Hernandez, R., and Minckley, W.L. 2005. Rivers of Mexico. In Rivers of North America. Eds. Benke A.C. and Cushing C.E., 1030-1084. Amsterdam, Netherlands and Boston, Mass: Elsevier Academic Press.

Instituto Nacional de Estadística Geográfica e Informática (INEGI). 2006*. Conteo de Población y Vivienda II, 2005*. Aguascalientes: INEGI.

INEGI. 1996. *Conteo de Poblacion y Vivienda 1995*. Aguascalientes: INEGI.

INEGI. 2001*. XII Censo General de Población y Vivienda 2000*. Aguascalientes: INEGI.

INEGI. 1991. *XI Censo General de Población y Vivienda 1990* Aguascalientes: INEGI.

International Boundary and Water Commission (IBWC). 2006*. Background Documents from Binational Rio Grande Summit: Cooperation for a Better Future, November 17-18, Reynosa, Tamaulipas and McAllen, Texas*. El Paso, Texas: IBWC.

IBWC. 2005a. USIBWC Commissioner Announces Resolution of Mexico's Rio Grande Water Debt. *March 10, 2005 Press Release*. El Paso, Texas: IBWC.

IBWC. 2005b. Mexico Pays Rio Grande Deficit. *September 30, 2005 Press Release*. El Paso, Texas: IBWC.

IBWC. 2005c. Status Report of Rio Grande Deliveries by Mexico. *Press Release October 8, 2005*. El Paso, Texas: IBWC.

IBWC. 2003. *Minute 309: Volumes of Water Saved with the Modernization and Improved Technology Projects, July 2, 2003*. El Paso, Texas: IBWC.

IBWC. 2002. *Minute No. 308: United States Allocation of Rio Grande Waters During the Last Year of the Current Cycle*. Ciudad Juárez, Chihuahua: IBWC.

IBWC. 2001. *Minute No. 307: Partial Coverage of Allocation of the Rio Grande Treaty Tributary Water Deficit from Fort Quitman to Falcon Dam*. Washington, DC: IBWC.

IBWC. 1970. *Treaty to Resolve Pending Boundary Differences and Maintain the Rio Grande and Colorado River as the International Boundary Between the United States of America and Mexico Signed at Mexico November 23, 1970*. El Paso, Texas: IBWC.

IBWC. 1968. *Minute No. 230: Additional Monuments 244A and 244B on the land boundary, between International Monuments Nos. 244 and 245*. Ciudad Juárez, Chihuahua: IBWC.

IBWC. 1944. *Treaty Between the United States of America and Mexico for the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande Signed at Washington February 3, 1944 and Protocol Signed at Washington, November 19, 1944*. Washington, DC: IBWC.

International Bible Society. 1984. *The Bible: The New International Version*. Colorado Springs, Colorado: International Bible Society.

Jiménez González, Gerardo. 2003. *El Valle de Ojinaga: en la junta del Bajo Conchos y el Bravo*. Austin, Texas: Environmental Defense.

Jiménez González, Gerardo. 2002. *Uso Agrícola del Agua en la Cuenca del Río Conchos*. Austin, Texas: Texas Center for Policy Studies.

Johnson, Allen. 1989. How the Machiguenga Manage Resources: Conservation or Exploitation of Nature? *Advances in Economic Botany* 7:213-222.

Jordán, Fernando. 1956. *Crónica de un país bárbaro*. México, DF: Asociación Mexicana de Periodistas.

Junta Central de Aguas y Saniemiento (JCAS) Chihuahua. 2005. *Presa San Juanito, Bocoyna*. Chihuahua, Chihuahua: JCAS.

Juster, Norton. 1961. *The Phantom Tollbooth*. New York: Epstein & Carroll.

Kelley, J. Charles. 1992. La Cuenca del Río Conchos: historia, arqueología y significado. In *Historia General de Chihuahua I: Geología, Geografía y Arqueología*, ed. A. Marquez-Alameda. Ciudad Juárez: Universidad Autonoma de Chihuahua and Gobierno de Chihuahua.

