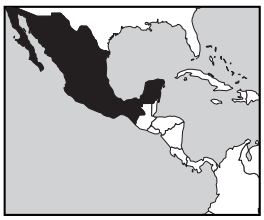

Guadalajara's water crisis and the fate of Lake Chapala: a reflection of poor water management in Mexico

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SUMMARY: This paper describes the water crisis faced by the city of Guadalajara with the drying up of its main source of water, Lake Chapala. This drying up of Mexico's largest lake will cause far-reaching economic and ecological consequences for the extended region. The paper also examines the underlying causes, which are centred on the inadequate and unsustainable management of the Lerma-Chapala river basin (that extends over five states). It looks at the innovative, although as yet insufficient, institutional response towards integrated sustainable water management in Mexico, which centres on a shift from centralized water management at the federal level to a multi-stakeholder and participative system based in river basins, and reflects on the current challenges posed.

I. INTRODUCTION

GUADALAJARA, MEXICO'S SECOND largest city, is facing a water crisis. Scarcity is the greatest threat and it is the urban poor who suffer most, with inadequate provision and by being the target of rationing through the state utility. This situation can only get worse as physical water scarcity grows. Lake Chapala is Mexico's largest lake and has been an important water source for Guadalajara for the last 50 years. It is of great ecological value as well as being important for the socioeconomic development of a large region. However, it is facing its most severe crisis in a century and prospects for the future are not very promising.

The lake's future lies in the management of the Lerma–Chapala river basin to which it belongs. In the 1980s, the river basin reached "closure", whereby demand for water outstripped capacity to replenish, and its condition is now critical. The overall water crisis in the region on which this paper focuses led to a transformation in water management in Mexico. In just one decade, Mexico has made important institutional reforms to decentralize water management and to broaden the participation of stakeholders in the decision-making processes. The creation of the river basin institutions[1] throughout the Mexican territory is central to the reform, and has allowed substantial progress towards decentralized and participatory management. In particular, the Lerma–Chapala basin council, which has responsibility for one of the most important river basins and whose situation is certainly the most critical and politicized, faces important challenges in resolving the crisis of the river basin, in order that water resources on which 15 million people depend can be managed in a sustainable way.

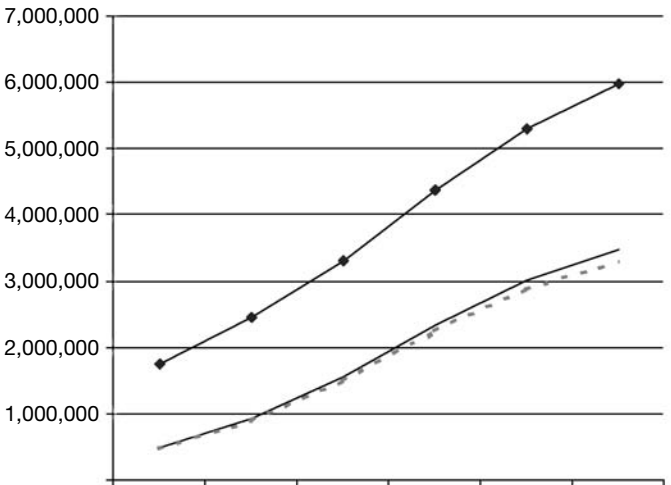
1. While river basin councils (*consejos de cuenca*) are at the core of these institutions, others, such as commissions, user committees and aquiferl committees (*Comités Técnicos de Aguas Subterráneas* – COTAS) have been created as support mechanisms.

This paper reflects on the problem of Lake Chapala's depletion and the broader crisis in the Lerma–Chapala river basin and how the situation is affecting a much wider region, with increased competition for resources among all water users across five states. The institutional response to the crisis is reviewed, as well as the challenges faced by these innovative, yet insufficient, mechanisms.

II. GUADALAJARA'S WATER CRISIS

GUADALAJARA IS MEXICO'S second largest city, after Mexico City. It is situated in the Central West region and is the capital of the state of Jalisco. Its metropolitan area, which encompasses four municipalities (Guadalajara, Zapópan, Tlaquepaque and Tonalá),[2] has a population of around 4 million. Birth rates and incoming migration in the last decades have led to rapid demographic growth, as shown in Figure 1. Estimates suggest that the population will reach 7 million inhabitants by 2025.[3] In economic terms, Guadalajara is the engine of Jalisco's economy, which has experienced considerable growth in recent decades (including a 25 per cent growth between 1995 and 1999) mainly as a result of the expansion of its industrial sector. Jalisco's economy currently accounts for 7 per cent of Mexico's GDP.

Figure 1: The growth in population of Guadalajara metropolitan area, Guadalajara conurbation and the state of Jalisco, 1950–1995



	1950	1960	1970	1980	1990	1995
Jalisco	1746777	2443261	3296586	4371998	5302689	5991176
Conurban Area	490129	915193	1544137	2335690	3003868	3482417
Metropolitan Area	452014	867035	1480472	2244715	2870417	3279424

SOURCE: INEGI (1995), "Conteo de población y vivienda 1995", Instituto Nacional de Estadística, Geografía e Informática.

