

# Transboundary Water Conflicts in the Lower Colorado River Basin

## Mexicali and the Salinity and the All-American Canal Lining Crises

Alfonso Andrés Cortez Lara



El Colegio  
de la Frontera  
Norte

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## INTRODUCTION. CONCEPTS, ISSUES, AND INQUIRIES

The Mexicali Valley has historically played a critical role in the struggle between Mexican and The United States' interests for control of land and water in the Colorado River. During the first forty years of the twentieth century, the Colorado River Land Company, owned by private interests in The United States, exerted a firm hold on the whole agricultural area of Mexicali, as well as on the water supply that sustained the agricultural transformation of the valley. Mexican President Lázaro Cárdenas initiated a land expropriation process that ended in 1937 to form and benefit groups of *ejidatarios* in Mexicali. This refers to a specific type of social/communal land property structure where each member of the *ejido* is endowed with a piece of land for production of about 20 hectares (Ward, 2001:106).

More recently, the 1992 Mexican Land Reform modified this original property structure by giving individual rights to each *ejidatario*. With this significant institutional change, farmers currently operate as private owners who are allowed to work, sell, or rent their lands, and at the same time the change induced the capability of self-management of irrigation.

The previously mentioned facts, together with the signing of the 1944 International Water Treaty between The United States and Mexico, modified the water management processes among water users. These facts provide information about the



current developmental characteristics taking place in the region, where transboundary water conflicts remain a core issue impacting local agriculture and irrigation performance in the Mexicali Valley.

The purpose of this book is to illustrate the characteristics and impacts of the institutional arrangements of local farmers in the Mexicali Valley, to address two emblematical transboundary water conflicts in the lower Colorado River Basin: the salinity problem (1961-1973) and the All-American Canal lining conflict during the 2000s, because Mexicali Valley's agricultural activities, irrigation, culture, and history are mostly based on flows from the Colorado River watercourse. This study provides an analysis of the viewpoints of farmers and water managers concerning transboundary waters and irrigation in the Mexicali Valley, Mexico. This chapter outlines a general contextual depiction of the region and also presents the key literature on institutions, irrigation, and transboundary water issues.

The Mexicali Valley is located in the most remote arid region of northwest Mexico. It is crossed by the 32° 30' north latitude and the 115° 00' west longitude geographical coordinates and it encompasses an irrigated area: Irrigation District 014 on the Colorado River, extending over 207 234 hectares (512 087 acres) (Conagua, 2002).

Regarding production, the crop mix in the Mexicali Valley has evolved in singular fashion. Largely acknowledged as a cotton-based cropping area since early 1900s, it gained momentum between 1920 and 1927 with more than 50 000 hectares grown annually on average, and 200 000 hectares grown annually between 1954 and 1955, nearly the entire valley. This latter period is widely known as the "cotton boom" in Mexicali (Henderson, 1964:266).

Afterward, crop mix begins because cotton production dropped drastically due to changes in international price trends, as well as domestic policies in Mexico and local

physical conditions of soils and water quality in Mexicali, which induced a selective process for continuing producing cotton and for diversifying the type of crops to grow (Hendersen, 1964:910). In this respect, during the period of interest of this book, the 1960s, in a list of 10 crops, cotton occupied 63 percent of the land, wheat 25.4 percent, and alfalfa 3.9 percent of the productive land; during the 1980s, in a list of 20 crops, wheat gained momentum with 41.1 percent of the land, cotton 23.2 percent, alfalfa 7.7 percent, and fresh vegetables appear with 4.8 percent of the land under production in the Mexicali Valley (Stamatis, 1993:21).

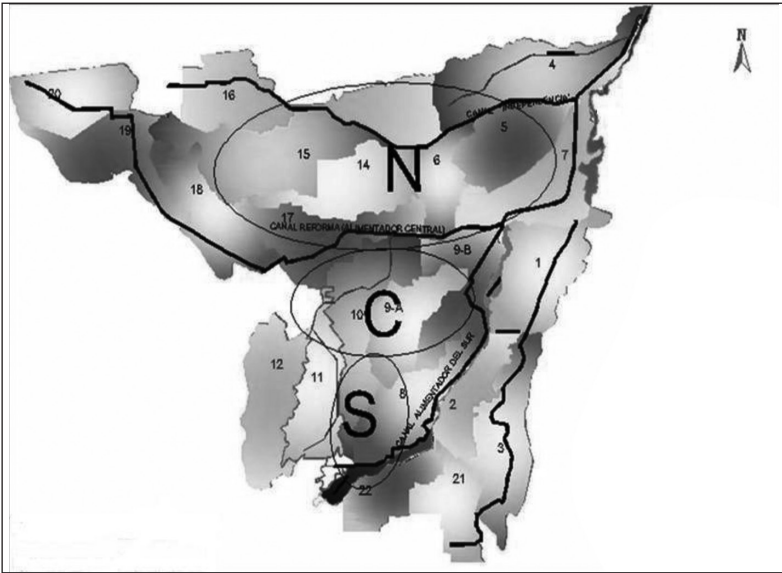
Currently, the official records show a list of more than 50 different crops, in which three predominate: wheat (72 697 hectares), cotton (32 064 hectares), and alfalfa (27 251 hectares), which together represented 79.8 percent of the total agricultural area under production in 2012. Also, these three types of crops reached a production value of 175 342 785 U.S. dollars, which represented 66.2 percent of the total gross production value during the agricultural year 2010-2011 (Sagarpa, 2012).

Water quality and availability, as well as transboundary water conflicts in the lower Colorado River Basin are among the paramount problems that have been faced by farmers operating in this agricultural region from the early 1900s (García-Acevedo, 2001:57; García Saillé, López, and Navarro, 2006:77). The Mexicali Valley is located at the borderline between southeastern California and northeastern Baja California. It encompasses a portion of the Mexican Irrigation District 014, Colorado River (Map 1). In this area, surface and groundwater run over geopolitical divisions in a general direction from North to South.

Irrigation water is mainly drawn from the Colorado River, which is also tapped for water by major border urban and rural areas in Mexicali and Tijuana in Baja California State and by the city of San Luis Rio Colorado in the state of Sonora (Cortez, Quesada, and Whiteford, 1999b:105).

A second source derives from groundwater or from the Colorado aquifer, which is naturally shared by The United States and Mexico (known as the Mexicali Valley aquifer on the Mexican side). Water supply from this aquifer has been largely contested between both countries; likewise, this water was not regulated in the 1944 International Water Treaty, and this fact has brought about critical controversies in regard to the use of and rights over groundwater.

*MAP 1. Mexicali Valley's Regions of Study Based on the Major Canal Network in the Irrigation District 014, Colorado River.*



*Source:* Colorado River Irrigation District, Irrigation Society, San Luis Río Colorado (2009).

Given the geographical features of this region and the water management issues implied, this research aims to examine two referential transboundary water conflicts that take place at different moments in the Mexicali Valley: the salinity problem, and the All-American Canal lining conflict, both of these involving agricultural water users to a different extent and showing their own institutional behavior features.

The institutional arrangements employed by farmers to influence water management decision-making processes jointly performed by the International Boundary and Water Commission (IBWC) and its Mexican counterpart (Comisión Internacional de Límites y Aguas, CILA by its acronyms in Spanish) have changed in recent history. Agricultural water users, generally acknowledged as key stakeholders, have worked to reach solutions to critical cross-border water conflicts. The local agricultural water users appeared to have exhibited different behaviors and exerted different influences during the conflict in the 2000s as compared with those of the conflict in the 1960s. These changes have influenced institutional responses in that they relate to transboundary waters and irrigation in the Mexicali Valley.

### Institutions, Irrigation, and Transboundary Water Issues

#### Institutions and Irrigation

The terms “institutions” and “organizations” are often used interchangeably, but it is useful to distinguish between them. Institutions are understood as “the humanly devised constraints that shape human interaction” and consist of the complexes of norms, values, and behaviors that persist over time and inform action (North, 1990:3). An organization is defined as a group of people with shared institutions and mutual recognition of opportunity sets. Additionally, organizations are systems of relationships for coordinating individual actions, according to some decision rule, a mix of authority and custom (Schmid, 2004:75). The combination of institutions and organizations that pertain to a particular resource and its management may be defined as the institutional arrangements. Therefore, institutional arrangements for irrigation water management include the following: *a)* an established policy and legal environment

(policies, laws, rules, rights, regulations, conventions, and customs, both formal and informal); *b*) water organizations, also called water users' associations, with responsibilities for irrigation management as a mean for collective action that can be used to manage Common-Pool Resources (CPRs), and *c*) processes and procedures for decision-making, coordination, and planning (Svendsen, Wester, and Molle, 2005:4).

In regard to the legal environment for water resources, it is important to emphasize that there are significant differences between the U.S. and Mexican water rights systems in terms of formal institutions. In Mexico, water coming from both underground and surface sources is said to be a "national property good"; as such, the rule functions similarly for the entire country. Water uses (including irrigation, domestic, commercial, and industrial) then hold "concessions to use" that are always regulated by the federal government, that is, the Mexican National Water Commission (Conagua, 1999:9).

In contrast, the water law system in The United States is a complex subject composed of state laws with little federal guidance. The two major doctrines comprise the "riparian rights" and the "prior appropriation;" the former, extended over the eastern states, is based on the premise that only persons who own land that is in actual contact with inland waters such as streams, rivers, lakes, or bays are granted rights of this sort, whereas the latter dominates in western states and establishes the "first in time, first in right" principle (Field, 2000:297; Dzurik, 2003:26).

Moreover, when considering the features of effective institutions, Lam (1998:53) points out that rules made by local stakeholders such as farmers are more likely to take information and knowledge of the local situation into consideration. Because farmers deal directly with the problems and benefits of irrigation on a daily basis, they likely understand issues, concerns, and impacts of water management decisions.



However, as more diffuse and naturally occurring factors influence water systems, effective management of irrigation systems becomes more complex. Ostrom et al. (1999:278) elaborated on the constraints that farmers face in participating in and influencing transboundary water issues, a specific type of CPRs. These authors assert that an effective role of such actors can be only reached under specific conditions of small watersheds and when no political boundaries are involved.

It is possible to list some of the factors that may affect both the involvement of farmers in irrigation and the effective management of irrigation systems. Involvement of farmers depends on environment and social dimensions such as physical, socioeconomic, and policy (Gulati, Meinzen-Dick, and Raju, 2005:242), while irrigation management performance principally depends on agro-ecological, technical, economic, historical, socio-cultural, and political-legal contextual characteristics (Uphoff, Ramamurthy, and Steiner, 1991:71).

Transboundary water issues may be better understood by considering all of those contextual characteristics as described by Uphoff, Ramamurthy, and Steiner, (1991) which also can be used to identify, describe, compare, and design effective institutions. This in turn may signify how institutions increase benefits from a fixed set of inputs; conversely, they also might reveal lower efficiency; thus, individuals are required to work harder to achieve the same type and level of benefits. In the last analysis, “institutions shape human behavior through their impact on incentives” (Ostrom, 1992:24).

In summary, institutional arrangements in place might either facilitate or hinder the problem-solving capabilities of participants in irrigation systems. Therefore, it may be helpful to learn from empirical studies of the performance of various institutional arrangements. Ideally, this examination would draw on and extend a theoretical framework that identifies the key attributes of successful collective action (Meinzen-Dick, Raju, and Gulati, 2002) with institutional attributes treated as variables that take on different values according to their specific circumstances (Tang, 1992: 13; Tang, 1994).

## Irrigation and Transboundary Waters: The United States–Mexico Border Region

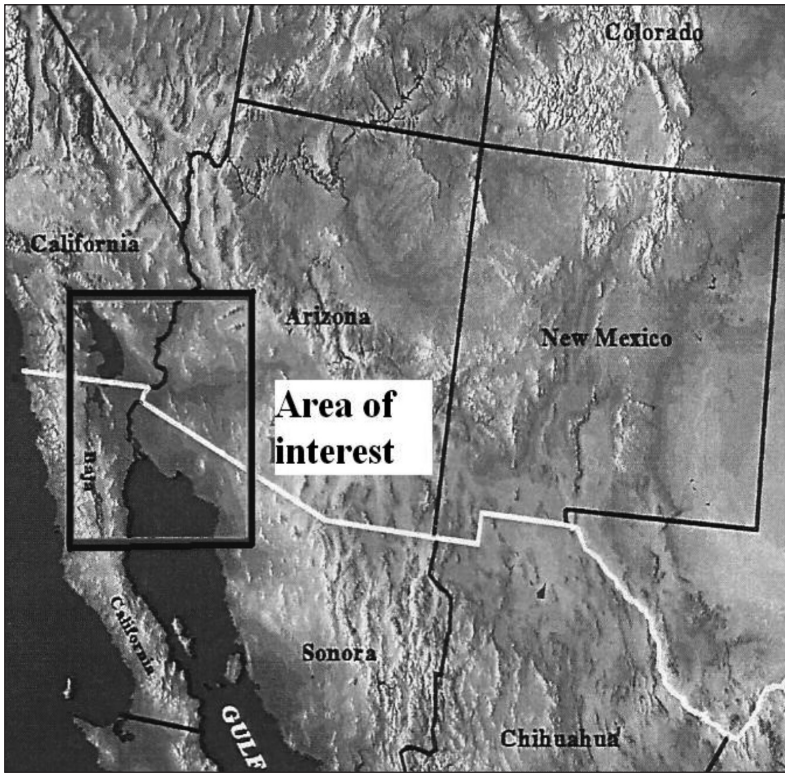
The rapid economic and population growth in the U.S.-Mexican border region stresses the utilization of transboundary waters (Cech, 2003:405). Population immediately adjacent to the border reached 12 million people in 2009 and is expected to reach 19.4 million by 2020 (EPA, 2009). Such a stress has gradually increased since the post- North America Free Trade Agreement (NAFTA) era. Yet even before NAFTA, Armstrong (1982:37) anticipated critical water problems in the U.S.-Mexican border region because of the rapid industrialization and urbanization processes taking place along the border areas, specifically in the lower Colorado River Basin (Map 2).

In addition, other studies show how global climate change is inducing social and physical vulnerability in the area of interest, that is the lower Colorado River Basin and the Mexicali Valley (Gleick, 1990; Kiparsky and Gleick, 2004:157; Wilder et al., 2013:340-384; García et al., 2013:27-50). Climate change and climate variability issues emerge as critical in the U.S.-Mexico border region amid several sources of uncertainty concerning meteorological observations.

Despite the difficulties of joint state predictive climate and hydrological models between the two countries, transboundary cooperation to address the impacts of climate variability and climate change is essential to promoting the best outcomes and to build regional adaptive capacity on both sides of the border (Wilder et al., 2013:350-352). The authors find that for the case of the lower Colorado River region, trans-border collaboration is playing a significant role in addressing environmental challenges at present.

In this respect, the researchers of the study underscore the role of The Colorado River Joint Cooperative Process (CRJCP), formed under the auspices of the IBWC and CILA, that in 2008 developed binational processes for meeting municipal,

MAP 2. Area of Interest



Source: Southern Nevada Water Authority, Resources Department (2000).

agricultural, and environmental needs in the delta. Within this context of binational collaboration, the authors find that, especially in the Colorado River system, regional impacts associated with extreme climate events are anticipated to include: a decreased water supply in storage reservoirs for urban use and irrigation, higher summer temperatures leading to stresses on energy provision during peak demand, extended and more severe drought periods, and higher evapotranspiration rates (Wilder et al., 2013:363-364).

Other researchers point out that issues as complex as trans-boundary water conflicts require permanent revision of legal and institutional frameworks (Brañes, 1991:62; Field,

2000:19). Field (2000) asserts that as nations pursue their economic growth and development goals, these conflicts are likely to become more frequent and severe. He also mentions that understanding the genesis of, and possible solutions to, international conflicts calls for an understanding of how international law and international political institutions function, or often do not function. In the same vein, this author emphasizes that economic efficiency is involved because it is important to be able to establish how a resource might be used in order to maximize its net social value. "How the total gets divided is also important, because fairness becomes an even more critical factor." Brañes (1991:65) establishes that overlapping legal instruments between countries threatens territorial sovereignty; thus, nation-states will lose capacity to manage water resources within their own nation. All things considered, implementation of The United States-Mexico International Water Treaty is a difficult matter and provisions established in the past are now insufficient to solve ever-increasing water-related problems (Mumme, 2004:5).

A need for strengthening local actors' participation in transboundary water issues has been noted by other authors (Browning-Aiken et al., 2004:354). These scholars see the potential for success in binational water resources planning and management on the U.S.-Mexican border with an increase in informal, regional "bottom-up" approaches rather than with more traditional "top-down" diplomatic or regulatory approaches based on formal treaties. The focal point of this argument is that the bottom-up, local people-centered approaches emphasize social processes, build relationships, and strive for consensus through shared value formation and the co-evolution of perceptions and preferences, which in turn tends to favor integrated watershed and water resources management.

Milich and Varady (1999:260) further elaborate on the use of the traditional top-down paradigm in an attempt to solve transboundary water conflicts in The United States-Mexico bor-

der region. Their analysis offers both a theoretical explanatory framework as well as an avenue for further inquiry. The authors assert that “local agents lack the capacity and motivation to be effective, and local informal arrangements that might have become the basis of formal cooperation are largely ignored.”

Kolavalli and Kerr (2002:213) assert that participation is widely accepted as a prerequisite to successful watershed management. Regarding the top-down and bottom-up, as well as the participation concepts, these authors go on to say that:

Recent years have seen a movement toward decentralized, participatory management of natural resources in developing countries. Inefficient and inequitable outcomes of top-down management approaches, along with increasing recognition of the site-specific complexities of management needs, have contributed to the interest in including resource users in management. Some of the most successful examples of participation, in which local people play a meaningful role in managing productive, sustainable and equitable natural resource management systems, come from non-governmental organizations (NGOs).

In relation to their research in several regions of India, Kolavalli and Kerr (2002:227) mention that although participation is necessary for successful watershed development, there is no shared understanding of its meaning, or of how to make it operational. While participation that enhances local communities’ ownership of development efforts and encourages creative solutions to site-specific problems in a complex environment is mostly fostered by NGOs, the authors’ findings, in line with those from Milich and Varady (1999) and other scholars who studied water conflicts along the U.S-Mexican transboundary settings, show that government agencies lacked staff with skills in social organization and the flexibility to give local people a substantial voice in the approaches that projects undertook.



The findings in the context of India, while maintaining the appropriate scale and site-specific conditions, fit the situation well of the stakeholders' participation in the U.S-Mexican transboundary settings such as the Mexicali Valley in the lower Colorado River region. In order to face this disadvantageous situation, other authors recommend acting in congruence with "substantive stakeholder representation" instead of only "stakeholder participation." This is said to be a better way to achieve efficient and equitable water management (Wester, Merrey, and De Lange, 2003:797).

### Transboundary Water Issues in the Lower Colorado River Basin

Farmers in the Mexicali Valley have faced, among several others, two significant cases involving transboundary waters that impact local irrigation: one is the salinity problem that took place during the 1960s and early 70s, the other is the All-American Canal lining conflict, which gained momentum in the 2000s (Doughman, 2002:199; Nier and Campana, 2007:42).

The salinity of the Colorado River results from an increase of the natural salts concentration process over time and throughout the watercourse (Cervantes and Bernal, 1991:129). Yet, in addition to this natural increase in water salinity, anthropogenic activity exacerbated critical conflicts during the period from 1961-1973, when the Mexicali Valley received significant amounts of salt from agricultural drainage in Yuma, Arizona, which affected the productivity of agricultural lands downstream. Oyarzabal-Tamargo and Young (1976:18) found that as consumptive uses and agricultural return flows increased in The United States, Mexico's Colorado River water that supported agriculture in the Mexicali Valley became saltier.

In 1961, a crisis was reached when a new drainage system for the Wellton-Mohawk irrigation project on the Arizona-California border began emptying heavily saline water into the river, immediately below the last U.S. diversion but above the diversion for Mexico. The sediments, technically denominated Total Dissolved Solids (TDS), increased from 785 mg/l or Parts Per Million (PPM) in 1959 up to 1,490 mg/l by 1962, causing extensive damage to irrigation networks and crops in the Mexicali Valley.

More recently, during the 2000s, the decision of The United States to improve the lining of the All-American Canal has resulted in a new transboundary water conflict (Utton, 1991: 480; Navarro, 1998; Cortez, 1999a; Ingram, 2000:185; Cortez and García-Acevedo, 2000; Cortez, Whiteford and Chávez, 2005; Sánchez, 2006:13). The All-American Canal lining project is part of a water conservation plan in California and consists of building a new parallel lined canal along 82 miles of the Mexicali-Imperial borderline.

The conflict emerged of late because there has been a direct hydrological interconnection between seepage from the unlined canal and the Mexicali Valley's aquifer since the early 1940s, when the canal initiated operations. The lining of the canal is expected to reduce by as much as 80 percent the inflows of groundwater crossing the border from north to south and that feed the aquifer on the Mexican side (Imperial Irrigation District, 1989; Conagua, 1991; Herrera et al., 2006:65). The All-American Canal's seepage represents a source of fresh, high-quality water for more than 19 000 hectares in the northeast portion of the Mexicali Valley where water is pumped through more than 470 deep wells for irrigation (Conagua, 1991). The All-American Canal lining project was finished in late 2010 and it is expected to have immediate impacts in Mexicali.

The lower Colorado River Basin region illustrates the diversity and complexity of the problems of sharing international waters, as well as of potential opportunities for finding cooperative schemes. In any case, it is useful to elucidate not only the evolution of institutional arrangements, the participation, and influence of key local stakeholders, but also how agricultural water users might influence transboundary water issues that in turn affect their lands' productivity and irrigation performance.

The suggestions from Uphoff, Ramamurthy, and Steiner, (1991) for analyzing the contextual characteristics (including political aspects) might help to better understand the features of the participation and impacts of institutional arrangements followed by farmers while managing water systems. In this regard, the political landscape observed in each case illustrates the costs and benefits of collective action resulting from the participation of farmers (e.g., unions and union of unions) in the salinity problem in contrast with the participation of farmers in the All-American Canal lining conflict (e.g., water users' associations and the irrigation society).

A quotation from the Mexican President Luis Echeverría is useful to explain the political context of the participation of farmers during the salinity problem. He contrasted The United States' actions in Vietnam and in Mexico during a speech to The United States Congress in 1972: It is impossible to understand why The United States does not use the same boldness and imagination that it applies to solving complex problems with its enemies to the solution of simple problems with its friends. Luis Echeverría, as presidential candidate and later as president of Mexico, emerged from the Institutional Revolutionary Party (PRI for its initials in spanish) and successfully transformed a regional issue into an international platform for promoting Mexican nationalism (Ward, 1999:131).

The agricultural unions have been always politically attached to PRI. This party dominated domestic politics in

Mexico for more than 70 years, but in 2000 Vicente Fox became the first president from an opposition party, the National Action Party (PAN for its initials in Spanish). In fact, it was in Baja California where transformation of the political landscape initiated when the first governor from this opposition party, Ernesto Ruffo Appel, took power in 1989. This enabled PAN to continue dominating the regional political scenario to date (Espinoza, 2002).

These facts elucidate that both national and local political contexts are notoriously different between the times of the salinity problem and those of the All-American Canal lining conflict. The farmers' unions exhibited political power in the first case because the majority of their leaders participated actively in politics at local, regional, and national levels. In addition, they were also influential in all aspects of agricultural development, including water management issues.

Today, unions no longer directly operate developmental aspects in the agricultural sector. Water users' associations (WUAs) and the Irrigation Water Society (SRI) replaced the unions in irrigation operation and management duties. The WUAs operate in a very different structure, of course, without formal links to political parties. Actually, they (WUA officials) are now diversified regarding the party they belong to, say, PRI, the Democratic Revolution Party (PRD for its initials in Spanish), and PAN. However, there exists a clear dominance of the latter party in terms of influencing local and national water management policies.

Such an independent, political diversification within WUAs and SRI constituencies partially explains the characteristics of the processes for collective action and the supposed inherent costs and benefits these imply: on the one hand, the unified political context dominated by PRI that facilitated the participation and impact of unions with reduced costs and maximized benefits principally due to the high extent of coordination and on the other hand, a diversified political context

dominated by the PAN that appeared to induce increased costs and reduced benefits, due to the difficulties in maintaining an integrated vision of the problem and its potential solutions. This latter assertion in agreement with Espinoza's (1998:109) findings regarding the main criticisms of PAN administrations due to the lack of an effective interaction project between government and society.

The study of agricultural water users in the context of transboundary waters is important for several reasons. First, it facilitates better understanding of the differentiated link among transboundary water issues, local farmers' organization, institutional features, and irrigation performance. Second, it also helps organizations and individuals evaluate strategies aimed at equitable, efficient, and sustainable use of highly contested water resources. Finally, researchers have often studied transboundary water management issues without proper consideration of key local stakeholders, such as farmers, and the institutional arrangements they implement to face transboundary water issues.

This study used the strengths of the institutional analysis approach to provide better insights into the complexities that transboundary water implies. It allows for identifying different ways to analyze the problems by focusing on key stakeholders, critical issues over time, and conflictive regions that in turn help to find effective processes for reaching cooperative behaviors as well as limitations to it (Yankelovich, 1999:39; Doughman, 2002:191).

At the last analysis, this study also contributes to the institutional analysis literature on irrigation management and expands the perspective of transboundary water conflicts in the lower Colorado River Basin, while including the standpoint of the local farmers. The practical contributions of this study will aid in improving the performance of farmers' institutions facing the challenge of working with both local irrigation matters and transboundary water issues.



Overall, this study examines socioproductive processes, that is the mechanisms for enhancing social well being and productivity in the rural area. It also examines forms of organizing, agricultural water users' associations, and institutions, both formal and informal in the Mexicali Valley and explores questions related with the impact of and changes in these institutions. The study also considers the degree of stress that agricultural activities, irrigation, and transboundary water conflicts exert on institutions. It also shows the significance of actor oriented and local participative processes as factors that might impact transboundary cooperation and equity.

It is hypothesized that transboundary water conflicts in the lower Colorado River Basin had, in the past during the salinity problem and currently have with the All-American Canal lining project, impacts on the productivity of lands and irrigation management in the Mexicali Valley. The type and extent of impacts are in turn related with the features of institutional arrangements put into practice by local farmers.

From the previously noted general assumption, it is thought that in the context of the agricultural water users' realm, informal institutions dominated the salinity problem era while formal ones did so in the All-American Canal lining conflict. It is also assumed that informal institutions are more effective than formal ones in allowing voice and influence over transboundary water issues; thus direct benefits in irrigation management and land productivity are achieved. Also, the impacts of institutional arrangements are differentiated by the region of the valley in each case under study. Finally, it is assumed that leadership and farmers' socially based political movements in the past induced water agencies to move forward towards a solution to the salinity problem, while current formal irrigation organizations lack the power to influence water agencies to find suitable solutions to the All-American Canal lining conflict.

An institutional analysis approach is used to review such issues. Seminal literature offers a variety of definitions of institutions and makes a differentiation between institutions (formal and informal) and organizations. North (1990:3) states that institutions are the rules of the game in society. The author categorizes formal institutions as those that refer to constitutions, statute and common law, and regulations. Institutions are the humanly devised constraints that shape human interaction; consequently they structure incentives in human exchange, whether political, social, or economic. Also, North defines organizations as groups of individuals bound by some common purpose to achieve objectives. North (1990:5)

An insight from these definitions is the manner in which organizations come into existence and how institutions influencing behaviors evolve; there is a feedback process, in part because of the linkages among situation, institutional structure, and performance, and it calls into being circular and cumulative causation, learning, and evolution processes (Schmid, 2004:21). The author asserts that institutions and organizations are mental constructs and that institutions are more than the rules of the game; they are enabled to do what the individual cannot do alone. Schmid underscores several categories of institutions as formal rights and informal habits and customs; thus institutions affect attitudes and preferences and provide clues to uncalculated action (2004:70).

The institutional analysis approach embracing this study focuses on three levels of analysis: the constitutional, the everyday, and the within-firms, and two degrees of formality, including the formal legislated institutions and the informal cultural institutions. The study also examines two particular types of effects of these institutions and populations: impacts and changes. Understanding the impact of a given institution may be distinguished from understanding institutional change (2004:11).

## Overview

Next, Chapter 2 explains the theoretical perspective and methods used in the research. The institutional analysis approach and its Situation-Structure-Performance (SSP) methodology stressed by Schmid (2004:12) is applied to understanding the changing role of Mexicali Valley farmers for operating local irrigation as well as for addressing transboundary water issues over time.

Analysis of primary data in Chapters 3, 4, and 5 addresses the core issues. Chapter 3 analyzes the views of farmers of the northern Mexicali Valley and Chapter 4 focuses on the farmers' perceptions of the central and southern Mexicali Valley. A differentiation of the institutional explanatory functions emerged in the two regions of the valley. The features of institutional arrangements, impacts, and changes present different behaviors and degree of stress in the three regions studied. For example, the salinity problem was critical in the central and southern Mexicali Valley, while the All-American Canal conflict is perceived as entertaining major risks in the northern region of the valley. However, the institutional response of farmers to the salinity problem was homogeneous, unified, and influential across regions, while the institutional response of farmers to the All-American Canal appears to be heterogeneous and disorganized across valley regions.

Chapter 5 analyzes the perspectives of water managers who operate in the Mexicali Valley, both older and newer water managers. It is hypothesized that water managers who have lived and worked in the Mexicali Valley since the times of the salinity problem (with more than 40 years of experience) differed significantly from the newer water managers in their relationship and views of impacts of institutions employed by agricultural water users. The institutional features, impacts, and changes as understood by water managers are also examined in this chapter.

Chapter 6 summarizes the major findings: farmers in the Mexicali Valley have lost the economic, political, and organizational power to address transboundary water issues. Furthermore, there appears to be social polarization and the differentiation of farmers within Irrigation District 014, Río Colorado, in Mexicali. There also appear to be different stress levels associated with both the salinity problem and the All-American Canal lining conflict, that depend on the specific sub-region of the valley under examination.

The study provides evidence of differences in perceptions between older water managers and newer water managers, as well as between farmers and water managers, on the impacts of institutional arrangements followed by agricultural water users in the Mexicali Valley. The two types of actors studied here –farmers (from northern and central), and the water managers (older and newer)– have been disregarded as key stakeholders with the capacity to influence positive change. Research findings suggest that taking key local stakeholders into account may help advance work toward achieving equity, efficiency, and sustainability in the management of highly contested transboundary waters.

# A MEANINGFUL PERSPECTIVE ON TRANSBOUNDARY WATERS

## The Institutional Analysis

Ostrom (1992:24) asserts “institutions shape human behavior through their impact on incentives.” In their work on irrigation and river basin management, Svendsen, Wester, and Molle (2005:4) point out that institutional arrangements typically include the following: *a)* the established policy and legal environment (policies, laws, rules, rights, regulations, conventions, and customs, both formal and informal), *b)* water users’ organizations with responsibilities in irrigation water management, and *c)* processes, mechanisms, and procedures for decision making, coordination, negotiation, and planning.

In exploring the efficacy of institutions, Lam (1998:53) observes that rules made by farmers are more likely to take into account local information and knowledge about the situation and context. Therefore, it appears that because the farmers deal directly with problems concerning irrigation in their daily lives, they likely understand water management problems best. Institutions may help increase the benefits that flow to individuals from a given set of inputs; conversely, they may increase inefficiencies and transaction costs in such a way that individuals have to work harder to reap the same benefits.

While examining power issues and definitions within the institutional analysis framework, Schmid (2004:73) highlights that institutional analysis is not about calculating advantageous exchanges and resource combinations; instead it's about the non-marginal questions of whose interests count via the distributions of opportunity sets. He adds that "to have an opportunity in your opportunity set is to have power". Power is "the ability of one actor to alter the decisions made and/or welfare experienced by another actor relative to the choices that would have been made and/or welfare that would have been experienced had the first actor not existed or acted" (Bartlett, 1989:30). In sum, power is the ability to have one's interests count.

### Water Systems and Institutional Analysis

Waterstone (1996:9) states that over the past decades, natural resource issues –including water– have transcended geopolitical divisions. Problems are exacerbated when water resources cross more than one jurisdiction. Such geopolitical divisions are often overlaid on shared water resources systems and frequently dissect common aquifers and rivers. The placement of political lines often creates disadvantages for one group of resource users while benefiting or privileging another. Nevertheless, such issues might be resolved by implementing technological or structural mechanisms. However, for such solutions to proceed, an appropriate institutional framework must be in place (10). Finally, Waterstone asserts that, "If transboundary water problems require changes in institutional arrangements for solution, clearly one essential step is the development of an appropriate framework for defining and analyzing institutions" (11).

Gregersen, Ffolliott, and Brooks (2007:43) note that many of the most useful watershed and water management approaches also involve complex systems of activities and events

from a technical perspective, and the same holds for the institutional context within which such activities take place. The authors use the term institutions in the broadest sense of its meaning—namely, to include all the ways by which people come together to cooperate, coordinate, and guide their activities—. Therefore, this term includes organizations that people establish, laws that people pass and implement through regulations and policies, and the various forms of collective behavior associated with the social, economic, and political mechanisms that people adopt. In other words, at any point in time, there is an institutional context within which watershed and water management takes place.

Also, institutional effectiveness depends on the complexity and complications introduced into the real world in an institutional context, which mostly relates to the following aspects: *a)* watershed boundaries are defined by physical factors and seldom coincide with political boundaries. This becomes a complicating factor if a river flows through several countries and international treaties need to be negotiated; *b)* stakeholder groups normally include a highly diverse set of entities and the interactions among these groups can be complex; *c)* watershed and water management responsibilities are shared by a multitude of organizations, and *d)* there is an intricate set of intertwined and conflicting laws and policies to govern behavior in a watershed (Gregersen, Ffolliott, and Brooks, 2007:44).

If institutional arrangements can facilitate or impede problem solving capabilities as well as the benefits of participants in water distribution systems, then the empirical study of the performance of various changing institutions and institutional arrangements may be useful. Such a study may draw on and extend theoretical frameworks that identify key attributes of collective action institutional structures in irrigation systems. It is possible to treat such attributes as variables that may acquire different values depending on the circumstances (Tang, 1994:225). In the final analysis, the variables and the



relationships among them may be systematically explored, including in ways that take into account varied settings and contexts.

Studying effective institutional arrangements for water management, especially in transboundary contexts, is conceptually challenging. For example, institutions that differ in principle and in practice, that may be contested, that are beset with ambiguities, and that are subject to the outcomes of political practices, may result in very different perceptions of efficacy. That is, what is defined as effective by some will be deemed ineffective by others. Nonetheless, there are strong connections among certain institutions and how water is managed (Svendsen, Wester, and Molle, 2005:5). Heathcote (1998:7) suggests that institutional arrangements for watershed management may be considered effective if they:

- 1) Allow for the provision of an adequate supply of water that is sustainable over many years with equitable access.
- 2) Maintain water quality at levels that meet government standards and other societal water-quality objectives.
- 3) Allow sustained economic development over both the short and the long term.