Kelly, Mary E. and Salvador Contreras. 1998. *Water Use and Water Management Policy in the Chihuahuan Desert Ecosystem*. Washington, DC: World Wildlife Fund.

Kelly, Mary and Concepción Luján Alvarez. 2004. *Agricultural Irrigation Conservation Projects in the Delicias, Chihuahua Irrigation District: A Report on Public Participation, Certification and Early Implementation*. Austin, Texas: Environmental Defense.

Kelly, Mary. 2001. *The Río Conchos: A Preliminary Overview*. Austin, Texas: Texas Center for Policy Studies.

Kelly, Mary and Cyrus Reed. 2000. *Expanding the Mandate: Should the Border Environmental Cooperation Commission and North American Development Bank Go Beyond Water, Wastewater and Solid Waste Projects and How do They Get There?* Austin, Texas: Texas Center for Policy Studies.

Kelly, Mary and Cyrus Reed. 2003. The CEC's Trade and Environment Program: Cutting-Edge Analysis, but Untapped Potential. In *Greening NAFTA: The Experience and Potential of the North American Commission for Environmental Cooperation*, eds. David Markell and John Knox. Stanford, California: Stanford University Press.

Kelly, Mary, Cyrus Reed and Lynda Taylor. 2001. *The Border Environment Cooperation Commission (BECC) and North American Development Bank (NADB): Achieving their Environmental Mandate*. Austin, TX: Texas Center for Policy Studies.

Klerigan, Efraín. 2005. Proyectan dique inflable para no verter agua al mar. *El Diário de Chihuahua.*

Klooster, Dan. 2006. Environmental Certification of Forests in Mexico: the political ecology of a nongovernmental market intervention. The Annals of the Association of American Geographers 96 (3): 541-565.

Knapp, Gregory. 1994. *Endangered Cultural Landscapes of the Equatorial Andes*. Paper presented at the 1994 Annual Meeting of the Association of American Geographers, San Francisco, Ca.

Knapp, Gregory. 1991. *Andean Ecology: Adaptive Dynamics in Ecuador*. Boulder, CO: Westview Press.

Knighton, David. 1998. Fluvial Forms and Processes: A New Perspective. London: Arnold (Co-published in New York by John Wiley and Sons.

Lammertink, J.M., Rojas-Tomé, J.A., Casillas-Orona, F.M. & Otto, R.L. 1997. *Situación y Conservación de los Bosques Antiguos de Pino-encino de la Sierra Madre Occidental y sus Aves Endémicas.* D.F. México: Consejo Internacional para la Preservación de las Aves, Sección Mexicana.

LaRochelle, Serge. 2002. *Common Property and Traditional Ecological Knowledge: Biodiversity Conservation in the Sierra Tarahumara, Mexico*. Unpublished Master's Thesis. Manitoba, Canada: Dept. of Natural Resources Management, University of Manitoba, Canada.

Levi-Strauss, Claude. 1963. *Structural Anthropology*. New York: Basic Books.

Lipper, Jerome. 1967. Equitable Utilization. In *The Law of International Drainage Basins*, eds. A. H. Garretson, R.D. Hayton and C.J. Olmstead, 15-64. Dobbs Ferry, NY: Oceana Publications.

Liverman, Diana. 1999. Vulnerability and Adaptation to Drought in Mexico. *Natural Resources Journal* 39 (1): 99-116.

Lowerre, Richard. 1994. *Update on World Bank Forestry Loan to Mexico*. Austin, Tx: Texas Center for Policy Studies.

Luján, Humberto. 2004. *La Invasión de Tamarisk (Cedro Salado) en el Bajo Río Conchos, Aguas Arriba de la Presa Derivadora Tarahumara*. Austin, Texas: Environmental Defense.

Luna, Leopold. 1997. *Water, Rivers and Creeks*. Sausalito, California: University Science Books.

Macias, Maria and Fatima Torres. 2001. Mennonite Colonies in Mexico Accept Change Slowly. *Borderlands* 19: 13.

Macklin, M.G. and Lewin, J. 1989. Sediment transfer and transformation of an alluvial valley floor: the River South Tyne, Northumbria, UK. *Earth Surface Processes and Landforms* 14: 233-46.

