INTEGRATED WATER RESOURCES MANAGEMENT: LIMITS AND POTENTIAL IN THE MUNICIPALITY OF EL GRULLO, MEXICO

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Abstract

Decreasing water availability per capita in more and more countries is the result of bad management over the past centuries. The 'world water crisis', however, is not inevitable.

The concept of Integrated Water Resources Management (IWRM) has been promoted over the last ten years as a possible way of reversing such a trend. One of its most fervent promoters is the Global Water Partnership, according to which "IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2000: 22).

A number of authors are critical of an appropriation of the IWRM concept by the Global Water Partnership devoid of its historical evolution over more than 70 years (Biswas, 2005; Mollard and Vargas, 2005a). As a result of this omission, these authors question the applicability and usefulness of the concept and call for assessing the effectiveness of IWRM implementation. The difficulties of practical IWRM implementation are manifold and include issues of scale, as well as institutional, political, and social constraints to sectoral and environmental integration (Tortajada, 2005; Duda and El-Ashry, 2000; Mitchell, 1990), that can be more or less specific to developing countries (Thioubou, 2002).

The 1992 Mexican Water Law, amended in 2004, explicitly refers to IWRM as a national objective. As a result, there has been fairly extensive research on the implementation of IWRM in Mexico at the national level. This study assesses the implementation of IWRM efforts in the municipality of El Grullo (Jalisco), to identify the local and necessary conditions to enhance these.

We first recall the innovative aspects of the IWRM concept, as compared to more traditional water management. Ambitious, integrated water resources management is a holistic approach that includes both the natural system (water and its diverse components –surface water/groundwater, quantity/quality- but also all other environmental resources such as land, forests and biodiversity in general) and the human system, including all the different uses (domestic, agricultural, industrial, etc.) (Mitchell, 1990). Integrated water management is an indicator of what Gleick (2000) qualifies as a change in paradigm between the 20th century –where infrastructure development enabled to better exploit resources, perceived as unlimited- and the 21st century, where finite resources are to be managed in order to

maintain ecological integrity. Integrated water resources management is necessary to realise this 'blue revolution' (Calder, 2005). It requires, on the one hand, a participative and negotiation-oriented institutional framework and, on the other hand, water pricing tools, so as to balance demand and supply (Meublat, 2001).

At the level of a municipality, implementing IWRM efforts translates, on the one hand, in ensuring good quality municipal water and sanitation services without impacting surrounding ecosystems and, on the other hand, participating –with other municipalities and institutions- in coordination activities at the level of the basin or sub-basin (Smits and Butterworth, 2006).

Seven months of fieldwork over a three-year period enabled to realise a number of interviews, both with households in the El Grullo municipality (in four urban neighbourhoods and three villages) and with key informants (the local authorities of El Grullo and five neighbour municipalities, members of the Ayuquila-Armería Watershed Commission and researchers from the partner institution IMECBIO). These interviews were complemented by direct observation as well as secondary sources of information.

Our results show that in spite of being well endowed in water resources, the municipality of El Grullo does not manage to provide good quality potable water services. Water distribution is irregular and forces households to resort to appropriate social practices (e.g. use of various storage methods and alternative water sources). The inequity of the variable water service quality is reinforced by a fixed water fee system, in the absence of meters. Further, the lack of any wastewater treatment station impacts riparian villages and aquatic ecosystems located downstream from the wastewater discharge. Efforts are currently underway to address these issues: the municipality wishes to have water meters installed, and is also negotiating a concession with a private company for a constructed wetland to treat municipal wastewaters.

At the regional level, the Ayuquila-Armería Watershed Commission, which was established in 1998, is criticised for the poor effective participation it generates and its lack of means and concrete results. Created in reaction to finance local priorities, the Inter-municipal initiative of the lower Ayuquila watershed, a negotiation platform that convenes ten municipalities, is in comparison relatively successful. Developed through a ten year trust-building process by the researchers from the University of Guadalajara and the directorship of the Sierra de Manantlán Biosphere Reserve, it has enabled the Ayuquila River to regain its original state, as well as set up a series of measures to protect the environment (e.g. the establishment of fire brigades and solid waste separation and recycling programmes). The Ayuquila-Armería Watershed Commission wishes, in turn, to replicate this model throughout the whole watershed. Although the management plan is still to be designed at the basin scale, these inter-municipal initiatives are indeed judged more flexible and better adapted to IWRM implementation.

These results show that in order for the El Grullo municipality to enhance its efforts in terms of IWRM, important changes must take place. More specifically, decentralisation must be reinforced, at the level of both the municipal water board and the Ayuquila-Armería Watershed Commission. First, the potable water tariffs should be set independently by the municipal water board, on the basis of its operating costs –and not on that of political calculations, as is actually the case by the Jalisco State Congress. This would contribute to put an end to the vicious circle entailed by the municipal board's insufficient financial capacity (i.e. lack of staff, limited infrastructure maintenance, heterogeneous water services, lack of meters, non-payment of fees, etc.), along with other factors at stake (like encouraging a culture of payment). The Ayuquila-Armería Watershed Commission should also benefit from more freedom and means, in order to increase its credibility among the municipalities its territorial borders encompass. The effective transcription of the 2004 reform of the Water Law, which seems to point in that direction, is awaited by all those interested in this issue.

This thesis thus confirms previous analyses of problems surrounding IWRM implementation in Mexico (Mollard and Vargas, 2005b; Tortajada, 2005; García, 2004; Centro del Tercer Mundo para el Manejo del Agua, 2003; Martínez et al., 2002b). It also highlights the importance of finding country-specific ways for ensuring effective IWRM implementation. In particular, this may mean considering other scales than that of river basins.

Keywords: Integrated water resources management, Mexico, municipality, decentralisation

Résumé

L'insuffisante quantité d'eau douce disponible par habitant qui menace un nombre croissant de pays résulte de mauvaises habitudes de gestion de la ressource, acquises au cours des siècles passés. La 'crise mondiale de l'eau' n'est cependant pas une fatalité.

Le concept de Gestion Intégrée des Ressources en Eau (GIRE) est promu depuis une dizaine d'années comme un moyen possible de renverser la vapeur. L'un de ses plus fervents défenseurs est le Partenariat Mondial sur l'Eau, pour lequel "la GIRE est un processus qui promeut un développement et une gestion coordonnés de l'eau, du sol et des ressources qui y sont liées, de manière à maximiser équitablement le bien-être économique et social qui en résulte, sans compromettre la durabilité des écosystèmes vitaux" (traduit de GWP, 2000 : 22).

Un certain nombre d'auteurs critiquent l'appropriation qui est faite du concept de GIRE par le Partenariat Mondial de l'Eau sans en reconnaître la conformation historique pendant plus de 70 ans (Biswas, 2005; Mollard et Vargas, 2005a). Ils mettent de ce fait en question l'applicabilité et l'utilité du concept, appelant de leurs vœux à une évaluation de sa mise en œuvre et des difficultés rencontrées à ce propos. Celles-ci sont nombreuses, que ce soit en termes d'échelle ou de contraintes institutionnelles, politiques ou sociales s'opposant à une intégration sectorielle et environnementale (Tortajada, 2005 ; Duda et El-Ashry, 2000; Mitchell, 1990), qui peuvent en outre être spécifiques aux pays en développement (Thioubou, 2002).

La loi sur l'eau mexicaine de 1992, réformée en 2004, fait explicitement état de la GIRE comme base de la politique nationale de l'eau. De ce fait, sa mise en œuvre au Mexique a déjà fait l'objet d'un certain nombre de recherches. Cette étude se concentre sur les efforts de gestion intégrée de l'eau dans la municipalité de El Grullo (Jalisco), afin d'identifier les conditions locales requises pour en améliorer les résultats.

Dans un premier temps nous rappellons l'aspect innovant de la gestion intégrée de l'eau par rapport à une gestion plus traditionnelle. Ambitieuse, la gestion intégrée de l'eau est une approche holistique qui inclut à la fois le système naturel (les divers composants de l'eau – eau de surface/eau souterraine, quantité/qualité- ainsi que ses interactions avec l'environnement naturel plus large comme le sol, les forêts et la biodiversité en général) mais aussi les divers usages humains de l'eau pris dans leur ensemble (usages domestiques, agricoles, industriels, etc.) (Mitchell, 1990). Elle est un indicateur de ce que Gleick (2000)

signale comme un changement de paradigme entre le 20ième siècle –où le dévelppement d'infrastructures permettait de mieux exploiter la ressource, perçue comme illimitée- et le 21ième siècle, où il s'agit plutôt de gérer une ressource limitée tout en préservant les cycles écologiques. La gestion intégrée de l'eau est nécessaire pour mener à bien cette 'révolution bleue' (Calder, 2005). Elle requiert, d'une part, un cadre institutionnel participatif et orienté vers la négociation, et d'autre part, des outils permettant de calculer le prix de l'eau, afin d'équilibrer l'offre et la demande (Meublat, 2001).

Au niveau municipal, mettre en œuvre des efforts de gestion intégrée de l'eau signifie tout d'abord assurer un service municipal d'eau potable et d'assainissement de qualité, sans affecter les écosystèmes environnants, et ensuite participer –avec d'autres municipalités et institutions- à des activités de coordination au niveau du bassin (ou sous-bassin) versant (Smits et Butterworth, 2006).

Sept mois de travail de terrain sur plus de trois années ont permis de réaliser de nombreux entretiens qualitatifs avec les habitants de la municipalité (dans quatre quartiers urbains et trois villages) ainsi que des informateurs-clé (autorités locales d'El Grullo et de quatre municipalités avoisinantes, membres de la Commission du Bassin Versant de l'Ayuquila-Armería, chercheurs de l'institut de recherche partenaire IMECBIO). Ces entretiens ont été complétés par de l'observation directe ainsi que des sources d'information secondaire.

Nos résultats montrent que malgré sa riche dotation en eau, la municipalité n'arrive pas à assurer un service municipal en eau de qualité. Celui-ci est très inégal suivant les quartiers et les villages, obligeant les habitants à faire face à travers des pratiques sociales adaptées (divers modes de stockage de l'eau et recours à des sources alternatives). L'inéquité qui résulte de la variabilité du service est encore renforcée par le système tarifaire fixe, en l'absence de compteurs. Par ailleurs, l'inexistence d'une station d'épuration des eaux usées, liée à l'insuffisante capacité financière d'El Grullo, défavorise les villages riverains et écosystème aquatiques situés en aval. Des efforts sont en train d'être mis sur pied afin de remédier à ces difficultés : la municipalité souhaite mettre en place des compteurs, et est par ailleurs en pourparlers avec une entreprise privée pour un projet de concession d'une lagune de décantation des eaux usées.

Au niveau régional, la Commission du bassin versant de l'Ayuquila-Armería est assez critiquée, après huit années d'existence, que ce soit pour la faible participation effective qu'elle convoque ou son manque de moyens et de résultats concrets. Au contraire, l'initiative inter-municipale de la partie médiane du bassin versant, plate-forme de négociation entre dix municipalités crée en réaction afin de financer les priorités locales, est un franc succès. Construite sur la base d'une confiance développée depuis une dizaine d'années par les chercheurs de l'Université de Guadalajara et la direction de la Réserve de la Biosphère Sierra de Manantlán, elle a permis à la rivière Ayuquila de retrouver son état originel et de mettre en place toute une série de mesures de protection de l'environnement (lutte contre les feux de forêt, tri et recyclage des déchets ménagers). A tel point que la Commission du bassin versant souhaite répliquer ce modèle afin d'en couvrir l'ensemble du bassin. Même si le plan de gestion restera fixé au niveau du bassin, de telles initiatives sont en effet jugées plus flexibles et plus adaptées pour mettre en œuvre une gestion intégrée de l'eau.

L'analyse de ces résultats montre que d'importants changements doivent avoir lieu afin que la municipalité d'El Grullo puisse améliorer ses efforts en termes de gestion intégrée de l'eau. La décentralisation en place doit notamment être renforcée, à la fois au niveau du service municipal de l'eau mais aussi de la Commission du bassin versant. D'une part, le tarif de l'eau potable doit pouvoir être fixé de manière indépendante par la municipalité, sur la base du coût de ses opérations –et non plus sur des principes politiques électoraux, comme c'est actuellement le cas au niveau du Congrès Etatique de Jalisco. Cela contribuera à mettre fin au cercle vicieux crée par une insuffisante capacité financière (personnel insuffisant, infrastructures mal entretenues, couverture du service très hétérogène, absence de compteurs, arriérés de paiements, etc.), en accompagnement d'autres mesures (comme l'encouragement à payer les factures). D'autre part, la Commission du bassin versant de l'Ayuquila-Armería doit pouvoir, elle aussi, bénéficier de plus de liberté et de moyens, afin d'accroître sa crédibilité auprès des municipalités incluses dans son champ d'action. La transcription effective de la réforme de la loi sur l'eau de 2004, qui va dans ce sens, est attendue au tournant par tous ceux qui s'intéressent à cette question.

Cette thèse permet donc de confirmer les analyses d'experts travaillant sur les problèmes de la gestion intégrée de l'eau au Mexique (Mollard et Vargas, 2005b; Tortajada, 2005 ; García, 2004 ; Centro del Tercer Mundo para el Manejo del Agua, 2003; Martínez et al., 2002b). Elle souligne aussi l'importance, pour chaque pays s'engageant dans la mise en œuvre de la GIRE, de trouver la manière la plus adéquate de le faire, qui ne passe pas forcément par l'échelle du bassin versant.

Mots-clés: Gestion intégrée des ressources en eau, Mexique, municipalité, décentralisation

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The universe of Mexico, which I have only just started to explore, is also an enchantment. I am delighted I had the chance to overcome certain prejudices I previously had regarding this country. It seems a very good complement to life in Switzerland: warm, full of life, colourful, sunny, but also loud and sometimes brutal, often unorganised and unpredictable!

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TABLE OF CONTENTS

List of Figures

List of Tables

List of Maps

List of Images

INTRODUCTION

In this chapter, we first present a snapshot of the global context of water, very often presented as one of crisis. In a second section, we introduce our research design: the institutional framework in which it took place, our research objectives and questions. The last section outlines the structure of the thesis.

1. A 'global water crisis': what kind of a crisis are we talking about?

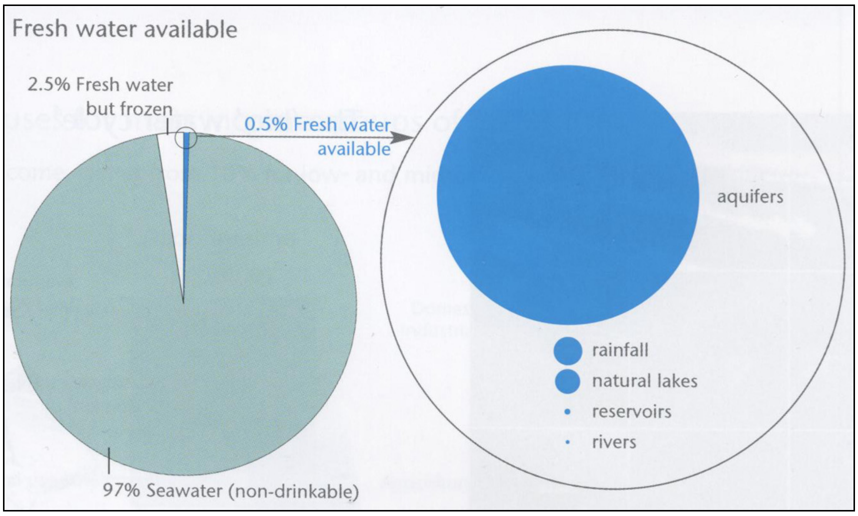
a. Facts and figures

Hereafter, we introduce the data which point out to a global water crisis: the reduction of freshwater availability per person –mainly due to rising demand and contamination of the resource- as well as the consequent environmental impacts.

Decreasing freshwater availability per person

Water resources (estimated to reach 1380 million km3) make up 70% of the planet's surface. But less than 3% of this is freshwater, the rest being saline. Moreover, 70% of the total freshwater is not available, as it constitutes the polar ices of Antarctic and Greenland. The 30% of freshwater actually available (12.3 million km3) is essentially groundwater (29%) and surface water (1%), which is the only easily accessible portion.

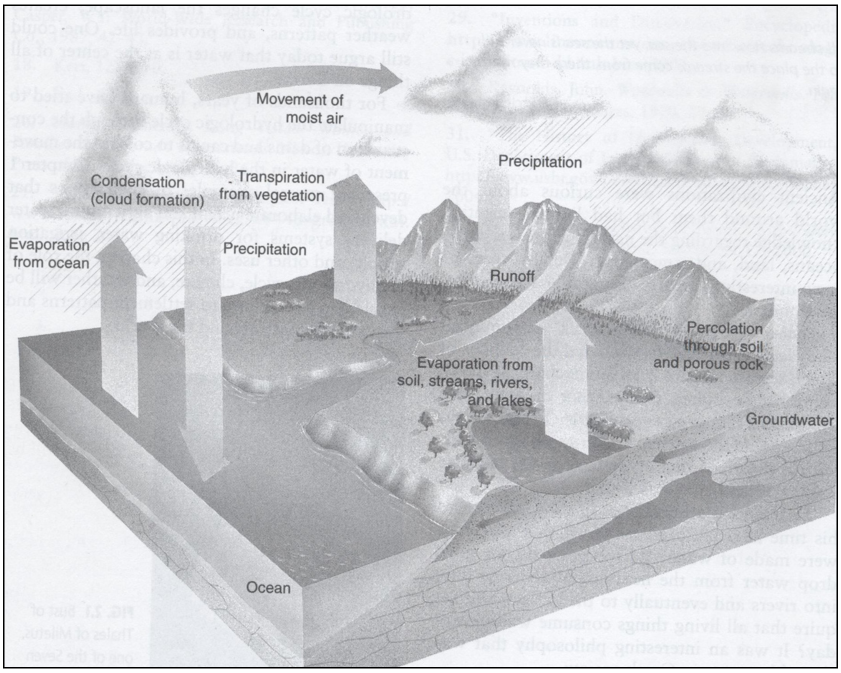
Figure 1: Available freshwater on Earth



Source: WBCSD, 2006: 1

Although water is a renewable resource that simply changes form and location –without creation or destruction- through the hydrologic cycle (see figure 2 below), two main factors are affecting its availability[1].