In addition, the authors mention that in order to be sustainable, water management must protect and restore natural systems, enhance the well-being of people, and improve economic efficiency. These three objectives may be mutually exclusive, as the partial attainment of one may negatively impact the attainment of the others. Because there are competing uses of water that may be incompatible, institutional arrangements for water management is of paramount importance while also being highly problematic (Svendsen, Wester, and Molle, 2005:6).

If institutions are viewed in managerial or interventionist terms, effective water institutions may contribute to sustainable water management by reducing transaction costs, enhancing collective action, and increasing certainty (Svendsen, Wester, and Molle, 2005:6). If a more process-oriented and dynamic view of institutions is adopted, analytical emphasis may be placed on how institutions are embedded in power

relations with equitable as opposed to economic efficiency concerns of greater importance (Svendsen, Wester, and Molle, 2005:6). This study attempts to take into consideration a mix of the managerial and the process-oriented views of institutional arrangements for water management within the context of a specific U.S.-Mexican transboundary setting. Individuals or organizations, also called “actors,” can play a number of roles vis-à-vis institutions. These may be simultaneously split among different actors, or separate (Svendsen, Wester, and Molle, 2005:7).

Therefore, this study considers the two-fold role of actors: in the form of individuals (e.g., agricultural water users) and organizations (e.g., WUAs) within the particular institutional context. In institutional analysis, “roles” are sets of expectations and tasks associated with a particular function (Coward, 1980:15), while “stakeholders” are individuals or groups that have a legitimate interest in outcome but that may or may not play an active role in decision making. Hence, actors in the watershed are a subset of watershed stakeholders and do not comprise the complete set of stakeholders (Svendsen, Wester, and Molle, 2005:7).

### Institutional Analysis Framework

Mitchell (2007:6) asserts that questions of performance are central to scholars and practitioners interested in environmental institutions. Mitchell goes on to say that,

We want to know “how well did this institution do at achieving a particular objective?” Performance questions move beyond causal questions of whether an institution influenced outputs, outcomes, or impacts to ask about how much an institution contributed to achieving—or at least contributed to progress toward a specified goal.—Questions of performance force us to specify a performance dimension in which we will evaluate an institution, that is, a criterion or objective of judgment.

In addition to defining and using performance dimensions, Schmid (2004:11) explains that institutional analysis should consider three levels of analysis: constitutional; everyday, and within-firm relationships and activities. Furthermore, these analyses should, according to Schmid, address institutions of two types: formal, legislated institutions and informal, cultural institutions. Schmid also instructs that institutional analyses need to examine questions of impact and change. That is, understanding the impact of a given institution may be distinguished from understanding changes in or as a result of institutions. In this chapter, the features and scope of institutional questions are explained as they relate to transboundary and irrigation water management (Biswas, 2008:17; Rap, 2004:16).

### Impact Analysis

The typical initial application of impact analysis examines how alternative formal and informal institutions affect commodity transactions as well as wealth distribution. For this analysis, formal institutions are treated as alternatives to informal institutions. That is, informal habits, organizations, and preferences are treated as given with human interaction responsible for shaping formal institutions (Schmid, 2004:11).

A subsequent phase of impact analysis attempts to explain how internal structures of organizations (e.g., farmers' unions and *WUAs*) and contractual arrangements affect performance, such as that of the management of transboundary and irrigation water. Therefore, the institutional framework defines and limits the set of economic organizations potentially open to a range of economic actors. One boundary may be a function of the transaction costs associated with the types of commodities exchanged and the nature of the exchange (Eggertsson, 1990:10). Another aspect of institutional impact analysis looks at the role of creativity and knowledge in

organizations, as members envision their future and attempt to adapt accordingly (Hodgson, 1999). In some cases, the impacts of an “everyday” institution cannot identify as absent an understanding of the internal structure and working of institutions (Campos and Nugent, 1997). When an institution is being analyzed by way of impact analysis, its performance is measured relative to that of others.

### Change Analysis

Schmid (2004:14) argues that impact and change analyses are embedded in each other. However, readers are reminded that understanding institutional change requires an evolutionary model that addresses what Ostrom (1992) sees as the influence of institutions in shaping human behavior. Schmid observes that individuals (e.g., agricultural water users) are born into an institutional context that shapes their thinking and performance (i.e., about irrigation management) and in turn, the thoughts of these individuals shape the institutional context (e.g., the National Water Law, WUAS’ ordinances for guiding operation, and even the International Water Treaty). Hodgson (1999:184) asserts that, “Neither individual nor institutional factors have complete explanatory primacy”. Change analysis essentially focuses on the processes of existing rules and conventions for making decisions as well as rules. Change analysis must explain changes over time in informal institutions and culture as well as changes in formal institutions created by legislatures, executives, and courts.

This book considers the long run as the time frame that encompasses both events from the 1960s until the 2000s. Therefore, undertaking analysis of institutional change may benefit from the use of a model of institutional change that incorporates feedback loops and change over time. Such an approach to institutional change analysis may consider dimensions such as technology, population, resources, and imagination. Technology

affects institutions and their outcomes, while institutions, in turn, impact the path of technology. To better understand changes in systems and communities' informal rules, it is necessary to understand the learning process of community members, including their beliefs, ideologies, and habit formation.

### Situation, Structure, and Performance Framework (ssp)

As Schmid (2004:16) points out, institutional economics theory suggests utilizing an analytical framework that focuses on the *a*) situation, *b*) structure, and *c*) performance (ssp) together with behavioral, signal, technology, and time variables.

Situation refers to the inherent characteristics of goods that affect human interdependence. The inherent characteristics of the benefits in this study, specifically waters in a transboundary watershed, may be categorized as a Common Pool Resource (CPR) that may be seen as a source of several kinds of interdependences. Kerr (2007:89) explains that "a watershed is a special kind of CPR: an area defined by hydrological linkages where optimal management requires coordinated use of natural resources by all users." The author mentions that management is difficult because watershed systems have multiple, conflicting uses; thus, any given approach will spread benefits and costs unevenly among users. As a final point, watershed development seeks to manage hydrological relationships (in the case of an irrigation district, which is another kind of CPR, the central aim is to manage both hydraulic and hydrological relationships to operate irrigation water) to optimize the use of natural resources for conservation, productivity, and poverty alleviation (Kerr, 2007:90).

According to Ostrom (1990), it is critical to distinguish the resource system (pool) from the resource units. The resource system or pool is a typical high exclusion cost good. For CPRs goods, there are three typical sources of interdependence included in the situation:

- a)* Incompatible Use of Good (IUG) due to scarcity, which might create an externality and a lost opportunity for future generations.
- b)* High and Low Exclusion Costs (HEC & LEC) to owner/user of the good to exclude others. The interdependence associated with an HEC good is similar to that in the Prisoner's Dilemma (PD) (Poundstone, 1992). Here, its distinguishing feature is a payoff function that produces a dominant choice to a calculating and selfish individual.
- c)* Economies Of Scale (EOS), which refer to the declining cost of adding another unit of the good, which raises the issue of who pays the fixed costs and who pays the marginal costs that are always falling (Schmid, 2004:16).

Structure refers to the institutional alternatives that people can choose to order the interdependences created by the situation. The actual structural choices may be informal and unconscious as well as formal. Structure also describes the relationships among people that define their relative opportunity sets, and is subject to human choice, but when informal structures only change slowly, they are often given in the short run impact analysis of formal institutional alternatives. Institutional structures may be seen as formal laws or as existing only in habits of the mind. Administrative, bargained, customary, and threat transactions, both formal and informal, and for both everyday economic and political functions are interlinked in an evolutionary, ever-changing, non-equilibrating meta-process. Finally, Schmid (2004:17) states that "opportunities in one context can be used to alter opportunities in another". General institutional structures or the major ways that individuals interrelate are the following:

- a)* Administrative transactions that consider people arranged hierarchically.
- b)* Bargained transactions that consider people arranged as legal equals.

c) Customary transactions such as social norms which are learned or habitual, internalized, and informal.

Performance refers to who gets what. Because people have different interests that may conflict, aggregate measures of total welfare may not be possible or useful. Performance consequences of alternative institutions must be disaggregated, in substantive terms, to who gets what goods. The performance measures should be focused on answering the question of whose interests count (who has power) with institution A compared with institution B. All performance measures in the analysis undertaken in the study have a stakeholder or interest group subscript reflecting the parties in a transaction (Schmid, 2004:19).

It seems clear that impact and change theories as they relate to institutional analysis are embedded in each other. The independent variable in an equation describing the impact theory of institutions may become the dependent variable in another equation describing institutional change. For example, the impact of political rules for making working rules is the adoption of a working rule whose impact on the economy can be studied (Schmid, 2004:302).

In Table 1, a general framework is formulated in order to link situation, structure, and performance for water resources, such as the transboundary CPR in the lower Colorado River. Such a framework is used in this study to support the analytical tasks.

### The Analytical Framework

Institutional analysis is applied to explore the features and impacts of institutional arrangements used for farmers in response to the salinity problem and the All-American Canal lining conflict. Therefore, this study specifies dependent variables of interest as well as the broad categories of independent variables.



*TABLE 1. Typical Sources of Human Interdependence for Water Resources and Links among Situation, Structure, and Performance*

<i>Situation</i>	<i>Structure</i>	<i>Performance</i>
Good: Common Pool Resource.		
Sources of human interdependence:		
<i>A) Incompatible Use Good (iug)</i>		
<i>a)</i> Between farmers and urban users (domestic level)	<i>a</i> <sub>1</sub> ) Farmers are factor owners (have power), may trade <i>a</i> <sub>2</sub> ) Urban users as factor owners, (beneficiary of regulation)	<i>a</i> <sub>1</sub> ) Farmers transfer water to the city whose bid is higher than farmers' reservation price <i>a</i> <sub>2</sub> ) Urban users maintain and farmers lose water access opportunity
<i>b)</i> Between water users of country A (upstream) and country B (downstream)	<i>b)</i> Imprecise definition of factor ownership at binational level. (e.g. groundwater resources)	<i>b)</i> Country B affected: wetlands, farmers, and cities. Increased costs for Bs
<i>B<sub>1</sub>) High Exclusion Cost (HEC)</i>		
<i>a)</i> Between farmers and urban users (domestic level)	<i>a)</i> Market. Bargaining Urban users must bid	<i>a)</i> Free-riders problem. Bid fails. City fees system strengthened and individual city consumers must pay for increased costs
<i>b)</i> Between country A (upstream) and country B (downstream) users	<i>No groundwater's ownership</i> <i>b</i> <sub>1</sub> ) Bargaining. Country B must bid country A <i>b</i> <sub>2</sub> ) Administrative transaction Standards and regulation, no trade allowed <i>b</i> <sub>3</sub> ) Customary transaction. Country B boycotts to As	<i>b</i> <sub>1</sub> ) Non-cooperative behavior- Country A maintains unilateral control over water resources <i>b</i> <sub>2</sub> ) Regulation favors country A. It keeps water control <i>b</i> <sub>3</sub> ) Few free-riders. Bid is successful. Sharing water system improves bilaterally
<i>B<sub>2</sub>) Low Exclusion Cost (LEC)</i>		
<i>a)</i> Among individual farmers (users in the same sector)	<i>a)</i> Market. Bargaining (water transfers). Agriculturist A bids to agriculturist B	<i>a)</i> Rights traded; individual farmers economize. Irrigation modules and government coordinate water transfers
<i>B<sub>3</sub>) Prisoner's Dilemma (PD)</i>		
<i>a)</i> Interdependent binary choices (binationally). Similar to HEC	<i>a</i> <sub>1</sub> ) Market. Only if ownership is clearly defined <i>a</i> <sub>2</sub> ) Administrative transaction. Litigation <i>a</i> <sub>3</sub> ) Bargained transaction. Collective action <i>a</i> <sub>4</sub> ) Customary transaction. Downstream users claim water rights	<i>a</i> <sub>1</sub> ) Dominant non-cooperative behavior for sharing water <i>a</i> <sub>2</sub> ) Prevalence of dominant choice and zero-sum game <i>a</i> <sub>3</sub> ) Dialogue and cooperation. Win-win situation <i>a</i> <sub>4</sub> ) Potential attainment of shared water rights. Total transaction costs increase
<i>C) Economies of scale (EOS)</i>		
<i>a)</i> Building and sharing water infrastructure (domestic/binational)	<i>a</i> <sub>1</sub> ) Monopoly vs. many firms <i>a</i> <sub>2</sub> ) Cost-sharing rules for building and operating <i>a</i> <sub>3</sub> ) Rules determine market	<i>a</i> <sub>1</sub> ) Unit cost versus variety tradeoff <i>a</i> <sub>2</sub> ) Difficulties to find payers of fixed and variable costs <i>a</i> <sub>3</sub> ) Potential economies of scale

*Source:* Compiled by the author based on Schmid (2004).

For impact analysis, institutional alternatives are independent variables. The dependent variable is a measure of substantive performance (e.g., benefits to agricultural water users as a result of their participation in the salinity and the All-American Canal processes). The set of independent variables that interacts with institutional variables contains good characteristics that create an environment of human interdependence, which in turn may help contextualize and describe the situation. Ultimately, the structure of institutional variables influences the outcome or performance. Thus, the term “function” should be read here as “facilitates” because institutional model processes are never fully deterministic (Schmid, 2004:13).

In impact analysis, the situation is given and we ask how different institutions affect the outcome of the interdependence that the situation creates, in the context of different interests of different people. The institutions may be formal or informal, or are often a fusion of both.

Performance= $f$  (institution X, or institution Y, holding a situation constant)

In diagrammatic form:



Situation here refers to the context of each case studied, that is, the salinity problem and the All-American Canal lining conflict. The linkage among situation, structure, and performance is a function of cognition and behavioral regularities of people experiencing the situation and their structured opportunity set.

In change analysis, institutions become the dependent variable. In this case, it is important to ask how changes of situational or independent variables (e.g., technology, demographics, power distribution, etcetera) alter the performance of existing institutions and how these changes are perceived as well as these possibilities are imagined by conflicting groups.

If everyday institution X is chosen in time 1, then the situation may change in time 2, so the performance changes. This in turn may lead to formal and informal institutional change in time 3, depending on perception and power. Formal institutions change, in part when everyday performance changes interrupt routines or depart from the performance desired by some group with the power to change the institutions, given the constitution in place at the time. Change may result from either (or both) a change in the rules for making rules or in the environmental situation.

Stated in functional form:

$$\begin{array}{l} \text{Change in everyday} \\ \text{formal institutions} \end{array} = f \begin{array}{l} (\text{rules for making} \\ \text{rules, change in the situation}) \end{array}$$

Informal institutions form largely unconscious learning.  
Stated in functional form,

$$\begin{array}{l} \text{Change in everyday} \\ \text{informal institutions} \end{array} = f \begin{array}{l} (\text{changes in widely shared learning,} \\ \text{functionality, power, and situation}) \end{array}$$

The new institution's performance may feed back and change the situation, including the thought processes of the actors as well as a given situation, such as the level of technology, causing continuous evolution.

If the physical situation does not change, then the only source of institutional change is ideology (i.e., preferences) and cognition. However, technology and ideology may also interact as technology provides a different world view. Technology can act as a metaphor and affect apparently unrelated institutions, for example, the change may be in biology and have effects on thinking in economics as applied to markets, among others (Mirowski, 2002:523-545).

Change in rules for making everyday rules may be referred to as change at the constitutional level (or at the international level, such as international water treaties), although it includes more broadly all political rules. While the constitution (or international water treaty) is itself a function of rules for

making constitutions, all of this ultimately rests on the fundamental ideology carried largely in people's heads that evolves as a result of functionality, power, and learning processes.

In functional form:

Change in rules =  $f$  (*changes in widely shared learning, functionality, power, and situation*)  
for making rules

The analytical framework helps to explain how such institutional arrangements guide the farmers' behavior and impacts on local agricultural activity and irrigation management, as well as on the ways the farmers face transboundary water conflicts.

Impact and change analysis functions are reviewed here in the way that they are embedded in each other. However, change analysis considers the review of the institutional differences shown by farmers to address the salinity problem and the All-American Canal lining conflict. This core function regarding comparisons between time one ( $t_1$ ) and time two ( $t_2$ ) explains the changing role of farmers of the Mexicali Valley in local irrigation and in facing transboundary water issues.

The examination of the changing role of local agricultural water users in the context of transboundary conflicts allows for a better understanding of the links among transboundary water processes, irrigation, and the institutional features of farmers operating in a boundary setting. This also helps to reveal the impact of the institutional arrangements in place, thus guiding organizations and individuals to evaluate strategies aimed at achieving equitable, efficient, and sustainable use of highly contested water resources (Cech, 2003:407; Rap, 2004).

A discussion of the explanatory functions obtained for groups of farmers and groups of water managers is developed in Chapters 3, 4, and 5, respectively.

# AGRICULTURAL WATER USERS IN THE NORTHERN MEXICALI VALLEY

The Mexicali Valley farmers' perspectives on local agriculture and irrigation have evolved over time. The following analysis explores how farmers in the northern Mexicali Valley participated in, influenced, and have been impacted by two significant water resource conflicts –the salinity problem and the All-American Canal lining conflict.– The research reveals local processes and institutions as well as their impacts on agricultural productive activities. The results show different views of these stakeholders concerning the degree of stress, features, and impacts of the participation of farmers and outputs across the two water conflict cases studied as well as across the regions of the Mexicali Valley.

This chapter focuses on the perceptions of nine farmers interviewed in the northern Mexicali Valley. First, the views of respondents concerning general aspects of the evolution of agriculture and irrigation in the Mexicali Valley are reviewed, both as a whole and in particular in the northern region of the valley. Next, the perceptions concerning the institutional response to the salinity crisis as well as the respondents' views of their participation and influence in addressing the salinity problem. Third, the views of farmers in the northern region concerning the impending impact of the All-American Canal lining project are described and the institutional devices used

by farmers in response to the All-American Canal issue are explored. Finally, the similarities and differences regarding the institutional responses to these two transboundary water crises in the northern region are addressed.

Data analysis in this and the chapters ahead includes the categorization of information and the identification of themes and sub-themes that emerged during the qualitative interview process. Such a process was useful in unraveling the concepts and arguments expressed by interviewees regarding transboundary water conflicts between The United States and Mexico, as well as irrigation issues in this region.

### The Irrigation Sector of the Mexicali Valley

As discussed in Chapter 2, the functioning and development of agriculture and irrigation in the Mexicali Valley is directly linked with issues of transboundary water management in the lower Colorado River Basin. Major changes in irrigation in the Mexicali Valley represent another focal point of the research regarding the impacts and the response of farmers to the salinity problem and the All-American Canal lining conflict. As the agricultural sector has changed, so too have irrigation practices changed in the northern Mexicali Valley over the last 50 years. Interviews with respondents from this region revealed that perceptions about both effective and ineffective irrigation management are present among northern farmers. In fact, this difference of opinion among irrigation users has led some farmers to argue that the operation of canals and wells, administration of resources, as well as conservation and development of infrastructure is gradually improving, while others argue strongly to the contrary. Among the respondents in this study, 78 percent agreed with the dominant idea of an effective irrigation management, while only 22 percent mention the prevailing, ineffective irrigation management in the Mexicali Valley after the WUAs were formed in 1991.

It was mentioned that, in general, better irrigation water management techniques have gradually been implemented to make better irrigation water use in the field; increased costs associated with irrigation service changes improve several other operational activities and management tasks within the irrigation district, and finally, improved irrigation technology, such as land leveling and efficient irrigation methods at the parcel level, improved deep wells and made for more lined canals for water distribution, which were lacking in the past and today are widespread in the Mexicali Valley. Regarding this latter aspect, it is important to emphasize that because the irrigation system is interconnected (wells and canals users receive the same individual water allotment on the order of 117 liters per second per day of irrigation operation), the agricultural water users impacted with surface water savings and the consequent reduction of infiltrations (e.g., the irrigators using wells) are systematically and formally compensated through a reduced energy fee and, if necessary, by using both sources of water in a complementary manner (Conagua, 1989).

Additional factors that the interviews revealed concerned explanations of effective irrigation management; for example, the learning experiences of members of the former Water Users' Societies that operated during the 1940s that are being used by current Water Users' Associations, the official establishment of Irrigation District 014 and the standardization of water rights per household or user that changed from 100 or 50 to 20 hectares of irrigated land in 1955, the experience gained by farmers as a result of the official intervention and subsequent formation of WUAs in the early 1990s, current development and implementation of irrigation and drainage, the articulation of possibilities for protecting water resources, and improving local environmental conditions, and the increased bargaining capacity of water users at different levels were revealed as explanatory factors regarding effective irrigation management in the region.



For example, as one respondent put it:

In this sense, here have been many advances... in previous times [40 years ago], we had to cross rough lands and the irrigation canals were built unlined over the natural terrain. Most frequently the irrigation network was not scientifically checked [...] to water my land in the past represented a real adventure, now, in the corner of my parcel there is a deep well and I just have to turn on the water faucet to opportunely access water for irrigation. (Rosalío, interview, 2009).

In contrast, others' experiences suggest that irrigation changes have not been at all positive. Ineffective irrigation management represents the notion of policy and operational failures of irrigation water users that are attributable to a broad range of factors. These factors include: the way current WUAs were imposed using a top-down approach, the high level of bureaucracy in the new co-management between WUAs and Conagua, lack of accountability to water users, mainly smallholders, by WUAs' officials erroneously following directives from superiors such as Conagua, the increase of harmful dominance by new, larger landholders that command and control irrigation water in their roles both as WUAs officials and/or as preferential water users, and the increased presence of interest groups within WUAs that resulted in apathetic, ineffective, and splintered participation.

At the same time, external factors such as increasing water demands from urban sectors appear to have resulted in the view of ineffective water management in areas with dependence on transboundary waters for irrigation, because management was more difficult. Those voicing a view of failed water management also commented on the inequality among water users, because WUAs officials supported specific groups of powerful farmers and ignored smallholders, evidencing a sort of elitism in water management. An absence of irrigation

technology and advancement programs, the permanent increase in irrigation water services costs, and the lack of a long-term vision of WUAs are seen as reasons for the failure of the water management regime. Furthermore, all of those factors have been seen as contributory to increased internal conflicts among users (e.g., surface vs. groundwater users and wheat vs. alfalfa growers), especially in seasons of high demand for water in the agricultural sector of the Mexicali Valley, which is typically during March and April of each year.

As one agriculturist put it:

Now, having developed an irrigation infrastructure, there are still critical problems in water distribution, often there is not sufficient water for irrigating my land and this is impacting my production costs... what is happening? [Maybe] there are powerful groups influencing an imbalance? Or maybe we don't know how to manage our irrigation module. (Benítez, Marcos, interview, 2009).

The differing views on the evolution and impact of irrigation management in the Mexicali Valley allow to differentiate irrigation water users into two principal groups: winners and losers. The evolution of irrigation in the Mexicali Valley may be understood in terms of the institutional explanatory factors described. The empirical findings of the study clearly show social polarization and differentiation among irrigation users in the Mexicali Valley, supporting the premise that the irrigation regime resulted in "structural inequity" (Galtung, 1980:64) and this in turn must be taken into account in order to understand the changing role of Mexicali Valley farmers in irrigation management and for facing transboundary water conflicts.

The perceptions of farmers in the northern region on the evolution of irrigation in the Mexicali Valley are described next. Of the nine respondents in the northern region of the

valley, seven consider that there exists a dominant effective irrigation management performance, and two express that irrigation management has shown to be ineffective, as they explicitly argued on the several factors explaining these contrasting views.

From this, the major findings with respect to the evolution of irrigation in the Mexicali Valley according to the northern farmers are that effective irrigation management perception dominates over the ineffective irrigation management view. Also, it is clear that there exists differentiation among irrigation water users, which in turn may elicit the presence of elitism among them. Finally, regarding the theme of increased irrigation service costs, it can be established that this is a two-fold issue because some see this fact as beneficial for reaching an efficient irrigation district operation, while others (a smaller portion) see this fact as affecting individual irrigators' incomes.

A general understanding of agriculture and irrigation changes from the perspective of farmers provides a background that allows for better understanding of the characteristics and impact of the institutions used by farmers during the salinity and All-American Canal episodes, respectively. These features help explain the high level of participation of farmers during the salinity problem (time one,  $t_1$ ) and the low level of participation during the All-American Canal lining conflict (time two,  $t_2$ ), which will be analyzed next.

### The Salinity Problem Period

Having discussed the general view that participants in this region shared about the evolution of agriculture and irrigation in the region, this section focuses on the perceptions of northern farmers concerning the impact of the increased salinity of water and land in the northern Mexicali Valley between 1961 and 1973. It is safe to say that farmers in this region have been impacted by salt pollution in their production and in the productivity of their lands. The institutional response

to the salinity problem appears to be directed toward finding a definitive solution to the problem. The salinity crisis that took place during the 1960s and early 1970s represents a critical transboundary water conflict that resulted in social, economic, environmental, and political impacts in the Mexicali Valley. The salinity problem was also a milestone in the bilateral relationship between The United States and Mexico.

The rising salinity of the Colorado River water, as it passed through the Mexicali Valley, impacted agriculture permanently through the high concentration of salts and increasingly deposited these on individual parcels during this period (Table 2).

TABLE 2. Damage to the Agriculture of Northern Mexicali Valley as a Result of the Salinity of the Colorado River

<i>Theme</i>	<i>Explanatory Factors</i>	<i>Frequency of Total Respondents</i>	<i>Major Findings</i>
SAD: Damage to agriculture of the Mexicali Valley	MIX: Disposed of salty waters upstream (salinity of the Colorado River)	6/9	Social, productive, economic, and environmental impacts  The salinity problem remains as a critical issue, halting productivity of some areas in the Mexicali Valley at present
	ROU: Existence of salty soils strip along the valley (salty route)	4/9	
	SAH: High extent of salts pollution in individual parcels	5/9	
	YED: High extent of crop yield reductions	5/9	
	ICS: Increasing production costs for individual farmers	3/9	
	CRI: High extent of contraction of agricultural credit to unproductive lands	3/9	
	SAR: Salinity problems remain since the salinity problem period	6/9	

Source: Compiled by the author based on database (Cortez, 2010).

Water delivered to Mexico as part of the 1944 Water Treaty included as much point source pollution as salty waters from drainage of agricultural lands in the Yuma Valley, Arizona. Such a phenomenon was well known as the salinity of Colorado River water.

Although salinity is due to natural mineralization processes that concentrate salts considering temporal and spatial scales along the Colorado River, water salinity into the watercourse is also induced by anthropogenic activity, which exacerbated conflicts when the Mexicali Valley received significant amounts of salts deriving from agricultural drainage operations in Yuma that affected the productivity of agricultural lands in the Mexicali Valley (Cervantes and Bernal, 1991:129). This salty water gave rise to what became known as the *ruta de la sal* (*salty route*), which represents a long strip of layered salty soils crossing the Mexicali Valley from north to south throughout its central area. Here, salts were rapidly accumulated and as a result, crops were damaged, this occurring with different levels of stress according to the physical conditions of water and soils in the entire valley (Map 3).

In the northern Mexicali Valley, productive, economic, and environmental impacts were felt at the individual parcel level with reductions in crop yields. Wheat was the major crop in this region that dropped its productivity, which at that time reached 4.5 tons per hectare on average, was reduced by 65 percent. At the same time, there were increasing production costs associated with salt accumulation in soils, including modifying productive practices for planting and fertilizing and more intensive water use to leach salts below the plant root area. Furthermore, farmers had to face a transitory but critical period of insufficiency of credit, which formerly had come from both governmental and private sources.

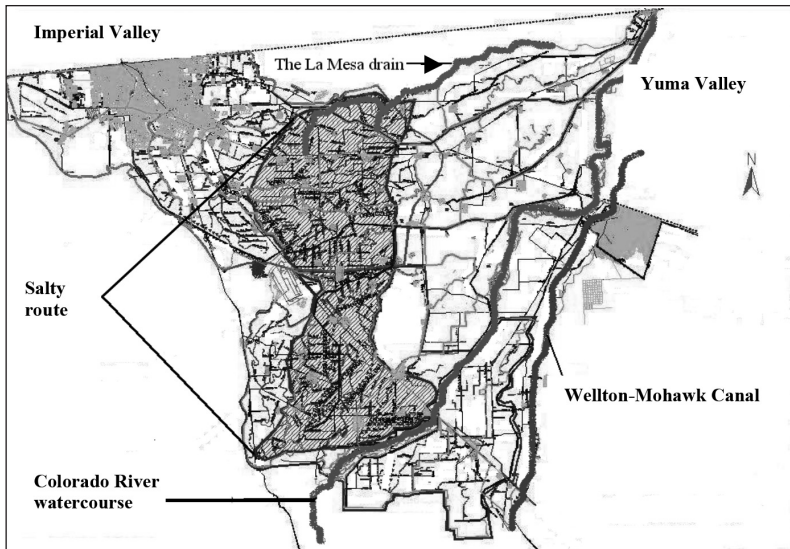
Farmers in this region explained the negative impacts of salinity: "I can easily remember how difficult those times were for all of us... on my parcel I could observe salts in the form

of large white spots over the land and also over the irrigation furrows.” (Agustín, interview, 2009).

Other farmer went further, mentioning that:

The water coming from the Colorado River was not even suitable for drinking... the lands became so hard for growing cotton and wheat, before the salinity problem occurred I used to “pick up” 170 packs per hectare of cotton and such a yield was gradually getting down to levels of 60 or 70 packs per hectare, then, I couldn’t pay my credits and the banking system stopped financing my agricultural activity until the solution was found some years later. (Dueñas, Martín, interview, 2009).

MAP 3. Location of the Salinity Problem Area Known as the Salty Route in the Mexicali Valley.



Source: The Mexican National Water Commission (2009).

The salinity problem process reached its crisis period between 1961 and 1973 when a permanent and definitive solution was negotiated and added to the 1944 International

Water Treaty. This event brought about socially based political movement on the part of farmers in the Mexicali Valley and the subsequent formulation of Minute 242 in 1973, which was named: *Permanent and definitive solution to the Salinity of the Colorado River Water*. (Ward, 1999:127). However, salinity issues remain a critical problem, currently affecting production in a vast portion of the Mexicali Valley (SAR). Today's salinity problems originated during the salinity crisis of the 1960s. They include high concentration of salts in the Sánchez Mejerada Canal (Southern International Boundary point of delivery to Mexico), the ineffective monitoring system employed by IBWC/CILA for measuring salts concentration of the Colorado River water at the Morelos Dam (Northern International Boundary point of delivery to Mexico), and the (permanent) accumulation of salts, mainly in the salty route in the central and southern Mexicali Valley.

A local water user explains:

I can see that the problem still exists, delivery of salty waters continues running from the north [The United States]. They [Americans] continue mixing waters to alter the salinity of the water delivered to Mexico into the Morelos Dam. The Americans [officials] agree to comply with the standards, and perhaps it is true, so the real problem is the salts' monitoring system that was implemented. The official "annual average" approach currently used isn't suitable for both parts, it is unequal and, in the end, it is affecting us. (Estrada, Joel, interview, 2009).

The explanatory factors (previously described in Table 2) that govern such perceptions are based on the direct experiences of the nine respondents in the northern region of the valley. Overall, they highlight the fact of a mixture of good and bad waters upstream in the Colorado River, on which six of nine respondents comment, and this in turn brought damages at the level of individual parcels and affected crop yields. In this regard, five of nine participants argued this point, as



well as on the association of the salinity problem process with the current one, which was highlighted by six of nine interviewees in this area. No less important were the resultant increased production costs that led farmers mainly located in the salty route area to struggle with the reduction of financial support from credit organizations due to unproductive lands.

The major findings on the perceptions of damages felt in the agricultural sector according to the northern farmers are that they see critical social, productive, economic, and environmental impacts and that the well known former salinity problem still remain critical and is halting the productivity of some areas in the Mexicali Valley.

### Participation of Farmers during the Salinity Period

Institutional responses by some farmers in the Mexicali Valley to the salinity problem may be understood by examining the farmers' participation and influence in the so-called permanent and definitive solution to the salinity problem. A high level of participation of farmers in local, regional, national, and bilateral efforts was observed during the salinity crisis. It appears that at the time there was effective vertical coordination between the social base at the local level and the State and Federal governments, including the Presidential authority in the region. This is strongly related with the political ties between all levels of government and the agricultural sector, specifically the farmers' unions, which were (and continue to be) mostly linked with the political party in power during the salinity problem, PRI (Table 3).

There appears to have been strong horizontal unification of society within the agricultural sector. The behavior of farmers in response to the salinity crisis emerged as highly uniform, with high levels of participation and a view that such participation had positive impacts on the salinity experience. Such horizontal unification across various members of the social

class had deep roots in households in the Mexicali Valley during the salinity problem, where relative favorable economic conditions in the agricultural sector helped to keep rural families rooted to related activities within the countryside.

TABLE 3. High Level of Participation of Northern Farmers as an Institutional Response to the Salinity Problem

Theme	Explanatory Factors	Frequency of Total Respondents	Major Findings
HIP: High level of participation in the salinity problem	UNI: Unity base at the household level	7/9	Effective vertical and horizontal coordination among farmers and several levels of government in Mexico
	FIC: Financial capacity of farmers	7/9	
	SOL: High degree of solidarity among farmers	8/9	
	CEJ: Fundamental local/neighborhood leadership	8/9	
	LOL: Outstanding local leaders	7/9	
	PAL: Principal leader	8/9	
	LAU: Local agricultural unions' leadership	8/9	
	SAU: Strong agricultural unions	9/9	
	PAU: Principal agricultural union	9/9	
	LEA: Significant presidential leadership	9/9	
	POS: Politics behind the salinity problem	4/9	

Source: Compiled by the author based on database (Cortez, 2010).

These economic conditions facilitated the financial ability of both individual farmers and agricultural unions to make monetary contributions to support the political activities of their respective unions. Being able to fund this political activity, such as unions and other representatives, further aided the socially based political movement. Since the times of the salinity problem and until recently (1992), a voluntary contribution of about five Mexican cents per unit of volume of water delivered was included in the irrigation fees in order to support the unions' action. On average, each agriculturist delivered 120 liters per second per service and up to five irrigation services per season; as such, each individual agriculturist (of a total of 14 000 users) contributed 300 Mexican pesos per year.

The fee collection process involved the joint participation of the *Comisariado Ejidal* and *Colonias'* representatives and officials from the former *Secretaría de Recursos Hidráulicos* (The Mexican Water Resources Ministry). This fact also facilitated a high level of social participation during the salinity period. As one senior agriculturist in the northern Mexicali Valley pointed out, the financial success of farmers in the region coupled with unions' desire to be effective, resulted in increased social participation. He reported that:

I can establish that the "money" was a basic incentive to participate because leaders always need money to mobilize themselves and in turn to mobilize the masses. This type of contribution was familiar and a social agreement to keep political power and strength of our productive sector and our leaders [...] the money, about five cents per liter of water delivered, was collected by the *Comisariado Ejidal* and deposited in a formal banking account of the *Secretaría de Recursos Hidráulicos*, which was jointly handled by the unions and the federal government. This was an effective collaborative mechanism that gave us power and presence. (Gerónimo, interview, 2009).