Magilligan, FJ and Stamp, ML. 1997. Historical land-cover changes and hydrogeomorphic adjustment in a small Georgia watershed. *Annals of the Association of American Geographers* 87: 614-635.

Martínez Rodríguez, José María and Cyrus Reed. 2002. *Acuíferos y Libre Comercio: El Caso de la Costa de Hermosillo*. Austin, Texas and Hermosillo, Sonora: Texas Center for Policy Studies and Red Fronteriza de Salud y Ambiente.

Martinez, Santiago. 2005. *Municipio de Carichí: Primer Informe de Gobierno* Carichi, Chihuahua: Presidente Municipal.

Marzulla, Nancie and Roger Marzulla. 2004. *Notice of Intent to Submit a Claim to Arbitration under Section B, Chapter 11 of the North American Free Trade Agreement, August 27, 2004, Marzulla & Marzulla and Don Wallace Jr (co-counsel for claimants)*. Washington, D.C.: Marzulla & Marzulla.

Massey, Doreen. 1995. Places and their Pasts*. History Workshop Journal* (39): 182-192.

Massey, Doreen. 1994. *Space, Place and Gender*. Minneapolis: University of Minnesota.

Massey, Doreen. 1993. Questions of Locality. *Geography* 78 (2): 142-149.

McKee, T.B., N. J. Doesken, and J. Kliest. 1993. The relationship of drought frequency and duration to time scales. In *Proceedings of the 8th Conference of Applied Climatology, 17-22 January, Anaheim, CA., pp. 179-184.* Boston, Mass: American Meterological Society.

Meeker-Lowry, Susan. 1993. Rainforest Marketing: Who Really Benefits*? Earth Island Journal* 8 (3): 42-44.

Meyer, William and BL Turner. 1996. Human Transformation of the Earth. *In 10 Geographic Ideas that Changed the World*, S Hanson, Ed. New Brunswick, N.J.: Rutgers University Press).

Milch, L and Robert Varady. 1999. Openness, sustainability and public participation: new designs for transboundary river basin initiatives*. Journal of Environment and Development* 8: 258-306.

Milloy, Ross. 2001. A Rift Over Rio Grande Water Rights. *The New York Times*, September 18, 2001, A14.

Moore, Christopher. 1996*. The Mediation Process: Practical Strategies for Resolving Conflict.* San Francisco, Ca.: Jossey-Bass Inc.

Moullof, Robert J. 1992. La Prehistoria del Noreste de Chihuahua: Complejo Cielo y Distrito La Junta. In *Historia General de Chihuahua I, Geologia, Geografia y Arqueologia*, ed. A. Marquez-Alameda, pp. 137-162. Ciudad Juarez, Chihuahua: Universidad Autonoma de Ciudad Juarez and Gobierno del Estado de Chihuahua, Mexico.

Morgan, D.L. 1988. *Focus Groups as Qualitative Research*. London: Sage Publications.

Mumme, Stephen P. and Ismael Aguilar Barajas. 2003.Managing Border Water to the Year 2020: The Challenge of Sustainable Development. In *The U.S. – Mexican Border Environment: Binational Water Management Planning, SCERP Monograph Series, No. 8*, Suzanne Michel, ed., 51-93. San Diego: San Diego State University Press.

Nadal, Alejandro. 2002. *Corn in NAFTA: Eight Years After. A Research Report prepared for the North American Commission for Environmental Cooperation*. Montreal: North American Commission for Environmental Cooperation.

Nadal, Alejandro. 1999. *Maize in Mexico: Some Environmental Implications of the North American Free Trade Agreement (NAFTA)*. Montreal, Canada: North American Commission for Environmental Cooperation.

NAFTA Secretariat. 1994. *The North American Free Trade Agreement*. Washington, D.C.: U.S. Trade Representative.

Nalven, Joseph. 1986. Transboundary Environmental Problem Solving: Social Process, Cultural Perception. *Natural Resources Journal* 26: 793-818.