Figure 2: The hydrologic cycle



Source: Cech (2005: 24)

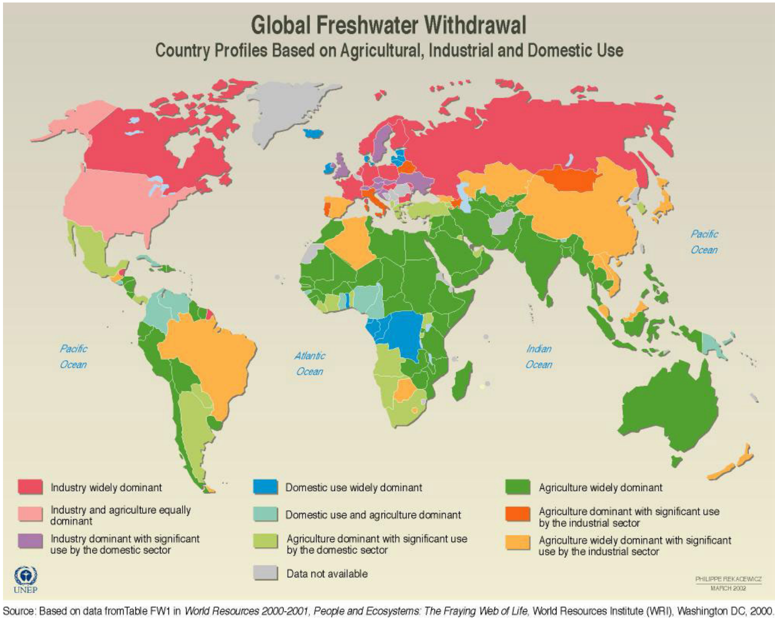
The first factor is population growth. Competition over the same amount of freshwater has rather intensified during the last century, as global population more than tripled –from 1.6 million to 6.1 million (reaching 6.5 million today). But global freshwater consumption increased even more than twice the rate of the population growth, rising six-fold between 1900 and 1995.

This is because population growth incurs an increase in water demand for agriculture, domestic use, hydropower, industry, etc. While agriculture has always maintained a prominent position (reaching 70% of total water use worldwide), during the last century industrial and municipal uses have at least tripled, reaching respectively 24% and 9% today (UNDP, 2006). These proportions nonetheless vary according to the countries (apart from that of domestic uses, similar to the world average): agriculture reaches more than 80% in

[1] This is without mentioning the effects of climate change on the hydrologic cycle, difficult to quantify (Dupont, 2006). Indeed although it could increase annual precipitation in some instances, rising temperatures can also increase the rate of evaporation and lead to loss of freshwater trapped in glaciers (WBCSD, 2006). In any case, all countries –and especially the poorest people in poor countries- "will feel the impact of changing rainfall patterns, extreme weather events and rising sea levels" (UNDP, 2006: 134).

low and middle-income countries[2] and drops to 30% in high-income ones, while industrial uses fluctuate between 10% to 60% respectively (UN-WWAP, 2006b).

Map 1: Freshwater uses by sector



Source: UNEP, 2002

Further, various changes in lifestyle (expectation to find all crops all year round, thus requiring more irrigation, or increased consumption of meat, as well as impacts of tourism on local resources) combined with urbanisation (water supply of big cities is often realised through over-exploitation of aquifers[3] or massive water transfers) also put more pressure on the resource (UN-WWAP, 2003a). Increasing affluence in countries like India and China for instance also entails increased water consumption, be it for basic water and sanitation needs or other lifestyle-induced changes (gardens, car-washes, swimming-pools, etc.) (WBCSD, 2006).

Water reserves are also decreasing because the natural components of the hydrological cycle (precipitation, infiltration, runoff, evaporation and transpiration) are being disturbed by human activities –such as deforestation, sedimentation, urbanisation- that prevent the cycle from pursuing its normal pathway[4] (UN-WWAP, 2006b).

[2] This is the result, among other things, of development policies in the 1950s-1970s that had the primary objective of increasing crop yields through the extension of irrigation (Meublat, 2001).

[3] Although underground water constitutes an important reserve, extraction rates often exceed the rhythm at which it is renewed.

[4] Evapotranspiration, which occurs at the level of plants and the soil, is reduced by deforestation or urbanisation. Sedimentation, for its part, impacts the water quality.

As a result, the availability of freshwater per person has decreased by 40% since 1970, and will continue to do so, by 30% until 2025 (UN-WWAP, 2003a). Reserves have plummeted from 16,800 m3 per year per person in 1950, down to 7300 m3 in 2000 and are expected to reach 4800 m3 in 2025 (Dupont, 2006).

This is sufficient on average, but does not reflect uneven distribution: a total of 700 million people live in 43 water-stressed countries today, a figure which is only bound to increase as most experience very high population growth. The latest data regarding global statistics speak for themselves: in 2002, 1.1 billion people still do not have access to safe drinking water, while 2.6 billion lack access to improved sanitation (UN-WWAP, 2006b).

Ecosystem-wise, freshwater biodiversity –which tends to be highest in tropical regions- is facing important losses: 50% of wetlands have disappeared in the past century, while 20% of all freshwater species are threatened or extinct, due in part to habitat destruction and pollution (IUCN, 2000).

The second factor impacting water availability, in addition to its relative scarcity, is its contamination (UNEP GEMS/Water Programme, 2004). As a reminder, 1 m3 of contaminated water puts 8-10 m3 of freshwater out of use (Dupont, 2006).

In developed countries, freshwater quality has degraded as a consequence of the socio-economic development that rose after the Industrial Revolution. Point source pollution now being rather under control[5], the priority is put on non-point source pollution (Somlyódy, 1995). Intensive agriculture, with over-use of chemical fertilisers and pesticides, is the main source of pollution of rivers and aquifers, makings the water dangerous and costly to treat.

In developing countries, demographic changes are important factors for the future. These countries harbour the fastest growing cities –which are also those with low levels of infrastructure for both water supply and wastewater treatment. The major issue might thus well be urban pollution management (Somlyódy, 1995). In Latin America, for example, 75% of the population is urban and only 2% of total urban sewage is treated (IUCN, 2000). Industry and agriculture also bear the responsibility for freshwater pollution.

Such pollution has chain-reaction consequences. Discharging untreated wastewaters into rivers alters freshwater species' habitat, thereby impacting on the whole ecosystem's functionality (IUCN, 2000). Consequently, rivers' efficiency to auto-purify decreases (Dourojeanni, 2002). This creates many potential hazards for populations living downstream, such as the contraction of water-borne diseases. By way of reminder, due to lack of access to safe drinking water, poor sanitation and insufficient hygiene, water-related diseases cause at

[5] Urban wastewater treatment has been ongoing for decades while important efforts were made to cut industrial pollution during the past twenty years.

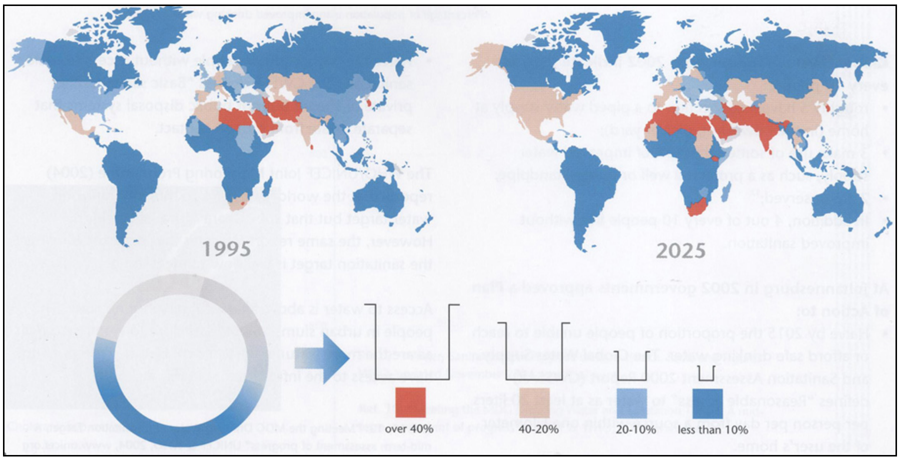
least three million deaths each year[6] –i.e. 8000 people per day, mostly children- essentially in developing countries (UN-WWAP, 2006b). But like hunger, lack of access to water of good quality is a silent crisis, not reaching the headlines like wars or natural disasters, although "it claims more lives through disease than any war claims through guns" (UNDP, 2006). River contamination also affects livelihoods through reduced fishing yields, which provide cheap and high quality protein (Hardoy et al., 2001).

These two factors (population growth and increasing contamination) contributing to decrease freshwater availability per person, are affecting a resource that is already very unevenly distributed, geographically speaking. About 60% of the resource is located in nine countries –Brazil, Russia, China, Canada, Indonesia, USA, India, Colombia and the Democratic Republic of Congo- even though local variations inside the countries can also be significant (WBCSD, 2006). As a means of comparison, Latin America has 12 times more water per person than South Asia (UNDP, 2006). Where important seasonal variations take place, average national data do not reflect the reality of the water availability either.

Future prospects

"About one third of the world's population already lives in countries considered to be 'water stressed' -that is, where consumption exceeds 10% of total supply[7]. If present trends continue, two out of every three people on Earth will live in that condition by 2025" (Annan, 2000).

Map 2: Freshwater availability prospects in 2025



Source: WBCSD, 2005: 8

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[6] Mainly diarrhoeal diseases (1.8 million deaths) and malaria (1.2 million), along with dengue, schistosomiasis, Japanese encephalitis, intestinal nematode infections (0.6 million altogether) –but many more infectious and non-infectious diseases related to water exist, for which sufficient data is unavailable.

[7] The threshold under which a country is considered to be experiencing water stress (i.e. translating that there is insufficient water to meet all agricultural, industrial, domestic and environmental needs) is 1700 m3/year/person.

By 2025, predictions estimate that "water withdrawal will increase by 50 percent in developing countries and 18 percent in developed countries" (UN-WWAP, 2003a). In regard to the future population increase and consequent water demand for food production, global demand for irrigation would rise by 17% compared to 2000, probably matched by a rise of 20% and 70% respectively for industrial and municipal uses (WWC, 2000).

As a consequence, water conflicts are bound to develop between demands for agriculture, human domestic supply, electricity production and ecosystems (Duda and El-Ashry, 2000), i.e. between the numerous human activities on the one hand, and between these and environmental needs on the other. With 60% of the world's population projected to be urban by 2030 (United Nations Population Division, 2002), water policies worldwide must therefore ensure a more balanced distribution between irrigation purposes and urban demand for water –which usually coincides geographically with industrial demand: "In many of these areas, water is being allocated to higher valued industry and urban uses, leaving agriculture and the environment to compete for decreasing amounts of water" (Molden et al., 2001: 15). As a result, predictions are made that "the area of water stress and conflict that is likely to intensify the most is not between cities and agriculture, but rather between nature and agriculture" (Moore, 2004: 49).

To face the problems of decreasing freshwater availability, two main opponent approaches exist. The first is technical, oriented towards exploring new sources of water supply, through three paths: increasing the exploitation of groundwater resources through sinkings; pursuing the 20th century's dam building policy; and desalinating sea water[8]. The second approach seeks to reduce our water consumption: although also based on technical innovation (such as drip irrigation or wastewater recycling), demand-oriented management requires an additional change in stakeholders' mentality beforehand (Dupont, 2006).

But the limited possibilities to increase supply as well as the current unsustainable situation in terms of impacts on the ecosystems lead many to conclude to the unbalanced arithmetic of water, under current management procedures[9] (WWC, 2000).

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[8] The technology of desalinisation produces 20 million m3 of freshwater daily, i.e. 1% of world consumption. It is particularly developed in some rich coastal countries like Kuwait, United Arab Emirates, Saudi Arabia, and Qatar, whose petrol can sustain this energy-intensive and costly technology (USD 1000/m3 on average), but is also spreading in Asia and southern Europe (de Fillipis, 2000).

[9] This situation is all the more challenging in developing countries, where lack of information and resources offer even less optimistic prospects.

b. A management crisis

In 2000, the *World Water Vision*, presented by the World Water Council at the 2nd World Water Forum clearly stated that the water crisis existing in many parts of the world is generally not caused by a lack of the resource, but by poor water management (WWC, 2000). The Human Development Report of 2006 concurs, insisting that most countries have enough water to meet all human and environmental needs and that “what passes for scarcity is a policy-induced consequence of mismanaging the resource” (UNDP, 2006). As resumed by F. Lasserre: “The actual crisis, much more than a question of scarcity, is one of sharing, distribution and choices made in the use of this water” (translated from Lasserre, 2005).

Illustrative of this, the Water Poverty Index (WPI) developed by the UK Centre for Ecology and Hydrology, attempts to describe the different factors that influence relative water poverty[10]. Although it demonstrates the strong connection between water poverty and income poverty, it nevertheless finds that some of the world’s richest countries, also richly doted in water resources –such as the United States- score poorly, while some developing countries like Guyana or Suriname are in the top-ten list. As highlighted by Dr. Abu Zeid, former President of the World Water Council: “In many countries, water shortages stem from inefficient use, the effective loss of available water too polluted for use by humans or nature or by the unsustainable use of underground water in aquifers, which can take thousands of years to replace. The WPI lays this out statistically in a valuable road map” (WWC, 2002).

Scientists like Falkenmark (1989) or Calder (2005) wish to avoid ringing an alarm bell. As the latter out points out: "Overstating the dangers may be counter-productive in terms of focusing necessary support. Policymakers and the public are not unaware of the vested interests of environmental scientists and environmental institutions in furthering crisis scenarios" (Calder, 2005: 1-2). Nonetheless, they also agree that more action is now needed to prevent irreversible environmental degradation currently underway.

Indeed, although the current ‘global water crisis’ was already announced in 1977 at the Mar del Plata Conference, the decade of the 1990s is remembered as was one of debate rather than action to address the crisis, which in the meantime, has become more acute (Duda and El-Ashry, 2000).

[10] It grades 147 countries according to five measures: resources (measuring the per capita volume of surface and groundwater that exist), access (measures a country’s ability to access water for drinking, industry and agriculture use), capacity (a country’s level of ability to purchase, manage and lobby for improved water, education and health), use (measures how efficiently a country uses water for domestic, agricultural and industrial purposes) and environmental impact (water quality, environmental strategies and regulations, and endangered species).

It is first the complexity of the networks that water, by nature, creates –through its links to other resources such as land and biodiversity, or its linking of the various human interests vested in its use- that makes the implementation of adequate management measures difficult (Brüschweiler, 2003). There is a need to approach these linkages all together: "There is no denying the existence of a global water crisis. The root causes of the crisis are complex. At the same time, our planet and its residents are experiencing a global crisis in land management, environmental management, and governance that is closely linked to the water crisis and is made worse by over-consumption of the North, population growth in the South, and rapid globalization of trade and economic systems. Solutions to these crises cannot be formulated in isolation" (Duda and El-Ashry, 2000: 123).

But according to Margaret Catley-Carlson, former Chair of the Global Water Partnership, the major issue that needs to be dealt with is not a lack of technical solutions or research on the topic: "The single biggest challenge isn't that the science isn't there, isn't that we couldn't devise better ways of managing water –it's the extreme reluctance of governments, of states, of communities to take water management as a serious issue" (IDRC, 2005). People are generally unaware, she says, of the extent to which changes in the last fifty years are modifying habits acquired over the last millennium. Free, unlimited access to water is no longer a possibility. In the end "it is attitude and behaviour problems that lie at the heart of the crisis […] inertia at leadership level, and a world population not fully aware of the scale of the problem means we fail to take the needed timely corrective actions" (UN-WWAP, 2003b: 4).

At stake is the governance of the 'Blue Revolution' for the 21st century, stated as such by the United Nations to establish a parallel with the 20th century's water-thirsty 'Green Revolution' (Meublat and LeLourd, 2001). Due to the specificities of each society in its relation to water, there is no one-size-fits-all governance response to the challenge (Peña and Solanes, 2002). More and more, discussions nevertheless take place at the global level to try and find solutions to the 'global water crisis'.

c. Water –and IWRM- at the forefront of the international agenda

The complexity of water issues has become particularly obvious during the last quarter of the 20th century, with progress made in scientific knowledge, as well as rising geopolitical tensions, economic costs or social risks worldwide. An increasing awareness of this 'global water crisis' spurred an institutional effervescence (see annex 1 for a presentation of the main institutions and their objectives), along with a parallel acceleration of global events dedicated to water. Hereafter we present the main such events and their outcomes in terms of water management principles.

In the arena of international policy[11], although initiatives had been undertaken as early as the 1950s to assess water resources or review watershed management and its consequences (White, 1998), the United Nations Conference on Water, held in 1977 in Mar del Plata, Argentina, constitutes a major benchmark which defined the first general principles for national and international agencies[12]. Its Action Plan covered issues such as water resources assessment, water efficiency, environment, health and pollution control, legislation and international cooperation. One of its great successes was the preparation of the 1980-1990 International Water Supply and Sanitation Decade, which provided the incentive for many countries to move forward in the area[13] (Biswas, 2004). After that, according to A.K. Biswas, no new ground was broken and "water disappeared from the international political agenda during the 1980s and 1990s" (Biswas, 2004: 81).

In 1990 a global consultation was nonetheless held by the United Nations Development Programme to compile regional assessments of the Decade, producing the *New Delhi Statement* (Salman, 2003a). The principles on which it was based[14] were recycled into what emerged, two years later at the International Conference on Water and the Environment, as the 'four Dublin principles': fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment; water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels; women play a central part in the provision, management and safeguarding of water; and water has an economic value in all its competing uses and should be recognised as an economic good (WMO, 1992).