As a result of such factors, there was strong solidarity between individuals and unions, which may be identified as one of the main characteristics of the farmers and their socially based political movement during the salinity period. As a complement to the solidarity seen at the household level during the salinity problem period, the interviews revealed the perception of outstanding leadership at different stages of the salinity period based on the political links of local officials at several levels of government. First, there was leadership at the local level with the official leader of the *ejido* (communal land structure), named the *comisariado ejidal*.

*Ejido* members used to be organized around the President of the *Comisariado Ejidal*, who usually was able to call for massive assemblies and who had significant political power based on his effective representativeness and credibility within the *ejido* or *colonia* (private property land structure), respectively. Such leaders also were seen as capable of coordination with leaders and officials of higher levels of government, including the then-dominant political party PRI, as well as with farmers' unions such as the Mexican Independent Peasants' Union (*Central Campesina Independiente*, CCI), the Mexican National Peasants' Confederation (*Confederación Nacional Campesina*, CNC), the Regional Farmers' Union (*Unión Agrícola Regional*, UAR), and the Mexican National Small Private Rural Owners' Confederation (*Confederación Nacional de Pequeños Propietarios Rurales*, CNPPR). It is observed that eight of nine percent of interviewees in this northern region underscored these latter factors.

It appears that those national unions based at the local level headed the farmers' socially based political movement in the region during the salinity period. These groups jointly gave voice to large numbers of farmers concerned with the salinity problem and interested in fighting to defend their interests. One organization, the CCI, was clearly identified by six of nine farmers interviewed as particularly outstanding in its

effort and involvement and its leader Alfonso Garzón, was noted for his ability to work with all of the unions, helping to bring about a horizontally, unified force. Although Alfonso Garzón is acknowledged as the main promoter and defender of the social movement regarding the salinity problem in the Mexicali Valley, it is also mentioned that he worked together with other leaders, such as Rodolfo Fierro, Salvador Solorio, Miguel Monge, and Luis Granados.

The economic, financial, and political strength of the various unions afforded them a central role as institutional participants during the salinity problem period. The total number of farmers interviewed in this region asserted that such agricultural unions, both formally and informally, voiced claims, complaints, and demands, as well as mobilized large protests so that governments of both countries worked toward finding a fair and suitable solution to the salinity problem. Also, they were seen as instrumental in advancing agricultural productivity and social welfare in the Mexicali Valley.

Similarly, all respondents commented on the leadership of the President of Mexico Luis Echeverría in his being imperative in advancing the process and achieving compensation from The United States for salinity damage to agricultural lands in Mexico. Farmers of the northern Mexicali Valley see the administration of President Luis Echeverría as a crucial indicator of the integration of horizontal and vertical forces needed for addressing the critical salinity issue.

The federal government was highly supportive of the farmers in various ways and at different stages of the salinity problem process. It established formal commitments that included delivering credit and technical assistance to growers affected by salt pollution, offering guidance and representation in bilateral negotiation for farmers, and achieving a formal permanent and definitive solution that included compensation for the salinity problem (IBWC-CILA, 1973), this concurring with financial support provided for farmers to improve their

production conditions in the Mexicali Valley through the rehabilitation program.

As some farmers put it: “Just a few months after the President [Luis Echeverría] visited the Mexicali Valley to see the problems occurring in our lands, agricultural credit started flowing and we were able to continue working our crops with the money that the President sent to us.” (Dueñas, Martín, interview, 2009).

### Types and Characteristics of Institutions during the Salinity Problem

Major findings of this study regarding views of northern Mexicali Valley’s farmers about their participation during the salinity period show that the characteristics of institutions and the social behaviors of farmers were based on a rich variety of human relationships. Institutions were principally characterized as informal processes based on strong farmers’ customs and ideologies that led to the creation of formal institutions, such as the addendum to the 1944 International Water Treaty, highlighting the establishment of Minute 242.

A high degree of unification within the agricultural sector was an informal institutional behavior that was guided by local and national leaderships that at the time enjoyed a high level of credibility and trust. This resulted, among the individual farmers and the many different unions, a more cohesive social force that was able to summon large protests and the capacity to boycott commerce between The United States and Mexico at the International Port of Entry in Mexicali.

At the same time, there was remarkable vertical integration with federal officials (including the President) directly engaged with the problem, the various groups, and the public, formal commitments *in situ* for solving the problem. Additionally, the social forces were somewhat financially independent because they utilized their own informal mechanisms to

collect funds. It is clear that the amalgamation of institutions and organizations, informal processes and groups, and formal entities were able to work toward suitable solutions to the salinity problem.

### Influence of Farmers on the Salinity Problem

The type and extent of participation and involvement of farmers in the salinity problem gave them significant weight as key social actors that, in turn, enabled them to press both Mexican and The United States governmental agencies to move toward reaching a binational agreement on the issue (Table 4).

The influence of farmers for finding a solution to the salinity problem was a function of the significant participation embodied in formal (e.g., collective action in the form of unions) and informal institutions (e.g., union of unions, individual actions, individuals' voluntary financial contributions, and large protests), which induced good communication and coordination with governmental agents at different levels. The proposed solutions to the salinity of the Colorado River water and the resulting damage to agriculture in the Mexicali Valley were analyzed jointly by Mexican officials, scientists, union leaders, as well as by individual farmers.

A proportion of four of nine of the northern farmers participating in this study confirm that during the salinity problem period, farmers in the Mexicali Valley had a strong influence on the modification of the binational framework for transboundary water management, particularly the establishment and later implementation of Minute 242 of the 1944 Water Treaty. This fact in turn represented the paramount technical and institutional solution to the salinity problem. Such a formal institutional change took into account the design of new water quality standards with the intention of reducing the concentration of salts disposed of into the Colorado River water entering Mexico at the Morelos Dam point of delivery.

TABLE 4. Influence of the Institutional Response (High Participation) of Farmers for Finding Technical Solutions to the Salinity Problem

Theme	Explanatory Factors	Frequency of Total Respondents	Major Findings
ITS: Influence of participation of farmers for reaching technical solutions to the salinity problem	IBI: Influential participation of farmers in inducing institutional change for binational water management	4/9	Farmers as key social actors pressing for a solution to the salinity problem, plus the politics behind the salinity problem process
	REQ: Influential participation of farmers in defining the implementation process of infrastructure for recovering water quality in the Colorado River	5/9	
	REL: Influential role of farmers in defining and implementing the rehabilitation program in the Mexicali Valley	7/9	
	REI: Role of farmers in the unfinished rehabilitation program	3/9	
	CAP: Influential participation of farmers for obtaining financial support to continue production	3/9	
	COR: High degree of corruption and mismanagement of the U.S. compensation and Mexican financial support funds by Mexican actors	3/9	
	POS: Politics behind the salinity problem issue	2/9	

Source: Compiled by the author based on database (Cortez, 2010).



Interviewees of the northern Mexicali Valley mentioned that during the salinity crisis, the farmers used their basic experience and expertise for land management, salinity detection, and irrigation water management, coupled with their practical skills gained through the salinity crisis with which they had to deal. Such acquired experience allowed the farmers to provide valuable inputs for scientists and other officials who were establishing/negotiating new parameters for salinity concentration limits on Colorado River water entering Mexico. The final outcome of the bilateral U.S.-Mexican negotiations, after the long trajectory of diplomatic tasks that gave rise to the previous Minutes 218 and 241, was the signing of Minute 242 in 1973. In addition, this latter agreement set a quality standard for water that Mexico would receive from The United States (García-Acevedo, 2001:72). The standard stipulates a range of  $121 \pm 30$  PPM of salts ( $115 \pm 30$  PPM of salts as U.S. norms) at the Morelos dam and having as measurement reference the salt concentration at the Imperial dam, localized 25 miles upstream of the Morelos Dam (Román, 1991:120).

As some farmers mentioned:

We the farmers had the capacity to immediately detect the problem (salinity) in our parcels, at the local level, and also to transmit this information to the several authorities related with the issue, communicate with experts and even contact and bring President Luis Echeverría here to Mexicali. The idea was to make all these people aware of the magnitude of the problem and to expose the practical tasks we might have to carry out to defeat the problem. (Benítez, Marcos, interview, 2009).

Another area at the binational level at which farmers influenced the salinity problem process was to call for significant infrastructure programs for improving irrigation water quality. Five of nine respondents in the northern Mexicali Valley note how farmers advanced this agenda through their sociopolitical activi-

ties aimed at building the Wellton-Mohawk Canal for drainage water canalization. The *Permanent and definitive solution to the salinity of the Colorado River water* (BWC-CILA, 1973) also stipulates the construction of a desalination plant financed by The United States to treat and direct water coming from the Wellton-Mohawk District throughout the Wellton-Mohawk Canal to the Gulf of California across the entire Mexican territory (García-Acevedo, 2001:72).

One of the major aspects that northern participants mentioned, as having influenced the establishment of technical solutions to the salinity problem was the high participation of the Mexicali Valley farmers, which resulted in the accomplishment of local infrastructure programs implemented by the Mexican government together with the farmers' unions to help recover the productivity of agricultural lands. Eight of nine interviewees stressed this issue. The "Rehabilitation Program for Irrigation District 014, Colorado River" included funding and specific activities at macro (irrigation district) and micro (individual parcels) levels for processes to leach salts, building large networks of open drainage systems, leveling lands, and lining major and secondary irrigation canals (northern, central, and southern irrigation water distributors). The hydraulic operation in the Mexicali Valley is sub-divided into three major irrigation sub regions: Independencia Canal (northern), Reforma Canal (central), and del Sur Canal (southern).

However, the water quality rehabilitation program showed implementation problems that in turn hindered the achievement of its basic goals. During the salinity problem period, it was observed that program implementation was incomplete, that salinity problems continued, and there was inefficient water use in the agricultural sector. This negative aspect blocking the technical solutions to the salinity problem can be better understood in words of one of the rehabilitation program beneficiaries:

However, after almost 40 years, we can see that the (promised) rehabilitation program was not finished at all. Perhaps just 70 percent of the program was achieved, even key technical aspects were disregarded, for example, the necessary land leveling slope! How incredible is this! How “experts” failed in determining the slope for appropriate irrigation, no slope instead of the normal one or two percent needed! Besides, although agreed to by our leaders and the government officials, there were many areas where the rehabilitation program was not implemented. (Fernández, Javier, interview, 2009).

In addition to the benefits that were to be received by the irrigation district as a whole through the rehabilitation program, there were also various benefits that farmers were to receive at the parcel level, directly impacting their production, productivity, and individual financial circumstances. According to the farmers interviewed, this is another key factor that explains the achievement of technical solutions to the salinity problem.

For instance, agricultural credit and technical assistance to implement and maintain crops, along with capital for machinery and equipment, were given to individual farmers, but were managed through the unions to which they belonged.

However, the financial support administrated by farmers’ unions diminished and limited the potential positive impact for individual farmers. Corruption was a characteristic of salinity compensatory fund management. Corruption among local farmers’ leaders was observed that impacted both individual (parcel) and general programs (irrigation district) operation. It is believed that corruption is the main reason why the rehabilitation program of the Mexicali Valley was not finished.

As some respondents assert:

As it always happens, some of our bad leaders engage in social actions that they have in mind as having a double purpose: one, the social, and the other the personal benefit from their actions. This explains how some people become rich overnight! [...] these

bad leaders knew about the social needs and how to manage the money to get personal benefits. For example, they knew about the money available and the need to acquire new major equipment to clear lands and build huge drains and canals to deliver water, but they just bought old equipment or subleased to others to partially fix the problems. The real problem was that our government trusted these people to perform their tasks and this fact facilitated dishonest behavior. (González, Ramiro, interview, 2009).

Finally, according to the perception of northern Mexicali Valley participants, it appears that politics played an important role in the farmers' participation as well as in their ability to influence positive outcomes toward reaching technical solutions to the salinity problem. Although a thorough political analysis lies beyond the scope of this study, the data suggests the importance of politics in enabling or constraining the participation of farmers during the salinity process.

The politics behind the salinity problem process refers to a premeditated or at least partially calculated, negotiation among high level spheres of both governments toward finding a technical solution to the salinity problem. It appears that there were political interests in The United States as well as in Mexico that worked toward a resolution that had social, economic, environmental, and political implications for key stakeholders in the Mexicali Valley.

This issue might be illustrated by the following assertion:

During the salinity crisis, rumors circulated among farmers of the whole Mexicali Valley in regard to the reason why the Americans mixed and sent salty waters to Mexico. One of the widespread comments among us and under the strong control of union leaders and officials both belonging to PRI, was that everything was part of a "big show" and that the so-called "de-liberate" pollution had already been negotiated at high spheres of both governments. And, as a result of Mexico's acceptance [of the damage], the Mexicali Valley might later receive significant

compensation to modernize the Irrigation District. This is why leaders and officials were so closed mouthed about communicating details on technical information about the negotiation process. (González, Ramiro, interview, 2009).

The lack of transparency in sharing information while the salinity process was taking place, especially with respect to the details of the negotiations, is why many of the farmers claim that such negotiations were premeditated with behind the scenes politics. That is, many farmers believe that because the final negotiations were already fixed, state and federal officials of the Mexican government were able to promote and facilitate a high level of participation of farmers in the process and, particularly, to establish technical solutions to the salinity problem.

#### Views of Northern Mexicali Valley Farmers of the Impact of Institutional Structures Adhered to by Farmers in the Mexicali Valley during the Salinity Problem

Schmid (2004:69) asserts that: "Institutions and organizations are mental constructs. They influence what things humans put together to produce physical things." The northern Mexicali Valley's farmers saw their informal institutions during the salinity crisis as favoring a high level of participation, which they viewed as more effective for reaching their objectives for recovering the productive status observed prior to the salinity problem period and improving water management conditions and agriculture in the Mexicali Valley.

Farmers created a dominant informal institutional response to the salinity problem that, according to participants in the northern Mexicali Valley, allowed farmers to be acknowledged as influential social and political actors who pushed to obtain direct benefits. They were also seen as influential in the process of negotiation and securing benefits at the binational

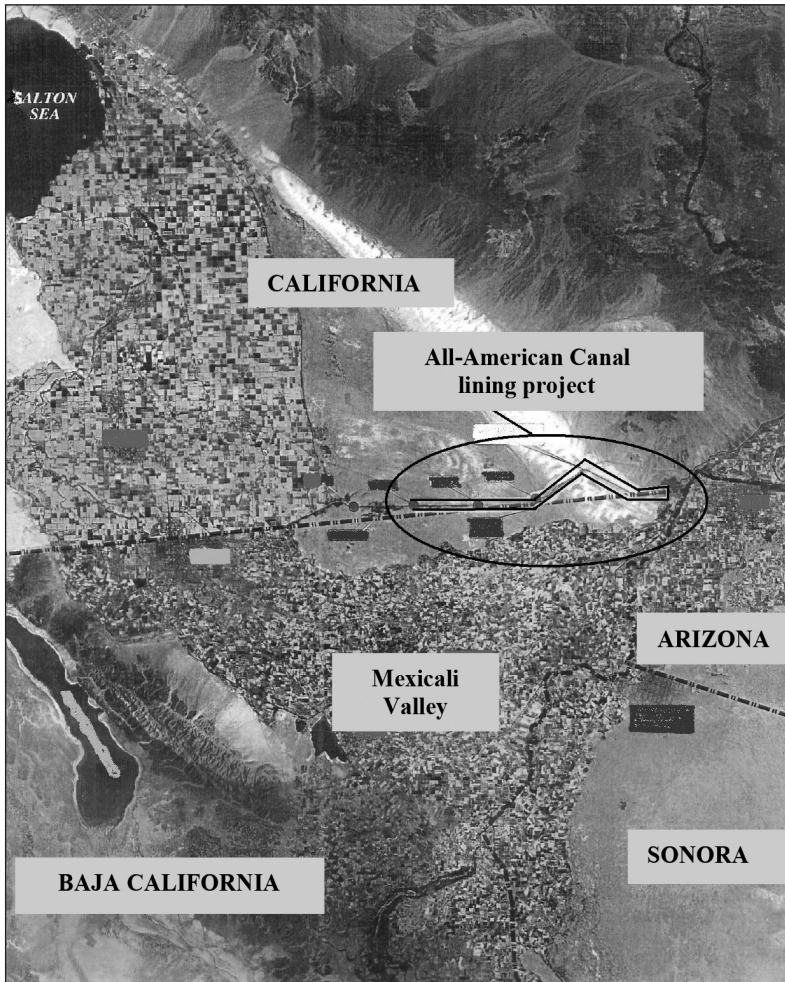
level through modification of the transboundary water management legal framework (IBWC-CILA, 1973). In fact, informal institutional structures were seen as effective tools, with the threat of large protests observed as a concern for high level authorities. Therefore, the informal institutions of individual farmers and their unions in the northern area were able to produce formal institutional change in local and binational frameworks for water management.

### The All-American Canal Lining Conflict

Next, this section focuses on the results of the analysis concerning the perceptions of farmers in the northern Mexicali Valley regarding the All-American Canal lining conflict. First, it discusses the views of farmers regarding the potential negative impacts of the All-American Canal lining project, as well as the impacts of institutional devices for addressing the All-American Canal lining issue. Farmers expect damage to the Mexicali Valley as a result of the operation of the lined All-American Canal. Potential adverse productive, economic, social, and environmental impacts in the northern Mexicali Valley are seen, along with the feeling that such harm might be gradually be shared across the entire valley (Map 4).

However, the All-American Canal lining project could also present an opportunity for farmers to properly address the conflict by involving key stakeholders and providing an opportunity to improve water management conditions on both sides of the border. This is so because current All-American Canal seepage provides a positive externality to agricultural lands and environment on both sides of the border because the canal seeping water is of good quality (about 800 ppm on average, and usually 300 ppm less salty than that of the Mexicali Valley aquifer) (Herrera-Barrientos et al., 2006:75) (Table 5).

MAP 4. All-American Canal Lining Project Location.



Source: Southern Nevada Water Authority, Landsat (June 2000).

The perception of the impending degradation of natural resources as a result of the implementation of the All-American Canal project is due to a variety of factors described by respondents. They emphasize the idea of generalized uncertainty about the extent of damage that each individual agriculturist might experience at the parcel or household level when seepage stops.



Despite uncertainty concerning the damage, interviewees state their point of view by informing, through several explanatory factors, on the potential impacts of this project in their area. For instance, four out of nine respondents express uncertainty despite the potential benefits of the big picture of improved irrigation system that would benefit users on The United States side of the border.

The following four factors described below exhibit a higher response frequency. For example, respondents have seen the All-American Canal issue as a persistent problem for farmers since the canal was built and started operations in 1942. Five out of nine respondents indicate that there have been adverse impacts since the beginning when All-American Canal seepage resulted in flooding problems in *ejidos* and *colonias* in nearby land parcels between 1944 and 1955. During the following ten years, after 1955, there was also flooding attributed to All-American Canal seepage, meanwhile, efforts were made to recover these lands. Today, after Mexican farmers have already adapted to canal seepage, the problem associated with the All-American Canal lining comprises the threat of expected damage, which might create potential water scarcity for farmers of the Mexicali Valley who have come to rely on seepage from the Canal for more than sixty years.

In this respect, an insightful interviewee reported that:

Just a few years [four or five] after the All-American Canal initiated operations, we could see major flooding problems in several productive *ejidos* encompassing the great area above the train tracks [northern Mexicali Valley] was totally damaged and rapidly became unproductive... ten years of flooding and ten more years to recover these lands, the best lands of the Mexicali Valley... today, we can foresee the opposite situation, there will be a critical scarcity, maybe during the same period of time that the seepage stops running to the Mexican side... the bottom line is "damage then and damage now." In the end [we have] cyclic damages to all of us the farmers. (Estrada, Joel, interview, 2009).



*TABLE 5. Impacts of the All-American Canal Lining Project on Agricultural Lands*

<i>Theme</i>	<i>Explanatory Factors</i>	<i>Frequency of Total Respondents</i>	<i>Major Findings</i>
JEO: All-American Canal lining as a threat to Mexicali Valley sustained agricultural development	UCY: Uncertainty about the impacts	4/9	Productive, economic, environmental, and societal risks perceived parallel to the opportunity to improve conditions at local and binational levels
	CYC: Cyclic damages induced by the All-American Canal	5/9	
	MES: The La Mesa Drain as a technical solution in the past	5/9	
	DRE: The La Mesa Drain as today's affected water source	4/9	
	RAF: Regional upper aquifer impacts	6/9	
	WEL: Deeper well digging	3/9	
	ADJ: Water adjustments for Farmers	3/9	
	RED: Reduction of growing areas	5/9	
	WET: Impacts on wetlands	4/9	
	NOR: No rights, irrigators affected	2/9	
	RUT: Small rural towns affected	2/9	
	MIG: Induced migration from Mexico to the United States	3/9	
	IOP: Opportunity for mutually improving water management	4/9	

*Source:* Compiled by author based on database (Cortez, 2010).

The same proportion of participants in this study area mentioned that as a result of the initial flooding problems of the All-American Canal, the La Mesa and the Culiacán major drains were built in 1954 along the Mexican side of the border to intercept the excess of water seeping from the All-American Canal. This technical solution to a transboundary water problem has given rise to the concept of seepage water rights for Mexican water users who have come to rely on and use such waters to irrigate agricultural land mainly located in the northern region of the valley since 1942.

The initial flooding problems became for the local farmers a new high quality freshwater source for irrigating significant portions of the Mexicali Valley. On this topic, four out of nine interviewees considered that ceding canal seepage might, at a first stage dry up waters feeding the La Mesa and Culiacán drains, eliminating these irrigation water sources for more than 2 000 hectares (about 200 rural households) in Irrigation Modules 4, 5, and 16, as well as for other areas under irrigation outside of the district limits (e.g., *Ejido Netzahualcóyotl*), all of these located in the northern and northeastern portions of the Mexicali Valley (DRE). The La Mesa and Culiacán drains (still) have the function of intercepting All-American Canal seepage in order to maintain the water table in this northern area under control (Cortez, 1999a:46); regarding the seepage intercepted, Conagua determined that such a flow is composed of 2 000 LPS deriving from All-American Canal seepage (1 200 intercepted by La Mesa and 800 LPS by Culiacán drains, respectively), which have a salts concentration of 900 PPM, only 100 PPM below the salts concentration in the All-American Canal water flow on the U.S. side of the border (Conagua, 1991a).

Another potentially adverse impact of the All-American Canal lining project concerns the regional upper aquifer. The majority of farmers (six out of nine) mentioned that without water seepage from the All-American Canal, the Mexicali Valley

aquifer will only be able to provide diminishing quantities and high water quality for more than 19 000 hectares (about 1 000 households) of agricultural lands in Irrigation Modules 4, 5, 6, 7, and 16 located in the northern and northeastern portion of the valley. In fact, the Mexicali Valley aquifer receives approximately 64 900 acre-feet per year (AF/Y) from All-American Canal seepage, which represents a quantity of water equivalent to the total annual consumption of the urban Mexicali area with a population of more than one million persons (USDOI 1994; Conagua, 2002). In addition, currently, this area has highly productive soils that are classified as first and second quality (72 and 23 percent, respectively) (García, López, and Navarro, 2006:83).

Studies estimate that an increase of soluble salts concentrations in water used for agriculture in the area might reach levels of 23.5 ppm per year, which would reduce yields of sensitive crops such as green onions (45 %), fruitages (34 %), and alfalfa and asparagus (15 %) (García, López, and Navarro, 2006:94). The likely degradation in both surface and groundwater sources will force alternative actions such as digging deeper wells. While the deeper aquifer may have better water quality and availability, accessing it will raise initial investment costs to irrigators. An interviewee points out that:

We might have to build new deeper irrigation wells or just deepen the ones already in operation. In the former case, it is possible to dig 20 new wells from the Mexicali International Airport area [northwest] to the Los Algodones Township area [northeast]. However, this might imply increasing costs to us. Besides, these wells cannot be built in other areas different from those in the northern region because of the risk of intrusive saline water coming in from the sea [south bond]. So, we are very constrained both economically, technically, and environmentally. (Gerónimo, interview, 2009).

In addition, two other core measures are envisioned by local water users, including the necessary water adjustments and the potential reduction of individuals' growing areas. One concerns implementation of water adjustment mechanisms among irrigators in order to limit irrigation water allotments at individual, sub regional, and irrigation district levels. These actions might take place given the operational linkages of the hydraulic network in the whole irrigation district, which includes surface and groundwater sources (canals and deep wells). It is important to recall that during the salinity problem episode, actions suggested to Mexico included:

Adjusting the frequency and amount of irrigation to the available water supply by adding groundwater to supplement the winter water, changing the delivery schedule, and 'adjusting' its cropping pattern to fit the quality and quantity of the water available in various seasons. (Ward, 2001:110).

Five out of nine respondents state that another measure could likely be the reduction of the size of growing areas at the individual parcel level. This type of response previously occurred in the region during the 1970s, when cotton growers were forced to reduce their irrigation rights (permits) from 20 to 18 hectares and when alfalfa growers were asked to reduce their individual irrigation rights from 20 to 16 hectares.

As one farmer pointed out:

Since we all belong to a whole unit or Irrigation District [system], we have to comply with a norm based on the "real" water availability. We the individual farmers have a water allotment right [concession] to irrigate 20 hectares that we "own" just if water availability allows it. The problem is that this would bring about social conflicts among farmers because many of us do not understand the difference between "ownership" and "concession." (Gerónimo, interview, 2009).

Also, adverse environmental impacts in the form of wetlands reduction are associated with the All-American Canal lining project. A series of small wetlands, formed since the initial operation of the All-American Canal in 1942, extends over 3 374.2 ha mainly surrounding the Irapuato and Netzahualcóyotl *Ejidos* in the northern Mexicali Valley (Zamora, Culp, and Hinojosa, 2006:29).

The vegetation, the wetlands that we currently see along the northern side of the valley originated from current [AAC] seepage. Here, we can see trees born 50 years ago. They function as air filters, as coolers of this hot region [...] there are many Alamo (cottonwood) and Mesquite trees, salty pines, etcetera, which embrace the many animal species of the place, such as quails, coyotes, rabbits, black doves [*chanates*], these later help us to control our crops' pests. (Benítez, Marcos, interview, 2009).

In this particular area of the northern Mexicali Valley, there are specific kinds of landowners who are irrigators who are not part of the Irrigation District; they do not hold water concessions. This group of 100 households belongs to *Ejido* Netzahualcóyotl and is known as *precaristas* (squatters). This *ejido* was founded after All-American Canal seepage had begun to cross the border toward the Mexicali Valley aquifer. *Ejido* Netzahualcóyotl's main water source is currently All-American Canal seepage, with which these farmers used to grow mostly alfalfa and wheat. Without doubt, if the canal seepage were stopped, this community would feel direct and significant environmental, economic, and social impacts. A leader of this community put it as follows:

We are so vulnerable and unprotected now, we also felt alone in this fight [against the All-American Canal lining project]. Now that we are getting production benefits to live and so we could survive to those flooding times, they [American officials] want to withdraw our only water source [...] Definitely, here impacts

are going to be felt strongly and this situation has us really uncertain about our future since we depend on the All-American Canal seepage. (Hirata, Jesús, interview, 2009).

In addition to the environmental degradation and potential economic impacts associated with the All-American Canal lining project for farmers in the Mexicali Valley, the societal impacts of this project also appears to be critical threats. Several small but well functioning rural towns are spread throughout the agricultural area, particularly in the northern area, and the water supply of these towns comes from the local aquifer, which receives All-American Canal seepage. There are thirty small towns in the region, each with a population of at least one thousand people. Major rural towns in the region that are potentially adversely affected by the All-American Canal lining project include Morelos City (7 913), Benito Juárez Township (4 609), Los Algodones Township (4 374), and Paredones Township (3 870) (Conepo, 2008).

According to those interviewed, one effect of the implementation of the All-American Canal lining project would be massive migration, both legally and illegally, from small rural towns and the agricultural sector to The United States. This customary practice of emigration has already been seen in the region in response to previous crises, such as the salinity problem of the 60s and 70s. When socioeconomic conditions are threatened, vulnerable groups of farmers tend to cross the border in order to find better opportunities to live and work. As one interviewee put it:

The significant factor in order for us to be rooted here in our lands is water availability. If our people go to The United States it is because they need to have a [better] way of living, I know because I have gone and I have returned to my land. Now, if the All-American Canal project is implemented, then my family and I might have to cross the U.S. border, we are going to jump the fence even if it is very high... we need to work, to eat, and to live. (Hirata, Jesús, interview, 2009).

It is noteworthy that some interviewees (four out of nine) mentioned that while the lining of the All-American Canal presents challenges, the project might also represent an opportunity for mutual improvement of productive and living conditions for water users on both sides of the border. This would be because there is a significant degree of interdependence in terms of economic exchange through export crops grown in the area, as well as through U.S. agricultural enterprises established on the Mexican side of the border, that attract a local workforce. As a result, key local actors, such as the farmers, may be able to play an effective role in shaping outcomes.

As seen during the salinity problem issue, local farmers have been directly linked with being influential in transboundary water issues since the beginning of agricultural activity in the Mexicali Valley. Unfortunately, it is reported that Mexican agricultural water users were not properly listened to in the discussion process over the All-American Canal lining project (Cortez and García-Acevedo, 2000:273; Cortez, Donovan, and Whiteford, 2009:143). This will be explored in the next section of this chapter. One interviewee summarized the issue of mutual equal-opportunity as follows:

The All-American Canal issue represents both a threat to our welfare and also an opportunity to improve our situation, to motivate and apply the “good neighbor principle” [...] it will depend on how we develop dialogue among ourselves as farmers and between ourselves and other users on this and on the other side of the border [...] it also depends on the leadership of our governments. (Benítez, Marcos, interview, 2009).

Such an assertion is in line with ideas from Doughman (2002:191) and Neir and Campana (2007:45) about potential binational cooperation in transboundary water issues and the peaceful resolution of water disputes regarding the All-American Canal lining conflict. However, it is also clear that according to the results of the All-American Canal lining dispute

process, neither cooperation nor peaceful resolution was reached between the parties involved. Therefore, farmers in the Mexicali Valley were disregarded as key actors in finding a suitable solution, thus, potential damage is expected to occur in the agricultural area (García-Acevedo, 2006:143; Cortez, Donovan, and Whiteford, 2009:144).

From this, it is established that farmers of the northern Mexicali Valley perceive significant productive, economic, environmental, and societal risks parallel to the opportunity to improve conditions at local and binational levels.

### Participation of Farmers in the All-American Canal Lining Conflict

In contrast to what occurred during the salinity problem episode, the participation of farmers in the All-American Canal lining conflict evidences features of social disarticulation among irrigation water users, as well as a lack of vertical and horizontal coordination among the users themselves, the productive sectors, and the different levels of government. This is related with the political landscape described in Chapter 1. During the All-American Canal lining conflict, the farmers' participation was mainly guided by operative entities such as the WUAs and the SRL, which replaced the unions for addressing transboundary water issues. Agricultural water users and their WUAs and SRL continue to have no direct links to political parties of any sort. However, water policy at the local and national levels today is guided by governments that emerged from PAN. Table 6 summarizes the factors that explain the low level of participation of the farmers in the All-American Canal lining process.

There appears to be widespread, generalized apathy among water users interviewed concerning the All-American Canal project and possible alternatives. Local agricultural water users expressed a lack of interest and motivation among



those who appear to focus their priorities on solving problems linked with their daily productive activity.

TABLE 6. Institutional Responses of Farmers to the All-American Canal Lining Process (Individual Farmers)

<i>Theme</i>	<i>Explanatory Factors</i>	<i>Frequency of Total Respondents</i>	<i>Major Findings</i>
	APA: Generalized apathy on the part of farmers of the Mexicali Valley	8/9	
	APS: Sub-regional localized apathy of farmers	4/9	
	LIN: Lack of information	8/9	
	MIN: Misleading information	7/9	
	TRA: Lack of transparency on the part of federal agencies	8/9	
	PLA: Presidential lack of accountability to locals	8/9	
	GLA: Lack of accountability to locals on the part of federal governmental agencies	7/9	No vertical coordination of farmers and federal government
DAS: Weak defense of farmers Against the All-American Canal lining project	ALE: Aging leadership in the Mexicali Valley countryside	8/9	
	LED: Disarticulated leadership in the Mexicali Valley	9/9	Horizontal social disarticulation of the agricultural sector
	ELE: External, urban-based leadership facing the AAC	6/9	
	LES: Lack of external support for farmers	5/9	
	NOF: Lack of farmers' financial capacity	8/9	
	REN: High degree of lands rented	7/9	
	DOW: Downward spiral in the agricultural sector	6/9	
	POC: Politics behind the AAC issue	3/9	

Source: Compiled by author based on database (Cortez, 2010).

Other factors discussed by participants, such as lack of information, lack of leadership and support, and the current critical political, social, and economic situation in the countryside, are seen as reasons for farmers to avoid participating, in a sustained and organized fashion, in the All-American Canal lining project. This apathy and withdrawal from problem solving processes is particularly noticeable in other areas belonging to Irrigation District 014, such as the San Luis Río Colorado Valley and the southern Mexicali Valley area.

Lack of information, misleading information, and a lack of transparency are identified by respondents as fundamental factors linked with the apathy and inaction among farmers that, in turn, has resulted in weak participation and involvement in the All-American Canal process. The official information that farmers have received about the issue according to respondent farmers is insufficient and untimely.

Furthermore, it is reported that such information is not widely and systematically shared among irrigation water users by agencies charged with addressing transboundary water problems, such as the Mexican Section of the IBWC/CILA and the Mexican National Water Commission (Conagua).

It appears that critical information on the All-American Canal lining project (e.g., transboundary impacts and legal processes) is often absent or misleading in communications from governmental agencies, and that these agencies tend to minimize the problem. Frequently, governmental and science perspectives tend to differ and show different data on impacts and basic information (Román and Ramírez, 2003:116). Many farmers see this as an example of lack of transparency on the part of governmental agencies that, in turn, hinders the individual or collective public involvement of irrigation water users.

The lack of presidential leadership and apparent federal governmental agency lack of accountability to farmers in the Mexicali Valley have combined to make information absent

or confusing to the potentially affected parties. Respondents frequently note that among the several federal administrations involved in the All-American Canal issue, there is a lack of leadership, lack of interest concerning local impacts, and a lack of accountability to locals. Not only that: respondents reported a complete absence of leadership and presence in the region on the part of the former President Vicente Fox at times when the issue became critical. Also, the current President, Felipe Calderón despite campaign rhetoric, has not addressed the All-American Canal lining conflict.

The All-American Canal issue is always used as a basic matter during politicians' campaigns. Just as other predecessors, President Vicente Fox (2000-2006) and President Felipe Calderón (2006-2012) as presidential candidates embraced the issue and made explicit public commitments on finding a solution. No previous President is reported to have shown such a lack of accountability and misunderstanding of the irrigation problems affecting and threatening the future of farmers of the Mexicali Valley as President Vicente Fox. His poor showing, in the eyes of respondents, stands in sharp contrast to the effective political and diplomatic actions of President Luis Echeverría (1970-1976) and his agencies during the salinity problem period.