Guadalajara's water-related problems are turning into a generalized water crisis, in which scarcity of the resource is the greatest threat. Although the majority of the population has access to "some kind" of piped water (94.5 per cent according to 1995 official figures, but there is no disaggre-

2. In addition to these four municipalities, the built-up area has reached three other municipalities. This larger area is referred to as Guadalajara Conurbation Area. In this paper, we will refer to Guadalajara Metropolitan Area as Guadalajara.

3. INEGI (1995), "Conteo de población y vivienda 1995", Instituto Nacional de Estadística, Geografía e Informática.

gated data with regard to the types of access), rationing of the domestic supply started several years ago as Lake Chapala, its main source of water,[4] was drying up. In view of the decreasing availability of water, the city faces the challenge of not only sustaining its current population and economic activity in the medium and long terms but also the threat to its future growth. For a number of years now, the government has been considering major hydraulic projects to draw water from alternative sources, but so far dependency on Lake Chapala's water continues. As will be discussed below, whether these major infrastructure projects to draw water from more distant sources are really needed is questionable. Different social actors have been stressing the need for other solutions, which are in the realms of demand management strategies, improvements in efficiency (rehabilitating the water network to reduce leakage, for example) and sustainable use of the water resources in general.

4. The percentage of Guadalajara's water supply coming from the lake varies according to the time period. In the past decade, it has been in the range of 60–80 per cent. Other sources of water are aquifers and minor local rivers.

a. Whose scarcity?

In most urban areas in low- and middle-income nations, there are large inequalities in the availability and distribution of water among neighbourhoods and families. Mexican cities are no exception. In his research on Mexico City, José Estéban Castro makes reference to the very large disparities in water consumption across sectors of the population that are directly related to the unequal access to the service: in the poorest neighbourhoods, water consumption per capita could be as low as four litres per day, while in the well-off areas piped water is wasted at rates that run into the hundreds of litres per day (including for discretionary purposes such as lawns and pools).[5] In Guadalajara, similar disparities exist. Water is overused and often wasted by one sector of the population, while hundreds of thousands face scarcity in their daily struggle. Again, this scarcity has mainly sociopolitical origins, and has important health and economic implications for poorer households. They use less water than is required for healthy living, have poorer quality sanitation and spend a high percentage of their income buying water from water vendors.

5. Castro, José Estéban (2003), "Urban water and the politics of citizenship: the case of Mexico City Metropolitan Area (1980s–1990s)", paper submitted to *Environment and Planning* A, St Anthony's College, University of Oxford.

Rationing measures taken by the state water utility reinforces inequalities in service provision. Unlike those of better-off households, dwellings of poorer households typically lack water-storage capacity, so the poor suffer most from the rationing that can occur several times a week during the dry season (and which can last for hours or even days). In fact, one can say that it is only the poor who are really affected by these measures. In addition, simple observation (weekly rationing plans are published in local newspapers) shows that poor neighbourhoods are the preferred targets for the cuts in service. Besides the unfairness in the design and application of rationing measures, some researchers suggest that these have rarely been shown to work effectively, as residents find ways of stockpiling water to ensure an adequate supply at times when the service is cut, while others often leave hosepipes and taps open so as not to miss the moment when the water supply resumes.[6]

6. Burton, Tony (2001), "Can Mexico's largest lake be saved? A year 2001 update", www.mexconnect.com/mex-/travel/tonyarticles/tblagunasaved3.html

Without a major change in the water culture of the major urban users, and fundamental transformations in service provision (to enhance social justice and effectiveness) and in measures to use water adequately, inequalities in access to water are likely to remain, or even worsen, in view of the physical water scarcity that Guadalajara is beginning to face.

b. Guadalajara's impact on the region

With regard to water resources, Guadalajara has an important impact on the region in two ways. The first relates to satisfying its water demand, where there is continued stress upon Lake Chapala, depleting local aquifers, and the ecological, social and economic conflicts that drawing on more distant sources presents (as discussed below); and the second relates to the discharge of untreated urban and industrial wastewater.

The Santiago River is the natural drainage path from Lake Chapala to the Pacific Ocean, and receives around 9 cubic metres per second of polluted water from Guadalajara.[7] It now sustains very little life along long stretches of its 547 kilometres before reaching the ocean, impacting on natural ecosystems and affecting the use of its water by other cities, smaller towns and farmers. Guadalajara's municipal governments have been breaching the National Water Law, which established that, by January 2000, all urban centres of more than 50,000 inhabitants should treat their municipal wastewater. [8]

c. Is Guadalajara's water crisis unique?