Natural Heritage Institute. 2001. *Rio Grande/Rio Bravo Designing a Common Future: A Physical Assessment of the Opportunities for Improved Management of the Water Resources of the Bi-National River Basin*. San Francisco, CA: Natural Heritage Institute.

NewsMax.com. 2003. U.S. Taxpayers Subsidize Mexico's Theft of Water, *NewsMax.com*, January 29, 2003.

North American Development Bank. 2000. *Board Resolution 2000-10: Expansion of NADB Sectors of Activity*. San Antonio, Tx: NADB, November 16, 2000.

Osorio, Victor. 2005. Vence el plazo para pagar deuda de agua. *El Diario de Chihuahua*, September 11, 2005,1B-2B.

Peattie, Lisa. 1987. *Rethinking Ciudad Guayana.* Ann Arbor, MI: University of Michigan Press.

Peet, Robert and Michael Watts. 1996*. Liberation Ecologies: Environment, Development, Social Movements*. New York: Routledge Press.

Peluso, Nancy. 1993. Coercing Conservation?: The Politics of State Resource Control. *Global Environmental Change* 3 (2): 199-217.

Pennington, Campbell W. 1963*. The Tarahumar of México: Their Environment and Material Cultur*e. Salt Lake, Utah: University of Utah Press, Salt Lake.

Perry, Rick. 2002. Remarks to South Texas Water Treaty Rally*. Press Release March 20, 2002*. Austin, Texas: Office of the Governor, Available at www.governor.state.tx.us.

Perry, Rick. 2005. *Mexico's Rio Grande Water Debt Paid In Full. Press Release, September 30, 2005*. Austin, Texas: Office of the Governor, Available at www.governor.state.tx.us.

Poole, Peter. 1995. Land-Based Communities, Geomatics and Biodiversity Conservation. *Cultural Survival Quarterly*. Winter 1995.

Portillo Terrazas, Jaime. 2005. *Diagnóstico del Municipio de Carichí, Chihuahua*. Carichi, Chihuhuahua: Municipio de Carichi.

Price, Marie. 1994. Ecopolitics and Environmental Nongovernmental Organizations in Latin America. *Geographical Review* 82(3):42-59.

Proctor, James D 1996. Whose Nature? The Contested Moral Terrain of Ancient Forests. In *Uncommon Ground: Rethinking the Human Place in Nature*, ed. William Cronon, 269-297. Norton: New York.

PROFEPA. 1998. *Informe Trianual: 1995-1997*. D.F., México: PROFEPA, Available at www.profepa.gob.mx.

Puente González, Arturo. 2002. *Economía del Agua en los Distritos de Riego del Río Conchos, Chihuahua, 1990-2001*. Mexico, DF: World Wildlife Fund.

Pupo-Walker, Enrique. 1993. *Castaways: The Narrative of Alvar Núñez Cabeza De Vaca*. Translated by Frances M. Lopez-Morillas. Berkeley: University of California Press.

Registrio Agrario Nacional. 2005. *Pre-Cierre Operativo del PROCEDE en Chihuahua.* DF, México: Registro Agrario Nacional.

Rendón Pimentel, Luis. 2005. Volumenes de Agua Concesionados y Utilizados en los Distritos de Riego del Rio Bravo. Presentation at IBWC/CILA Binational Cooperation Forum, November 2005. Mexico, DF: CONAGUA.

Residencia de Agrologia. 1965. *Estado de Chihuahua, Informe Sobre el Estudio Agrologico Detallado por Fotointerpretacion del Valle de Ojinaga, Proyecto Presa El Granero*. Chihuahua: Residencia de Agrología.

Reyes-Gomez, V.M., Nuñez-López, Daniel; Muñoz-Robles, Carlos. 2005. *Caracterización de la Sequía Hidrológica en la Cuenca del Rio Conchos*, unpublished paper. Cd. Aldama, Chihuahua: CEISS.

River Systems Institute, Texas State University. 2006. PROJECT RIO: *Sustaining the Future of the Rio Bravo Summary Document.* San Marcos: River Systems Institute.

River Systems Institute, Texas State University. 2005. A Regional Framework for the Development, Management and Sustainable Use of the Water Resources of the Rio Bravo Drainage Basin: PDF-A Proposal to UNEP. (San Marcos, Texas: River Systems Institute).

