Water and agriculture in the Lerma-Chapala Basin in Central Mexico

Farmers' efforts to manage decentralization and save surface water

MSc. Thesis by Hans Paters

November 2004

Irrigation and Water Engineering Group
Instituto Mexicano de Tecnología del Agua (IMTA)
Institut de Recherche pour le Développement (IRD)

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Water and agriculture in the Lerma-Chapala Basin in Central Mexico

Farmers' efforts to manage decentralization and save surface water

Master thesis Irrigation and Water Engineering submitted in partial fulfillment of the degree of Master of Science in International Land and Water Management at Wageningen University, the Netherlands

Hans Paters

November 2004

Supervisor(s):

Ir. Flip Wester

Irrigation and Water Engineering Group
Centre for Water and Climate
Wageningen University
The Netherlands
www.dow.wau.nl/iwe

Sergio Vargas & Erik Mollard

Instituto Mexicano de Tecnología del Agua
Institut de Recherche pour le Développement
Paseo Cuauhnáhuac 8532, Progreso
Jiutepec, Morelos. Mexico C.P. 62550
www.imta.mx **www.ird.org.mx**

Research done as part of the Basin Synthesis Study of the Lerma-Chapala River Basin, Mexico, within the Comprehensive Assessment of Water Management in Agriculture Program (CA) of the International Water Management Institute (IWMI).

Abstract

Water-saving interventions quite often originate from the desks of water engineering bureaucrats or NGOs. In the Lerma-Chapala Basin, a grassroots organization of farmers has gathered about 50 Water Users Associations on basin level in order to improve surface water use in the basin. The organization enlivened the Lerma-Chapala River Basin Council and intended to stimulate farmers' participation in the Council. In fact, this organization tried to improve agricultural planning in accordance with water allocation policies and agro-industrial demands, by offering farmers contract farming guarantees. The diversification of cropping patterns by 'bottom-up' induced multi-stakeholder processes provides important practical lessons to farmers, policy-makers and students of Integrated Water Resource- or River Basin Management, Irrigation Management Transfer, Public Private Partnerships, Participatory Irrigation Management, Multi-Stakeholder Platforms and multi-disciplinary research. This research aims at investigating the effectiveness of saving water in a river basin from socio-economic, physical, political and organizational points of view and provides pertinent knowledge for institutional response to groundwater mining in the Basin's irrigation units.

Summary

Water scarcity is increasingly perceived as the limiting factor for both agricultural and industrial transition in many developing countries. It is a source of increasing competition between rural agricultural areas, the urban industrial sector and the environment in many countries. In many cases water is not scarce in absolute physical terms, but rather politically or economically contested between users and different uses.

This case study examines competition over water resources in a context of decentralized, market and user-centered approaches in the Lerma-Chapala River Basin in central Mexico. Today, globalization, the implementation of the General Agreement on Tariffs and Trade (GATT), the North American Free Trade Agreement (NAFTA), and the implementation of 'social neo-liberalism' economic theories, are the main drivers for more efficient and sustainable use of water resources with strong stakeholder participation.

The Lerma-Chapala River Basin is located in central Mexico, crosses five states and covers approximately 55,000 km^2. Whereas the basin accounts for 9% of Mexico's GNP, it is in serious trouble, since water is being polluted and there are few renewable water sources. Lake Chapala, Mexico's largest natural lake, at the tail end of the river Lerma and the Basin is drying as a result of water over-extraction. Lake Chapala generates significant tourism and real estate revenues, but also provides Guadalajara, Mexico's second largest city, with 190 Million Cubic Meters (MCM) of water annually. Agricultural production in the basin is important but depends for large parts on the management of water. Apart from procuring irrigation water to agriculture, the basin also provides drinking water for around 15 million people (11 million in the basin and 2 million each in Guadalajara and Mexico City).

Chapter 1 of this thesis describes the conceptual and contextual backgrounds to this research. Starting with some conceptual water management approaches this chapter will introduce irrigation management transfer (IMT) and the creation of water users associations (WUAs). These water reforms are known as the 'Mexican Model' for the rapid implementation of the reforms. Besides the formation of the WUAs also the signing of a surface water treaty, promulgation of a new water law and further institutional responses will be brought in. These institutional responses have played an important role in the prelude to a grassroots

organization of farmers. The chapter ends with a problem definition, research question and methodology of the study in order to rationalize the investigation.

Chapter 2 is the crux of this thesis, because it describes and analyses the emergence and functioning of the farmer-run initiative on integral agricultural planning. This *Grupo de Trabajo Especializado en Planeación Agrícola Integral* (GTEPAI, Specialized Working Group on Integral Agricultural Planning[1]) tried to strengthen multi-stakeholder processes and broaden farmer participation in the River Basin Council (RBC) by developing links between farmers, government agencies, agro-industries, and research institutes. Through a network and organization building effort the GTEPAI attempted to alter cropping patterns in order to save water and increase economical returns to agricultural productivity in *Distritos de Riego* (Irrigation Districts).

The GTEPAI initiative got paralyzed by the end of 2003 and chapter 3 will hypothetically extend the GTEPAI farmer efforts to groundwater and surface water management in the *Unidades de Riego* (Irrigation Units). The *Comisión Nacional del Agua* (CNA, National Water Commission) has weak control over these private and collective irrigation systems that account for half of the irrigated area in Mexico. The disproportionate free-for-all groundwater use in the Lerma-Chapala Basin causes underground reservoirs to run dry and drives poorer farmers out of business. The chapter explores the potential of integral crop diversification in the *unidades* based upon experiences with the GTEPAI initiative. Ultimately the chapter reveals groundwater use reduction strategies that hinge on institutional and organizational development.

Chapter four concludes the findings from the previous chapters and combines them in order to reflect on the two most important institutional responses in the Basin that contain potential for improved water management.

[1] Throughout the text, Spanish terms are italicized, while the Spanish acronyms are translated in English the first time they are used.

Table of Contents

Boxes

Figures

Tables

Abbreviations and Acronyms

ANIAME	*Asociación Nacional de Industriales de Aceites y Mantecas Comestibles,* National association of nutritive oil and grease industries
ANUR	*Asociación Nacional de Usuarios de Riego*; National Water Users Association
ARLID	Alto Rio Lerma Irrigation District; ID-011
ASERCA	*Apoyos y Servicios a la Comercialización;* Assistance and Services for the Commercialization of Agriculture
BANRURAL	*Banco Nacional de Crédito Rural*; National Bank of Rural Credit
CAPRO	*Cámara de Aceites y Proteínas de Occidente*; Western oil and protein board
CC	*Consejo de Cuenca*; River Basin Council
CEA	*Comisión Estatal de Agua*; State Water Commission
CEAG	*Comisión Estatal de Agua de Guanajuato*; CEA of Guanajuato

CEH	*Comisión Estatal Hidráulico*; Hydraulic State Committee
CENAPROS	*Centro Nacional de Investigación para Producción Sostenible*; National Research Centre for Sustainable Production
CENATRYD	*Centro Nacional de Transferencia de Tecnología de Riego y Drenaje*; National Centre for Irrigation and Drainage Technology Transfer
CFE	*Comisión Federal de Electricidad*; Federal Electricity Commission
CNA	*Comisión Nacional del Agua*; National Water Commission
COFUPRO	*Coordinadora Nacional de las Fundaciones Produce*; National Coordination institute of state 'Produce' Foundations
CONACYT	*Consejo Nacional de Ciencia y Tecnología*; National Science and technology Council
COTAS	*Comités Técnicos de Aguas Subterráneas*; Technical Groundwater Committees
DDR	*Distrito de Desarrollo Rural;* Rural Development District
DR	*Distrito de Riego*; Irrigation District
FAO	Food and Agriculture Organization of the United Nations
FIRA	*Fideicomisos Instituidos Relación Agricultura en el Banco de México*; Trustee-ship of the Agricultural Sector within the Mexican Bank
FIRCO	*Fideicomiso de Riesgo Compartido*; National Shared Risk Trust Fund
GATT	General Agreement on Tariffs and Trade
GOM	Government of Mexico
GTEPAI	*Grupo Técnico Especializada de Planeación Agrícola Integral*; Specialized Working Group on Integral Agricultural Planning
HC	*Comités Hidráulicos*; Hydraulic Committees
ID	*Distrito de Riego*; Irrigation District
IM	*Modulo de Riego*; Irrigation Module
IMT	Irrigation Management Transfer
IMTA	*Instituto Mexicano de Tecnología del Agua*; Mexican Institute of Water Technology
INCA-RURAL	*Instituto para el Desarrollo de Capacidades del Sector Rural*; National Training Institute for the Agricultural Sector
INEGI	*Instituto Nacional de Estadística, Geografía e Informática*; National Institute for Statistics, Geography and Information in Mexico
INIFAP	*Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias*; the National Forestry, Agriculture and Livestock Research Institute
IRBM	Integrated River Basin Management
IRD	*Institut de Recherche pour le Développement*; (French) Research Institute for Development
IWE	Irrigation and Water Engineering group
IWMI	International Water Management Institute, formerly IIMI
IWRM	Integrated Water Resources Management
LAN	*Ley de Aguas Nacionales*; National Water Law
MASAS	*MAnejo Sostenible de Aguas Subterráneas*; Sustainable Groundwater Management program
MEG	*Grupo de Seguimiento y Evaluación*; Monitoring and Evaluation Group
MISA	*Manejo Integral de Suelos y Agua*; Integral Soil and Water Management
MP	Mexican Pesos (1 MP ˜ 0.10 US$)
MSP	Multi Stakeholder Platform
NAFTA	North American Free Trade Agreement
NGO	Non-Governmental Organization

OI	*Otoño Invierno*; Autumn Winter (season)
O&M	Operation and Maintenance
PROFECO	*Procuraduría Federal del Consumidor*; National Consumer Counsel from the Ministry of Economy
PROCAMPO	*Programa de Apoyos Directos al Campo*; Program for Direct Support to Agriculture
PRODEP	*Programa de Desarrollo Parcelario*; Plot Improvement Program
PROMMA	*Proyecto de Modernización del Manejo del Agua*; The Management Modernization Project
RBC	River Basin Council
REPDA	*Registro Público de Derechos de Agua*; Public Register of Water Rights
SAGAR	*Secretaría de Agricultura, Ganadería y Desarrollo Rural*; former Ministry of Agriculture, Livestock and Rural Development
SAGARPA	*Secretaría de Agricultura, Ganadería y Desarrollo Rural, Pesca y Alimentación*; Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food
SARH	*Secretaría de Agricultura y Recursos Hidráulicos*; former Ministry of Agriculture and Water Resources
SDA	*Secretaría de Desarrollo Agrícola*; Secretariat of Agricultural Development
SDAyR	*Secretaría de Desarrollo Agropecuario y Rural*; Secretariat of Agricultural and Rural Development
SDR	*Secretaría de Desarrollo Rural*; Secretariat of Rural Development
SEDER	*Secretaría de Desarrollo Rural*; Ministry of Rural Development
SEMARNAT	*Secretaría de Medio Ambiente y Recursos Naturales*; Ministry of Environment and Natural Resources
SEMARNAP	*Secretaría de Medio Ambiente y Recursos Naturales y Pesca*; former Ministry of Environment, Natural Resources and Fisheries
SENER	*Secretaría de Energía*; Ministry of Energy
SPI	*Sistemas de Pequeña Irrigación* (small irrigation systems)
SRH	*Secretaría de Recursos Hidráulicos*; former Ministry of Water Resources
SRL	*Sociedad de Responsabilidad Limitada*; (Farmer-run) Limited Responsibility Society
TWG	Technical Working Group
UNPEG	*Unión de Productores y Exportadores de Garbanzo*; Union of chickpea producers and exporters
UN	United Nations
US	United States (of America)
WB	World Bank
WHI	Water Harvesting Irrigation systems
WUAs	Water Users Associations

Measures

Ha	Hectare
m3	Cubic Meter
MCM	Million Cubic Meters

Acknowledgements

In the first place, I want to thank you, the reader, for showing interest in the subject and this report in particular. It is a pleasure presenting this thesis research that I have conducted in Mexico from April 2003 until September 2003 and elaborated in Wageningen (the Netherlands) from October 2003, until November 2004.

I consider this thesis as the first real examination in my study Tropical Land Use at Wageningen University, because it is a genuine product of my own interests in the field of societal development and water management. With this thesis, I aim at contributing to the school of thoughts of the Irrigation and Water Engineering group at the university. It is not for nothing that I try to contribute to this department, since I really enjoyed a lot of fun (too much sometimes) and personal development during five years of working with the different lecturers, assistants, students and visitors of this department from all over the world.

Fortunately, this part of the report gives space for acknowledgement to the IWE group, but even more, I would like to start a kind of advertising campaign, which will end at the last page of this report. As such, I hope to represent the multi-disciplinary character of my education, but also a diversity of adopted fruitful thoughts from the various tutors. Therefore, I would like to give my thanks to all teachers behind the scenes.

In particular I want to thank my thesis supervisor, Flip Wester, who roped me in for the job during a nice department get-together. Working with Flip has been a great pleasure during the whole research period and with honor, I enjoyed all his kind and intellectual support. In the second place I want to thank Bert Bruins for his contributions as second reader and study advisor. Furthermore, I want to show my appreciation to Jaime Hoogesteger, with whom I performed the field research. I also want to acknowledge his family in Mexico for their warm welcome and help.

In Mexico there are many people that receive my best wishes and thoughts, since they really helped me having a nice time, besides the greatest education they have given to me.
I particularly want to thank my 'GTEPAI-tutors' Gaby, Raúl, José de Jesús, Alejandro and my field supervisors at IMTA (Sergio and Eric). Of course I really would like to thank all the other persons involved in this research, but there are too many to mention. Of course this is a great compliment, since I was really surprised by the kind help and warm welcome of all people involved. The many persons I have met in a short period, showed great interest in the research. Thanks for your nice collaboration! I also want to thank the International Water Management Institute (IWMI) for their support.

Last but not least, (not least at all) I want to thank my fiancée Nicole for all her support while completing this thesis.

Furthermore I hope that my great appreciation to everyone involved is reflected in this document and that you enjoy reading and revealing new insight.

Hans Paters,
November, 2004

Chapter 1: Surface Water Savings Study in the Lerma-Chapala River Basin

1.1 The Commencement of a Study

The case study is part of an IWMI program on Comprehensive Assessment of Water Management in Agriculture and coordinated by the Irrigation and Water Engineering group (IWE) of Wageningen University in collaboration with the Mexican Institute for Water Technology (IMTA, Instituto Mexicano de Tecnología del Agua). The study is a major thesis course within the multi-disciplinary study Tropical Land Use at Wageningen University.

This chapter will present the theoretical and contextual background to this surface water saving investigation. Primarily the setting will be described and accomplished with water management concepts like irrigation management turnover, Basin Closure and Water Savings. In addition it will outline increasing pressure on institutional responses during the 1990s and conclude with a short problem definition and research question. Finally, the research methodology explains the research activities that were necessary to answer the research question.

The Lerma-Chapala River Basin with an area of 54,300 km² covers almost one and a half times the size of the Netherlands. The river Lerma originates in the mountains near the Mexican capital, Mexico City, and flows to the west of the country to supply Lake Chapala which covers an area of 111,200 hectares at full capacity and is the largest lake of the nation. The basin (**figure 1-1**) lies between Mexico City and Guadalajara, the two largest cities of Mexico, and crosses five states: Querétaro (5%), Guanajuato (44%), Michoacán (28%), Mexico (10%) and Jalisco (13%).

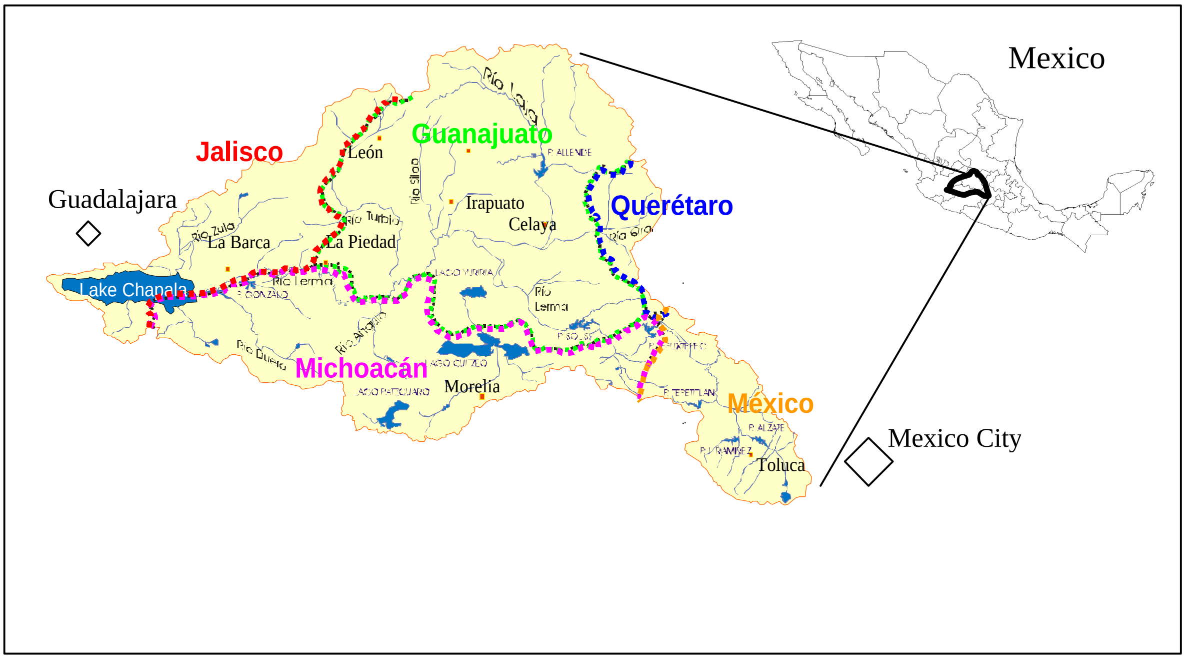


Figure 1-1: The Lerma-Chapala River Basin; State Limits and Lake Chapala (CEASJ, 2003)

The economy of the River Basin accounts for 9% of Mexico's GNP and is the source of water for around 15 million people (11 million in the basin and 2 million each in Guadalajara and Mexico City) (Wester, Burton and Scott; forthcoming, 2005a). Increasing demands of different sectors and increasing awareness of the environmental importance of water put pressure on the resource, the different uses and its users. The most obvious evidence of the so-called water scarcity in the River Basin is that Lake Chapala is drying up. For many people this drying up, symbolizes the mismanagement in the basin. Farmers, as biggest consumers within the basin at present encounter pressure to manage the resource in a more efficient way to make water free for other uses and the recover of the Lake. It is unclear up to what degree their attempts to reduce surface water use are effective. This research will therefore describe and analyze the major water saving efforts of farmers in the Irrigation Districts of the Lerma-Chapala River Basin.

Simultaneously with declining lake levels from the beginning of the 1990s, farmers in *Distritos de Riego* (Irrigation Districts; IDs) were made responsible to manage their irrigation schemes upstream. The national economic crisis of the eighties was a persuasive justification for an ideological-economical reform towards a more market-oriented doctrine. Consequently, as part of the transformation process, Irrigation Management Transfer (IMT) has taken place and the government shifted responsibilities concerning water allocation, irrigation system operation and maintenance of Irrigation Districts to its users. These IDs consist of a number of *Módulos de Riego* (Irrigation Modules, IMs), each module with its own water user association. The installation of these Water Users Associations (WUAs) took place quite rapidly. From 1990 until 1995, more than 2/3 of the country's 3.2 million ha network, divided into 80 Irrigation Districts, had been transferred to 316 irrigation associations (Groenfeldt and Sun, 1997).

Despite rather average weather conditions in the basin, climate could not make up for the man-made shortages of water that became more and more visible. Although rainfall in the past ten years has been only slightly below average, total water depletion in this basin exceeds supply by 9% on average (Wester *et al.*, 2005a). Although relations are not completely clear, Lake Chapala is drying up because of extensive evaporation and excessive groundwater and surface water extractions. In the winter growing season of 1999-2000 the *Comisión Nacional del Agua* (CNA, National Water Committee) transferred 240 MCM surface water from storage reservoirs in the River Basin, normally used for irrigation, towards Lake Chapala in order to save it from depletion, without due compensation to its legitimate users in the Irrigation Districts. The next winter season some farmers, WUAs leaders and supporters started an initiative to resolve and mitigate the severe social and economical consequences of those water transfers to the surface water farmers of the River Basin.

1.2 Conceptual Outline

1.2.1 River Basin Closure, Intensified Water Use and the Need for Water Savings

1.2.1.1 The River Basin

By definition a River Basin is the entire geographical area drained by a river and its tributaries: River Basins are separated by geologic and topographic features such as mountain ridges or other high elevation land forms. According to Molle (2002) basin-level studies will provide more detailed knowledge on the cause-effect relationships between water use and societal and agriculture-environment interactions. He adds that the growing awareness of the interrelated nature of anthropogenic water uses and of the natural water cycle within a basin, together with the limitations of traditional approaches based on the augmentation of supply, have led to the emergence of widely popular concepts such as Integrated Water Resources Management (IWRM), or Integrated River Basin Management (IRBM).

In brief, IRBM is the management of water systems as part of the broader natural environment and in relation to their socio-economic environment (www.riverbasin.org). An important premise of the ecological perspective is that social groups relate to the environments in which they operate - both the physical and natural habitat and the socio-political milieu, through the mediation of socially organized activities which aim at satisfying the requirements of collective survival (Micklin, 1973). Molle (2003) recommends a framework to study River Basin developments in which he calls the development of societies and expansion of their infrastructure and resource use ‘anthropogenization’. This gradual ‘anthropogenization’ of River Basins generates economy-wise, society-wise and resource-wise complexity (see **box 1-1**).

Box 1-1: Complex River Basins ‘Anthropogenization’ (Molle, 2003)

- Resource-wise, the growing interception of surface and underground water flows alters the natural hydrological regime, as reservoirs (e.g. constructed dams) and return flows from uses determine changes in the resource base in terms of quantity, timing and quality. This also has critical implications on ecological equilibriums and dynamics and more generally on the environment.

- Society-wise, water users and people in general find themselves in a situation characterized by growing interaction and interdependence. When one’s water use deprives someone else from the water he or she is expecting for his/her consumption or productive activities, social resources must be mobilized to define socially accepted patterns of water allocation and management: in other words, water becomes “everyone’s business”. With the emergence of water as a scarce and therefore valuable resource, politics and the structure of power within the society must also be factored in the analysis of the access to water resources.

- Economy-wise, with the growing commercialization of agriculture and of inter-sectoral linkages, the different economic activities within the basin and their respective productivity in water use will be defined within the wider national and international economy. Economic alternatives offered to investors as well as to farmers, especially when faced with decreasing supply, critically shape the nature of change and are also largely governed by macroeconomic structures.

Molden, Sakthivadiel and Samad (2000) identify three general phases of basin development. In the first phase of basin development a large part of the available water remains unused. Agriculture is mainly rain-fed and dams (storage capacity) are constructed in order to irrigate irrigation systems. The unused water flows out of the basin into the next downstream basin or into the sea. Water management tends to be demand-driven, and few conflicts are recorded. Water quality remains good and pollution can be easily mitigated by releasing more water from reservoirs (Molle, 2002).

In the second phase, which Molden *et al.* (2000) call the utilization phase, water shortages begin to appear. This phase is generally characterized by degradation of water quality and by environmental problems, as well as by the overdraft of groundwater. According to Molle (2002) in this phase construction of large dams is not longer promising and the augmentation of supply comes from smaller secondary reservoirs and from an increase in the pumping capacity required to access superficial as well as deep aquifers.

The last phase, into which the Lerma-Chapala Basin can be categorized, is the stabilization phase in which pressure over water resources from different segments of society increases. The allocation between different sectors becomes a point of tension (cf. Multiple Stakeholder Platforms). In this phase, institutions have to evolve as to allow the reallocation of water from lower to higher valued uses and to tackle environmental degradation and aquifer depletion. Supply and demand meet each other in the supply-demand equation and the basin matures. The *development trajectory* of the River Basin shows how a particular society has grown, evolved and developed its productive activities within a given physical, climatic and ecological context.

1.2.1.2 Basin Closure

In the Lerma-Chapala River Basin demands increase and drainage effluents are captured and reused; the basin is closing. At the source of the River Lerma water gets polluted immediately by industries. In the Lower Basin where the contexts are different, the pollution mainly comes from sewage water from the cities. This water is called '*aguas negras*', which means that it is black and polluted water from the start. In addition, the runoff gets stored in reservoirs in order to irrigate in the state of Guanajuato for the largest part. Lake Chapala dries up, because of reduced base flow of the river Lerma mainly and gets heavily polluted. Apart from the environmental catastrophe, Seckler (1996: 2) argues as follows;

> 'As population and economic activity grow in a water basin, it gradually evolves from an open to a closed state, where all the dry-season flow of usable water is captured and distributed. Most of it evaporates and whatever remains is so polluted that it cannot be used. This creates massive 'head-ender, tail-ender' problems at the level of the entire water basin. Tail-enders (…) receive progressively less water of progressively lower quality'.

This is exactly the case in the Lerma-Chapala Basin where the RBC searches for consensus-based solutions which involves reaching agreement between five different states about surface water allocation. The River Basin Council (RBC) that was created in 1993 can be seen as a MSP (Multiple Stakeholder Platform), which are defined as 'contrived situations in which a set of more or less interdependent stakeholders are identified, and, usually through representatives, invited to meet and interact in a forum for conflict resolution, negotiation, social learning and collective decision making towards concerted action'. (Röling, 2002: 39) The RBC clearly shows how the allocation between different uses and among users from different parts of the basin becomes an issue of continuous tension in a closed and polluted River Basin (Molle, 2003).

1.2.1.3 Water Savings in a Closed River Basin

As said by Seckler (1996), when water basins become closed, they become, by definition, more efficient. This is why the scope for improving water use efficiency is low, and the degree of water scarcity in the future will be greater than commonly assumed. According to Seckler (1996) the efficiency concept is tricky and procuring additional fresh water supplies is highly problematical. The focus however in general is on saving water by increasing efficiencies in agriculture. According to Seckler (1996) this is the central problem of water resources management and careful research and development work is needed to create wet Water Savings and to avoid chasing the red herring of dry Water Savings.

Conversely to common beliefs and policy discourse, increased surface water use efficiencies thus do not necessarily result in real Water Savings. Although efficiencies can be increased on the local and farm level, this will not change the overall efficiency of the entire basin. After all the total water supply remains the same and all water will be used or reused in a closed basin. Water that is 'saved' in one place, in a closed basin, is used or reused in another place and consequently these savings are called dry or paper Water Savings. These dry Water Savings can also be called distribution savings (which could incorporate labor savings). According to Seckler (1996), real/ wet savings or efficiency gains can be achieved by;

- Increasing output per unit of evaporated water
- Reducing water losses to sinks
- Reducing the pollution of water
- Reallocating water from lower valued to higher valued uses.

Although water basins become more efficient by closure (Seckler, 1996), there are still important efficiency gains which have to be studied in Integrated River Basin Management. According to Molle the definition of a sound water management nevertheless remains a challenge, as it;

> 'Requires not only an in-depth understanding of physical flows, human activities, socio-economic conditions, societal, political and cultural contexts, but also of how they interrelate with each other. In addition, as most River Basins are quite large, the spatial heterogeneity of all these factors, as well as their scaling-up, are critical issues that need to be addressed'. Molle (2003: 2)

1.2.2 Effective and Sustainable Water Management in a River Basin

1.2.2.1 Water Control in Socio-Technical Systems

A comprehensive look at irrigation (systems) requires insight in its technical, organizational or institutional and socio-economic and political aspects. By definition this would be:
'Irrigation systems are socio-technical systems (static) (I), in which water control (II) (dynamic) is the central activity'. (Mollinga, 1997)
Irrigation systems are complex systems, complex in the sense of 'consisting of different elements, related in diverse ways'. The heterogeneity or complexity of the system is summarized in the term socio-technical. The different elements and relationships between these elements constitute an irrigation system as a socio-technical system.

The triangle of people, technologies and water summarizes in a single formula all activities that take place in irrigation. In more detail these irrigation activities are worked out for example by Uphoff (1986). He has provided a useful and comprehensive description of irrigation activities with his well-known ‘cubic matrix’. He distinguishes three types of activities: water use activities (acquisition, allocation, distribution and drainage), control structure activities (design, construction, operation and maintenance) and organizational activities (decision-making, resource mobilization, conflict management and communication).

The context or circumstances that make it possible that irrigation activities are conducted as they are can be called conditions of possibility. Mollinga (1997) distinguishes the following;

1.) the agro-ecological system and technological infrastructure (climate, weather, vegetation, soil, topography, technologies other than the irrigation system itself)
2.) the agrarian structure or transition (markets for labor, land, technology, credit, inputs and outputs, and social relations of class, gender, ethnicity, religion, kinship etcetera at household, village/ community and other levels)
3.) the state and the institutions of civil society: government agencies like the Irrigation Department (CNA), the legal system, policy making institutions (River Basin Council), development NGOs, social movements, education and training institutes, international donor and lending agencies (World Bank, Mexican Bank), local government institutions (CEH[2], CEA[3], SDA[4], SDR[5]), municipalities, etcetera.