The problem of water scarcity is not confined to Guadalajara; it is becoming a critical issue in large areas of the country and for a number of urban centres (among them Mexico City). [9] The continual rapid urban and industrial growth experienced throughout much of Mexico since the 1940s, together with the expansion of irrigated agriculture, has greatly increased the demand for water. But there is another factor, namely geographical distribution. Population centres, manufacturing industry and a large proportion of the irrigated agricultural land have been concentrated heavily in the centre and the north of the country, which have among the least plentiful water resources. This has increased the social and political conflicts associated with access to water and has also generated an unequal scarcity that has affected the most vulnerable populations, namely the urban and rural poor (because of the unequal distribution of water), and the farmers and fishermen (because the water is diverted to urban and industrial centres).[10]

III. LAKE CHAPALA AND THE LERMA–CHAPALA RIVER BASIN

LAKE CHAPALA IS around 80 kilometres long, has an average width of 12.5 kilometres and covers an area of approximately 1,120 square kilometres. It is the third largest lake in Latin America and the second highest, after Lake Titicaca, with an average altitude of 1,524.6 metres above sea level.[11] It regulates the Lerma–Santiago water basin (the Lerma River is the main water supplier to the lake, which is then drained by the Santiago River) and has been an important climate regulator in the region (Figure 2). It provides a habitat to a variety of fish and a number of migratory birds from North America during the winter. In recent decades, it has become a favourite retirement place for Americans and Canadians, who value the beautiful scenery, the weather and the relaxed lifestyle. A number of towns are located along the lake's shore, where fishing and tourism are important economic activities.

Ideas for using the waters of Lake Chapala and the Santiago River to supply Guadalajara go back to the sixteenth century; however, it was not

7. *Público* (2003), "Miles de especies en riesgo por la presa de Acrediano", 17 March 2003.

8. CNA (2002), *Compendio básico de agua en México*, Programa Nacional Hidráulico 2001–2006, Comisión Nacional del Agua.

9. The situation in Mexico City is also critical – see Connolly, Priscilla (1999), "Mexico City: our common future?", *Environment and Urbanization* Vol 11, No 1, pages 53–78.

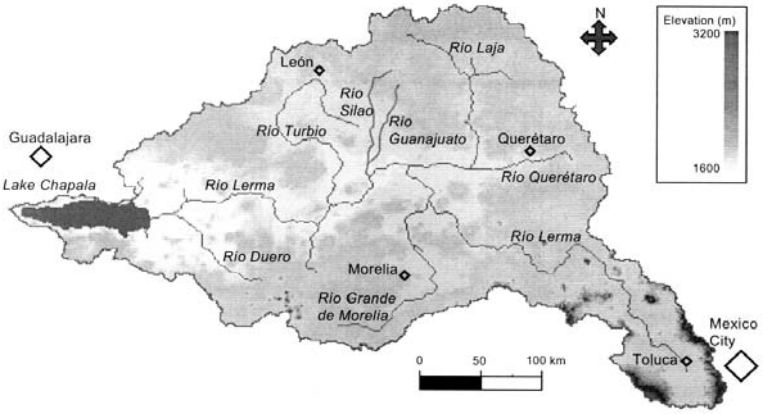
10. Avila, Patricia (2003), "Water management and conflict in Mexico", paper presented at the conference Crossing Water Thresholds in Guadalajara, Mexico, May 2003, LEAD International, www.lead/org/events/default.cfm?target=details&ID=504&page=5 (accessed 1 May 2003).

11. CANACO (1989), *Chapala. Acercamiento a su problemática*, Cámara Nacional de la Industria de la Construcción Delegación Jalisco.

until the mid-twentieth century that projects were seriously evaluated and implemented. In the early 1950s, the city was facing water shortages (until then it had relied on local rivers and aquifers), and its population was predicted to grow from around half a million to one million inhabitants within a short period. It was clear that this water system was the only viable source for the growing city and, with engineering works that finished in 1956, Guadalajara's dependence upon the waters of Lake Chapala had begun.[12]

12. See reference 11.

Figure 2: Topography and stream network of the Lerma–Chapala river basin



Note: The Santiago river is not shown; it drains Lake Chapala towards the Pacific Ocean.

SOURCE: Wester, Philippus, Martin Burton and Eduardo Mestre (2001), "Managing the water transition in the Lerma–Chapala basin, Mexico", in Abernethy, C L (editor), *Intersectoral Management of River Basins: Proceedings of an International Workshop on Integrated Water Management in Water-stressed River Basins in Developing Countries: Strategies for Poverty Alleviation and Agricultural Growth*, Loksop Dam, South Africa, 16–21 October 2000, IWMI, Colombo, Sri Lanka.

a. The exploitation of Lake Chapala

The lake's significance in Mexican society has evolved over time. As would be unimaginable today, at different times in the nineteenth and early twentieth centuries politicians had plans to drain the lake to gain agricultural land, plans that fortunately faced enough opposition to prevent them from being implemented. However, between 1904 and 1909, the lake's wetland area was artificially dried out, the justification being to get rid of an area prone to flooding that was a breeding ground for the malarial mosquito.[13]

Lake Chapala's historical water levels from 1934 to 1998 are detailed in Figure 3 and illustrate the two critical periods of the last century. As a result of these, awareness of the value of the lake increased significantly and, as of the first period of decline in its levels in the 1950s, the lake started to receive more attention from Mexican society in general. The lowest level (*cota* 90.8 m)[14] was reached in 1954, after years of continuous drought and increasing use of the basin's water, mainly for irrigation purposes. The lake recovered its level after some years of higher than average rainfall.