Robbins, Paul. 2004. *Political Ecology: A Critical Introduction*. Malden, Mass: Blackwell Publishing.

Rocheleau, Dianne, Barbara Thomas-Slayter, and David Edmunds. 1995. Gendered Resource Mapping: Focusing on Women's Spaces in the Landscape. *Cultural Survival Quarterly* Winter 1995.

Rodríguez Piñeda, José Alfredo, Daniel Nuñez López and Carlos Muñoz Robles. 2005. Crisis Hidrológica México-USA?: Hubo o No Sequía en La Cuenca del Río Conchos en el Periódo 1993-2002. Unpublished paper presented at *Binational Rio Grande Summit: Cooperation for a Better Future, McAllen, Texas, November 2005*.

Rosson III, C. Parr, Aaron Hobbs and Flynn Adcock. 2003. *The U.S./Mexico Water Dispute: Impacts of Increased Irrigation in Chihuahua, Mexico*. College Station, Texas: Center for North American Studies.

Sachs, Wolfgang. 1991. Environment and Development: The Story of a Dangerous Liaison. *The Ecologist* 21(6): 252-257.

Sauer, Carl. 1938. Theme of Plant and Animal Destruction in Economic History. *Journal of Farm Economics* 20:765-775.

Schmandt, Jurgen, ed.. 1993. *Water and development: the Rio Grande-Río Bravo*. Austin, Texas: Lyndon B. Johnson School of Public Affairs.

Schmidt, Robert. 1992. Chihuahua, Tierra de Contrastes Geográficos. *In Historia General de Chihuahua 1: Geología, Geografía y Arqeología*, ed. A. Marquez-Alameda. Chihuahua: Universidad Autonoma de Cd. Juarez y Gobierno del Estado de Chihuahua.

Schumm, Stanley, A. 1991. *To Interpret the Earth: Ten Ways to be Wrong*. Cambridge, England: Cambridge University Press.

Schumm, S.A. and Lichty, R.W. 1965. Time, space and causality in geomorphology. *American Journal of Science* 263: 110-119.

Secretaría de Agricultura Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA). 2001. *Ley de Desarrollo Rural Sustentable*. D.F. México: Diário Oficial de la Federación, December 7, 2001.

Secretaria de Desarrollo Rural. 2004. *Programa de Desarrollo Forestal Sustentable del Estado de Chihuahua*. Chihuahua: Gobierno del Estado de Chihuahua.

Secretaría de Gobernación. 1992. *Decreto por el que se reforma el articulo 27 de la Constitución Política de los Estados Unidos Mexicanos*. D.F., México: Diário Oficial de la Republica, January 6, 1992.

Secretaría de Medio Ambiente, Recursos Naturales y Pesca. 1995. *Programa Forestal y de Suelo 1995-2000*. D.F., México: Secretaría de Medio Ambiente, Recursos Naturales y Pesca, Mexico.

Servicio de Información Agroalimentaria y Pesquera. 2005. *Anuario Estadístico Pecuario, 2004*. Aguascalientes: SAGARPA.

Sjoberg, Gideon, Norma Williams, Ted R. Vaughan and Andree Sjoberg. 1991. The Case Study Approach in Social Research: Basic Methodological Issues. In *A Case for the Case Study*, eds. Joe Feagin, Anthony Orum and Gideon Sjoberg. Chapel Hill: University of North Carolina Press.

Stake, Robert E. 1978. The Case Study Method in Social Inquiry. *Educational Researcher* 7 (2): 5-8.

Stake, Robert E. 1995. *The Art of Case Study Research*. Thousand Oaks, California: Sage Publications.

Sudbrock, A. 1993. Tamarisk control, Fighting Back: An overview of the invasion, and a low-impact way of fighting it. *Restoration and Management Notes* 11: 31-34.

Sundberg, Juanita. 1998. NGO Landscapes in the Maya Biosphere Reserve, Guatemala. *Geographical Review* 88(3): 388-412.