This was the beginning of a new economic approach to water management, which developed throughout the 90s decade. Rising statistics about water stress in many countries provoked a change in perception, which led from unbounded belief in water development projects, to realising the finiteness of the resource and the need for its careful management. The traditional approach of supply management (extending supply to meet increasing needs) was reversed towards one articulated around demand (Allouch, 2002). It also initiated the ongoing debate regarding the definition of water as an economic good versus that of a human right.

[11] Over a span of 50 years starting in the 1950s, at scientific research level many international programmes were also initiated to address the need for basic data and research related to water: UNESCO's International Hydrological Program, the World Meteorological Organization, the World Health Organization, the Food and Agriculture Organization, the United Nations Environment Programme, the International Council of Scientific Unions, the World Bank and IUCN programme on large dams (White, 1998).

[12] It also constitutes the sole conference specifically dedicated to water under the aegis of the United Nations.

[13] Successes were unfortunately neutralised by the population growth during that decade (Salman, 2003a).

[14] Among these, the first was dedicated to the 'Protection of the environment and safeguarding of health through the integrated management of water resources' (Salman, 2003a).

For Biswas, in addition to the counter-productiveness of the form it took[15], the Dublin Conference was organised far too late to be able to feed any input into the Earth Summit a few months later. In terms of content, nothing new was brought forth, ignoring "critical issues like major programme initiatives, including how much would such programmes cost, where would the funds come from, and how and by whom would the programmes be implemented" (Biswas, 2004: 83). Water was not mentioned in the Rio Declaration on Environment and Development, while the chapter of the global action plan (Agenda 21) dedicated to the *Protection of the quality and supply of freshwater resources: Application of integrated approaches to the development, management and use of water resources* was largely inspired by the Mar del Plata Action Plan (Salman, 2003a).

Further, at the Rio Conference, known worldwide for having launched 'sustainable development' as a global concept [16], water was relatively neglected compared to issues of biodiversity, climate change and deforestation and the ozone layer (Biswas, 2004). For Meublat (2001), water was left aside at Rio because during its preparation process at the end of the 1980s, global issues like climate change, biodiversity or deforestation provided more interesting stakes for some actors of this geopolitical game, like the USSR and the USA. According to him, it is actually this marginalisation of the water issue in 1992 which contributed to the institutional outburst that followed –creation of the International Network of Basin Organizations, the Global Water Partnership, the World Water Council, the Stockholm International Water Institute and various professional associations- in order to regain a high profile in the international political agendas, and access to corresponding financial sources.

Starting 1997, World Water Forums have been held every three years, the theme of integrated water resources management more central each time[17]. In 2000, in The Hague, the landmark document *The World Water Vision* stressed that: "It is essential to take a holistic approach to integrated water resources management (IWRM). Decisions must be participatory, technically and scientifically informed, and taken at the lowest appropriate level –but within a framework at the catchment, basin, and aquifer level, which are the natural units by which nature manages water" (WWC, 2000). In 2003 in Japan, the Global Water Partnership's IWRM toolbox was introduced. The main theme of the last such forum, held in Mexico City in March 2006, was 'Local Actions for a Global Challenge'. Along with four other framework themes, IWRM was discussed, in particular "diverse river basin approaches and experiences […] in an attempt to further elaborate on the political, social,

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[15] It was conveyed as an experts' meeting, whereas UN world conferences can only consider recommendations from inter-governmental meetings (Biswas, 2004).

[16] The actual first reference to sustainable development was in the Bruntland report *Our Common Future,* published by the World Commission on Environment and Development in 1987 (Holliday et al., 2002).

[17] The forums are organised by the World Water Council, a think-tank on IWRM issues.

economic, institutional, technological and cultural factors that have an influence over the performance of such integrated approaches" (CNA and WWC, 2004). According to Jean Fabre, Deputy Director of UNDP, although the official attendance to the Forum demonstrated that water is still not considered a priority, one of its positive outcomes was to increase awareness of certain technical problems, in particular the need to manage water in an integrated way and not according to different sectors (irrigation, industry…) as has traditionally been the case (Dubuis, 2006).

In 2000, adopting integrated water resources management was recognised as one of the actions needed to achieve the Millennium Development Goals (MDGs) of the United Nations' Millennium Assembly, now "the centrepiece of the global development agenda"[18]. The concepts underlying IWRM are recognised as important for MDG goal 1 (related to extreme poverty and hunger), goals 4, 5 and 6 (human health) and especially goal 7 (environmental sustainability and access to water and improved sanitation) whose target 10 specifically aims: "To halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation" [19] (UN Millennium Project, 2005: xix). Nevertheless, as Calder (2005) reminds, trade-offs will have to be negotiated between the different goals and vested interests constitutive of these goals, and control needed to ensure that MDG-driven water and sanitation schemes do not damage the environment, while environmental schemes do not disadvantage poor people.

Compared to the Rio Conference ten years before, in 2002, the World Summit on Sustainable Development in Johannesburg focused on combating hunger and on access to water and sanitation (Chautard, 2002). To do so, "governments embraced integrated water resources as the model for the future" (UNDP, 2006: 153). As part of the claim for measurable progress of other water-related targets included in the Johannesburg Plan of Implementation, they sent a call to all countries to "develop integrated water resources management and water efficiency plans by 2005, with support to developing countries" (UN-DESA, 2002).

In 2004, the Third World Centre for Water Management undertook a survey to assess the impacts of the conferences that have had direct implications for the water sector, held between 1977 and 2003 (Mar del Plata, Dublin, Rio, Marrakech, Bonn, The Hague, Johannesburg and Kyoto). Results show that although these events do increase awareness and provide opportunities for interaction, they have in general been very little cost-effective, offering too many homogenous solutions and producing too few impacts, and should be more output-oriented in the future (Third World Centre for Water Management, 2005).

[18] Not surprisingly, Jeffrey Sachs, commissioned to report on progress made towards the MDGs, concludes that most countries will not make it by 2015; to do so would require a six-fold budget for UN antipoverty work, and investment in infrastructure (roads, ports, energy) and health care (Calder, 2005).
[19] The issue of sanitation was added in the aftermath of the Johannesburg Conference (Chautard, 2002).

According to Salman, the problem resides in the fact these conferences and forums produce resolutions or declarations that, contrary to Conventions, are statements with no legally binding effects on the countries adopting them, the same being true for their action and implementation plans (Salman, 2003b). To make things worse, these documents "awash in generalizations and compromising language, reflecting a clear inability to reach an agreement on any of these issues […] lack specific measurable actions and programs" (Salman, 2003b: 17).

Below we have summarised the major milestones and institutional mushrooming that show a rising preoccupation for water in the international arena during the 1990s and early 2000s, to both raise awareness about and find solutions to the 'global water crisis'.

International milestones		Creation of major institutions
	1950	International Council on Irrigation and Drainage (1950)
	1960	UNESCO International Hydrological Programme (1965-1974)
		The International Water and Sanitation Centre (1968)
	1970	International Association of Hydrological Sciences (1971, evolving since 1922)
		International Water Resources Association (1972)
United Nations Conference on Water (Mar del Plata, 1977)		UNEP Global Environmental Monitoring System for Water Programme (1978)
	1980	
International Drinking Water and Sanitation Decade (1981-1990)		
Global Consultation on Safe Water and Sanitation for the 1990s (1990)	1990	Water Supply and Sanitation Collaborative Council (1990, evolving since 1988)
International Conference on Water and the Environment (Dublin, 1992)		International Office for Water (1991)
United Nations Conference on Environment and Development (Rio, 1992)		International Network of Basin Organizations (1994)
		Global Water Partnership (1996)
		World Water Council (1996)
Earth Summit +5 (New York, 1997)		Stockholm International Water Institute (1997)
1st World Water Forum (Marrakech, 1997)		
United Nations' Commission on Sustainable Development sixth session (New York, 1998)		European Commission DGs Research, Development and Environment Task Force on Water and Environment (1997)
International Conference on Water and Sustainable Development (Paris, 1998)		
		International Water Association (1999)
Millennium Summit (New York, 2000)	2000	The International Water Management Institute (2000, evolving since 1983)
2nd World Water Forum (The Hague, 2000)		World Water Assessment Programme (2000)
		World Bank Water Resources Management Group (2000)
International Conference on Freshwater (Bonn, 2001)		International Water History Association (2001)
World Summit on Sustainable Development (Johannesburg, 2002)		
International Year of Freshwater (2003)		UN Water (2003)
1st Alternative World Water Forum (Florence, 2003)		
3rd World Water Forum (Kyoto, 2003)		
International Decade for Action "Water for Life" (2005-2015)		
2nd Alternative World Water Forum (Geneva, 2005)		
4th World Water Forum (Mexico City, 2006)		

2. The research design

The purpose of this section is to present the institutional setting in which this research took place, as well as the research's backbone: its objectives, and the questions that guided it.

a. Institutional framework

Swiss research and North/South issues

This PhD research project was developed in the framework of the Laboratory of Urban Sociology (LaSUR) of the Ecole Polytechnique Fédérale de Lausanne (EPFL) in Switzerland.

In 2001, the LaSUR, who has a long research tradition regarding urban societies in Latin American countries, was selected as one of the eight institutions to be part of the National Centre of Competence in Research (NCCR) 'North-South', one of the fourteen such programmes implemented by the Swiss National Science Foundation to strengthen the country's position in terms of international research.

The NCCR North-South can be identified as an effort towards what Bolay refers to as a responsible and supportive scientific collaboration (Bolay, 2004d). Co-funded by the Swiss Agency for Development and Cooperation, it has the objective "to engage in research partnerships for mitigating syndromes of global change" [20] (Hurni et al., 2004: 12). Disciplinary, interdisciplinary and trans-disciplinary research focused on sustainable development is undertaken in both Switzerland and partner countries, in particular through support of PhD studies, while research results also feed into small development projects.

During the first phase of this research programme (2001-2005)[21], each of the eight Swiss partner institutions was in charge of a thematic –ranging from natural resources to water, sanitation and urban agriculture, health, environmental conflicts, livelihoods and institutions, governance. Research activities were also concentrated in specific regions throughout the world (NCCR North-South, 2003).

The LaSUR focused its research activities on the theme of social practices and empowerment in urban societies, in the Caribbean and Central America region. The aim was "to identify and promote innovative forms of social practices that contribute to the integration of

[20] Syndromes of global change are "clusters of ecological, social, economic, etc. problems or symptoms that form typical patterns, are based on similar processes and emerge in different regions of the world, thereby actually or potentially resulting in adverse impacts at the global level" (Hurni et al., 2004: 12).

[21] The second phase of the NCCR North-South (2005-2009) underwent very important restructuring (NCCR North-South, 2005), which we will not detail here as our PhD was designed prior to such changes.

different groups of urban stakeholders by examining strategies of populations compared to top down policies implemented by public authorities" (LaSUR, 2002: 2).

Inside this overarching topic, various research projects were developed in several countries of the region, around three sub-themes: intermediate cities in borderlands such as Haiti-Dominican Republic or Costa Rica-Nicaragua; urban violence and insecurity in Venezuela and San Salvador; and environmental risks, development and urbanisation: identification of strategies for sustainable regional planning focusing on natural resource management in the context of urban-rural interactions, in Mexico.

Research collaboration in the Ayuquila watershed, Mexico

This PhD project was developed as part of the third sub-theme, whose specific environmental core coincided with my personal interests. In particular, the institutional partner in Mexico, the Manantlán Institute of Ecology and Conservation of Biodiversity (IMECBIO) from the Centre for the South Coast of the University of Guadalajara (CUCSUR-UdG), had been working closely with the Sierra de Manantlán Biosphere Reserve. This is a protected area part of UNESCO's International Network of Biosphere Reserves, an institutional set-up I had already had the opportunity to work for.

Several other research projects were also developed under the theme of environmental risks, development and urbanisation in Mexico: another PhD study (that of Silvia Hostettler, on land use changes and trans-national migration), various MSc. and BSc. studies and a research project studying the impacts of urbanisation on the management of natural resources in eight municipalities in the region (Gerritsen et al., 2005).

The topic of this research partially resulted from in-depth discussions with researchers from the IMECBIO during the first long period of fieldwork. In particular, water resources' management had been identified as one of the priorities to be dealt with by these actors and the municipalities they work with, inside the Ayuquila watershed (more details are provided for in Chapter 3, which presents the area of study).

One of these, the municipality of El Grullo, was chosen for several reasons: the challenges it is confronted with, as it is one of the rare municipalities in the region to expect an increasing water demand due to urban growth, and is also bordered by the Ayuquila River, thus offering interesting insights into riparian issues; the fact it has always been one of the leader municipalities in the region with respect to environmental initiatives; its small size, making it easier to study than any of the others; and its proximity to my municipality of residence (Autlán).

To say it in NCCR North-South terms, in this urban/peri-urban and highland-lowland syndrome context, my PhD research project aimed to contribute to a better understanding of three of the priority core problems identified in the Caribbean and Central America region: urbanisation (access to water, services, management of waste); river depletion and pollution; and inadequate institutional mechanisms to solve environmental conflicts. These core problems are linked to the syndromes of freshwater availability reduction and of urban sprawl (Barrera et al., 2004).

Some personal anecdotes, highlights of seven months of fieldwork over a span of three and a half years, are presented in annex 2. They introduce the general context from which the research cannot be dissociated.

b. Research objectives and questions

Information gap

As we saw in the first section of this introductive chapter, IWRM has been promoted worldwide since the mid-1990s by many international institutions. As we detail in Chapter 1, its actual implementation encounters many problems.

According to A.K. Biswas, one of the most virulent opponents to such a promotion, the concept is being diffused despite the fact there is no agreement regarding its definition, implementation procedures, nor whether it has enabled any real difference in improving water management practices, and he calls for an assessment of the concept's applicability (Biswas, 2005).

Likewise, although Calder (2005) finds it positive that many of the UN water-related conferences played an important role in developing concepts such as IWRM, even more than their frequency[22], he questions the usefulness of preaching the same thing to the converted. More useful would be to undertake studies of "what is going wrong on the ground, why these ideals are not being met" (Calder, 2005: 75). In particular, the specific constraints in developing countries –such as legal, institutional, political, technical, socio-economic, and informational constraints to integrated water management- must be better acknowledged (Thioubou, 2002).

Basing ourselves on such appeals, and confirmed in such a topic by Mexico's 2004 reformed Water Law that explicitly refers to IWRM as one of the national objectives, we decided to

[22] At least 20 such conferences took place during the last three decades of the 20th century (Calder, 2005).

study the implementation of such a concept in our region of study, in particular to identify the pitfalls it encounters.

Objectives and questions

Due to limited time and scope within this individual research, it seemed neither realistic nor optimal to undertake the study of IWRM at the level of the whole watershed, its recommended scale of implementation.

Convinced that the local scale, as highlighted at the last World Water Forum, has a very important part to play, and inspiring ourselves from the framework developed by a European research project in southern Africa , studying the constraints municipalities face in implementing IWRM[23], we therefore narrowed our study down to see to what extent a municipality, part of such a watershed, can participate in the process.

As a result, we defined the following research objective and questions:

General research objective: The objective of this study is to analyse a concept that is promoted internationally –integrated water resources management- in order to identify the necessary local conditions for its practical implementation.

Research question 1: In what respect is an IWRM innovative compared to traditional water management?

Research question 2: How is the potable water management system designed in the municipality of El Grullo, Mexico?

Research question 3: What are the local and necessary conditions to implement an IWRM?

The methodology used to answer these questions is presented in Chapter 3.

3. Thesis structure

The dissertation is organised in four chapters.

[23] The project is presented with more detail in Chapter 1.

Chapter 1 presents an overview of the literature review regarding IWRM (its history, implementation tools, examples and the problems encountered), as well as the conceptual framework that structured this research (approaching IWRM through the lens of a municipality).

After giving a snapshot of the water resources' situation in Mexico, Chapter 2 outlines how IWRM has started to be implemented in the country, though a long legislative, institutional – and unachieved- process.

In Chapter 3, we introduce the area of study, from the broad regional perspective of the Ayuquila-Armería watershed, narrowed down to the municipality of El Grullo. We also explain the research methodology we developed, in terms of data collection and analysis.

Chapter 4 presents our main research results regarding El Grullo's approaches to implementing IWRM, at both a local scale –through the provision of water and sanitation services- and a regional one –through its involvement in the Ayuquila-Armería Watershed Commission and the Inter-municipal Initiative for an Integrated Management of the Ayuquila River Basin. Emphasis is put on the necessary changes required to enhance these efforts on both scales.

In a concluding chapter we wrap up our main findings, outline the limits of the exercise and contribute reflections to some of the ongoing debates related to IWRM (best implementation scale, international transposition potential and ways forward for a better applicability).

CHAPTER 1 – INTEGRATED WATER RESOURCES MANAGEMENT: WHY, WHAT, HOW AND WHERE? LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

"Integrated Water Resources Management (IWRM) can be regarded as the vehicle that makes the general concept of sustainable development operational for the management of freshwater resources" (UN-WWAP, 2003a: 37).

To prevent a further aggravation of the water management crisis, IWRM has been widely promoted by a number of organisations since the 1990s. In this chapter we first identify more precisely what it means, to then analyse its status of implementation. In a third part, we focus on the implications of IWRM for a specific scale of implementation: the municipal level.

1. Why did IWRM come to exist, and what is it? Debate around its history and definitions

No clear-cut consensus exists as to when IWRM actually started.

According to A.K. Biswas, 2006 Stockholm Water Prize winner, its actual promoters falsely state that it stems in the 1992 Dublin International Conference on Water and the Environment. He explains this by the fact that in the 1990s, many in the water profession "began to appreciate that the water problems have become multi-dimensional, multi-sectoral, and multi-regional, and filled with multi-interests, multi-agendas, and multi-causes, and which can only be resolved through a proper multi-institutional and multi-stakeholder coordination" (Biswas, 2005: 321). Such preoccupations led to a rediscovery of IWRM, and its subsequent prompt adoption, "to the extent that some people and institutions now consider it to be the 'holy grail' of water management" (Biswas, 2005: 328).

Since then, a worldwide promotion of IWRM has been engaged, often without acknowledging its historical background (Biswas, 2005). What might explain such an attitude could be the important evolution, definition-wise, of the concept[1], from its early beginnings until today. More cynically, it could also be the fact its actual promoters want to be remembered as the 'inventors' of the term.