The already mentioned triangle of irrigation activities (water, people and technologies) is embedded in these conditions of possibility and therefore puts the activities in a context.
All elements within this context are interrelated. Changes in one element would lead to changes in the others; that is why it is called a system. Irrigation can be understood as a network, consisting of heterogeneous elements. People build these networks which are therefore social constructs. The people that build these networks do not have equal access to resources; they have different positions of power and particular objectives. The social regulation of these physical processes is exactly the objective of irrigation. The physical and social is not the same thing, but they are intimately related, and need to be understood by looking at the way they shape each other (Mollinga 1997).

1.2.2.2 Water Control

Water control as a concept consists of three dimensions (Mollinga 1997);

1.) Technical control
2.) Organizational or managerial control
3.) Socio-economic and political control

The relation between technical (1) and managerial (2) control on one hand, and socio-economic and political (3) control on the other, is two-sided. Socio-economic and political conditions influence what happens inside irrigation systems, and irrigation practices within irrigation systems have implications for the evolution of these socio-economic and political conditions.

With IMT implementation, technical control was partly handed over to the farmer associations in the Modules (WUAs). By definition the organizational or managerial control

2 CEH; Hydraulic State Committee
3 CEA; State Water Commission
4 SDR; State level Sub-secretary of Agricultural Development
5 SDA; State level Sub-secretary of Rural Development

should be transferred completely. The devolution of socio-economic and political control is ongoing, and should be guided by mainly market principles and assisting governmental institutions, like the CNA as an independent water institution. The devolution of socio-economic and political control means in this context the evolution of the farmer-run Limited Responsibility Societies and the emergence of the GTEPAI. The consequent problems or even conflicts emerging from the decentralization of water management in Mexico, shows us that water control may be defined, according to Mollinga (1998), as a political process of contested resource use.

1.2.2.3 Effectiveness of Farmers' Efforts to Save Surface Water

When applying Mollinga's framework for water control in socio-technical systems, effective water control would mean: effective technical control, effective organizational or managerial control and effective socio-economic and political control of surface water use. Boelens provides the following concepts (aspects of sustainable water management) that can be combined with Mollinga's framework (Boelens, Hazeleeger and Vos, 2001);

- Institutional viability
- Equity
- Political democracy
- Economic viability
- Productivity, efficiency and effectiveness; technical sustainability
- Security of access to water
- Ecological equilibrium

The integration of these concepts within the water control model provides the following framework for the analysis of an effective and sustainable water management or control;

a) Technical indicators
   - Productivity, technical efficiency and effectiveness (conveyance, application efficiencies)
   - Ecological equilibrium of water management
b) Socio-economical and political indicators
   - Economic viability,
   - Equity
   - Security of access to surface water
   - Political democracy
c) Organizational or managerial indicators
   - Institutional viability
   - Organizational effectiveness (decision-making, resource mobilization, communication and conflict management)

These indicators categorize the effectiveness analysis of water savings efforts. Although this structure permits a disconnected analysis of the various components of an effective and sustainable water management, in practice they are very much related. With this conceptual structure I search for a better understanding of shortcomings and strengths of the GTEPAI initiative. In order to understand the emergence and functioning of the GTEPAI process it is necessary to describe the institutional changes that preceded the GTEPAI emergence. In this context, especially IMT, the 1991 surface water treaty, a new national water law in 1992 and the creation of a River Basin Council are important alterations.

1.3 Water Contest and the Institutional Landscape in the Lerma-Chapala Basin

1.3.1 Some Tragedy of the Commons

The population of Mexico increased enormously the past century. In 1920, Mexico had 14.3 million inhabitants. Thirty years later, this population increased already to a number of 25.8 million people. In 1980, the size of population was 66.8 million and this amount of inhabitants grew further to 97.5 million Mexicans by the year of 2000 (INEGI, 2003). Due to this explosive population growth, the pressures on resources increased like-wise and the management of water quality and water quantities suffered terrible developments. Already in 1968, Hardin strongly argued that in general ‘the population problem could not be solved in a technical way’ in what he stresses the ‘tragedy of the commons’, which would be inherent to overpopulation and the use of resources held in common (Hardin, 1968).

Because population almost doubled between 1960 and 1980, the central government of Mexico (GOM) encountered Hardin’s population problem and troubles in governing the country and a tragically recessive economy during the eighties. Earlier policies originating from the fifties such as imposed import controls, mandated production targets, marketed crops, subsidized agricultural inputs, limited land transactions and a heavily subsidized irrigation sector by investing in infrastructure were no longer valid and could not improve growth, rural poverty and nutrition for the poor (Gorriz, Subramanian and Simas, 1995).

When haciendas (landed property or large landholdings) were broken-up from the 1930s onwards under the government of General Lázaro Cárdenas (1934-1940), a struggle was started between private farm interests and the recipients of the agrarian land reform program (*ejidos*). *Ejidatarios* are members of *ejidos*, land reform communities created after the Mexican Revolution of 1910. This struggle over land and water resources continues to date and was intensified by the amendment of Article 27 of the Mexican Constitution in 1992, which allows the sale and transfer of *ejido* land (Scott and Silva-Ochoa, 2001). Due to the NAFTA and the 1992 amendment *ejidos’* collective management of land, water and other watershed resources are increasingly passing to private, individual hands, according to Scott and Silva-Ochoa (2001).

In the state of Guanajuato all *ejido* systems together possess approximately the same area of land in comparison with the private systems (117,004 ha versus 115,353 ha). The size of landholding per private producer is however more than 4 times higher on average (CNA/CP, 1998). According to Wester *et al.* (2000), landholdings per *ejidatario* are typically less than 5 ha. *Pequeños Propietarios* are private farmers with a limit on land ownership of 100 ha. In practice it is however possible to manage even much larger areas, with nominal ownership in the hands of family members, friends and others.

Whereas *ejidos* and private growers had differential access to land and water resources, both groups were heavily subsidized by a series of governmental support programs. The highly subsidized irrigation sector and a reduction in the expansion of irrigated area precipitated the agrarian crisis of the 1980s (de Janvry, Gordillo and Sadoulet, 1997). In order to infuse the economy after the crisis, the irrigation sector had to undergo reorganization. According to Trava (1994, also Gorriz *et al.*, 1995; Johnson III, 1997; Kloezen, Garcés-Restrepo and Johnson III, 1997; Rap, Wester and Pérez-Prado, 2004) the government decided to reduce the costs of agriculture, as an ingredient of the eighties economic crisis, which relied on big investments, subsidies and technical incentives. To achieve this goal, financial autonomous organizations, which could function in a neo-liberal market setting, should be created.

1.3.2 Governing Decentralization

Under the National Development Plan (1988-1994) the Mexican government called for a program that would transfer the management of Irrigation Districts to water users associations (Garcés Restrepo, 2001). These water reforms in Mexico were part of a larger set of neo-liberal reforms enacted during the presidency of Salinas de Gortari (1989-1994) with the support of international funding agencies (Rap *et al.*, 2004). The authors contradict the general notion of economical crisis and institutional changes leading to irrigation management transfer (IMT). They examined the success and origin of IMT and included historical, political and bureaucratic processes that engendered and sustained Mexico's water reforms into their analysis. In their analysis, Rap *et al.* (2004) view policy actors as the unit of analysis. 'The articulation of reforms as the focus of attention, clarifies why and when water reforms are effectuated and how alliances are negotiated through which reforms gather momentum' according to the authors. (Rap *et al.*, 2004: 2)

Wittfogel already in 1957 advocated the tendency of centralized organization as unavoidable in controlling water, which would imply an all powerful bureaucracy (Wittfogel, 1957). This may hypothetically explain why in 1989 together with the launch of a decentralization process a central (independent) water body, the CNA, was created. The powerful hydraulic bureaucracy ('hydrocracy') only accepted the decentralization reform, if their interests were protected by the creation of an independent water body, which became the CNA. CNA was created by presidential decree and granted the agency the responsibility to define the country's water policies and allocate water to users through licenses and permits (Svendsen, Trava and Johnson, 1997). According to Svendsen *et al.* (1997) the new policy of IMT created autonomous and self-financing water utilities to provide water services in cities and in irrigation districts, encouraged water re-use and water quality conservation and promoted a new water culture based on the efficient use of the resource (see also Rap *et al.*, 2004).

As said by Rap *et al.* (2004), the composition and the commitment to the water reforms emerged from a complex and protracted process of interaction and enrolment between policy actors such as senior '*hydrocrats*', the Mexican presidential candidate and World Bank officials. These hydraulic bureaucracy seniors played a crucial role in the generation of policy strategies and the discourse on the water reform package in the 1980s, as part of an ongoing struggle within the Mexican hydraulic bureaucracy.

These segments of the hydraulic bureaucracy are called the 'lobbyists' by Garcés Restrepo (2001). According to Garcés Restrepo, the new government of Salinas de Gortari pressed on modernizing the country. With this drive for modernization, the idea of the transfer of the irrigation systems began to fall in place which served the purposes of the lobbyists. They did not get a new Ministry but they got the next best thing, which was the creation of CNA as the sole authority in charge of the country's water resources (Garcés Restrepo, 2001).

1.3.3 The 'Mexican Model': Irrigation Management Transfer to WUAs (first phase) and SRLs (second phase)

1.3.3.1 First Phase Irrigation Management Transfer

The water reforms, which included the transfer of government-managed Irrigation Districts to Water Users Associations (WUAs), were part of a larger set of neo-liberal reforms (Rap *et al.*, 2004). The transfer of Irrigation Districts' management (and other water reforms) was thus an element of a major agricultural and political reform initiated at the highest level of government. According to Wester *et al.* (2005a) the reforms were driven by market-oriented economic and political imperatives and resulted in:

- Removal/ reduction of subsidies to agricultural production;
- Privatization/ elimination of public sector input supply and crop marketing bodies;
- Removal/ reduction of tariffs and barriers to agricultural trade;
- Reform of the Mexican Constitution to permit the sale and renting out of '*ejido*' land.

The IMT program was launched in 1989 and intended to run until the end of the year 2000 (Garcés Restrepo, 2001). The program aimed at; ensuring the sustainability of the Irrigation Districts, reducing the financial burden on the government, making users responsible for operation and maintenance, hereby increasing the efficiency of water use, improving and sustaining system performance and reducing the number of public employees in the districts (Garcés Restrepo, 2001). The objective of the reform was to stimulate economic growth through private investment in agriculture and reducing public expenditure on irrigation through creating financially self-sufficient WUAs that would shoulder the full O&M costs of the irrigation systems (Espinosa de León and Trava 1992; Gorriz *et al.*, 1995; Johnson 1997; Trava, 1994; Vermillion, 1997; Svendsen *et al.*, 1997).

The CNA divided Irrigation Districts in *módulos*, which are generally secondary canal command units on the basis of hydraulic boundaries. Although the definition of system boundaries in practice was problematical to some WUAs (interview with Raúl Medina de Wit), in existing literature, there is hardly any notice to this limitation of the IMT program. The hydraulic boundaries were in practice not clear to the users and also land and water entitlements were not registered well enough to distinguish between *de facto* and registered users.

Nonetheless, the devolution of managerial responsibilities for operation, maintenance and administration of the IDs took place very rapid (Ujjankop, 1995; Groenfeldt and Sun, 1997; Garcés Restrepo, 2001; Johnson, 2002; Palerm-Viqueira, 2004). Five years after the launch of IMT, already two thirds of the country's 3.2 (or 3.38; according to Urban, Wester and Kloezen, 2000) million ha network, had been transferred to 316 WUAs (Groenfeldt and Sun, 1997). According to Romero Pérez and Mollard (2003) twelve years after the kick off of the transfer process, the first stage can be considered to be fully completed, with the formation of 454 WUAs in 81 out of 82 Irrigation Districts in the country. According to Kloezen *et al.* (1997, and Kloezen and Garcés-Restrepo, 1998) the transfer of management to these WUAs has had some impressive performance improvements as a result, like measurable improvements in matching expenditure and farmers' perceived needs, significantly improved financial self-sufficiency, increased levels of managerial accountability and significantly improved levels of expenditure on maintenance (Kloezen *et al.*, 1997, 1998).

Whereas IMT resulted in improvements in system maintenance and O&M cost recovery, changes in agricultural and economic productivity and costs to farmers are related to the wider set of neo-liberal agricultural and economic reforms that started in the 1980s, according to Kloezen *et al.* (1997). The authors also conclude that the IMT program had very little impact on surface water allocation and distribution, and the use of groundwater.
Although the Mexican IMT Model is known and advocated as one of the most ambitious and successful of its kind worldwide, Kloezen *et al.* (1997) and Garcés-Restrepo (2001) searched evidence for the claimed success in the largest ID of the Lerma-Chapala Basin. They attribute the success of rapid implementation to the following conditions:

- The Mexican IMT program was part of a wider set of neo-liberal economic reforms;
- IMT was made workable as it met with a political commitment at the highest levels and large groups of economically powerful farmers.
- IMT was accompanied from 1992 onwards by the introduction of a new National Water Law (LAN; *Ley de Aguas Nacionales*) that recognizes water rights to water user associations (WUAs), as well as the authority and responsibilities of water users.
- Flexibility of the program made it work; different settings explain the different processes of WUA development. Although it was a top-down process, the flexibility of the program to a degree prevented farmer resistance.
- Promotion and training campaigns together with the promise of rehabilitation and modernization of the districts were supplementary incentives for farmers to participate in the WUAs.
- Overcoming resistance by the irrigation agency through re-organization of the CNA.
- Additional financing arrangements: The program was designed with very clear financial targets. Each step of the implementation process had specific funds allocated to it.
- Many support services that were previously provided by government agencies also became part of the WUA responsibilities in addition to the O&M and administrative services they had taken over.

The first phase of IMT in which WUAs started to develop, took place quite rapidly and in this initial phase of the program four main actors were involved. Urban *et al.* (2000) identify water users, WUAs, CNA and *Comités Hidráulicos* (Hydraulic Committees, HCs) as main actors in the provision of maintenance services at the main system and secondary level. In 1992 a new national Water Law prescribed the creation of HCs at district level which should translate the law into practice each year. The HCs were created to ensure adequate management of water and irrigation infrastructure at district level. The HCs gather the WUAs of the *módulos* of an Irrigation District. The HC is a district organization (covering more than 100,000 ha in the largest district of the Basin) in which presidents of the WUAs, CNA and State representatives come together in order to formulate and propose the regulations of the district and monitor their application (CNA, 1999b). According to the 1992 Water Law (article 66) the Hydraulic Committee is a mediating and coordinating body, whose structure and mode of operation are to be defined in the regulations of the respective Irrigation District (Urban *et al.*, 2000).

In fact, the 'creation' of HCs was in many cases a transformation of the former *Comités Directivos* (Executive Committees) of the Irrigation Districts (SAGAR, 2001). The tasks of the HC are the resolution of disputes between water users and between WUAs, knowing and monitoring maintenance programs in the district, being aware of the annual irrigation plans and their execution and being aware of and commenting on how water fees are determined and collected by WUAs (LAN 1992; art. 99 in Urban *et al.*, 2000). Garcés Restrepo (2001) comments that the HCs have to decide on issues related to seasonal planning, water trading and access to externally funded system improvement programs.

As elements of the IMT process these HCs are important institutions, since they purportedly provide a venue for participatory management, negotiation, and decision making in which the CNA, WUAs, and local state officials meet in order to plan annual irrigation and promote user support programs (see chapter 2). The HCs can be seen as forerunners of the *Sociedades de Responsabilidad Limitada* (Limited Responsibility Societies, SRLs; see following section) and GTEPAI (chapter 2) which deal with comparable responsibilities, but in a progressive 'farmer-run' and hence more decentralized way.

Quite contrary to positive experiences of HCs being scenes for participatory management or being mediating bodies, there are also strong complaints about the biased discussion themes, namely water for irrigation and irrigation infrastructure. Several elements and production factors like commercialization of agriculture, incorporation of other rural activities, management of other natural resources and social development issues are not per definition included in the seasonal planning platforms (SAGAR, 2001). Urban *et al.* (2000) contribute that in the ID-011 the CNA district representative has delegated the right to approve the yearly O&M plans to the HC, which is a loose interpretation of the Water Law, since CNA is formally responsible for the approval.

1.3.3.2 Second Phase Irrigation Management Transfer

The second part of the IMT program involves the aggregation of Irrigation Modules into SRLs which are farmer-run federations that take over CNA responsibilities. The Irrigation Modules, that are defined in stage one of the IMT program, bring about water users associations that can organize themselves into SRLs in the second stage of the process. The formation of such a SRL should follow the next five stages according to the CNA (Garcés Restrepo, 2001);

1. Formal constitution of the SRL (1996 in the ID-011)
2. Compile O&M plan and administrative instructions
3. Hand over of the main system infrastructure, machinery and equipment from CNA to SRL (1997 in the ID-011)
4. Agreement on the percentages of water fee collection to be paid to CNA for handling of the head-works and corresponding roads.
5. Training of SRL staff by CNA in planning, operation and administration of the Irrigation District.

Despite prescriptions for SRL formation, only in the Alto Rio Lerma Irrigation District (ARLID; ID-011) such a federation of WUAs has been formed to manage the main system (Mollard and Romero Pérez, 2003; Kloezen, 2000) within the Lerma-Chapala River Basin. Although originally 21 SRLs were planned to be created by 1994 (World Bank, 1991), in the rest of the country about 12 SRLs have been formed, mostly in the north and northeast of the country (e.g. state of Sinaloa), where there are large scale irrigation systems (Mollard and Romero Pérez, 2003). The responsibility of a SRL is to distribute water from the head works to the WUAs, to discharge of any excess water to the drainage system and to maintain the transferred infrastructure (Urban *et al.*, 2000). The expenses of these activities are covered by fees that are paid by the WUAs. The formation and consolidation of a SRL depends on several conditions. Romero Pérez and Mollard (2003) mention the attractiveness of infrastructure to administer, socio-economic factors like agro-industrial integration and political support to the strengthening of such a farmer-run federation. The authors argue that the SRL in the ID-011 was a strategic initiative to protect the interests of large landholdings and form a pressure group in the negotiations of the RBC, which is dominated by CNA.

The SRL is composed of the WUAs' representatives, one CNA and one state representative. The difference with the SRL and HC is that in the case of a SRL, the president is a user representative and in the HCs the district chief engineer of CNA should preside. In the HC of Guanajuato it is however not the CNA district, but CNA state manager with the Minister (or representative) of Agriculture of Guanajuato State (Urban *et al.*, 2000) that preside the Committee. The SRL and HC deal with different irrigation matters. Urban *et al.* (2000) explain that in the case of the ID-011, the SRL and HC assemblies are often held on the same day, but that functions are clearly different to the participants. The SRL deals with internal matters such as internal organization of maintenance activities, additional services for their members, like commercialization of products. The HC on the other hand deals with the definition of local water policies (e.g. water distribution between *módulos* and irrigation service fees) and is the final decision making body, when compared to the SRL.

1.3.4 The Surface Water Treaty of 1991, the 1992 Water Law and the River Basin Council (1993)

1.3.4.1 The Surface Water Treaty of 1991

While 1989 was a historic year in view of the national IMT water reform, also in the Lerma-Chapala there was a historic agreement. On April 13, 1989 the federal government and river basin state governments signed an agreement in order to resolve and mitigate the basin's water related problems. On September 1 of that year a Consultative Council (CC) was established to follow up the agreement and evaluate goals and tasks derived from the water agenda (Mestre, 1997).

In 1990 the CC installed a technical working group (TWG), which would elaborate a treaty on availability, distribution and use of the basin's waters. The TWG detailed future plans for a Structuring and Sanitizing Program for the River Basin (Navarrete Ramírez, 2002). In August 1991 almost two years after the initial Basin co-ordination agreement, a surface water treaty was signed in order to sustain the water level of Lake Chapala and consequently ensure the domestic water supply of Guadalajara, downstream (Wester *et al.*, 2005a). According to Scott and Flores-López (2001) the water allocation agreement exclusively dealt with surface water and with one notable exception only addressed agricultural water demands. To preserve Lake Chapala the treaty sets out three allocation policies (**box 1-2,** page 14) indicative of critical, average and abundant volume of water in the Lake (Navarrete Ramírez, 2002).

Although the 1991 surface water treaty was observed by the WUAs (Wester *et al.*, 2005a) in the next eight years and the volume used was smaller than the volume allocated, the Lake level dropped to its lowest level since the signing of the 1991 treaty in 1999. The River Basin Council (RBC; see next section) recognized the shortcomings of the treaty. One of the deficiencies was the lack of information on water extractions by the Irrigation Units. Another inadequacy was the calculation procedure for the next year's allocation based upon the previous year's water availability. The data used for the comprehensive hydrological calculations came from the period 1950 to 1979 under the rules of the treaty (Wester *et al.*, 2005a).

In August 2000 (Wester *et al.*, 2005a) the Council signed an amendment of the 1991 treaty and hydrological data from 1945 to 1997 were incorporated in the calculations. Further complications and criticism came mainly from the state of Guanajuato and to a lesser extent from the other four states. The states experienced too little influence and insufficient input in the design of the surface runoff model of the CNA and this amendment was felt as imposed on them. One reason for this despondency was the weak and proportional representation of the states and the water users in the RBC.

Box 1-2: Surface Water Allocation according to the 1991 Surface Water Treaty (Wester *et al.*, 2005a)

To allocate surface water fairly among users in the basin, the governors of the five states in the basin and the federal government signed a treaty in August 1991 (CCCLC, 1991). An important objective of the treaty is to maintain adequate water levels in Lake Chapala and to ensure Guadalajara's domestic water supply. To preserve Lake Chapala the treaty sets out three allocation policies, namely critical, average and abundant, based on the volume of water in the lake (less than 3,300 MCM, from 3,300 to 6,000 MCM and more than 6,000 MCM, respectively).

Each year the Council verifies the volume stored in Lake Chapala to determine the allocation policy to be followed for the next year. For each allocation policy, formulas have been drawn up to calculate water allocations to the irrigation systems in the basin, based on the surface runoff generated in each of the five states in the previous year. The following table indicates how this works for the ARLID. Based on extensive modeling of these formulas it was concluded that the resulting water allocation would not impinge on the 1,440 MCM needed by Lake Chapala for evaporation.

Table 1-1: Water Allocation Policies for the Alto Rio Lerma Irrigation District (CCCLC, 1991 and Wester *et al.*, 2005a)

Lake Chapala Volume	Surface Runoff Generated (SRG) in the State of Guanajuato (MCM)	Volume Allocated (VA) to Irrigation District (MCM)
Critical	if SRG between 280 and 1,260 if SRG > 1,260	then VA = 94.2% of SRG -262.8 then VA = 924
Average	if SRG between 144 and 1,125 if SRG between 1,125 and 1,400 if SRG > 1,400	then VA = 94.2% of SRG -135.6 then V A = 924 then VA = 955
Abundant	if SRG between 19 and 1,000 if SRG between 1,000 and 1,200 if SRG > 1,200	then VA = 94.2% of SRG -17.9 then VA = 924 then VA = 955

1.3.4.2 The 1992 Water Law

The HCs, CNA and WUAs were not exclusively determining the institutional environment in the Lerma-Chapala River Basin, during the first phase of IMT. Besides existing state institutions like CEAs (from 1991 onwards), SDAs and SDRs, another important institution was created on basin level by prescription of the 1992 Water Law. The 1992 Water Law was the legal complement that strengthened the unification of government responsibilities in the CNA and prescribed the formation of the HCs on district level on the one hand. More importantly perhaps this law defined an integral approach for managing surface and groundwater in the context of river basins, which it considers as the ideal geographical unit for the planning, development and management of water (Wester *et al.*, 2005a) on the other hand.

The 1992 Water Law mandates decentralization, stakeholder participation, better control over water withdrawals and wastewater discharges and full-cost pricing. In order to realize these policies in practice, river basin councils (RBCs) have been created by CNA as coordinating and consensus-building bodies between the CNA, federal, state and municipal governments and water user representatives (CNA, 1999b), at the river basin level in 25 river basins (CNA 2000a). The Lerma-Chapala River Basin Council has been established as Mexico's first River Basin Council in response to the drying up of Lake Chapala in the 1980s and the severe contamination of the Lerma River (Mestre, 1997).

The agro-ecological conditions in the Lerma-Chapala Basin played an important role in its leading function. Not only is the basin of economic importance to the country, but it is at the same time under great danger of environmental tragedy. Mestre (1997) points out that economic development exerts heavy pressure on land use in the basin, which caused a loss of vegetation in general, and in particular has levied a heavy toll in terms of deforestation and erosion, both on plains and slopes. Flooding and erosion reduce the lifespan of hydraulic works and raise river maintenance costs and have a destructive environmental impact.
While recognizing nature's limited bearing capacity, the federal government (president Salinas de Gortari) and the five state governments signed a co-ordination agreement to improve water management in the basin already in April 1989. According to Mestre (1997) and Wester *et al.* (2005a) a formal Consultative Council (CC) was formed in September 1989 with the following objectives:

- to control and regulate the allocation of surface water and distribute water fairly among users
- improvement of water quality by treating municipal raw effluents
- increasing water-use efficiency
- conserving the river basin ecosystem

According to Wester *et al.* (2005a), the initial success of the CC and TWG was influential in the creation of a new National Water Law in 1992 (LAN, 1992: e.g. Art.13) that allowed for the establishment of River Basin Councils to build consensus among the federal, state and municipal governments and water users. While responsibility for water management was retained by CNA, the RBCs were conceived as important mechanisms for negotiation and conflict resolution. The 1992 National Water Law supported the IMT process by defining property rights over water, and providing the new service arrangements with clear rights, roles, functions and responsibilities (Garcés Restrepo, 2001).

1.3.4.3 The Lerma-Chapala River Basin Council

Inspired by the French model of river basin management, in January 1993 the Lerma-Chapala River Basin Council was the first created RBC in Mexico as a mechanism for negotiation and conflict resolution, by converting the CC into a Council with user and sector representatives (Mestre, 1997; Mollard and Vargas Velázquez, 2003; Wester *et al.*, 2005a and Wester, Hoogesteger van Dijk and Paters; forthcoming, 2005b). The uses that are represented in the Council are agriculture, fisheries, services, industry, livestock and urban (see **figure 1-2**). Decisions are formally taken in the RBC by a Governing Board made up of the CNA director, the five state governors and a representative for each of six distinguished water uses (Wester *et al*., 2005a).

According to Wester *et al.* (2005a), the structure of the River Basin Council is complemented by a stepped form of user representation, consisting of water user committees for the six water use sectors represented on the Council. The authors explain that these sectoral committees can be formed at the regional, state or local level on the basis of already existing WUAs or other legally recognized water management groups. These water user committees delegate representatives to the User Assembly of the Council, which in turn elects the six user representatives on the Council.

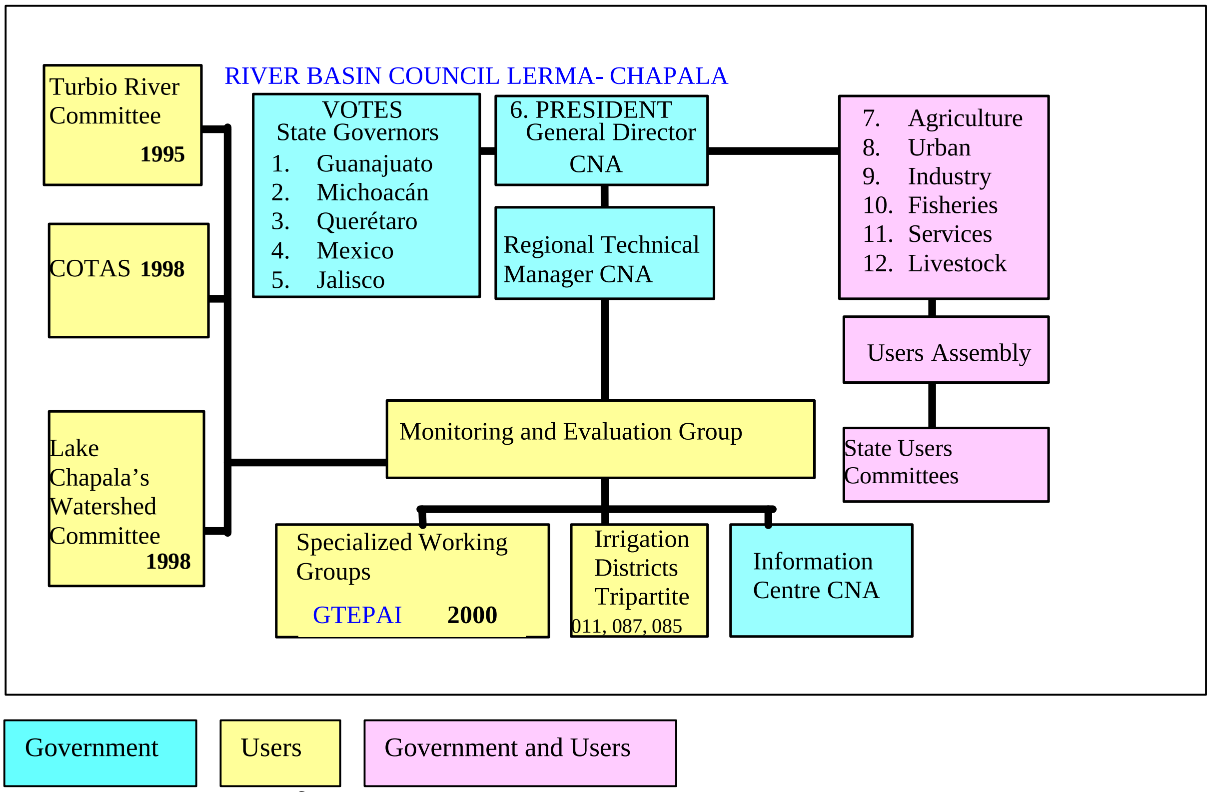


Figure 1-2: Structure[6] of the Lerma-Chapala River Basin Council (Free after CNA, 2000 in CEHGTO, 2003)

In practice the Monitoring and Evaluation Group (MEG), presided by CNA, takes decisions in the Council. According to Wester *et al.* (2005a) the MEG is the main decision-making body, with a membership that mirrors the interests on the Governing Board. The authors argue that ensuring effective representation of water users and uses has been a challenge for the Lerma-Chapala RBC in order to achieve consensus-based decisions. Formally, the user representatives on the Council are elected, but in reality, the links with their constituencies are often weak (Wester *et al*., 2005a).