Likewise, it is reported that local leadership is weak, in some cases nonexistent. In the countryside, an aging population is one constraint on the public participation of farmers in issues such as the All-American Canal. Individual and collective leaders are practically nonexistent, and the former political power of these leaders to mobilize and articulate social and governmental forces is completely missing. As a result, dispersed and uncoordinated leadership among farmers or irrigation water users has limited their ability to undertake unified action against the All-American Canal lining project.

In this respect, one agriculturist shared the following:

Ernesto Derbez, the former Minister of Foreign Affairs during the Fox administration, came here to Mexicali [City] but he did not visit the affected area in the valley. He just said that the President sent him to see to the issue [AAC] in depth. He told us that “if you farmers disagree or are affected in some way...we are going to find the best solutions for you”... but he never returned to Mexicali during the remainder of that federal administration period. Now, Felipe Calderón, during his political campaign for the presidency, came here as well and said: “I’m going to address, with all my resources, the All-American Canal issue. I will work harder than in the past.”... however, the All-American Canal lining project has already started. (Hirata, Jesús, interview, 2009).

It is common to see various ‘factions’ of farmers within the same Irrigation District when they come together for planning meetings of the “Irrigation District Hydraulic Committee.” called by officials of the Conagua. The *Irrigation District Hydraulic Committee* is a planning mechanism for irrigation water use and management for Irrigation District 014, Colorado River. It is constituted of representatives of agricultural users of the 22 irrigation modules and the SRL, as well as Conagua officials. (Conagua, 1991b).

These factions or allied interests include large and small farmers, exporters and domestic producers, Mexicali Valley and San Luis Río Colorado Valley producers, wells-based and canal-based irrigators, northern and southern agricultural water users, *ejidatarios* and private owner producers, and farmers belonging to PRI, PAN, or PRD. With the exception of the latter political party, the fact of the matter is that these very “interest groups” managed to join together, to participate, and to act as unified and influential forces during the salinity period. Today, farmers are dispersed, not unified, weak, and without local leadership. A farmer may explain this as follows:

What is happening is that if all we farmers had the same political ideology then we would work together like in the past [...] the

current minimal leadership in the countryside of the Mexicali Valley has been deteriorating our past strong level of unification [...] farmers' leaders manipulated by the current government are decreasing our strength as an agricultural sector. (Adame, Rosalío, interview, 2009).

Another interviewee mentioned that:

Maybe we could synchronize our strength as water users' associations, but who is going to organize us? Who is going to finance us? Who is going to prepare an effective strategy to defend our water? Who is going to give us guidance? Is the government the leader (Conagua, CILA)? Are the experts our allies? I don't think so! We are a very disarticulated and weak rural society. (Dueñas, Martín, interview, 2009).

Moreover, such a lack of leadership and unified sociopolitical organization within the agricultural sector of the Mexicali Valley has enabled social actors such as entrepreneurs belonging to urban areas of Mexicali City to advance their own interests. External leadership of the industrial and urban sectors has taken on the issue of the All-American Canal for the region, including the farmers.

This factor shows a significant shift in the type of individuals and organizations voicing concerns with transboundary water conflicts (even those that mainly affect the agricultural sector). The Economic Development Commission of Mexicali (CDEM), an entrepreneurs' organization headed by the Mayor of the Baja California state capital, Mexicali, has brought a civil action against The United States Department of Interior in order to stop the All-American Canal lining project. In July 2005, the CDEM, jointly with another environmental group of Baja California, sued the U.S. Department of the Interior to stop the project, presenting an argument for implementing a "Precautionary Principle" for potential damages to the economy and the environment on the Mexican side (Elenes, 2009).

That lawsuit, according to interviewees, disregarded the agricultural sector and incorporated agricultural sector participation in the form of “moral support.” As an interviewee points out, the rise of urban based leadership makes clear the absence of rural farmers’ leadership on water issues such as the All-American Canal issue:

When our heads [the President and local leaders in the countryside] do not act, then there is no guidance. In fact, I think nowadays there are no leaders with moral values, there are neither committed leaders nor governors nor Presidents...people came here [to the *ejido*] from CDEM, they had received some money from state governmental agencies [...] they invited us to participate in the process but we have no money to do that and we had to trust them [CDEM] to solve “our” problems...but nothing happened, nothing was resolved. (Hirata, Jesús, interview, 2009).

One topic that arose from explaining the perception of farmers as their being unorganized and weak is that absence of external financial and technical support from experts and governmental agencies (in contrast to what occurred in the past during the salinity problem process). The task of organizing, participating in, and leading an effort to address the All-American Canal conflict feels nearly impossible to farmers without effective support from governmental agencies and the urban sectors.

Another factor attributed to the lack of participation of farmers of the Mexicali Valley in the current transboundary water conflict surrounding the All-American Canal lining issue is the absence of financial capacity of agricultural water users to unify and organize. The voluntary contribution of funds for organization during the salinity problem process was accomplished using irrigation water fees. This institutional device was eliminated as a mechanism for funding farmers’ unions. Immediately after the irrigation water transfer process in the Mexicali Valley in the early 90s, the voluntarily

contribution fee disappeared from the agricultural water users' accounts, thereby diminishing union operations and leadership expenditures. One agriculturist who was interviewed shared his concerns as follows:

We are not the same people working in the Mexicali Valley [...] the fact is that we put our financial responsibility aside; we “new” organized irrigators considered that the donation [voluntarily contribution] of three or five cents per liter of water delivered was no longer necessary to support our “social actions”, we simply stopped giving money and this decision was a big mistake. As a result, our unions became more disarticulated, the CCI cut links with the CNC and the UAR, people started withdrawing their memberships [...] we divided ourselves and when we were asked to voluntarily contribute, we just responded: “well, no money anymore.” (Estrada, Joel, interview, 2009).

Other factors also explain the adverse conditions within the agricultural sector, including the loss of financial capacity and organization and its absence as a unified force for addressing address the All-American Canal lining conflict. Many, if not all, people interviewed echoed the sentiments that, “we are not the same people working and living in the Mexicali Valley countryside”, (Hirata, Jesús, interview, 2009), and they go on to point out the high level of agricultural land rented, the permanent price erosion of agricultural products, and the increased costs for the majority of inputs for production in the downward spiral trend.

From this, major findings on the institutional responses of individual farmers to the All-American Canal issue demonstrate an overall lack of the vertical coordination of farmers and federal government, as well as a horizontal social disarticulation of the agricultural sector, resulting in weak participation and defense of All-American Canal seepage water. Among the main explanatory factors underscored by northern farmers are the following: generalized apathy, lack of information

released to farmers, the transparency of water agencies when dealing with this issue, and the observed lack of presidential (Presidents Fox and Calderón) accountability to water users of the Mexicali Valley (eight out of nine respondents mentioned this aspect).

Also, disperse and disarticulated leadership among farmers in the Mexicali Valley (all respondents mentioned this aspect) and the absence of financial capacity of agricultural water users for unification and organization (eight out of nine), were perceived as two interrelated core factors that diminished effective farmers participation.

Such previously described conditions among others appear to hinder social organization and participation in what respondents called “secondary issues”, (Estrada, Joel, interview, 2009), such as the transboundary water conflicts related with the All-American Canal. This lack of participation regarding fundamental aspects of the agricultural area, that is, the defense of a basic water source, is resulting in further weakening of the agricultural sector that continue to use a high proportion of the region’s available water, as much as 86 percent from both water sources.

### Participation of Water Users’ Associations in the All-American Canal Lining Conflict

As discussed in Chapter 2, an organization may be thought of as a means for collective action such as that applied to CPRS management for individual members (e.g., agricultural water users) within a boundary (e.g., irrigation system or district). An organization is a given set of people with shared institutions and mutual recognition of opportunity sets. At the same time, organizations are systems of relationships for coordinating individual actions according to some decision rule of persuasion (Schmid, 2004:75). Thus, institutional arrangements for water management include the following: *a)* the



established policy and legal environment, *b*) water management organizations with responsibilities in water management, and *c*) processes, mechanisms, and procedures for decision-making, coordination, and planning (Svendsen, Wester, and Molle, 2005:4).

Two questions explored in this research comprise the following: 1) Can the current institutional arrangements (WUAs and SRL) followed by farmers in the Mexicali Valley effectively encourage the governance of transboundary waters used for local irrigation? and 2) What circumstances and contexts can help local WUAs and SRL ensure the viability of this strategic resource? Tang (1992:8) contrasts the depressing scene of many bureaucratic irrigation systems with the positive experiences of other successful community organizations. He points out that: “in these [successful] organizations, farmers are able to construct, maintain, and operate their own irrigation facilities effectively.” In exploring the features of effective institutions, Lam (1998:53) notes that rules that are made by farmers are more likely to take information and knowledge about the local situation into consideration. Because farmers are the ones who deal with problems concerning irrigation in their daily needs, they are likely the ones who understand their own problems best.

Various factors appear to affect both involvement of farmers in local organizations and effective management of irrigation systems. These factors depend on the environment dimensions, including *a*) physical, *b*) socioeconomic, and *c*) policy (Gulati, Meinzen-Dick, and Raju, 2005:242), as well as contextual characteristics encompassing *a*) agro-ecological, *b*) technical, *c*) economic, *d*) historical, *e*) socio-cultural, and *f*) political-legal (Uphoff, Ramamurthy, and Steiner, 1991:71). Effective management of irrigation systems, especially when confronted with changing environmental conditions, is complex, which is in line with Ostrom et al. (1999:278), who elaborated on the limitations and opportunities of local farmers for participating in and influencing transboundary water issues.

If institutional arrangements can facilitate or impede the problem-solving capabilities of participants in irrigation systems, then it may be possible to learn from a previous study about changing institutional arrangements. The WUAs established in the Mexicali Valley, in accordance with Tang (1992), Lam (1998), and Ostrom et al. (1999), appear to have lacked the capacity to keep them involved, thus are ineffective representatives for participating in transboundary water issues such as the All-American Canal lining conflict. This differs significantly with the level of participation and influence of agricultural water users during the salinity problem period, when their organizations were farmers unions not WUAs. The explanatory factors for low levels of participation of WUAs are depicted in Table 7.

The WUAs of Irrigation District 014, established over the Mexicali, Baja California and San Luis Río Colorado and Sonora valleys, were formed as part of the Irrigation Transfer Policy implemented in Mexico. The Conagua, on behalf of the Mexican Federal Government, “gives the legal Water Concession under the form of an Irrigation Service and Hydraulic Infrastructure use” to the 22 WUAs belonging to “Distrito de Riego 014, Río Colorado, Baja California and Sonora” (Conagua, 1991a).

These organizations were intended to substitute for other organizations of agricultural water users previously used and were framed as more “managerial” (Fisher, 1990) in nature, as opposed to being more “communitarian” (Barber, 1998). Such a managerial perspective for stakeholder organizations is keeping in line with the directives of such agencies as the International Bank for Reconstruction and Development (IBRD), the World Bank (WB), and the Inter-American Development Bank (IDB) (Doughman, 1999:68). As such, WUAs were established by utilizing a top-down approach. As a result, WUAs in Mexicali continue to possess limited ability for managing water, resolving conflict resolutions, and addressing transboundary water issues that directly impact irrigation operation in the Mexicali Valley.

TABLE 7. Institutional Responses of Farmers' WUAs to the All-American Canal Lining Process

<i>Theme</i>	<i>Explanatory Factors</i>	<i>Frequency of Total Respondents</i>	<i>Major Findings</i>
ELU: Low level of participation of agricultural WUAs in the AAC	IMU: Top-down imposed WUAs	4/9	WUAs not effectively involved with any representation in the AAC process
	LER: WUAs entitled to participate in the AAC process	5/9	
	BUR: Bureaucracy of co-management	5/9	
	ALA: WUAs' lack of accountability to individual users	4/9	
	GIA: Groups of interest and apathy within WUAs	7/9	
	LAN: Large landholders command WUAs	7/9	
	LIM: Lack of information about formal mechanisms to participate	8/9	
	LAC: Lack of formal coordination mechanisms	8/9	
	LIC: Lack of coordination with IBWC/CILA	9/9	
	POC: Politics behind the AAC	3/9	

Source: Compiled by the author based on database (Cortez, 2010).

Thus, individual water users argue that this shift in philosophical principles, together with the way WUAs were imposed on the Mexicali Valley (and on the rest of the country) doomed them from the start as a means for the effective participation of farmers.

One interviewee expressed it as follows:

President Carlos Salinas (1989–1994) made the meaningful decision of transferring the official irrigation districts to water users, this in agreement with the guidelines imposed by the Inter-American Development Bank, in order for this agency to continue financing the irrigation sector in Mexico [...] the 23 WUAs and the umbrella organization, the SRL, were formed in 1991 and 1998, respectively. However, we are still “controlled”, or at least depend on, upper water agencies such as Conagua. Thus, it is difficult to participate in issues like the All-American Canal although this issue directly impacts our irrigation performance. [...] I can remember that in the past, during the salinity crisis, we had the strength and also the mechanisms to effectively deal with. (Benítez, Marcos, interview, 2009).

Even though agricultural water users and their representatives have not formally participated in the AAC process, WUAs do have the authority to defend their legal interests. Because the water seeping from the All-American Canal has represented a fundamental source for more than 60 years, the All-American Canal lining project is a direct threat to the productive and irrigation performance in the Mexicali Valley. This right to the seepage water (according to the years of using it) may entitle farmers to formally participate in the All-American Canal process. However, the limitations of WUAs impede them from doing so. Heavy bureaucratic and inefficient co-management between WUAs and Conagua also gets in the way. Two central themes relating to the bureaucratic barriers are increasing costs for the socially-based political movement as well as lack of agricultural leadership.

In addition to this co-management feature's halting effective participation of farmers, there is a perceived lack of accountability to individual farmers (the majority of whom are small scale producers) of the WUAs. The WUAs have direct operative links with several agencies: first, the upper-level SRL (water users' organization operating the three main canals in the Irrigation District), second, Conagua (through Irrigation District 014, Colorado River) focusing on the regulatory aspects, and finally, the City of Mexicali water authority that is named Comisión Estatal de Servicios Públicos de Mexicali (CESPM), which receives water from the modules' irrigation canals to serve both rural and urban townships. WUAs lack of accountability to small landholders is frequently reported in the several irrigation modules. Instead, representatives of WUAs tend to be accountable to upper agencies, such as Conagua or to some group of powerful users.

The following five explanatory factors that northern farmers argue as they relate to the low level of participation of WUAs are the most significant among those listed in Table 7. For instance, seven out of nine participants in this study area mentioned that interest groups within WUAs are observed and they have been identified as another factor that induces apathy and lack of water user participation. The same proportion of participants emphasized that, typically, those seen as participating in WUAs are large-scale farmers, the new big landholders.

In this same venue, eight out of nine interviewees perceived an absence of coordination between WUAs and key governmental water agencies, also seen as an aspect of ineffective participation in the All-American Canal process. They also perceived that this lack of coordination may be explained, in part, by the lack of information about and development of formal mechanisms to strengthen institutional links between WUAs and agencies, such as IBWC/CILA, which traditionally focuses on transboundary water issues, even

though these water issues directly affect local agriculture and irrigation.

It appears that a core explanatory factor (as all respondents mentioned) is the fact that WUAs' representatives do not appear to properly inform their constituencies on critical issues and, for this reason, both IBWC/CILA and WUAs are frequently criticized by the individual farmers participating in this study. Furthermore, there appears to be no formal coordination mechanisms between IBWC/CILA and WUAs for jointly analyzing and establishing courses of action. Such formal links or institutional mechanisms for working together simply do not exist. That is, despite the importance of having good communication and coordination between the water agencies responsible for distributing water coming in from The United States, farmers situated at both water delivery points in the Mexicali Valley (Northern International Boundary) and San Luis Río Colorado Valley (Southern International Boundary) have no such formal mechanisms for communication with the international agency responsible for controlling international water distribution in Mexico, such as IBWC/CILA.

Respondents articulated a need for WUAs as a kind of formal institution that can represent farmers' interests and formally engage in the All-American Canal lining issue. That is, local farmers' representatives would be able to raise their concerns with the All-American Canal lining effectively with authorities at state, federal, and international-level water agencies. It appears that there is significant sentiment among local farmers for building bridges between current top-down and the new bottom-up approaches. It is believed that in doing so, this action may defeat the current status quo of low levels of participation of farmers in the All-American Canal issue. As one farmer puts it:

The CILA thinks that we the farmers are not good participants; CILA thinks we are not reasoning people, that we are mostly un-

educated. They [CILA] always negotiate with the IBWC, but our viewpoint is not valid for them for use as an argument in the processes of conflict resolution about transboundary water issues like the All-American Canal [...] I really would appreciate it if someday, the CILA and Conagua officials in Mexicali could formally invite us to participate, to present technical documents, to set forth our standpoints, to consider our concerns, to collaborate with them toward building an unified force. But this has never happened before and might not happen in the near future. [...]. This lack of coordination is the main reason why our representatives make a lot of mistakes while negotiating critical issues. (Dueñas, Martín, interview, 2009).

Finally, local, national, and international politics are seen by local farmers as a factor blocking their participation in the All-American Canal dispute. Respondents describe their perception about politics as of having already arrived at a predetermined outcome for high level negotiations between governments concerning the All-American Canal issue. From this, the project will be implemented subject to later review based on Principles and Mechanisms for Compensation instead of on standards that protect and benefit farmers in the Mexicali Valley. Such standards being promoted by CDEM are based on the Precautionary Principle.

Several schools of thought on Environmental Economics state that the Precautionary Principle implies that under conditions of uncertainty of environmental damage, it must consider a hybrid criterion where efficiency, sustainability, ethical and ecological principles come together to inform decision-making. (Perman, et. al, 2003:249).

It is important to underscore that in 2012, and two years after the All-American Canal lining project was finished, new binational initiatives partially confirm the perspectives expressed by farmers during the All-American Canal lining conflict. Resolution 7 (b) of Minute 319 of the International Water Treaty signed in November, 2012, identifies binational

opportunities for water conservation in Irrigation District 014, Colorado River and water operation improvements to conduct Mexican water through the new All-American Canal.

Such a high priority binational initiative considers the potential conduction of Mexican water through waterworks to be built in the near future. The plan considers connecting the All-American Canal in the U.S. to the Río Colorado-Tijuana aqueduct in Mexicali, Mexico (IBWC-CILA, 2012:18). It is safe to say that a past conflict is now undertaking new ways of collaboration both to attend to the potential binational water shortage envisaged in climate change reports for the regions, as well as for compensating diminishing sources of the water previously seeping to the Mexicali Valley aquifer.

#### Views of Northern Mexicali Valley Farmers of the Institutions Used by Farmers during the All-American Canal Lining Conflict

Respondents noted very different characteristics of the institutional arrangements in the Mexicali Valley during the All-American Canal lining process, from those of the salinity problem period. In the case of the All-American Canal, farmers of the northern Mexicali Valley described institutions that set about to constrain them both as individuals and as members of organizations. This in turn resulted in the participants' point of view that the outcome of the All-American Canal issue will have, at best, weak support and poor outcomes as far as farmers in the Mexicali Valley are concerned. The formal and informal institutions in the region, according to those interviewed, may as well be characterized by processes anchored in the viewpoint dominated and guided by formal institutions that represent wUAs, that are in turn dominated by a few powerful individuals and who have avoided raising the All-American Canal lining issue. It appears as though there is a horizontal disconnection among households in the agricultural sector, an absence of farmers' participation in the water



management process, and only nominal vertical integration of farmers in state and federal agency information gathering, negotiation, and decision making.

During the All-American Canal lining episode, there appears to have been generalized apathy among farmers, lack of leadership, and no financial support to facilitate individual farmers' ability to voice their concerns. Furthermore, the bureaucratic co-management process between WUAs and Conagua, while superficially appearing to promote representativeness, eroded individual farmers' interests because the WUAs were dominated by powerful, large extension landowners.

What respondents shared was a picture in which institutional arrangements that served farmers during the salinity problem episode, failed to do so during the All-American Canal conflict period. As a result, only a weak attempt appears to have been made to defend, protect, and argue about the continuation of All-American Canal seepage or another freshwater source for agriculture into the Mexicali Valley. Such concerns were taken to the U.S. Ninth Circuit Federal Court by a coalition of groups representing community and environmental interests on both sides of the border.

The effort was spearheaded by CDEM, an urban-based economic development corporation. Important co-plaintiffs in the suit included Citizens United for Resources and the Environment (CURE), a California-based non-profit organization focused on sustainable development and resource management, as well as Desert Citizens Against Pollution (Desert Citizens), a community based non-profit organization concerned with environmental justice. Even the U.S. town of Calexico, California, intervened in the suit. Seeking to enjoin the project as a violation of property rights and environmental interests, the case thus represented an international effort to access the U.S. court system on behalf of cross-border economic and environmental interest groups (Cortez, Donovan, and Whiteford 2009,144).

The coalition of plaintiffs brought about a total of eight claims against the Department of the Interior, the Bureau of Reclamation, and relevant regional and local entities. Initially dismissed by the federal district court for a variety of technical deficiencies, new hope for their claims emerged when the Ninth Circuit enjoined the project from proceeding pending an appeal in 2006. Ultimately, in April 2007 the Court of Appeals found broader substantive grounds upon which to dismiss all eight claims, foreclosing further legal challenges and insulating the All-American Canal lining project from judicial review (Cortez, Donovan, and Whiteford, 2009:148).

### Influence of Farmers in the All-American Canal Lining Conflict

As discussed previously, there has only been low-level participation by farmers in the All-American Canal process. This in turn has resulted in little or no influence in identifying potential solutions to All-American Canal seepage elimination. This decreased participation has taken place at the same time the Mexicali Valley has seen a diminishing agricultural economy and the loss of farmers' political power (Table 8).

A large proportion (8 of 9 of interviewees) in the northern area of the valley revealed that a major factor behind the marginal influence of the farmers in the All-American Canal lining process, may be the institutional behavior of contemporary governmental agencies at both the state and federal levels. Interviews revealed that Mexicali's agricultural sector has experienced more than twenty years of governmental indifference. It was learned that small landholders have undergone systematic reductions in credit and subsidies, while production costs have risen and agricultural product prices have fallen.

According to six out of nine respondents, these factors have resulted in a downward spiral leading to detrimental economic

*TABLE 8.* Influence of the Institutional Response (Low Participation) of Farmers of the Northern Mexicali Valley for Finding Solutions to the All-American Canal Lining Conflict

<i>Theme</i>	<i>Explanatory Factors</i>	<i>Frequency of Total Respondents</i>	<i>Major Findings</i>
DIT: Influence of participation of farmers in finding solutions to the All-American lining conflict	ING: Indifference of domestic governments to support the agricultural sector	8/9	Agricultural sector as a whole and WUAS with neither economic nor political power to influence suitable solutions
	DOW: Downward spirals in the Mexicali Valley	6/9	
	ORG: Deteriorated organizations	8/9	
	CIL: Loss of capacity for influencing positive change	8/9	
	ELE: External, urban-based leadership facing the AAC	5/9	

*Source:* Compiled by author based on database (Cortez, 2010).

conditions that further weakened organizational structures, which in turn reduced social participation and agricultural leadership, as influential forces for addressing transboundary water conflicts such as the All-American Canal issue. A proportion of eight out of nine participants asserted these aspects, all of this can be illustrated as follows with one interviewee's opinion:

Nowadays, the government [federal and state officials] sees as "inconvenient" that we the farmers organize ourselves to call for crowded public meetings in order to raise our concerns and disagreements with the current agricultural and water public policies. They dislike that we use mass media such as local, national and even the international press, radio, and TV; they [governments] just want us out of the way as to participation. To them [governments] it is very "sticky" that we express our reality, the awful reality, and the truth about what is happening in the Mexicali countryside [...]. Why have we no power and room to participate? Well, the answer is because there is a remarkable lack of

support of any sort on part of the government [municipal, state, and federal] in terms of creating good conditions for economic growth, thus the power to induce a positive change such as an upward spiral. (González, Ramiro, interview, 2009).

### Views of Northern Mexicali Valley Farmers of the Impact of the Institutional Structures used by Farmers during the All-American Canal Lining Conflict

The impacts of the institutional arrangements used by farmers during the All-American Canal lining process to address transboundary water issues, local irrigation management, and agricultural development in the northern Mexicali Valley appear to have been minimal. In fact, the formal institutions followed during the All-American Canal lining conflict actually blocked local stakeholder participation and made the stakeholders ineffective social actors. Their viewpoint and interests vis-à-vis the All-American Canal lining project were effectively ignored. That is, few or no commitments for compensation or improved water management were made for agriculture in the Mexicali Valley, despite the likely damages envisaged for regional agriculture.

Instead of the formal institutional addressing of farmers' concerns about the All-American Canal process, farmers were impeded from becoming significant and influential actors in this process. This was also true at the binational level, for example, in the modification of the transboundary water management legal framework. The formal institutional structures, such as WUAS and SRL, appeared to be dominated by urban-based leadership such as the CDEM, as well as by several federal agencies. Farmers lost economic and political power and were unable to be influential in transboundary water issues affecting the Mexicali Valley, irrigation and agricultural activity. As such, this key stakeholder is no longer seen as a social actor with the capacity to induce institutional change.

## Conclusions

The findings on the institutions of farmers of the northern Mexicali Valley show that institutional arrangements have changed from effective mechanisms to other lesser ones, between the period of the salinity problem and the All-American Canal lining conflict. Agricultural water users have lost their economic and political power, which has diminished their capacity to participate and influence the transboundary water issues affecting their productive activity and irrigation operation and management.

In general, a combination of formal and informal institutions has influenced the farmers' social behavior. In the case of the salinity process, informal institutions dominated the context (e.g., individual mobilization, congregation of unions, and commercial boycotts), allowing farmers to participate and influence change at local and binational levels. In contrast, during the All-American Canal process, farmers ended up relying on formal organizations (e.g., WUAs) and institutions. There was virtually no unified social behavior, effective leadership, nor economic and political power. Major differences between the salinity problem and the All-American Canal lining processes are explained next (Table 9).

First of all, northern farmers perceive a significant difference between Presidents Luis Echeverría and Vicente Fox in terms of accountability to local people and their interests, such as defending the Mexicali Valley's precious water resources. While the salinity problem period was characterized by institutions with strong leadership, skillful diplomacy, energy, and a sense of patriotism, the All-American Canal lining period was described as one in which President Vicente Fox was strongly criticized by farmers for his absence of leadership and disregard of local interests in the sustainability of the region. The distinct approaches used by the two presidents appear to have had repercussions on the organization and strength of farmers as a unified force.

TABLE 9. Perceptions of Farmers of the Northern Mexicali Valley Concerning Major Institutional Differences Between the Salinity Problem and the All-American Canal Lining Conflict

Theme	Explanatory Factors	Frequency of Total Respondents	Major Findings
DIF: Major institutional differences between the SAL and AAC	DIP: Extent of presidential leadership	5/9	
	DOR: Extent of farmers' organization	6/9	
	DAL: Degree of farmers' leadership	7/9	Different/reduced presidential and local leadership
	DIG: Type of groups pressuring SAL and AAC	6/9	
	CIL: Capacity for influencing changes.	7/9	However, similar politics behind the salinity and All- American canal issues are in fact perceived: high-level politicians in both countries make no transparent agreements
	SOS: Socioproductive structure (due to level of lands rented)	2/9	
	BEC: Economic constraints in Agriculture	5/9	
	SIP: Politics behind salinity problem and the All-American Canal	3/9	

Source: Compiled by author based on database (Cortez, 2010).

During the salinity problem, farmers exhibited unity through the informal institutional structure of the union of unions, whose operation was based on self-financing mechanisms and headed by outstanding local leaders. Contrariwise, during the All-American Canal lining conflict, there was organizational, economic, and financial disaggregation within the irrigation sector and a decrease in the representativeness and effectiveness of WUAs.

For instance, farmers' unions, such as the CCI, CNC, UAR, and CNPPR, were outstanding organizations that dominated

during the salinity period, but urban-based groups such as the CDEM in the All-American Canal process have replaced them. As a result, the capacity of farmers to be involved and influence transboundary water issues has significantly diminished, together with the economic constraints faced by the majority of farmers in the Mexicali Valley.

Although mentioned by only a small proportion of interviewees (3 of 9), a significant aspect explaining the possibilities for either facilitating or blocking the institutional response of farmers in both cases under study is perceived in terms of the politics behind such an event, in which premeditated negotiation between high level governmental actors occurs to face and solve a technical problem transformed into conflict and where damage is allowed to occur and then the affected party is compensated for this.

Finally, it is clear that there are negative externalities in both the salinity and All-American Canal lining processes. As illustrated for the former case, it is expected that implementing a compensatory approach might surmount the latter one, but for this to occur, more intensive and structured participation of farmers should take place. As noted, in the former case  $t_1$ , participation of farmers was promoted and supported to accelerate compensatory measures, while in the later case ( $t_2$ ), participation of farmers as key stakeholders has been hindered by a diversity of factors that in turn, might block the implementation of compensatory measures in the near future for the All-American Canal lining project impacts.





## AGRICULTURAL WATER ISSUES FOR USERS IN CENTRAL AND SOUTHERN MEXICALI VALLEY

This chapter describes the perceptions of farmers living and working in the central and southern Mexicali Valley as they relate to the two transboundary water conflicts under analysis. While there are many similarities among water users in the northern, central, and southern areas of the valley, this chapter focuses on highlighting the differences revealed from the analysis.

To explore the viewpoints of the ten central Mexicali Valley farmers and the eight southern Mexicali Valley farmers interviewed, the similar and different factors that emerged from interviews were first identified. It appears that the level of societal stress in the case of the salinity problem, this was higher in the central and southern Mexicali Valley as compared to that of the northern area, while the All-American Canal lining issue appears to be of major concern in the northern Mexicali Valley. Not surprisingly, the institutional responses of farmers to the salinity issue were broader and stronger in the central (and southern areas) than in the northern Mexicali Valley. In the case of the All-American Canal process, the institutional response, although generally described as weak, remained a predominant idea of farmers in the northern Mexicali Valley, and even in the urban area located in the northern region as well.

## Agriculture and Irrigation in Central and Southern Mexicali Valley

In line with experiences and perceptions shared by farmers in the northern Mexicali Valley, participants in this area of the valley pointed out significant structural changes, such as social polarization among the farmers resulting from water management issues. 5 of 18 respondents in the region did report having made progress, such as technology improvements for land management, diversification of cropping patterns, and significant land reforms that allowed expanding their land ownership.

Water users in central Mexicali Valley with a progress viewpoint evidenced this perspective, in the same manner as agricultural water users from the northern area of the valley. However, in comparing the explanatory factors raised by 3 of the 18 respondents, one factor—the change in the scale of land operations—varies significantly in magnitude from that observed and expressed by respondents in other areas of the valley (e.g., expansion from normally 20 hectares to 200 hectares in the northern and up to 150 hectares in the southern Mexicali Valley). In the central Mexicali Valley, respondents emphasized that typically, new scale or size of agricultural land operations (including irrigation water allocations) tended to be larger than in the near past, so much that it resulted in areas of land operated per household from 20 hectares to around 500 hectares for economically sustainable agricultural production.

For 12 of 18 respondents with the view that agricultural functioning resulted in gradually reduced quality of life or regression, additional arguments or factors were expressed by farmers in the central Mexicali Valley. 7 of 18 participants mention that these factors refer to heavily bureaucratic processes including the increase of paperwork to access agricultural credit, together with a loss of organizational capacity

to grow crops on the part of farmers. These farmers in the past formed and organized large productive cooperatives both for processing agricultural products and for managing livestock operations. One half of the interviewees assert that the new scale operations that ensued resulted in increased leasing of agricultural land in this area of the valley; thus currently about 95 percent of the original owners rent out their lands.

One respondent highlighted these interlinked aspects:

In times of the salinity [crisis], there were crowded farmers' meetings and public manifestations, a very well organized and headed agricultural sector was unified and strong. Now, for the case of the All-American Canal, we are so disarticulated. Why? Because in those times almost everyone worked his own land, there was no land-rental phenomenon [...] now, it is a different situation, now normally in this sub-region [central], there are just a few farmers working the lands, which hold up to 1 000 hectares for each individual to grow. For example, here in the *ejido* [Ejido Nuevo León], just about 10 out of 265 original registered *ejidatarios* [owners] are working their lands, that is 96 percent of the lands are rented to other "new large landholders"! This is because of the lack of agricultural credit and the cumbersome [bureaucratic] processes to get money from both private and official banking corporations. It seems to me that the Mexicali Valley is deteriorating and that it is returning to the "ancient" times of the large landholders, who concentrate vast land extensions. (Abel, interview, 2009).

The regression view expressed by participants in central Mexicali Valley can be linked with the worsened condition observed in terms of a drastic reduction of regional gross domestic product (GDP) in the agricultural sector in recent years. For instance, the trend shows a declining GDP that changed from average levels of five percent during the 1990s to three percent in 2000 and to two point six percent in 2007 (Inegi, 2008).

In regard to the GDP concept, Field (2000:18) mentions that conventional GDP measures are deficient in many respects. The author underscores that one important problem is that they only measure the value of goods and services that move through markets. Another problem is that GDP measures do not allow for natural resource depletion, however, depreciation may also occur in a society's natural resource capital (Field, 2000). The production of conventional goods and services requires inputs from the natural environment, such as water and agricultural land, which might require a formal natural resource accounting exercise in the Mexicali Valley.

Farmers in the Mexicali Valley who perceived some degree of regression in the area also show practical and, at the same time, valuable knowledge based on their lifelong experience as farmers. They see a gradual depletion in their resource base, (e.g., soils and water). Farmers have noticed how their land has been gradually losing its natural productivity, as a result, they have been using fertilizers, pesticides, and water intensively, which in turn has direct repercussions on increased production costs. In the same vein, farmers have seen a diminished quality of both groundwater and surface water sources for irrigation in Mexicali. This latter aspect will be discussed next.

Another major issue raised by farmers of the central and southern Mexicali Valley concerns changes in the management and development of the irrigation sector. First, precisely as in the northern Mexicali Valley, the majority of respondents emphasized increased factionalism among agricultural water users, with a rise in elitism among irrigation water users. As such, these factors inform the perception of ineffective irrigation water management. Concerns regarding ineffective irrigation management dominate discussions, accordingly to the opinion of 10 out of 18 respondents.

Conversely, additional factors mentioned by five participants in the central and southern region attribute the opportunity to undertake irrigation water transfers at different

scales of operation to effective irrigation management. These potential transfers include levels of operation and modes, such as intraparcels changes in water use by an individual agriculturist (e.g., using individual surpluses of a normal water allotment in a second crop within the same agricultural cycle), intramodule transfers among individual farmers (e.g., a wheat grower with a water surplus transferring water allotment rights to an alfalfa grower, with a water deficit within the same module or sub-region of the irrigation district), intermodule transfers among water users within the same irrigation district (e.g., irrigation water transfers among water users in the central Mexicali Valley and water users in the southern Mexicali Valley), and the possibility of negotiating water transfers from agricultural to urban uses.