[1] Throughout this research we refer to IWRM as a 'concept', even though it is far from being a pure academic product resulting from a theorist tradition. IWRM corresponds more to a hybrid between global preoccupations and a certain political ideology, and, as such, could also be termed as a 'model'.

a. Evolution of the definition over the last 75 years

The ongoing worldwide promotion of IWRM has taken place regardless of the fact no consensus has been found with regards to its definition (Biswas, 2005). In his analysis of the literature, Biswas identifies 37 different possible meanings of the concept, according to the authors' viewpoint on the different issues that should be 'integrated' (see annex 3).

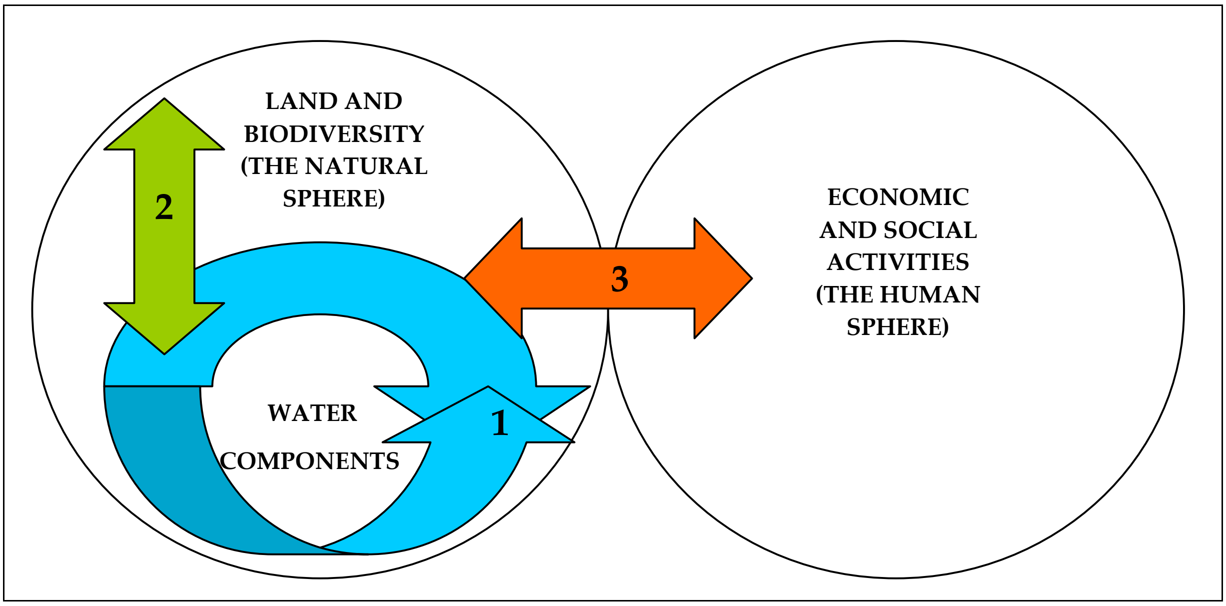
Mitchell's typology (1990) enables to simplify this broad spectrum, as he presents three possible interpretations of integrated water management.

The first is the systematic consideration of the various components of water (surface and groundwater, quantity and quality) and their interrelationships. In this case, management is jointly concerned with water supply, waste treatment and disposal, and water quality.

The second possible interpretation considers water as a component that interacts with other systems, in particular those of land and the environment. Land-based activities indeed have many impacts on water flows and quality, while water also impacts the land through erosion, salinity and wildlife support. Management then focuses on floodplains, erosion control, non-point sources of pollution, preservation of wetlands and fish habitat, agricultural drainage and recreational uses of water.

Finally, the third interpretation concerns the interrelationship between water and social and economic development, water being both an opportunity and a barrier. Management focuses on hydroelectricity, transportation of goods and manufacturing or industrial production.

Figure 3. The interpretations of IWRM according to Mitchell: an increase in scope and complexity



These three interpretations are not automatically exclusive of one another, as we will see: hereafter we have tried to date them all along the 75-year span of IWRM's existence during the 20th century.

IWRM, understood as the interactions between the different water components (apart from that of its quality, still not considered an issue[2]) and those between water and the human sphere –i.e. respectively the first and third interpretation- first emerged in the 1930s.

Until then, water management had essentially been organised around single purpose projects: dams on rivers were built either for hydropower or storage, irrigation or cities (White, 1998). Such an approach was the logical extension of the 19th century's engineer works, whose achievement to provide water for industrialisation and urbanisation had been a main factor in improved quality of life and extended life expectancy (Calder, 2005).

During the 30s, the move from single to multi-purpose water projects in the Tennessee, Loire and Ganges rivers marked the beginning of integrated water resources management (Duda and El-Ashry, 2000; White, 1998). Due to engineering developments, dams could then be used both for hydropower and storage for irrigation or cities, as well as flood protection (Aubert, 2000), while deep wells allowed extraction of groundwater for domestic uses (White, 1998). Reflecting the concurrent increasing needs for either new water sources –from either the surface or the ground- or to find places to discharge the wastewaters, the term "catchment" evolved from meaning the headwaters, to include the whole land surface part of a hydrological unit (Calder, 2005).

It is also during this period that treatment of domestic and industrial waste was initiated (White, 1998). These first ever preoccupations of water quality issues were to grow stronger over the next decades (de Jong, 1995).

Thus in this 'first generation of IWRM', the multi-use of water for human activities started to be considered, as well as water in its different components of quantity and quality, surface and groundwater.

The last interpretation of IWRM –concerning the interactions between water, land and ecosystems- can be coined as the 'second generation of IWRM'. It started in the 1960s, but really took shape twenty years later. The decade of the 1960s was when was initiated the first questioning of "the full social and environmental impacts of the great networks of river management works that were re-shaping the natural landscape from the Columbia to the Volga to the Mekong to the Snowy Mountains" (White, 1998: 22). The faith in technological and anthropo-centred approaches that dominated the first big half of the century had led to

[2] Ever since the first water boards, set up around 1200 A.D. to control drained lands in the Netherlands, only water quantity had ever been an issue (de Jong, 1995).

such environmental problems and scarcity of freshwater of good quality, that this gave rise to calls for better water management (de Jong, 1995). But in spite of the environmental movement's growing influence during the late 1960s and 1970s (Gleick, 2000), at the time integrated water management still meant considering how to manage water resources in order to satisfy the maximum of human uses (Le Coz, 1994).

It was not until the late 1970s/early 1980s that the needs of the environment, recognised as a "valid 'user' of water" (Calder, 2005: 104), were taken account of in water planning and management (Gleick, 2000; Le Coz, 1994). The green movement had evolved into several branches: for the scientific ecologists or those from the Deep Ecology movement, this has to do with the fact that each living being has a right to live –each specie playing a specific role in the biosphere- while for the dominant utilitarian ecologists, nature must be protected for the services it provides us with (Nevers, 2005).

In the 1990s, the approach evolved specifically towards integrating the management of land, water and ecosystems, leading some authors like Duda and El-Ashry (2000) or Calder (2005) to prefer the even more explicit term 'Integrated Land and Water Resources Management'. It is the interrelationships between these natural elements that once more justify their integration into one management process (Martinez et al., 2002b). Such recognition coincides with the acknowledgment of the global land and environmental crisis, closely linked to the water crisis: land degradation through soil erosion or salinization, and loss of biodiversity through water diversion, wetland drainage or agricultural pollution (Duda and El-Ashry, 2000).

According to these authors: "Many cross-sectoral water conflicts stem from sector-by-sector, supply-side projects", the worst-case scenario being the Aral Sea Basin, where focus on irrigation development in the 60s led to an environmental disaster in the region. On one hand, governmental subsidies and lack of water legislation and pricing policies led to water logging and salinization in 50% of the irrigated lands, entailing billions of dollars of remediation costs. On the other hand, the diversions for irrigation "permanently destroyed the downstream Aral sea ecosystem" –reducing its area by 50% and its volume by 70%- thereby disrupting not only fishermen communities' livelihoods but also national economies (Duda and El-Ashry, 2000: 118).

Other examples of such interlinked crises' include dryland basins in Africa, where "more than any continent, effective management of land and water resources and their ecosystems (…) constitutes a necessary condition for food security, poverty reduction, human health, and economic progress" (Duda and El-Ashry, 2000: 120). Traditional systems, based on the multi-use of the same area through time by different actors (a rotation between floodplain recession farmers, herders and fishermen), inherently acknowledged the interlinkages between water, land and other resources. They were widely affected by the building of dams for irrigation or hydropower production. Today, analysis show that the economic benefits of this new mono-use is less important than the former ones, and rehabilitation has sometimes enabled the old flooding system to coexist with the new infrastructure (Duda and El-Ashry, 2000; André de la Porte, 2000). The continent suffers in general from "weak institutions, fragmented and ineffective policies and programs, and continued reliance on piecemeal, sector-based development approaches without considering upstream and downstream needs of biodiversity, people, and institutional reforms" (Duda and El-Ashry, 2000: 120).

The resulting dilemma then concerns water allocation between human livelihoods and ecosystems, two water dependent users: "Trade-offs will be needed between different water functions –a task even more complex than the more conventional efforts to deliver water for people, industry and irrigation" (Falkenmark, 2003: 9).

This additional layer constitutive of an IWRM –considering the environment as a user in addition to all other users- does not however exclude the previous ones, as illustrated by de Jong (1995). In a synthesis of the worldwide contributions made to the Living with Water conference in 1994, he links the emergence of integrated water resources management to the awareness of sectoral management problems in the 1970s. According to him, the urgency of the situation is what explains why the concept of IWRM, already "in gestation for many years" (de Jong, 1995: 394), was brought forward so fast: after more than a thousand years of sectoral management, water is considered as a system whose different elements (quantity, quality, ground and surface) are linked together; consequently, the land and environment to which it is also linked are also considered, as well as the various uses of water.

To summarise, be it dated to start in the 1930s or later according to the authors, the multi-sectoral characteristic of integrated water resources management is the crucial core of the concept.

Historically, the countries where the concept of IWRM was developed undertook an approach that was far from being integrated (which is still the case for most countries today): at first, water rights were related to land ownership (Chéret, 2004). Water is indeed considered as a good than cannot be appropriated, at least in its running form, in the jurisdictional systems of most countries: its uses can be shared by the various stakeholders who have the corresponding access and use rights (historically, allocation of such rights and related conflict resolutions were the responsibility of the water users' assembly) (Barraqué, 1994). With the development of capitalism between the 16th and 19th century in Europe, States nationalised important rivers in order to undertake bigger scale activities like hydroelectric production or navigation: the sectoral administration of water was born (Ibid.). In just a few centuries, such a sector-by-sector management has resulted in pollution, overexploitation of aquifers, drying up of river portions and floods: IWRM was born from the need for all users to work together to manage their resource (Chéret, 2004).

Consequently, there is now a growing recognition of the need to eliminate the boundaries set up by such sector-specific management, which ignored the inherent characteristics of water (i.e. the numerous interactions between water components themselves, as well as those with other systems, be they from the natural or the human sphere):

> "[Integrated water resources management] is an approach that regards water as a system (…) one that, wherever necessary, crosses the borders that man has artificially created" (de Jong, 1995: 394).
>
> "The present sectoral organisation of water management institutions belies the multifunctional nature of water: the adaptation of integrated management concepts and methods is an urgent need. Integrated Water Resources Management (IWRM) is seen worldwide as THE solution to this problem" (Brüschweiler, 2003: 5).
>
> "Institutions are rooted in a centralised culture with supply driven management and fragmented and sub-sectoral approaches to water management. Few water managers view water holistically, but the integrated approach is required, among others, because of the biophysical reality where water movement through the catchment links the livelihood and resource perspectives" (Jonch-Clausen, 2004: 10).

Now, integration is to take place both within the natural system (land and water management, surface and groundwater, upstream and downstream) and within the human system (cross sectoral integration of policies and strategies, and integration of all relevant stakeholders in the decision-making processes) (Jonch-Clausen, 2004).

A holistic response is required to overcome the typical problems linked to fragmented water management, whatever the regulation choice adopted (public, private or both): there is a need for coordination between policies related to water supply and demand, the quantity and quality of water resources, the use of superficial or groundwater, water resources' multiple uses, the management of land, vegetation and water, the management of externalities, etc. (Peña and Solanes, 2002; WWC, 2000).

Overall, during the 20th century, the meaning of integrated water resources management has been fleshed out with new dimensions of integration. Starting the 1930s, where it encompassed both multi-sectoral water management for human uses and taking the interrelationships of water components into account, it evolved to also include the uses of the environment from the 1980s onwards. Resuming this, in current keynote literature, IWRM refers to the need of integration, both within and between the natural system, which determines water availability and quality and provides related environmental services, and the human system, determining resource use and pollution (UN-WWAP, 2003a).

b. Recent institutionalisation of IWRM

Since the 1980s, the call for water sector reforms was a recurrent one in all international water conferences, but lack of action resulted in extending the scope of local problems across borders (Duda and El-Ashry, 2000). This led to a more official stance being taken with regards to integrated water resources management at the international level. The different perspectives related to IWRM were embodied by the Dublin and Rio Conferences in 1992, and later reinforced by those in Bonn and Johannesburg (Odame-Ababio, 2004).

The main output of the Dublin Conference, an experts' meeting which was organised to provide input for the United Nations Conference on Environment and Development (UNCED) taking place in Rio a few months later, were the four guiding 'Dublin principles'. The holistic, participatory, gender and economic principles "provided an important 'mind set' for water resources development and management" (Jonch-Clausen, 2004: 15):

Consequently, a few months later at the Rio Conference, chapter 18 of Agenda 21 had a programme area dedicated to integrated water resources development and management, based on these four principles (Calder, 2005): "Integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its utilisation. To this end, water resources have to be protected, taking into account the functioning of aquatic ecosystems and the perenniality of the resource, in order to satisfy and reconcile needs for water in human activities. In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems. Beyond these requirements, however, water users should be charged appropriately" (United Nations, 1992).

While Agenda 21 calls for an integrated management of land, water and ecosystems on a basin or sub-basin scale, the other main outputs of Rio –the three Rio Conventions- also have either direct (the UN Convention to combat desertification) or indirect (Convention on

Biological Diversity, Framework Convention on Climate Change) links with water and land management (Duda and El-Ashry, 2000).

As we saw in the introductory part of this research, while some, like the prominent A.K. Biswas, are very critical of the Dublin and Rio conferences in terms of their actual added-value for water resources management, for others on the contrary, the Dublin-Rio principles "are the cornerstones of IWRM and provide the basis for the blue revolution" (Calder, 2005: 113). According to Calder, while the green revolution was a technical one, based on plant breeding, pesticides and fertilisers, with the objective to increase productivity, the blue revolution is one of a more philosophical nature, although also relying on technical advances. It is concerned with the way we treat the environment and one of its assets in particular, water, to guarantee a sustained access for drinking and sanitation needs, as well as various industrial uses along with the needs of ecosystems (Calder, 2005). IWRM "replaces the traditional, fragmented sectoral approach that has led to poor services and unsustainable resource use. IWRM is based on the understanding that water resources are an integral part of the ecosystem, a natural resource, and a social and economic good" (UN-WWAP, 2003a: 377).

The Global Water Partnership, "established in 1996 as a response to the Dublin and Rio conferences" (GWP, 2003a: 9) defines itself as "an international network of organizations involved in water resources management which promotes IWRM through both the creation of fora at global regional and national levels directed towards facilitating change, and the systematic creation, accumulation, and dissemination of knowledge to support the process of change" (GWP, 2003a: 7). It was set up by the World Bank, the United Nations Development Programme and the Swedish government, because there was no home agency dedicated to water inside the United Nations –but the partners also wished a more flexible set up than, precisely, an UN agency (Alan Hall, GWP Network Director, personal communication).

The GWP explicitly recognises the Dublin principles as the basic IWRM principles (GWP, 2004b; GWP, 2000).

One of the conditions to facilitate the introduction of an integrated approach is a clear definition of the concept: "Too often, people have had only a vague idea as to what 'integration' means, and/or there have been differing perceptions as to what it means. In such situations, it is not surprising that confusion has been frequent, and that many planning documents have been characterised by vagueness or fuzziness" (Mitchell, 1990: 5). The author further argues that: "unless the concept is defined clearly, it will be difficult to establish goals and targets, and to monitor progress" (Mitchell, 1990: 3).

Acknowledging this need, to provide a common framework the Global Water Partnership proposed a definition of IWRM in 2000 –until then never unambiguously defined- "with the 'M' referring to both 'development and management'":

> "IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2000: 22).

The integration dimension concerns both the natural and the human system and must take place both within and between these categories (GWP, 2000).

Hereafter, we have broken down this rather long definition into several elements, to quickly explain what is meant by each:

"A process which promotes..."	The concept of 'process' clearly indicates a lengthy time frame. This is something many promoters of the concept tend to forget, so even the GWP is trying to calm spirits down by insisting on this aspect (Alan Hall, personal communication)
"the co-ordinated development and management…"	According to Martínez et al. (2002b), *development* is delimitating zones of different capacity of use and defining forms of intervention and use of the natural resources included in the watershed, while *management* includes the executing operative procedures of development, follow-up, control and evaluation
"…of water, land and related resources…"	Explicit reference is made to the interrelationships between water and other natural systems
"…to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems"	The balance sought is that "between the use of the resources as a basis for the livelihood of the world's increasing population and the protection and conservation of the resource to sustain its functions and characteristics" (GWP, 2000: 12).

In other words, this definition encompasses the three interpretations suggested by Mitchell presented earlier. It is now the most commonly used definition of IWRM (Smits and

Butterworth, 2006; Biswas, 2005). This can be explained by the fact the GWP's definition filled a vacuum, and also because it has been promoted through important visibility efforts like the world water forums, workshops and partnerships (Alan Hall, personal communication).