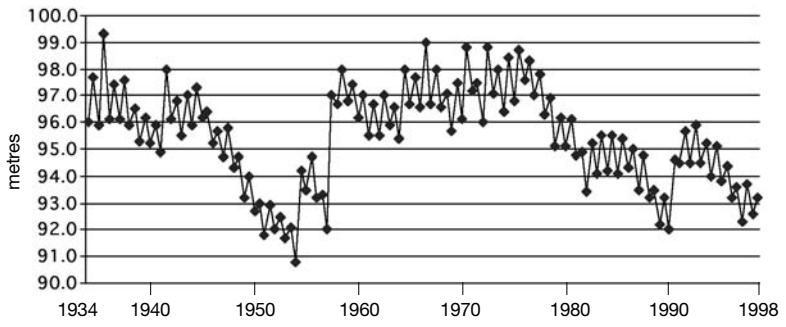
However, the second and current crisis is of a more critical nature.

13. See reference 11.

14. The term *cota* is used when referring to the lake's level (and thus its estimated capacity). During the first hydraulic works in the lake, a system of levels and topographic altitudes was established and a *cota* "100" reference point was set on a specific part of a bridge. However, this figure has nothing to do with the full capacity of the lake, which has been determined at *cota* "97.8". The units from the *cota* "100" reference point are metres.

Unlike in the 1950s, when a number of consecutive years of poor rainfall were the main cause of the lake's extremely low levels, the second period of decline, starting in 1979, has had less to do with low rainfall and more with the fact that demand for water along the basin started to exceed its ecological capacity to recover.[15]

Figure 3: Changing levels within Lake Chapala; highs and lows per year 1934-1998



b. Present and future for Lake Chapala

As a result of irresponsible actions and increased human activity in the water basin, over a very short period of time the lake has suffered a series of important transformations that would otherwise have taken much longer.[16] Its waters have been polluted by municipal, industrial and agricultural liquid wastes mainly from the Lerma River, which receives wastewaters along large sections of its course, and runs for around 700 kilometres to the lake (crossing the states of Mexico, Querétaro, Guanajuato and Michoacán).

The erosion caused by deforestation and by changes in land use across the Lerma basin has led to an increased flow of sediments into the lake. This, in turn, has increased water turbulence, limiting the lake's biological production. The accumulation of sediments has contributed to a loss of depth, which is already quite serious due to the decreasing amount of water supplied by the Lerma River. The shallowness of the lake has increased its water temperature, leading to higher evaporation rates.

Increasingly, large areas of the lake's surface are being invaded by *lirio acuático*, a plant that feeds on the nutrients that have flowed into the lake. The *lirio* exacerbates the loss of water through evaporation, limits light penetration into the water and constrains the free movement of boats, thus having an impact on fishing and recreational activities. Although different studies catalogue the pollution of the lake's waters differently (some are more alarming than others), it is acknowledged that the presence of organic matter, detergents, heavy metals and pesticides has decreased fish stocks. (Some endemic species, such as the "white fish", are about to become extinct.) The lake's pollution also poses a threat to human health through the consumption of contaminated fish and is an economic challenge for the more than 2,000 local residents who still depend on fishing for their livelihoods.[17] In view of the lake's current situation and trends, the questions raised are: what are its future prospects, and can it be saved? The lake's situation is very much linked to the basin's closure, reached in

15. Wester, Philippus, Martin Burton and Eduardo Mestre (2001), "Managing the water transition in the Lerma–Chapala basin, Mexico", in Abernethy, C L (editor), *Intersectoral Management of River Basins: Proceedings of an International Workshop on Integrated Water Management in Water-stressed River Basins in Developing Countries: Strategies for Poverty Alleviation and Agricultural Growth*, Loksop Dam, South Africa, 16–21 October 2000, IWMI, Colombo, Sri Lanka.

16. Sours Renfrew, Edwin (1990), "La problemática del lago de Chapala. Una perspectiva regional", in Alba Vega, Carlos, *Chapala. Ecología y planeación regional*, El Colegio de Jalisco and Goethe Institute, Guadalajara.

17. See reference 16.

the 1980s, which was due, among other factors, to the increase in the constructed storage capacity upstream and to the expansion of irrigated lands. In light of the present situation, Eduardo Mestre, expert on the Lerma–Chapala basin points out:

"After a modest recuperation in the early 1990s, lake levels are again low, due to poor rainfall and continued over-exploitation of surface and groundwater, making it unlikely that the lake will recover without exceptional run-off as generated through a major hurricane."[18]

18. See reference 15.

Although few studies have been undertaken, groundwater reserves along the basin are said to be far more depleted than before, which makes the basin's situation even more critical and reduces the chances for a recovery in the lake's level.[19]

19. See reference 6.

Photo 1: Views of Lake Chapala from a) the late 1960s and b) from 2003, from the same harbour
SOURCE: Pablo Hermosillio Villalobos (2003) for the recent photo. The name of the photographer for the earlier photo is unknown.