Water transfers within the central region's irrigation district (irrigation modules 9A, 9B, 10, and 17) have been taking place. However, other theoretically possible trading mechanisms (e.g., agricultural sector-urban area) are encountering trouble with the practice. Farmers appear to see water transfers from agriculture to urban and industrial uses as a threat to the viability of agriculture. In any event, 5 out of 18 interviewees noted that farmers organized as WUAs and the SRL are now better positioned for negotiating critical issues, as they relate to water trading.

As a respondent in the central Mexicali Valley explained:

Here in this irrigation module [number 10], we have excellent personnel, both representatives and water managers working together and in coordination. They have done a very good job of getting shared financial resources from our own water service fees [30 percent], as well as from governmental contributions for acquiring special large equipment and machinery to keep our drains open and the major irrigation network in suitable condition, for leveling our individual parcels, for buying secondary canal water-control devices, for lining or piping interparcel irrigation networks, etcetera. (Jiménez, Ramón, interview, 2009).

In contrast, disappointment with the region's irrigation water management system appears to be even more profoundly felt by farmers in the central area than by those of the northern Mexicali Valley. This is evidenced by the comments of ten respondents, who emphasize high level of bureaucracy, hydraulic operation system failures, and increasing irrigation water service costs, among several other negative factors.

In addition to the increased frequency and intensity of the factors raised by northern farmers disappointed in water management, central region farmers point out operational problems in the irrigation district as a whole. Respondents mention how their region's WUA representatives lack a system-wide perspective and that there is inequality among agricultural water users, insufficient irrigation technology, lack of governmental investment, and lack of interagency coordination. The respondents also point out that naturally occurring seismic activity can affect irrigation infrastructure and hydraulic operations in this particular central region of the Mexicali Valley.

A proportion of 5 out of 18 respondents emphasize local irrigation system operational problems, while mentioning the theme of frequent bad planning and operational procedures by water users' representatives and officials of their WUAs. Discussion also revealed clear differences in how irrigation management was undertaken in the several modules of the central Mexicali Valley, as compared with that of modules in the northern and southern regions. In the central region, irrigation modules rely on one major central canal and water flows through it to irrigate their crops (modules 9A, 9B, 10, 11, 12, 17, 18, 19, and 20) (Map 1 in Chapter 1).

The same proportion of participants mentions that this fact, coupled with an apparent absence of a system view by WUAs and SRL officials, resulted in the fragmentation of the hydraulic irrigation system. This in turn led to the disregarding of key technical and managerial links among irrigation

modules, which affected the operational efficiency of the irrigation district. It was observed that one of the main tasks of the Mexicali Valley SRL was supposed to be the promotion of a system wide vision, as well as the coordination among their twenty three WUA members. However, respondents pointed out that after more than 10 years of operation of the SRL (since 1998 to date), there continue to be divergent interests among irrigators that have resulted in irrigation water operation problems at the irrigation district level.

For example, 7 out of 18 interviewees in the central Mexicali Valley state that equality among irrigation water users is lacking. That is, support given to agricultural water users from both WUAs officials and governmental water agencies such as the Conagua appears to show a high degree of elitism because it tends to favor productive activities for vegetable and alfalfa producers over wheat or grain producers. Also, central region participants commented on the privileged treatment given to WUAs of the northern Mexicali Valley (i.e., at the head water source and wells area) as opposed to WUAs located in the central and southern Mexicali Valley.

The few current investment programs that involve the state and federal governments and water users focus mainly on particular groups of producers, such as those using wells in the northern sub-region. Those with the viewpoint that irrigation management is ineffective (10 of 18 central and southern region respondents) also indicate the lack of coordination between the two main governmental water agencies, CILA (which receives water from The United States) and Conagua (which delivers water to farmers and city users). One water user expressed his disappointment in the following manner:

No, I think that they [irrigation modules] are increasing the cost of the water service [...] I can see it daily, they have a lot of people working in the office and also in the field. There are many *canaleros* [water canal operators at field level], besides, their wages

are so high, including those of the officials and “our honorary” representatives [...] supposedly, the modules were created to support us so we could have more efficient water operation at an affordable cost, right? (Carlos, interview, 2009).

A permanent natural process in the central Mexicali Valley region pointed out by one half of the respondents as a critical problem for water management and other societal risks is the intensive earthquake activity in this area. For example, during February 2008, about 450 earthquakes of magnitudes ranging from 3.0-5.5 on the Richter scale were registered by The United States Geological Survey (USGS) and the Center for Scientific Research and Higher Education of Ensenada (Centro de Investigación Científica y de Educación Superior de Ensenada, CICESE). Another one occurred on December 30 2009, registering a magnitude of 6.0, and on April 4 2010, the strongest and most devastating earthquake in 122 years registering a magnitude of 7.2 on the Richter scale affected 59 000 hectares and 25 000 people living in the central and southern areas of the Mexicali Valley. The earthquakes’ epicenters were located in central Mexicali Valley and they are linked with three different geological faults: the Imperial, Laguna Salada, and Cerro Prieto fault lines (USGS, 2010).

As a result, earthquakes have impacted the operation of major lined canals, such as the Reforma Canal and Nuevo Delta Canal, both serving the majority of central and southern irrigators. Furthermore, seismic activity is reported to maintain the irrigation network in the central Mexicali Valley permanently damaged, and to induce seepage and flooding problems in agricultural lands as well as into nearby rural towns (García, 2010:6). A respondent put it this way:

Here [central Mexicali Valley], we have an enormous specific problem that also weakens and affects the irrigation operation. Constant underground movements affect investments made in



costly hydraulic infrastructure that we have to repair every year or two or it simply stops functioning and then has to be built up again in order to maintain our water operation levels. Frequently, the Reforma and Nuevo Delta canal bases drop and the water delivery devices stay high, so we have to re-invest in raising the canal bottom and lining additional canals [...] this is critical in nearby areas of the *ejidos* Tlaxcala, Nuevo León, Veracruz, Saltillo, Oaxaca, and other nearby *ejidos*. (Jiménez, Ramón, interview, 2009).

It appears that social polarization and differentiation among irrigation water users in the central Mexicali Valley also support Galtung's concept of "structural inequity" (Galtung, 1980:64). As in other regions of the Mexicali Valley, there seem to exist changing roles of farmers vis-à-vis local irrigation management and transboundary water issues in the central Mexicali Valley, as well as a failure to consider actor-oriented and more participative processes directed toward improving irrigation water management.

Developing an appreciation of agricultural and irrigation changes by farmers in the region, provides a background for better understanding of the type and extent of the impacts of institutions in the central Mexicali Valley in terms of response to the salinity and the All-American Canal processes. It appears that, despite some disagreements from other regions, farmers engaged in high levels of participation (institutional behavior) during the salinity problem period ( $t_1$ ) and low levels of participation (institutional behavior) during the All-American Canal lining conflict ( $t_2$ ). Major institutional differences were observed in the central Mexicali Valley communities between  $t_1$  and  $t_2$ . Subsequent sections identify and describe the institutional arrangements complied by farmers at the central Mexicali Valley during both times under analysis.

## Beyond Salinity: The Salty Route

This section focuses on the perceptions of farmers of the central and southern Mexicali Valley, regarding damage to the agricultural sector as a result of the salinity of Colorado River water. It is generally understood that the central area of the valley suffered more than other areas because of this sub-region's soil features, which can be associated with significant productive, economic, and social impacts (Clemings, 1996:135). Therefore, one would expect that central and southern region farmers' institutional responses to the salinity crisis would evidence some differences relative to other regions. As a result, the focus is primarily on elements that stand out for central and southern region farmers and the institutional response to the salinity problem (Table 10).

While some factors appear in both the function for the northern region and the central and southern region's institutional response to the salinity issue, different factors are highlighted here. Based on the interviews implemented in the central and southern Mexicali Valley area, there are significant differences concerning how the farmers felt and assessed physical impacts or damage to the agricultural sector due to the salinity in this agricultural area as well as in the entire Mexicali Valley.

For instance, a significant number of respondents (10 of 18) mentioned a widespread adverse impact to water users in the central area of the valley. Portions of or whole parcels were described as becoming saltier, with the corresponding use of the term salty route for parcels localized along a region or strip with significant salt accumulation. Respondents understand this physical feature to be a key indicator of the damage of salinity to the regional agriculture. A large proportion of respondents (16 of 18) also discussed significant crop yield reductions, which were as great as 80 and 70 percent in principal crops such as cotton and wheat, respectively. At

the same time, 7 out of 18 respondents mentioned increasing production costs associated with farming in the salty route. Also, respondents reported that official agencies observed productivity challenges as barriers to their being able to offer financial support, mainly during the initial stages of the salinity process and the presidential administration of Gustavo Díaz Ordaz.

TABLE 10. Damages to the Agriculture of Central and Southern Mexicali Valley as a Result of the Salinity Problem

<i>Theme</i>	<i>Explanatory Factors</i>	<i>Frequency of Total Respondents</i>	<i>Major Findings</i>
SAD: Damages to the agriculture of the Mexicali Valley	MIX: Disposal of salty waters upstream (salinity of the Colorado River)	5/18	Significant social, productive, economic, and environmental impacts.  Salinity problem more critical for CAH than for NAH
	ROU: Existence of salty soil strip along the valley (salty route)	10/18	
	SAH: High degree of salts pollution in individual parcels	10/18	
	YED: High extent of crop yield reductions	16/18	
	ICS: Increasing production costs for individual farmers	7/18	
	CRI: High degree of contracting agricultural credit for unproductive lands	7/18	
	RED: High degree of individual parcel-size reduction	9/18	
	ABA: High proportion of farmers abandoning agriculture	9/18	
	SAR: Salinity problems remain	12/18	

Source: Compiled by author based on database (Cortez, 2010).

One half of the participants in this study area mention that as a result, agricultural water users showed wide variations in their social and productive behaviors. First of all, individual efforts to compensate for the negative impacts of the salinity included emergency actions to modify the scale of operation. For example, the most common emergency action, according to the interviewees, was for “salt-stressed” farmers to reduce the normal size of agricultural operations from 20 to 18 hectares, on average. Second, depending on the extent to which farmers were impacted by salts pollution, many of these abandoned, either temporarily or permanently, agricultural activity on their land. Some chose to leave their parcels to migrate to Mexican urban areas, while others went to work on the field in The United States.

One respondent who lived through the salinity problem shared this response:

During several years, land operations were reduced. We received water to irrigate 14 or 16 hectares instead of the 20 hectares of our normal water rights. For this reason, we asked for water sources mixture [wells and canals] for the impact to be reduced to just 18 hectares [...] anyway, a lot of people here had to leave either permanently [land sold] or temporarily [inactive land]. Many of them emigrated to Los Angeles [California] and many others to their place of birth in central Mexico. It was a really critical moment when we had no money to survive. (Cecilio, interview, 2009).

According to 12 of 18 respondents, farmers in the majority of areas of the Mexicali Valley stressed continual salinity problems. It appears that even today, the salinity problem remains a critical issue affecting agricultural productivity in the Mexicali Valley. This assertion is in line with the work of Clemings (1996:135), who studied *ejidatarios* of the central area of the Mexicali Valley.

## The Challenge of Central and Southern Mexicali Valley Farmers during the Salinity Problem

The institutional response of farmers of the central and southern Mexicali Valley during the salinity problem period shows additional explanatory factors, in contrast to those by farmers in the northern Mexicali Valley (Table 11).

Interviewees revealed that there was intensive participation at the individual level, even in instances in which the majority of people persisted in implementing productive, economic, and social actions that enhanced their capacity to adapt to damage. There appears to be tremendous persistence among central Mexicali Valley farmers, because they have confronted previous periods of water scarcity, the salinity crisis, and today, the All-American Canal lining conflict.

Such a high degree of adaptability to adverse conditions was emphasized by 7 out of 18 respondents, who mentioned how farmers created a variety of technical processes in their parcels as a response to avoiding reduction in crop yields. Such informal institutional behavior (adaptability) responded with changes in crop growing techniques, even with the absence of technical support from official agencies. For example, individual farmers attempted non-conventional furrow irrigation methods and planting system modifications (e.g., placing seeds at the bottom of an undulation so that contact with salt was minimized).

Eventually, the development and substitution of crop varieties more tolerant to salts were undertaken. As one senior agriculturist pointed out, his ability to face and overcome the problem was not easy: 12 of 18 respondents reported outstanding local leadership. In addition to the often mentioned Alfonso Garzón, other outstanding leaders indicated included Hipólito Rentería, Celestino Salcedo, and Francisco Aguilar in regard to their ability to mobilize masses of people. However, farmers from the central Mexicali Valley strongly criticized

*Table 11. High level of Participation of Central and Southern Mexicali Valley Farmers as an Institutional Response to the Salinity Problem*

<i>Theme</i>	<i>Explanatory Factors</i>	<i>Frequency of Total Respondents</i>	<i>Major Findings</i>
HIP: High level of participation in the salinity problem	UNI: Unity base at the household level	7/18	Effective vertical and horizontal coordination among farmers and several levels of government in Mexico  Adaptation capacity shown by farmers  Failing leadership
	ADA: Adaptation to adverse situation	7/18	
	FIC: Financial capacity of farmers	14/18	
	SOL: High degree of solidarity among farmers	12/18	
	CEJ: Fundamental local/neighborhood leadership	5/18	
	LOL: Outstanding local leaders	12/18	
	FAL: Failing local leaders	7/18	
	PAL: Principal leader	12/18	
	LAU: Local agricultural union leadership	9/18	
	SAU: Strong agricultural unions	16/18	
	PAU: Principal agricultural union	5/18	
	LEA: Significant Presidential leadership	16/18	
	EXS: External support from local industry and commercial sectors	9/18	
	SSS: Strong governmental support	9/18	

*Source:* Compiled by author based on database (Cortez, 2010).

other widely acknowledged leaders in other parts of the valley, such as Rodolfo Fierro. 7 out of 18 respondents tagged this leader as failing to protect and defend the interests of central and southern Mexicali Valley farmers. One respondent mentioned the following:

The great financial support coming from President Luis Echeverría for recovering our lands during the salinity problem was poorly managed by some leaders, such as Rodolfo Fierro. This is the reason that many agribusinesses, livestock, and grazing operations in this central sub-region declared bankruptcy [...] only a few, corrupt people belonging to the “political group” of Rodolfo Fierro became millionaires, bought extensive lands, and this hindered our agricultural recovery and development [...] We initiated the fight against Rodolfo and his *cacicazgo* (political bossism), he wanted to control everything and everyone and we always tried to save “our” agri-industries before they went bankrupt [...] it was impossible at those times, but nowadays he [Rodolfo Fierro] no longer controls our productive will, we finally defeated him, he is not such a “big leader” anymore. (López, Sergio, interview, 2009).

Two other factors reported by one half of respondents to have impacted farmer participation in the salinity process comprise the extent and type of support coming from external political, governmental, and economic sectors. This support was provided in addition to the internal financial capacity of agricultural water users (e.g., voluntary contributions included in irrigation service fees).

At the local level, this external moral and economic support came from the commercial and industry sectors in Mexicali. For instance, commercial and industrial leaders jointly organized fundraising actions that during the salinity crisis provided water users with meals, water, and shelter. As one respondent recalled: “Yes, there was a lot of support coming in from the businesses of Mexicali (City), they used to provide us

[farmers] with help of any sort, like meals and clothes, while we were attending long, crowded meetings.” (Martínez, Felipe, interview, 2009).

In line with the strong national presidential hold and leadership of President Luis Echeverría, respondents reported strong state and federal agency support, which resulted in the technical assistance, financial programs, and organizational guidance provided to the farmers affected by the salinity problem.

### Institutional Behavior of Central and Southern Farmers during the Salinity Problem

The features perceived by central and southern Mexicali Valley farmers concerning the institutional arrangements engaged in by farmers during the salinity process show a type of human relationship that enabled opportunities for a high level of participation in such a process. These institutions were characterized by informal processes based on strong farmer customary transactions (ideologies), that resulted in the later implementation of formal institutions such as the modification of the Water Treaty, and the parallel compensation mechanism.

For instance, the high degree of unity among farmers embodies an informal institutional social behavior guided by local and national leadership that enjoyed a high level of credibility in society. This fact made individual farmers and their respective unions a cohesive social force, that possessed the capacity to organize large demonstrations to boycott commerce between The United States and Mexico. Also, they had a remarkable vertical and horizontal coordination capacity to ask federal officials, (even President Echeverría), to directly solve the problem and to establish public formal commitments for solving the problem. President Echeverría visited the problem area several times during the salinity crisis and even after the solution was reached.



Furthermore, such a social force was financially independent because they also employed autonomous informal mechanisms for collecting funds (voluntarily given). Also, a hallmark noted in this central sub-region was the intensive participation and emergence of local leaders, that aided in developing federal programs to ameliorate the crisis, while the problem was mainly noticed and across the salty route, which is principally located in the central and southern Mexicali Valley.

Another specific institutional feature was the informal customary transactions and standard operational procedures that were predominant among the people working in this region. While having just a few alternatives for continuing to produce, they exhibited a significant capacity for adapting to the adverse situation created by salt on their lands. Farmers from the central Mexicali Valley had to face the problem in field and underway in order to keep their lands productive through the modification of water and land management procedures, this even without having formal official technical support at the beginning of the salinity problem.

Individual farmers participated in the aforementioned issue even before the design and implementation of the Mexicali Valley rehabilitation program. In this respect, it is important to highlight the mismanagement of administrative procedures for the financial program administration created to support individual and organized farmers. Respondents mentioned corruption as a particular feature that halted the progress of the rehabilitation program, rendering it incomplete.

Farmers from all across the valley mentioned that control, direction, and decision-making were performed jointly between federal governments and local water users. However, a surfeit of problems presented, such as corruption and incomplete program implementation. This fact can be observed as a customary transaction or informal institution that dominated the entire salinity process in its compensatory stage. However, a combination of [different] institutions and organizations

were in place. Informal processes and groups dominated the scenario and also put pressure on formal entities mobilized for finding suitable solutions to the salinity issue, with the overall aim of acquiring benefits to for recovering the productivity or their lands and receiving compensation for damages to the agricultural sector.

The findings discussed previously outlined the distinctive factors that explain the high level of participation of Mexicali Valley farmers during the salinity problem period. These institutional features of the farmers' participation, in turn, inform about their significant and effective influence for inducing solutions to salinity in terms of legal, economic, and technical changes and finally, for obtaining benefits for the Mexicali Valley countryside.

With the exception of the issue of politics behind the salinity process mentioned by northern Mexicali Valley participants, the institutional depiction below is similar to that described in the previous chapter (Table 12).

Here, the issues underscored by interviewees in the central Mexicali Valley are pointed out. 10 of 18 interviewees spoke of the influential participation of farmers in the salinity process for the subsequent modification of transboundary water issues. In line with this influential participation, farmers of the Mexicali Valley were also benefited in different ways, for example, in the implementation of the rehabilitation program (all respondents mentioned this issue), in receiving better water quality and large hydraulic infrastructure, such as the Wellton-Mohawk Canal, in order to eliminate the risks of salts contamination and finally, the benefits felt at the parcel level when the government delivered financial support for continuing production (12 of 18 respondents commented on this point). Together, these factors are understood by the farmers interviewed in this study area as a key influence in reaching technical solutions to the salinity problem.

*TABLE 12.* Influence of the Institutional Response (High Participation) of Farmers in Finding Technical Solutions to the Salinity Problem

<i>Theme</i>	<i>Explanatory Factors</i>	<i>Frequency of Total Respondents</i>	<i>Major Findings</i>
ITS: Influence of participation of farmers for reaching technical solutions to the salinity problem	IBI: Influential participation of farmers in inducing institutional change for binational water management	10/18	The farmer as key social actor pressing for a solution to the salinity
	REQ: Influential participation of farmers in implementing water quality infrastructure in the Mexicali Valley and Colorado River	5/18	
	rel: Influential role of farmers in defining and implementing the rehabilitation program	18/18	
	REI: The role of farmers in the unfinished rehabilitation program.	3/18	
	CAP: Influential participation of farmers for obtaining financial support to continue production	12/18	
	COR: High extent of corruption and mismanagement of U.S. compensation and Mexican financial support funds by Mexican actors	7/18	

*Source:* Author's elaboration based on database (Cortez, 2010).

Also, similar to the case of northern farmers' responses, corruption was mentioned by 7 out of 18 central and southern Mexicali Valley respondents as a current issue in the salinity process. In general, central Mexicali Valley respondents feel they were both principally affected by the salinity problem and mainly benefited by technical solution programs as compared with other areas of the Mexicali Valley.

### Views of Central and Southern Mexicali Valley Farmers of the Impact of Institutional Structures Complied with by Farmers of the Mexicali Valley during the Salinity Problem

The impact of the institutional arrangements adhered to by farmers of the Mexicali Valley concerning transboundary water issues, local irrigation performance, and agricultural development is highlighted in this section. From the perspective of central and southern Mexicali Valley farmers, informal institutions created by farmers during the salinity crisis resulted in a high level of participation, which was more effective for recovering the productivity that existed prior to the salinity crisis, and improving water management conditions and agriculture in the Mexicali Valley.

The impacts of putting into practice an overall dominant informal institutional response to the salinity crisis, allowed the farmers to be acknowledged as influential social and political actors who pressed to acquire direct local benefits, such as the definition and implementation of financial programs at the parcel level, as well as the rehabilitation program at the irrigation district level.

In fact, such a rehabilitation program was initially visualized among the central Mexicali Valley farmers, those most negatively affected by salinity, in order to establish a new cropping pattern based on grazing areas and livestock, to substitute for the traditional cotton and wheat production in this

area. The most positive impact resulting from the dominant informal institutions created and put into practice by farmers, was the so called rehabilitation program, despite the fact that internal problems among farmers existed during its operation. The program is also acknowledged as one of the major benefits obtained as a result of the high social participation in the salinity process.

Also, farmers were influential in the process of receiving benefits at the binational level through modification of the transboundary water management legal framework, specifically the establishment of Minute 242 of the 1944 Water Treaty. In fact, informal institutional structures, such as the large protests instigated through the cooperation of the irrigators, were a concern to high level authorities. This procedure utilized by individual farmers and their unions, in turn produced formal institutional change in the local and binational frameworks for water management.

### Farmers and the New International Water Divergence

In this section, farmers' perceptions regarding the All-American Canal lining process. First, the views of farmers on the potential damages that the All-American Canal lining project might bring in Mexican territory are addressed. Next, the impacts of institutional devices for addressing the issue are discussed.

In general, farmers expect productive and economic as well as environmental damages to the Mexicali Valley, as a result of the implementation of the American hydraulic project. Particularly farmers in the central Mexicali Valley, in contrast with those of the northern valley region, neither identified social factors such as the deterioration of rural small towns nor indicated migration as explanatory factors that could induce damages to the Mexicali Valley agricultural sector.

The factors represent technical aspects of the potential negative impacts. Similar to the perception of northern Mexicali

Valley farmers, these factors were also mentioned by the majority of farmers (6 out of 10 respondents) as explanations of the type and extent of risks envisaged as a result of the implementation of the All-American Canal lining project. In addition, central Mexicali Valley interviewees communicate a concept that represents a macro-level vision of the problem. For example, they categorize the impacts of the project as more generalized and extending to the whole Mexicali Valley, instead of to a specific region of Mexicali; the northern or northeastern side of the valley near the All-American Canal lining project.

When addressing the potential negative impact on the regional aquifer, 12 of 18 respondents in the central and southern Mexicali Valley mentioned that the damage would not only occur in irrigation modules located near the project area (irrigation modules 4, 5, 6, 7, and 16 located at the northern and northeast Mexicali Valley), instead the damage might be gradually felt throughout the entire Irrigation District, in that it encompasses an interconnected hydraulic compound of wells and canals that serve the same irrigation system, as well as the agricultural water users ruled by the same local institutional framework, such as WUA Titles of Concession and the Irrigation District 014 Ordinance, which emphasize equity issues in access to water.

The same proportion of respondents asserts that, as a result, one of the impending productivity impacts with respect to Mexicali Valley farmers is the reduction of land to grow crops. For instance, wheat growers expect to reduce their individual land parcels from 20 to 14 hectares, and cotton and alfalfa growers may be affected similarly. An interviewee summarizes his standpoint by mentioning the following:

The All American Canal lining project will affect us tremendously! The number of hectares for cultivation might be reduced again! We already went through this situation in the past when

water shortage took place and we had to cultivate just 14 instead of our normal 20 hectares of wheat. (Martínez, Felipe, interview, 2009).

### Participation of Farmers in the All-American Canal Lining Conflict

As discussed in Chapter 3 for the case of northern Mexicali Valley, the institutional response of farmers to the All-American Canal lining process is seen by central Mexicali Valley irrigators as ineffective, and accompanied by a notorious lack of cohesion because there was no coordination with official water agencies and even within the agricultural water users' sector itself. (Table 13).

Aspects related with generalized apathy was largely mentioned by 14 of 18 respondents. Also, 5 out of 18 participants underscored either lack or manipulation of critical information on the part of water agencies or lack of presidential and local leadership. A significant number of participants emphasized a high degree of land-leasing phenomena observed after the NAFTA signing (10 of 18), as well as deficient mechanisms for financing the participation of farmers in the All-American Canal process (12 of 18) as two key factors that led to a remarkably weak defense of the All-American Canal issue on part of the farmers.

An interviewee's assertion better describes the issue of weak participation and ineffective defense by farmers of the All-American Canal seepage:

Even though this project might affect the whole area of the valley, there are no more crowded farmers' meetings to fight against this project. Now, there is a high level of disorganization among farmers. Besides, there are only a few "original" farmers because most of us are renting our lands. (Noriega, Rolando, interview, 2009).

TABLE 13. Institutional Responses of Farmers to the All-American Lining Process (Individual Farmers)

<i>Theme</i>	<i>Explanatory Factors</i>	<i>Frequency of Total Respondents</i>	<i>Major Findings</i>
	APA: Generalized apathy on the part of farmers of the entire Mexicali Valley	14/18	
	GBC: State government intervention	7/18	
	LIN: Lack of information	5/18	
	MIN: Misleading information	5/18	
	TRA: Lack of transparency on the part of federal governmental agencies	5/18	
	PLA: Presidential lack of accountability to locals	5/18	
	GLA: Lack of accountability to locals on the part of federal governmental agencies	7/18	
DAS: Weak defense of farmers against the All-American Canal lining project	ALE: Aging leadership in the Mexicali Valley countryside	7/18	No vertical coordination of farmers and federal government
	SOI: Indirect sources of Information	3/18	
	ASY: Formal users' assembly mechanism to inform	7/18	
	LED: Dispersed and disarticulated leadership in the Mexicali Valley	10/18	Horizontal social disarticulation of the agricultural sector
	ELE: External, urban based leadership facing the AAC	7/18	
	LES: Lack of external economic and technical support for farmers	5/18	
	NOF: Lack of farmers' financial capacity	12/18	
	REN: High degree of lands rented	10/18	
	DOW: Downward spiral in the agricultural sector	9/18	
	POC: Politics behind the AAC issue	5/18	

Source: Compiled by author based on database (Cortez, 2010).



Only 3 out of 18 respondents highlighted that as a result of officials not sending timely information to farmers they mainly use indirect sources of information, such as isolated television programs, radio, and the local printed press to learn about the All-American Canal process. This suggests that the majority of information for farmers is very informal and mainly circulated among themselves as rumors.

As a matter of fact, 7 out of 18 interviewees assert that individual agricultural water users asked WUA representatives for more accurate and timely information about the issue, as well as for technical support from governmental agencies. This resulted in some scattered and not crowded meetings in WUA assemblies and brought about the intervention of state, government representatives at some final stage during the All-American Canal process. An interviewee went further in this aspect by stating the following:

Actually, I don't really know about the present issue at all. I realize that such a project could cause us serious problems, and also here in the central area, not only to farmers living on the northern side. However, the little I know about it I read it in some articles in *La Voz* [local newspaper] and also I have heard about it in the radio [...] well, for this particular issue, one module meeting was held here at the *ejido* to offer "moral" support from the state governor, Eugenio Elorduy, who was the only one that seemed interested in the conflict. (Oropeza, Efraín, interview, 2009).

The role of organized agricultural water users in WUAs also explains the type and extent of the participation of the irrigators' sector in the process. 10 of 18 respondents from the central and southern Mexicali Valley indicate that WUAs were neither formally nor effectively involved in the issue, similar to the opinion of northern farmers. In fact, WUA representatives tended to avoid the All-American Canal issue altogether (Table 14).

Although WUAs had the fundamental role of pressing the state government to intervene in the All-American Canal lining conflict, in order to press federal government to strongly defend the issue on behalf of the farmers potentially affected, a few participants in this study area (5 out of 18) mentioned that WUA performance as a social and productive element was not effective. This was mainly due to their lack of a system view, which led to the sector's social disintegration as well as to overwhelming internal irrigation planning and operational problems among irrigation modules. Both causes impeded effective representation of the Mexicali Valley agricultural water users' interests in the All-American Canal lining issue.

In agreement with northern farmers' views, central and southern Mexicali Valley farmers perceive that the characteristics of institutional arrangements followed by farmers of the Mexicali Valley during the All-American Canal lining conflict, contrast with those followed during the salinity problem process. Farmers, both as individuals and as formal organizations, show institutional structures that tended to constrain the creation of opportunities for proper participation in the All-American Canal process. This in turn explains the apparent weak support and minimal outcomes as far as farmers in the Mexicali Valley are concerned with the All-American Canal issue.

While there was a combination of formal and informal institutions influencing farmers' behaviors, formal organizations such as WUAs, which systematically avoided addressing the All-American Canal issue, dominated. The notable social disarticulation within the agricultural sector and the lack of political and economic power, hindered their involvement in the process and blocked effective representation. Hence, the farmers were also limited in their coordination with Mexican state and federal agencies related with the All-American Canal lining issue.

TABLE 14. Institutional Responses of Farmers' WUAs  
to the All-American Canal Lining

<i>Theme</i>	<i>Explanatory Factors</i>	<i>Frequency of Total Respondents</i>	<i>Major Findings</i>
	IMU: Top-down imposed WUAs	10/18	
	LER: WUAs entitled to participate in the AAC process	3/18	
	BUR: Bureaucracy of co-Management	9/18	
	ALA: WUA lack of accountability to individual users	9/18	
	GIA: Groups of interest and apathy within WUAs	7/18	
	LAN: Large landholders command and control WUAs	7/18	
ELU: Low level of participation of agricultural WUAs in the AAC process	LIM: Lack of information about formal mechanisms to participate	5/18	WUAs not effectively involved with any representation in the AAC process
	LAC: Lack of formal coordination mechanisms	5/18	
	LIC: Lack of coordination with IBWC/CILA	5/18	
	ROL: Pressing role of WUAs	5/18	
	SYS: WUA lack of system view	5/18	
	OPE: Irrigation operation problems	5/18	
	POC: Politics behind the All-American Canal lining issue	5/18	

Source: Compiled by author based on database (Cortez, 2010).

Generalized apathy and lack of leadership, together with limited financial capacity in the irrigation sector, presented unfavorable conditions for individual farmers to voice concerns on the transboundary issue. Instead, they rested on the representation of WUAs as formal institutional structures. However, the heavy bureaucracy in the co-management between WUAs and Conagua resulted in a loss of representativeness in the All-American Canal lining process. From this, it was observed that WUAs showed a remarkable degree of accountability to federal water agencies as much as a lack of coordination with key transboundary water agencies, such as the IBWC/CILA-Mexican section.

These facts show the type of formal institutional arrangements complied with by farmers during the All-American Canal lining conflict. As such, the formal institutions maintained the farmers under the umbrella of urban-based leadership, which led to low level of participation and weak defense against the All-American Canal lining project on the part of agricultural water users.

Central and southern Mexicali Valley farmers also perceive that the weak defense against the All-American Canal lining project and the low level of participation exhibited by formal agricultural water users' entities, such as WUAs and the SRL, limited the influence of farmers in finding suitable solutions to the impending impairment that the project will produce in the agricultural area of the Mexicali Valley. The foremost factor leading to such institutional behavior and the consequent non influence of farmers in the issue, comprises the diminished economic situation within the rural realm.

### Views of Central and Southern Mexicali Valley Farmers of the Impacts of the Institutions Used by Farmers during the All-American Canal Lining Conflict

The impacts of the institutional arrangements used by farmers during the All-American Canal lining process are devel-

oped next. From the perspective of central Mexicali Valley farmers, the formal institutional structures farmers adhered to during the All-American Canal lining conflict obstructed their participation in the process, and also rendered them ineffective in promoting the farmers' viewpoint as well as obtaining compensation commitments.

The farmers were also irrelevant actors, thus preventing them from influencing positive change at the binational level, for instance, through modifications of the transboundary water management legal framework regarding transboundary groundwater management. The formal institutional structures complied with by farmers, such as the administrative transactions represented by the participation of WUAs within the context of urban-based leadership, is seen as a realistic behavior showing the farmers' loss of economic and political power for influencing local irrigation management, and effectively facing transboundary water issues affecting agriculture in the Mexicali Valley. As such, this once key stakeholder is no longer seen as a social actor with the capacity to produce formal institutional change at the binational level in the case of the All-American Canal conflict, which contrasts significantly with the institutional behavior of farmers during the salinity problem process.

## Conclusions

This chapter demonstrates that, according to the central and southern Mexicali Valley farmers interviewed, the institutional arrangements of farmers in the Mexicali Valley, and their impacts in each case, the salinity problem and All-American Canal lining conflict have changed significantly. As a result, agricultural water users have lost economic and political power, which in turn has weakened their capacity to participate in and influence the transboundary water issues affecting their agricultural productive activity and irrigation performance.

Combinations of formal and informal institutions have guided the farmers' social behavior. However, it is noted that for the case of the salinity problem process, informal institutions dominated the context (e.g., large protests and commercial boycotts). This feature allowed them to participate in the salinity process and influenced institutional change locally and binationally.

In contrast, during the All-American Canal lining conflict, farmers mainly relied on the formal water users' associations and institutions in place. As such, the impact of their social behavior on the process was all but unnoticed. The social articulation, leadership, and economic and political power that could help them change the context of potentially adverse conditions for transboundary conflicts and local irrigation were lacking. Major institutional differences between the salinity and All-American Canal processes can be explained next. A difference between presidential leadership and level of accountability to farmers (Luis Echeverría vis-à-vis Vicente Fox) was perceived. While the salinity problem was in process, Luis Echeverría exhibited personal and institutional behavior characterized by strong leadership, skillful diplomacy, and a sense of patriotism, whereas President Vicente Fox was highly criticized by farmers because of his disregard for this region's agricultural sustainability.

Also, this difference in presidential institutional behavior had repercussions on the level of organization and strength of farmers, particularly those in the central Mexicali Valley, as a unified force. For instance, during the salinity process, which had a higher negative impact than in any other region of the valley, farmers showed the capacity to adapt both crops grown and irrigation techniques rapidly in order to face the adversities brought about by the salinity of the Colorado River. Later, they fostered unity and strength through their unions, whose operation was based on self-financing mechanisms and headed by outstanding local leaders.