But for Biswas, IWRM's popularity is also linked to its fuzziness: "This type of almost universal popularity of a vague, undefinable, and unimplementable concept is not new in the area of natural resources management. (...) it can be argued that the vagueness of a concept to a significant extent increases its popularity, since people can easily continue to do whatever they were doing before, but at the same time claim that they are following the latest paradigm (...) in order to attract additional funds, or to obtain greater national and international acceptance and visibility" (Biswas, 2005: 325-326).

The information and communication revolutions just lead to spread such gospels all over the world and Biswas is quite critical of the concept's usefulness: "is it just an aggregation of trendy words collectively providing an amorphous definition which does not help water planners and managers very much in terms of actual application of the concept to solve real-life problems?" (Biswas, 2005: 322).

According to a panel of researchers that reviewed experiences of IWRM in projects of the European Union, it is the inadequate definition of IWRM that prevents understanding why it is difficult to make it operational (Gyawali et al., 2006). To overcome this, they suggest the concept of Constructively Engaged Integrated Water Resources Allocation and Management instead, but acknowledge that for other researchers, it is essentially a concept that cannot be made operational (Ibid.).

A.K. Biswas (2004), for example, points out the numerous questions raised by the GWP's definition, such as: who promotes the process? What are the boundaries of 'related resources'? How do you realistically organise a management between various ministries where there is so little coordination (like water vis-à-vis agriculture) or where expertise is so different (water vis-à-vis environment)? And how are the trade-offs operated between the maximisation of economic welfare, social welfare and the sustainability of ecosystems? In particular, which parameters are to be maximised? How to maximise 'economic and social welfare'? Who decides what is 'equitable'? What about the 'sustainability' of ecosystems: how is it measured? How are 'vital ecosystems' identified?

"Some have argued that integrated water resources management is a journey, and not a destination, and the concept provides only a road map for the journey" (Biswas, 2005: 333). For this researcher, such an argument is not very useful in terms of practical implementation, and he clearly condemns the inapplicability of IWRM: "In the absence of both an operational definition and measurable criteria, it is not possible to identify what constitutes an integrated water resources management at present" (Biswas, 2005: 324). As a result, "the only objective conclusion that can be drawn is that even though on a first reading the definition formulated by the Global Water Partnership appears impressive, it really is unusable, or unimplementable, in operational terms" (Biswas, 2005: 323) and "it does not provide any real guidance to water professionals as to how the concept can be used to make the existing water planning, management and decision-making processes increasingly more and more rational, efficient and equitable" (Biswas, 2005: 323).

Biswas insists that IWRM's long lasting permanence is conditioned by the capacity to change this: "Unless the current rhetoric can be translated effectively into operational reality, integrated water resources management will remain a fashionable and trendy concept for some years, and then gradually fade away like many other similarly popular concepts at earlier times" (Biswas, 2005: 328).

2. Implementing IWRM

In the last section, we presented the variety of definitions attached to the concept of IWRM. Hereafter, we focus on issues related to its implementation: first, the array of tools that are associated with the process; then, examples of IWRM officially recognised as such; finally, we discuss some constraints linked to the implementation process.

a. How to implement IWRM?

An array of tools

Historically, until the end of the 1980s, the trend in the area of water resources was to increase infrastructure (Tortajada, 2005). Water development works were everywhere: "During the 20th century, developed countries invested heavily in hydraulic works (dams, canals, dykes, locks, etc.) to provide their increasing populations with food through irrigation, energy through hydropower and transport through navigation, and to protect them from floods" (SIWI, 2005). Starting the second half of the century, the same is true for developing countries, supported by international institutions or bilateral cooperation (Meublat, 2001). In all cases, these policies, with an underlying 'plumber rationality', were usually designed by technical State administrations (Meublat, 2001).

In the early 1990s, a switch was operated towards a sector-by-sector management of water resources, and in the late 1990s, towards IWRM –i.e. a multi-sectoral management, integrating environmental and social issues (Tortajada, 2005).

This switch from the central concept of water *development* (i.e. facing increasing demand by building new dams, pipes, etc.) to water *management* (i.e. facing demand with whatever water is already available) can also be referred to what Gleick calls a "changing water paradigm" (Gleick, 2000: 127): from that of the 20th century, focused on growth and increased water supply, to a post-20th century one, where we must think differently in order to find ways to meet our needs within the limited water supply, while also preserving the ecological cycles.

According to Allan (2005), the switch corresponds to the end of the 'hydraulic mission' of 'industrial modernity' in the North[3], which had started in the 19th century, and to the beginning of 'reflexive modernity' in the late 1970s. Since then, three successive paradigms dominated each decade (green in the 1980s, economic in the 1990s and political-institutional starting 2000) and 'certainty' that larger water withdrawals for food production were sound had definitely been replaced by 'uncertainty'.

However we choose to name such a drastic change of mind-frame, this evolution or 'blue revolution' can be explained by a conjunction of several factors.

The first one is that by the end of the 1980s, most water developments in interesting sites had been realised, and the only ones remaining had prohibitive economic costs (Calder, 2005; Gleick, 2000).

Then, at the level of development banks such as the World Bank or the Asian and Inter-American Banks, infrastructure projects alone had revealed their limits to improve the social and economic conditions of people's livelihoods (Tortajada, 2005). Worse still, in many cases they also generated important social and environmental costs, which led to the creation of the World Commission on Dams in 1997 (Calder, 2005). In 2000, its report assessing the development effectiveness of large dams, stipulates that their positive contribution to irrigation, domestic and industrial consumption, electricity generation and flood control, is counterbalanced by many significant unacceptable social and environmental impacts (Ibid.). By trying to anticipate the water demand, such a supply-oriented strategy proved counterproductive, leading directly to exhaust both surface and groundwater sources, to degrade ecosystems and to more poverty (Meublat, 2001).

A third factor leading to the 'blue revolution' –and linked to the previous one- was the growing influence of the environmental movement on the type of responses needed, to implement the new mind-frame it had given birth to: from purely technical, these broadened

[3] This 'hydraulic mission' is still ongoing in the South, however.

to require all actors to take their responsibilities (Barraqué, 1994). As explained by Dr. Caroline Sullivan, head of the interdisciplinary team who developed the Water Poverty Index at the UK Centre for Ecology and Hydrology: "In the past, water problems were often dealt with by providing engineering solutions, which to a large extent were productive, but sometimes neglected important social or cultural issues. Today however, with increasing public empowerment, devolution of responsibilities in the water sector, and an increasing awareness of ecological issues, such solutions are no longer adequate to address most water management problems" (WWC, 2002).

The 'blue revolution', by increasing the complexity of both decision-making and action, implies a new model to face water demand within the limits of water supply. Such a model is supported by two main strata: on one hand a participative and negotiation-oriented institutional framework; on the other hand, pricing mechanisms to ensure that water supply meets demand (Meublat, 2001).

At the level of development banks, the shift from development of water resources in sub-sectors to its holistic management materialised through activities like: demand management, water pricing, private sector involvement, social participation, river basin management... (Tortajada, 2005: 298). Such policies had mostly been implemented in countries with market-based economies, but following the end of the Berlin wall in 1989, many centrally planned economies –such as the former Soviet Union, China or India- joined in this neo-liberal programme, aiming at more efficiency and often 'supported' by structural adjustment programmes, through trade liberalisation, deregulation, privatisation, stakeholder participation and decentralisation (Calder, 2005).

Taking into account environmental, social and economic aspects, these policies were expected to result in more effective regulations, incentives and environmental protection. To achieve IWRM, it was also recognised that "appropriate institutions would have to be developed, with adequate managerial and technical expertise and financial resources" (Tortajada, 2005: 298).

For example, the World Bank's Water Resources Management Policy, adopted in 1993, "calls attention to the need for countries and development organisations to adopt a more comprehensive approach to water resources management (World Bank, 1993). This represents a quantum shift from sector-by-sector projects to a more holistic approach recognising the river basin as the appropriate unit to not only manage water quality, quantity and ecosystems, but also sectoral development initiatives. Economic sectors are now asked to take full responsibility for preventing the degradation of water resources by modifying existing activities, using pollution prevention strategies in new activities, and coordinating across sectors so that the water environment can be sustained for its multiple purpose uses. (…) A whole host of financial, management, economic, policy reform, technological, and participatory tools are also recommended, including use of market-based instruments" (Duda and El-Ashry, 2000: 122).

Hereafter we shortly present these main tools, set forward to implement IWRM.

Demand management

It was promoted at the eighth session of the United Nations' Commission on Sustainable Development in 2000, where the need to increase productivity of water use in irrigated as well as rain fed agriculture was recognised as a key policy priority (UN-WWAP, 2003a).

"Water demand management aims to improve water use efficiency by incorporating soft solutions, such as capacity building, with hard solutions, such as water reuse. […] While motives and social norms are often underestimated in water resources management, attitudes and perceptions of policy-makers, water managers and users do actually shape the outcome of a strategy such as demand management"(SIWI, 2005).

The two types of solutions needed – both soft and hard- were the themes of the Stockholm 2005 World Water Symposium: avoid waste and increase recycling (through economic incentives, price structures and pollution charges in the industry, and technical measures such as drip irrigation, scrutiny of water subsidies, price incentives, etc. in the agricultural sector).

Recycling systems, in addition to their "sustainability" characteristic –by reducing water abstraction and wastewater discharge- also seem particularly interesting for low income countries as they have a potential of being affordable, and can become income-earning activities (solid waste management for the time being, but sanitation also has potential) (Eawag, 2005).

Water pricing

Water was recognised as an economic good at the Dublin conference in 1992: having a multiplicity of ends it cannot simultaneously satisfy, it indeed meets the requirements for such a categorisation –as a reminder, economics was defined by Robbins (1935) as "the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses" (Perry et al., 1997). This definition is actually a compromise between those that wanted to allocate water through competitive market pricing –thus treating it as a purely private good- and those that wanted to treat water as a human right[4]. But the difficulty to reach a consensus reflects a sterile ideological debate: the confusion lies in assuming that an economic good is necessarily a private good, while it is on the contrary possible to have a full-cost pricing approach in the framework of public management (Allouch, 2002).

Water being an economic good, its price is determined on one side by demand (the utility provided to humans and their corresponding willingness to pay) and on the other by supply (the cost of providing the resource in a certain quantity, quality and location) (Cech, 2005).

Historically, as water resources were plentiful with respect to demand, they had a very low price or were even provided for free. The 'blue revolution', however, requires this to change: "Where water is provided to users at a price less than the supply cost, a situation common in most parts of the world except the UK, the incentive for conservation and waste reduction is absent. This negative demand management leads to the paradox that in a situation where the water resource is already under stress, the subsidy is actually encouraging users to make additional demands upon it" (Calder, 2005: 81). For example, in Mexico, irrigators pay only 11% on average of the water's full cost (Cech, 2005).

The alternative is to admit the limits of the water resource and sources, and price it in order to cover the costs of supply and discourage low value uses. Water-pricing at the true cost of the resource (integrating its economic, social and environmental values) is defended by the United Nations Environment Programme as a way to ensure more water for the poor, at a lower price then the one they actually pay –much heavier, both in monetary terms and health-wise, than the rest of the population (UNEP, 2002). According to Fournier, a differentiated tariff system enables to subsidise the needs of the poorest citizens that cannot cover them, while introducing an incentive tax for less vital uses, which can also be different according to the uses (recreational uses like water for swimming pools would be more expensive than uses for industry or agriculture) (Fournier, 2000).

Such policies are difficult to implement, first and foremost because of the risk of unpopularity they entail. Their benefits are nonetheless starting to be acknowledged as outweighing their drawbacks, and methods to value water (so as to calculate the price) have been devised for various uses such as domestic, irrigation, hydroelectricity generation or recreational uses (Calder, 2005).

[4] Following a citizen movement initiated in 1998 to defend the recognition of water as a human right –among other things, through Alternative Water Forums- in 2002 the United Nations' Economic and Social Council, Committee on Economic, Social and Cultural Rights, in its General Comment 15, stated that: "the human right to water entitles everyone to sufficient, safe, acceptable, physically accessible, and affordable water for personal and domestic uses" (United Nations Economic and Social Council, 2002).

"Full-cost pricing of water, coupled with innovative approaches to subsidies, and technological innovation (…) will be the instruments that make the overall approach of holistic integrated water resource management (IWRM) and participatory governance yield their hoped-for results. Implementing these measures will take political will and implies changes from current practices" (WWC, 2000: 18-19). A package of reforms is needed:

- Full-cost pricing requires efficient, transparent and accountable service institutions, as well as governmental support to poor customers to pay their bills;
- Participation requires users to raise money and agree on spending purposes;
- The private sector needs a predictable, transparent regulatory framework and the guarantee of getting a reasonable return on investment before it invests financially or in terms of know-how;
- Public providers need to compete on a level playing field with private ones to be efficient.

To realise this, innovative approaches to institutions and technology will be needed (WWC, 2000).

Private sector involvement

Privatisation is sometimes an openly wished-for alternative to unsatisfactory public water management (linked to inefficiency, insufficient financial resources or technical expertise).

Private sector involvement in water resources management and development –which does not imply private ownership of water resources- was called for at the Bonn conference in 2001 (UN-WWAP, 2003a).

There are two main types of water privatisation: the 'British model' (where both the assets – the network, treatment plants, etc.- and their operation are privatised) and the 'French model' where the assets remain publicly owned and the management, operation and development of systems is concessioned for a limited period of time. In addition, two other types of privatisation also exist: the Build-Operate-Transfer and Build-Own-Operate-Transfer schemes (usually for treatment plants), where the private sector is involved in the financing, construction and operation and makes a return on investment by selling the treated water, and the service contracts, where goods and services (like billing or revenue collection) are bought from the private sector (UN-WWAP, 2003a).

Today, the private sector controls only 5% of water and sanitation services, but 40% of this market, localised in 100 countries, is controlled by 'the big three' (all French firms): Veolia (ex-Vivendi, from the Générale des Eaux), Ondeo (subsidiary of Lyonnaise des Eaux) and Saur (which belonged to Bouygues until 2004 and is now property of the investment fund Paribas Affaires Industrielles). The other most important firms involved are Suez (France), Bechtel (USA) and RWE/Thames Water (Germany and Great Britain) (Laimé, 2005).

These water multinationals keep on gaining market shares, especially since the 1980s, where several factors concurred to increase their usefulness: the decrease of public research in this sector, the public deficits' surge and the increasing rigor of European standards, requiring specialisation (Laimé, 2005). According to Barraqué, in the recent European Union's Framework Directive on Water (from 2000), the new quality standards are so high that the investments needed to meet them can only be supplied by important capital –implying mass privatisation. Each country is indeed facing costs varying between 10 to 60 billion euros (to realise the census of all their reserves, clean up lakes and rivers, enhance wastewater treatment and massively renovate pipes) (Labarthe, 2005).

This trend is encouraged by the World Bank[5] and other financial institutions, putting forwards the fact it will help eliminate monopolies and thus entail better conditions for the local population through automatically lower prices (Brüschweiler, 2003).

Nonetheless, in practice, many examples highlight that the opposite has happened, the most-well known being that of Cochambamba, in Bolivia. In 1997, the extension of a World Bank loan to the government, conditioned by the privatisation of water and sewage utilities in La Paz and Cochabamba, led to a tariff surge (+300%) realised by Bechtel. The popular reaction triggered the famous 'water war' in Cochabamba, leading the company to leave the country and since, water is co-managed between the State and community organisations (Gago, 2005). Problems also occurred in Argentina or in Manilla, the capital of the Philippines, where a similar arm-wrestling, this time between the company and the local authorities (who refused a fee raise in 2002) led the company to suspend the payment of its concession. Since then, debts have been exchanged against the entrance of the government into the shareholding, but prices are five times those of 1997, and between one to five million inhabitants do not have access to potable water (Petite, 2005a).

Numerous NGOs (grouped for example in the Council of Canadians or the Latin-American Water Tribunal) are criticising the World Water Council and its water forums for trying to give the impression that a 'worldwide consensus' has been reached to impose privatisation. In addition, the lack of recognised authority of the Council (it has no mandate whatsoever from the United Nations) makes it feebly representative, and it is generally accused of representing the interests of the World Bank and water multinational firms.

[5] Between 1990 and 2002, the World Bank attributed USD 19.3 billion to reform water systems worldwide (Petite, 2005b).

"Admittedly, there is no ready solution to be applied worldwide. State governments, civil society, the private sector, or any combination of these three, might have to cooperate to make the water sector more profitable" (Brüschweiler, 2003: 7). Public-private partnerships, presented as *the* solution at Johannesburg, have so far given disappointing results, both for the States who thought they had found the perfect alternative to succeed where they had failed, and for the firms, which thought they could apply the same profitability schemes as in other sectors like electricity (Caramel, 2005). With only 5% of water infrastructure financed by the private sector between 1990 and 2002 (compared to 44% in telecommunications for instance), it is predicted that public capital will remain the major source on a predictable horizon (Ibid).

Social participation

The second Dublin principle stresses the need for water development and management to be based on a participatory approach, involving users, planners and policymakers at all levels.

But participatory methodologies are much older than 1992, developed by social and management scientists in governmental and non-governmental organisations working on development issues (Calder, 2005).

Although participation of stakeholders is recognised as a necessary condition to the success of the new approach to water management, the problem with such approaches is that "it is not difficult to stage-manage 'participation' to provide the 'gloss' on decisions and approaches that are being sought by particular pressure groups" (Calder, 2005: 296).

As illustrated by Pimbert and Petty (1995) in their typology, a whole continuum exists, spanning from passive participation, where people are purely informed of decisions, to self-mobilisation, where actors actually take independent initiatives, intermediate types of participation ranging from that by giving information, by consultation, for material incentives, functional (to meet determined objectives) and interactive (joint analysis).

As 'participation' is seldom absent from any project or programme nowadays –be it related to water or not- the real challenge resides in managing to instil a participatory approach closer to the far end of the spectrum than to its beginning.

In the long-run, participation can only be effective if certain conditions are in place: a real political will to create and maintain spaces for participation, along with the capacity of civil society to organise itself and make good use of such opportunities (Bolay et al., 2004).