1.3.5 Water Contest Leading to 'Out of Agriculture Transfers'

Despite WUAs' obedience to the surface water treaty, the level of Lake Chapala was critically low in 1999 and the Council decided to revise the 1991 treaty as it was clearly not rescuing

[6] Structure of the RBC as approved in the third extraordinary meeting of the MEG (CNA, 2000 in CEHGTO, 2003)

Lake Chapala. In the ARLID's reservoir there was enough water stored to cover full allocation to the farmers for irrigation in the autumn winter season. To shore up water levels in Lake Chapala the Council nonetheless decided to release the additional storage of 240 MCM in the Solis Dam (see **figure 1-3**). This was the first time since 1991, when the treaty was signed, that water was physically transmitted from the agricultural sector to the environmental and urban sector. Due to the reduced allocation one fourth of the surface water irrigated area was not irrigated in the 1999/2000 winter season. The next winter the problems were more or less the same and the WUAs throughout the basin let 200,000 ha out of 235,000 ha stand idle. The decision for omitting irrigation was taken in the HCs of the districts, upon request from Lake Chapala's Watershed Committee (DDR/L, 2000).

Figure 1-3: Solís Dam in Guanajuato (Lerma-Chapala Users Committee, 2002)

Nonetheless the CNA unilaterally decided a second transfer of 270 MCM to the Lake in 2001 mainly from the main irrigation reservoir in Guanajuato and also planned another release of 280 MCM for the summer season of 2003. These transfers met with heavy resistance from the surface water users, because they did not agree with CNA's interpretation of the 1991 treaty.

The second and third water transfers to Lake Chapala were not negotiated with the farmers. The surface water treaty of 1991 and its amendment in 2000 did not justify such water transfers. The function of the RBC as a mechanism for negotiation and conflict resolution was also neglected and degraded the Council to nothing more than a discussion platform. The ultimate authority that CNA regained over the nation's waters by the 1992 Water Law, demonstrates essential power differences in the negotiating and decision-making processes in the RBC.

1.4 Problem Definition, Research Question and Methodology

1.4.1 Problem Definition

In the context of extensive institutional changes and increasing pressure on water resources Irrigation Management Transfer has taken place in Mexico. The central government has shifted managerial responsibilities concerning water allocation, irrigation system O&M, financial control to Water Users Associations. On the basis of a rapid WUA formation and a participatory river basin management approach, a farmer-run initiative has emerged in order to represent and defend farmers' interests by diminishing the sector's water use. The GTEPAI over-arched the Irrigation Districts in the basin and aimed at horizontal empowerment of the WUAs by joining their abilities and efforts in order to reduce their water use.

It is unclear however how the GTEPAI emerged and managed to join efforts of different Irrigation Districts from different states. It is unclear up to what degree GTEPAI attempts to make water available for other use are effective. It is not clear how saving surface water will help farmers to sustain their livelihoods and reverse depletion of Lake Chapala and other water bodies. In a closed river basin context with multiple interlinked water uses and users, not only agriculture (mainly WUAs) should encounter the responsibility to use the available water more efficient and effectively. The River Basin Council and hence the other users and uses need to search for enhanced management of the River Basin's water in quantitative and qualitative aspects. The functioning of this Council as a legitimate conflict-solving body gets however undermined by unilaterally decided water transfers.

1.4.2 Research Question

What is the effectiveness of the GTEPAI initiative (mainly in the ID-011) in saving surface water within the context of increasing water contestation in the Lerma-Chapala River Basin in Central Mexico, from 2000 until 2003?

1.4.3 Type of Research

The research in the Lerma-Chapala Basin was a practical field research from April 2003 until August 2003. I started the case study in January 2003 by exploring the context of the Lerma-Chapala River Basin through a literature study and discussing research issues within this context with my teacher and supervisor, Flip Wester. Together with him, I decided to perform a practical research in the Lerma-Chapala Basin from April until September 2003 and investigate the GTEPAI effort that manifested itself by the end of 2000. Thanks to his helpful contacts in the Basin's network I got an entrance to the Councils' stakeholders and their information. After arrival in Mexico I approached various participants in the GTEPAI initiative (see **figure 1-4**) in order to obtain information about their role in the process and their vision on the GTEPAI activities. The first actor of the GTEPAI network I met was Gabriela Monsalvo Velázquez, vice-principle of the department of Integral Soil and Water Management (MISA) of the *Secretaría de Agricultura, Ganadería y Desarrollo Rural, Pesca y Alimentación* (SAGARPA; Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food). Gabriela explained the complicated institutional setting from the start and offered her valuable connections with all kind of important persons in the institutional scenery.

Quite unfortunate however my first research result was the discovery of the GTEPAI's termination at the same time as I started the research.

1.4.4 Research Methodology

Despite the abrupt end of the GTEPAI by the end of 2002, I continued researching the GTEPAI network and available documentation. A lot of information could be gathered through interviews with different RBC stakeholders and authorities, from a broad range of institutes and organizations. The GTEPAI actors were nevertheless primary sources of information about their activities and interests in the farmer-run event.

Figure 1-4: GTEPAI 'Entrepreneurs', (Monsalvo and Wester, 2003)

From the left to the right: Samuel Aguilera, Alejandro Ramírez, Juan Mayorga, Gabriela Monsalvo, Raúl Medina, Raymundo Rocha and Guillermo Hernández.

Besides some formal but mostly informal interviews, I also asked for written information concerning the GTEPAI process, other water saving programs and concepts. Because the research took place in an area were a lot of scientific research already had taken place, there was a great supply of literature to support qualitative and quantitative analyses. Relevant sources of information and documentation are obtained from the CNA, SAGARPA, SEMARNAT, INIFAP, IMTA, IWMI, RBC, WUA, GTEPAI, SRL, SDA, SDR, CEA, CEH and COTAS institutions among others. In addition, the internet provided many documents about the Lerma-Chapala River Basin in the format of scientific literature or local newsletters that reported actual water stories that supported or contradicted the primary sources.

During the field research I tried to visit as much as possible MEG meetings, especially because of the third transfer that started on the 10th of May 2003. Despite some large distances and expensive hotels, I traveled to the various institutes spread over the whole basin in order to trace the GTEPAI network. Unfortunately the GTEPAI initiative was inactive during my stay, though some participants continued certain components of the GTEPAI strategies.

The leader of the movement and representative of the agricultural sector met powerful opposition in the MEG of the RBC and came under increasing attacks in the media, which led him to decide to withdraw and take up his own farming business. Nevertheless, Raúl Medina helped me with my research by kindly inviting me to his organic farm, located on the bank of the ultimate end of the River Lerma.

The visits to the '*rancho*' (the farm) of Raúl resulted in some unreliable 'research results', besides the important rendezvous with the GTEPAI leader and agricultural representative. Apart from a perceived increase in mosquitoes in the region during the past years, recently also crocodiles immigrated from the south of Mexico towards Lake Chapala supposedly, while the third transfer was taking place. The crocodiles were observed near the ranch and explained by climatologic changes, but a more plausible reason was their escape from a crocodile farm, due to high river levels. The high water level of the River Lerma was manufactured by upstream water releases from irrigation reservoirs and initial summer rains, which caused the flooding of large parts in the Basin and an unexpected recovering of Lake Chapala.

In *La Barca*, a village near the farm of Raúl, I was privileged to meet another important actor and companion of Raúl within the GTEPAI initiative (and previously behind the 'Mexican IMT Model' of Irrigation Modules and Districts to WUAs). This person, José de Jesús Lomelí López, was head of the Jalisco *Distrito de Desarrollo Rural-06* (DDR-06, sixth Rural Development District), the Jalisco DDR department of SAGARPA. While taking me with him on trips to farmer meetings in some local municipalities and WUAs, José de Jesús taught me some of the typical GTEPAI strategies in joining farmers and their interests. During these reunions with municipal authorities, water users, crop promoters from INIFAP and private companies, I could still learn from the GTEPAI spirit, despite of its ending.

By the end of the practical period of research I gathered an enormous amount of digital information, which I can consider the data bank of the GTEPAI. The information came from institutes in the Basin that I visited, but also from the World Bank, FAO and international NGO's. Together with the interviews, internet articles and related scientific research reports I aim at providing a comprehensive case study about the impact of farmer efforts to deal with the new opportunities and conflicts they face in managing surface water and decentralization policy prescriptions.

Chapter 2: ‘IMT makes GTEPAI and GTEPAI makes IMT’

2.1 Introduction

This chapter will describe and analyze the GTEPAI initiative as a result of the previously described changing contextual conditions of possibility. The institutional changes very much influenced the agrarian structure or transition, the agro-ecological system and technological infrastructure in which irrigation activities are embedded and undertaken. The ongoing processes behind the emergence of this working group will be detailed in order to provide the necessary documentation of a quite unique phenomenon that has potential of making IMT succeed. As such, this description is a decisive attempt to revise and complete the earlier claimed success of IMT in Mexico. Countries that encounter a resembling transition towards a more market-oriented or neo-liberal society might learn from this reflective analysis. The central argument of this chapter is that GTEPAI or comparable processes could have the potential to make IMT succeed and enter decentralization into a next phase. IMT is fundamental to the GTEPAI in the first place, but the GTEPAI can hence be fundamental to the real success of IMT in the end.

The practical implication of this group however remains a ‘better use of water’, which means making it available to other sectors and simultaneously protecting the agro-ecological environment, agricultural productivity and rural livelihoods. In the process of decentralizing of water management responsibilities, it is important to recognize that the transfer of management is not an easy concept. Principally WUAs were created as more or less isolated user organizations under the auspices of CNA. A decade after IMT, the WUAs in the Lerma-Chapala Basin gathered and dominated for two years the agenda of the RBC. During this relative short period, the GTEPAI attempted to achieve farmer participation (in decision-making) in the RBC. As a group, the WUAs aimed at showing their potency by managing most urgent physical, economical and organizational deficiencies at stake.

2.2 Different Backgrounds to the GTEPAI Emergence

2.2.1 The Water Transfer of 1999 as Trigger for the Emergence of the GTEPAI

In 1999, CNA released 240 MCM from the largest Irrigation District’s (ID-011) main reservoir in the state of Guanajuato (head area of the River Lerma). This first water transfer was a physical but also political reaction to decreasing levels of Lake Chapala and the little surface water runoff generated in 1998, conform the surface water treaty of 1991. Although sufficient water was available in the basins storage reservoirs (**figure 2-1**) to meet concessions for irrigation in the various districts; only 648 out of 955 MCM were allocated to the largest Irrigation District in the River Basin (Wester *et al.*, 2000). As a result of the reduced allocation to the Alto Río Lerma Irrigation District (ID-011) some 20,000 ha out of 77,000 ha went without surface water irrigation in the winter season. Four of the eleven WUAs in the district did not cultivate, while in the other seven WUAs irrigation was restricted to a maximum of three hectares per landowner.

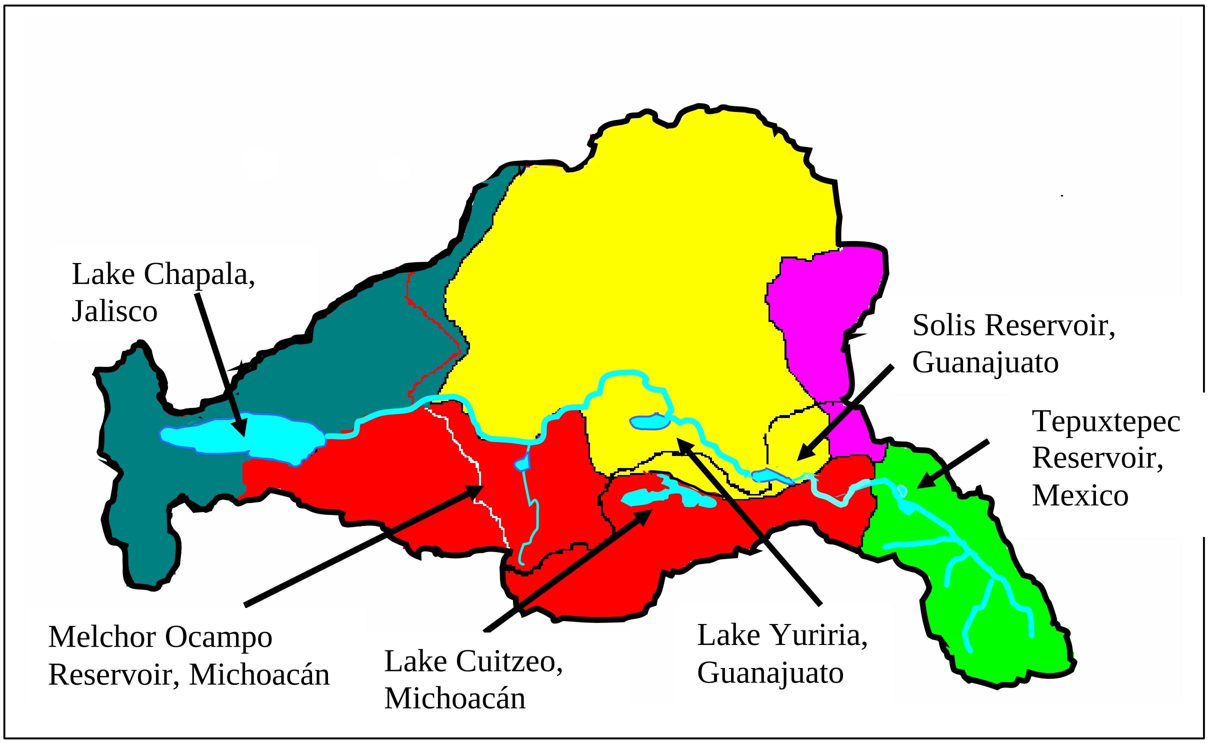


Figure 2-1: Water Bodies involved in the Water Transfers to Lake Chapala (except for Lake Cuitzeo and Lake Yuriria) (free after CNA, 1998)

Surface water allocations are for a large part based on the runoff generated from the year before. Since 1999/2000 was a critical year, also the outlooks for the next winter season were not promising. As a result of reduced allocations in 2000/2001WUAs decided to let stand idle 200,000 ha out of 235,000 ha (Wester *et al.*, 2005a and 2005b). For many of the better off farmers who could switch to groundwater irrigation this was not that problematic, but for many poorer farmers who mainly rely on surface water, the implications were disastrous. In addition, many poor farmers who traditionally pumped return flows from the Lerma River were hard hit as the use of this precarious source of water was prohibited and enforced through army patrols along the river (Wester *et al.*, 2005a and 2005b).

The transfers (three in total, up to date) became heavily contested and caused basin-wide conflicts among and between farmers, authorities and environmentalists of the different states. Although the transferred amounts are small compared to evaporation losses from Lake Chapala (24 % of total surface water depletion in the basin), they are gigantic from the WUAs' point of view. The farmers do not understand why in particular their irrigation water needs to be transferred to the Lake, where it will be lost due to evaporation instead of really saving the Lake from extinction. Leaders of several WUAs decided to take action and they started to meet in order to discuss ways to strengthen the representation of their interests in the River Basin Council. In May 2000, the presidents of WUAs located in Jalisco, Guanajuato and Michoacán met each other for the first time in order to deal with the shortages of water and consequent socio-economic depression in (surface water) agriculture. The transfer of 1999, half a year before this first meeting can therefore be regarded as trigger for the emergence of the GTEPAI.

2.2.2 Agricultural Support Programs and IMT behind the GTEPAI Emergence

The emergence of the GTEPAI may appear to be a direct result of the transfers, but this is not fully the case. The context for such a joint farmer-run initiative was already shaped by the separate, but in parallel, development of the WUAs and the experiences of its leaders. Although the first water transfer in 1999/2000 triggered some WUAs' presidents to take action, it was IMT, the formation process of WUAs and Hydraulic (seasonal planning) Committees (in case of the tail-end districts) that built their capacities for taking action. Since the launch of irrigation management transfer (IMT) in 1989, the leaders of the water user associations (WUAs) empowered their organizations by building them and hence trained their managerial capacities with the practical implementations of the management turnover.

Although the activities or steps to be carried out during the first stage of the IMT seem quite clear in IMT implementation strategy, in practice nevertheless WUAs faced considerable difficulties with information management and unclear limits of the Irrigation Modules and the absence of updated users registers (interview with Medina de Wit, 2003). Many farmers did not know whether they belonged to a certain Module sometimes and crucial infrastructure was absent or inadequate in several cases. Because the limits were not clear and users not registered well enough, the associations could not tax and consist of all users from the start.

The lack of information, when Irrigation Modules were handed over to the users, caused not only problems to the leaders, but also zeal to find out about uncertainties. To Raúl Medina (IM president and later GTEPAI leader) it was not clear what happened with the taxes farmers had to pay to the CNA for their part in operating irrigation. The money was not spent in the right way however by the CNA and therefore farmers made complaints and asked the CNA officials for clarification. The regional CNA official could not answer their questions about the taxes. Therefore, Raúl went to the capital where an international meeting about the success of the Mexican IMT was taking place. A higher ranked CNA official there could explain to him what happened with the money for 'IDRI'[7]. About 30% of the '*cuota*' (tax) was meant for research in irrigation and drainage in the Modules, but this was far too much in the eyes of the involved farmers, since the regional CNA did not spend the money in studying their drainage and irrigation problems.

Raúl Medina was progressive and took his tasks as an IM/ WUA president seriously. Very often people are blamed for working to their own benefit and not dealing with their duties that genuinely. Raúl Medina quite contrary felt highly esteemed with his tasks as a Module president and researched the possibilities of his function in order to improve the socio-economic situation in the adjacent IMs by improving their irrigation and drainage infrastructure. With this progressive attitude and well-matched charisma in leading the Module, he draw attention of other Module presidents who wanted to replace some established district leaders, who were close friends of the regional CNA officials. Raúl Medina at a certain moment got elected to represent the whole district and from this position he got appointed to the position of president of the Lake Chapala's Watershed Committee in 1998. When the RBC decided to form this organization, in order to resolve problems of the Lake with local knowledge, CNA gathered 11 adjacent Modules of the Lake's watershed and the members of the Modules elected Raúl Medina to lead this committee. From this

[7] 'IDRI', would be 'investigación en drenaje y riego', which means investigation in irrigation and drainage, but Raúl did not remember exactly the right term

committee (see **figure 1-2**, page 16) the MEG and CNA got the request for the approval of the development of a farmer-run Working Group in 1999.

The MEG is the actual decision-making body of the RBC (Wester *et al.*, 2005a and 2005b) and is supported in its decision-making by five *Grupos de Trabajo Especializado* (Specialized Working Groups, GTEs). Five of these working groups (see **figure 1-2**, page 16) were already established by the MEG itself and public officials from various institutions and different states were appointed to operate these groups (Monsalvo and Wester, 2003). According to Navarrete Ramírez (2002) these specialized working groups could not function well, since logistical support for the development and integration of the groups has been lacking. In addition, he remarks that there has been hardly any user participation in the groups and that the specialized working groups lack correlation with the distinguished uses in the RBC. At the time of requesting for the development of the GTEPAI in 1999, Specialized Working Groups existed for 'recovery', reorganization, efficient use, soil and water conservation and sustainable development of the River Basin.

Within this context of exploring a farmer-run organization it is important to mention the support and initiative of SAGARPA segments to such a project. An explanation can be found in the unique opportunities that such a movement offers to combine SAGARPA expertise and programs. According to Wester *et al.* (2005a), the IMT program resulted in a removal and/or reduction of direct and indirect subsidies to agricultural production and elimination of public sector input and privatization of crop marketing bodies supply. This is however not fully the case or misleading since the public sector and GOM put a lot of money and effort in supporting the agricultural sector, together with funds from foreign donors. The exact amount of investments is not easy to verify, but the following section describes most governmental efforts behind the emergence of the GTEPAI.

In order to build the associations, farmers received direct and indirect training and support from various governmental programs. These programs and institutes in general aimed at agricultural development and a more efficient use of water. The Hydraulic Committees functioned in this context as platforms between farmer representatives and the CNA in order to promote studies, support services and programs to improve water use, and systems' infrastructure (Garcés Restrepo, 2001). In the WUAs, two-monthly General Assemblies inform farmers about the establishment of the water service fees and the maintenance and rehabilitation programs. As said by Kloezen (2000) WUAs occasionally invite experts from both the public and private sectors to put relevant issues into the picture.

A comprehensive analysis of all these programs is not available and can therefore not be presented within this analysis. They play however a crucial role in channeling subsidies and incentives from the government and different donors towards farmers or their associations and strengthen the process of management transfer by maintaining indirect support. On first sight, this might be confusing, since one of the main reasons behind IMT was reducing the financial burden of the irrigation sector on the government. Notwithstanding, according to Garcés Restrepo (2001) the division of irrigation fees for the actual cost of O&M and administration changed from 15% paid by the users (and 85% by the government) to a farmers contribution of 72% (and the GOM the remaining 28%; CNA, 2000b) in the ID-011, ten years after IMT. In 2002 the percentage that was paid by the government even decreased to 8% and 75% by the farmers and 17 % by the farmer-run SRL. It is therefore lamentable that a transparent picture of governmental expenditure through Agricultural Support Programs in irrigated agriculture is not quite accessible.

Despite difficult access to information about budget flows a short description of the major programs and efforts is indispensable when analyzing the emergence of the GTEPAI. The depicted programs and institutes all contributed to a certain part of the claimed success of IMT and the emergence of the GTEPAI. These programs were not only relevant, because of their financial support, but they also influenced the water management discourses in the RBC, HCs or WUAs.

2.2.2.1 Governmental Support Programs

The programs that supported the farmers with their activities in the field might thus explain some of the origins of experiences that were fundamental to the emergence and manifestation of the GTEPAI in the first place. Secondly, these programs might explain governments' hidden but essential role in making decentralization of the surface water irrigation sector work. The following programs and institutes are in general initiated by SAGARPA and CNA from 1986 until 1998:

Before and together with IMT:

1985 IMTA, '*Instituto Mexicano de Tecnología del Agua*'; The Mexican Institute of Water Technology was installed under the former SARH[8] Ministry on the basis of the National Water Planning Commission as 'an autonomous public organization' in order to develop technology and train the necessary qualified human resources in order to ensure the rational utilization and integrated management of water resources and has been re-organized twice; in 1994 (by SEMARNAP[9]) and in 2001 (by SEMARNAT[10]). IMTA played a crucial role in the IMT program, while it aims at strengthening research, training, and development of specific water programs, mainly in water quality and efficient use of water.

1989 INCA-RURAL ('*Instituto para el desarrollo de Capacidades del sector RURAL*'; SARH[2] created the National Training Institute for the Rural Sector (for further explanation see the ANUR program), based upon a Training Centre for the technicians of the Ministry and farmers from the Carrizo Valley in Sinaloa, which was initiated by presidential decree already in 1970. The institute established close relations with the CNA and BANRURAL in order to promote micro-business in new market settings (Patrón, 1998).

After IMT:

1991 '*Programa de Uso Eficiente del Agua y Energía Eléctrica*'; the Program on Efficient Water and Energy Use was initiated by the CNA and re-installed in 2001 upon request of the GTEPAI. The program aims at a better use of water and energy in the WUAs (also in private irrigation systems) at the field level by providing money for investments in better pumping equipment, pressurized irrigation systems and plot leveling. All WUAs in the ID-011 asked for participation in the program, but in the end, several users and WUAs complained about favoritism in user involvement (Kloezen, 2000).

1991 ASERCA; '*Apoyos y Servicios a la Comercialización*'; Assistance and Services for the Commercialization of Agriculture is a program under suspicious of

8 SARH; former Ministry of Agriculture and Water Resources
9 SEMARNAP; former Ministry of Environment, Natural Resources and Fisheries
10 SEMARNAT; Ministry of Environment and Natural Resources

SAGARPA and was installed by presidential decree in order to encourage the commercialization of agriculture, opening to external and internal markets and their liberalization.

1993 PROCAMPO; '*Programa de Apoyos Directos al Campo*'; the program operates as a sub-program of ASERCA and administers direct subsidies from the government (SAGARPA) to grain producing farmers with positive discrimination of small landholdings in order to compensate for income losses, due to the neo-liberal reforms. From 1995 on this effort became part of the following program;

1994 '*Alianza para el Campo*'; Alliance for the Countryside provided the '*Ferti-irrigación*' sub-program (1996) or 'Technification of Irrigation' program. The components of the program can be seen as a rehabilitation and modernization package through technological improvements together with subsidies on seeds and fertilizers in order to increase crop production and reduce water losses at the same time. The '*Alianza para el Campo*' program also aims at compensating for the loss of income due to neo-liberal reforms (Kloezen, 2000).

1994 ANUR; '*Asociación Nacional de Usuarios de Riego*'; the National Association of Irrigation Associations was installed under the SAGAR Ministry[11], based upon the 1989 INCA-RURAL institute, with the objective to strengthen the training of technicians, managers and users of the transferred Irrigation Districts. The programs of ANUR focus on 'technification' and on-demand irrigation.

1996 PROMMA; '*Proyecto de Modernización del Manejo del Agua*'; The Management Modernization Project was expected to assist the GOM to improve its water resources policies and management capabilities in different areas under the responsibility of the CNA and was expected to be completed by 2002 (Tortojada, 2001). The general objectives were promoting conditions for sustainable, equitable and economically efficient water use, improving water use administration and reducing risks related to irrigation infrastructure.

1996 INIFAP; '*Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias*'; the National Forestry, Agriculture and Livestock Research Institute of SAGARPA launched CENAPROS '*Centro Nacional de Investigación para Producción Sostenible*'; National Research Centre for Sustainable Production, which is responsible for the research coordination concerning no-tillage, conservation tillage and enhanced water use. '*Alianza para el Campo*' supports certain elements of the program. INIFAP provided the GTEPAI with studies on alternative cropping patterns, tillage methods and cultivation areas among other issues.

1996 PRODEP; '*Programa de Desarrollo Parcelario*'; this Plot Improvement Program is a project designed by SAGARPA (with assistance of the World Bank) in order to support the Irrigation Districts with IMT, by offering shared investments in conservation of the districts infrastructure, plot leveling and efficient water use.

1997 COFUPRO; '*Coordinadora Nacional de las Fundaciones Produce*'; this organization is the National Coordination institute of state *Produce* Foundations. In 1996 the federal and state governments asked farmers to join together in *Produce* organizations in order to investigate and optimize soil and water use, commercialization of products, genetic modification, nutrition and reproduction and agro-industrial processing. COFUPRO makes part of an investigation

[11] SAGAR; former Ministry of Agriculture, Livestock and Rural Development

alliance with SAGARPA and CONACYT ('*Consejo Nacional de Ciencia y Tecnología*'; National Science and technology Council, created in 1970) in order to support the transfer and innovation of agro-industrial technologies.

1997 '*Nivelación de Tierras*'; The Agricultural Development Secretary of Guanajuato (SDA) supported the leveling of fields (see PRODEP program), which was carried out by private companies and later on by some Irrigation Modules.

1998 CENATRYD; '*Centro Nacional de Transferencia de Tecnología de Riego y Drenaje*'; the National Centre for Irrigation and Drainage Technology Transfer is established by the CNA and ANUR with participation of institutions like IMTA, SAGARPA, FIRA, INIFAP, BANRURAL and Produce Foundations in order to support IMT with technology transfer.

Besides the governmental efforts, also private projects (**figure 2-2**) made way for the emergence of the GTEPAI. Projects that claim certain water savings like eco-farming, zero-tillage, conservation tillage (horizontal multi-plough technology from Cuba) and soil leveling were offered to farmers by the private sector, before and after IMT. In addition, markets for other crops than wheat gave notice of their interest in crops that could be cultivated in the basin. Altogether there were many programs and projects from both private and public sector that related to a better use of surface water at the moment of the transfer.

These programs, projects and efforts from institutions and producers aiming at a better use of resources in agriculture do not pertain in the same way however to the five states and nine different Irrigation Districts. There are considerable differences between developments in the different states on the different levels, which make reality quite complex to comprehend, apart from the amount of programs (under continuous reorganization or designation) mentioned above.

Figure 2-2: GTEPAI/ Brewery Advertisement in the Santiago Valley in Guanajuato (GTEPAI, 2002b)

Translation; 'I earn more with barley malt; and use less water'

2.3 GTEPAI becoming part of the RBC

2.3.1 Genesis of the GTEPAI

IMT and institutional change processes shaped a context in which leaders of the WUAs developed far-reaching organizational skills. New institutional arrangements were created in a process of local negotiation between water users, farmer leaders and irrigation managers. In general there were four actors (Urban *et al.*, 2000) that were involved in decision making about the new institutional arrangements, concerning the support programs and services from the government. In all the districts these groups were the CNA, the WUAs, the HC, individual users and in Guanajuato the farmer-run SRL. The three new institutions, WUAs, HC, SRL (and RBC on the basin level) functioned as intermediary settings between government and users in which the various efforts came together.