Conversely, during the All-American Canal lining process, organizational, economic, and financial disarticulation within the irrigation sector were observed. Also, lack of effectiveness of WUA representatives resulted in criticism due to their inability to formally intervene in the issue, as well as a lack of a system view. This fact in turn brought a change in the type of organizations or pressure groups involved when critical transboundary water issues occur. For instance, while the farmers' unions were dominant in the past, urban-based groups have now replaced them. As a result, the capacity shown by farmers during their participation in the salinity problem for influencing transboundary water issues, and inducing institutional change at different levels is now diminished, along with the economic constraints faced by the majority of small farmers operating in the Mexicali Valley.





## WATER MANAGERS' VIEWS

This chapter brings to light themes, ideas, and concepts regarding the perspectives of water managers in the Mexicali Valley in terms of the evolution of irrigation sectors, as well as the farmers' participation and influence in the salinity problem and All-American Canal lining processes. Different views emerged regarding the degree of stress induced by these two transboundary water conflicts, the features and impacts of participation of farmers in the salinity problem and All-American Canal, and finally, the outcomes depending on the cases studied. In order to do this, the views of two categories of water managers were analyzed: the older and the newer irrigation water managers.

The category of older water managers encompasses water officials who are working or who formerly worked with governmental water agencies (e.g., SRH and the former Mexican Hydraulic Resources Secretary, currently Conagua) and who held offices during both the salinity problem and All-American Canal lining conflict episodes. These six respondents studied may at present continue serving either Conagua or the water users' associations (e.g., WUAS or SRL). Also, in a few cases in this study the older managers recently retired. A major feature of this type of subject is that they have had a high degree of mobility among the distinct areas of the irrigation district, as such, they express their opinion in reference to

the entire Mexicali Valley, instead of only a specific region of the valley.

The newer water managers include water officials who recently began working in the irrigation water sector, as such they have directly experienced only more recent processes, like the All-American Canal lining conflict, but were not working during the salinity problem period. This group of participants encompasses water managers belonging to the Mexican National Water Commission (Conagua), the International Boundary and Water Commission (IBWC/CILA), and the water users' associations (WUAs).

First, the institutional and descriptive functions generated to respond to the central research questions of the study are explored, these are, the institutional characteristics of farmers for each case (salinity problem and All-American Canal lining project), the impacts of the institutional arrangements employed in their productive activity and irrigation, as well as in their behavior in facing critical transboundary water conflicts, the different levels of stress in transboundary water conflicts, and finally the influence of Mexicali Valley farmers for inducing institutional change at local and binational levels.

In a subsequent section, both older and newer water managers' perspectives are analyzed. This section begins with a description of general aspects regarding the evolution of irrigation in the Mexicali Valley. Next, it discusses irrigation water managers' perceptions of farmers' institutional responses to the salinity problem process and the conditions for participating in and influencing the permanent and definitive solution. Then, it discusses the views of irrigation water managers concerning the pressures of the All-American Canal lining project and the institutional devices utilized by farmers to address it. Finally, this chapter explains the major differences among the cases studied.

## Older Water Managers' Perceptions

As discussed in preceding chapters, agriculture and irrigation development in the Mexicali Valley are directly linked with transboundary waters in the lower Colorado River. Accordingly, the perceptions of older water managers in regard to the evolution of these interrelated sectors are explained in order to understand central aspects of this study. First, the views articulated by older water managers regarding the major changes that have taken place during the last five decades (from early 1960s to 2008) in the Mexicali Valley are regarded.

All of the older manager respondents emphasize the progress standpoint as a process, explaining the positive change noted in socioeconomic growth, technical advances, and human development in both the agricultural and irrigation sectors (Table 15).

Institutional factors for the progress standpoint appear to be similar to those revealed by farmers. For instance, a third of participants have observed significant changes in cropping patterns, with a transformation from a production plan largely dominated by cotton and wheat until the mid 1960s to what currently incorporates 50 different types of cultivations. They also noticed larger scales of operation, which have changed from the original allotment of 20 hectares per household (in 1955) to about 150 hectares on average today. This has resulted in a new hoarding phenomenon process, derived from the high proportion of land under rental contract in which only a few farmers operate large growing areas.

In addition, one half of respondents emphasized higher land productivity as a result of technological improvements and intensive use of fertilizers. In this same venue, the majority of participants (five out of six older water managers interviewed) mentioned that such technological improvements included the implementation of new production techniques and methods

*TABLE 15.* Perceptions of Older Water Managers in the Mexicali Valley Concerning the Evolution of Regional Agriculture

<i>General Perception</i>	<i>Explanatory Factors</i>	<i>Frequency of Total Respondents</i>	<i>Major Findings</i>
	DIV: Crop diversification	2/6	
	LAR: Larger scale of agricultural operations (from 20 to 150 hectares on average)	2/6	
	HIL: High land productivity	3/6	
	TIM: Technology improvements for land management	5/6	
	HUM: Human resources Improvement	3/6	
	POP: Growing population of rural areas	3/6	
	URB: Urbanization of rural small towns	3/6	
	IWT: International Water Treaty	4/6	
	MOD: The Mexicali Valley as a development model	2/6	

*Source:* Compiled by author based on database (Cortez, 2010).

that focused on crop production as well as on land and irrigation water management skills.

Four out of six interviewees considered that the advantageous condition afforded by the institutional arrangement for transboundary water management, such as the 1944 Water Treaty, is a key factor that has brought direct benefits for developing agriculture and irrigation in the Mexicali Valley.

Additionally, half of the participants asserted that the ongoing human resources development, regarding to the availability of more experienced practitioners and skilled farmers, as well as technicians with higher educational levels, have supported

the growing agricultural and irrigation sectors of this region. In addition, social aspects are highlighted, because steady population growth in rural areas is taking place parallel to the improvement of the public services infrastructure (water, energy, communication and transportation systems, and education), which facilitate the function of a diversified economy in the small rural towns widespread in the Mexicali Valley.

Taken together, all of these aspects have enabled the Mexicali Valley rural area to gain a national and international recognition as a social and productive system, that has faced adverse situations and where both institutional and socioproductive adaptation procedures have been its major strength. Examples of this are the establishment of an international water treaty that mainly benefits the regional agricultural sector, and the achievement of changing cropping patterns with the significant participation and influence of local farmers.

To illustrate this viewpoint, an older water manager who has served several regions of the Mexicali Valley since 1965, formerly as an official belonging to a governmental water agency and now as a water manager in a WUA in the northern side of the valley, expressed the idea of progress as follows:

To me, the evolution of the Mexicali Valley means a sort of “progress”. Some years ago, unworkable rough lands were dominant, water control devices made of wood were in use, there were no lined secondary irrigation canals, thus there was low water use efficiency, say 40 percent or less. Also, the dominance of practically a single crop in the entire valley, say cotton. Now, and after the rehabilitation program was implemented, crops were diversified, irrigation canals were lined, efficient irrigation systems at the parcel level are spread across the valley, therefore, water availability increased. There is no comparison between past and present times in regard to the socioeconomic situation, available technology, and the capacity of technicians for land and water management. (Pérez, Próspero, interview, 2009).

Another irrigation water manager currently working for a governmental water agency, and who has been living in the central Mexicali Valley for more than sixty years added the following:

One of the most significant aspects is that now there are more prepared technicians. Besides, there are also more experienced and capable farmers who have developed individual and group initiatives to grow and sell their production. They also have an integral view of how to develop the Mexicali Valley's agricultural sector. Another point is that the Mexicali Valley is becoming an attractive place to live and work, given the extent of urban development of rural towns and the availability and low cost of basic public services, as well as education, including higher education. It is true, crises come and go recurrently, but they are also learning experiences that help to attain progress." (Corrales, Jorge, interview, 2009).

As mentioned previously, older water managers voice a consistent view on the positive change of agriculture in the Mexicali Valley. They mention the high extent of agricultural lands rented in the valley (from 50% to 60%, approximately) as a negative factor only for the agricultural development of small owners. The dominant view of progress on part of older water managers contrasts with the standpoint of farmers, who underscore the existence of two fold and intertwined perspectives of progress and regression with consequent social polarization among farmers, which was discussed in previous chapters.

The changes in irrigation in the Mexicali Valley are another key topic, because it supports aspects analyzed later regarding the salinity problem and the All-American Canal lining conflict, both informing about the changing role of Mexicali Valley farmers in local irrigation and for addressing transboundary water issues.

In line with what was asserted by farmers of the three regions of the Mexicali Valley, older water managers observe that major changes in irrigation take two opposite directions: one relates perspectives on effective irrigation management, while the other relates perspectives on ineffective irrigation management, both present among water managers. As such, there are some (half of participants of this group of interviewees) who mention only a few factors concerning the operation of canals and wells, administration of resources, as well as conservation and improvement of infrastructure as a result of better valuation of available water resources. In contrast, there are other respondents (the second half) who assess irrigation sector evolution of the Mexicali Valley as a failing process, based on the observed lack of effective users' organizations, water quality constraints, the high level of bureaucracy in WUA-Conagua co-management, and the lack of investment in hydraulic infrastructure and building the capacity of the WUAs.

Arguments expressed by participants supporting the perception of effective irrigation management emphasize differentiation among practices for irrigation water use, which have been gradually improving from the 1960s to current times: a differentiation of irrigation technology such as land leveling, efficient irrigation methods at the parcel level, lined canals for water distribution that were lacking in the past, increased costs for water services to make it more suitable for irrigation water management operation, and the implementation of optimizing irrigation and drainage methods.

Also, respondents emphasized on the capacity of local agricultural water users to adapt rapidly to alternating periods of water surplus and scarcity in the lower Colorado River water course, which has left meaningful learning experiences for better facing water management adversities.

A proponent of effective irrigation management expressed himself as follows:

During the 1960s, there were some periods of surplus water from the Colorado River, followed by long periods of critical scarcity. As such, water management problems have always existed: surplus brings about some sort of irrigation operational problems and experiences for administering water in excess, while scarcity shows that water reductions induce different types of duties, technical thinking, and the need for infrastructure. These aspects represent a huge learning process for everybody. At the end of the day, irrigation water management reaches more appropriate levels of investment and efficiency because we can now set up better planning processes for measuring, controlling, distributing, and administering available water resources in the Mexicali Valley. (Robles, Gerardo, interview, 2009).

In contrast, respondents arguing that irrigation changes have not been at all positive set up a long list regarding institutional factors that explain the ineffective irrigation management perception, which is three times larger than that for the view of effective irrigation management. The ineffective irrigation management list includes fundamental aspects such as the deficient WUAs performance, capacity building constraints, and incomplete technological development for irrigation, which together have led to internal conflicts among agricultural water users in the Mexicali Valley.

Older water manager interviewees placed emphasis on a broad range of factors, including the misguided implementation of official strategies imposed on WUAs and their representatives by using a traditional top-down approach, and the high level of bureaucracy noted in the new co-management era between WUAs and SRL and Conagua. In this co-management process, Conagua became a regulatory entity at the time that managed the principal water infrastructure (i.e., the Morelos Dam and the head section of the irrigation district, including the main canal named the All-Mexican Canal) prior to delivering water to the SRL, which operates the three major canals in the irrigation district (the northern, central, and southern



major canals); these canals in turn deliver water in each control check point of the twenty three WUAs (or irrigation modules) that operate the secondary and interparcel irrigation and drainage network (Conagua, 1999).

Also, other factors were revealed by respondents, such as the lack of accountability of WUAs to their constituency, mainly smallholders, and the dominance of new large landholders who employ command and control irrigation water management by acting as both WUA officials and as preferential water users. This aspect is revealed to cause inequality among individual water users and the prevalence of elitism in the irrigation sector.

Also, older water manager participants mentioned the lack of WUA involvement in key transboundary water issues affecting their own irrigation performance, as well as the ineffective participation of WUAs within the (Mexican) Colorado River Basin Council, which functions more as an ineffective forum or formal institution device to express opinions than as an effective task force mechanism to address local irrigation and binational water management issues.

Additional interlinked illustrative factors embrace the idea that training for water users and managers continues to be a major need, that hinders proper water management at each operational level (e.g., parcel, irrigation module, and irrigation district). Contrary to this aspect, although interrelated, respondents mentioned that an effective water saving education strategy within the irrigation sector is lacking, because farmers have barely begun to understand the significance of considering preventive measures for avoiding potential scarcity and caring for the natural environment.

One explanation for this behavior comprises the lack of long term view, as well as a system view among agricultural water users, who do not properly include the ever increasing water demand trends deriving from the urban sector as a result of the high population growth rate in the region. According to

the Baja California State Population Council (Conepo for its name in spanish), the joint population of Tijuana and Mexicali registers 2 755 000 inhabitants (2008), which is growing rapidly at annual rates of five and two and a half percent, respectively. In the end, all of these factors taken together are inducing irrigation operational problems among modules in the Mexicali Valley.

Furthermore, older water managers express technical-operative aspects that induce the view of dominant, ineffective irrigation management. For example, the lack of irrigation technology in the irrigation canals and wells networks, as well as in parcels, has hindered annual irrigation plans. There remains a major need for water users to broaden and accelerate hydraulic infrastructure investment programs that might help to improve irrigation operation, water distribution, timely access for individuals, and management within and among irrigation modules.

Water quality problems originating at the main source (the Colorado River watercourse entering Mexico) continue to be cause for international disagreement, particularly in regard to issues related with salinity that ultimately is directly linked with agricultural productivity and irrigation performance in the Mexicali Valley. In the local agricultural realm, water quality means water quantity, this due to the fact that agricultural production factors establish technical parameters for crop tolerance to salts in water and soils.

This fact brings about water management problems in the Mexicali Valley, because under conditions of high salt water concentration in relation to crop tolerance parameters, an additional quantity of water for leaching salts must be included in irrigation plans. Such a water volume (leaching water requirements for reaching a potential crop yield such as 100 %) achieves an average level of 20 percent of normal crop consumptive use (Conagua, 1989).

These factors have led to critical internal conflicts in the irrigation district between individual water users, for instance, surface vs. groundwater users, wheat vs. alfalfa growers, or northern vs. southern water users. These internal conflicts emerge mainly during the periodic critical season of high water demand in the agricultural sector, which is normally observed during March and April of each year.

An older water manager summarizes this viewpoint:

On the one hand, I guess that WUAs and irrigators in general are less participative than they were in the past, maybe their age represents a constraint, and I don't know exactly why this occurs. On the other hand, I think we created a "water bureaucracy monster." With some exceptions, the inside people are just focused on the political aspects for continuing in the power that a WUAs' representative has, they (representatives) seek to manipulate the module instead of administrating it. Technical aspects of the irrigation module are often left aside, for example, the measurement of volumes received and delivered. There is still a huge challenge to create awareness among the module's representatives about operation, efficiency, scarcity, the system view, long-term view, equality among users, investment, and of course about the importance of transboundary waters. (Quezada, Antonio, interview, 2009).

Several findings mentioned here show that the dominant perspective of older water managers on the progress in the agricultural sector of the Mexicali Valley differs from the farmers' point of view. This fact in turn illustrates the different perspectives between water managers and farmers about agriculture developmental aspects. Such a major finding correlates with Robert Chambers' findings, which assert that in rural realms, each type of actor visualizes socioproductive advances or regression at a different degree and according to their own reality (Chambers, 2000:58).

In regard to the evolution of irrigation, there is an agreement between agricultural water users' and water managers' perspectives, both supporting the idea of parallelism in terms of effective and ineffective irrigation management that, in principle, elucidates a differentiation among irrigation water users. This in turn represents a foundation for appreciating the changing role of farmers in irrigation and facing transboundary water issues because it demonstrates the perils of not considering participative processes.

Analysis of general aspects in agriculture and irrigation changes (as seen by older water managers) helps to better understand the type and impact of institutions adhered to by farmers during the salinity problem and the All-American Canal lining conflict. Water managers and farmers see general features differently. For example, it was noticed that the progress view dominates over the regression view, in fact, the older water managers' viewpoint does not consider the regression view, which contrasts with the farmers' general statements.

Older water managers enhance the progress view by mentioning significant changes over time in terms of human and professional development, modernization of rural towns, significant technological changes, diversification of crop patterns, and higher levels of land productivity. This fact also shows the supremacy of the older water managers' managerial standpoint, which is mainly guided by the official governmental perspective.

In addition, perceptions of effective and ineffective irrigation management co-exist among older managers' views. Based on evidence on more specific issues linked with their irrigation operational activity, the managerial perspective expressed recognition in some degree of advances within the Mexicali Valley's irrigation sector. However, they also see the high degree of bureaucracy, elitism among individual water users, and the WUAs, lack of a system view, lack of technology, and lack of investment among many other factors that

strengthen the viewpoint of ineffective irrigation management. In short, these might represent fundamental factors explaining the differences among agricultural water users in the Mexicali Valley.

Taken together, all of this helps to explain water manager views on the participation level of farmers during salinity problem ( $t_1$ ) and All-American Canal lining conflict ( $t_2$ ) processes, as well as the major institutional differences observed between one time and another. The following sections identify and describe the perceptions of water managers on the institutions complied by farmers in each case.

### The Fight Against Salinity

The negative impacts of the salinity of the Colorado River water on Mexicali Valley agriculture are perceptible to water managers, once they deal with the high concentrations of salts permanently deposited in individual parcels during the 1961-1973 interlude. Older water managers observed different degrees of impacts or stress depending on the region studied.

Water delivered to Mexico throughout the Colorado River watercourse as part of the 1944 International Water Treaty registered upstream deliberated point source pollution while mixing salty waters originating from the drainage system of agricultural lands in the Wellton Mohawk and Yuma valleys in Arizona. This was formally known as the salinity of Colorado River water. From hydrology and watershed-management perspectives, Point Source Pollution (PSP), unlike Non-Point Source Pollution (NPSP), is characterized by easier problem solving once the source of pollution (e.g., agricultural sewage collected by the drainage system) is punctually detected and traced. In this case, the regulator observes each polluter's discharge (e.g., at the irrigation district level) (Brooks, et al., 1997:209).

Half of this group of respondents pointed out that such an event brought about different extents of damage to the Mexicali

Valley, depending on the region and the type of soil texture and structure where the salts were deposited. As such, the problem was more severe in the central and southern regions, which are dominated by silt and clay soils that lay over a very impermeable and multilayer soil structure. This results in the formation of the so called salty route, which represents a long strip of layered soils orienting from north to south and mainly located throughout the central and southern Mexicali Valley.

Negative productivity and economic impacts on individual parcels were recognized by the majority of older water managers (four out of six) as the major issue explaining the detrimental aspects of the salinity problem. Older water managers mention that as a result of this problem, the Mexicali Valley underwent drastic reductions in crop yields in approximately 40 percent of these, as well as a reduction of workable lands at the amount of four hectares per household on average, which is equivalent to 20 percent of the total individual allotment at the times. These negative impacts caused increasing production costs due to the need to modify productive practices for planting and fertilizing, as well as the need for more intensive water use to leach the salts deposited.

Moreover, farmers were required to face a critical period of credit insufficiency. During the salinity crisis, financial organizations classified farmers as unproductive, excluding them from normal financing programs.

A third of older water managers interviewed mentioned that such a situation pressed farmers to abandon agricultural activity, mainly those who were more vulnerable and living in the central and southern regions of the Mexicali Valley. An excessive number of household heads had to temporarily or permanently leave the Mexicali countryside to migrate to urban areas in Mexico or The United States.

Although the salinity problem had its critical period between 1961 and 1973, two thirds of older water manager participants declared that salinity continues to be considered a

significant problem that aggravates water management in the irrigation district. The salinity problem had its origins in the 1960s and is directly linked with the following factors: the current high concentration of salts in the Sánchez Mejorada Canal, which is located in the San Luis Río Colorado Valley in Sonora, but within Irrigation District 014, the unsuitable salts monitoring system employed by IBWC/CILA at the José María Morelos International Dam point of delivery and control, and the resulting permanent accumulation of salts across the entire salty route. An interviewee states the following regarding this:

The problem is that even today, the well known *ruta de la sal* [salty route] exists and the effects of accumulated salts are still observed in such a region that encompasses a huge agricultural area of impermeable soils located in portions of several irrigation modules belonging to the three major regions of the valley, for example, modules 8, 10, 11, 12, 14, 15, 16, and 17. (Robles, Gerardo, interview, 2009).

Institutional responses of Mexicali Valley farmers regarding the salinity problem may be better understood by examining the perceptions of older water managers of farmers' conditions for participating and influencing the so called permanent and definitive solution to the salinity crisis. A high level of participation of farmers during this process was observed. It appears that there was effective vertical coordination between the social and productive base at the local level with state and federal governmental agencies, as well as a strong financial capacity of farmers to mobilize and participate.

Four out of six older water manager respondents highlighted that the cohesive behavior among farmers emerges as a primary factor explaining both the high level of participation and the positive impact of farmers on the salinity problem process. Older water managers confirm that horizontal unification has

deep roots in the unity base originating at the household level, as well as in the high level of solidarity which may be explained by the dominant and favorable economic conditions exhibited at the time in the agricultural sector, which in turn allow for maintaining rural families rooted to related activities within the Mexicali Valley countryside.

Furthermore, the economic conditions of the agricultural sector at the time facilitated the financial ability of individual farmers and agricultural unions, which were entitled to collect voluntary and previously agreed upon monetary contributions, in order to support political activities and participation in the salinity process. Such funding provides the capacity to afford a socially based political movement, as well as to cover agricultural union expenses. This aspect is proposed as a key factor that facilitates the high level of social participation of farmers during the salinity crises.

Older water managers' interviews revealed perceptions of outstanding leadership at different stages of the salinity problem process, which functioned because of the strength of a unified social base and the political links that locals maintained at several government levels. The basic kind of leadership was personified in the figure of local authorities, such as the President of the *Comisariado Ejidal*. This person was formerly a natural and influential social leader with the ability to call for massive assemblies and who also possessed significant political power based on his effective representativeness, credibility among constituency, and suitable coordination with leaders and officials of upper-level organizations such as governmental agencies, political party representatives, and farmers' unions.

The economic, financial, and political strength of several unions provided them with a central role as institutional participants during the salinity period, and they expressed themselves both formally and informally, with the capacity to claim, complain, and sue the governments of both countries in a trajectory toward finding a fair and suitable solution to



the salinity problem so that agricultural productivity, and social welfare in the Mexicali Valley could be recovered. Within this context, the leadership of President Echeverría was imperative for effectively advancing the process and reaching significant achievements to compensate for the damages that took place in Mexican-territory agricultural lands. Farmers broadly acknowledged that the Echeverría-Álvarez presidential administration guidance was crucial for achieving social cohesion, as well as horizontal and vertical coordination.

In addition to the unity demonstrated by household and union levels, it is important to note what the majority of older water managers identified as one of the core factors that farmers created to address the salinity problem: the capacity to survive and mechanisms to defeat damage was the immediate informal institutional response of farmers, in order to overcome practical problems in the field.

For example, many farmers of the central and southern Mexicali Valley began working on practical production practices and tasks for avoiding yield reduction, after identifying salt deposits on their lands (noticed in the form of large white stains). Such adaptation behaviors included innovative procedures for land management, changing irrigation techniques, combining surface and groundwater sources (with different salt concentrations among them), modifying planting systems, and finally in the long term shifting agricultural plans toward more salt tolerant crops.

One older water manager emphasized this issue:

Farmers in the Mexicali Valley have a huge capacity to survive; they are very intelligent and intuitive people. I think that if they could, they would be able to write a large amount of technical books on the salinity of soils and water management to prevent damage to several crops [...] after finding a couple of obstacles in the way, they changed cropping patterns, they changed seed varieties, they modified the terrain for planting seeds, and modi-

fied soil management practices, etcetera, and all of this was done before they went on to march against the salinity problem at the U.S. port of entry or at governmental agency offices. (Quezada, Antonio, interview, 2009).

Major findings on the perceptions of older water managers regarding the participation and the institutional arrangements adhered to by Mexicali Valley agricultural water users during the salinity process point out that, in line with farmers' perception of the three regions reviewed, institutions appear to be characterized by informal processes based on strong farmer customary transactions, which enabled them to participate strongly in the salinity problem process.

This type of informal participation brought about the change and the later implementation of formal institutions that modified the 1944 International Water Treaty. This fact fits Schmid's (2004:12) theory of the Situation-Structure-Performance link and the evolutionary perspective useful for understanding institutional change.

Older water managers acknowledge that the high extent of harmony among farmers embodies an informal institutional social behavior, guided by local and national leaderships. This fact in turn converted individual farmers and their alliance of unions into a unique cohesive social force that had the capacity to summon, large protests in order to boycott bilateral commerce are an example of this. They also had a remarkable vertical and horizontal coordination ability for requesting that federal officials (and even President Echeverría), directly attend to and resolve the problem.

Furthermore, such a social force was financially independent because they also employed informal mechanisms to collect funds among individual farmers. A primary characteristic noticed by older water managers interviewed in the study, not solely for the central region but also for all of the Mexicali Valley farmers, was the comprehensive participation of local

leaders who encouraged the emergence of other additional informal, but effective social habits.

For instance, respondents indicate that during the salinity crisis, farmers developed a capacity to adapt rapidly to the adverse situation of salty soils. Local farmers were required to face the problem rapidly in order to keep their lands working and producing; all of this was made possible through the modification of traditional water and land management practices. Ultimately, older water managers observed that several institutions and organizations were in place during the salinity process, yet they went on to state that informal institutional structures dominated the context and also pressed formal entities to work toward reaching suitable solutions for local farmers during the salinity crisis.

Older water managers recognized that the high participation and involvement of farmers in the salinity problem process afforded them noteworthy weight as central social actors, and enabled them to press both Mexican and U.S. federal governments to advance toward finding a fair binational negotiation in such matters.

Water managers also pointed out that the influence of the participation of farmers in finding technical solutions to the salinity problem was mainly due to the use of formal (collective action through mobilization of unions) and informal (individual actions supporting large demonstrations for inducing commercial boycott) institutional behavior, and devices that ensured strong coordination with governmental agents at different levels. The majority of respondents (five out of six) mentioned that technical solutions to the salinity of the Colorado River water and soils in the Mexicali Valley were examined, analyzed, and legitimated jointly by Mexican officials (i.e., the ministries of water resources, agriculture, foreign affairs, and economy), scientists, and agricultural union leaders, as well as by individual farmers. As a result, the modification of the binational framework for transboundary water management,

particularly the establishment of Minute 242 regarding water quality standards, was reached, thus embodying the most important technical solution to the salinity problem.

This fact induced formal institutional change in the binational water framework (IBWC-CILA, 1973), as well as establishing the definition and implementation of water quality standards to reduce the concentration of salts in the Colorado River watercourse entering Mexico, through the José María Morelos International Dam. Older water managers revealed that farmers manifested the practical experience that they had gained in land and irrigation management, while experiencing salinity in some agricultural areas of the valley during the crisis, and even prior to this episode. This in turn represented valuable feedback for experts and scientists, who utilized this information to set up and later negotiate technical water parameters. Regarding this, an older water manager pointed out the following:

Then, pressed by intensive farmers' unions' actions and permanent large protests at the U.S. Port of Entry in Mexicali in order to induce commercial boycotts, several international agreements emerged. First, the design and operation of hydraulic bypass devices, such as the Wellton-Mohawk canal, to send highly [concentrated] salty water to the Gulf of California throughout Mexican territory but without accounting for it in the 1944 Water Treaty; second, the establishment of water quality norms or limits for salinity in Colorado River water (IBWC-CILA, 1973), and third, huge financial support to invest in irrigation infrastructure for the entire Mexicali Valley. (Pérez, Próspero, interview, 2009)

Another aspect in which farmers had outstanding influence was building infrastructure programs for recovering irrigation water quality. This was accomplished by applying pressure through sociopolitical activities seeking to induce the building of the Wellton-Mohawk Canal, for conducting salty waters crossing the border deriving from The United States to the Gulf of California.

In line with assertions from farmers, the majority of older water managers (four of six) mentioned that the direct benefits obtained by farmers as a result of their participation in the salinity problem process are those stemming from local infrastructure programs, put into practice by the Mexican government in agreement with the farmers' unions in order to recover the productivity of their agricultural lands. Implementation of the so called rehabilitation program included specific actions and funding to develop projects simultaneously at both irrigation district and parcel levels, for instance, land fertility improvements through the implementation of irrigation techniques for salt leaching, building large networks of open drainage systems, land leveling, and lining of major and secondary canals.

In addition to the general benefits obtained by farmers, they received individual financial support for implementing land recovery duties and infrastructure at the parcel level. Also, agricultural credit and technical assistance were provided through union administration for the purchase of large machinery and equipment focused on production and land management. The situation was described by an older irrigation water manager:

The most important benefits gained by farmers as a result of their significant participation and influence in setting up solutions to the salinity problem were the following: first, they could exhibit their strong cohesive and political capacity as individuals and leaders; second, they demonstrated their ability to influence the salinity problem process in order to receive financial benefits for implementing infrastructure programs, and third, they showed their strength for inducing modifications of the Water Treaty and rendering it more suitable for achieving their productive goals. All of these taken together, including farmers, leaders, water managers, water agencies' officials, and governmental actors, had the vision at such a critical moment to obtain the benefits and solve the problems that are present continue to accrue direct benefits for the regional countryside. (Corrales, Jorge, interview, 2009).

## The Magnifying Glass of Older Water Managers on Salinity and the All-American Canal Lining

On the one hand, older water managers see that informal institutions implemented by farmers during the salinity period favored their high level of participation, which demonstrated its effectiveness in achieving the main objectives of improving conditions for transboundary water management in the lower Colorado River, as well as for local irrigation in the Mexicali Valley.

The older water managers' views corroborate the impacts of following a dominant informal institutional response to the salinity process that allowed farmers to be acknowledged as influential actors who pushed toward receiving benefits, such as the reestablishment of farm credit programs at the parcel level and the rehabilitation program for recovering land quality at the irrigation district level.

Also, older water managers noted that the rehabilitation program was initially seen as a strategic regional policy, that attempted to establish a new crop pattern based on grazing and livestock to replace traditional cotton and wheat production in the Mexicali Valley. The rehabilitation program is considered one of the major benefits obtained as a result of strong farmer social participation during the salinity process; as such it is observed as the major benefit of the informal institutions implemented.

Finally, the older water managers interviewed recognized that farmers were influential in the process of obtaining benefits at the binational level through modification of the transboundary water management framework. As a matter of fact, the informal institutions in place, for example, locals' social behavior regarding large protests for inducing commercial boycotts at the International Port of Entry in Mexicali, were seen as social procedures created and used by farmers and their union of unions in order to produce formal institutional change in the binational water management framework.

On the other hand, older irrigation water managers expect a combination of productive, economic, social, and environmental damages to the Mexicali Valley as a result of the All-American Canal lining project. Such damage could occur gradually and show a different degree of stress, depending on the region of the valley analyzed. However, older water managers asserted that as long as the All-American Canal process properly addresses and involves key stakeholders, it might also represent an opportunity for improving water management conditions on both sides of the border.

Older water manager participants perceive potential deterioration of natural resources (e.g., water sources and land) as a result of the implementation of the All-American Canal lining project. However, they express uncertainty about the specific damage that individual farmers could experience at the parcel or household level as a result of cut back canal seepage, due to the physical and socioproductive characteristics of the agricultural sector, which differ from place to place in relation to soil type, water source availability and quality, crop types, socioeconomic conditions, and the distance of individual farmers from the project setting.

Also, older water managers mentioned that at the beginning, canal seepage was seen as a persistent problem for farmers at the time that the All-American Canal was built and began operations in 1942. Cyclic damages may have been observed from the beginning, when All-American Canal seepage impacted the agricultural activity of the northeastern Mexicali Valley, which caused flooding over nearby parcels, continuing to damage agricultural lands for more than ten years during the 1950s. Today, older water managers notice that the danger is returning as a potential shortage for farmers of the Mexicali Valley and to be initially felt in the northern and northeastern regions. An interviewee who served as a Co-nagua manager for many years explained the following:

Definitively, the All-American Canal lining will bring about problems that initially will affect the irrigation district in Mexicali, because seepage represents a water source. There is some uncertainty about the real quantity and thus has varied over time, first a lot of water and flooding areas and now, after La Mesa drain and the wells were built, it is clear that there is a much lower water table in the area (northern). I directly evaluated seepage volumes by using the wells' line, however at this time there are several studies that have established either 75 or 80 or 83 or 100 million cubic meters per year [...] the point is that there is no agreement on this. But there is no doubt; the impact will be seen among farmers in the whole irrigation district, not just in the northern area. (Pérez, Próspero, interview, 2009).

As a result of these initial flooding problems, the La Mesa and Culiacán Drains were built on the Mexican side adjacent to the borderline in order to intercept the excess of water seeping from the All-American Canal. The solution to this transboundary water problem gave rise to seeping water, which since then has been used by farmers to irrigate about 2 000 hectares (Conagua, 2001). This means that initial flooding problems became fresh water sources used for irrigation in large land extensions in the northern Mexicali Valley.

Also, half of older water managers interviewed identified the impending diminishing quantity and quality of the Colorado River aquifer as it flows into its Mexican portion, this is said to exert an immediate impact on more than 19 000 hectares of agricultural land located in the northeastern area of the valley. As a result of the expected reduction of surface and groundwater sources, older water managers foresee the need for digging deeper wells in order to compensate for the potential damage. But this in turn might bring together increasing needs for hydraulic infrastructure investments in order for groundwater to be pumped from deeper zones.

Based on the risks previously foreseen, the majority of older water managers interviewed (four of six) have held the same



opinion that farmers express regarding a key issue that might affect agricultural productivity and irrigation management in the Mexicali Valley. That is, making water adjustments among agricultural water users through irrigation water allotments at individual parcel and irrigation module levels, as well as at the entire irrigation district level. This also provides the particular feature in the irrigation district (including Mexicali and San Luis Río Colorado valleys), which operates through an interconnected hydraulic system that usually mixes surface and groundwater sources.

Furthermore, reductions in the crop growing area at the individual parcel level might also take place as a result of the implementation of the All-American Canal lining project. However, opportunities to overcome the potential adverse conditions exist, as well as investment projects and sufficient short term financial support.

Older water managers, in agreement with some northern Mexicali Valley farmers, consider that the All-American Canal process might also represent an opportunity for mutually improving productive conditions between water users on both sides of the border. As a matter of fact, key local actors such as agricultural water users, must play an effective and significant role in this process, similar to the one they played during the salinity problem episode. Despite the importance of this type of stakeholder, farmers have not engaged in effective or extensive participation in the debate over the All-American Canal lining.

Older water managers noted that in contrast to what occurred during the salinity problem, the participation of Mexicali Valley farmers in the All-American Canal lining conflict is characterized by significant disarticulation among irrigators, as well as a lack of vertical coordination with water agencies involved in this issue.