River basin management

The concept of 'integrated water resources management' is often mistaken with that of 'integrated watershed[6] management' (or 'integrated river basin management') because of the similarity of the wording.

The distinction is that IWRM does not automatically take place at the basin level, it can be applied at different scales: international (for transboundary waters), national or sub-national (like municipalities) (Alan Hall, GWP Network Director, personal communication).

The river basin, nonetheless, constitutes the officially favoured implementation scale since it was recognised as the most logical implementation unit in 1992. This is because, as highlighted by researchers working in the Ayuquila watershed in Mexico, it is the scale that allows, on one hand, to analyse the consequences of decisions taken in terms of water, land or vegetation management, while also providing the appropriate framework to plan the means to correct the environmental impacts of such management (Martínez et al., 2002b). For example, it is the interdependencies between upstream forest management and downstream land and water quality, which provided the basis for the classical example of payments for environmental services: the Catskills scheme, supplying New York City with clean water at a reasonable cost.

According to Martínez and his colleagues, other links that watersheds encompass which are not normally highlighted are those between natural resources and human activities and between inhabitants of the watershed themselves, by the simple fact that they depend on a common hydraulic system (Martínez et al., 2002b). "At the basin level is where the diagnosis of interlinkages must occur to take into consideration characteristics of the basin, its ecosystems, and its communities" (Duda and El-Ashry, 2000: p.124).

This is made more explicit in the alternative formulation to watershed management suggested by Falkenmark and Folke (2002): 'socio-ecohydrological catchment management'. Part of the problem is that the inhabitants of such a catchment are not automatically aware of these interdependencies…or sometimes quite voluntarily unaware of them (Ibid.) As Falkenmark (2003) states: "The catchment can basically be seen as a mosaic of partly incompatible land and water demands so that the overall challenge is to orchestrate this complex system for compatibility. This will involve three different types of balancing, in order to:

[6] The watershed (or river basin, drainage basin or catchment) is the total land area that drains surface water to a common body of water (usually a river) (Cech, 2005). The various interchangeable terms that exist either reflect national subtleties or scientific backgrounds (with a focus either on water or land) (Alan Hall, personal communication).

- Satisfy societal needs while minimizing the pollution load added and accepting the consumptive water use that is involved;

- Meet ecological minimum criteria in terms of fundamental ecosystem determinants: environmental flow to be left uncommitted in the rivers, secured flood flow episodes, and acceptable river water quality;

- Secure hydrosolidarity between upstream and downstream societal and ecosystem needs" (Falkenmark, 2003: 30).

For such an orchestration, management agencies at basin and aquifer level are required. Watershed organisms or councils vary immensely from country to country, due to the various structures they can take, responsibilities they can be in charge of and legal frameworks in which they operate. They should nonetheless have certain basic characteristics: they must be inserted in the country's legal framework, have a juridical personality, include the main actors and dispose of an independent budget. Their functions traditionally include: the coordination of the management of water resources in the watershed; planning water use and management; a role of arbitration in case of inter-sector conflicts in water use; the generation of basic information about the watershed, and control of extreme events, water availability and quality; and fund-raising for the planned actions. They must not replace other organisms in charge of water management, but instead provide a coordination and stimulation platform to implement its objectives (Martínez et al., 2002b).

River basin organisations can be authorities, entities, commissions or councils with more or less decision-power, and their role must be clarified and made official to promote cooperation and avoid duplication of activities and lack of both human and financial resources (Tortajada, 2005).

The concept of river basin management has been particularly promoted since the Dublin Conference in 1992, but it has actually been evolving for two centuries (Meublat and LeLourd, 2001). Initiated in France in 1803, and adopted by countries such as Spain or the United States of America, the first model of watershed management was dedicated mostly to canalising the resource through dams, to provide water for irrigation, hydroelectricity production and domestic use. The second generation of watershed management –which integrated more participation- was also originally developed in France[7], with six river basin agencies created in 1964. These raise their revenues through user fees and polluter fees to then invest them in priority issues, usually environmental enhancement in basins.

[7] Although according to some, France only scaled up the first model of participative basin management, which developed in the Ruhr basin at the beginning of the 20^{th} century.

Since then, the approach of basin management, the central feature of which is the integration of participation and economic instruments, has gained widespread recognition, particularly boosted by the global water forums. The European Union's Water Framework Directive (2000), largely inspired by the French experience, promotes integrated river basin management for Europe. The International Network of Basin Organizations, created in 1994 by the French Ministry of the Environment, now counts 62 member countries and has regional networks covering all continents (INBO, 2006).

But according to Alan Hall, GWP Network Director, it is mainly environmentalists with a scientific background who tend to see integrated river basin management as 'the' solution, while political and social scientists do not, because river basin management does not take socio-political systems into account. For him, the river basin is one management unit among others –not the only possible one, and not always the best one either. In particular, too often than not, moribund basin water management authorities do not benefit from revenue-raising mechanisms, but are imposed as part of a top-down scheme anyway, to fit into national or regional ambitions[8] (Alan Hall, personal communication).

Information

Another important tool for effective planning and management is that of good quality information, be it regarding the ecological status (quantity and quality of water sources) or more societal elements such as the capacity and condition of infrastructure, as well as the demand for and access to water supplies for different purposes (Batchelor, 2005).

For Calder, one of the problems is that a lot of policies are based on "land and water myths" (such as the fact that water harvesting is benign, or that increasing tree cover will increase local rain), instead of modern science. He stresses the need to better share knowledge, including between countries (Calder, 2005).

Due to the frequent inaccurate or out-of-date secondary information held at ministerial or NGO level, participatory survey and GIS software can be useful tools to generate such information. Indeed, the 'blue revolution' requires combining both hard tools like computer-based models, with socio-economic ones, like participatory approaches, to determine the impact on the environment, socio-economics, equity (Calder, 2005). Among hard-system tools, "decision support systems have a role to play here not only in testing out the impacts of water resource management strategies on stakeholder interests (…) but can also assist

[8] For example, in Sweden, submitted to the Water Framework Directive and the catchment management approach, the past successful water management based on districts is being fitted into basins to attain conformity (Alan Hall, personal communication).

water resource managers by providing a focusing framework for defining stakeholder issues and interrelationships. The greatest strength of these systems is that they provide the means for integrating information from different disciplines" (Calder, 2005: 299). To make this a common reality will require time: today, different databases still are the norm, even for the different elements of water (surface water, groundwater and water quality).

Examples of such tools include: the European Union's WaterWare Decision Support System, applied to the Thames Basin in Great Britain and the Rio Lerma/Lake Chapala in Mexico, to evaluate impacts of new water legislation, see where new developments can be made, and develop strategies to control pollution; or the NELUP database, more oriented towards land-use changes and their impacts on hydrology. More easily used by decision-makers, the EXCLAIM tool (Exploratory Climate Land Impact and Management), based on GIS, to see both biophysical and socio-economic impacts of watershed interventions (like changes in forest cover, irrigation), is used in the Limpopo basin of South Africa (Calder, 2005).

In this new framework, "the largest task is going to be managing the allocation of water for direct use to meet human needs and protect the environment" (WWC, 2000: 25). But for some, the environment should not be considered as a similar claimant to human uses, as the "environment (broadly defined) is the foundation on which the entire ecological and hydrological systems function and thus must be seen as part of the reality we are dealing with. Human uses are the ones to be arbitrated, but in a context that ensures the robustness of the underlying ecological and hydrological systems –and their ability to regenerate from the vagaries of seasonal or long-cycle fluctuations and continue to sustain the growing human and biological populations that will rely on these systems for their existence" (WWC, 2000: 27). Research priorities should be on providing more data on the "acceptable levels of human interference with the environment" for awareness raising and informed decision-making (Ibid.)

Historically water allocation was 'first come, first served' (or 'prior appropriation rights'). Now the question is: how to prioritise the manifold demands for water, especially when all outflows are committed, and no new rights can be allocated? Three different options exist:

- Top-down approaches, like the priority system in South Africa (highest priority for human consumption, then the environment, then productive uses). But to face supply shortage, some non-price instruments such as rationing or prohibiting use are inconvenient and do not take account of the different values of water for different consumers;
- Market-based approaches: either allocation of water to those able to pay higher price, (difficult when lobbies like agriculture want to protect the subsidies they receive) or

transferable rights, enabling to increase efficiency by helping to transfer water to higher use values.

- Virtual water through the transfer of commodities, operating in the Middle East and North Africa for 25 years: countries with water scarcity buy goods requiring high water inputs (like cereal), freeing water for high value uses like domestic or industrial (Calder, 2005).

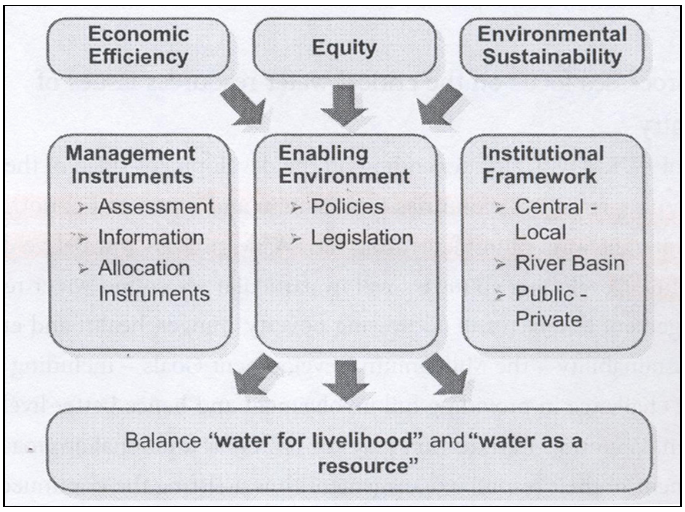
The Global Water Partnership's approach to implementing IWRM

As part of its terms of reference –"the Global Water Partnership was established to encourage programs to fill gaps in research and technical assistance required for the implementation of integrated water resources management" (WWC, 2000: 67), the GWP produced a whole series of technical papers addressing pressing issues linked to the theory and practice of IWRM (Jonch-Clausen, 2004). Among these are the GWP guides on how to implement IWRM.

The first guide, called the Toolbox, is the result of an effort to organise the vast array of possible tools for IWRM. It was produced in 2002 and a second version was updated for the 2003 World Water Forum. An interactive on-line version is also available, which also provides case studies illustrating practical experiences related to each tool.

The toolbox groups 50 tools in 13 key change areas, all together constituting 'the three pillars of IWRM': the enabling environment of policies and legislations (laws and regulations), financing and incentive structures; the institutional framework through which these can be implemented (central-local, river basin, public-private); the management instruments required for this (water resources and demand assessment, information and monitoring, allocation instruments) (Jonch-Clausen, 2004).

Figure 4: The three pillars of IWRM

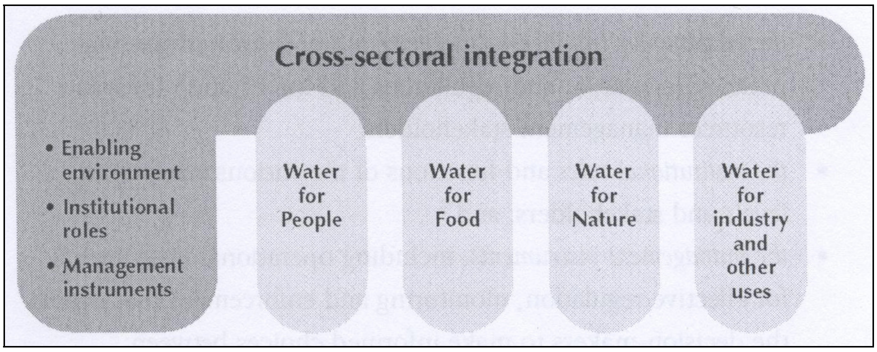


Source: Jonch-Clausen, 2004: 16

Such a framework is acknowledged for example in the United Nations 2003 World Water Development Report (UN-WWAP, 2003a: 376).

The 'GWP comb' illustrates the cross sectoral integration wished for, and the role of IWRM in their linkage:

Figure 5: The three pillars' role in cross-sectoral integration



Source: GWP, 2000: 29

There is no sequential order, although the instruments are logically used after the 'rules of the game' and the institutional framework are both in place (Jonch-Clausen, 2004). Figure 6 presents the 13 specific key change areas:

Figure 6: The IWRM Toolbox

A THE ENABLING ENVIRONMENT

A1 Policies – setting goals for water use, protection and conservation.
This part of the framework deals with water policies and their development. Policy development gives an opportunity for setting national objectives for managing water resources and water service delivery within a framework of overall development goals.

A2 Legislative framework – the rules to follow to achieve policies and goals.
The required water laws covers ownership of water, permits to use (or pollute) it, the transferability of those permits, and customary entitlements. It underpins regulatory norms for e.g. conservation, protection, and priorities.

A3 Financing and incentive structures – allocating financial resources to meet water needs.
The financing needs of the water sector are huge, water projects tend to be indivisible and capital-intensive, and many countries have major backlogs in developing water infrastructure. Financing approaches and incentives are required to achieve the development goals.

B INSTITUTIONAL ROLES

B1 Creating an organisational framework – forms and functions.
Starting from the concept of reform of institutions for better water governance, the practitioner needs to create the required organisations and institutions – from transboundary to basin level, and from regulatory bodies, to local authorities, civil society organisations and partnerships.

B2 Institutional capacity building – developing human resources.
Upgrading the skills and understanding of decision-makers, water managers and professionals will take place in all sectors, and capacity building for regulatory bodies and for empowerment of civil society groups will need to be undertaken.

C MANAGEMENT INSTRUMENTS

C1 Water resources assessment – understanding resources and needs.
A set of tools are assembled to assist water resources assessment, starting with the collection of hydrological, physiographic, demographic and socio-economic data, through to setting up systems for routine data assembly and reporting.

C2 Plans for IWRM – combining development options, resource use and human interaction.
River, aquifer and lake basin planning entail a comprehensive assembly and modelling of data from all relevant domains. The planning process must recognise social, economic and environmental needs using a range of assessment tools.

C3 Demand management – using water more efficiently.
Demand management involves the balancing of supply and demand focusing on the better use of existing water withdrawals or reducing excessive use rather than developing new supplies.

C4 Social change instruments – encouraging a water-oriented civil society.
Information is a powerful tool for changing behaviour in the water world, through school curricula, university courses on water and professional and mid-career training. Transparency, product labelling and access to information are other key instruments.

C5 Conflict resolution – managing disputes, ensuring sharing of water.
Conflict management has a separate focus as conflict is endemic in the management of water in many places and resolution models must be at hand.

C6 Regulatory instruments – allocation and water use limits.
Regulation in this context covers water quality, service provision, land use and water resource protection. Regulations are key for implementing plans and policies and can fruitfully be combined with economic instruments.

C7 Economic instruments – using value and prices for efficiency and equity.
Economic tools involve the use of prices and other market-based measures to provide incentives to all water users to use water carefully, efficiently and avoid pollution.

C8 Information management and exchange – improving knowledge for better water management.
Data sharing methods and technologies increase stakeholder access to information stored in public domain data banks and effectively complement more traditional methods of public information.

Source: Jonch-Clausen, 2004: 38

According to Mollard and Vargas (2005a), who analysed the GWP's introduction paper to IWRM for the 4th World Water Forum, among the tools put forward to realise an IWRM, cost-benefit analysis remains the central tool, even though social and environmental should also be taken into account. Two criteria are thus essential: technical efficiency (with both technical-agricultural techniques, reducing leaks, recycling- and economic tools- water fees) and allocative efficiency[9] (calculating where water has the highest productivity).

Both these criteria result from the growing concern to raise water productivity: its physical productivity, through the approach aiming at 'more crop per drop', or its productivity as measured by added value in production, i.e. transferring water to uses which proportionally, contribute more to the country's wealth (UNDP, 2006). The first has recorded good progress, albeit mostly concentrated in developed countries –the development of affordable drip irrigation technologies should nonetheless change this (Ibid). The worry with technological innovation indeed remains the social discrepancies it can contribute to exacerbate, as frequently "access to water-thrifty innovations requires access to capital, knowledge and wider infrastructure" (UNDP, 2006: 152). As for the option of diverting water to higher added-value uses, promoted by those in favour of a 'softer' solution than technical innovation, it suffers from two main drawbacks: first, there is little evidence that any high-value industry was delayed in its development because of competition for water with agriculture; second, such diversions remain dangerous in countries where most of the population's livelihoods still depends on it –particularly the most vulnerable people (UNDP, 2006).

In 2002, ten years after the Rio Conference and Agenda 21, 193 countries committed to the Johannesburg Plan of Implementation at the World Summit on Sustainable Development. Its Chapter IV dedicated to *Protecting and managing the natural resource base of economic and social development* includes a call to "develop integrated water resources management and water efficiency plans by 2005, with support to developing countries" (United Nations, 2002).

Referred to more simply as National IWRM Plans, these differ from the IWRM *approach* in that "whereas an IWRM approach results from a process of change, an IWRM Plan is a time-bound exercise to guide the implementation of such changes" (GWP, 2004a: 5).

Torkil Jonch-Clausen, former Chair of the GWP's Technical Committee, recognising that the WSSD target is unlikely to be achieved in so little time, encourages the interpretation of such an objective as a planning process which should be completed or well underway, and which would "progressively identify necessary strategies and actions in water resources management, water infrastructure development, improved water efficiency and better water service provision" (Jonch-Clausen, 2004: 14).

[9] In practice, the drawback of this approach is that it does not take into account other aspects than economic criteria, such as social wellbeing and environmental protection (Mollard and Vargas, 2005a).

To help face the major challenges raised by this call for IWRM Plans, alongside the Toolbox the Global Water Partnership and its partners produced other sources of information[10], more specifically aimed at providing support for IWRM planning, because "though the process, structure and content of a Plan will vary from country to country, every Plan will share certain features" (GWP, 2004a). Important to highlight is the switch from 'plan' to 'strategy' in the document *Catalyzing Change:* it was undertaken "to emphasize the dynamic and change-oriented nature of the process", thus better reflecting "the spirit of the WSSD call" (GWP, 2004b: 3). Nevertheless it is also an acknowledgement of the need for a more realistic time-frame: "A water resources strategy is usually a step on the way to the development of a plan as the basic goals and objectives need to be set and the key directions of the changes agreed before embarking on detailed planning" (Cap-Net, 2005: 5).