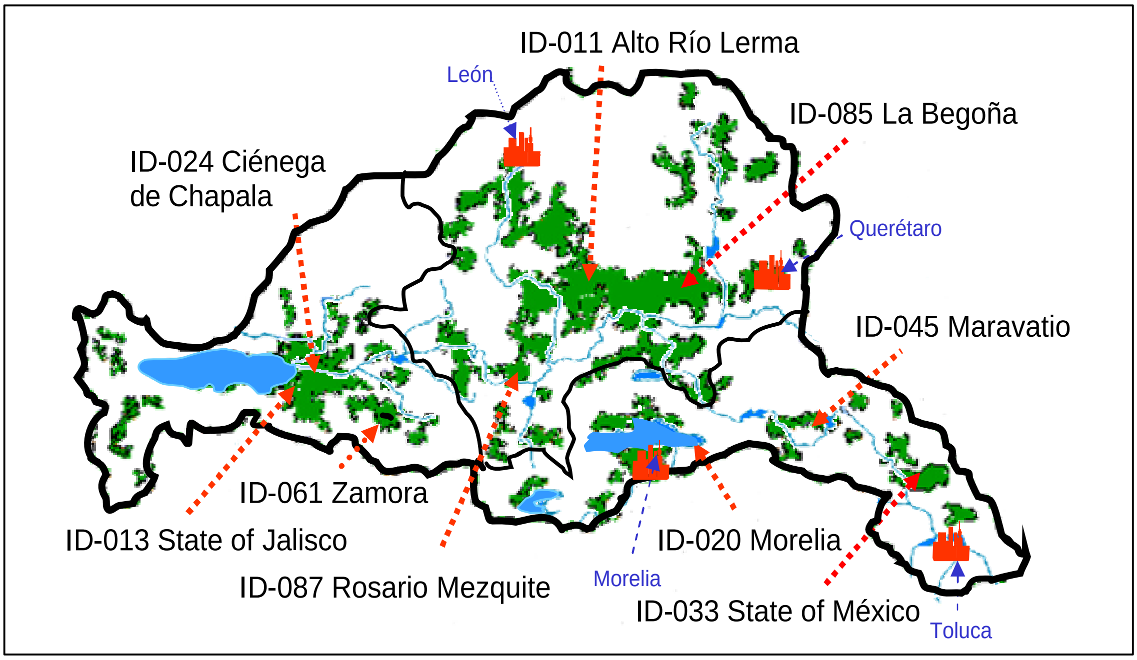


Figure 2-3: Location of Irrigation Districts in the Lerma-Chapala River Basin (CNA, 2001a)

Although the WUAs evolved in different ways, the water transfers from the Solis Dam in Guanajuato affected them all in a bad way. Until 2000, WUAs of a particular Irrigation District had only dealt with the CNA, but there were no horizontal linkages between WUAs from different districts (Wester *et al.*, 2005a). When the transfer took place, all farmers in the basin's districts were more or less affected. Through some strategic networking various WUAs leaders met with each other and IWMI scientists in May 2000. Gabriela Monsalvo and Flip Wester, who were working for IWMI at that time, facilitated an agricultural gathering of district leaders. The initiative to join forces and discuss the water-related problems was further developed in Lake Chapala's Watershed Commission (see **figure 1-2**) in the River Basin Council, which was presided by Raúl Medina de Wit.

This first meeting of the agricultural sector in May 2000 of the presidents of the Irrigation Districts 087 from Michoacán, 013 in Jalisco and the ID-011 from Guanajuato, which is the largest and most influential in the River Basin (**figure 2-3** and **table 2-1**) forms the starting point for the GTEPAI initiative.

Table 2-1: Areas of the 9 Irrigation District in the Lerma-Chapala River Basin (CNA, 2001a)

Irrigation District	**Area in ha**
011	112,772
013	26,570
(020)[12]	(19,860)
024	46,466
033	17,738
045	9,749
061	18,009
085	10,822
087	63,450
Total	305,576

The second gathering of WUAs leaders (14-8-2000) was visited by the Governor of the Jalisco state, because of personal interest in the subject. The (state-) representatives of the Irrigation Districts were surprised and impressed by this interest from 'the top' of the nation. Within this reunion it became clear that, besides the many differences in the districts, they stumbled upon common problems. These problems were categorized as hydraulic, social and economical factors of agricultural productivity. The socio-economic troubles were comparable, but the physical water problems differed and ask for a further short explanation;

In Jalisco they encountered typical tail end problems, like decreased water quantities reaching the end of the River Lerma. The districts' concession rights were based on the discharges of the River Lerma, when constructed storage capacity and irrigated area were considerably less in the upper reach of the Basin. Furthermore they could not grow vegetables due to heavily polluted water in the river and strong fluctuations, because of upstream water management.

In Guanajuato, support services and programs were most actively provided by the state government and institutions, but the irrigation water got transferred directly from the Solis Dam reservoir, which stores the surface water for irrigation. They claimed that saved water quantities (150 MCM) were neglected nor compensated but transferred to Lake Chapala. The Guanajuato representative asked for the conception of a water bank to store (the rights to) water quantities that were not used.

In Michoacán in the ID-087 Rosario-Mezquite there had been a long history of water conflicts among the users. Although the dam Rosario-Mezquite initially was designed to irrigate only 14,200 ha in the Jalisco Irrigation Module 'La Barca', in 1973 the SRH[13] authorized 14,720 ha to be irrigated in five Irrigation Modules in the District 087 and 4,280 ha in two Guanajuato Modules. By 2000 however 45,000 ha were irrigated instead of the 33,200 ha with rights, mainly because of demands from Guanajuato farmers.

12 The area of this Irrigation District in general is generally not included in the total amount of Irrigation Districts' area in the Basin, since the district is located in a closed watershed within the Lerma-Chapala Basin. Without the ID-020 the total area is approximately 285,000 ha

13 *Secretaria de Recursos Hidráulicos*; former Ministry of Hydraulic Resources

The representatives agreed on the consciousness that transferring water was nothing more than escalating existing problems without resolving the shortages they felt. The economic and social implications of the water shortages were numerous and strongly related to agricultural standstill, due to the transfer and restrictions on cultivation area. The three leaders of the Irrigation Districts therefore formed a triad, focusing on water shortages, representation of water users in the RBC and socio-economical problems due to the irrigation restrictions and the water transfer. On the 17th of November 2000 in a meeting of Lake Chapala's Watershed Committee the other WUAs from the state of Mexico and Querétaro joined the congregation of Irrigation Districts after the request by the agricultural representative in the 51st reunion of the MEG (15th of November, 2000) two days before that meeting.

As a result of the horizontal linkages between the Irrigation Districts, the combined WUAs established a farmer-run Specialized Working Group within the RBC, focusing on Integral Planning of Agriculture. Very quickly after the joining of the Irrigation Districts from the state of Mexico and Querétaro this farmer organization got officially approved and installed as the GTEPAI within the RBC on the 6th of December 2000.

The PAI part of this working group (GTEPAI) denotes three aspects, which are (literally translated): Planning, Agriculture and Integral (integration). According to the representative of the agricultural sector the integral planning of agriculture is based on three dominant factors; a hydrological factor, an economic factor and a social factor. The strategies based upon these three components will become comprehensible by analyzing the reunions of the GTEPAI, in which the perceptions were discussed and shaped into concrete actions.

2.3.2 GTEPAI Functioning and Strategies

2.3.2.1 Reunions

One month after the 51st reunion of the Monitoring and Evaluation Group (MEG), the GTEPAI was officially installed on the 6th of December 2000 (GTEPAI, 2000). The following quote is from the inauguration and illustrates the overall objective of the working group:

> 'The organization that has to be constituted should be an official grouping of participating farmers, relevant associations and representatives from the five states, which collectively should consolidate their demands for water. At the same time they should elaborate proposals which would join forces of; the Ministry of Agriculture, the Ministry of Environment and commercialization companies from the five states in order to use and protect natural resources in a better way. Furthermore farmers are searching for financial resources that (without making them contingent to crop marketing bodies[14]) present a rentable and productive overall effort. The specific governmental institutions should support this process of creating independence and sustainability'. (Raúl Medina de Wit, 6-12-2000)

The problems WUAs faced and the solutions they discussed and proposed can be found in three inter-related fields of activities as might be concluded from the first reunions of the GTEPAI in which the WUAs develop the basic strategies of action:

[14] Crop marketing bodies (*cadenas de producción*) or production chains with agro-industrial processing companies.

1. Reasoning: Research and documentation on the impacts of reduced water availability within an integral approach and the proposal of programs in order to achieve the desired **Planning** of agriculture
2. Integral philosophy: The **Incorporation** of all relevant efforts related to **Integral** water and soil management by establishment of a coordinating and facilitating office and vision.
3. Reactivation and enhancement of **Agricultural** activities by implementation of these two approaches.

The joining of forces (integration effort) is seen as a method to discuss problems and solve them by collective action in order to make agriculture profitable and more water efficient at the same time. In order to join forces it was necessary to know problems and windows of opportunity related to a better resource use. The first basic principle of the GTEPAI was therefore to study the implications of water scarcity and possible solutions to the existing problems, which were principally identified as follows;

- Reduced water availability (deficits in supply) for the WUAs and consequent socio-economic implications;
- Lack of financial certainty, which embraces problems in almost any aspect of agricultural production and its commercialization;
- Difficult access to new markets on individual base.

Secondly the 'incorporation of efforts' is as much a philosophy as a strategy or necessity, according to the diverse backgrounds and interests of people and institutions involved. The main objective of the principle was to create an office (or an annex in each state) in order to coordinate, facilitate and integrate ongoing processes. The declaration of purpose recorded at the first GTEPAI meeting (between the new working group, the CNA, SAGARPA and state representatives) demonstrates both strategies of action (see **box 2-1**).

Box 2-1: General Conclusions and Agreements from the first GTEPAI Reunion (GTEPAI, 2000)

1. The Ministries supported and would back up any initiative that would lead to an enhanced water management;
2. The assistance to farmers would back up the development of self-governing and sustainable WUAs. An office of coordination and facilitation was necessary to support these processes;
3. Access to information and awareness about water problems needed to improve, because many farmers were not involved yet;
4. The strategic value of a Crop Catalogue for all three water policies (surface water treaty of 1991) was recognized, as well as a corresponding Commercialization Catalogue; This Commercial Diary or Catalogue should provide information on prices, markets, demands and commercialization lines per region;
5. The importance of strengthening of the agro-industrial production chains;
6. Vertical and horizontal institutional strengthening through a homogeneous strategy;
7. Solidarity and joint interest of producers in the River Basin needed to come forward;
8. GTEPAI should claim its position within the River Basin Council;
9. The Jalisco nucleus of Integral Planning of Agriculture would elaborate the statutes of the GTEPAI.

2.3.2.2 Statute and Philosophy

According to the statutes and conform the basic ideology, the official target of the GTEPAI (2000) was elaborated by the Jalisco nucleus as follows;

> 'The establishment of inter-institutional linkages between society and government, by means of a platform in order to realize processes of planning and management of activities and programs concerning integral agricultural development, within a framework of socio-economical and cultural development which guaranties an efficient, effective, profitable, equitable and sustainable use of soil and water within the Hydrological River Basin Lerma-Chapala'. (Article 1.1)

Box 2-2: Excerpts from GTEPAI Proposal of Statutes (GTEPAI, 2001)

Article 2.1: To establish linkages with the other working groups of the RBC
Article 2.2: To concur with participants of the GTEPAI and to suggest proposals to the MEG in the RBC about specific programs concerning:

- Conservation and modernization of hydro-agricultural infrastructure, (Article 2.2.1.)
- Improvement, conservation and sustainable soil use, (Article 2.2.2.)
- Integration of sowing and irrigation programs for the different growing cycles, (Article 2.2.3.)
- Education and organization of irrigation systems' users in order to improve their administration, conservation and modernization, (Article 2.2.4.)
- Organizational education, based on the sustainability of the WUAs with respect to gender issues on all levels of representation in the River Basin Council (Article 2.2.5.)
- Education and organization concerning production and commercialization of this production. (Article 2.2.6.)
- Research and development of integral alternatives to traditional crops (Article 2.2.7.)

Article 2.4: To reach agreements and motivation for participation and collaboration between research institutes, organizations, local, municipal, state, federal, national and international authorities and governments, concerning the development of integral agricultural planning programs or other specific projects.
Article 2.5: To evaluate the socio-economic impacts of the growing cycles (reasoning) which were or were not established due to critical restrictions on water availability for irrigation, related plant and seed mortality rates and agricultural, urban and industrial development policies.
Article 2.6: To urge on, strengthen, and improve the water users associations on all levels of integration and participation and assure equal and equitable space for individual or group development and participation, irrespective of gender, age, social or economical position, ideology or religion.
Article 4: Integration of state sub-delegations of the GTEPAI and state government bodies; the state delegations consist of representatives of the agricultural sector from Irrigation Districts, URDERALES (Irrigation Units for Rural Development) and COTAS (Technical Groundwater Committees)

Box 2-2 shows important strategies for sustainable and integrated irrigation management. The GTEPAI statutes specify a certain way of behavior in relation to surface water management in the districts and their relating towards the broader institutional and agricultural context. Especially the intention of relating the GTEPAI initiative to the COTAS and Irrigation Units in the basin demonstrates far-reaching possibilities of coping with integrated basin management and planning of groundwater, derivative water and surface water irrigation (see chapter 3). Due to logistical and financial shortcomings from the start, the support of the SRL of Guanajuato was used for diffusion and facilitative means. The support of the SRL was necessary to get started in the first place, but also demonstrates that the GTEPAI initiative largely depended on the cooperation of the most progressive irrigation nucleus in the Basin.

2.4 Sustainable Water Management Analysis of the GTEPAI

The results of GTEPAI activities will for a large part construct the answer to the main question of this research;

> *What is the effectiveness of the GTEPAI initiative (mainly in the ID-011) in saving surface water within the context of increasing water contestation in the Lerma-Chapala River Basin in Central Mexico, from 2000 until 2003?*

The effectiveness of the GTEPAI activities in this context will be analyzed in three main parts according to the following concepts, which will be integrated in the conclusions, where an all-embracing answer to the research question will be presented;

Sustainable water management or water control effectiveness:

2.4.1 Technical effectiveness and sustainability (page 33-41)
- Productivity, technical efficiency and effectiveness (conveyance, application efficiencies)
- Ecological equilibrium of water management

2.4.2 Socio-economic and political characteristics of the GTEPAI effort (page 41-43)
- Economic viability,
- Equity
- Security of access to surface water
- Political democracy

2.4.3 Organizational or managerial effectiveness (page 43-46)
- Institutional viability
- Organizational effectiveness (Uphoff, 1986: 42) (decision-making, resource mobilization, communication and conflict management)

2.4.1 Technical Effectiveness and Sustainability

Keywords;
- Productivity, technical efficiency and effectiveness (conveyance, application efficiencies)
- Ecological equilibrium of water management

2.4.1.1 Exploration of the Physical Context

Besides the recognition of the environmental problems concerning Lake Chapala’ running dry, the GTEPAI also tried to identify the physical impact of water scarcity on the agricultural sector within the context of the 1991 surface water treaty's availability policies. As a result of their exploration of the basin-wide impacts of reduced water availability for surface water irrigation, it became clear how much technical aspects of the irrigation systems were influenced by the lack of irrigation. The agricultural productivity considerably decreased with reductions in cultivated area of 20,000 ha in 1999/2000 and 200,000 ha in 2000/2001 out of 235,000 ha. Whereas surface water use was restricted to 3 ha per user in 1999/2000 and omitted in 2000/2001, increased groundwater pumping might have circumvented these restrictions. Technical implications of irrigation inactivity were deterioration of infrastructure and machinery that belonged to the WUAs. Some sources mention that the agricultural inactivity lasted more than 1 year in the tail area of the Basin, where water scarcity caused economical depression for 4 years in certain Irrigation Modules in the Jalisco ID-013 (GTEPAI, 2002a).

In order to improve technical efficiencies, GTEPAI could take advantage of the available technification programs. Several governmental support programs were offering expensive and long-term improvements in irrigation 'technification' or modernization. ANUR promoted 'on demand irrigation' by conveyance tubes. The *Alianza para el Campo* program also supported technical innovations like drip- and sprinkler irrigation systems and improved off-takes in combination with fertilizers and improved seeds packages. In addition IMTA had programs on irrigation efficiencies improvement comparable with components of the programs on Efficient Water and Energy Use, the Management Modernization Project (PROMMA), Plot Improvement Project (PRODEP), the Rehabilitation and Modernization of the Irrigation Districts Program, COFUPRO (Transfer and Innovation of Agro-industrial Technologies), Plot Leveling and CENATRYD (National Centre for Irrigation and Drainage Technology Transfer).

The GTEPAI nevertheless needed quick, equitable and feasible solutions to the economical crisis of agriculture in the Basin. In order to make a better use of water the GTEPAI promoted a basin-wide change of cropping patters in harmony with water availability following the water policies of the 1991 treaty. Other strategies to reverse the negative water balance within the GTEPAI initiative were lessening undesired evapotranspiration by the stimulation of organic agriculture, increasing the organic matter of soils, the establishment of terraces and slope contours in mountainous areas and stimulation of no-tillage and conservation tillage practices (GTEPAI, 2002b).

2.4.1.2 Physical Results

After the autumn-winter season 2000/2001, when agriculture in the districts almost stood still, during the next autumn-winter growing cycle of 2001/2002 the GTEPAI accomplished the first physical results of the first year's agricultural planning. The technical dimensions of the results that are claimed by the GTEPAI during the 2001/2002 season are the following;

The GTEPAI (2002b) claimed to have elaborated a physical conversion on 55,000 ha in the IDs from high to low water demanding crops, of which 46,000 ha in ID-011 in 2001/2002. In fact, only in this district GTEPAI achieved demonstrable physical results. The crops that were promoted by the GTEPAI before the autumn-winter season of 2001/2002 were barley, safflower, canola and chickpea. In total there have been cultivated 31,489 ha of barley in ID-011 out of a total of 31,651 ha (99% of the barley cultivated in the basin) during the OI 2001/2002.

A more reasonable result to claim (**table 2-2**; page 36 and **figure 2-4 and 2-5**) seems an initial 'GTEPAI conversion' from wheat to barley on no more than 20,000 ha. While comparing with the 1998/1999 OI; 11,000 ha of barley were already cultivated before the GTEPAI promoted the shift towards less water-consuming crops. In addition there were hardly any changes in the cultivated areas of other crops (**table 2-2**) between the autumn-winter seasons 1998/1999 and 2001/2002.

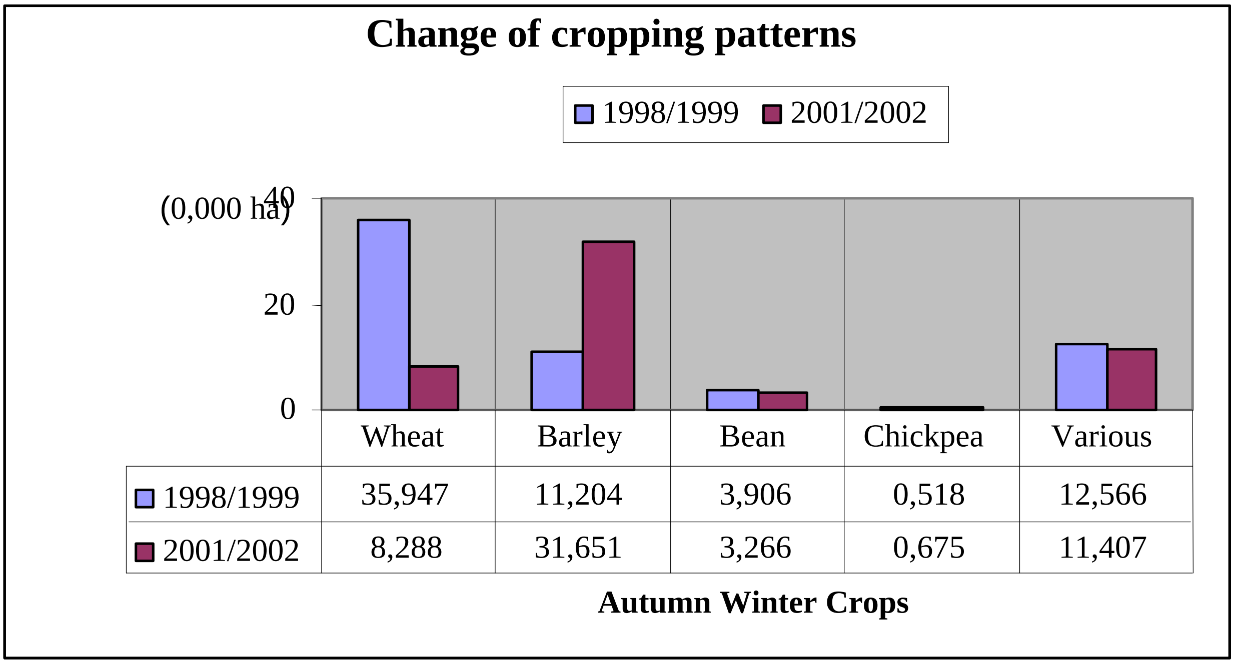


Figure 2-4: Comparison between Cropping Patterns in ID-011 during two OI Seasons. (GTEPAI, 2002b)

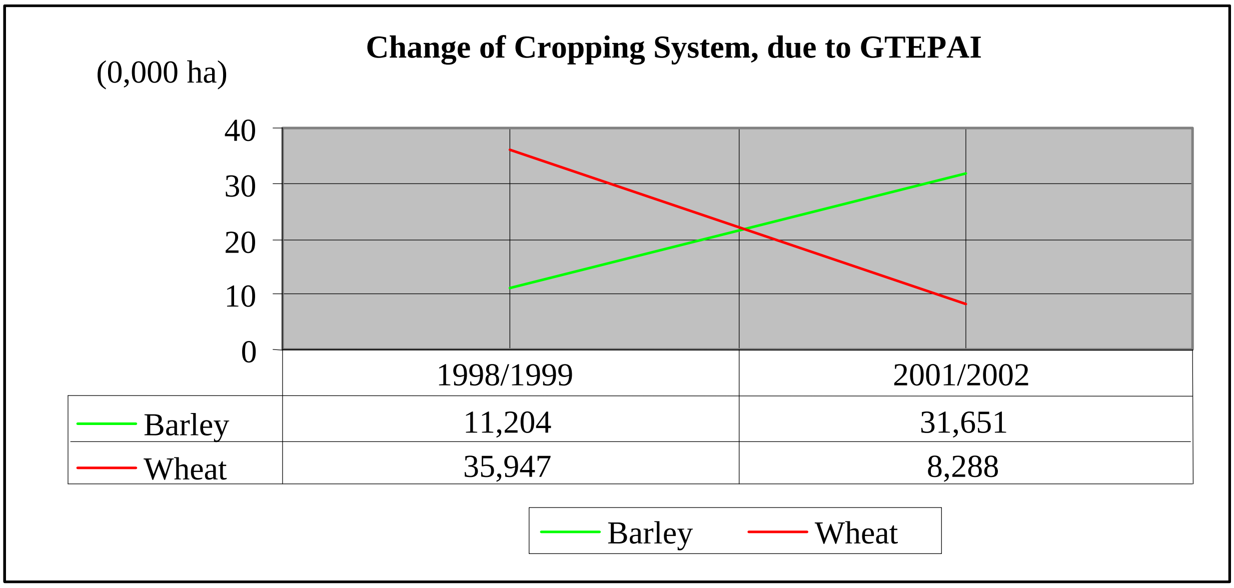


Figure 2-5: Comparison between Traditional Wheat and (GTEPAI) Barley Cropping Areas

Secondly, as a consequence of the shift to barley on 20,000 ha, while skipping one irrigation turn, GTEPAI claims different Water Savings in the range of 60 to 100 MCM. The most reasonable and defensible Water Saving appears to be 53 MCM (**table 2-2**) during the OI 2001/2002. According to the technical working group (TWG) of the RBC, which allocates the surface water every year to the districts, this is the maximum amount of water (not used or saved) that can be claimed, during that season. These 53 MCM in the first place account for the difference between the authorized amount of 779 MCM to the ID-011 before the growing season and the actually used 726 MCM during the growing season (**table 2-2**). Initially in 2000 the authorized amount of water was set at 529 MCM for the next autumn-winter season, but during that growing season this quantity was adjusted during the 56th meeting of the MEG on 6th of November 2001 with an additional amount of 250 MCM for the ID-011 in Guanajuato. The 250 MCM was available and belonged to the farmers; since they did not use it the year before, when they led stand idle 200,000 ha throughout the whole basin (not only in ID-011). It is therefore strange that the ID-011 achieved to negotiate the additional allocation to the district.

Furthermore 53 MCM is the volume 'saved' by replacing of 20,000 ha of wheat with a traditional irrigation depth of 1.20 m as in the season of 1998/1999 by 20,000 ha with barley ($I_{depth\text{-}Ba}$: 0,94 m). The amounts that are claimed by the GTEPAI in different presentations differ because of variances in applied irrigation depths. As well as in theory as in practice these irrigation depths can significantly differ, but in general farmers can establish barley with one irrigation turn less than the cultivation of wheat requires (i.e. four irrigation turns of 0.30 m each). In theory this entails an increasing irrigation efficiency with a factor 1.3, compared to the traditional system.

Table 2-2: Calculation of Barley Water Saving (CNA, 1999c and 2002)

	Authorized	Used	Not used
1998/1999 ID-011	955 MCM	920 MCM	(35 MCM)
2001/2002 ID-011	779 MCM	726 MCM (registered)	53 MCM
20,000 ha wheat replaced by barley	779 MCM	725 MCM (calculated)	($I_{depth\text{-}Wh}$ -$I_{depth\text{-}Ba}$) = (1.2 – 0.93) => 0.27 m * 20,000 ha = 54 MCM

The data can also be interpreted in a different way, when comparing the amounts of water used and areas cultivated with these volumes, regardless of productivity. In the 1998/1999 OI 64,141 ha have been cultivated with 920 MCM (1.43 m/ha), compared to 55,287 ha with 726 MCM in the OI 2001/2002 (1.31 m/ha), which denotes an averaged irrigation depth reduction of 0.12 m/ha. On the established 55,287 ha this reduction indicates a saving of 66 MCM, whereas the assumed fallow of almost 9,000 ha points to a water use reduction of 116 MCM with an irrigation depth of 1.31 m/ha.

Though not cultivating (or perhaps using groundwater) leads to the largest water 'savings', the changes in irrigation practices and cropping patterns promise important reductions in water use by the WUAs. What happens with water that is not used is not clear: Therefore it is not appropriate to call reduced water use in the district Water Savings. A third physical outcome of the change of crops was a record production of more than 300,000 tons of barley with an ensuing reduction in industrial imports for the production of beer. GTEPAI also established pilot plots to demonstrate less water-consuming crops like canola, safflower and chickpea (3,000 ha) which have prospective markets for the Irrigation Districts.

2.4.1.3 Physical Dimensions of the Change of Crops

The productive changes were achieved by fundamental organizational, managerial and socio-economic efforts as will be explained further on. Changing from wheat cultivation towards the growing of different crops nevertheless required far-reaching changes. The purchase of not well-known seeds and varieties, the adjusting of sowing machines and knowledge and means for different soil preparation, fertilization, water supplies, soil moisture control, plague control and improved harvesting were important to the succeeding of the initiative. These technical requirements for the conversion of crops were elaborated by the GTEPAI with support from DDRs, SDAs, SDRs, CEAs, CEHs and INIFAP in a Crop Catalogue, with a focus on barley and to a lesser extent canola, safflower and chickpea and other crops that were grown in the basin. This Crop Catalogue formed the guideline for agricultural production and the change towards less water consuming and remunerative crops. Optimal cultivation areas were elaborated in line with water consuming properties of the crops. In addition the GTEPAI worked out a corresponding Marketing or Commercialization Catalogue in order to assure the buying of expected harvest.

The definition of crops in this Crop Catalogue was based on the crop water demand and an optimum development plan for different regions. INIFAP (research centre of SAGARPA) provided soil maps related to the different crops and the national water commission (CNA) provided the information on water availability. ASERCA, the marketing assistance project of SAGARPA, supported the Crop and Marketing Catalogues with knowledge inputs from their own crop conversion and oleaginous crops programs.

To promote the change of crops the GTEPAI established pilot plots in collaboration with the INIFAP research institute and progressive farmers. Furthermore the GTEPAI organized crop workshops with the participation of the following interested agro-industrial companies (GTEPAI, 2002a):

- *Impulsora Agrícola S.A. de C.V.*; this beer brewery industry was of major importance to the GTEPAI and the conversion from wheat to barley.
- *Grupo Quilantán, UNPEG* (*Unión de Productores y Exportadores de Garbanzo*, Union of chickpea producers and exporters), and *Scoular de México*; these chickpea exporters provided markets in Spain and the USA for chickpea processing and re-exportation towards other countries principally in Latin America.
- *CAPRO* (*Cámara de Aceites y Proteínas de Occidente*, Western Oil and Protein Board) *and ANIAME* (*Asociación Nacional de Industriales de Aceites y Mantecas Comestibles*, National Association of Nutritive Oil and Grease Industries) were interested in the potential of Mexican (GTEPAI) agriculture to provide their industries with oleaginous crops like safflower and canola.

In order to improve harvest business the GTEPAI could apply for technical assistance of the National Consumer Counsel (PROFECO) which is an organization established by the Ministry of Economy. PROFECO provided technical support to the commercialization of harvests by offering a project on verification of weighing machines and humidity measurement devices.