It appears that to the majority of older water managers (five of six respondents), there is generalized apathy among agricultural water users regarding this transboundary water conflict,

which is demonstrated through a noticeable lack of interest and motivation for participating in the All-American Canal lining dispute. Instead, farmers tended to prioritize their day to day operative functions above any other activity. Also, older water managers consider that the lack of information in relation to the All-American Canal lining issue, together with the observed governmental officials' tendency to mislead farmers, are among the motives for farmers not participating in the process.

This institutional behavior of farmers is intertwined with the lack of transparency in the process handled by water agencies, and this in turn represents fundamental factors linked with the farmers' apparent apathy. Ultimately, older water managers mentioned that all of these factors taken together explain the farmers' weak participation and involvement in the All-American Canal lining conflict.

Older water managers also identified the lack of formal (official) information shared by water agencies about critical aspects, as neither opportune nor systematically widespread among irrigation water users. According to older water manager views, farmers frequently received deceptive information about the All-American Canal lining project, such as the physical impacts and the details of the litigation process. In short, governmental agencies tend to minimize imminent problems.

Lack of presidential leadership and accountability to farmers on part of governmental agencies are congruent with mechanisms that are employed to render information insufficient or confusing. Older water managers noted the lack of leadership and accountability to locals by Presidents Fox and Calderón, when they were compared with those of other presidential administrations. The managers expressed that no other presidents showed such a lack of accountability and misunderstanding of the transboundary water conflicts that directly threaten Mexicali Valley's agriculture. This insensitive attitude shown by presidents from the National Action Party (PAN) resulted in a weak, disarticulated, and ineffective role of federal agencies in facing the All-American Canal issue.

Not only presidential, but also local leadership was absent and weak. Older water managers emphasized that aging is becoming the most prevalent characteristic in society that hindered in participation farmers in the All-American Canal issue. Individual and collective leaderships are practically absent, and the farmers' past political power to mobilize and articulate social and governmental forces is totally diminished. Dispersed leadership among irrigation water users is at the same time fragmented, representing a barrier for building up a unified, strong participation that would exhibit the importance of irrigation water users as social and productive actors.

Moreover, four out of six of older water managers interviewed pointed out that such a lack of leadership and strong political organization within the agricultural sector in the Mexicali Valley, gave rise to the participation of the leadership of other social actors within the urban sector. Urban based groups took up the All-American Canal lining issue on behalf of the regional society, preparing and lobbying for an injunction process against The United States government. This fact shows a significant change in the type of traditional social actors and organizations, voicing and claiming transboundary water conflicts.

In July 2005 the CDEM, an urban-based local entrepreneur organization, promoted civil action against The United States Department of the Interior, requesting halting the All-American Canal lining project. They argue that the project might be accompanied by social, economic, and environmental damage on the Mexican side, thus the disputing legal rights over canal seepage. However, in April 2007 the federal court of San Francisco, California lifted the injunction and the U.S. side became the winner of the legal trial (Cortez, Donovan, and Whiteford, 2009:135).

In line with the farmers' views, an additional major factor supporting older water manager perception on the disarticulation and weakness of the agricultural sector, refers to the lack of financial and technical support provided by governmental

agencies for them to participate in the All-American Canal. The key tasks of organizing, participating, and leading such issues are difficult for farmers, given the unfavorable economic conditions in the sector.

The majority of respondents stated that another factor that explains the unnoticed participation of farmers of the Mexicali Valley in this current transboundary water conflict, is the nonexistent financial capacity of agricultural water users for incursion in a unified fashion. Respondents mentioned that in the new era, after the irrigation water transfer in the Mexicali Valley, the voluntary contribution included in irrigation water fees disappeared from agricultural water users' accounts, and this fact has stopped their financial capacity to afford their unions and leaders' mobilization. An elder irrigation water manager pointed out the following:

Now, [there] only remain a few leaders in the Mexicali Valley. They don't really do anything significant that would give recognition to the agriculturist as an important actor in the 'All-American' conflict. When the salinity [problem] occurred, farmers had a huge self-financial capacity deriving from a portion of their own irrigation water fees. These monies were used to support farmer participation in the conflict, as well as to help unions and leaders to organize crowded meetings, in order to ultimately find fair and suitable solutions for all parties. Now, this money is no longer available and this represents a key factor that limits farmer participation in this conflict. (Robles, Gerardo, interview, 2009).

### Participation of WUAs and the SRL in the All-American Canal Lining Conflict

This section discusses the categories of factors affecting both the involvement of farmers in irrigation and the effective management of irrigation systems, while considering socioeconomic, sociocultural, historical, and political-legal aspects, as well as technical and agro-ecological factors.

It is clear that if more naturally occurring factors were to be included in those influencing farmer involvement (consequently the effective management of irrigation systems), the situation would become more complex. This assertion confirms the concepts compiled by Ostrom et al. (1999:278) concerning the limitations and opportunities of agricultural water users for participating and influencing transboundary water management issues. In this aspect, older water manager views, in line with those of farmers from all regions of the valley, indicate that WUAs lack the capacity for continued involvement and at this point, that they have no effective representation for participating in the All-American Canal lining issue.

Although being part of the water transfer process in the early 1990s, older water managers recognized that WUAs were imposed from the top; this fact brought about several initial technical problems and constraints for proper irrigation water management functioning. For instance, the deteriorated irrigation infrastructure received from the government by farmers, along with the legal limitations to formal participation in transboundary water management issues, affected local irrigation. Thus, the way that the water transfer process took place in the Mexicali Valley speaks to the original failures impeding agricultural water user representatives' effective participation in the All-American Canal lining issue.

An example of this is that WUA representatives do not participate in formal mechanisms established by the IBWC/CILA for attending to and discussing both the salinity and All-American Canal issues (round tables numbers 1 and 5 respectively, which function as binational technical steering committees). As such, agricultural water users as a whole have lost their combative capacity for formally expressing their needs. An interviewee mentioned the following:

Irrigation module representatives and officials are more focused on local operation and the collection of irrigation service fees than on any other aspect. They do not participate in the "external"

issues that undoubtedly affect irrigation operational performance as well. They systematically disregard binational problems, such as the salinity and the All-American Canal conflicts. In fact, the modules have not engaged in any activity for seeking financial support to carry out the technical studies necessary with regard to the social, economic, productive, and environmental impacts of the project, as well as the potential alternatives that they might implement. The umbrella organization, the Irrigation Society [SRL], should perform this, given its high level administrative status as the representative of all irrigation water users in the Mexicali Valley. (Corrales, Jorge, interview, 2009).

Additionally, older water managers mentioned that the normal day to day hydraulic operative problems that WUAs are responsible for solving, block their capabilities to promote and stimulate effective collective action focused on transboundary waters. The weighty bureaucratic co-management between WUAs and SRL and Conagua is a structural feature that hinders operative efficiency for irrigation management and at the same time, it affects the development of proper mechanisms for effective representation of agricultural water users in transboundary water issues. Two core aspects that impeded the participation of agricultural water users are increasing costs for socially based political movements, as well as the lack of political leadership in the Mexicali Valley. Instead, local irrigation operative tasks are now the focus of this co-management, while fundamental linked issues are left aside. As one respondent stated:

They [WUA representatives] are more occupied in the irrigation service, main and secondary irrigation canal operation and with the collection of water administration fees. This is carried out in “coordination” with Irrigation District [officials]. However, they are not really engaged in the All-American conflict, or they may be, but just a little. At least here in my module [central Mexicali Valley area], transboundary water issues are disregarded; moreover, both [WUAs and Conagua] only think of how to increase irrigation water fees. (Robles, Gerardo, interview, 2009).

Older water managers highlighted the lack of a system view that WUAs should show while operating the irrigation district. It appears that the complexity of the irrigation system is not well understood by some irrigators' representatives, although these representatives continue to exist at a time when conflicts are at different levels among WUAs (including 23 irrigation modules within the irrigation district), between well and canal users, irrigators and environmentalists, and irrigators and urban users. Moreover, older water managers consider this fact an additional aspect inducing agricultural water user disarticulation and disintegration, preventing it from being a unified social force that might participate in transboundary water issues.

Also, older water managers self-criticized their own function within the irrigation system expressing a perceived lack of accountability to some farmers such as small scale producers, due to the frequent pressures that powerful large landholders impose on WUA directors. This fact in turn is acknowledged as a constraint to the participation of farmers as a strong group in the All-American Canal issue, because they (small scale farmers) do not feel proper support from superiors, such as the WUAs. Instead, WUA representatives tend to show strong accountability to superior agencies such as Conagua, or even to some types of influential and powerful growers operating large land extensions.

Interest groups within WUAs are often observed. This factor induced apathy and blocked out necessary social cohesive power for participating as a unified sector in the All-American Canal lining conflict. WUA representatives who control their operation, and most frequently are large scale growers who use significant volumes of water, induce this behavior.

In addition, lack of coordination between WUAs and SRL and some governmental water agencies represents another aspect related with the ineffective participation of farmers in the All-American Canal lining issue. This lack of coordination

is explained by the deficient level of information provided to water users about formal mechanisms for strengthening institutional links between WUAs and SRL and key water agencies such as IBWC/CILA, which is traditionally focused on transboundary issues. As stipulated in the 1944 Water Treaty, the Mexican Section of IBWC/CILA receives 90 percent of the water allotment coming from the Colorado River at the Morelos Dam or at the Northern International Boundary (NIB) point of delivery, and the remaining ten percent is received at the Sánchez Mejorada Canal or at the Southern International Boundary (SIB) point of delivery. Next, IBWC/CILA contacts officials from Conagua, which delivers water to the agricultural water users at hand, who are represented by SRL and WUAs.

Despite the fact that the majority of older water manager respondents noted the need for joint analysis and action that might trigger their respective responsibilities, they mentioned that there is a lack of systematic formal coordination and dialogue between IBWC/CILA and WUA officials. Their normal water operational duties link them with each other, however, there is a generalized perception of no institutional collaboration for working on critical transboundary water issues.

Older water managers recognize the need for the deeper involvement of WUA representatives in transboundary water conflicts because they directly affect irrigation and agricultural development. Older water managers suggest a mechanism of participation based on a democratically defined design that facilitates the implementation of technical alternatives through the establishment of water management plans (at both irrigation module and irrigation district levels). Such plans must consider not only local aspects, but also interlinked transboundary water issues.

In the specific case of the All-American Canal disagreement, the majority of older water managers interviewed (four out of six) stressed additional domestic alternatives that the irrigation sector in Mexicali could develop in order to reduce the imminent



impacts of the lining project. These alternatives should take into consideration increasing water use efficiency in both the major and secondary irrigation networks, as well as at the parcel level. They also mentioned the need for implementing a large infrastructure plan that includes the following: lining major canals and interparcel network, building water reservoirs in appropriate places in the irrigation district, replacing water delivery devices, expanding drip and sprinkler irrigation systems, improving and repositioning deep wells, and installing parcel level drainage pipe tiles. Older water managers estimate that through these actions, global water savings could reach levels of 10 to 15 percent of the total water used in the Mexicali Valley.

However, this entire investment effort will not help if the plan does not include capacity building programs to improve water management within WUAs. In addition, institutional responses of farmers will be necessary to reduce conflicts over highly contested transboundary waters.

It is noteworthy that the growing demand for scarce water resources in the lower Colorado River region is pressing water users, and that water use efficiency programs are needed on both sides of the border. In fact, the All-American Canal lining is part of a larger water saving plan in southern California (Plan 4.4). On their part, both Conagua and SRL-WUAs implement permanent irrigation water-efficiency programs on the Mexican side in Mexicali.

However, the focal point in this analysis is that water use efficiency programs in Mexicali have not induced major impacts in other water users. However, if this happens they are immediately compensated (with additional sources of water) by the irrigation system. The transboundary conflict under analysis emerged because the All-American lining project will induce externalities to Mexico, given that seepage water has been crossing the border and feeding surrounding wetlands and the upper aquifer in the Mexicali Valley since 1942 and until 2010, when the All-American Canal project was finished, that is nearly 70 years.

Recent binational initiatives for water management and conservation established in Minute 319 signed in 2012, could represent a new opportunity to jointly face the impending water shortage in the lower Colorado River Basin region, while simultaneously helping to solve transboundary water conflicts and local irrigation in Mexicali (IBWC-CILA, 2012).

### Views of Older Water Managers in the Mexicali Valley of Institutions Used by Farmers During the All-American Canal Lining Conflict

In line with the perceptions of farmers, older water managers asserted that the characteristics of institutional arrangements agricultural water users in the Mexicali Valley during the salinity, and the All-American Canal processes, are significantly different. Regarding the case of the All-American Canal, the set of human relationships embraced by farmers constrained their ability to participate in such a process. This in turn resulted in a weak defense against the All-American Canal lining project.

Formal and informal institutions, which played a part in the All-American Canal lining case, were characterized by farmer behaviors that were mainly guided by formal organizations embodied in the SRL and WUAs, which were usually unrelated with the All-American Canal issue. Agricultural water users were not effectively involved in the case, therefore they did not achieve the vertical coordination required with state and federal agencies for effective representation in the process.

Apathy and lack of leadership are the leading habits shown by farmers and WUA representatives regarding the All-American Canal issue. This, together with the lack of financial capacity within the irrigation sector for supporting specific activities to enhance participation and collective action, rendered SRL-WUAs an ineffective institutional structure. Bureaucratic co-management between WUAs and Conagua made

them lose representativeness in the process. Although entitled to participate and defend any aspect regarding water management affecting the irrigation sector and agriculture, SRL-WUAS showed accountability to federal water agencies, as well as a lack of coordination with key transboundary water agencies such as the Mexican section of the IBWC/CILA.

Older water managers pointed out these facts to illustrate the type of institutional arrangements complied by farmers during the All-American Canal lining conflict. As such, the dominating formal institutions put into practice by agricultural water users brought them to remain under the influence of urban based leadership, which was unsuccessful against the All-American Canal lining project.

Congruent with the low level of participation that farmers and WUAS showed in the case of the All-American Canal lining conflict, their influence for inducing a solution in which they would receive benefits was also unobserved. According to the views of older water managers, there was no influence of farmers in the All-American Canal lining issue. This is in part explained by the deteriorated social organization within the agricultural sector, whose traditional farmers' unions are diluted and no political and economic power to negotiate or even engage in dialogue, with governmental agencies about issues related with irrigation in the Mexicali Valley.

Current formal institutional structures that represent irrigators' interests, WUAS and SRL function more as water operational devices that adhere to strategies established by governmental agencies to a greater extent, than as formal organizational structures dealing face to face with agricultural water user concerns.

Half of older water managers interviewed declared that local farmers' leader participation with state and federal Congresses, and even within the Assembly of Senators, is no longer a common event. As a result, farmers have lost influence to voice and induce formal institutional change as they did during the salinity problem period. This fact explains the lack of political

power of farmers to influence transboundary water issues and to stay in touch with key water agencies, such as the Mexican section of the IBWC/CILA. Instead, other social actors representing the urban area led the issue and represented regional interests, even those of the farmers.

In this regard, an older water asserts the following:

Nowadays, in the middle of the All-American Canal conflict, I see a more disorganized participation of the agricultural sector than in the past. I feel that the problem is mostly minimized and regionalized by the water agencies. I also feel a weak participation and influence of farmers and for this reason, they have no power to put pressure on official representatives. (Pérez, Próspero, interview, 2009).

Older water managers understand the needs of the irrigation sector and the problems that the All-American Canal lining project might cause to the Mexicali Valley. As such, managers tend to be tied to the farmers' interests and concerns since older water managers often have family ties because they used to live in the Mexicali Valley countryside. In addition, as experienced professionals, older water managers proposed technical alternatives to ameliorate the negative effects of All-American Canal lining on the Mexicali Valley.

For example, they mentioned that in addition to what they believe the agricultural water users should do, the Mexican government must seek and promote mechanisms to receive financial support for irrigation infrastructure that might improve water use and management efficiency. They added that funding could come from the several sectors that are directly or indirectly impacted by the project (e.g., farmers, state government, federal government, urban users in Mexicali and Tijuana), as well as in the form of compensation from The United States government.

Given that the rights acquired over the canal seepage was a controversial issue for Mexican farmers, older water managers expressed their point of view on the motivations (for The United States) as well as the impacts (for the Mexicali Valley). Therefore, in line with some farmers, older water managers considered that the compensatory approach is the most appropriate way to avoid further damage to the local irrigation sector and, ultimately, to agriculture of the Mexicali Valley. However, other farmers (i.e., those working in the northern Mexicali Valley) did not accept the compensatory perspective. Instead, they pursued the implementation of the Precautionary Principle Approach, which suggested that the project should be stopped while the risks for the area are thoroughly assessed, considering officials' and users' inputs from both sides of the border.

Older water managers highlight the impact of institutions used by farmers during the All-American Canal conflict to address transboundary water management issues, irrigation, and local agricultural development. They affirm that overall, the formal institutions employed during the All-American Canal lining conflict hindered the farmers' participation and made them ineffective actors in the process, and if they had participated the likelihood of farmers obtaining compensation for potential damages in the form of investments for improving irrigation water management could have been better.

Evidence suggests that the formal institutional structures that prevailed during the All-American Canal issue impeded farmers from attaining importance as social actors, instead they were frequently disregarded. Older water managers affirmed that the lack of social organization among individual farmers made them lose the capacity to form a unified force, that might have induced a positive change. This type of informal institutional behavior has been absent now in the rural realm during the All-American Canal episode, instead the formal structures of SRL-WUAs comprised the unique organizational

devices representing the farmers' interests and as such, they lacked leadership. There were also ineffective mechanisms for coordination with key water agencies related with the issue, such as the Mexican section of the IBWC/CILA.

Likewise, farmers and their WUAs were irrelevant actors in the process of influencing positive change at a binational level. For example, they were not formal participants in IBWC/CILA roundtables 1 and 5, which were constituted as the special steering committee for addressing current salinity issues and the All-American Canal lining transboundary water conflict. This demonstrates that formal institutional structures farmers adhered to, such as the administrative transactions represented by WUAs, are seen by older water managers as an institutional behavior that denotes loss of political power to influence local and transboundary water issues, affecting local irrigation in the Mexicali Valley.

Furthermore, older water managers insist that farmers and their WUAs and SRL are key stakeholders, who no longer represent a social force with the capacity to induce institutional change on transboundary water issues and, as an older water manager summarized: "Just as they used to be in the past during the salinity problem." (Pérez, Próspero, interview, 2009).

### Newer Water Managers' Perceptions: Additional Salient Issues

In this section, perspectives of the newer water managers interviewed are analyzed in order to elucidate differences related to the perceptions of older water managers, regarding the salinity problem and All-American Canal lining issues. Also, the issue of how new water managers see the institutional participation is discussed and the influence of agricultural water users in the Mexicali Valley in such issues as transboundary waters, which directly affects local agriculture and irrigation.

Even though there are several coincidences among the expressed perspectives, there are also differences that merit analysis. On the one hand, older managers showed significantly broader experience on these issues currently under study, exposing more ties to farmers' interests. On the other hand, new managers expressed a more managerial perspective based on their superiors' policy approach. This feature was noted while reviewing the institutional functions obtained, on which new managers frequently expressed similar views as older managers, but these appeared not to be as strongly accepted each institutional function of both cases.

This section focuses on additional factors and the major differences between institutional aspects embracing the main topics reviewed: the major changes in the irrigation sector, the salinity crisis, and the All-American Canal lining conflict.

New water managers mentioned that the evolution of irrigation is based on two core factors that explain their dominant view of effective irrigation management. The first is more efficient water use compared with that of past times and other regions of the country. The second is the growing irrigation technology in the Mexicali Valley, which in turn is linked with increasing water use efficiency and effective irrigation management. Conversely, failures in irrigation management are also mentioned and this is noticed in the operational, administrative, and conservation tasks carried out by the SRL and WUAS. The newer water managers interviewed emphasized that organizational constraints among individual irrigators, as well as the 23 irrigation modules, are inducing managerial problems at the irrigation district level. An interviewee reflects the following on these issues:

We consider that the Mexicali Valley case has served as an example or development model based on an ensured water source, the Colorado River flow. This fact has allowed for an "impressive" agricultural development of this region [...] It is from the diversification of crops and the efficient operation of the water

system through the 1944 Water Treaty and afterward that the Mexicali Valley is now what it is! [...] However, every advance or progress is always accompanied by problems and, in this sense, a good, benefit, or progress for someone often brings about a bad one for others. Such is the case of the agricultural development that brings together water sources pollution, pesticides damage to humans, increasing water demands and scarcity, commercialization problems, etcetera. (Sosa, Federico, interview, 2009).

### The Salinity Problem Issue: Newer Water Managers' Views

Newer and older water managers' views regarding the salinity problem, and the way in which farmers faced it appear to be analogous. Newer water managers articulated only a few arguments to explain the negative impacts of salinity on agriculture and irrigation in the Mexicali Valley, the participation of farmers in the conflict, and the influence of farmers towards finding solutions. For instance, newer water managers highlighted the damage in the Mexicali Valley due to the salinity of the Colorado River, while simultaneously expressing descriptive aspects such as the following:

It was a "technical" need of the U.S. users to mix sewage with cleaner "white" waters and then deliver this as polluted water downstream into Mexico, as part of a unilateral solution to domestic problems. As a result, salinity in Mexican agricultural lands began and brought about a drastic reduction in crops' yields, as well as in agricultural lands in the Mexicali Valley. (Torres, César, interview, 2009).

Also, the salinity problem is considered as a critical transboundary water conflict that to this day continues to represent costly consequences for local farmers. Yet, newer water managers emphasized the high level of adaptability as a habit that local agricultural water users utilized, as a valuable social



process to face the productivity adversities that the salinity crisis brought about.

Regarding the farmers' high participation during the salinity problem period, newer water manager respondents highlighted the highly effective diplomacy put into practice by the Mexican government, which was tightly coordinated. This was so due to the high degree of farmer participation characterized by a strong, unified force that helped governmental agents and agencies to defend and negotiate a definitive solution to the salinity problem. This fact afforded local farmers recognition as key actors to pressure both the state and national governments to obtain compensation. In this regard, farmers were highly influential and, as such, the main beneficiaries of the negotiation process.

For example, newer water managers mentioned that farmers were thoroughly informed about the process, having significant and direct participation in the definition of the technical parameters to be included in the updated international water framework between The United States and Mexico (IBWC-CILA, 1973), as well as in the building of the Wellton-Mohawk Canal bypass device to carry drainage water through Mexican territory into the Gulf of California.

In this aspect, the newer water managers' points of view are in line with those of older water managers as well as farmers, who recently raised the issue through the voices of their representatives in the Colorado River and the Baja California Basin Council (*Consejo de Cuenca del Río Colorado y de Baja California*, CCRC y BC). They insisted on the significance of such an achievement when Juan Salgado-Becerra, an elderly agriculturist and representative of the agricultural water users in the CCRC y BC, recalled that:

I am a lucky man; I am one of the participants and defenders of the farmers during the salinity problem, one of the few that are still alive and up to date. And I want to ask the new federal

officials here to always keep in mind that those achievements were too costly to us, and that you officials must now defend the idea of maintaining the flow of the Wellton-Mohawk Canal that currently feeds one of the most important wetlands in the region, the Santa Clara Wetlands, localized right at the end of the Colorado River. (Salgado-Becerra, 2009).

Finally, newer water managers noted that another benefit that farmers obtained a result of their high degree of participation and technical and political influence in the salinity problem, is related with their daily productive activity. Such a benefit refers to the financial support and official intervention to implement the Mexicali Valley's rehabilitation program, in order to recover the productivity of agricultural lands.

### The All-American Canal Lining Conflict: Newer Water Managers' Views

In regard to the All-American Canal lining conflict during the 1990s and 2000s, all of the newer water managers' views about the imminent damages that the All-American Canal lining project would bring to the Mexicali Valley appeared to be in line with those of farmers and older water managers.

In addition to the factors expressed by older managers, newer water managers emphasized environmental perils, as well as the confusion caused between water users from both sides of the border due to gaps in the current binational water framework. The risk of losing a large wetlands area, together with other natural ecosystems, is seen by the majority of newer water manager respondents as one of the major concerns, and is considered a significant factor that induces stress over the contested waters at a binational level.

Additionally, newer water managers mentioned that property rights to water seepage belong to many actors, including farmers, a critical controversial issue between users in both

countries, for instance regarding the interpretation of the Prior Appropriation Approach. Thus, property rights to the All-American Canal seepage became an international controversy that was brought to litigation in U.S. federal courts by the CDEM and the CURE.

This controversy was partially due to the contrasts in the interpretation of the Prior Appropriation Approach: according to The United States, the surface water that flows through the All-American Canal belongs to The United States because it represents the first user, as for Mexico current All-American Canal seepage is not a surface water source, but rather groundwater that was instead first used by Mexican farmers and the regional environment (Elenes, 2009).

It appears that for newer water managers, such dissimilar positions seem to be hindering the achievement of a cooperative behavior, that IBWC/CILA promoted in order to negotiate a win-win situation instead of the compensatory approach or litigation. Ultimately, this conflict also blocked the establishment of the Good Neighbor Principle. In this regard, a newer water manager involved in binational water management issues directly stated the following:

Another aspect causing high pressure over scarce and contested water resources in this region is without a doubt its environmental use. We have valuable ecosystems, maybe better valued by the international community than by locals. An important area of wetlands and other water ecosystems linked with the All-American Canal seepage is going to disappear. We are facing the issue of the All-American Canal and we disagree with the perspective of mitigation/compensation. We prefer to speak in terms of the context of international cooperation, that is, we are attempting to induce a win-win situation. However, the controversy over water rights and the litigation process is blocking the implementation of this approach. (Sosa, Federico, interview, 2009).

Newer water managers articulated similar views to those expressed by older managers regarding to the farmers' institutional participation in the All-American Canal lining conflict. Additionally, newer water managers emphasized explanatory factors that generally state the lack of vertical coordination between farmers with state and federal agencies, showing a diminished leadership of farmers as key agents of change.

Newer water managers highlighted the generalized apathy shown by irrigators during the All-American Canal episode, demonstrated by a lack of unified and effective farmers' participation in the All-American Canal conflict. At the same time, newer water managers mentioned that the All-American Canal lining's virtual conflict is partly explained by the nature and understanding that farmers have about the case itself.

This assertion recalls the process of a strong and effective participation of farmers during the salinity problem, due to the characteristics of the conflict at the time when Colorado River water salinity had already caused damage to agricultural lands in the Mexicali Valley. Farmers responded through informal customary transactions or habits, such as the amalgamation of a union of unions, as well as a commercial boycott as the core informal institutional device.

Moreover, newer water managers mentioned that water agencies such as Conagua and the Mexican section of the IBWC/CILA appear to be the proper, and maybe, unique instances to review and solve the conflict. Under this perception, newer water managers stressed the idea that irrigation water users are not observed by such agencies as key actors, who could influence the negotiation process. This is evident despite a diplomatic acknowledgement implemented by the IBWC-CILA and the Mexican Ministry of Foreign Affairs, who failed to reach a suitable solution for both countries. This in turn induced the involvement of social actors other than farmers, such as the CDEM and CURE organizations.

As a result, these urban-based and environmentalists groups initiated an unsuccessful civil action against the U.S. government. On April 6 2007, the 9<sup>th</sup> Circuit Court of Appeals in San Francisco California, lifted the injunction issued in July 2005 that had impeded the lining of the All-American Canal. This federal court rejected all the of the litigants' arguments. Among other reasons, the Judge Sidney R. Thomas said that the 1944 Water Treaty states that the Mexican government is allowed 1.5 million acre-feet of water from the Colorado River annually and is entitled to no more (Perry, 2007).

In this complex issue, individual farmers were considered minor social actors working toward a solution. In this regard, a newer water manager linked with transboundary water issues went further, establishing that:

There is not enough information; there continues to be "confusion" about seepage water property rights; Americans think that the water is entitled to them, while conversely Mexicans think that the water is entitled to them; Americans think that water seepage is classified as surface water, while Mexicans think that this is a groundwater source [...] I think that the problem is different from that of salinity just because there is no problem yet, that is this problem is right now just a potential problem. At present, have no real and direct impact [...] For me, the complexity of the process, altogether with the remarkable loss of the farmers' political and economic power, represent the main reason for them to be excluded as an influential social group. Besides, the lack of the farmers' involvement and influence in the All-American Canal issue is due to their diminished level of organization. Farmers are not participating in the process because the work of the commission [IBWC-CILA] is carried out through technical committees or task forces where there are only official advisors from Conagua and other governmental agencies; there are no farmers' representatives there. These task forces work as supports for our diplomatic action in seeking cooperative measures [...] It

is important to note that although the issue has been presented at the highest diplomatic level [presidential], the expected positive result has not occurred, so different from the salinity era. Therefore, some citizens' groups, such as the CDEM, have taken legal actions within The United States, although unsuccessfully. (Sosa, Federico, interview, 2009).

Also, newer water managers agree with older water managers' and farmers' views regarding the role of WUAs in the Mexicali Valley, which appears to be a weak formal institutional device for participating in and influencing the All-American Canal process. WUAs were not involved effectively and systematically, nor were they coordinated with key water agencies such as the IBWC in regard to the All-American Canal issue. Thus, WUAs did not properly represent local irrigators' interests within the context of the transboundary water conflict that could affect their irrigation. This fact demonstrates the ineffective participation and lack of influence of agricultural water users in this issue, either as individual farmers, organized irrigators, key actors and agents of positive change or, at least, as key defenders of their own current and future development:

We [officials] need to encourage farmers to be more participative, just as some NGOs have demonstrated to be in regards to environmental aspects [...] Farmers have shown a lack of integral propositions and this represents a constraint to them for participating in technical committees. They should be more open minded in order to seek cooperative behavior so that both agriculture and other sectors could be benefited. For example, we see how the All-American Canal issue would bring about critical problems referred to water shortage for agriculture and in addition, we also see that there is inefficient irrigation management. In other words, it is true that agricultural lands could be affected, but it is also true that there is at present a wasteful use of irrigation water in the Mexicali Valley. (Torres, César, interview, 2009).

## Conclusions

The views of older and newer water managers show that farmers' institutions and organizations have changed from effective mechanisms in the salinity crisis period ( $t_1$ ), to ones that have been less so in the All-American Canal lining conflict ( $t_2$ ). In this chapter it is demonstrated that older water managers exhibited broader knowledge in the analyzed issues, while simultaneously offering more profound argumentation and a greater number of explanatory factors than those of newer water managers.

It was also discovered that the effects of salinity of the Colorado River water and the All-American Canal lining project are similar in scope, but they possess different characteristics that both affect irrigation and agricultural development in the Mexicali Valley. As such, the institutional responses of irrigators evidenced significant changes over time ( $t_1$  vis-à-vis  $t_2$ ). For instance, water managers noted that agricultural water users showed a loss of economic and political power that reduced their capacity to organize, participate in, and influence transboundary water issues that affect their own agricultural activity and irrigation.

For both types of water managers studied in this chapter, major differences between the salinity problem and the All-American Canal lining conflict can be explained as follows: Water managers perceive a difference between the institutional behaviors of different presidents of Mexico during the salinity and All-American Canal episodes, focusing on Echeverría (PRI) and Fox and Calderón (PAN) respectively. Leadership is mainly assessed in terms of levels of accountability to locals and the characteristics of their official interventions for improving the Mexicali Valley farmers' adverse situation, while facing the All-American Canal lining issue. Farmers of all regions of the valley, as well as water managers recognized that during the salinity crisis and President Echeverría

showed strong leadership and overall, skillful diplomacy, whereas Presidents Fox and Calderón were criticized due to the fact that they disregarded the sustainability and future development of the region.

Such distinct presidential behaviors had direct repercussions on the level of organization and strength of farmers as a unified force, as well as on the predominance of local leadership. During the salinity crisis, farmers showed unity embodied in the informal institutional structure of the union of unions, which was self-financed and headed by local leaders who enjoyed high levels of credibility.

Conversely, during the All-American Canal conflict, organizational, economic, and financial disarticulation within the irrigation sector was clearly noted along with the lack of effective representation of WUAs and SRL in the issue. As a result, a major change took place: strong farmers' unions during the salinity period were replaced by urban based groups representing the interests of all water users in the All-American Canal lining issue. Hence, the capacity shown by farmers in the past for influencing the definitive solution to salinity is now significantly weakened, within the context of the All-American Canal conflict.

In general, newer water managers' views are in line with older water managers' perceptions, concerning the themes and sub-themes emerging from the qualitative analysis, as well as the type of explanatory factors for each institutional function. Yet, newer water managers always showed fewer arguments and factors supporting their views. That is, older water managers tended to express better understanding of transboundary water issues and as such, offered broader explanations for the causes, effects, behaviors, and alternatives included in the institutional explanatory functions.

This would appear to be a logical outcome, given older water managers' deep and integrated knowledge concerning issues based on their own experience from working in the



Mexicali Valley, while living through the two periods of analysis: the salinity and All-American Canal issues. This in turn enables older water managers to understand the problems and to be concerned with the farmers' socioproductive conditions.



# REFLECTIONS AND LESSONS: WATER, LAND, AND SALINITY IN A TRANSBOUNDARY SETTING

## Changing Role of Agricultural Water Users Between the Salinity and the All-American Canal Lining International Disagreements

This study showed the impact of the institutional arrangements farmers adhered to in the Mexicali Valley during two critical transboundary water conflicts that affected irrigation and agricultural development: the salinity problem ( $t_1$ ) and All-American Canal lining conflict ( $t_2$ ). The types and impacts of institutions farmers complied with for participating in and influencing decision-making in such events at the local and binational levels, have changed over time to the extent that agricultural water users are acknowledged as key stakeholders, who pushed to reach solutions to critical cross border water conflicts in the past salinity crisis. However, nowadays they are exhibiting different institutional behaviors and diminished influence during the All-American Canal lining conflict. This fact in turn corroborates on the occurrence of factors that favor or halt suitable processes for transboundary and irrigation water management in the region.

Schmid (2004:3) states that an institutionalized combination of several perspectives that link the physical, legal, social,

economic, and political aspects around water issues should consider the bottom-up approach as a necessary condition for facing the complexity of managing cross boundary waters, moreover if irrigation water is involved. This study emphasizes the aspects not addressed in studies and literature: the institutional characteristics that determine the context of efficiency and in this domain, the research focuses on the changing role of key actors (such as agricultural water users), in achieving efficiency to manage transboundary waters that in turn, may affect irrigation in the Mexicali Valley.

Qualitative inquiry provides an analysis of the views and meanings of farmers and water managers regarding the evolution of local agriculture and irrigation, the ways in which transboundary water issues are faced by farmers, and the social and productive processes in the Mexicali Valley. This study suggests that farmers' social and productive processes, forms of organizing, and institutions changed over time, influenced by the context or the situation in place, and that this has impacted to a different extent local agriculture and irrigation.

Considering that socio-organizational and institutional features determine management capabilities, the first question explored reflects the characteristics of institutions employed by the farmers in each case: the salinity problem and the All-American Canal. Next, guided by the second and third central questions, the institutional arrangements farmers adhered to are explored to see how they affected the farmers' productive activity and irrigation water management, and how this impact demonstrated different levels of stress according to a particular area of the valley, that is the northern, central, and southern Mexicali Valley. Finally, the fourth research question investigated the influence of farmers on inducing institutional change, at both local and binational water management levels.