These more action-oriented references correspond to a new phase in the Global Water Partnership's work, after having contributed to influence the global water agenda and raise awareness of the IWRM during its first seven years of existence (GWP, 2003a).

To implement IWRM Plans, Jonch-Clausen (2004) identifies seven major steps:

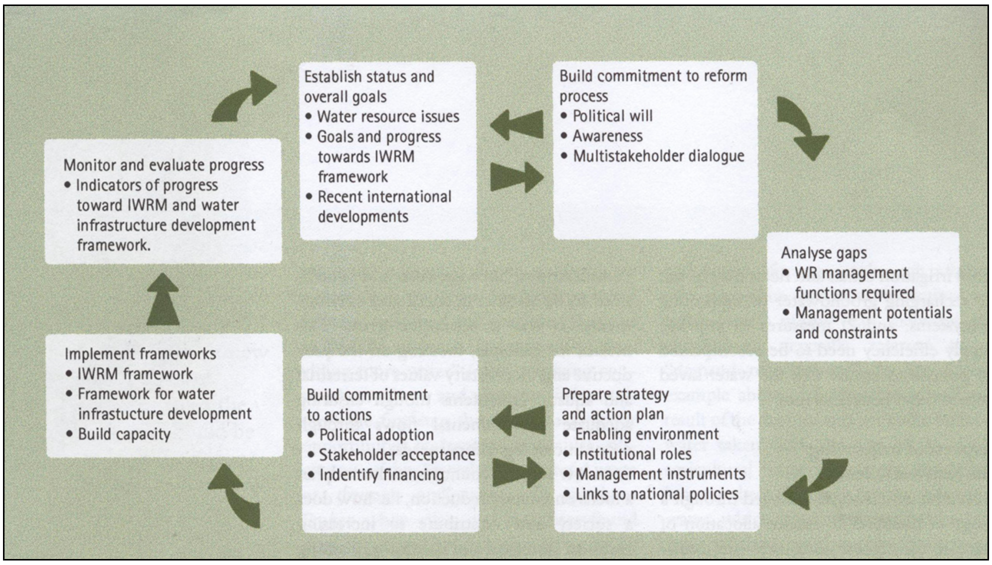
1	Establish status and overall goals: identify livelihood-demand and resource-impact water issues, elements in place and where progress is needed towards IWRM, endorsed international agreements like water forums
2	Build commitment to reform (via political will, awareness raising, multistakeholder dialogue)
3	Analyse gaps in IWRM framework (identify required management and development functions): - Resource management functions, such as formulation of policies for water allocation and wastewater discharge permits, water resources assessments, monitoring, enforcement, information - Water services and infrastructure management functions, including policies, laws, regulations and enforcement (and infrastructural requirement and water efficiency) - Financing functions and mechanisms: grants and internal sources, user fees, subsidies, loans and equity capital
4	Prepare Strategy and Action Plan (actions to address identified gaps in the enabling environment, institutional roles, management instruments, and links to national policies)
5	Build commitment to action (political adoption at inter-ministerial coordination and Parliament level, stakeholder acceptance which often requires communicating how actions can improve lives of both men and women, fund raising): institutionalisation of water resources in domestic budget preparation is necessary
6	Implement frameworks: - IWRM framework with potential resistance to reform from those who do not wish to see a shift in power from centralised to basin organisations

[10] In particular: "*...Integrated Water Resources Management (IWRM) and Water Efficiency Plans by 2005": Why, What and How?; Catalyzing Change: A handbook for developing integrated water resources management (IWRM) and water efficiency strategies;* and The Cap-Net *Integrated Water Resources Management Training Manual and Operational.*

	- Framework for water infrastructure development: "The IWRM framework is developed to manage resources in such a way that economic and social welfare is improved. (…) The IWRM may for instance, prioritise water for domestic water supply, set 'game plans' for water user groups and include regulations that prevents pollution of sources" (Jonch-Clausen, 2004: 30) - Framework for water efficiency with shift from supply to demand management - Capacity building
7	Monitor and evaluate progress[11]: there should be both universal indicators to be used for worldwide joint assessments, but also tailor-made indicators to the country context: - Impact indicators on water resources availability and trends: demand for major uses, demand-livelihood challenges, threats from pollution, user conflicts - IWRM process indicators: awareness and political will, framework for stakeholder participation, prioritisation of water management issues, roles and functions within WRM identified and defined, potential and constraints identified, stage of development of IWRM framework - Performance indicators on how the IWRM framework works (national policies, legislative frameworks, financing and incentive measures, organisational set-ups)

Important to remember is that: "No country ever 'completes' the cycle, it is an ongoing learning and development process in which countries find themselves at different stages" (Jonch-Clausen, 2004: 33).

Figure 7: The IWRM cycle



Source: GWP, 2004b: 12

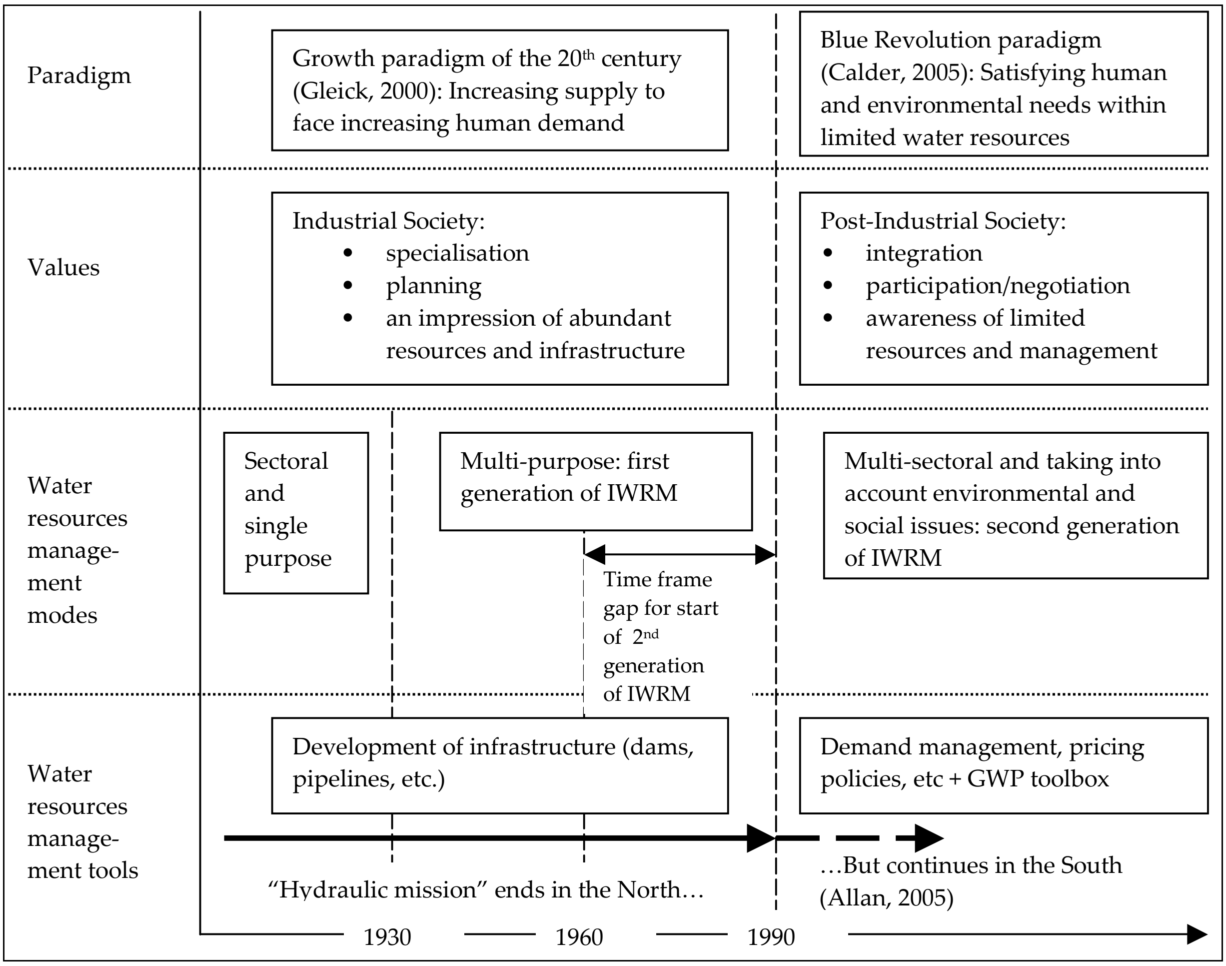
Recognising that putting the IWRM goal into practice is very context-specific, the Global Water Partnership is diffusing its Toolbox and other IWRM information sources through its worldwide regional and country networks, as well as the World Water Forums.

[11] The GWP produced two technical briefs dedicated to help define such follow-up tools (indicators for defining the strategy, as well as monitoring and evaluation).

To summarise, according to A.K. Biswas, a paradigm shift took place between the Mar del Plata Conference in 1977 (where the focus was on formulating national and operational water policies) and the subsequent "UN major water fora" after the Dublin and Rio conferences in 1992, promoting instead sustainable development, integrated water resources management and integrated river basin management (Biswas, 2002).

One can associate the evolution between the two with that between the Industrial Society's values (focused on specialisation, planning, an impression of abundant resources and infrastructure) reflected in the Mar del Plata Declaration, and the values of the Post-Industrial Society (focused on integration, participation/negotiation, awareness of limited resources and management) reflected in the Declaration of Dublin (Peña and Solanes, 2003).

Figure 8: Paradigm shifts in water management during the 20th century



Source: Compilation from Calder (2005), Tortajada (2005), White (1998) and Mitchell (1990)

b. Examples of IWRM worldwide

According to experts that have taken into account the experience of countries which have started to try and implement IWRM and water efficiency plans: "An IWRM plan is a blue print that adapts IWRM principles to country conditions to permit a change from fragmented ways of managing water resources to an integrated way" (Chéret, 2004: 7).

In an effort to monitor efforts undertaken towards IWRM, the Global Water Partnership undertook two surveys to evaluate the status of IWRM plans[12] that had been called for at Johannesburg[13].

The first survey, which took place in 2003[14], indicates that out of the 108 countries surveyed (45 in Africa, 42 in Asia and the Pacific, 22 in Latin America), "around 10% have made good progress towards more integrated approaches, 50% have taken some steps in this direction but need to increase their efforts, while the remaining 40% remain at the initial stages of the process" (GWP, 2004: 3). In addition to this rather general classification, a more detailed assessment also concentrated on each country's IWRM related policy, institutional and operational developments, in ten areas seen as important building blocks to develop an IWRM Plan.

Interestingly they point out that "those countries that have made the most progress towards adapting and reforming their water management systems towards more sustainable water management practices have often started by focusing on specific water challenges" (GWP, 2004: 3), such as South Africa which focused on drinking water and sanitation.

In annex 4, we present an overview of the 14 countries assessed as having made good progress.

A second survey assessed the status of the 2005 target for National IWRM and Water Efficiency Plans, and was released at the 4th World Water Forum in Mexico in March 2006, a place for countries "to report on their progress, to share and learn from their experiences, and to further refine their implementation strategies" (Japan Water Forum, 2004: 4).

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[12] In the surveys, "IWRM Plan" refers to "integrated water resources management and water efficiency plans".

[13]The surveys were conducted through the GWP's regional networks in non-OECD countries (so Mexico, for instance, is not included), therefore limiting the scope to countries where the GWP has either a Regional or Country Water Partnership. The resulting regional reports, while integrating official viewpoints (through either the analysis of official documents or the involvement of government officials in the GWP's multistakeholder platforms), were not official government documents, but based on qualitative assessments of senior professionals which did not dispose of a common normative grid.

[14] Although this was only one year after the call for IWRM plans had been made, the objective of this first survey was to establish "a status baseline, to be able to measure a moving target" (Alan Hall, personal communication).

Following the same classifications, but with 95 countries having responded this time, the results indicate 21% of countries with plans in place or substantial progress, 53% having progressed but needing to do more and 26% at the initial stage only.

Although the two surveys are not directly comparable as they do not concern the same countries and did not use the same questionnaires, "they do indicate a trend with an increase from 60% to 74% in those countries that have taken steps towards better water resources management through the IWRM approach" (GWP, 2006b: 5).

But in spite of the growing awareness these figures suggest, lack of implementation is a preoccupation:

> "While it shows a growing degree of seriousness about setting national strategies and plans, there are only occasional comments related to progress in actually implementing the elements of an IWRM approach" (GWP, 2006b: iii).
>
> "IWRM is a process that leads to improved planning, better governance and a balancing of social, environmental and economic goals and is not easily measured. The survey is based on a combination of qualitative and quantitative measures and it has shown that more work is needed on how to monitor progress on achieving a more integrated approach to water resources management and development " (GWP, 2006b: iii).

This survey will be followed by "a more comprehensive initiative on monitoring integrated water resources management that GWP and others aim to carry out with the World Water Assessment Programme during 2006-2009" (GWP, 2006b: 2). It is indeed recognised that the 2002 call for 2005 IWRM plans was too short term[15], as apart from the actual fact of drawing up the plans, the real issue is to embed these into national development plans; nonetheless, the call enabled to set forward the process and change mentalities (Alan Hall, personal communication).

Another similar survey was realised by the Japan Water Forum and presented at the 4th World Water Forum, concerning 85 countries and including OECD countries. In addition to such surveys, several platforms exist to exchange experiences regarding IWRM at country level: the Global Water Partnership's Toolbox, the UN-World Water Assessment Programme's case studies, and the World Bank's case studies.

[15] The CSD has in fact decided to revise the targets at its next meeting in 2008 (Alan Hall, personal communication).

By crossing these various sources of information, several countries are identified as having reformed their water policies, on the basis of IWRM, such as China, India, Thailand, Uganda and Burkina Faso (UN Millennium Project, 2005; Jonch-Clausen, 2004). For example, Uganda started an IWRM process in 1993, and managed to build a "consistent policy and legislation [that] provides the guidance and rules for priorities of water use, allocation and wastewater discharge and where stakeholder participation and decentralisation provides local level involvement" (Jonch-Clausen, 2004: 32). However, as with other such countries: "Implementation will prove a stern test" (UNDP, 2006).

Since 1997 and 2000 respectively, Brazil and South Africa have water laws that encourage the integration of ecological considerations (Duda and El-Ashry, 2000). Brazil has put in place a considerable decentralisation process, while South Africa has put in place a top-down priority system for water allocation (the highest priority for human consumption, then the environment, then productive uses) (UNDP, 2006).

But the model put forward is Australia's Murray River basin approach to face a severe environmental crisis caused by over-allocation of irrigation water in a semi-arid region (UNDP, 2006). The Murray-Darling Basin Commission uses IWRM as a foundation guiding principle, with a specific focus on cost sharing arrangements between different levels of government –states distributing water rights to users- as well as community and private sector organisations (Jonch-Clausen, 2004). One fourth of the river flow is reserved as an environmental flow by combining several economic instruments (Duda and El-Ashry, 2000).

It is recognised that reproducing the conditions Australia benefits from in developing countries will be a challenge, as this would require a highly decentralised national water planning, institutional arrangement bringing together all ministries involved in water allocation, priority given to the environmental reserve before starting annual allocation for other uses (UNDP, 2006).

There have also been important efforts at a regional level, such as the European Union's Water Framework Directive (WFD), entered into force in 2000. The WFD's principles are: taking a river basin approach, protecting the quality of water by integrating four key objectives (protection of the aquatic ecology, specific protection of unique and valuable habitats, protection of drinking water resources, and protection of bathing water), through a combined approach of both source and effects controls –emission limits and quality standards- as well as extending public participation and adequate pricing (European Commission, 2000). At the 2005 World Water Week in Stockholm, the European Commission published a leaflet presenting the coherence between IWRM principles and WFD requirements.

The Directive requires all water bodies –inland and coastal- included in the European Union to reach a good status by 2015. Transposition in national legislation was to be reached by 2003 and publication of management plans by 2009 (European Commission, 2000). River basin districts are to be established in which river basin management plans (six-year cycles for preparation, implementation and review) have four elements: characterisation of impacts, environmental monitoring, environmental objectives and design and implementation of programmes of measures (Calder, 2005). Problems identified include high costs for implementation of regulatory standards, and technical problems in defining good ecological status (as there is a need to find reference sites without human influence or activities) (Calder, 2005).

In 2003, acknowledging that "within the European Union, the need to comply with the Water Framework Directive has made IWRM a priority for all water authorities" but that national efforts are not coordinated in any way, the French Office International de l'Eau and the International Network of Basin Organisations undertook the project IWRM.Net. It aims at constituting "a European-wide research network for improving dissemination of Integrated Water Resources Management research outcomes". To do so, the project inventories all European research on IWRM in the 25 countries, and groups the various research managers in order to define common demand-driven research strategies (Office International de l'Eau, 2003).

Beyond the strict European Union (EU)'s borders, the EU Water Initiative, launched in 2002, was designed to contribute to the achievement of the Millennium Development Goals for drinking water and sanitation, within the context of an integrated approach to water resources management (European Commission, 2004). It is based on regional partnerships and multi-stakeholder involvement.

Further, the European Union commissioned a review of a sample of 67 projects undertaken by its International Scientific and Technological Cooperation (INCO) Programme, during three EU research framework programmes (from 1994 to 2006). The EU-INCO had indeed adopted the IWRM paradigm since the mid-1990s and the objective of the review was "to learn lessons from past investments in water research with an IWRM focus, [and] identify strengths and weaknesses with particular emphasis on the problems of implementing IWRM principles" (Gyawali et al., 2006:1). Alongside recognising the tangible benefits of investments in human and institutional capital in the partner countries, one of its main outcomes is the call for scientists to develop more communication with water managers and decision-makers (including to sometimes communicate unpleasant results), in order to increase the impact of these research activities: "They must learn how to engage in political processes" (Gyawali et al., 2006:12). To do so, the reviewers conclude on the need for a constructively engaged integrated water resources allocation and management – 'allocation' being added to be more explicit on the need to undertake re-allocative policy reforms (Gyawali et al., 2006).