Whereas traditional wheat cultivation requires 4 irrigation turns per growing cycle, more profitable crops like barley, chickpea, safflower and canola need only 1, 2 or 3 irrigation turns. A simple, but realistic calculation shows the potential water use reduction of a crop conversion. If the GTEPAI could achieve that 100,000 ha would pass over one irrigation turn (with a net irrigation depth of 0.27 m), this would mean a reduction in surface water use of 270 MCM in the Irrigation Districts. In theory this would completely resolve the over-extraction of surface water use in the basin, which was estimated by the CNA at 259 MCM (CNA, 1999a). The potential of such a water use reduction is even greater, when wheat producers in the *Unidades de Riego* would shift to barley or even less water consuming crops.

2.4.1.4 Comparison with Technification results

In comparison to this potential in surface water savings, the effectiveness of the 'technification' related programs can be demonstrated by an example of the Huanímaro Irrigation Module in the ID-011. This IM is used as a pilot project to test irrigation software developed by IMTA (www.imta.mx and www.invdes.com.mx) in parallel with technification of the system. The *'Sistema Computacional para Asistir la Planeación, Diseño y Actualización de Proyectos de Zonas de Riego'* (Computer Program for Assistance in Project Planning, Design and Actualization in Irrigation Zones, Splad-ZR) supposedly combines engineering methods and procedures from agronomy, geography, hydraulics and environmental disciplines.

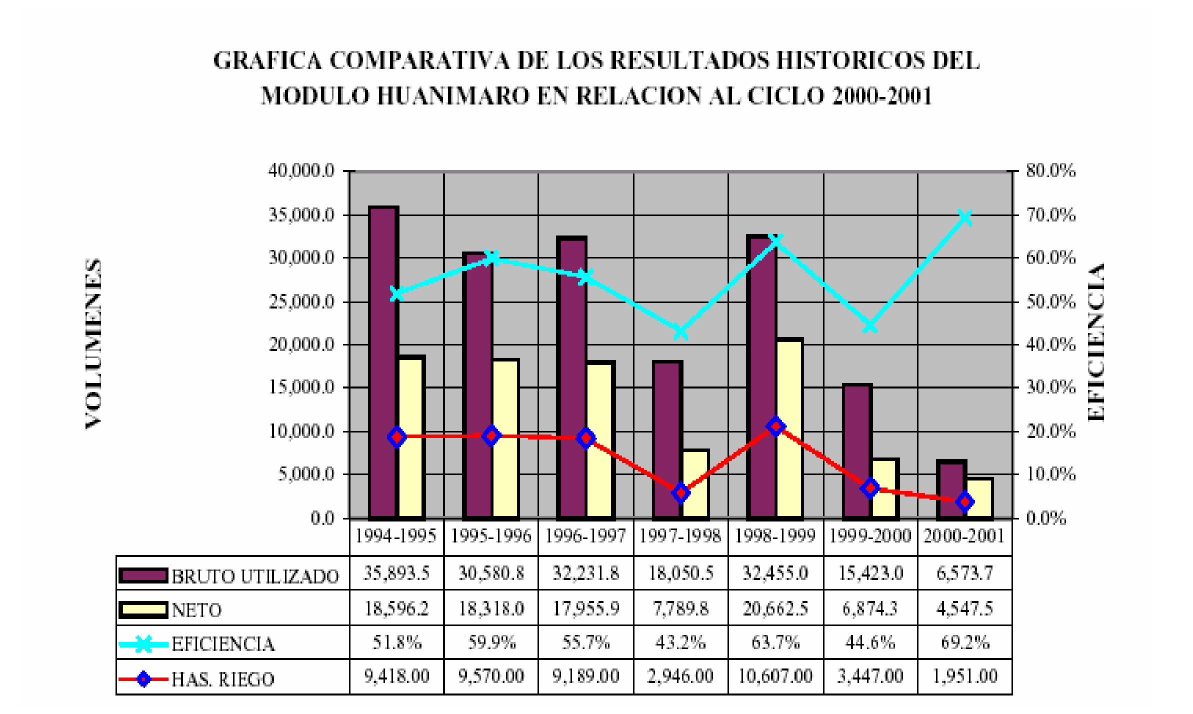
According to Rodríguez Ríos (2001) the IM was selected in order to test and implement volumetric supply of irrigation water. The concept of volumetric supply is based on measuring water volumes and more accurate tax these volumes in order to economically stimulate farmers to be more efficient in their use. With financial support from the '*Alianza para el Campo*', '*Uso Eficiente del Agua y la Energía Eléctrica*', '*Programa de Desarrollo Parcelario*' (PRODEP) and '*Rehabilitación y Modernización de la Infraestructura*' programs (as described on page 24-26), 1,532 ha in the Huanímaro module have been 'technified' from 1997 to 2001 at a cost of MP $22 million or MP $14,586/ha (SRL; ID-011, 2001).

The technification efforts in the Irrigation Module of the ID-011 have resulted in an irrigation efficiency of 70% during the OI season 2000/2001. The Huanímaro example is considered to be a successful example, because the average irrigation depth decreased with almost 0.08 m (from 0.38m to 0.30). The Water Saving that is claimed by this result is 1.2 MCM during the first irrigation turn of the OI season 2000/2001 (SRL; ID-011, 2002). The water is however not really saved, because the module attends 410 additional hectares with the supposedly 'saved' water, according to the SRL of the ID-011 (2002). Rodríguez Ríos (2001) argues however that areas that were normally irrigated with groundwater could be irrigated with saved surface water which therefore contributed to the preservation of the under laying aquifer.

When analyzing the data Rodríguez Ríos (2001) presents in **table 2-3** it is not clear how and which efficiencies have improved. Assuming {Eo= Inet/ Igross} for the calculation of overall system efficiency, it is not clear how storage efficiency (Es), conveyance efficiency (Ec), application efficiency (Ea) have changed in the system. Quite possibly, certain conveyance efficiencies could have been improved in the irrigation system by the installation of 36 new pumping sets and 90 km of conveyance pipes. It remains unclear what the modernization effects are on the different parts of the irrigation system and how this will influence overall system efficiency.

It is important to note that it is not clear how the system is defined. If the infrastructure on 8,656 ha (10,607 – 1,951 ha) that were not used (when comparing 2000/2001 with 1998/1999) deteriorates by lack of maintenance or use, it is quite possible that the overall system efficiency is much lower. The concept of efficiency proves to be tricky, since dynamic system boundaries (different areas under cultivation), weather and/or allocation conditions and crops cultivated seem not to be included in the presented data.

Table 2-3: Increased Irrigation Efficiencies in the Huanímaro IM (with translated legend, after Rodríguez Ríos, 2001)



	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
Gross volume used	35,893	30,580	32,231	18,050	32,455	15,423	6,573
Net volume used	18,596	18,318	17,955	7,789	20,662	6,874	4,547
X Efficiencies	51.8%	59.9%	55.7%	43.2%	63.7%	44.6%	69.2%
Hectares	9,418	9,570	9,189	2,946	10,607	3,447	1,951
Volumes per hectare are calculated with the data derived from Rodríguez Ríos (2001)							
I_{Gross} (vol./ha)	3.81	3,20	3,51	6,13	3,06	4,47	3,37
I_{Net} (vol./ha)	1,98	1,91	1,95	2,64	1,95	1,99	2,33

The technification of the module resulted however in an increased ratio of net volume used per hectare (**table 2-3**), which means that farmers managed to apply more of the supplied water to their crops, but on a considerably smaller area than in previous years. Whereas parts of the module's irrigation system might have improved, the greatest (Water Saving) result is achieved by not cultivating 8,656 ha in 2000/2001 and 7,160 ha in 1999/2000 (taking 10,607 ha in 1998/1999 as a maximum system size). The system performance of 2000/2001 indicates a hypothetical water use of 21.9 MCM compared to 18.6 MCM, while getting less water (gross water use of 31.7 MCM instead of 35.9 MCM), when cultivating the same area (9,418 ha; **table 2-3**). According to Scott and Garcés Restrepo (2001) it is not desirable to reduce the gross water gift in the ID-011, since a reduction of 10 % would theoretically result in an additional average aquifer decline of 0.91 m/year.

By presenting the Huanímaro 'success story' in this way, I want to argue for improved studies and less biased technification efforts, since there are many studies in the Basin that are not accurate or contradictory to other findings. In general it may be concluded that complete studies incorporating exact and accountable data on type of user or system, sources of water used, crops cultivated, irrigation depths applied, economic and physical productivity, program costs, destinations of 'saved water' etc. are lacking. The magnitude of studies gives freedom to manipulation and biased interpretations. The pride of the ID-011 and IMTA about the water savings and technification approach with Splad-ZR is explicable, but certainly needs further analysis. The costs of the technification success are high and the results are not necessarily sustainable. It is important that comprehensive studies of socio-economic, organizational and legal aspects go together with technical analysis and recommendation of technification programs.

Exclusively technical improvements were not reasonable for the GTEPAI. Many farmers lacked the necessary money to participate in the cost of technical investments (interview with Alejandro Ramirez Zaragoza, 2003). In general it is hard to take financial risks, if expected returns are marginal. Apart from the financial limitations also the technical effectiveness of the irrigation 'technification' projects is questionable. According to the CNA (CNA, 2001a) conveyance efficiency in the ID-011 decreased from 72.4% in 1992 just after IMT to 60.4% in 2000, despite the enormous investments in technification and modernization of the district. The results that can be achieved through these programs are long-term results that need renewal and not necessarily resolve the water scarcity and economical problems that farmers are facing.

2.4.1.5 Physical-Technical Effectiveness

The 'guiding, manipulating or mastering of physical processes' (Mollinga, 1997), which is the 'technical' part of water control, was strongly influenced by the GTEPAI initiative. The effectiveness and sustainability of the effort depends on freedom of movement while dealing with important management and planning requirements of agriculture. A crucial problem that the WUAs faced was the lack of money within the organizations, but more importantly on household level. In order to master the physical irrigation and cultivation processes, solutions can not easily be found in expensive infrastructural improvements. The GTEPAI initiative realized rather quick and equitable solutions to physical problems with a greater impact than the 'technification' efforts.

Indicators for the technical effectiveness of the GTEPAI are productivity, technical efficiency, effectiveness (water storage, conveyance, application efficiencies) and the ecological equilibrium of water management. Whereas the GTEPAI has not been effective in direct infrastructural efficiency increases, the effort reactivated agriculture in the districts and service fees for maintenance of the districts' infrastructures. The GTEPAI did form a basis for technical improvement combining the technical support programs with the crop conversion. The most important effect of the GTEPAI is the reactivation of productivity with space for future challenges. Besides the cultivation of barley also vast productions of canola, chickpea and safflower have great potential in reducing surface water use and diminishing commercialization risks. The Water Savings that are claimed by the GTEPAI are however not per definition real Water Savings, since the concept hinges on the destination of saved water.

If saved water would be lost to a sink or polluted, such that it could not be used anymore, it would not be savings at all; instead it would be water losses. On the other hand if the saved water would be allocated to higher valued uses or if the output per unit evaporated water would increase, water would be saved in a wet sense. If the reuse of derivative drainage water would increase without pollution, the basin would converge to 100% efficiency, while uplifting irrigation efficiencies by sprinkler systems and drip irrigation would only impact the distribution of water (Seckler, 1996). According to Seckler the programs that support the installation of sprinkler systems result in water losses, since 'about the best way to maximize evaporation losses, is throwing fine particles of water through hot air'. (Seckler, 1996)

The GTEPAI and the farmers in ID-011 prefer to increase the cultivated area with water that is authorized, but not used. As such with the same amount of water, more yields per evaporated unit could be reached and saved water could be called wet Water Savings. The problem is that it is unclear what has happened with the saved water of the GTEPAI crop conversion. Therefore real savings can not easily be claimed and water that apparently remained in the Solis reservoir is eventually lost to evaporation from the reservoir, River Lerma and Lake Chapala moreover. The next section will further explore the economical dimensions of the water saving effort, since the financial output per unit evaporated water has considerably changed due to the change of cropping patterns.

2.4.2 Socio-Economic and Political Characteristics

Keywords;

- Economic viability
- Equity
- Security of access to surface water
- Political democracy

2.4.2.1 Alleviation of the Economical Impact of Water Scarcity

In order to resolve the low economical performance of agriculture in the districts, the combined WUAs performed an economical analysis simultaneously with the technical exploration of water savings. As a result of this socio-economic investigation, it became clear that all Irrigation Districts in the basin had similar problems. The economic problems can be summarized as low returns to conventional wheat production together with scarce and insecure water supplies and difficult economic development. The insecure or absent water allocations have led to economic stagnation in certain rural areas, causing an intensification of social and cultural problems. Due to growing poverty and poor prospective, many people emigrate from the rural areas in the basin to the big cities in Mexico and the United States. The emigration is very much related with low incomes in both rural and urban areas in Mexico. The emigration from Jalisco has lead to labor shortage at state level, according to del Conde (2001)

While Lake Chapala was running dry and urban water demands increased, many farmers met with serious conflict. Although water is essential to their production and income, the business was not quite lucrative anymore. Important outcomes of the restricted allocations and inactive agriculture during OI 2000/2001 for farmers, were a heavy burden of debts, moderated acquisition power, the sales of their water and land rights, the sales of belongings, leasing of land or tenant farming, social discontent and deteriorated quality of life and a perceived import of drugs, aids and violence into their culture with the temporal return of emigrants.

Within this context of rural difficulties the GTEPAI searched for equitable solutions to more than 50,000 affected farmers. The GTEPAI estimated that about 5,000,000 people in the basin were indirectly affected by the agro-economical misery. Scott and Flores-López (2001) estimated that the benefits forgone in the ARLID (ID-011) amount to US$ 14 million as a result of the reduced water allocations and water transfer during the OI 1999/2000.

2.4.2.2 Socio-Economic Outcomes

In order to make agriculture profitable, the GTEPAI participants established alliances with agro-industries that were depending on import of basic material for their production. The most important deal was negotiated with a brewery that needed barley for beer production. This industry invested in a regional marketing centre that would increase the sales prices of barley (GTEPAI, 2002b). In order to instigate the GTEPAI initiative, the state governments (SDA and SDR) supported the GTEPAI with a total investment of $13,000,000 Mexican pesos (˜ US$ 1,300,000) in order to support the promotion of less water consuming crops. The Jalisco state provided $4,000,000, Michoacán $6,000,000 and Guanajuato $3,000,000 Mexican pesos.

The core result of the Integral Agricultural Planning of the working group during 2000 and 2001 was the conversion from wheat to barley on 20,000 ha, besides 11,000 ha that already produced barley before the initiative. The record harvest of 300,000 tons of barley on 31,000 ha signified a general income for Guanajuato’s rural sector of $ 450 million Mexican pesos. In addition it entailed a reduction in imports for the industries involved. An inherent achievement of the alliances between farmers, SAGARPA and the barley agro-industry was the agreement of commercialization contracts in advance. These contract farming guarantees from a national brewery had considerable advantages concerning security of marketing. Towards participating industries like the brewery SAGARPA functioned as an institutional and financial guarantee and organized meetings between farmer representatives and industries, while the GTEPAI was still under formation (GTEPAI, 2002b).

Wheat harvests were conventionally sold without contracts and basin-wide planning. Therefore many farmers offered their production at the same moment, enabling buying industries to lower the market prices of wheat. The contracts that were signed by the GTEPAI and the brewery decreased uncertainty in crop marketing. The re-activation of the Irrigation Modules’ operation, after a year of stand-still, also resolved the danger of uncertain tax generation (irrigation service fees), necessary for the maintenance of equipment and infrastructure. The economic viability of the WUAs was consequently sustained by the GTEPAI.

2.4.2.3 Socio-Economic Effectiveness

The GTEPAI initiative was a relatively quick and promising answer to low returns in agriculture and it decreased societal tensions that could possibly undermine stability of the RBC and success of IMT. The movement, but more generally its philosophy is a workable effort from a socio-economic perspective. There are quite a few demands from regional industries that can be met by the agricultural supply from the Basins Irrigation Districts (and irrigation units). The mediation between markets, farmers and governmental bodies promises feasible cooperation and win-win solutions, such as the conversion from wheat to barley on

20,000 ha. Nonetheless the interplay between government, markets and farmer organizations is not necessarily a panacea, by reason of its temporal character.

In order to sustain economic and social development through such cooperation processes, long term agreements should be established. The GTEPAI facilitation effort between the industries, WUAs and authorities disappeared as quickly as it emerged. The strength of the horizontal linkages between WUAs also embraced the complexity of basin-wide inter-regional solutions. Due to head ender-tail ender problems and manipulation of these dissimilarities by sector representatives, state authorities and supportive media, it was almost impossible for the GTEPAI leader and agricultural representative to deal with opposition to the initiative. The viability of the GTEPAI depended too much on financial support from other institutes, because the WUAs were not financially autonomous. Political support to the initiative was fundamental for the emergence and functioning of the group, but political forces also influenced its abrupt ending.

Besides the economic viability as an indicator for the effectiveness of the GTEPA, also equity of water management is an important indicator for effectiveness of the effort. In order to resolve the problems in the districts the GTEPAI searched for economic solutions that would benefit all farmers. The strength of the initiative was after all based on the cooperative production of large areas of barley, without discrimination. Also the access to surface water was protected, since the initiative provided production scenarios for any of the three policies as determined in the surface water treaty of 1991. The surface water treaty nevertheless did not outline water transfers to Lake Chapala.

2.4.3 Organizational or Managerial Effectiveness

Keywords;
- Organizational effectiveness
- Institutional viability

2.4.3.1 Exploration of Basin-Wide WUAs and Inter-Institutional Linkages

Under the lead of the agricultural representative, Raúl Medina de Wit, GTEPAI strived to strengthen the influence of farmers in RBC decision-making. The GTEPAI more generally strengthened multi-stakeholder processes (network building) in the RBC, because the aim of the GTEPAI was to establish inter-institutional linkages between society and government, by means of organization in order to realize processes of planning and management of activities and programs concerning integral agricultural development.

In order to achieve such enhanced planning of agriculture, the GTEPAI explored all advantageous inter-institutional linkages between government, water users and market bodies. The innovative idea to alter crops encompassed a complete change of cropping patterns from sowing to harvesting and marketing. Therefore, various organizational needs were identified in order to perform the physical and socio-economic features.

Access to information and awareness about water problems needed to be improved and propagated. In addition the GTEPAI motivated farmers' active participation in democratic representation processes, because too many farmers were still not involved in organizational affairs. In order to reach these objectives, communication needed to improve in order to create awareness and participation in the GTEPAI process. Therefore GTEPAI promoted an office that would coordinate and facilitate the information and communication about alternative crop management and organize GTEPAI meetings through the basin.

The planning methodology of the GTEPAI is derived from WUA leaders' experiences in agricultural planning in the HCs. The HCs that were created through execution of the 1992 water law prescriptions, formed venues for cooperative seasonal planning, water trading and access to externally funded system improvement programs (Garcés Restrepo, 2001) between the CNA, WUAs and state authorities. As an improved farmer-run version of a HC, the GTEPAI invited many stakeholders to influence its private-public gatherings in a more decentralized way. The authority that was held by the CNA in the HCs was now more in hands of the WUAs as they merged into the GTEPAI. As such the GTEPAI is a good example of how to transform institutions during decentralization processes. Important in this process remains the strong effort of SAGARPA actors to realize this authority shift to the farmers.

2.4.3.2 Results of GTEPAI Organization Building

Although the GTEPAI got officially installed as part of the RBC with support from SAGARPA and the CNA, the desired coordination office was never installed, neither at the basin level, nor at state and district level. Nonetheless, the absence of this office got solved by the use of offices from participating institutions, like Irrigation Districts offices and the SRL in Guanajuato. The result of the GTEPAI was an impressive organizational effort in order to perform the intended extensive change of cropping patterns in the Irrigation Districts of the basin. Most actively was the participation of the ID-011, followed by the active participation of the IDs 013, 022, 024, 061, 085 and 087. The ID-s 033 and 045 from respectively the states Mexico and Michoacán only have actively contributed to the official creation of the GTEPAI.

By the effort of the WUAs leaders and their network, the GTEPAI achieved the participation of many institutional stakeholders and involved them in the initiative from the very first start. Representatives of other water uses in the RBC voted during MEG decision-making in favor of the agricultural use during the GTEPAI activities. An example is the decision to authorize 250 MCM extra to the ID-011 in the autumn-winter season 2001/2002. As a result of the efforts to integrate stakeholders in agricultural planning, the following institutions contributed to the initiative;

SAGARPA, CNA, the SEDER Ministry (Ministry of Rural Development), FIRA (Trusteeship of the Agricultural Sector within the Mexican Bank), FIRCO (Mexico's national Shared Risk Trust Fund), 'Banrural' (National Bank of Rural Credit), State governments like SDR and SDA (Secretaries of Rural and respectively Agricultural Development), SRL (Limited Responsibility Society) of Guanajuato (ID 011), CEHs (Hydraulic State Committees), CEAs (Agricultural State Commissions), Irrigation Modules by their WUAs representatives, Irrigation Districts' representatives, Lake Chapala's Watershed Commission, ANUR (National Water Users Association), INIFAP (SAGARPA's research institute), PROFECO (National Consumer Counsel from the Ministry of Economy), barley-, white chickpea-, oleaginous- transforming industries, farmers, scientists and many others (also behind the scenes).

In this process of incorporation of institutions (their programs), farmers and business, it was crucial to prevail over differences in interests between states, uses and users. The representative of the agricultural use, Lake Chapala's Watershed Commission and leader of the GTEPAI movement had to embody an impressive diversity of interests. Especially head and tail-end differentiation was an important societal obstacle that had to be overcome between the WUAs. The support of all mentioned organizations to the representative must therefore not be underestimated. The support itself from all these groups is possibly the greatest result, apart from the significance of each contribution.

In addition, the experience of joint labor between citizens and governments is a practice of mutual advance in the decentralization process. One of many remarks of institutional pluralism or segregation is quoted as follows; 'In Mexico there are infrastructure and human resources to develop research as well in INIFAP as in the universities. What unmistakably is lacking is the integration of forces'. (Claverán Alonso, 2000)

The integration of institutional forces that was intended by the GTEPAI is certainly very important. During the research many times it seemed that different institutions were doing the same thing, with the same or complementary objectives, but in an uncoordinated way. The separated modus operandi of several institutions might find its origin in an unclear and contested division of responsibilities between the different reorganized ministries; nowadays SEMARNAT and SAGARPA (see Rap *et al.*, 2004 for a detailed historical analysis). The GTEPAI aim of achieving farmer participation and better representation is fundamental to long term decentralization processes. The GTEPAI can be seen as a political amalgamation mechanism, because it brought together farmers, institutes and water use representatives in the RBC. The fact that a user representative influenced decision-making in the most important River Basin Council of Mexico, while representing the largest water use, can be considered as a political triumph, in view of CNA's domination in decision-making.

2.4.3.3 Organizational Efforts

The alliances that have been established neither can be explained one by one, nor can they be explained as a rule of thumb. There are too many processes behind the overtures and alliances. The GTEPAI made use of existing relations between participants and organized settings to explore common interests. In addition new alliances arose from market demands and potential agricultural supplies. It is not obvious who are responsible for the various inputs of innovative ideas. Therefore some of the results will be explained as if they exclusively originated from GTEPAI proposals.

Important organizational actions undertaken by the GTEPAI were the reunions or platforms in which necessities got discussed, combined and related. Examples of issues in these gatherings are the following; water shortages, water transfers, promotion of alternative crops and orientation of information about alternative crop management, institutional and financial guarantees, transfer of information and communication, governmental support to users, promotion of more reunions trough the basin, demonstration plots together with transfer of technology and guaranteed marketing contracts (GTEPAI, 2002b).

2.4.3.4 Organizational Effectiveness

The organizational effectiveness of the GTEPAI reunions can neither be expressed quantitative, nor qualitative very easy. In total the GTEPAI organized 18 reunions and as much meetings between SAGARPA authorities and GTEPAI leaders. The organizational effectiveness of the GTEPAI efforts is in a straight line related to its physical and socio-economic effectiveness. Following Uphoff's definition of organizational activities (1986), the GTEPAI's organizational effectiveness, can be assessed on the ability to collectively improve participation in decision-making, resource mobilization (except for the creation of a coordination office), communication and conflict management while considering the relatively short period of action.

The organizing capacities of the WUAs leaders and their allies have led to an overwhelming quick answer to the water scarcity as it occurred in 1999/2000. Nevertheless the organizational basis for this rapid reaction was founded earlier during the development of the WUAs from 1989 onwards and the institutional changes that farmer leaders encountered, such as the HCs. The organizational performance that resulted in the official creation of the GTEPAI shows positive long-term effects of IMT.

The institutional viability, which is another indicator of effective management in this analysis, has proven to be rather low. The GTEPAI initiative became dormant after the withdrawal of its leader. As such this farmer-run organization can be easily ignored, since it did not live long enough to prove its potential. Although the organization was not strong enough to sustain, it did make an important afterward contribution to the success of 'Mexican IMT Model' that is claimed by many World Bank officials (Groenfeldt and Sun, 1997). The GTEPAI is a clear example of successful demand management following from the definition of Groenfeldt and Sun (1997): 'This situation, where the irrigation users determine who their managers will be, may be referred to as demand management'. The GTEPAI responded after all not only to farmers' demands of irrigation management, but also to production demands of regional industries, such as the brewery and environmental water needs in addition. The creation of the GTEPAI can be viewed as a clear example of almost complete and successful stakeholder integration and cooperation. The initial physical and economical results of the GTEPAI are of minor importance compared to the organizational success, which lays at the basis of these achieved results.

Not only it is important to be aware of the existence of a farmer-run initiative that can make IMT really successful, but moreover the GTEPAI shows how integration of stakeholders shows potential in problem solving. Despite the abrupt end of the GTEPAI, the main actors continue to work with some of the strategies. It is quite possible, if not recommended, that a similar initiative will arise from the agricultural sector. In order to provide such multi-stakeholder with a useful outline, the following chapter will explore the groundwater context in which GTEPAI strategies seem quite useful.

Chapter 3: Groundwater Mining enfeebles Surface Water triumph of the GTEPAI

3.1 Introduction to Invisible Irrigation Reservoirs

By analyzing the GTEPAI effort as presented in the previous chapter, it becomes clear that the organization represents combined processes that can produce dynamic short- and long-term solutions to water related problems. Although the organization originated from the IDs which mostly use surface water, lessons can be learnt from the GTEPAI, when trying to improve groundwater (and surface water) management in the Basin's Irrigation Units in a similar context. In this chapter, the groundwater context will be examined in order to draw lessons from the GTEPAI initiative towards integrated water resource management. This chapter will therefore describe water flows, such as evaporation, groundwater extraction and recharge, which significantly influence the basin's water balance (see **table 3-1**, page 48). Despite the short life of the GTEPAI as an organization, there are strategies behind the organization that show more potential to tackle groundwater problems than current efforts to resolve severe over-extraction. After explaining some physical aspects of the groundwater situation, this chapter will describe potential efforts to reverse the over-extraction of aquifers in large parts of the basin.

Figure 3-1: Aquifers of the Lerma-Chapala River Basin in the five constituent States (CNA, IMTA, 2002)

Figure 3-1 shows 37 aquifers in the Lerma-Chapala Basin that are recognized by the CNA (CNA and IMTA, 2002). The aquifers can be seen as the invisible underground reservoirs of the basin, since they provide 380,000 ha out of 795,000 ha with groundwater (48%), mainly in farmer-managed or private irrigation systems. About half of the area of irrigated agriculture is irrigated with groundwater and the amounts of water used in groundwater irrigation and surface water irrigation are similar (3,160 MCM and 3,424 MCM respectively).

Besides comparable amounts of water used from both sources and area cultivated with these amounts of water, there is however a significant difference between the availability of these major water sources. According to calculations and measurements of the CNA (1999a), groundwater recharge is only 70 % of surface water runoff (3,980 MCM/ 5,757 MCM) on average. While groundwater irrigation is 'booming business' in the Bajío (mostly), it is not quite likely that groundwater recharge will 'boom' at the same pace.

The Mexican Law dictates priority to domestic water use (CNA, 1999b), which places pressures on agriculture to free-up water. Therefore the surface water sector (59% of total surface water depletion on 235,000 ha in IDs and 180,000 ha in IUs) would have to diminish its consumption by 7.5% in order to restore the equilibrium in the Basin's water balance (CNA 1999a). Out of basin transfers are assumed to continue under the priority scenario to the urban sector, although it is not clear whether the out of basin transfers really benefit Guadalajara. The transfers might generate (or compensate) considerable losses to evaporation and deep percolation on the way to Guadalajara via Lake Chapala. Yet there are several projects planned to supply Guadalajara with water from other basins than the Lerma-Chapala Basin. One of these projects, constructing the Arcediano Dam, is heavily contested between environmentalist, Jalisco state authorities and local politicians.

Table 3-1: Water Balance of the Lerma-Chapala Basin (averaged over 1985-2000)

(Free after CNA, 1999a)

	Surface Water		**Groundwater**		**Total**	
	MCM	%	MCM	%	MCM	%
Runoff / Recharge	5,757	100	3,980	100	9,737	100
Irrigated Agriculture	3,424	59	3,160	79	6,584	68
Urban	40	>1	751	19	791	8
Out-of-Basin Transfer (also urban)	237[15]	4	323[16]	8	560	6
Industry	39	>1	239	6	278	3
Other	6	>1	148	4	154	2
Total Consumptive Use	3,746	65	4,621	116	8,367	86
Evaporation from water bodies[17]	2,270	39	-	-	2,270	23
Total Depletion	6,016	104	4,621	116	10,637	109
Balance	-259	> -4	-641	-14	-900	**-9**
Contribution to the deficit		29		71		100

Groundwater users, who are foremost responsible for the imbalance of the Basin as a group would have to diminish their use by 20%, while their groundwater consumption (79 % of total groundwater depletion on 50,000 ha in IDs and 330,000 ha in IUs) causes 71% of the Basin's over-extraction (see **table 3-1**; 641MCM/ 900 MCM).