The lake's fragility has increased public awareness in the surrounding localities, in Guadalajara and throughout Mexico, and environmental NGOs, academic institutions, chambers of commerce and other organizations and civil society in general have been formulating proposals for the recovery of the lake. However, the issue has become highly politicized and there is no consensus on the way forward, given the complexity of the problem and the fact that decisions need to be made at different levels and across several socioeconomic sectors across different states. Awareness has also grown at the international level. Lake Chapala was chosen at the World Summit on Sustainable Development in Johannesburg in 2002 as a candidate "on test" for a year to be part of the Living Lakes Association, in order to receive international support for its recovery. However, the future of Lake Chapala depends on the integrated and sustainable management of the Lerma–Chapala river basin as a whole. And, given Guadalajara's current dependence, what is clear is that if the lake dries up, the city's future is at risk.

c. The "water transition" in the Lerma–Chapala river basin

Lerma–Chapala is an immense river basin in West Central Mexico, covering 54,300 square kilometres and extending across the states of México, Querétaro, Guanajuato, Michoacán and Jalisco. It includes 14 cities with populations of more than 100,000, contains 10 per cent of Mexico's population and has some of the most productive agricultural land, with 750,000 hectares of irrigated farmland (accounting for 14 per cent of the irrigated area of Mexico). This area, known as El Bajio, is considered to be the country's breadbasket. Furthermore, the basin is home to a rapidly growing industrial sector (around 3,500 diverse industries), and the commercial and service activities in the basin's region account for more than one-fifth of all national transactions.[20]

The catchment is a crucial source of water for approximately 15 million people – 11 million in the basin and approximately 2 million each in Guadalajara and Mexico City (it provides a partial supply for both cities). Therefore, the basin is immensely important to the economic and social development of Mexico.

However, it is also one of the most over-committed water basins in the world, with total water depletion exceeding supply by an average 10 per cent in past years.[21] The main water user in the basin is the agricultural sector, which uses around 78 per cent of the basin's resources. However, due to the closure of the basin, this sector faces fierce competition from the growing demands of industrial and domestic users.[22]

Turton and Ohlsson note that, in closed basins, water scarcity per se is not the key issue but, rather, whether a social entity has the adaptive capacity to cope with the challenges of water scarcity.[23] They argue that two institutional transitions need to take place when water becomes more scarce. The first is when water abundance becomes water shortage, a period dominated by the "hydraulic mission" (embodied typically by central government agencies and engineers constructing hydraulic infrastructure). The second necessary transition is when water shortage becomes water scarcity, and where limits to exploitation become evident. Making this second water transition, from supply-oriented development to water-demand management, requires substantial changes in institutional arrangements for water management, possibly including the

20. See reference 10.

21. Unchecked groundwater pumping has produced declines in aquifer levels of 2.1 metres per year, while surface water depletion exceeds supply in all but the wettest years. Source: see reference 15.

22. See reference 10.

23. Turton and Ohlsson (2000), in Wester et al. (2001), see reference 15.

creation of water basin councils. As put by Wester and colleagues:

"under favourable socioeconomic and political conditions this transition can be made, resulting in a stabilization of water demand and the birth of sustainable water management. However, this transition is not automatic, and whether and how well it occurs is a function of the adaptive capacity of society."[24]

In the case of Mexico, the significance of the crisis of Lake Chapala and the challenge presented by the closure of the Lerma–Chapala basin have promoted innovation in the creation of institutional mechanisms. These institutional responses are trying to make possible a sustainable management of Mexican water basins.

24. See reference 15.

IV. INSTITUTIONAL RESPONSES – A SHIFT FROM CENTRALIZED WATER MANAGEMENT TO INNOVATIVE COOPERATIVE MECHANISMS

MEXICO IS WELL known for the important water sector reforms it initiated in the early 1990s,[25] which have moved towards a decentralization of the decision-making processes and have broadened social participation in these processes. The highly hierarchical and centralized structures for water management that had existed for a long time, and which were characterized by increasing federal control over all decisions relating to water development and management, allowed a determined and quick decentralization.[26] In 1989, an important turning point for water management in Mexico, based on the recognition that the water authority should be a specialized and non-sectoral entity in the management of surface and underwater resources, the National Water Commission (Comisión Nacional del Agua – CNA) was created. The activities of the CNA lie within a broad and modern legal framework, especially since the creation of the National Water Law (*Ley de Aguas Nacionales*) in 1992.

25. Merrey, Douglas J (2000), "Creating institutional arrangements for managing water-scarce river basins: emerging research results", paper presented at session on Enough Water for All at the Global Dialogue on the Role of the Village in the 21st Century: Crops, Jobs, Livelihoods, at EXPO 2000, Hanover, Germany, International Water Management Institute, Colombo, Sri Lanka, www.zef.de/gdialogue/Program/Papers-Day-2/sid-water-Merrey.pdf, (accessed 15 February 2003).