Swyngedouw, Erik. 1997. Neither Global nor Local: Glocalization and the Politics of Scale. In Spaces of Globalization: Reasserting the Power of the Local, ed. Kevin Cox, 137-166. New York: Guilford Press.

Texas Center for Policy Studies. 2001. *Binational Declaration: The Río Conchos and the Lower Río Bravo/Río Grande*. Austin, Texas: TCPS.

Texas Water Resources Institute and the New Mexico State University Water Task Force. 2007. *Efficient Irrigation for Water Conservation in the Rio Grande Basin: 2006-2007 Progress and Accomplishments Report* (College Station, TX: Texas Water Resources Institute).

Thompson, Cecilia. 1985. *History of Marfa and Presidio County, 1535-1946. Volume One, 1535-1900*. Austin, Texas: Nortex Press.

Topete, J. Ernesto. 2004. Fox: Agua, asunto de seguridad nacional*. El Diario de Chihuahua*, August 4th 2004, A1 and A8.

Trejo-Pech, Carlos, Liz House and Carmen Lopez-Reyna. 2003*. Cargill Hybrid Seeds Mexico: A Case Study*. Paper presented at the International Food and Agribusiness Management Association Annual Meeting, Cancun, Mexico 2003.

Tribunal Superior Agrario. 1996. *Juicio Agrario Numero 438/92, Relativo a la Solicitud de Dotación de Aguas, Promovida por las Autoridades Ejidales del Poblado Parritas, Municipio de Saucillo, Estado de Chihuahua*. D.F., Mexico: Tribunal Superior Agrario.

Trimble, S.W. and Mendel, A.C.1995. The cow as a geomorphic agent—A critical review. *Geomorphology* 13: 233–253.

Trimble, S.W. and Pierre Crosson. 2000. U.S. Soil Erosion Rates--Myth and Reality. *Science* 289 (5477): 248-251.

Turner, Woody. 2001*. Forest Cover Change in the Sierra Tarahumara: Remote Sensing as a Tool for Monitoring Areas of Conservation Concern*. Washington, D.C.: Conservation International.

Umemoto, Karen. 2001. Walking in Another's Shoes: Epistemological Challenges in Participatory Planning*. Journal of Planning Education and Research* 21 (1): 17-31.

UNESCO. 2002. *Guiding Principles for Projects on Biosphere Reserves*. New York: UNESCO, Man and the Biosphere Project:.

US Agency for International Development. 2005*. Mexico: US AID Profile, FY 2005*. Available at http://www.usaid.gov.

U.S Water News Online. 2003. Texas Ag Commissioner Keeps Up Push on Mexico Water Treaty. *U.S. Water News Online* October 2003. Available at uswaternews.com).

Van Schoik, D. Rick, Elena Lelea and Amy Conner. 2006. Executive Summary: Proceedings of Border Institute VI: Transboundary Ecosystem Management. In *The U.S.-Mexican Border Environment: Transboundary Ecosystem Management*, Kelly Hoffman, ed., ix-xxv. San Diego: Southwest Center for Environmental Research and Policy.

Varady, R. G., D. Colnic, R. Merideth, and T. Sprouse. 1996. The U.S.-Mexico Border Environment Cooperation Commission: collected perspectives on the first two years. *Journal of Borderlands Studies* 11 (2):89-119

Vasquez-Castillo, M.T. 2001. Mexico-US bilateral planning: institutions, planners and communities. *European Planning Studies* (9): 649-662.

Vayda, Andrew P. 1983. Progressive Contextualization: Methods and Research in Human Ecology. *Human Ecology* 11(3):265-281.

Vayda, Andrew and Bradley B. Walters. 1999. Against Political Ecology*. Human Ecology* 27 (1): 167-179.

Vergara Gonzalez, Juan Manuel. 2005. Declaran Veda por Sobreexplotacion*. El Diario de Chihuahua*, October 28, 2005, 5A.

Walker, David, John Paul Jones III, Susan M. Roberts and Oliver R. Frohling. 2007. When Participation Meets Empowerment: The WWF and the Politics of Invitation in the Chimalapas, Mexico*. Annals of the Association of American Geographers* 97 (2): 423-444.