[15] Towards Guadalajara
[16] Towards Mexico City
[17] Lake Chapala evaporates 1440 at maximum capacity

According to Scott and Garcés-Restrepo (2001) the principal effects of groundwater over-exploitation in the basin include:

- Land subsidence, settling and terrain fissures
- Increased costs of groundwater exploitation related to deeper wells, large motors or pumps and higher energy consumption
- Lower discharges and efficiencies of older devices
- Deterioration of water quality due to rapid transport of industrial contaminants and increased use of fertilizer and pesticides

Making surface water use more efficient will only hasten these effects, while groundwater recharge reduces through such irrigation modernization programs. The GTEPAI initiative, aiming at reducing irrigation depths and irrigation practices by promoting remunerative and less water consuming crops is therefore an important project.

The 1992 water law returned ultimate control over the IDs to the CNA, because this law defines CNA as the highest authority in the districts. In addition, physical control of primary infrastructure, such as large dams is in hands of the CNA (Wester *et al.*, 2005a). In the case of groundwater management there is however hardly any physical control by CNA over approximately 16,000 farmer-managed or private irrigation systems (510,000 ha) that are supplied by 1,500 smaller reservoirs and an estimated 26,000 tube wells. Although it is very difficult to control all these wells, CNA is still legalizing permits for drilling wells. The drilling of ever deeper wells throughout the basin as well as around and in Lake Chapala (about 30,000 ha of the former lakebed) demonstrates the essence of water to agriculture and economical productivity. In the Bajío mostly commercial farmers still increase their productions with a rush for the region's 'liquid gold' (Hoogesteger van Dijk, 2004).

Since at least the mid 1980s, water resources in the basin have been over-committed, resulting in significant pressure on surface water sources and alarming declines in the levels of groundwater and Lake Chapala (de Anda, Quiñones-Cisneros, French and Guzmán, 1998). Moreover, water quality is a rapidly increasing problem, with an accumulation of toxics in water bodies like Lake Chapala. Most significantly, water is being reallocated from the agricultural to the urban and industrial sectors, albeit in an uncoordinated manner. With almost 800,000 ha of irrigation in the Lerma-Chapala basin, the study area is important from the perspective of agricultural production (Scott and Garcés-Restrepo, 2001).

3.2 Damming the Underground Freedom: Past and Present Efforts

Wester *et al.* (2005a) quite rightly declare groundwater to be the strategic resource for the basin and not surface water. Surface water is fully allocated and industrial and domestic uses depend almost entirely on groundwater, whereas 21 of the 37 aquifers in the basin are already over-exploited. In order to deal with the results of competition for groundwater in agriculture, there are several mechanisms to break through the 'laissez-faire' situation for mostly commercial farmers. The 'laissez-faire' of these entrepreneurs in agriculture probably go well with market-oriented ideologies of the GOM, which might explain the sluggish character of most mechanisms.

In order to dam the underground problems, the following mechanisms can be distinguished in the Lerma-Chapala Basin:

3.2.1. Veda decrees
3.2.2. Studying the underground
3.2.3. COTAS
3.2.4. Tarifa-09
3.2.5. *Technification and modernization of irrigation*

3.2.1 Veda Decrees

In earlier days, 'Vedas' were enacted to preserve groundwater. Already in 1946, the Constitution was amended to enable the federal government to intervene in aquifers in overdraft, by issuing pump permits or dec1aring that new pumps may not be installed (Wester *et al.*, 2000). According to the CNA and IMTA (2002) the Vedas were placed on the following municipalities and regions (see **figure 3-1** for the location of aquifers in the Basin):

1948; the region around León in the state of Guanajuato;
1949; La Caldera springs in Abasolo and the eastern zone of San Miguel de Allende in the state of Guanajuato; Alberca de la Cañada and Villa del Marqués in the state of Querétaro;
1952; Bajío region, Celaya zone;
1958; Silao, Irapuato and Salamanca in the state of Guanajuato; Valleys around Querétaro and San Juan del Río in the state of Querétaro;
1964; Morelia and Charo in the state of Michoacán; Querétaro in the state of Querétaro; San José Iturbide, Doctor Mora and San Luis de la Paz in the state of Guanajuato;
1970; Rosario Mezquite, Michoacán;
1976; North and northwest of the state of Guanajuato*
1983; the whole state of Guanajuato*
1987; some municipalities in the state of Jalisco.

* (CEAG, 2003)

Despite the legal restrictions of the Vedas, there is no difficulty in drilling new wells, beside technological or financial restraints. From the 1950s onwards, large groundwater extractions started in order to supply the urbanization, industrialization and agricultural development. Only in the state Guanajuato the number of wells increased from approximately 2,000 in 1958 to 16,500 in 1997 (Guerrero, 1998) and 17,000 in 2000 (CEAG, 2003). According to Hoogesteger van Dijk (2004) the amount of wells in the state of Guanajuato is currently estimated at 19,600 wells of which 16,000 are officially registered in the *Registro Público de Derechos de Agua* (Public Register of Water Rights, REPDA), 2,000 in process of regularization and 1,600 illegal. If the latter estimation were correct, the amount of 26,000 deep wells in the whole basin would also be higher.

Quite easily, one can argue that the Vedas have not worked. Although farmers must ask the CNA permission to sink new wells, this permission in practice can be bought. According to Wester *et al.* (2005b), CNA gives preference to the lucrative business of legalizing 'irregular' pumps, instead of using the Vedas to dam groundwater extraction. This to a degree explains how it is possible, despite large areas under Veda protection, that aquifers are running dry in the Basin.

3.2.2 Studying the Underground

On basin level there are 37 aquifers of which 21 are over-exploited, according to the most recent data (CNA and IMTA, 2002), all located in the head and middle of the basin. The exact amount of aquifers is unclear nonetheless, since the CNA demonstrates different figures in different presentations. Four years earlier CNA (1998) identified 40 aquifers, where studies of CEAG and *Universidad Nacional Autónoma de México* (National Autonomous University of Mexico, UNAM) complicate the situation. CEAG studied aquifers principally in the state of Guanajuato and recognized only 15, instead of 19 aquifers in the state. UNAM/OG (2000) identified only two unconfined aquifer systems in the state and the differences show important misunderstanding in the basin.

According to Hoogesteger van Dijk (2004), in 1966 a Groundwater Directorate was created within the SRH. This directorate was charged with evaluating and monitoring the groundwater sector in Mexico. Hoogesteger van Dijk (2004) adds that the studies were stopped during the 1980s and resumed by CNA in 2000, based on studies of CEAG from 1995 onwards. Based upon the CNA information from 1998 (CNA, 1998), it can be argued that CNA already started its own aquifer studying or used the CEAG information for their presentation. The uncertainty of data shows an important problem of most data: sources are hardly mentioned and calculations are not transparent enough, when available. The studies of the underground show a lot of confusion, because extraction and recharge figures that are reported by the different institutes differ a lot. For example the CEAG data for 1999 present an erroneous water balance, since the difference between runoff and water use is mistaken to be negative, which almost doubles the overall deficit (see **table 3-2**). A lot of times it is however not possible to identify errors, because calculations are hardly ever presented.

Table 3-2: Erroneous Guanajuato Water Balance

Sources; *Superficial*: IEE, 2000
Groundwater: CEAG, 1999

	Superficial	Groundwater	Total	Corrected Difference
Runoff and recharge (MCM)	1,987	2,949	4,936	
Extraction (MCM)	1,557	4,195	5,752	
Difference (MCM)	- 430	- 1,246	- 1,676	- 816

CNA calculated deficits in the Basin's water balance, due to over-exploitation of groundwater, from 607 MCM in 1998 to 1,318 MCM in 2001. CEAG reports even higher deficits, while considering only the state of Guanajuato, from 773 MCM in 1998 to 1,246 MCM in 1999 (see **table 3-3**).

Table 3-3: Groundwater Deficits in the State of Guanajuato (CEAG; 1998, 1999; 2000; 2001a)

(in MCM)	Recharge	Extraction	Deficit
CEAG 1998	2,951	3,724	- 773
CEAG 1999	2,949	4,195	- 1,246
CEAG 2000	2,821	3,981	- 1,160
CEAG 2001	2,952	4,148	- 1,196

These study results are slightly misleading, since the values are averaged, though recharge and extraction differ considerably per region or aquifer. Despite inconsistencies in these studies and regional differences, it is clear that groundwater is being mined considerably, even without exact evidence and unanimity. The most important evidence of lowering aquifer levels can be found in the field where many wells run deeper and deeper or even dry. Scott and Garcés-Restrepo (2001) report continuous declines in aquifer levels of 2.1 meters per year sustained over decades. Hoogesteger van Dijk (2004) details the reasons behind the differences in study results, but also highlights effects like subsidence, settling and terrain fissures, consequent damage to infrastructure and pollution of aquifers in the state of Guanajuato.

3.2.3 COTAS

In 1993, CNA recognized the shortcomings of Veda regulation by signing a co-ordination agreement in the RBC to regulate groundwater exploitation. Consequently, CNA promoted the creation of aquifer management councils (COmités Técnicos de Aguas Subterráneas). These aquifer management councils started to develop from 1995 officially, but more dynamically from 1998 onwards and mainly in the state of Guanajuato. CNA prescribed the formation of COTAS (COmités Técnicos de Aguas Subterráneas), which are technical committees for groundwater. Although the CNA prescribed the formation of technical groundwater committees, CEAG promotes the organizations as ‘Consejos Técnicos de AguaS’ (also COTAS, technical water (users) councils), but as organizations for all water resources and in close collaboration with the GTEPAI (CEAG/MS, 2001b).

The proposal of CEAG in June 2001 for collaboration with the GTEPAI ‘project’ (CEAG/MS, 2001b) has not evolved unfortunately. In paragraph 3.3 (page 56) possible characteristics of such collaboration will be presented. Despite the efforts of CEAG, the COTAS are established as groundwater management councils in which aquifer users have to reach mutual agreements about groundwater regulation. Based on developments in the state of Guanajuato, the structure of the COTAS has been defined at the national level in the rules and regulations for River Basin Councils (CNA, 2000a). In these rules, the COTAS are defined as full-fledged user organizations, whose membership consists of all the water users of an aquifer. They are to serve as mechanisms for reaching agreement on aquifer management taking into consideration the needs of the various sectors using groundwater (CNA, 2000a).

The most advanced COTAS, in the valleys of Querétaro and León have worked out guidelines for groundwater extraction with support from aquifer management projects (CNA and IMTA, 2002). The World Bank PROMMA program supports management projects which ‘stimulate the organized participation of aquifer users with the aim to establish mutual agreements for reversing groundwater depletion, in keeping with Artic1e 76 of the water law regulations’ (CNA, 1999b; in Wester *et al.*, 2005a). Under the PROMMA program (see chapter 2) money and strategies are channeled towards the CNA and COTAS via the '*MAnejo Sostenible de* Aguas Subterráneas' program (MASAS; program on sustainable groundwater management). The purpose of the PROMMA program was to provide the necessary support to the water sector so that the targets of the 1992 National water Law (Anon, 1997) could be achieved.

CNA and SEMARNAP (1998) clearly stipulated the functions of COTAS. Also the guidelines for sustainable groundwater management (MASAS) prescribe conditions like strict extraction control, integrated supply and demand measuring, prevention of new perforations, complementary facilities of investigation and development of knowledge on aquifers and their conservation, extensions on irrigation 'technification' and measurement on the impact of this modernization on groundwater supply and diffusion of information (CNA and IMTA, 2002). Discourse in COTAS nevertheless focuses principally on installing sprinkle and drip irrigation systems to save groundwater, although the tough issue of how to reach agreement on an across the board reduction in pumping has not been broached yet (Wester *et al.*, 2005b).

The formation of the COTAS needs time and central incentives (Hoogesteger van Dijk, 2004) to survive or develop. Hoogesteger van Dijk (2004) studied the latest developments of COTAS in the state of Guanajuato and he concludes their need for legitimate power in order to control groundwater use. CEAG/FGK (2004) remarks that bottom-up actions need to be facilitated by top-down provisions, in order to achieve community participation and progress on aquifer management and protection. In many cases, COTAS mediate between institutions, their support programs (as described in chapter 2) and groundwater farmers (Hoogesteger van Dijk, 2004). Although to date none of the established COTAS has yet devised effective ways to reduce groundwater extractions, institutional response to groundwater problems seems a first step in dealing with the underground problems.

3.2.4 Tarifa-09

Tarifa-09 (tariff-09) is a subsidy on electricity for agricultural use. As such, it is a support in pumping costs for groundwater irrigation. Although CNA (2001a) condemns a 'traditional and propagated culture of free of charge water use and high subsidies on groundwater use', CNA plays an important role in the electricity subsidizing. In 2000, CNA agreed with the *Comisión Federal de Electricidad* (Federal Electricity Commission, CFE) and president Zedillo (at that time) to offer the tarifa-09 subsidy to irregular pump owners in order to reduce their electricity costs. Simultaneously CNA would gain control over irregular pumps by means of electricity pricing mechanisms.

Scott, Shah and Buechler (2003) demonstrate that marginal values of groundwater in the Basin lie between US$ 0.07 and 0.72 per m^3 (compared to US$ 0.06 – 0.24/m^3 for canal water). Tariff-09 subsidizes MP 0.32 (˜ US$ 0.032) per kW/h and this subsidy is proclaimed by Fox Quesada, the Mexican president (2002), to give Mexican farmers the highest subsidy compared to the other countries under the North American Free Trade Agreement (NAFTA).

With special energy prices for agriculture, a complex concept of incentives was introduced. The energy pricing is a politicized issue for various reasons. Although subsidizing energy (and hence groundwater use) thwarts any plan to dam the underground problems, it can win votes and support from (influential) groundwater users. Furthermore, tarifa-09 is not (anymore) accessible to illegal groundwater users that are not (yet) registered in the *'Registro Público de Derechos de Agua'* (Public Register of Water Rights, REPDA). In that sense, it makes a difference to illegal groundwater extractions, but these irregular wells continue to be normalized.

The importance of the subsidies must not be under-estimated, since these subsidies make the Mexican production more competitive with their mostly North American negotiation partners. While offering tarifa-09 to irregular pump owners a start has been made in controlling the groundwater extractions. By gradually increasing the energy prices it would be easier for CNA to pressure groundwater users to reduce their water use. Nevertheless, in comparison with the gravity of groundwater over-extraction and the pressure on surface water users, tariff-09 unequally favors groundwater use. Kloezen and Garcés-Restrepo (1998) state that owing to the subsidized energy tariff (tarifa-09) the cost of pumping water had not yet exceeded the cost of surface water and as such, this has never been an incentive for well owners to economize on water. In addition Scott and Garcés-Restrepo (2001) argue that in general well owners use more water (higher RWS[18]) than surface water users, because they do not wait for the rains to come but start irrigating as soon as they can. While comparing canal (surface) water use and private well water irrigation the latter generally have a lower RWS in winter which gets compensated by a higher RWS in the summer season.

Groundwater tends to be the principal water source for private growers. Consequently, 'leaky' surface water supply coupled with the large irrigation depths in the Irrigation Districts amounts to an indirect water transfer from the '*ejido*' (surface water) to the private sector according to Scott and Garcés Restrepo (2001). Tariff-09 is therefore contested subsidy, whereas private farmers are favored, despite their 'bad' performance as a group. CEAG (2004/FGK: 2) highlights this bad performance differently:

> 'In the 1990s major efforts were made by federal government (the CNA) to register and administer the groundwater abstraction and use rights system. Lack of consistent enforcement has meant that those who decided not to follow the rules were usually not sanctioned, thus deterring the rest of the user community to cooperate or comply with the regulation processes'.

There are several proposals to adjust the tariff-09. SAGARPA and SENER (Secretaría de Energía, Ministry of Energy) proposed an annual bonus of 5 % of the electric energy costs for farmers who improve their irrigation equipment (www.sagarpa.gob.mx). The Ministries also announced a proposal of the CFE to deliver cheaper electricity out of peak hours. According to Hoogsteger van Dijk (2004), a night irrigation tariff would stimulate farmers to irrigate at night. This would reduce peak demand for the CFE, reduce electricity costs for farmers and decrease evaporation losses. In addition, there are other plans to increase the energy price (or decrease the subsidy) when farmers exceed their irrigation concession.

It seems difficult to regularize groundwater extractions by energy pricing. According to Scott *et al.* (2003), groundwater farmers tend to maximize the volume they pump, due to the large differential between fixed and recurring costs for a well. In order to recover the high capital investment, farmers very often increase the total area irrigated per well. Whereas CNA does not control the groundwater extractions at field level, CFE will face comparable problems in controlling the energy use. Hoogesteger van Dijk (2004) mentions the fact that many users have debts with the CFE that are not paid. CFE cannot easily cut energy at field level or collect the numerous debts. Although the idea of manipulating groundwater use by regulating electricity is creative, there are many constraints. In the (inter-) national debate over

[18] Relative Water Supply = Total Water Supply (Irrigation + Precipitation)/ Total Crop Demand

privatization of the Mexican energy sector, mechanisms for controlling groundwater extractions pale into insignificance.

3.2.5 Technification and Modernization of Irrigation

Not only in Mexico, but in general modernization of irrigation is seen as solution to scarcity problems. In order to save water and make it free to other than agricultural use, great emphasize is placed on a more efficient use of irrigation water. As explained in chapter one, the concepts of 'on demand management' and 'increasing efficiencies' on a basin level require a better understanding of the basins water balance and exchanges between the different water sources (groundwater, surface water and derivative or drainage water). The narrow 'technification' approach of the CNA is therefore emphatically criticized in this report.

Technification or modernization programs are not only programs that aim at improving efficiencies. The technologies, including aspersion, sprinkler, dripping, filtration, automation equipment and pumping accessories that are promoted by the CNA programs are supplied by private stakeholders. According to the US department of Commerce (2004) the Mexican market for irrigation equipment is primarily driven by government funds given directly to farmers. According to the US department of Commerce the goal of the GOM is to add 124,000 acres[19] (approximately 50,000 ha) to the irrigated land surface every year. In addition it is argued that opportunities for U.S. companies in the irrigation industry are good although US firms face strong local and foreign competition.

CNA and IMTA (2002) put predominantly effort in technification or modernization of irrigation. This supposedly water saving effort dominates all other efforts in whichever CNA publication or presentation. Paradoxical effects on aquifer levels are the danger of the technification approach, which is prescribed to the surface water sector. As argued by Seckler (1996), Scott and Garcés Restrepo (2001) more efficient surface water application reduces groundwater recharge. Whereas mostly IDs are pressured with the technification indoctrination, also in COTAS of Guanajuato most of the discussions revolve around increasing irrigation efficiencies, according to Wester *et al.* (2005a and 2005b).

The technification bias, as part of modernization and decentralization strategies, is not quite deliberate. The focus on installing sprinkle and drip irrigation systems to save water diverts the attention from the main task of the COTAS. COTAS were created with the aim to establish mutual agreements for reversing groundwater depletion, in keeping with Artic1e 76 of the water law regulations (CNA, 1999b). According to Wester *et al.* (2005a and 2005b), Hoogesteger van Dijk (2004), Foster *et al.*(2004), Scott *et al.* (2003) they are not effective however in reversing groundwater depletion. Scott *et al.* (2003) quite rightly state that institutional relations between the federal, state and local levels do not allow regulatory and participatory approaches to groundwater management in the Basin. 'While these dynamics are evolving, it is likely to take longer to establish functioning institutional arrangements than the pace of groundwater overdraft (in Guanajuato) will permit' (Scott *et al.*, 2003: 4).

The long-term solutions offered by technification programs are an additional argument for a radical change in approach. As said by Scott and Garcés Restrepo (2001) the cornerstone of the current Mexican irrigation modernization program is to tackle the problem of 'water

[19] An acre equals 0.41 ha.

losses' through a variety of strategies to improve water use efficiency at all levels. The authors argue that such an approach would negatively impact the already declining groundwater resources. Especially the intended technification of the IDs should be reconsidered: major rehabilitation and modernization programs in which canals are lined and supposedly efficient water application technologies (drip and sprinkler) are theoretically less effective in saving water on basin level than crop alterations and decline of cultivated area by institutional response. The institutional responses that hesitantly started in the Basin (and on national level) are the COTAS and organization of the *Unidades de Riego* as URDERALES.

3.3 Organization of the Unidades de Riego

The IMT of the 1990s resulted in the organization of an estimated 88,000 water users in the Basin's Irrigation Districts. In addition there are approximately 100,000 water users in approximately 16,000 Irrigation Units (CNA/MW, 1999). These *Unidades de Riego para el Desarrollo Rural* (Irrigation Units for Rural Development, URDERALES or IUs), which cover about 510,000 ha of which 330,000 ha are irrigated with groundwater (CNA, 1993 and CNA/MW, 1999) are also called *Sistemas de Pequeña Irrigación* (Small Irrigation Systems, SPI) or Water Harvesting Irrigation (WHI) systems. The Irrigation Units are farmer-managed or private irrigation systems with own water sources from private and collective wells and some 1,500 smaller reservoirs, which serve 180,000 ha.

In the RBC, agriculture as largest water user is pressured to reduce its water use and make water free to other use. In the Council, there is however no distinguishing representation of groundwater users, surface water users, Irrigation District or Irrigation Unit farmers. The agricultural representative in the Council has to represent all interests of different users from different systems and locations in the basin. The GTEPAI effort was a pioneering step in achieving farmers' participation in the Council's decision-making processes, despite its relatively short and therefore small impact. Ideally, farmer organization, participation and representation of Irrigation Unit farmers would be one of the next steps, but the COTAS can not yet achieve participation of the aquifers groundwater users. According to Hoogesteger van Dijk (2004), user participation in most COTAS lies between 3 and 10%. CEAG adds that COTAS have assumed to represent users at CNA and other instances (CEAG, 2003). The representation of large private growers and collectively managed small irrigation systems remains a challenge for the RBC.

The reduced inflow from the Lerma River to Lake Chapala is in general not related to practices in the water harvesting irrigation (WHI[20]) systems. Although there are an estimated 39,500 systems that account for 46% of the irrigated area in the country, the *unidades* are relatively unexplored from a water management perspective (Silva-Ochoa *et al.*, 2000). Approximately 16,000 of these *unidades* are located in the Lerma-Chapala Basin. Scott and Silva-Ochoa (2001) comment that in pursuit of the first objective of the CC (see also page 14), the 1991 surface water treaty was signed. According to the authors this treaty banned further development of water harvesting in an attempt to increase runoff flows to Lake Chapala. CNA did not inventory the constructed capacity of about 1,500 minor storage structures in the surface water treaty (CNA, 1993; CNA, 1999d), although this capacity accounts for 27% of the basin's constructed surface water storage volume, according to Scott

[20] Water harvesting is the capture, storage, diversion and application of surface runoff water in a small-scale Irrigation Unit.

and Flores-Lopéz (manuscript in preparation) and provides 43 % of the area under surface water irrigation (180,000 ha).

According to estimations of a combined technical study of SEMARNAT, CNA and IMTA (2002) in the IDs average water depths vary from 0.31 m in the ID-033 in the state of Mexico to 1.20 m in the ARLID (ID-011) in Guanajuato. The URDERALES apply irrigation depths between 0.31 m in the ID-033 in the state of Mexico to 0.60 m in the ARLID (ID-011) in Guanajuato. Average system level efficiency would be 35 % in the IDs, whereas efficiencies in various *unidades* would be higher, despite more aggravating use of groundwater. CNA and IMTA (2002) seem to agree with Scott and Silva-Ochoa (2001) that improved conveyance efficiencies in the *unidades* result from flexible management due to the smaller size of the irrigation systems (although the former leave out the management component). CNA and IMTA (2002) argue that despite the fact that IDs have a higher agricultural productivity per ha, their productivity from a water perspective is poor, compared to the *unidades*, due to water fees that do not cover the service costs (mainly in ID-061, ID-087 and ID-024). Scott *et al*. (2003) explain that farmers tend to irrigate in excess of crop water requirements, since irrigation generally represents a relatively small fraction of the total input costs while it conveys a significant degree of risk mitigation for other production factors (seed varieties, fertilizers, etc.).

The presentation of the *unidades* in this chapter is provided in order to anticipate problems they face (or will face), which are similar in different gradations to the problems of the WUAs that gathered under the GTEPAI initiative. The GTEPAI formation was based on the following problems that WUAs in the basin faced in common (page 30 and 31);

- Reduced water availability
- Lack of financial certainty and means for investment returns
- Difficult access to markets
- Need for strengthening of the agro-industrial production chains
- Weak vertical and horizontal institutional cooperation
- Lack of basin-wide farmer organization and joint interest
- Fragile position and weak representation in the River Basin Council
- Lack of strategically planning

3.3.1 Productivity in the *Unidades*

In parallel with agriculture in Irrigation Districts, the state of Guanajuato has the largest area under irrigation in irrigation units. In Guanajuato, 94% of the area of these *unidades* is irrigated with groundwater from deep wells (Silva-Ochoa *et al.*, 2000). The area that is cultivated in 3,521 registered *unidades* in Guanajuato accounts for 46% of the total cultivation area in irrigation units in the Basin. According to Hoogesteger van Dijk (2004), only 54 of these 3,521 *unidades* have been organized into WUAs to date. In total the IUs account for 65% of the total area under irrigation in the basin.

Apart from comparable amounts of water used in the IDs and IUs (page 48) and unequal refill (surface water runoff is 1.45 higher than groundwater recharge), organization and productivity are also important parameters to compare both systems. Palacios-Vélez (1997) designates that farmer-managed irrigation have higher agricultural productivity on average than government-administered Irrigation Districts in Mexico. According to Dayton-Johnson (1999) the *unidades* in the state of Guanajuato produce 74% of the amount of the state's irrigated agricultural output, while farmers in the districts produce 26%. Although these percentages do not differ very much with the area relation (65% versus 35%), Dayton-Johnson (1999) insinuates that the value-weighted disparity would be greater. Based on national figures he argues that productivity in the *unidades* measured in terms of value per unit of irrigation water is 78% greater than in the districts (FAO, 1994).

A problem with this kind of indications is that they hide performance features of the *unidades*. The IUs belong to a heterogeneous group of small-scale irrigation systems that are controlled and managed by their users. According to Silva-Ochoa *et al.* (2000) the management of these systems is dynamic and diverse and the number of users in the unidades varies between one and more than 600 users. As said by Silva-Ochoa *et al.* (2000) the *unidades*' productivity levels are directly related to external factors including commodity prices. They add that 88% of the *unidades* in Guanajuato grow grains and are therefore in crisis with gross productivity values between 5,400 and 10.000 MP/ha (1999). In many cases the *unidades* are examples of subsistence farming and are the water harvesting techniques supplemental to rain-fed agriculture. Fruit and vegetable production (garlic, broccoli, squash, onion, chili, potato, strawberry and asparagus) (Dayton-Johnson, 1999) representing 6% of the harvested area in the region (del Conde, 2001) has productivity levels up to six times higher (Silva-Ochoa *et al.*, 2000). Not only there is great variation in production levels, but also in their way of harvesting water, access to water, land tenure and number of users. Also managerial structures in the *unidades* show diversity and may consist of informal WUAs, government recognized WUAs, water judges, pump groups or commercial management (Silva-Ochoa *et al.*, 2000).

Growing governmental pressure on the allocation of scarce water to industrial and urban uses has important implications for the sustainability of the *unidades*. In order to ensure their viability in the context of scarce and contested water, the poorer *unidades* depend on direct or indirect subsidies from the government. In order to access government support programs as described in chapter 2 (page 24-26), organization of the *unidades* is required. In many cases the organization of users in the *unidades* embraces the organization of particularly women, since migration causes the feminization of smallholder agriculture in Mexico according to Scott and Silva-Ochoa (2001). In most cases, women lack the formal '*ejido*' title (usually remaining vested with migrating male family members) which obstructs their access to credit programs (Katz, 1999).

According to Scott and Silva-Ochoa (2001) the signing of the NAFTA has resulted in lower basic grain prices. They also comment that the traditional water management and allocation systems in the *unidades* are pressured by increasing water scarcity and competition at the watershed and river basin levels. Scott and Silva-Ochoa (2001) remark that WHI systems use water that may have more productive uses downstream, particularly when considered from an inter-sectoral perspective of competition among agriculture, urban, industrial and environmental demands for water. In order to increase the productivity of water in these WHI systems and in order to continue to receive basin level allocations, Scott and Silva-Ochoa (2001) and Foster *et al.* (CEAG/FGK, 2004) recommend a crop diversification in the *unidades* in order to reduce groundwater use. Such a crop diversification could only be achieved in my opinion with similar efforts that preceded the GTEPAI change of cropping patterns.

The characteristics of the majority of *unidades* can be considered to be similar to the problems WUAs faced in the IDs by the end of the past century. Mostly *ejidos* in the *unidades* that depend on basic grain subsistence farming face the need to organize themselves on higher level than their community. According to Scott and Silva-Ochoa (2001) the e*jidos*' collective management of land, water and other watershed resources will increasingly pass to private, individual hands. For many farmers, selling the land is the only opportunity to earn money on the short term.