26. See reference 15.

a. The creation of basin councils (*consejos de cuenca*)

During the 1990s, the CNA created a participative system for water management based on river basin councils (*consejos de cuenca*), a central component of the reforms. According to the Economic and Social Commission for Latin America, the speed and determination of the CNA in decentralizing water management through the formation of these multisectoral and participative institutions has been unprecedented, and its experience should serve other countries interested in creating participative and multisectoral institutions.[27] Overcoming a number of obstacles, the CNA has achieved the installation of 26 *consejos de cuenca* covering all the Mexican territory, and these are now in a long period of consolidation.

27. Dourojeanni, Axel, Andrei Jouravlev and Guillermo Chávez (2002), *Gestión del agua a nivel de cuencas: teoría y práctica*, Documentos de Trabajo No 1, CEPAL and Colegio de México, Mexico City.

According to the National Water Law, which states the legal basis for the creation of the *consejos de cuenca*, these are:

"instances of coordination and orchestration between the three levels of government (federal, state and municipal) and the representatives of water users, with the objective of formulating and executing programmes and actions for a better management of water bodies, the development of the hydraulic infrastructure and of the respective services, and the preservation of the basin's resources."[28]

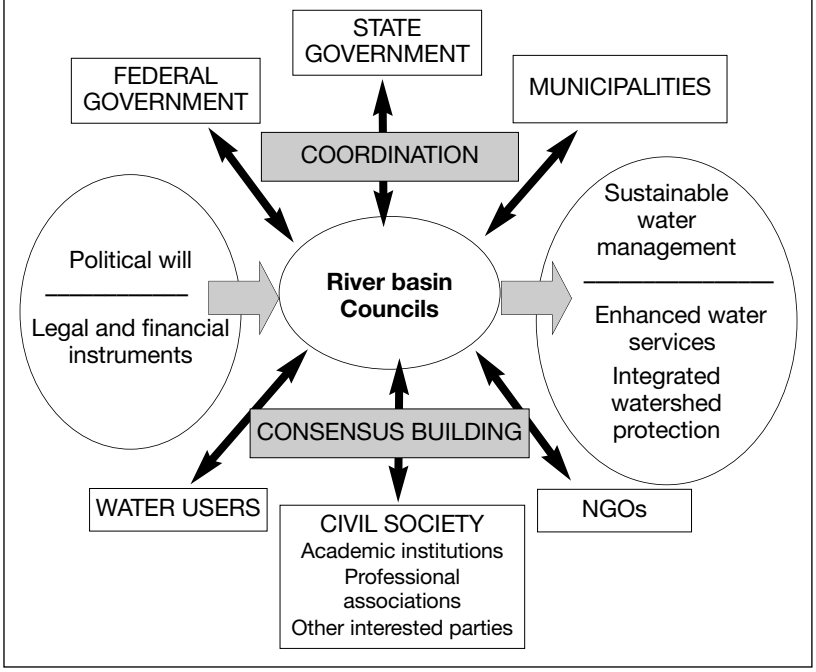
User representatives for each type of use are typically included, being defined by the National Water Law as agriculture, agro-industry, domestic, services, industry, ecological conservation, fishing, urban public and

28. Ley de Aguas Nacionales, in Dourojeanni et al. (2002), see reference 27.

multiple.[29] There are particular mechanisms for legitimizing each user's use of the water resources. Other supporting organizations, either temporary or permanent, are formed around the *consejos de cuenca*. This is the case, for example, of the GSE (Grupo de Evaluación y Seguimiento), which provides follow-up and periodically evaluates the execution of actions and agreements made within the councils.

29. See reference 27.

Figure 4: The philosophy behind the river basin councils in Mexico



SOURCE: Wester, Philippus, Martin Burton and Eduardo Mestre (2001), "Managing the water transition in the Lerma–Chapala basin, Mexico", in Abernethy, C L (editor), *Intersectoral Management of River Basins: Proceedings of an International Workshop on Integrated Water Management in Water-stressed River Basins in Developing Countries: Strategies for Poverty Alleviation and Agricultural Growth*, Loksop Dam, South Africa, 16–21 October 2000, IWMI, Colombo, Sri Lanka.

The achievements, shortcomings and limitations of the different *consejos de cuenca* vary. While the first water basin councils were created almost ten years ago, for example the Lerma–Chapala basin council in 1993, others have been created only recently. As previously mentioned, overall they are still in a period of consolidation, and it is believed that the consolidation of the *consejos de cuenca* will help substantially in creating a "new water culture" in Mexico.

b. Managing the water transition in the Lerma–Chapala river basin

As stated above, the institutional changes are part of the transition from supply- to demand-management in the Mexican water sector. The Lerma–Chapala basin council was the first to be established in response to the drying up of Lake Chapala in the 1980s and the severe contamination of the Lerma River.[30] According to Eduardo Mestre, who actively partici-

30. See reference 15.

pated in the formation of the councils:

"A wide-ranging diagnosis existing by mid-1989 clearly presented four capital problems in the Lerma river basin: scarcity as well as unsuitable water allocation, pollution, inefficiency of water use and environmental degradation. To turn the tide, it became clear that it would be insufficient to maintain that the federal government was solely responsible for this chaos and for its solution or mitigation."(31)

31. Eduardo Mestre, as quoted in Wester et al. (2001), see reference 15.

The federal government and the governments of the five states falling within the river basin signed an agreement in April 1989 adopting four main objectives to improve water management in the basin:

- allocate surface water and groundwater fairly among users and regulate its use;
- improve water quality by treating municipal and industrial effluents;
- increase water-use efficiency; and
- conserve the river basin ecosystem and protect watersheds.