Weissert, Will. 2005. Mexico to Issue U.S. Water Debt Payments. Associated Press, Thursday, March 17, 2005.

Wilder, Margaret. 2002. *In Name Only: Water Policy, the state and ejidatario producers in Northern Mexico*. Tucson, Arizona: University of Arizona, PhD Dissertation.

Wilder, Margaret and Patricia Romero Lankao. 2006. Paradoxes of Decentralization: Water Reform and Social Implications in Mexico. *World Development* 34 (11): 1977-1995.

Williams, G.P. and Wolrman, M.G. 1984. Downstream effects of dams on alluvial rivers. *United States Geological Survey Professional Paper 1286*.

Wilson, Patricia. 1997. Building Social Capital: A Learning Agenda for the Twenty-first Century. *Urban Studies* 34 (5-6): 745-760.

Wilson, Patricia. 1996. Empowerment: Community Economic Development from the Inside Out. *Urban Studies* 33 (4-5): 617-630.

Wolman, M.G. 1967. A Cycle of Sedimentation and Erosion in Urban River Channels. *Geografiska Annaler* 49a: 385-395.

Wolman, M.G. and Gerson, R. 1978. Relative scales of time and effectiveness of climate in watershed geomorphology. *Earth Surfaces Processes* (4): 189-208.

Wolman, M.G. and Miller, J.P. 1960. Magnitude and frequency of forces in geomorphic processes. *Journal of Geology* (68): 54-74.

World Wildlife Fund. 2006. *Carta de invitación a la discusión sobre Aguas Transfronterizas y Derecho Internacional. D.F. México: World Wildlife Fund.*

World Wildlife Fund. 2004. *Programa de Manejo Integral de la Cuenca del Río Conchos*. Cd. Chihuahua, Chih: WWF.

World Wildlife Fund. 2002. *WWF's Global Conservation Programme: Global 2000 Ecoregions*. U.K.: World Wildlife Fund, available at wwf.org.

Wunder, Sven. 2007. The Efficiency of Payments for Environmental Services in Tropical Conservation. *Conservation Biology* 21 (1): 48-59.

Zimmerer, Karl. 1993. Soil Erosion and Social (Dis)courses in Cochabamba, Bolivia: Perceiving the Nature of Environmental Degradation. *Economic Geography* 69(3): 312-327.

Zimmerer, Karl and Thomas Bassett. 2003. *Political ecology: an integrative approach to geography and environment-development studies.* New York: Guilford Press.

VITA

Cyrus Bayard Hutchins Reed was born November 11th, 1965 in a cold – but free -- hospital room in London, England. Second son of Robert C. Reed (deceased 1985), who at the time was getting his PhD in anthropology at the University of London and Helen Hutchins Reed, who would later become a Spanish professor at SUNY-Oneonta, Cyrus, older brother Jason, and family would move to snowy Syracuse, N.Y. in 1968, where Bobby Reed would become part of the faculty. After a brief time in Sevilla, Spain in 1975-76, Cyrus would complete his high school work in 1983, and enter Princeton University, graduating in 1987 with a degree in comparative literature with a certificate in Latin American Studies. After traveling with friends in Central America, Cyrus would land an 18-month job at The Tico Times, an English-language weekly in San José, Costa Rica, in the process meeting Nicaragua's Rosa María López Duarte, who would later become his wife. In 1990, he entered graduate school at the University of Texas in Latin American Studies and the following year in Community and Regional Planning, graduating with an M.A. and M.S. in 1994. That year, he began working with the Texas Center for Policy Studies, authoring numerous publications and eventually becoming its director in 2002. In 1997, first son, Oran Isaías López Reed was born, and in 1998, he entered the Geography Department at the University of Texas at Austin to pursue a PhD in geography. In 2000, Marcel Oliver López Reed was born. In addition, Cyrus has also worked as a contracted lobbyist for the Lone Star Chapter of the Sierra Club at the Texas Capitol during the 2005 and 2007 Texas legislative sessions. He defended his dissertation in April of 2007 and earned his degree in August of 2007. In September he will begin working again for the Lone Star Chapter of the Sierra Club.

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