In order to improve productivity and save water simultaneously in the *unidades*, the GTEPAI effort seems the most attractive alternative for short term or even long term improvements. The institutional response of organizing and building COTAS and URDERALES with support from governmental institutes and programs is not an obstacle for farmer-run organizations. With support from CNA, SAGARPA, state delegations and agro-industries, the *ejidos* could start a crop alteration, make water free to other use and discuss their joint interests. In 1999 the gross productivity values on more than 200,000 ha in the Guanajuato *unidades* lay between 5,400 and 10,000 MP/ha according to Silva-Ochoa (2001). The GTEPAI negotiated a gross productivity value of 15,000 MP/ha with contract farming guarantees from agro-industries for the production of barley. This economic advantage can be achieved by the organization of large crop alterations as has been proven by the GTEPAI.

In reaction to the U.S. Farm Bill from the 8th of May 2002, which protects U.S. farmers, the GOM (re-)introduced governmental subsidies to certain crops. According to Celaya del Toro (SAGARPA/CT, 2002) the GOM introduced '*precio objetivo*' (direct subsidies) to cultivation of maize, sorghum, barley, oats, wheat, and oleaginous crops (soy, sunflower, safflower and canola). With these direct subsidies from SAGARPA it is possible to reduce water use per unit, the import of Mexican agro-industries and simultaneously guarantee production in the *unidades* and the districts.

The modernization of irrigation, prescribed by neo-liberal economic reforms has far-reaching consequences for all farmers in the Lerma-Chapala Basin. Not only in the IDs, are farmer efforts necessary to make decentralization policies succeed. Competition for water and pressure from the environment and NAFTA make the situation for the poorest farmers very difficult. In order to gain responsibilities, access to governmental support programs and agribusiness covenants, the organization and representation of *unidades* needs immediate support.

Without adequate support (long term co-operation) and protection from CNA and SAGARPA, such multi-stakeholder integration has little future. The problems that the ministries have to overcome, in order to mediate better water management, are conceptual changes. The bureaucrats from the ministries are not quite capable in managing water. Although IMT recognized such bureaucratic limitations, the processes in formal decision-making (venues) are still hardly influenced by water managers, but dominantly prescribed by technocrats, bureaucrats and politicians.

3.4 Damming the Underground Freedom: 'Dominance or Facilitating Regulation?'

The Lerma-Chapala River Basin offers many conditions of possibility, concerning water management and rural development. In order to improve the management of water there are several strategies that show promise. In the first place there are direct subsidies and important support programs (governmental support) for farmers, which can help them, competing with the other NAFTA producers. Secondly there are local markets and agro-industries that want to provide products to more than 20 million people in Guadalajara and Mexico City (CONAPO, 2000). The accessibility of market demands, government expertise, funds and bulky agricultural supplies offer windows of opportunities for their integrated management. Water management is an important instrument to deal with these opportunities as can be concluded from the GTEPAI assessment. The organization of the largest category of water users is an urgent affair in the regulation of the Basin's water resources. More than anything else in the context of the RBC, the *unidades* need ongoing support and stimulation in order to reduce their groundwater extractions and manage both water and agriculture beyond system level.

In order to improve integrated water management (note: groundwater, surface water and drainage water) it is important to set priorities. Apart from the struggles in the districts and the RBC about surface water allocation and use (which may continue to be 'leaky'), there are several possibilities in order to reduce groundwater extractions in the *unidades* and districts.
The integrative facilitation of groundwater use reductions is one way to improve Mexican agriculture within NAFTA context. On the other hand, from a water preservation perspective only, one could also argue strict law enforce, considering the severe problems.

3.4.1 Stimulation of Organizational Efforts

In order to encourage water saving efforts in the *unidades*, their organization is crucial. Also CNA (2001) recognizes the importance of URDERAL organization, since they should be 'organized into civil societies that can sustain themselves'. The prescribed strategy in the organization process of the *unidades* stands for technification efforts that are in line with the *Alianza para el Campo* program. Although the achieved Water Savings of the GTEPAI are quite modest savings, this public-private-cooperative planning group offers a quite unique strategy towards wheat cultivating irrigation systems in the *unidades*. The GTEPAI combined several concepts and interests that could also reduce groundwater extractions in the *unidades*. These GTEPAI concepts together with other ideas will be presented in this section in order to provide applicable mechanisms for organization of the *unidades* with the intention to save water.

In Guanajuato, Flores-López and Scott (2000) estimated with satellite images the total area under traditional wheat/ barley cultivation at 103,883 ha with an averaged irrigation depth of 1.35 m in the OI of 1998/1999. Although the GTEPAI achieved a reduced surface water gift on 20,000 ha in the ID-011, crop diversification has great potential in mitigating the physical and socio-economical water related problems in the Basin. Not only traditional wheat cultivation consumes enormous amounts of water in the autumn-winter seasons, but also alfalfa, the 'easy crop', consumes in Guanajuato nearly 40% of all water (Flores-López and Scott, 2000). With a combined water consumption of 2,830 MCM out of 3,672 MCM, traditional wheat, barley (note; with four irrigation turns) and alfalfa cultivation accounts for 77% of the water use (see **table 3-4**).

Table 3-4: Estimated versus Reported Irrigated Areas (major water consuming crops), OI 1998/1999, State of Guanajuato (Flores-López and Scott, 2000)

Crop	Estimated irrigated area (ha)	Reported Irrigated area at SDAyR[21] (ha)	Percentage reported	Estimated volume used (MCM)	Reported volume used (MCM)	Percentage reported
Wheat/Barley	103,883	81,900	79%	1,402	1,106	79%
Alfalfa	96,841	45,665	47%	1,433	675	47%
Total area OI	**300,598**	**169,391**	**56%**	**3,648**	**2,130**	**58%**

The crop diversification to less water consuming crops or varieties is studied and promoted by INIFAP the research institute of SAGARPA. INIFAP is studying pastures that have higher productivity and less water consuming characteristics compared to alfalfa, but very much the same market (regional dairy industries). INIFAP is also trying to demonstrate with pilot farmers that alfalfa can be grown with less than half of the actual used water (Hoogesteger van Dijk, 2004). Also other crops and varieties are experimented on pilot plots with cooperative farmers and on INIFAP experimental fields throughout the Basin. Very often INIFAP researchers and SAGARPA authorities organize municipal gatherings in which certain crops are promoted. Many of these crops have guaranteed market prices by SAGARPA subsidies since 2002. In 2002 the GOM reintroduced subsidies in reaction to the US farm bill signed by George W. Bush on the 13th of May of that year (SAGARPA/CT, 2002). The crops that have higher water productivity than wheat and guaranteed minimum price are barley, safflower and canola.

The crop diversification to less-water consuming crops is more attractive under large collective or organized cultivation, combined with the market guarantees from either SAGARPA (*precio objetivo*) or agro-industries. Contract farming (Marañón Pimentel, 2001) can be a component of the crop diversification, given that negotiated contracts with the private sector (*Impulsora Agrícola S.A. de C.V.*) have been established in the case of barley (and more generally in export oriented horticulture in the Bajío). Logistical and informative support and farmer organization are indispensable for such an initiative, while considering the weak points of the GTEPAI. Together with help from public institutes, farmers in both *unidades* and *distritos* can offer organized and large productions. Joint interest (e.g. economical) in water management and production can bind farmers and enhance their commitment and involvement in organizational efforts.

A smaller concept to stimulate water management by market regulation was the concept of a water bank. The water bank concept has been promoted by the CNA and the Lake Chapala Watershed Commission in order to stimulate a water (rights) market. The water bank would buy water entitlements that are not used by farmers and make this water available to the environment or other users. In 2001, CNA and the Lake Chapala Watershed Commission proposed the concept in which the CNA, RBC, Lake Chapala Watershed Commission, COTAS and CEAs would jointly coordinate the buying of Irrigation Districts' water rights with federal funds (CNA, 2001a). Such a concept, in which groundwater users can denounce their water concession right and bargain compensation, would ideally benefit the aquifers. There are however several risks, because illegal water use and lack of accurate measurement

[21] *Secretaría de Desarrollo Agropecuario y Rural*; former State Secretariat of Agricultural and Rural Development

hinder the functioning of such a bank. For the functioning of the concept both rights registers in REPDA and flow measurement need to be up-to-date. Apart from the technological and legal constraints, it is questionable if such a water bank concept will result in wet Water Savings, when water volumes are redistributed and not diminished.

The advantages of the crop diversification are important in the Basin's context. Although the Basin accounts for 9% of Mexico's GNP (CNA, 1999a, page 1), the prosperous businesses are in hands of a few. For many farmers in the *unidades* and districts it is too risky or expensive to improve their irrigation technologies, because of marginal incomes.

The technification efforts should therefore be studied more critically. At this moment it seems that any modern technology is an improvement in the eyes of CNA, but this is alas not the always the case. The enormous efforts to modernize the Irrigation Districts might have counteractive effects, whereas rich private growers in the *unidades* receive support, which they actually do not need that much in my opinion. The technification efforts should be assessed on their impact on aquifer levels and levels of the various water bodies in the Basin. Many times the technification components are presented as if they were equitable, ever lasting improvements that automatically generate water savings by increasing conveyance efficiencies.

Certain concepts of irrigation technification, like plot leveling and conservation tillage, may reduce the water need of groundwater irrigation systems and improve water infiltration and aquifer recharge. It is however questionable how these technification methods will enhance farmers abundant irrigation practices in search for maximization of productivity. It is quite common to enlarge the area under cultivation and therefore use 'saved' water on supplementary plots, if possible.

Technification efforts should aim at improving water quality and increasing the output per unit of evaporated water in order to achieve real Water Savings. Crop diversification is an attractive methodology for increasing the output per unit of evaporated water. The re-use of derivative (urban, industrial or agricultural) water combined with wastewater treatment are important strategies to realize water saving efforts. The River Lerma and its tributaries that scarcely nourish Lake Chapala are classified as contaminated (CNA, 1999a). Contijoch (2003; 22, see **box 3-1**) explains the dual function of agriculture as a victim and cause of pollution and the relations of surface water and groundwater in relation to derivative water sources (i.e. drainage water and urban wastewater). The technification efforts should in the first place respond to water quality aspects and reducing groundwater extractions, but CNA seems to play a waiting game, while shifting groundwater use reduction responsibilities to immature organizations (COTAS) and municipalities in the case of urban water treatment. During the past 40 years, water quality has severely deteriorated throughout the Basin, with hardly any treatment of urban and industrial wastewater before 1989 (see **box 3-1**).

Box 3-1: Water Quality Aspects and Interrelated Water Resources

"The availability of surface and underground water is connected to changes in the environment and pollution. These aspects have to be considered in the implementation of programs to improve water irrigation efficiency and develop drainage solutions. The overuse of water in irrigation, in some basins, exceeds their capacity to regenerate resources, absorb pollutants, and satisfy the population's needs.

Moreover, overuse has impoverished and disequilibrated the ecosystems. A reduction has been noticeable in the cropped area in the last few years, and pollutants have shown up in streams and in rivers. As discussed above, agriculture is both cause and victim of its own pollution. By using water for irrigation, agriculture became a source of pollution through runoff of organic and chemical substances into water bodies and through erosion, producing a net loss of soil, salinization, and water logging. Agriculture is a victim, because reuse of agricultural water and municipal and industrial wastewater pollutes soil and crops and transmits disease to consumers and workers.

In Lake Chapala, pollution associated with the deterioration of water quality has invited the growth of algae and aquatic weeds. The Ministry of Health reported 5,620 deaths from waterborne diseases in 1999. The most frequent bacteria are coliforms of human origin, which reflect poor sanitation in Mexico. Nitrate levels in underground water have increased, and 10 out of 100 Mexicans drink water that does not meet the country's lowest acceptable quality norm for drinking water (10 mg of pollutants per liter)." (Contijoch, 2003: 22)

3.4.2 Law Enforcement as a Regulation Mechanism

Whereas Veda restrictions have failed to reduce groundwater extractions in basin, repressive law enforcement and more coercing mechanisms can play an important role to dam underground freedom. With the alarming situation of many aquifers in the Basin and the drying of Lake Chapala (despite unexpected temporal recovering), restrictions on cultivated area during scarcity events temporal or permanent enforced restrictions seem unavoidable. Especially in federal zones in the former lakebed and in the *unidades* Veda decrees could be established with imposed control. The scarcity policies (1991 surface water treaty) that are established for surface water users should be reconsidered, while restrictions on groundwater use makes more sense. Trueba Coronel (2002) blames the lowering of Lake Chapala for a large part on irrigation practices in federal irrigation zones that are cultivated with groundwater from the aquifer beneath the Lake. Trueba Coronel (2002) calls these wells absorption wells which would cause the scarce entering water from the River Lerma to be 'lost' in the subsoil.

Eventual restrictions could entail cultivation area, water volume or pumping hours. It is a matter of choice whether CNA puts effort in armed protection of surface water transfers or enforcement of Veda decrees by army and police patrols. Apart from these patrols, such restrictions could also be negotiated with the groundwater users. According to Marañón Pimentel (2001) there is a decree that stipulates a maximum volume of water per unit area ($6m^3$/ha/year) which is independent of the type of crop cultivated. Many groundwater farmers violate this regulation as described by Marañón Pimentel (2001) by the example of broccoli cultivation in the Bajío region of Guanajuato. While alternatives for production are available, the authorities could prohibit and control the cultivation of certain crops like alfalfa and wheat, while promoting the mentioned alternatives.

Another mechanism to regulate groundwater use could be to restrain monopolies of large private growers. These private farmers often make use of nominal ownership in the hands of family members, friends and others in order to circumvent the lawful limit on land ownership of 100 ha (Wester *et al.*, 2005a). The regulation of these large landholdings is difficult, since they have the resources and mechanisms to oppose eventual regulation. According to Romero Pérez and Mollard (2003) the creation of the farmer-run SRL in the ID-011 was a strategy to protect the interests of large landholdings and form a pressure group in the negotiations of the RBC, which is dominated by CNA. Many of these large landholders are export producers which in fact export transformed groundwater, which in turn is stimulated by the NAFTA.

The most effective way of regulating groundwater use seems energy pricing. With increasing pumping depths, also energy prices (typically electricity costs) increase. The GOM subsidizes the electricity costs for agricultural use with a special '*tarifa-09*' (tariff-09). The abrupt removal of this energy subsidy would dramatically disturb current water use, which off course is a powerful but dangerous mechanism. According to Scott *et al.* (2003) calling off this power tariff will double the tariff costs for (illegal) well owners. Most probably, pressure on other water sources and illegal extractions of water will increase, while removing the power subsidy. In reference to Hoogesteger van Dijk (2004) the removal of these subsidies generates funds that could be used for the stimulation of increasing water productivity.

While rigorous changes in subsidy arrangements might result in radical reactions of farmers or illegal use of electricity, subtle changes seem possible. CNA and CFE could reward farmers that reduce their water and electricity use by a change of crops. The combination of farmer responses to market demand and environmental pressure on water could be rewarded by continuation of *tarifa-09*. Especially alfalfa growers and wheat producers in the state of Guanajuato, where applied irrigation depths are the largest, can be encouraged to cultivate barley and white or forage chickpea varieties, as possible alternatives, according to the GTEPAI Crop Catalogue (CCPLCh, 2001)

Chapter 4: Confluence of Water Streams in the Institutional Landscape

4.1 The Sequel of the River Basin Council

Because the Lerma-Chapala can be considered a closed River Basin, several concerns fall into place. Principally in closed basins the question of saving water revolves more around re-distribution of water than theoretically saving water by increasing irrigation efficiencies. After all inter-sectoral transfers are inevitable in the closed basin and most logically the irrigation sector will need to allocate water to other use. Secondly the irrigation sector is historically divided in Irrigation Units and Irrigation Districts and is a heterogeneous sector that makes use of three main water sources; groundwater, surface water and derivative water (surface- and groundwater from agricultural drainage and urban or industrial wastewater). Surface water and groundwater resources are linked and their quantitative use mainly in agriculture determines the Basin's water balance. From a river basin perspective their mutual influences are of utmost importance to an integrated water resource management (IWRM) or Integrated River Basin Management (IRBM). The division between irrigation districts and units and difficult control over the latter in the Mexican context put pressure on the relatively young RBC. The division not only complicates integrative management, but moreover institutionalized a biased approach to water management in which mostly surface water allocation is contested.

Although the Mexican platforms are created as mechanisms for negotiation and conflict solving, such a basin level water management approach generates conflicts. Disproportionate representation of water uses and water users causes troublesome functioning of the Council, since certain interests and responsibilities are not well enough represented. It is unclear if the Council will improve representation of interests, since user participation and concern got seriously undermined by the water transfers from Guanajuato towards Jalisco. While the GTEPAI drew together the farmers from the distinctive and 'rival' states, its ending by the end of 2002 also put an end to the active cooperation between the water user associations and state authorities from the different states.

The call for basin-wide cooperation unfortunately further decreased with a stunning recuperation of Lake Chapala by the end of 2003. 'Although the exceptionally good rains of 2003 led to the recovery of Lake Chapala, with stored volumes jumping from 1,330 MCM in June 2003 to 4,250 MCM in January 2004, this did not cool down tempers' (Wester *et al.*, 2005b). In the first place CNA was accused for the enormous erosion and flooding in the basin, resulting from the rains and the third water transfer from the Solis Dam in Guanajuato, with a lot of damage to irrigation infrastructure and agricultural production. In August 2003, Guanajuato farmers occupied the CNA regional office and they diverted transfer water to Lake Yuriria to express their anger at CNA. In November 2003, the Jalisco representative on the RBC demanded another transfer of water from upstream dams to Lake Chapala, fuelling the anger of farmer representatives and further straining the relationship with Guanajuato (Wester *et al.*, 2005b).

The problems between Guanajuato WUA leaders, Jalisco environmentalists (many North American retirees) and state government depend very much on the central role of the CNA in the Council. Although increasing user participation, democratization and decentralization of power are hegemonic rationales behind water reforms and institutional changes, they do contradict in principle with the creation of the central, powerful and independent water body (i.e. CNA) in 1989. Quite illustrative, Mody (2001) argues that in general there is a need for greater integration and central decision making in certain dimensions to achieve a holistic approach to river basin management, including decentralization objectives;

> ‘From the earlier focus on the physical management of water, today, river basin management has more holistic objectives, including sustaining the broader ecosystem. Thus, not only must traditional objectives of water supply, waste treatment, and water quality be met to address the requirements of competing users, but also the interdependence of various elements of the water and environment must be recognized to ensure that resources are used in a sustainable manner. This more holistic approach thus leads to the need for greater integration and centralized decision making in certain dimensions while making feasible and increasing the desirability of decentralization and stakeholder participation. (Mody, 2001: 1)

This quote from Mody resembles what in practice is happening in the Basin. The transformation from a rather physical approach towards a more holistic approach to water management in the Council is encouraged by some of its stakeholders. Contijoch (2003) points out that the role of the CNA as Mexico’s sole authority for water is being challenged every day by state governments. In addition the author concludes that the basin councils in Mexico in general are inconclusive regarding how far down decision-making should be decentralized. Contijoch (2003) relates these challenges to the new democratic era the country is living. Although he is quite positive about the expertise in conflict resolution that the CNA personnel now have, I argue that CNA plays a dangerous game sometimes with powerful parts of society and water resources in general. In my opinion the threats with civil disobedience are possibly part of Mexican (or any other) culture, but need to be taken seriously.

The threats express the shortcomings of the Council in which farmers only have little voice. Especially while CNA circumvented the Council as a decision making platform for inter-sectoral water allocations with the two latest unilateral decided water transfers. The authority of CNA is not only challenged by state authorities as Contijoch states, but also by farmer representatives and their constituencies, which can be quickly mobilized and manipulated by half truths. Wester *et al.* (2005a) mentioned that certain farmer representatives already in 2001 as an alternative to GTEPAI collaboration have vowed that not a single drop of water would be passed to Lake Chapala as in October 1999 and that they have threatened with civil disobedience if CNA would repeat the transfer of water. Although the occupation of the CNA office in Celaya, Guanajuato was quite peaceful (**Figure 4-1**; page 67), this protest was a disobedient reaction to the latest transfer. Mostly in the state of Guanajuato farmer representatives and local politicians were discussing their manners of protest and fortunately more drastic forms of protests than the occupation of the office and illegal transmit of transfer water to Lake Yuriria instead of Lake Chapala didn’t find enough support.

Wester and Warner (2002) call IRBM and stakeholder participation the twin planks of a new consensus on how water should be managed. The authors point out that assumptions on scale, boundaries, appropriate institutions and procedures underlying this new model are, however, not as self-evident as they seem, but outcomes of socio-political choices. The transfer of water from mainly the upstream Solis Dam towards Lake Chapala is a clear example of a political choice, based upon contested assumptions. Especially this transfer of water from the agricultural to the urban, industrial, environmental or ‘real-estate’ sector is ‘a substantial threat to irrigation with grave implications for social equity and agricultural productivity'. (Wester and Warner, 2002) The reaction of WUAs presidents in 2000 to join forces and start the GTEPAI is in the light of the continuous difficulties with IRBM and stakeholder participation still a viable alternative to civil disobedience.

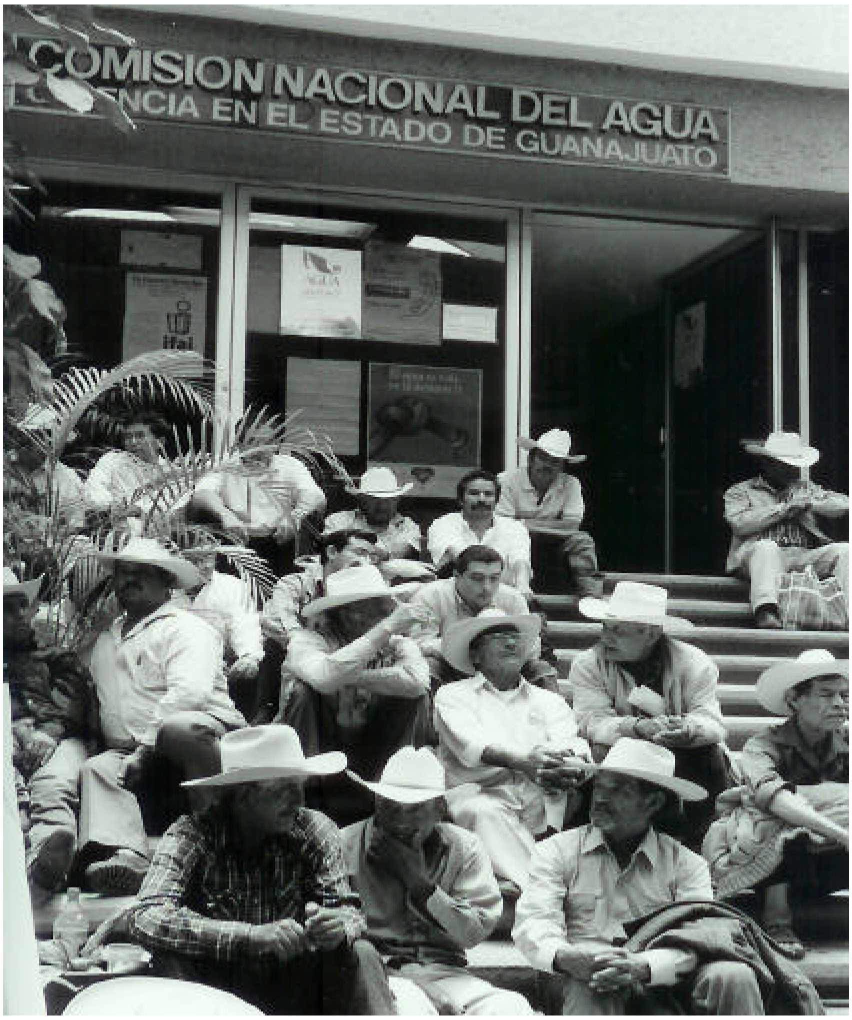


Figure 4-1: Farmer occupation of the CNA office in Celaya, Guanajuato. (Picture taken by Jaime Hoogesteger van Dijk)

4.2 The Importance of the GTEPAI

The GTEPAI can be seen as a result from farmer concern, political collaboration and market exploration, despite water scarcity. These ingredients mainly determined the innovative initiative that officially started by the end of 2000 and came to an end exactly two years later. During this period the GTEPAI has developed a workable concept for agricultural production aiming at sustainable resource management in various aspects. The GTEPAI did nevertheless not survive the processes of political contest over surface water in the Council. Another reason for its ending is the lack of money to support the initiative which is directly linked to political choices.

Monsalvo (1999) and Kloezen (2000) show how WUAs can be important forms of political capital for their leaders. Also the formation of the farmer-run SRL in Guanajuato is viewed as a strategy to protect the interests of large landholdings and form a pressure group in the negotiations of the RBC, by Romero Pérez and Mollard (2003). The GTEPAI and SRL attempts to better represent farmers' interests in the Council generally can be seen as bottom-up answers to political RBC affairs, dominated by the authoritarian hydrocracy. The GTEPAI achieved the development of a productive planning concept in which less water was used in the IDs. It was not effective in ensuring its continuation and therefore did not realize long lasting institutional viability from a sustainable water management perspective. Based upon IMT induced processes and programs, GTEPAI on the other hand has proven that rapid organization of farmers is an important mechanism in the basin, with promise for 'the other half' of the agricultural sector.

Especially for the *unidades de riego* the organization of farmers and development of a similar concept is a realistic challenge. In particular all efforts that state authorities put in the development of COTAS[22] and URDERALES could be combined on different levels. The organization of the groundwater users and irrigation units is of utmost importance from a water saving perspective, but moreover from an economical perspective, since Mexico has to deal with the consequences of the North American Free Trade Agreement. Not only have prices for basic grains fallen, due to the agreement, but especially poorer farmers can not pay for increased groundwater costs (Wester *et al.*, 2005a). Scott and Silva-Ochoa (2001) put emphasis on the importance of crop diversification and relate a dispersed nature, relatively small size and suitability under resource-poor conditions to it, in order to show the potential of the *unidades*. According to Scott and Silva-Ochoa (2001), WHIs in addition are not 'likely to attract significant external support or imposed management, but they do offer considerable potential for poverty eradication (Van Koppen 1998) and equitable resource access (Merrey 1997).' The GTEPAI functions as an example of how the potential in the basin can be implemented by efficiently using available networks and resources.

Besides the contested management of surface water in the Basin, representation, organization and regulation of groundwater users and Irrigation Unit farmers need to improve from a sustainable water management perception. Wester, Merrey and de Lange (2003) explain why Mexico has not felt it necessary to consider the significant numbers of rural poor who are voiceless, and facing 'water deprivation' and to invest in social mobilization for the establishment of RBCs. They point out that this social mobilization is especially relevant for farmers in the irrigation units who depend on surface (and derivative) water.

According to del Conde (2001) farmers with landholdings smaller than 5 ha generally can either take the risk of cultivating at a maximum profit of $3,000 MP/ha under the best scenario, or rent their plots at $2,000 MP/ha. The insecure and low incomes translate in minimum financial capacity to invest in new production opportunities and water management styles (del Conde, 2001). The psychological effect of low expectancy to farming is not known, but besides the emigration from rural areas, GTEPAI notified social discontent, deteriorated quality of life and a perceived import of drugs, aids and violence into the culture.

Wealth differences can be extremely large in Mexico and have major implications on the governance of water. Bardhan and Dayton-Johnson (2002) explain the relation of heterogeneity in three dimensions to wealth differences. The first dimension to heterogeneity is inequality of wealth and power within a community and a second heterogeneity may be observed in the division of labor. A third dimension of inequality might be called socio-

[22] The COTAS are not described in this chapter, because they have not proven to function yet.

cultural heterogeneity, which is illustrated by the Jalisco-Guanajuato conflicts, but may also be classified as typical head-end/tail-end heterogeneity. According to Bardhan and Dayton-Johnson (2002), inequality that may favor provision of collective goods can justifiably be called an 'Olson effect'. According to the authors, Olson's hypothesis suggests that inequality is beneficial to successful irrigation management. Olson (1965: 34) more or less anticipated what happened during the GTEPAI initiative;

> In (smaller) groups marked by considerable degrees of inequality – that is, in groups of members of unequal 'size' or extent of interest in the collective good – there is the greatest likelihood that a collective good will be provided; for the greater the interest in the collective good of any single member, the greater the likelihood that that member will get such a significant proportion of the total benefit from the collective good that he will gain from seeing that the good is provided, even if he has to pay all of the cost himself.

In consistence with the findings of Monsalvo (1999) and Kloezen (2000), IMT produced WUAs in which 'some community members specialized in political leadership, which facilitates community projects' as Bardhan and Dayton-Johnson (2002) explain the second heterogeneity. Raúl Medina de Wit, GTEPAI leader, president of the Lake Chapala Watershed Commission and representative of the agricultural sector (between May 1999 and June 2003), put great effort (labor and energy) in leading the rather large aggregation of District farmers in the Basin. The 'significant proportion of the total benefit from the collective good' is best illustrated by Raúl's struggle for the development of organic agriculture in Mexico. Such leadership and commitment may be essential to collective action, but the representation of collective interests is delicate or even impossible in a basin that is politically bigger than its geographical boundaries.

The importance of the GTEPAI can be compared with its effectiveness. Like efficiency (Seckler, 1996), also effectiveness and importance are subjective and 'tricky' concepts. The effectiveness and importance of the GTEPAI go beyond its lifespan of three years within the Lerma-Chapala River Basin context. GTEPAI can be seen as a clear example of Mexican potential to further develop integrative water management as well in practice as in theory. How the RBC will deal with such management development depends in Mexico very much on the flexibility of the CNA to cope with innovative water management styles and devolution of power.