Schmid (2004:17) states that institutional impact analysis attempts to explain how alternative formal and informal institutions affect commodity transactions and substantive economic outcomes of wealth and its distribution, whereas

institutional change analysis requires an evolutionary model. The author affirms: “individuals are born into an institutional world that shapes their thinking, and their thinking shapes the institutional world.” (Schmid 2004:17). As such, change analysis is essentially about the learning process combined with the existing rules for making rules; it must explain change in informal institutions and culture as well as in formal institutions created by legislatures.

The major findings of this research are quite thought provoking. Based on the primary (farmers’ and water managers’ interviews) data analyzed in this study, the following general conclusions are drawn:

- 1) It appears that the social, demographic, and economic contexts in the Mexicali County (including rural and urban areas) have changed significantly between  $t_1$  and  $t_2$  in such a way that both industrial and urban developmental aspects are currently gaining momentum.
- 2) It is noted that there are opposite views among farmers concerning agricultural development and irrigation evolution in the Mexicali Valley. Some consider that agricultural development and irrigation are declining, while others state the contrary. This is related to the observed social polarization and high degree of elitism among agricultural water users.
- 3) During the salinity problem period, unified, strong participation and leadership among farmers was mentioned as the hallmark of informal institutions and the ways of organizing that they created.
- 4) Conversely, in the All-American Canal lining episode, there was weak participation by a disarticulated agricultural sector represented by formal organizations such as water users’ associations (WUAs) and an irrigation society (SRI), which were replaced by urban-based groups such as the Mexicali Economic Development Commission, which dominated at the time.

- 5) There are different levels of stress perceived in both the salinity problem and the All-American Canal lining conflict, depending on the region of the valley studied. The salinity affected mainly the central and southern areas, whereas the All-American Canal lining project is observed as posing more risks initially in the northern Mexicali Valley.
- 6) There are convergences and disagreements exist between farmers and water managers regarding the views of the impacts of farmers' participation. Major convergences refer to perceptions about farmers' institutional effectiveness in the salinity problem, as well as to their minimal institutional participation and lack of impact during the All-American Canal lining conflict.
- 7) On comparing  $t_1$  and  $t_2$ , it appears that farmers have lost the economic, political, and organizational power to participate in and exerting an influencing institutional change concerning transboundary water issues.
- 8) There are significant differences between older and newer water managers' perceptions, as well as between those of water managers and farmers, concerning the impacts of institutions adhered to by agricultural water users in the Mexicali Valley. Older water managers are more tied to farmers' concerns and newer water managers appear to maintain a more managerial stance.

Such findings show that when comparing  $t_1$  and  $t_2$ , agricultural water users' institutions and socio-organizational and productive conditions in the Mexicali Valley have changed. Prevailing informal institutions, organizations, and procedures created by farmers during  $t_1$  were effective structures for participating in and influencing the local and transboundary water management policies, that directly affected irrigation functioning and agricultural development in the Mexicali Valley.

Conversely, for the  $t_2$  case, the dominant formal institutions based on the voices of organizations such as the SRL and WUAS (or their inactivity) were ineffective institutional devices that

encouraged participation and influenced transboundary water issues that are directly linked with local irrigation functioning and ultimately, the well-being of the agricultural sector in the Mexicali Valley. In sum, the changing role of farmers between the salinity and All-American Canal episodes may be explained by the types of institutions they put in practice.

### Environment for Institutional Impact and Change in Local Irrigation and Transboundary Water Conflicts

The general aspects analysis related with the evolution of agriculture and irrigation in the Mexicali Valley represent a background that allows for better understanding of the type, impact, and change of institutional arrangements farmers adhered to during the  $t_1$  and  $t_2$  transboundary water episodes. General features expressed by farmers in this regard help explain the significant change in the extent of farmers' participation, as well as that of the impacts of institutions during the salinity and All-American Canal processes.

Findings show that water managers embrace a dominant view of progress in the agricultural sector of the Mexicali Valley that differs from that of farmers. This in turn confirms a concept raised by Chambers (2000:58), which affirms the different perspectives between uppers/superiors (i.e., managers) and lowers/inferiors (i.e., farmers) regarding agricultural developmental aspects and in which each type of actor can visualize social and productive advances or regression, to a very different degree and according to their own reality.

Regarding the evolution of irrigation, there is an agreement between agricultural water users' and water managers' views; both supporting the idea of parallelism between effective and ineffective irrigation management that as a principle, elucidates the existence of irrigation user categories in the Mexicali Valley.

Aspects concerning the evolution of agriculture and irrigation in the Mexicali Valley, from the viewpoints of farmers and

water managers, clarify the types and impacts of institutions adhered to by farmers during  $t_1$  and  $t_2$ . Farmers and water managers perceive such aspects differently. For example, the progress view dominates over the regression one for water managers, while the opposite is true for farmers. Furthermore, the older water managers interviewed do not mention the regression view. This contrasting perception between interviewees shows the dominance of the water managers' managerial perspective.

In addition, views of effective and ineffective irrigation management co-exist among older water managers. Convinced by the weight of the evidence in the field regarding more specific issues linked with their own activity, the managerial perspective expressed recognition of significant advances in irrigation in the Mexicali Valley, while also observing the manner in which a high degree of bureaucracy, elitism among individual water users, WUAs' lack of a system view, lack of technology, and lack of investment, among many other factors (a longer list than the one offered by farmers), support their perspective on ineffective irrigation management.

The aforementioned might represent fundamental factors that explain the differences among agricultural water users belonging Mexicali Valley regions; the northern, central, and southern areas. All of this taken together as a general framework, helps to explain both the farmers' and the water managers' views on the extent of participation of farmers during  $t_1$  and  $t_2$ , as well as the major institutional impacts and changes observed between both time frames.

In summary, the empirical findings from this qualitative research indicate that social polarization and differentiation among irrigators in the Mexicali Valley may be embraced by the concept of "structural inequity" (Galtung, 1980:64). This in turn is meant as a basis for appreciating the changing role of farmers in the Mexicali Valley, regarding local irrigation and transboundary waters.



## Do Institutions Matter for Irrigation and Transboundary Water Management in the Mexicali Valley?

The institutional analysis approach employed in this research is characterized by a combination of perspectives: it attempts to explain the emergence of institutions according to an evolutionary trend, that emphasizes not taking the individual preference function as a given, and it assumes that an individual builds up new conceptions and habits (Hodgson, 1999) through cognition and learning processes. Also, institutional analysis demonstrates the necessity for “creative thinking,” which can be interpreted as an emerging, broad approach that combines a variety of perspectives (Acheson, 2000). Embraced by this theoretical-methodological stance, institutions are generally regarded as regularities and social behaviors, or as the rules of the game in society (Schotter, 1981; Ostrom, 1990), including the humanly devised constraints that shape human interactions (North, 1990). Hence, power issues emerge as an elemental standpoint in the analysis.

Schmid (1995) elaborates on aspects of factual statements and value judgments for understanding institutions. The former aspect explains how the world works, the latter what people ought to do, or the potentialities of policy change. Considering that natural resources are fundamental for economic development and that they tend to be scarce, issues such as externalities and transaction costs are central in institutional analysis, as well as for understanding fundamental institutions.

CPRs are a suitable laboratory for observing sources of human interdependence (Ostrom, 1998). The author formulates “design principles” that characterize all robust Common Pool Resources (CPRs) institutions. By basic design principles, she means “essential elements or conditions that help to account for the success of these institutions in sustaining CPRs and gaining the compliance of generation after generation of appropriators to the rules in use.” (Ostrom, 1998). These design principles

play an important role because they can affect incentives in such a way, that appropriators commit themselves to confirm to operational rules devised in these systems to monitor each other, obey the rules, and replicate CPRs institutions across generational boundaries.

Schmid (2004) adds that in this context, institutions can be understood as the human relationships that structure opportunities or constraints; a constraint on one person is an opportunity for another. Context institutions also affect beliefs and preferences, providing order and predictability for human interaction.

According to Schmid (1995), the underlying issue regarding natural resource use and exploitation is scarcity. Thus, incompatible use goods (IUG) and high exclusion costs goods (HEC) embrace the dominant sources of human interdependence. The author asserts that assigning property rights is not sufficient without the effective accompaniment of regulatory institutions, yet the effectiveness of institutions is a function of the type of the natural resources in question, as well as the sources of human interdependence (situation).

Considering that the more naturally occurring factors are those that influence the involvement of farmers in the use of water resources and the effective management of irrigation systems, the situation becomes more complex. This fact justifies the assertions deriving from studies that have elaborated theoretically on the limitations and opportunities of farmers for participating and influencing transboundary water management as particular types of CPRs (Ostrom et al., 1999:278; van Laerhoven and Ostrom, 2007). While analyzing CPRs, the authors do find that most successful resource management practices often involve small to relatively large groups within a single country. Additionally, these authors find that particular transboundary settings—such as large, shared international basins—represent a challenge to addressing problems, due to the nature of the inherent difficulty to manage resources.

Taking into account such a setting constraint, other authors insist that management and conflict resolution concerning transboundary resources depend on the cooperation of the appropriate international institutions, as well as of those working at the national, regional, and local levels (Axelrod, 1984; Dawes, 1990; Meidinger, 1998; Yaffee, 1998).

This study suggests that while analyzing the institutional issues surrounding local irrigation and transboundary water management in the lower Colorado River Basin as a type of international CPR, the salinity problem and the All-American Canal lining project may bring about the changing role of Mexicali Valley' farmers, regarding irrigation and transboundary water management in this particular setting.

### Institutions, Farmers, and the Salinity Problem

The situation in the salinity problem case expresses three main features or sources of human interdependence, for the good under study (the transboundary common pool resource): *a)* Incompatibility in Use (IUG), *b)* High Exclusion Cost (HEC) and its variant of Cooperation Choices (PD), and *c)* Economies of Scale.

Taking into consideration the lack of factor ownership regarding water quality standards for sharing transboundary waters between The United States and Mexico during  $t_1$ , the major institutional structures exhibit a variety of alternatives: binational bargaining options, administrative (regulation) and customary transactions, definition of property rights for water quality, collective action, cost sharing rules for implementing water infrastructure programs, and institutional change in or adaptation of the binational water framework, International Water Treaty.

In Chapters 3 and 4, the farmers' perceptions concerning the salinity crisis issue were analyzed. The data gathered confirms that the features of institutions and social behaviors Mexicali

Valley farmers adhered to during this episode demonstrated a broad variety of human relationships that taken together, enabled them to create opportunities for achieving a high degree of participation. Such institutions are characterized by informal processes based on the farmers' strong customary ideologies or habits, which resulted in the subsequent implementation of formal institutions, such as internal contracts to develop the well-known "Rehabilitation Program of the Mexicali Valley" or the addendum to the 1944 Water Treaty (IBWC-CILA, 1973) at the international level.

For instance, during  $t_1$  the high degree of unification and coalition within the agricultural sector represented an informal institutional behavior, guided by local and national leadership that enjoyed a high level of credibility among farmers. This fact made individual farmers and unions of different sorts into a much more cohesive social force, that had the ability to mobilize large protests to boycott bilateral commerce between The United States and Mexico. Also, they showed significant coordination capabilities in asking Federal Government Officials (including the President) to directly solve the problem and establish a formal commitment toward solving the critical salinity problem.

Furthermore, such a group, or a union of unions, showed a high degree of autonomy, because it employed formal and informal independent financing mechanisms to collect funding to support the farmers' several political activities and their social participation. This specific process entertained similar characteristics to those of a fundraising mechanism, which was voluntarily contributed through a portion of the water fees (five Mexican cents per liter of water delivered at the individual parcel level, or on the normal irrigation water allotment basis) of each irrigation schedule, along the agricultural productive cycle.

Federal water agencies and farmers' unions jointly administered these funds. Although a combination of institutions and

organizations were in place at the time, informal processes and groups dominated the scene and also pressured formal entities to mobilize towards finding suitable solutions to the salinity problem, with the overall aim of receiving compensation and benefiting the local agricultural sector in the Mexicali Valley. In addition, the impacts of institutional arrangements Mexicali Valley farmers created and adhered for facing transboundary water conflicts, managing local irrigation, and inducing agricultural development during  $t_1$ , were consistent with positive repercussions for the whole Mexicali Valley. From the farmers' standpoint, their institutions favored a high level of participation and this, in turn, appeared to be an effective mechanism for reaching the main objectives of recovering the productive status that farmers possessed prior to the salinity crisis period, thus improving irrigation water management and regional agricultural productivity.

Evidence of the impacts of implementing informal institutions during the salinity crisis allowed farmers to gain acknowledgement, as influential social and political actors who pushed for acquiring direct local benefits, such as the definition and implementation of financial programs at the parcel as well as at the macro level, for the entire Mexicali Valley district.

Furthermore, farmers were influential in the process of obtaining benefits at the binational level through the stimulation they provided for modifying the legal framework regarding transboundary waters, specifically the establishment of Minutes 218, 241, and 242 of the 1944 International Water Treaty, all of these related with the salinity problem. In fact, informal institutional structures such as customary transactions represented by the confederation of formally established farmers' unions, which promoted the commercial boycott and represented a Standard Operational Procedure (SOP) utilized by farmers, that ultimately produced formal institutional change in local and binational legal frameworks for irrigation and transboundary water management, respectively.

## Salinity and Farmers: Water Managers' Views

In Chapter 5, the data demonstrates that for water managers, (and coinciding with what the interviewed farmers affirmed), institutions created by farmers during the salinity problem were characterized by informal institutional processes, based on strong farmers' customary transactions that enabled the farmers to participate strongly in such a process. This type of participation resulted in the change and later implementation of formal institutions. This fact fits Schmid's (2004) concept of the Situation-Structure-Performance link and the evolutionary model for understanding institutional change.

To illustrate this point, the way older water managers see that the high degree of harmony existing among farmers embodies an informal, institutional social behavior guided by local and national leadership is emphasized. This fact allows individual farmers and their respective unions to form a strong informal cohesive social force, denominated the union of unions. In addition, the main characteristic of farmers observed by older water managers in the entire Mexicali Valley during  $t_1$  was the local leaders' high level of participation, which enhanced other informal but effective social behaviors and operational procedures for managing water and lands in the productive arena, as well as participating in massive meetings. For instance, farmers developed a capacity to adapt to an adverse situation created by salinity on their lands. Local farmers addressed the problem by modifying several water and land management practices, in order to maintain the production of their lands.

Also, informal institutions farmers adhered to proved to be effective devices for achieving their main objectives, such as improving conditions for farmers in the Mexicali Valley. Evidence concerning such impacts demonstrates that informal institutions allowed farmers to gain recognition as key actors who pushed forward to receive benefits, such as the definition and implementation of supportive agricultural credit programs at

the parcel level. Water managers mentioned that the rehabilitation program was initially seen as a strategic regional policy, that attempted to establish new crop patterns based on grazing and livestock, to replace the traditional cotton and wheat production in the Mexicali Valley. The rehabilitation program is acknowledged as one of the major benefits obtained as a result of strong farmers' social participation during  $t_1$ .

Water managers also recognize that farmers were influential in the process of obtaining benefits at the binational level, while simultaneously encouraging modifications of the transboundary water management framework. In fact, informal institutional structures such as customary habits were crucial in achieving this purpose.

### Institutions, Farmers, and the All-American Canal Lining Conflict

The situation in the All-American Canal lining case expresses two main features, or sources of human interdependence for the good under study: *a*) Incompatibility in Use (IUG) and *b*) High Exclusion Cost (HEC) including its variant of Interdependent Binary Choices (PD).

In view of nonexistent factor ownership regarding transboundary groundwater resources between The United States and Mexico during  $t_2$ , major institutional structures elicited a variety of alternatives: binational bargaining options, administrative (regulation and litigation) and customary transactions, collective action and potential claims in international courts and finally market mechanisms after defining property rights.

The data analyzed in Chapters 3 and 4 regarding the All-American Canal lining conflict, shows that according to the farmers interviewed the characteristics of institutional arrangements employed by farmers of the Mexicali Valley during  $t_1$  and  $t_2$  differ significantly. Farmers participating as individuals and as formal organizations (e.g., water users' associations and

the irrigation society) operated institutional structures that tended to constrain themselves from creating opportunities to have broader participation in the All-American Canal lining conflict, exposing a noticeably weak defense of the issue.

Such a combination of formal and informal institutions was characterized by processes implicit in the farmers' behavior, which was mainly guided by formal institutions embracing organizations such as WUAs and SRL, which systematically eluded and excluded the All-American Canal lining conflict from their normal operational procedures and managerial responsibilities. Social disarticulation within the agricultural sector and the lack of political and economic power hindered agricultural water user involvement in  $t_2$ , thus blocking effective representation and influence for finding a proper solution in order for water users not to become affected.

Generalized apathy and lack of leadership, together with nonexistent financial capacity within the irrigation sector for participating in such issues, represented unfavorable conditions for individual farmers to voice their concerns, rather than the constituency used to rely on water users' association representation as the formal institutional structure on which they could count. Yet heavy bureaucracy in co-management processes among WUAs, SRL, and Conagua rendered a loss of representativeness in this process. Instead, WUAs and SRL exhibited remarkable accountability to federal water agencies, and a lack of coordination with key transboundary water agencies such as the Mexican section of the IBWC/CILA. Such institutional behavior brought agricultural water users to remain under the umbrella of external leadership, which represented the hallmark of the low level of participation and weak defense of the All-American Canal issue on the part of agricultural water users.

The impacts of institutional arrangements complied with by farmers during  $t_2$  for facing transboundary water issues, managing local irrigation, and developing agriculture evidenced



that dominant formal institutional structures hindered their participation, and made them appear as ineffective actors in achieving their objective of being considered as a voice that might be heard by negotiators for improving water management conditions in the Mexicali Valley.

The findings of this study for the  $t_2$  case show that agricultural water users appeared to be irrelevant actors within the process of influencing positive change at the binational level. For example, farmers did not induce, participate in, or influence a needed modification of the legal framework regarding transboundary groundwater management issues, which is currently nonexistent and ultimately gave rise to the All-American Canal lining conflict. The formal institutional structures farmers were engaged during  $t_2$  are observed as a social behavior, that demonstrates the farmers' loss of economic and political power for influencing the transboundary water issues that affect agriculture in the Mexicali Valley. As such, this key stakeholder is no longer a social actor with the capacity to produce formal institutional change at the binational level.

### The All-American Canal Lining Conflict and the Farmers: Perspectives of Water Managers

In line with the farmers' standpoints, in Chapter 5 the water managers state that formal institutions embraced by farmers during  $t_2$ , appeared to obstruct the farmers' participation and made them ineffective actors in reaching the main objective of being considered in the All-American Canal process. Farmers could have obtained compensation for potential damages, in the form of investments for improving irrigation water management and agricultural development in the Mexicali Valley. Hence, the prevailing formal institutional structures blocked farmers from attaining significance as social and political actors, as such they were frequently regarded as irrelevant in this process.

Water managers revealed that the lack of social organization of individual farmers induced them to lose the capacity to form a unified force that might have exerted an influence on a much needed positive change. These types of habits (rather than being promoted) were absent in the rural realm during  $t_2$  and as a result, formal structures of WUAs and SRL were unique organizational devices representing the farmers' interests.

In the same manner, farmers and their WUAs and SRL were irrelevant actors in the process of influencing positive change at the binational level. For example, they were not formal participants in IBWC roundtables 1 and 5, which were constituted as special steering committees for analyzing (current and remaining) salinity issues, as well as the All-American Canal lining conflict, respectively. This proves that the formal institutional structures embraced by farmers are observed by water managers as an institutional behavior, that indicates loss of political power for influencing transboundary water issues affecting irrigation and agriculture in the Mexicali Valley. Moreover, both older and newer water managers stated that farmers and their WUAs and SRL are key stakeholders, however, they also stated that these no longer represent a social force with the capacity to produce formal institutional change at a binational level.

Although older water managers and newer water managers shared some similar opinions, there are also significant differences between them regarding to their perceptions on the role of farmers in irrigation and transboundary water issues. For example, older water managers exhibit significant wider experience in these issues studied by frequently exposing more elaborate arguments, characterized by being much more related with the farmers' interests and concerns. In contrast, newer water managers (e.g., those belonging to the Mexican section of the IBWC/CILA and the Conagua) expressed a more managerial perspective based on their superiors' policy approach.

The previous assertion is mainly presented in general terms and under an overall managerial view based on the efficiency of water use standpoint (Svendsen, Wester, and Molle, 2005:16). This feature can be better understood on reviewing the institutional functions obtained, in which new water managers often expressed not only nearly the same, but also less explanatory factors for the two cases under study.

### Implications

The implications of knowing the changing role of farmers in managing irrigation and facing transboundary water conflicts, are that such knowledge may enable currently operating agricultural water users, as well as other key stakeholders (such as water managers and agencies), to look at the institutional structures that best fit a specific situation in place and ultimately, to find a way towards reducing current and potential conflicts over the ever increasing competed transboundary waters of the lower Colorado River Basin.

The primary aim is to encourage cooperation among several water users and between countries, in order to find effective mechanisms that may facilitate the task of reaching the fundamental goals of acquiring equitable, efficient, and sustainable use of water at the local, regional, and binational levels. Regarding the most suitable institutional structures to put into practice, this study suggests that because transboundary water conflicts are an ever lasting issue that in turn are also intertwined with local irrigation in the Mexicali Valley, effective inclusion and representation of key stakeholders such as agricultural water users in these processes might facilitate the achievement of the aforementioned fundamental objectives. In the same vein, it is important to call for significant changes in key organizations directly related with transboundary water issues such as the Mexican section of the IBWC/CILA, who must promote the participation of farmers in round tables 1 (salinity issues) and 5 (All-American Canal lining issues).

There was a combination of formal and informal institutional arrangements that took place during  $t_1$ . However, the clear predominance of informal customary habits that were put in practice during the salinity period was observed, and these were effective in promoting a high degree of the farmers' social participation, thus obtaining direct benefits for the irrigation and agricultural sectors. To the contrary, the formal institutional structures agricultural water users adhered to during  $t_2$  appear to be ineffective devices that do not aid the agricultural sector for participating in and influencing the All-American Canal issue. Thus, given the physical interconnections of the lower Colorado River transboundary water system, the major goals in the irrigation sector of the Mexicali Valley were not achieved. Here, it is important to rethink the role of farmers' WUAs and SRL in order for them to participate beyond operative tasks through their representation in transboundary water issues, given that they depend on these water sources for operation.

The main findings of this study concur with Schmid's (2004) statements on the significance of institutional arrangements as enabling or constraining the achievement of a particular productive goal. The author adds that an organization is a way for achieving collective action, such as CPR management for individual members within a boundary. He also mentions that an organization is a certain boundary of people with shared institutions and mutual recognition of opportunity sets. Organizations are systems of relationships for coordinating individual actions, according to some decision rule of persuasion and a mix of authority and custom. This institutional behavior was present in  $t_1$  and absent in  $t_2$ . The key point is to recover the self-financial capacity that farmers had in  $t_1$ , which in turn might help to increase their capacity to organize themselves and effectively participate in transboundary issues that affect local irrigation.

An urgent need for recovering and strengthening local actor participation in transboundary water issues has been addressed

by other authors, who established that the potential for success in the process of binational resource management along the U.S.-Mexican border increases with an informal, regional bottom-up approach rather than with a more traditional top-down diplomatic or regulatory approach. The focal point of this argument is that the bottom-up, local people-centered approach emphasizes social processes, builds relationships, and strives for consensus through shared value formation and the co-evolution of perceptions and preferences, which in turn tends to favor integrated water resource management (Browning-Aiken et al., 2004).

Others authors recommend acting in congruence with “substantive stakeholder representation” instead of only “stakeholder participation.” This appears to be a better way to achieve equitable, efficient, and sustainable water management (Wester, Merrey, and de Lange, 2003:798; Wester, Shah, and Merrey, 2005:232). This is what occurred in the salinity problem case, whereas during the All-American Canal lining conflict, farmers in the Mexicali Valley could not effectively promote it. Milich and Varady (1999) elaborate on the use of the top-down paradigm in an attempt to solve transboundary water conflicts in The United States-Mexico border region. They go on to say that: “local agents [officials] lack the capacity and motivation to be effective, and local, informal institutional arrangements that might have become the basis of formal institutions for cooperation are largely ignored.” This latter assertion describes what occurred during the All-American Canal lining conflict.

Furthermore, in line with the findings of this study, Schmid (2004:99) states that an institutionalized combination of several perspectives that link the physical, legal, social, economic, and political aspects around water issues should consider the bottom-up approach as a necessary condition to face the complexity of managing cross-boundary waters. Ultimately, this study suggests that institutional aspects determine the context of efficiency and that this determines the changing role of

agricultural water users in managing local irrigation and for facing transboundary water conflicts. All of this taken together encourages increasing the effectiveness of facing transboundary water conflicts as well as reducing critical issues impacting local irrigation and agriculture in the Mexicali Valley.

However, as mentioned in previous sections of this book, new binational collaborative initiatives addressed in Minute 319 of the International Water Treaty, signed on November 20 2012, identify binational opportunities for water conservation in Mexican Irrigation District 014, Colorado River and water operational improvements to conduct Mexican water through the new All-American Canal. Currently under this new binational context, after the signing of the Minute, local agricultural water users represented by the Irrigation Society (SRI) have been participating in IBWC/CILA technical round tables related with salinity and water conservation projects. As such, it is certain that a past critical conflict is now becoming an opportunity for collaboration to face a potential water shortage in the lower Colorado River Basin, that might come as a result of the threats of climate change and climate variability issues (Wilder et al., 2013).

In sum, the institutional analysis approach used in this study on the salinity problem and the All-American Canal lining conflict, facilitates the understanding of the changing role of farmers in the Mexicali Valley. Such a role is a reflection of both the type of institution in place, as well as of how agricultural water users organize themselves. In addition, such a methodological tool is useful in informing about the evolution of institutions and processes that rendered these key stakeholders powerless over time ( $t_1$  vis á vis  $t_2$ ) to induce positive change.

This study also makes it possible to discern the main disagreements and convergences between the two categories of water managers studied (older and newer), and between farmers and water managers in regard to perceptions concerning the degree of stress that each transboundary water issue entailed in Mexicali Valley, Mexico.

Finally, the study also demonstrates the impacts of the institutional arrangements (formal and informal), that were complied by agricultural water users, to face remarkable events in the recent history of the lives of the local people and the salinity and All-American Canal lining issues, both affecting irrigation and agricultural development in the Mexicali Valley. In the end, the valuable lesson obtained from institutional arrangements created by agricultural water users during the salinity crisis, and the All-American Canal lining episodes might help local farmers induce the necessary institutional adaptation and evolution, in order for them to properly face the everlasting challenges of living and working in a transboundary setting.





## APPENDIX A

### GLOSSARY

AAC	The All-American Canal lining conflict.
CAH	Agricultural water users in central Mexicali Valley.
CCI	Central Campesina Independiente (The Mexican Independent Peasants' Union).
CDEM	Comisión de Desarrollo Económico de Mexicali (The Mexicali Economic Development Commission).
CESPM	Comisión Estatal de Servicios Públicos de Mexicali (The Baja California State Public Water Services Commission of Mexicali).
CICESE	Centro de Investigación Científica y de Educación Superior de Ensenada (The Center for Scientific Research and Higher Education of Ensenada).
CILA	Comisión Internacional de Límites y Aguas entre México y los Estados Unidos, Sección Mexicana. (International Boundary and Water Commission Between Mexico and The United States, Mexican Section).

COLEF	El Colegio de la Frontera Norte (The Northern Border College).
CNC	Confederación Nacional Campesina (The National Farmers' Confederation).
CNPPR	Confederación Nacional de Pequeños Propietarios Rurales (The National Small Rural Owners' Confederation).
COLSAN	El Colegio de San Luis (The San Luis College).
CONAGUA	Comisión Nacional del Agua (The National Water Commission).
CABC	Consejo Agropecuario de Baja California, A.C. (Agriculture and Livestock Council of Baja California).
Consejo de Cuenca	Consejo de Cuenca del Río Colorado y de Baja California (The Colorado River and Baja California's Basin Council).
CPRs	Common Pool Resources.
CURE	Citizens United for Resources and the Environment.
Distrito de Riego 014	Irrigation District No. 014, Colorado River (Conagua).
IBRD	International Bank for Reconstruction and Development.
IBWC	International Boundary and Water Commission Between Mexico and The United States, United States Section.
IDB	Inter-American Development Bank.

IIE	The Institute of International Education.
NAH	Agricultural Water Users in Northern Mexicali Valley.
NAFTA	North American Free Trade Agreement.
NIB	Northern International Boundary point of Water Delivery, or International Morelos Dam.
NMGRs	Newer Water Managers.
NPSP	Non-Point Source Pollution.
OMGRs	Older Water Managers.
ppm	Parts per million (or milligrams of salts per liter of water).
PAN	Partido Acción Nacional (The National Action Party).
PRI	Partido Revolucionario Institucional (The Institutional Revolutionary Party).
PRD	Partido de la Revolución Democrática (The Democratic Revolution Party).
PSP	Point Source Pollution.
SAH	Agricultural Water Users in Southern Mexicali Valley.
SAL	The Colorado River Salinity Problem.
SIB	Southern International Boundary Point of Water Delivery, or the Sánchez Mejorada Canal.

SOP	Standard operation procedure.
SRH	Secretaría de Recursos Hidráulicos, formerly the Mexican Hydraulic Resources Ministry.
SRL	Distrito de Riego Río Colorado, Sociedad de Responsabilidad Limitada de Inversión Pública de Capital Variable (Colorado River Irrigation District, Irrigation Society of Public Investment).
UAR	Unión Agrícola Regional (The Regional Farmers' Union).
UCMEXUS	The Center for U.S.-Mexican Studies of the University of California, San Diego.
USGS	United States Geological Survey.
WB	The World Bank.
WUAs	Agricultural Water Users' Associations.
WUSs	Agricultural Water Users' Societies (formerly irrigators' associations during the 1950s).

## APPENDIX B

### METHODOLOGICAL NOTE

Qualitative research was carried out in order to identify and characterize evolving aspects of the institutional arrangement features, and productive practices involving local irrigation and transboundary waters. Van Hofwegen and Jaspers (1999:3) propose the following methodological steps, among others, as a practical process for institutional framework assessment: *a)* review reports about water management situations combined with registered problems, *b)* identify and select relevant stakeholders at different operational and organizational levels, and *c)* elaborate and implement interviewing procedures considering face to face interviews with key informants, such as agricultural water users and water managers.

Two cases allowed for comparisons over time, that is salinity problem vis-à-vis All-American Canal lining conflict. Case study methods have been used to study CPRs, such as irrigation systems operation and management (Ostrom, 1990; Poteete and Ostrom, 2003) and also while assessing integrated water resources management programs (van Hofwegen, 2001:39).

For the case of this study, both agricultural water users and water managers (older and newer) were difficult to reach during field research work. In the case of the former group of interviewees, subjects are mainly very elderly people who, although in good condition to respond in a first round of interviews, moved away from the area and in some cases, passed away before a second interview could be conducted during the

research process. The same is true for water managers (older). Thus, it was very critical to choose the type of interview to implement, as well as the individuals who could address two comparative moments over time.

A series of face to face semi-structured, in depth, open-ended interviews addressing key informants were used in this research as the main qualitative tool. These key informant individuals are encompassed in two major groups: *a)* farmers re-grouped into three categories according to the irrigation area to which they belong, namely, northern, central, and southern Mexicali Valley, and *b)* water managers/officials working (or retired) for water agencies at the local (e.g., WUAS), national (e.g., Conagua), and binational (e.g., the IBWC/CILA) level. Water managers were in turn re-grouped into two categories according to level of experience or their time in service.

Given the characteristics of the study in which the major domains and research questions to be explored were previously and widely defined, the overall aim was to acquire richness in relevant information, thus going as deep as possible in the analysis. Therefore, richness in relevant information is obtained through the perceptions of people who lived and worked in the study area, during both the salinity problem and the All-American Canal lining conflict. As such, the appropriate subjects for this research are complementary units or sampling groups of cases, namely farmers and water managers in the Mexicali Valley.

Accordingly, the study employs two types of units of analysis, individual farmers (sub-grouped according to their location in Mexicali Valley area) and water managers (sub-grouped by their level of experience or time working in the valley) as they relate to the issues explored; both groups of units often have different perspectives. The entire interviewing process included 36 interviewees in total: 27 farmers and nine water managers divided according to the following sample frame:

## Interviews implemented in the Mexicali Valley \*

Irrigation Area in the Valley	Types of Subjects Studied		
	Farmers	Older Water Managers	Newer Water Manager
I. Northern	9	6	3
II. Central	10		
III. Southern	8		

*Source:* Compiled by author based on database (Cortez, 2010).

\*All data collected was recorded in Spanish and then translated into English by the author.

Local farmers in Mexicali are users of transboundary waters, as such their productive performance is and has been directly linked with the salinity problem and the All-American Canal lining conflict. Water managers are people (technicians) who serve or served as operative intermediates between the water source and agricultural water users through the several levels of water infrastructure operation, such as the international boundary points of delivery (IBWC/CILA at the José María Morelos International Dam and the Sánchez Mejorada Canal), irrigation district headwater delivery points (Conagua at the Matamoros Wash Dam and the All-Mexican Canal) and finally, the canals' major network and wells as well as secondary, tertiary, and interparcel canals for irrigation (SRL and WUAs). In the case of water managers, both older and newer, their high degree of rotation among areas in the valley did not allow dividing the groups by region of study, like in the case of farmers, thus their responses were mainly focused on the whole Mexicali Valley.

Finally, by using pseudonyms and aggregated data analysis and reports, this study protects the privacy of the key informants interviewed, according to the international regulations for human-subject protection.





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*Transboundary Water Conflicts in the Lower Colorado River Basin:  
Mexicali and the Salinity and the All-American Canal Lining Crises*

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This book presents the views of irrigation water users and managers who experienced two critical and emblematic transboundary water conflicts in the lower Colorado River that affected the people's daily lives, particularly in the Mexicali Valley region. While analyzing both the Colorado River Salinity Problem in the 1960s and the All-American Canal Lining divergence in the 2000s, the institutional analysis approach employed in this book has a comprehensive scope that describes in detail the features of the conflicts, as well as the changes in people's ways of participating in facing such crises. Also, such an institutional learning process allows identifying possible binational cooperative alternatives to jointly face not only suitable ways out of critical conflicts for both countries, but also to face the tremendous threats of climate change in the Colorado River Basin, in which all people living and working there hold key roles as users of the same principal water source of the region. Best transboundary water management strategies for the Colorado River can be reached when a diverse and broad base of key actors in the two countries are directly involved in the processes of effective participation. This in turn might improve the ability to deal with the everlasting water conflicts. As a result, major perils of extreme water events, such as drought or flooding, can be effectively addressed on bearing in mind the overall goal of developing, managing, and using this precious water source in an equitable, sustainable, and efficient fashion.



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