A consultative council was formed immediately to follow up on these objectives and, based on the National Water Law of 1992, it became the Lerma–Chapala river basin council in January 1993. Since then, a challenge for the council has been to ensure effective user representation. Until the end of 1998, the council was very top-heavy. Its president was the federal minister for agriculture, and later on for the environment, while its members were the governors of the five states, the federal ministers of five key ministries and the general directors of CFE, PEMEX and CNA.(32) Evident in this institutional design was that control over water and financial resources was the driving force in the inter-agency alignments within the basin. In 1998, following a reform of the National Water Law, the institutional design changed, with the addition of user representatives from six different sectors (agriculture, fisheries, services, industry, livestock and urban). However, the users on the council were nominated by the CNA, and do not necessarily reflect the interests of the water-use sector they represent.(33)

32. CFE (Comisión Federal de Electricidad) is the state-owned electricity company, while PEMEX (Petróleos Mexicanos) is the state-owned oil company that has monopoly over oil production and its market in Mexico.

33. See reference 15.

To rectify the problem of inadequate representation, the CNA is currently working to establish a stepped form of user representation, which consists of user committees in each state for each of the six sectors represented, giving a total of 36 user committees. The idea is that each committee will draw their membership from already existing organizations, such as those in irrigation districts. The committees will vote for a representative to the user assembly at the basin level which, in turn, elects the six user representatives on the council. In addition, fora at the sub-basin level, such as river basin commissions and aquifer technical committees (Comités Técnicos de Aguas Subterráneas – COTAS) complement the council.(34) As part of the process of strengthening stakeholder participation in the council, a participatory planning process was started throughout the basin in the belief that local stakeholders have a better understanding of the problems within the region and will play a decisive role in plan implementation. To mobilize stakeholders and build consensus, the CNA organized a number of workshops attended by user representatives, representatives of the three levels of government and representatives of civil society (including NGOs and research institutes.).(35)

34. See reference 15.

35. See reference 15.

c. Challenges

In light of the complicated transition from a highly centralized management of water resources to one in which states, municipalities and water users

have a greater say, the creation of this participative system has been an important step. Nonetheless, from a water perspective and considering that the basin is still in crisis (including Lake Chapala), time is running out, and the efforts that the Lerma-Chapala river basin council has made in the last ten years will need to be redoubled to tackle the challenges lying ahead. Mestre points to three main challenges, as follows.(36)

36. See reference 15.

Surface water allocation mechanisms. The governors of the five states in the basin and the federal government signed a treaty in 1991 that sets out surface water allocation mechanisms for the basin. A major concern was to maintain adequate water levels in Lake Chapala and to ensure Guadalajara's domestic water supply. Despite the good performance of these mechanisms and the strict application of the 1991 treaty, Lake Chapala's volume has halved in the past eight years. Thus, the surface water treaty has failed to achieve the objective of rescuing the lake. Mestre points out that the mechanisms need to be improved with regard to the basis on which the allocation volumes are determined, so that they better take into account the basin's rainfall and run-off data and their trends.

Groundwater allocation mechanisms. A much more serious challenge that the council and other water management stakeholders in the basin urgently need to address is the serious depletion of the basin's aquifers. Specialists agree that the long-term consequences of continued depletion easily overshadow those of Lake Chapala drying up.(37)

37. See reference 15; also see reference 6.

Although the council started coordination agreements to regulate the extraction and use of groundwater in 1993, progress on the ground has been much slower. A key problem is that the council, through the CNA, does not physically control the water extraction infrastructure (the wells), as it does in the case of surface water (the dams). Rights to the extraction of groundwater historically had been given to municipalities and individual users. The technical committees (COTAS) started to operate in selected aquifers in 1995, but they face fundamental problems. They are not financially or administratively autonomous organizations and they lack legal status and decision-making powers, so their agreements may or may not be taken into account by the CNA. Placing aquifer management in the hands of the aquifer users, under the supervision of the river basin council, state water commissions and the CNA, would be more promising for reducing extraction than solely relying on federal regulation.

Representation of interests on the council. The institutional arrangements for water management in the Lerma–Chapala basin revolve around who controls water. With basin closure, the competition for access to water is becoming more severe, and the rural poor are losing access to water as a result of reductions in surface irrigation and increased costs for the use of groundwater for irrigation. Unfortunately, meeting the water needs of poor women and men and including them in decision-making processes are not priorities for the council nor in the larger set of institutional arrangements for water management in Mexico. Mestre highlights that:

"the council needs to seriously start considering how to safeguard and improve the access of the poor to water, and how to combat the current de facto concentration of water rights in the hands of the few."(38)

38. See reference 15.

V. POLITICS AND THE QUEST FOR NEW WATER SOURCES FOR GUADALAJARA

HOWEVER, ALL THESE innovative mechanisms and efforts towards integrated water management in Mexico still operate within a larger political

environment that sometimes hinders decision-making capacity and implementation. The case of Guadalajara's search to solve its water crisis is a clear example of how politics and power still have important roles in decision-making processes.