4.3 The Role of CNA

Altogether the Lerma-Chapala River Basin Council, with its deficiencies and opportunities, can play an important role realizing further decentralization and better management of water resources. Although GTEPAI did not sustain, the concept holds more promise than the actual discussions in the basin's COTAS. Multi-stakeholder integration and collaboration can be an important mechanism to reduce water use, but these reductions should make sense. First of all it does not help if water savings are not recognized and water transfers not broadly agreed upon. Secondly water use reductions are not necessarily water savings and surface water use reductions might easily harm the recharge of aquifers. In the third place water export should be reconsidered, since large landholdings that depend on large groundwater extractions produce for export. The vegetables exports are indirect exports of water that is not accessible to the poorest. Gradual increases in electricity prices for pumping can partly regulate this lucrative business for the richest.

Beside the representation of interests, stakeholder participation and reduction of agricultural water use, while safeguarding productivity, there is an additional important challenge that still stands out. The poor technical and economical performance of water treatment utilities needs to be greatly improved (CNA, 1999e). Wester *et al.* (2000) quite rightly mention that water (over-)exploitation in a closing river basin results in a complex interplay among declines in water quality.

Nonetheless the outcome of this complex interplay is less complex. In general water quality is poor in the basin and not well enough dealt with. CNA and IMTA (2002) classified 52% of twenty monitored water bodies in the basin as polluted or heavily polluted. Only 9% of the monitored water bodies received an acceptable water quality classification, which means that the water is suitable for human consumption after conventional treatment. Also groundwater quality continues to deteriorate due to rapid transport of industrial contaminants and increased use of fertilizer and pesticides in agriculture (Scott and Garcés-Restrepo, 2001). CNA and IMTA (2002) demonstrate a biased view on the degradation of water quality; Lake Chapala is seen as purifying water body through its mineralization of bio-degradable contaminants. In addition the Lake functions as a capture of heavy metals and prevents them from confluence with drinking water for the ZMG. Water is also considered to be '*apta para usos industriales*' (suitable for industrial uses) instead of polluted when derived from these industrial uses. Nonetheless CNA and IMTA (2002) observe that occasional industrial water treatment before discharge in the River Lerma has the objective to increase water availability by re-use, instead of improving water quality.

Such indifferent observations and position are quite typical for CNA and demonstrates again the danger of a '*laissez faire- laissez passer*' approach in practice. CNA as guardian of the nation's water resources is typically not the appropriate institute to include concerns of voiceless and poor people in river basin water management, despite mandatory stakeholder representation by law. Whether actual or innovative institutions will be able to deal with most urgent water management affairs in a comprehensive, legitimate and less biased way is not easy to predict. Important lessons can however be drawn from the GTEPAI experience. Although GTEPAI responds to most ambitious dreams of many policy makers in developing countries, the initiative is not accorded such significance in Mexico. The recognition of GTEPAI as an important 'spontaneous' side-effect of water reforms can make these reforms more valuable. The GTEPAI indicates certain dimensions of greater integration and central decision-making that were needed to achieve a more holistic approach to river basin management (Mody, 2001; see page 66). Therefore the 'I' in GTEPAI denotes the most important intention of the participants in the initiative, which is greater integration, regardless of great differences that exist. The lesson that can be drawn from this initiative I like to phrase in a question that might serve as an untimely reconsideration;

'What will happen, when you really meet your objectives?'

Although I did not ask Raúl exactly this question, he replied the following answer to my question about his feelings with reference to the ending of the GTEPAI;

'You have to accept that the process of achieving the objectives of an organization, transform the organization and its objectives. The organization is flexible and dynamic and you should not stick with the main objectives when those are for the most part achieved'.

Especially with the actual recovery of Lake Chapala in quantitative terms, it might be the right moment for the CNA to reflect on its role in the Council and reconsider certain bias.

While surface water allocations will continue contested between users, uses or different states and cultures, water quality is their common concern. It is CNA's task to manage both water qualities as water quantities in a flexible way and unravel its own dogmatic thinking. Real and further devolution of CNA tasks should be continuously explored, which means that CNA has to go back over its responsibility to define the country's water policies and responsibility to allocate water to users through licenses and permits repeatedly. The optimistic expectations of a 'new IMT induced water culture' (Svendsen *et al.*, 1997 and Rap *et al.*, 2004) based on the efficient use of water, need moderation. Changing conventional technocratic thinking and altering top-down dominance by CNA institutes and employees are more realistic objectives in realizing 'a new water culture'. How water management evolves in the Basin and in the country depends first and foremost on the professionalism of the CNA as guardian of the nation's water resources. The willingness of farmers (and other actors) to put forward comprehensive projects to make water free for other use from the agricultural sector, may however be severely endangered. CNA scarcely recognizes surface water savings and does not compensate for transferred surface water and related inundations. Instead of supporting the construction of initially fragile, but promising farmer-run initiatives, CNA trusts in its control over large dams, diverse technification of all irrigated agriculture and inter-sectoral and inter-basin water transfers to suffice growing water demands.

References

Anon (1997). Ley de Aguas Nacionales, su Reglamento y Ley Federal del Mar. Delma, 4th edition. México.

Bardhan P and Dayton-Johnson J (2002). Inequality and the Governance of Water Resources in Mexico and South India. Revised version of a paper prepared for the workshop 'Economic Inequality, Collective Action and Environmental Sustainability', held at the Santa Fe Institute, September 2001.

Boelens R, Hazeleeger B and Vos J (2001). Developments in Irrigation from the Perspective of Integrated Water Resources Management. An Exploration of Topics and Institutions. In IRC Reference Guide on Water Resource Management.

Camp R (1999). Politics in Mexico: the Decline of Authoritarianism. , Oxford University Press, New York.

CCCLC (Consejo Consultivo de Evaluación y Seguimiento del Programa de Ordenación y Saneamiento de la Cuenca Lerma-Chapala) (1991). Acuerdo de Coordinación de Aguas Superficiales. Colección Lerma-Chapala Vol. 1 No. 5. Queretaro, Mexico: CNA.

CCPLCh (Comisión de la Cuenca Propia del Lago Chapala) (2001). Participación Ciudadana en Gestión del Agua. Medina de Wit R. (ed.). La Barca, Jalisco, Mexico.

CEAG (1998). Estudios Hidrológicos y Modelos Matemáticos de los Acuíferos del Estado de Guanajuato. CEAG, Guanajuato, México.

CEAG (1999). Estudios Hidrológicos y Modelos Matemáticos de los Acuíferos del Estado de Guanajuato. CEAG, Guanajuato, México.

CEAG (2000). Estudios Hidrológicos y Modelos Matemáticos de los Acuíferos del Estado de Guanajuato. CEAG, Guanajuato, México.

CEAG (2001a). Actualización de los Balances de los Estudios Hidrológicos y Modelos Matemáticos de los Acuíferos del Estado de Guanajuato. CEAG, Guanajuato, Guanajuato, México.

CEAG/MS (2001b). Participación Social para la Gestión Integral del Agua en Guanajuato. Montoya Suárez J. (ed.). CEAG, Guanajuato, México.

CEAG (2003). User participation in Groundwater Management in Mexico: The Technical Water Users Councils (COTAS) in Guanajuato State. Guanajuato, Mexico.

CEAG/FGK (2004). The COTAS Progress with Stakeholder Participation in Groundwater Management in Guanajuato, Mexico. Foster S. Garduño H. and Kemper K. (eds.). Guanajuato, Mexico.

CEASJ (Comisión Estatal de Agua y Saneamiento Jalisco) y Instituto de las Américas (2003). Ponencia; Cuenca Lerma-Chapala y Guadalajara. Lugo Arias F T (ed.) Mexico D.F. Mexico.

CEHGTO (Comisión Estatal Hidráulico Guanajuato) (2003). Problematica de la Participacion Social en el Consejo de Cuenca Lerma-Chapala, Mexico. Navarrete Ramírez A. (ed.). II Encuentro de Investigadores del Agua en la Cuenca Lerma-Chapala. Chapala, Jalisco, Mexico.

Claverán Alonso R (2000). Panorámica de la Labranza de Conservación en México y América Latina. INIFAP - CENAPROS

CNA (1993). Plan Maestro de la Cuenca Lerma-Chapala. Documento de Referencia, CNA, Mexico City.

CNA (1998a). Lineamientos Estrategicos Region Lerma-Santiago-Pacifico Diagnóstico de la Situación Actual. Cuenca del Rio Lerma. Gualberto Limón J. (ed.). CNA, Gerencia Regional Lerma-Santiago-Pacífico. Mexico.

CNA/CP (1998) (Comisión Nacional del Agua/ Colegio de Postgraduados). Diagnostico preliminar sobre Superficies Regables y Volúmenes Requeridos en las Unidades de Riego Organizadas y sin Organizar. Montecillo, Estado de México. CNA, Subdirección General de Operación, Coordinación de Uso Eficiente del Agua y la Energía Eléctrica.

CNA and SEMARNAP (1998). Los Consejos de Cuanca en México, Definiciones y Alcances. Unidad de Programas Rurales y Participación Social, Coordinación de Consejos de Cuenca, México.

CNA (1999a). El Consejo de Cuenca Lerma-Chapala 1989-1999. 10 Años de Trabajo en Favor de la Gestión Integral y Manejo Sustentable del Agua y de los Recursos Naturales de la Cuenca. CNA, Guadalajara. Mexico. In; Wester, Burton and Scott (2005a).

CNA (1999b). Ley de Aguas Nacionales y su Reglamento. CNA, Mexico City. In; Wester, Burton and Scott (2005a).

CNA (1999c). Volumenes Maximos de Extracción de Agua Superficial para los Sistemas de Usuarios de la Cuenca Lerma-Chapala. Ciclo noviembre 1999 - octubre 2000. Boletin No. 9. Mexico: CNA.

CNA (1999d). Diagnóstico regional. Proyecto Lineamientos Estratégicos para el Desarrollo Hidráulico de la Región Lerma-Santiago-Pacífico. Comisión Nacional del Agua (CNA). Gerencia Regional Lerma-Santiago-Pacífico. Guadalajara, Mexico: CNA.

CNA (1999e). Regional Vision North America (Mexico). Mexico City, Mexico: CNA. In; Wester, Burton and Mestre (2000).

CNA/MW (1999), Proyecto Lineamientos Estratégicos para el Desarrollo Hidráulico de la Región Lerma-Santiago-Pacifico. Diagnostico Regional, CNA, Montgomery Watson (ed.). Guadalajara, Mexico.

CNA (2000a). Reglas de Organización y Funcionamiento de los Consejos de Cuenca. Mexico City, Mexico: CNA.

CNA (2000b). Congreso Internacional de Transferencia de Sistemas de Riego: Programa. Mazatlan, Abril 2-9 (hojas de promoción). In; Garcés-Restrepo (2001).

CNA. (2000c). Actualización de las Bases y Procedimientos para el Cálculo de la Disponibilidad y Distribución de las Aguas Superficiales. CNA, VIII Gerencia Regional Lerma-Santiago-Pacífico, Mexico.

CNA (2000d). Volumenes Maximos de Extracción de Agua Superficial para los Sistemas de Usuarios de la Cuenca Lerma-Chapala. Ciclo noviembre 2000 - octubre 2001. Boletin No. 10. Mexico: CNA.

CNA (2001a). Programa Hidráulico de Gran Visión Región Lerma 2001-2025. Zaragoza M.A. (ed.). Plan Maestro. Mexico: CNA.

CNA (2001b). Volumenes Maximos de Extracción de Agua Superficial para los Sistemas de Usuarios de la Cuenca Lerma-Chapala. Ciclo noviembre 2001 - octubre 2002. Boletin No. 11. Mexico: CNA.

CNA (2002). Volumenes Maximos de Extracción de Agua Superficial para los Sistemas de Usuarios de la Cuenca Lerma-Chapala. Ciclo noviembre 2002 - octubre 2003. Boletin No. 12. Mexico: CNA.

CNA and IMTA (2002). Estudio Técnico para la Reglamentación de la Cuenca Lerma-Chapala. CNA, Mexico.

CNA and SEMARNAT (2003). Programa Especial Cuenca Lerma-Chapala 2003; Cuidar el agua para un dulce futuro. CNA, VIII Gerencia Regional Lerma-Santiago-Pacífico, Mexico.

Comité de Usuarios de Riego, Lerma-Chapala (2002). Vocalia Uso Agrícola Consejo de Cuenca Lerma-Chapala Plan de Trabajo. Medina de Wit R. (ed.), Mexico.

Contijoch M (2003). A Solution and an Opportunity in Mexico toward an Interdisciplinary and Integrated Approach to Agricultural Drainage. The World Bank, Agriculture and Rural Development Working Paper 12. Washington, DC. United States of America.

Dayton-Johnson J (1999). Irrigation Organization in Mexican Unidades de Riego;
Results of a field study. Irrigation and Drainage Systems 13: 55–74. Kluwer Academic Publishers, the Netherlands.

DDR (Distrito de Desarrollo Rural de Jalisco) (2000). Sustitución del Cultivo de Trigo por Cultivos de Menor Demanda de Agua, en la Región Ciénega de Chapala. Nota Informativa; Lomelí López J. de J. (ed.). Guadalajara Jalisco.

de Anda J, Quiñones-Cisneros S E, French R H and Guzmán M (1998). Hydrologic Balance of Lake Chapala (Mexico). Journal of the American Water Resources Association. 34(6): 1319–1331.

de Janvry A, Gordi1lo G and Sadoulet E (1997). Mexico 's second agrarian reform: Household and Community Responses, 1990-1994. San Diego: Center for US-Mexico Studies, University of California.

del Conde O (World Bank Consultant) (2001). Estrategia de Modernización del Manejo del Agua en el Bajo Lerma (project document; unpublished draft).

Espinosa de Leon and Trava Manzanilla J L (1992). Transferencia de los Distritos de riego a los usuarios. Paper presented at the ICID (Comisión Internacional de Irrigacion y Drenaje) Tercera Conferencia Regional Panamericana, Mazátlan, Sinaloa, Mexico.

FAO (1994). La agricultura de riego en México, Proyecto UTC/MEX/030/MEX EL-08-94, Documento Técnico No. 8. Food and Agriculture Organization, Rome.

Flores-López F J and Scott C A (2000). Superficie Agrícola estimada mediante Análisis de Imágenes de Satélite en Guanajuato, México. IWMI, Serie Latinoamericana No. 15. México, D.F., México: Instituto Internacional del Manejo del Agua.

Fox Quesada V (2002). Versión estenográfica de las palabras del licenciado Vicente Fox Quesada, Presidente Constitucional de los Estados Unidos Mexicanos, durante el acto inaugural de la XIII Convención del Mercado de Valores. Mexico D.F., Mexico. (www.bmv.com.mx)

Garcés Restrepo C (2001). Irrigation Management Devolution in Mexico. INPIM, FAO: International E-mail Conference on Irrigation Management Transfer.

Gorriz C, Subramanian A and Simas J (1995). Irrigation Management Transfer in Mexico: Process and progress. Washington, D.C: World Bank Technical Paper No. 292.

Groenfeldt D and Sun P (1997). Demand Management of Irrigation Systems through Users Participation. In: Water: Economics, Management, and Demand. E. & F.N. Spon, London, U.K., pp. 304-312

GTEPAI (2000). Sesión de Instalación y 1ª Reunión de Trabajo; 1ª. Relatoría. Monsalvo-Velázquez G (ed.). Mexico City, Mexico.

GTEPAI (2001). Propuesta de Reglamento de Trabajo; 2ª Reunión. Salamanca, Guanajuato, Mexico.

GTEPAI y Comisión de la Cuenca Propia del Lago Chapala-AC (2002a). Planeación Agrícola Integral Cuenca Lerma-Chapala. Salamanca, Mexico.

GTEPAI y Comisión de la Cuenca Propia del Lago Chapala-AC (2002b). Resultados de la Planeación Agrícola Integral en la Cuenca Lerma-Chapala Ciclo Agrícola 2001/2002. Medina de Wit R. (ed.).

Guerrero V (1998). Participación Social en el Aprovechamiento Sustentable de las Aguas Subterráneas - El caso de Guanajuato, Pp. 33–42 in Memoria del Simposio Internacional de Aguas Subterráneas, 7–9 December 1998. León, Guanajuato, Mexico.

Hardin G (1968). The Tragedy of the Commons. Science, 162(1968):1243-1248

Hoogesteger van Dijk J D (2004). The Underground; Understanding the Failure of Institutional Responses to Reduce Groundwater Exploitation in Guanajuato. MSc Thesis Irrigation and Water Engineering Group, Wageningen University, Wageningen.

IEE (Instituto Estatal de Ecología) (2000). Informe Ambiental del Estado de Guanajuato.

Johnson III S H (1997). Irrigation Management Transfer in Mexico: A Strategy to Achieve Irrigation District Sustainability.

Johnson III S H (2002). Irrigation Management Transfer: Decentralizing Public Irrigation in Mexico. Water International, 22 (3), September, 159-67. 437:9. in; Water Resources and Economic Development, Maria Saleth R (Ed.).

Katz E (1999). Mexico: Gender and Ejido Reform. World Bank, Washington, D.C.

Kloezen W H, Garcés Restrepo C, and Johnson III S H (1997). Impact Assessment of Irrigation Management Transfer in the Alto Rio Lerma Irrigation District, Mexico. IIMI Research report No.15. Colombo, Sri Lanka: International Irrigation Management Institute.

Kloezen W H, Garcés-Restrepo C (1998). Assessing Irrigation Performance with Comparative Indicators. The case of the Alto Rio Lerma Irrigation District, Mexico. IWMI Research Report 22. Colombo, Sri Lanka: International Water Management Institute.

Kloezen W H (2000). La Viabilidad de los Arreglos Institucionales para el Riego después de la Transferencia del Manejo en el Distrito de Riego Alto Río Lerma, México. IWMI , Serie Latinoamericana No.13. México, D.F., México: Instituto Internacional del Manejo de Agua.

Marañón Pimentel B (2001). La Agricultura de Contrato en el Sector Hortícola Exportador en El Bajío, México. Oficina Regional de la FAO para América Latina y el Caribe. México, D.F., Mexico.

Merrey D J (1997). Expanding the Frontiers of Irrigation Management Research. Results of Research and Development at the International Irrigation Management Institute, 1984 to 1995. Colombo, Sri Lanka: International Irrigation Management Institute.

Mestre E (1997). Integrated approach to River Basin Management: Lerma-Chapala case study; attributions and experiences in Water Management in Mexico. Water International. 22(3): 140–152.

Micklin M (1973). Population, Environment and Social Organization: Current Issues in Human Ecology. Hinsdale (III.). Dryden Press.

Mody J (2001). Management of River Basin Systems Through Decentralization. www.lnweb18.worldbank.org

Molden D, Sakthivadiel R and Samad M (2000). Accounting for Changes in Water Use and the Need for Institutional Adaptation. In Abernethy (Ed.) 2000. Intersectoral Management of River Basins. International Water Management Institute (IWMI), Sri- Lanka.

Mollard E and Romero Pérez R (2003). Las Sociedades de Responsabilidad Limitada ¿Un Espacio de Representación de Interés Agro-empresarial? XII Congreso Nacional de Irrigación. Centro de Ferias y Exposiciones de la Ciudad de Zacatecas, México.

Mollard E and Vargas Velázquez S (2003). La Politización del Agua en la Consejo de Cuenca Lerma-Chapala: En el Contexto de la Reforma a la Ley de Aguas Nacionales en 2003. 4° Congreso de la AMER, Morelia, Mexico.

Molle F (2002). Development Trajectories of River Basins: A Conceptual Framework. IWMI Research Paper; Draft. IWMI. Colombo, Sri Lanka: International Water Management Institute.

Molle F (2003). River Basin Development: a Framework for Case Studies (draft 4). 12 pages. IWMI Research Paper; Draft. IWMI. Colombo, Sri Lanka: International Water Management Institute.

Mollinga P (1997). Water Control in Socio-technical Systems: a Conceptual Framework for Interdisciplinary Studies. Lecture notes; Course Irrigation and Development, IWE, 2002. Wageningen: Wageningen University, the Netherlands.

Mollinga P (1998). On the Waterfront: Water Distribution, Technology and Agrarian Change in a South Indian Canal Irrigation System. Ph.D. Thesis Wageningen: Wageningen Agricultural University.

Monsalvo G and Wester Ph (2003). Por un Manejo Integral, Sostenible y Equitativo de la Cuenca Lerma-Chapala, México. Universidad Iberoamericana, León y Consejo de Ciencia y Tecnología de Guanajuato. Guanajuato, México.

Navarrete Ramírez A (2002). Problemática de la Participación Social en el Consejo de Cuenca Lerma-Chapala, México. PowerPoint (Computer) Presentation. Chapala, Jalisco, México: CEH.

UNAM (Universidad Nacional Autónoma de México) (2000). Proyecto para el Manejo Sustentable del Agua Subterránea en la Cuenca de la Independencia, municipios de San José Iturbide, Dr. Mora, San Luis de la Paz y Dolores Hidalgo, San Miguel de Allende y San Diego de la Unión, Gto. 100 planos a color. Instituto de Geología, Universidad Nacional Autónoma de México (UNAM). Ortega-Guerrero, M.A. (ed.). México, DF.

Palacios-Vélez E (1997). Las Unidades de Riego o Pequeña Irrigación. In Antología sobre Pequeño Riego. Vol. I, Martínez-Saldaña T. and Palerm-Viqueira J (eds.). Montecillo, Mexico: Colegio de Postgraduados.

Palerm-Viqueira J (2004). Irrigation Institutions Typology and Water Governance through Horizontal Agreements. Reference Number: 608a. Colegio de Postgraduados, Mexico.

Patrón Castro R (1999). Centro de Capacitación Benito Juárez. Centro Nacional de Transferencia de Tecnología de Riego **y** Drenaje (CENATRYD), Revista ANUR A.C.

Rap E, Wester Ph and Pérez-Prado L N (2004). The Politics of Creating Commitment: Irrigation Reforms and the Reconstitution of the Hydraulic Bureaucracy in Mexico. In P.P.

Mollinga and A. Bolding (eds.). The Politics of Irrigation Reform. Contested Policy Formulation and Implementation in Asia, Africa and Latin America. Ashgate Publishers, Aldershot and Burlington, pp. 57-94.

Rodríguez Ríos J (2001). La Dotación Volumétrica en el Distrito de Riego 011 Alto Río Lerma Guanajuato. XI Congreso Nacional de Irrigación. Simposio 6. Distribución, Medición y Entrega Volumétrica del Agua. Guanajuato, Guanajuato, México.

Röling N (2002). Beyond the Aggregation of Individual Preferences. Moving from Multiple to Distributed Cognition in Resource Dilemmas. In; Leeuwis and Pyburn (eds.), Wheelbarrows Full of Frogs. Social Learning in Rural Resource Management, Koninklijke Van Gorchum, Assen, pp. 25-47.

SAGAR (2001). La Organizacion Social para la Planeacion de la Administracion de la Cuenca Lerma-Chapala.

SAGARPA/CT (2002). Ley de Seguridad Agropecuario e Inversión Rural 2002 (Farm Bill). Celaya del Toro V (ed.). México D.F. Mexico.

Scott C A and Silva-Ochoa P (2001). Collective Action for Water Harvesting Irrigation in the Lerma-Chapala Basin, Mexico. International Food Policy Research Institute (IFPRI), Washington, DC. Series: CAPRI Working Paper, no. 20.

Scott C A and Flores-López F J (2001). Water Productivity Estimates of Primary Withdrawals and Water Recycling in the Lerma-Chapala Basin, Mexico. Unpublished paper

Scott C A and Flores-López F J. (undated). Manuscript in preparation. The 'Bordería' Water Harvesting System: Evaporation and Infiltration Tradeoffs at a Watershed Scale.

Scott C A and Garcés-Restrepo C (2001). Conjunctive Management of Surface Water and Groundwater in the Middle Rio Lerma Basin, Mexico. In A.K. Biswas and C. Tortajada (eds.). Integrated River Basin Management: The Latin American Experience, Oxford University Press, New Delhi, pp. 176-198.

Scott C A, Shah T and Buechler S (2003). Energy Pricing and Supply for Groundwater Demand Management: Lessons form Mexican Agriculture. www.iwmi.cgiar.org/iwmi-tata; IWMI. Colombo, Sri Lanka: International Water Management Institute.

Seckler D (1996). The New Era of Water Resources Management: From 'Dry' to 'Wet' Water Savings. Research Report No.1. Colombo, Sri Lanka: International Irrigation Management Institute (IIMI).

SEMARNAT (2001). Documento Base del Programa para la Sustentabilidad de la Cuenca Lerma-Chapala. SEMARNAT: Mexico.

Silva-Ochoa P, Quijada-Uribe G, Monsalvo-Velázquez G and Ramírez-Calderón J (2000). Unidades de Riego: La Otra Mitad del Sector Agrícola Bajo Riego. IWMI, Serie Latinoamericana No. 19. México, D.F. México: Instituto Internacional del Manejo del Agua. International Water Management Institute.

SRL Guanajuato (2001). Distrito de Riego 011 Alto Río Lerma Guanajuato. Productores Agrícolas de los Módulos del Distrito de Riego 011 Alto Río Lerma. Salamanca, Guanajuato México.

SRL Guanajuato (2002). Distrito de Riego 011 Alto Río Lerma Guanajuato. Productores Agrícolas de los Módulos del Distrito de Riego 011 Alto Río Lerma. Salamanca, Guanajuato México.

Svendsen M, Trava J and Johnson III S H (1997). Participatory Irrigation Management: Benefits and Second Generation Problems. Lessons from an International Workshop held at CIAT, Cali, Colombia, 9-15 February 1997. Economic Development Institute of the World Bank, Washington, DC.

Tortojada C (2001). Capacity Building for the Water Sector in Mexico: An Analysis of Recent Efforts. IWRA, International Water Resources Association. Third World Centre for Water Management, Atizapan, Estado de Mexico, Mexico. Water International, Volume 26, Number 4, pages 490-498, December 2001

Trava J (1994). Transfer of Management of Irrigation Districts to WUAs in Mexico. In: Indicative action plan and proceedings of the national seminar on Farmers' Participation in Irrigation Management. Groenfeldt (ed.) Aurangabad, Maharashtra, India: Water and Land Management Institute (WALMI).

Trueba Coronel S (2002). Proyecto Michoacán-Chapala/2002. Universidad Autónoma Chapingo. México-Texcoco. Mexico.

Ujjankop S R (1995). Mexican Model of Participatory Management and its applicability in our context. Paper presented in the workshop on Land and Water, Bangalore, India, December 7-8, 1995.

Uphoff N. (1986). Improving international irrigation management with farmer participation. Getting the process right. Studies in Water Policy and Management, No.11. Westview Press, Boulder. London.

Urban K, Wester Ph and Kloezen W H (2000). Institutional Analysis of Maintenance Service Provision in the Alto Rio Lerma Irrigation District, Mexico. Maintain-Discussion paper on case study No.6. Eschborn, Germany: IWMI-GTZ.

Van Koppen B (1998). More Jobs per Drop: Targeting Irrigation to Poor Women and Men. Amsterdam, The Netherlands: Royal Tropical Institute KIT.

Vermillion D L (1997). Impacts of Irrigation Management Transfer: A Review of the Evidence.

Wester Ph, Burton M and Mestre-Rodríguez E (2000). Managing the Water Transition in the Lerma-Chapala Basin, Mexico. In Abernethy (Ed.) (2000). Intersectoral Management of River Basins. Page 161-182. International Water Management Institute (IWMI), Sri- Lanka

Wester Ph and Warner J (2002). River Basin Management reconsidered. Chapter 4 in Turton, A R and Henwood R (Eds.) Hydropolitics in the Developing World: A Southern African Perspective, African Water Issues Research Unit (AWIRU).

Wester Ph, Merrey D J and de Lange M (2003). Boundaries of Consent: Stakeholder Representation in River Basin Management in Mexico and South Africa. in World Development,Volume 31, Issue 5 , May 2003, pp797-812.

Wester Ph, Burton M and Scott C.A (forthcoming; to be published in 2005a). River Basin Closure and Institutional Change in Mexico's Lerma-Chapala Basin. Chapter 9 of the IWMI Book on River Basin Management. IWMI. Colombo, Sri Lanka: International Water Management Institute.

Wester Ph, Hoogesteger van Dijk J D and Paters H (forthcoming; to be published in 2005b). Multi-Stakeholder Platforms for Surface and Groundwater Management in the Lerma-Chapala Basin, Mexico. Draft forthcoming

Wittfogel K (1957). Oriental Despotism: A Comparative Study of Total Power. New Haven. Connecticut, Yale University Press.

World Bank (1991). Mexico Irrigation and Drainage Project. Staff Appraisal report. Report No. 9779-ME. Washington, D.C.: World Bank

Internet References

CONAPO (Consejo Nacional de Población) (2000). www.conapo.gob.mx

RBI (River Basin Initiative) (2001). www.riverbasin.org

SAGARPA and SENER (2002). www.sagarpa.gob.mx/cgcs/boletines

IMTA (Instituto Mexicano de Tecnología del Agua) www.imta.mx (www.imta.mx/otros/comer/page3.html)

INEGI (Instituto Nacional de Estadística, Geografía e Información) (2003). México. www.inegi.gob.mx

'Investigación y Desarrollo' (Research and Development): Monthly science and technology supplement of the journal 'La Jornada'. www.invdes.com.mx

US department of Commerce 2004 www.stat-usa.gov