In the late 1990s, Jalisco's government, with the help of the federal government, made serious efforts to design actions and projects to solve Guadalajara's water supply problem and protect the natural environment by treating its wastewater. A set of actions and integrated projects was proposed, which included the use of a complementary source (besides Lake Chapala), the rehabilitation of the current urban networks, and the enhancement of the capacities and modernization of the water utility, as well as the construction of the required treatment plants. The projects were to be financed in part through a loan from the Japanese government's Overseas Economic Cooperation Fund (OECF). However, there was no consensus within the political sphere on the best project or on the details of the loan conditions, and little was done by the different actors to work together and to come up with a common position. Instead, after a period of struggle, the projects and loan were aborted because of the political fight between the ruling and opposition parties in the state congress.[39]

Similarly, the last three political periods have been characterized by delayed action and a lack of unified political will. Jalisco's government continues to fail to fulfil its commitment to the CNA concerning treatment of the city's wastewater, and the deterioration of the Santiago River continues.

However, the crisis of Lake Chapala and the increasing water scarcity can no longer be ignored. Pressure from Mexican society and from the international community to save the lake has stimulated Jalisco's political system into action, and some degree of political unity among parties has been achieved on this matter. In early 2003, the state congress authorized Jalisco to incur a debt of US$ 670 million in order to launch a second set of infrastructure projects to tap new water sources for Guadalajara and to build the required plants to treat its wastewater. [40]

The main proposal for the supply side is to construct a dam in the area known as Arcediano, in the basin of the Rio Verde (a tributary of the Santiago River), and to replace Chapala with this dam as the main source of water. [41] While this proposal has been well received by the local congress and a few segments of society for its apparent action in the name of Chapala, it has also been heavily criticized. Experts, professional associations, academics and NGOs are challenging this proposed solution to Guadalajara's water supply problems and putting forward alternatives that would avoid the construction of the dam, as well as stressing required actions for the recovery of Lake Chapala. It is believed that the government's solution is unnecessary and unsustainable for the region. The definition of the problem has been so heavily politicized over recent years that perhaps the only thing that remains clear is the confusion among the society of Guadalajara. As the researcher and water expert at the University of Guadalajara, Salvador Peniche, puts it:

"the government is making the technical discussions of the construction of the dam prevail, avoiding opening the debate over the development model proposed for the region, and trying to validate the project with citizens and institutions in a decision that has already been taken."[42]

39. *Informador* (1998), 31 March 1998.

40. *Público* (2003), "Aprueban en comisiones crédito para el agua", 7 May 2003.

41. The government argues that the project will guarantee Guadalajara's water supply for 30 years, while eliminating pressure upon Lake Chapala and local aquifers. However, different social actors have demanded more transparency and access to the information on which decisions are based. In general, Guadalajara's civil society has serious doubts as to whether Jalisco's political class is making the right decisions – see *Público*, 3 April, 3 May and 7 May 2003.

42. Peniche Campos, Salvador (2003), "Arcediano: remedios del pasado para problemas del futuro", *Gaceta universitaria*, Universidad de Guadalajara, 2 June.

VI. CONCLUSIONS

THE CASE OF Guadalajara's water crisis and the broader problems in the Lerma-Chapala basin illustrate the issues faced by many cities in low- and middle-income countries in water-scarce regions, where overstressed natural systems combined with poor water management in periods of demographic and economic expansion have led to water stress and, in some cases, to water resource scarcity. It also shows that not all water scarcity problems are of a physical nature, but that sociopolitical aspects also come into play, affecting predominantly the urban poor.

The institutional mechanisms for water management created in Mexico in the last decade show how society can respond to crises created by human activity. In many cases, irresponsible actions alter and put stress on the environment in such a way that not only are the natural ecosystems severely modified but the possibilities for further and just social development are also threatened. However, as illustrated by the case of the Lerma–Chapala basin council, these institutions face a number of challenges in order to become real collective governance schemes and achieve an integrated and sustainable management of the water resources. The often-irreversible nature of environmental problems can be seen in the case of Mexico's water resources, where the rate of solving the problems lags far behind the rate of degradation.

From the case of the Lerma–Chapala basin, we can see the inextricably linked urban–rural issues, in which a solution for one sector can be obtained at the expense of other groups in society. In this basin, as in many other closed basins throughout the world, more and more water is being diverted from agricultural activities towards urban use and, typically, the small farmers are the ones who suffer most.

Internationally agreed goals, such as Goal 7 of the Millennium Development Goals (to which most governments and international agencies have committed themselves) which, in relation to access to water, states the target of "*reducing by half the proportion of people without sustainable access to safe drinking water by 2015*",[43] can be very difficult to achieve in practice. However, as this case has illustrated, it should be a task that relates to society as a whole.

43. UN–HABITAT (2003), *Water and Sanitation in the World's Cities*, Earthscan, London.