Other regional initiatives include the West African Regional Action Plan on IWRM and the Central American Action Plan for IWRM (Jonch-Clausen, 2004); the Global Water Partnership's 14 regional partnerships (GWP, 2006a); the partnerships developed by Cap-Net, an international network focused on capacity building in IWRM, supported by the United Nations Development Programme and the Netherlands (Cap-Net, 2006); or the United Nations' Environment Programme's IWRM 2005 Programme, to accelerate the implementation of IWRM plans in seven regions through technical and financial assistance (UNEP, 2006).

But for Mollard and Vargas (2005a), assessing the introduction paper of the theme Integrated Water Resources Management produced by the Global Water Partnership for the 4th World Water Forum in Mexico in March 2006, not one example of successful IWRM implementation is given, because there are no successes anywhere. For them, this is where the cleverness of the approach resides: the conditions are never realised for an IWRM to spontaneously take place, which is why politicians should put in place top-down ones (and if by chance, a success did take place somewhere, they would immediately say this is a successful IWRM).

For these researchers, the examples put forward, insufficiently documented, actually question the usefulness of an IWRM more than anything else, as they do not result from such an approach but from the type of water management in place (either participative or authoritarian). Suggesting a classification of countries according to their governing characteristics (either legitimate, i.e. based on social participation; authoritarian; or neither), they suggest that IWRM favours authority with administrative neutrality, something dangerous for both societies and democracy (Mollard and Vargas, 2005a).

c. Problems of applicability

However, all those working on IWRM coincide on recognising that it is "a difficult concept to achieve in practice" (Duda and El-Ashry, 2000: 118). As illustrated by the results of the two surveys led by the GWP: "Integrated approaches are widely accepted as the main vehicle or instrument to manage water in more effective ways, and the international community has made considerable efforts and progress in increasing awareness of water resources and their management. However, their implementation remains incomplete in both developed and developing countries" (UN-WWAP, 2003a: 371).

Dourojeanni (2004), questioning precisely why IWRM is such a difficult concept to put into practice, warns that there is no simple answer (or else the problem would already have been solved).

The literature interested by this question identifies several constraints to IWRM implementation, both in terms of integration between sectors and with the environment.

Sectoral integration problems

According to Tortajada (2005), the acceptance of IWRM, which promotes a multi-sectoral and multi-disciplinary approach, has been prompted by the specificity of the water sector: its numerous linkages with many others sectors makes it difficult to rely on one discipline, institution or sector only to resolve the problems. As highlighted by Gyawali: "The different definitions of the basic concept have in common that they recognise that water's natural and socio-economic functionalities transcend sectoral approaches to planning, intervention and management and thus also disciplinary boundaries of knowledge" (Gyawali, 2006: 83).

It is s precisely the numerous interdependences it has with other spheres such as energy, agriculture, or the environment that render such a holistic approach unrealistic, according to Biswas (2005). He explains that IWRM's very fast popularity can be linked to the reassurance it provides: an inherent comprehensiveness, in a world where such encompassing approaches are far from being the norm. Due to the explosive increase in information and knowledge in both social and natural sciences since the end of the 16th century, nowadays disciplinary fragmentation is inevitable, to the extent that "with the frontiers of knowledge expanding continuously, it is becoming increasingly difficult for professionals to keep up with the advances even in their limited areas of interest" (Biswas, 2005: 329).

Somlyódy, referring specifically to water quality issues, for example, suggests the existence of an inherent contradiction between the increasing amount of knowledge needed to manage their complexity on one side, "and more efficient integration across various disciplines, emissions, sectors, countries, cultures, and societies on the other side" (Somlyódy, 1995: 250).

For Biswas, the same applies to institutions: IWRM would seem to stir nostalgia of a time where things were simpler and could be grasped holistically, institutional-wise. Today, it would also be impossible to put all interlinked sectors together in one same institution: this would require too many different technical capacities, and would be too big to manage (Biswas, 2005). Due to the inherent intersectoral linkages with agriculture, energy and transportation, it is impossible for any organisation to undertake a comprehensive analysis of all water management measures, while aiming at efficient water use for food production.

Various reasons explain this organisational constraint: the limits of professional training and competence, the limits of any organisation in terms of authority, the unpredictability of the future, etc. (White, 1998). Citing Falkenmark, Somlyódy points out that "the administrative infrastructure basically mirrors the scientific divisions" (Somlyódy, 1995: 257). This is echoed by Mariño and Simonovich's analysis: "Current institutional arrangements (laws, policy, and organizations) in many countries are probably the greatest single impediment to effectively managing water resources. They are generally complex, bureaucratic, competitive, *ad hoc*, inflexible, unresponsive, poorly integrated, and they result in systems that have poor accountability, lack foresight and prevent open communication and robust debate between stakeholders" (Mariño and Simonovic, 2001: v).

In any case, sectoral integration is still lagging, even in OECD countries (Duda and El-Ashry, 2000: 118). "The reality is that the traditional institutions are still basically sectoral, where most of the sectors tend to focus on activities related to one specific use and not to their multiple use or management at appropriate regional levels" (Tortajada, 2005: 300).

The administrative sectoral management –involving the different ministries of irrigation, agriculture, water and the environment- was set up to manage resources of land, water and forests "long before the need to coordinate them was fully appreciated" (Tropp, in press: 30). Be it between technical or economic priorities or professional specialisations (such as water engineers and soil conservators), although "policy documents and guidelines in most countries will urge co-ordination and co-operation (...) generally the attitude is not toward integration and co-operation" (Mitchell, 1990: 216). Boundary problems, such as professional biases or suspicions, arise whenever two or more interests overlap: wetlands, for example, provide important habitat for wildlife, while their drainage frees up land for agriculture; or dams produce hydroelectricity but prevent fish migration (Mitchell, 1990).

Resistance to change can be motivated by fear of losing authority or influence and leads to 'garbage can'[16] decision-making, like in the USA where the water sector is extremely fragmented according to physical, institutional and political-technical dimensions (Deyle, 1995). In addition to hidden agendas, fuzzy legitimation, unclear functions and huge structures also undermine integration: "The combination of organizational culture, personalities and participants' attitudes can pose a major obstacle to integration and co-operation" (Mitchell, 1990: 15). This is also true for de Jong (1995), who identifies the feeble will inside organisations to take a broad view instead of defending their interests, as one of the three bottlenecks to implementing IWRM, alongside communicational problems and historical anthropocentric approaches.

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[16] Deyle explains that 'garbage can decision-making', developed by Cohen et al. (1972), relates to decisions made "when a mixture of problems, solutions, and participants come together in an organizational 'space'", but unlimited in their flux (Deyle, 1995: 389).

Participation of stakeholders and decentralisation might not favour integration either, when in the name of integration, some national water institutions might wish to extend their responsibilities, risking more centralisation and concentration (Biswas, 2005).

In three sessions held at the 4th World Water Forum in Mexico, in April 2006, dedicated to examine to what extent and how countries have adopted and implemented IWRM principles, the main obstacles identified to crucial institutional reform are "limited capacity, low public awareness, poor political support, and inadequate funding" (UN-WWAP, 2006a: 7). Political support and funding is bound to increase, as the growing understanding of the importance of water for development, a success recognised to the IWRM approach, intensifies (UN-WWAP, 2006a). On the other hand, also required are increased civil society involvement and monitoring mechanisms with "indicators, quantitative as well as qualitative, which can more clearly reflect the progress toward implementing IWRM and meeting IWRM-goals and objectives, namely more equitable, efficient and environmentally sustainable use of water. The challenge is to develop indicators sensitive to local differences and priorities while able to deliver at the global level" (UN-WWAP, 2006a: 10).

In order to overcome such sector-integration difficulties, various solutions are suggested.

Countries implementing integrated approaches rarely first establish objectives to then distribute activities to the agencies in place, as these usually had their own interests beforehand: coordination mechanisms are sought for afterwards (Mitchell, 1990). So in order to create synergies "to produce collective benefits for all sectors in the basin (…) rather than inducing competition among sectors" (Duda and El-Ashry, 2000: p.124), a first step could be the creation of interministerial committees at the national level, as well as basin specific interministerial committees to ensure that sectoral ministries collaborate among sub national political jurisdictions for basin management (Duda and El-Ashry, 2000: 124).

These recommendations coincide with the finding of the WWF's Water and Wetland Index survey, led in 20 countries in Europe and northern Africa in 2003, to assess, among other things, the extent to which water policies and legislations have applied the IWRM principles. The results conclude that focused communication –still absent in most countries- must increase between bodies responsible for water and other sectors like land use planning and agriculture. Even more important, cross-cutting committees should be created to remedy to the lack of coordination, in all of the countries, between authorities managing different water components (ground, surface, coastal…) (WWF, 2003).

Such committees would constitute processes to facilitate what Mitchell calls 'bargaining at the boundaries', where most management problems are located: between levels of government (local, state, federal), among agencies at the same level of government (water, agriculture, forestry, wildlife...) or among divisions within departments, which usually have fragmented and shared responsibilities (Mitchell, 1990).

In addition to boundary problems, Mitchell identifies the range of concerns to be addressed and integrated as one of the two main barriers to effective integrated water management. Apparently, a common pattern in most countries had been to start off with a few elements: navigation, flood control and drainage (eastern States of USA) or hydropower generation, irrigation and flood control (western States), or irrigation, hydropower and flood control (in Japan). Then in the 70s, the questions of pollution and quality started to emerge and new management functions appeared. Realising the difficulty to implement these comprehensively, the tendency was generally to narrow all these down to only a few functions - those of primary concern in each specific country- while considering their linkages (such as irrigation and water supply in Nigeria) (Mitchell, 1990). Though acknowledging that at a strategic level (what can be done), it is desirable to think comprehensively, i.e. taking into account the broadest possible range of variables that may be significant, at the operational level (what will be done), a more focused, 'integrated' approach is needed, implying a smaller number of variables (the most significant, i.e. which account for a big proportion of the management problems) and their interrelations (Mitchell, 1990).

The six instruments used for integration that Mitchell identifies are very context-specific: legitimation through a mix of legislation, political commitment, and administrative decisions; a small number of functions to integrate; structures evolving from centralised organisations with many functions towards decentralisation; formal and informal mechanisms to facilitate coordination and integration between legitimation instruments, functions and structures is one of the greatest needs of the moment, with existing mechanisms ranging from inter-departmental or inter-agency committees to other tools like water rights (New Zealand), pricing policies (Canada), abstraction licences (Great-Britain), water supply and waste management charges (Poland), or public participation in decisions (the United States and Canada); finally a need for more organisational culture reinforcing the benefits of integration (Mitchell, 1990).

To overcome *institutional* bottlenecks, de Jong calls for broad, open-minded analyses of the current situation, eventually leading organisations to adapt. He also highlights the need for implementation on a small scale –leading to further expansion once it has proven good results- and the need to keep area-specific due to specificities in history, hydrology and culture: sometimes water companies will be best, other times environment boards will (De Jong, 1995). He stresses the need for clearly defined, commonly accepted, properly supported, and more anticipatory than reactive goals, as well as inclusion of citizen participation for wide support (De Jong, 1995).

Deyle also identifies convening appropriate stakeholders to define a shared problem (interdependency) and identify shared goals (vision) as necessary steps to move from 'garbage can' decision-making to potential long term collaboration. The transformation into a long-term alliance also depends largely on favourable circumstances (political will and leadership, time for the trust to build and relationship to mature) and conveners: "Where efforts to consolidate or integrate water management institutions have succeeded, the political, organizational, and environmental conditions have generally been exceptional. (...) A fortuitous crisis has often created a problem policy window that facilitates such an initiative" (Deyle, 1995: 396)

A very important condition for an effective implementation is to first identify common goals and activities and then see how individual organisations can contribute to these (instead of the other way around, i.e. trying to find how various organisations' goals can be coordinated to establish the context for integrated water management) (Mitchell, 1990).

For Mostert et al. (in press), these steps are part of the social learning approach they prompt to improve cooperation across boundaries ('learning together to manage together'). Although IWRM is recognised as being context-specific, striking implementation problems identified in the Netherlands, which has a relatively long history of IWRM, include limited process management (decision-making through a lot of cooperation) and contextual constraints (the general culture still favours individual initiatives compared to shared responsibilities) (Mostert, submitted).

Environmental integration problems

Too often, environmental concerns receive inadequate attention in IWRM planning. This is the common conclusion of several national reports submitted to the 4th World Water Council in April 2006: "Negative environmental externalities, which detrimentally affect water resources, continue to be too often ignored, while the positive contribution of ecosystem services to the water regime, a healthful environment and rural livelihoods is consistently undervalued" (UN-WWAP, 2006a: 8).

Most progress remains to be made in integrating land management and downstream biological diversity: "The challenge in dealing with the complex nexus of global environment, development, and water resources is to reform these policies, reduce damaging subsidies and bring the environment into the mainstream of economic decision making" (Duda and El-Ashry, 2000: 124).

"Approaches focusing on preventive action still lag behind traditional curative solutions. Risk reduction had not been well integrated into water resource management, which continues to be viewed primarily as a technical problem with economic repercussions, while its sociocultural and environmental aspects are often ignored" (Brüschweiler, 2003: 5).

Environment is often the weak link of IWRM because the needs of the environment in water are not yet scientifically established, which is the purpose of calculations linked to environmental flows (Odame-Ababio, 2004).

Further, it is interesting to note that few studies have focused on the linkages –be they economic or ecological- between upstream and downstream areas in the framework of freshwater ecosystems (IUCN, 2000). Those who have mostly concentrate on case studies where upstream rural land-use activities, such as forest-clearing for agricultural or pastoral activities, impact on downstream urban water use. On the contrary, the issue of the impacts of urbanisation on downstream water quantity and quality for rural areas seems insufficiently addressed (FAO, 2000). A possible explanation could be the fact downstream rural stakeholders might not have the power to voice the environmental problems they are faced with, nor the financial capacity to pay the upstream stakeholders to reduce the damage they incur (Kiersch, 2000b). However, "competition over water allocation within river basins, especially between upstream and downstream areas, between large-scale and subsistence-level uses and between commercial and ecosystem uses, is becoming a source of severe economic and political conflict" (Iftikhar and Emerton, 2003).

In this respect, the socio-economic dimension of environmental flows is now gaining momentum, while focus was initially on its biophysical aspects: the evaluation of the impacts of water allocations on downstream socio-economic activities is necessary in order to undertake informed tradeoffs (Niasse et al., 2004). In a worldwide survey on environmental flows (Moore, 2004: 45), it was highlighted that IWRM and its application needs attention in many areas of the world.

As highlighted in a worldwide survey on Environmental Flows (Moore, 2004: 26): "In the context of Integrated Water Resource Management, it is crucial that both water quality and environmental flows are considered and integrated in water management decisions". The author concludes that to remedy the current imbalance, there is a need for acknowledging the tradeoffs existing between the economic, social and environmental flows.

It is important to highlight that the concept of environmental flows has evolved from a purely environmental focus (their necessity for specific fish species' survival), to a more holistic approach including socio-economic aspects[17]. The human dimension of environmental flows is receiving increasing attention, due to the direct link between flows and livelihoods, including economic costs and benefits –the poorest communities in developing countries are often dependent directly or indirectly on the ecological goods and services provided by environmental flows for their livelihoods like subsistence fishing or small-scale irrigation activities- but also other social dimensions such as aesthetics, important cultural features and recreation (Moore, 2004).

So calculating the environmental and social benefits and costs of different environmental flow regimes (the basis of Environmental Flow Assessment) is a necessity to contribute to the environmental sustainability and social equity dimensions of IWRM (IWMI et al., 2004a).

Further, the results show that environmental flows are being taken into account in IWRM to some extent, demonstrating that further integration in water policy and management is possible, provided more experiences are shared. In particular, results show that there is a particular need for a better understanding of the costs and benefits associated with the implementation of the concept environmental flows: "By establishing a structured and transparent decision-making process that incorporates environmental, social and economic costs and benefits, more informed tradeoffs can be made" (Moore, 2004: 48).

According to Duda and El-Ashry, the key obstacle to integrated management of water, land and their biological diversity is the lack of commitment to undertake the necessary reforms. In particular, policy reforms are needed to encourage irrigation efficiency, through change in water pricing and removal of the massive government subsidies for irrigation water and land development. Other policy reforms must be designed to prevent unsustainable irrigation practices leading to salinization, contamination, eutrophication – a problem in many seas, due to excessive application of nitrogen fertilisers- or excessive diversion which disrupt ecosystems and livelihoods (Duda and El-Ashry, 2000).

But despite the call for such policy reforms at the end of each international conference for the past two decades, nothing much has changed. This is why countries willing to undertake such reforms are offered support by the Global Environment Facility (GEF) and its implementing agencies (UNDP, UNEP and World Bank), through incremental cost grants. The GEF is encouraging an IWRM at river basin level, "an integrated approach to land, water and ecosystem management". To do so, it encourages using the synergies between the three Rio global environment conventions (desertification, biodiversity and climate change) (Duda and El-Ashry, 2000: 116).

[17] This explains why other notions are also being used: in a global survey undertaken to evaluate the perceptions, specific implementation procedures and challenges related to the topic (Moore, 2004), a total of 57 different terms were identified, the most common being "environmental flows", "minimum flows" or "in-stream flow requirements".

For example, in the transboundary Aral Sea basin, environmental flows, elimination of subsidies, introduction of water charges and investment in irrigation efficiency are being undertaken. Essentially, the policy, legal and institutional reforms consist of: reform of water pricing policies, taking into account environmental considerations (through either regulatory or market-based instruments), stakeholder participation and creation of institutions at the river basin level, taken as the management unit.

For Calder, many of the problems lie in governance, defined by the UN-WWAP as the exercise of economic, political and administrative authority to manage a country's affairs at all levels, i.e. “the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences” (Calder, 2005: 269).

Similarly, Dourojeanni recalls that although water managers may have given their allegiance to IWRM, their decisions might be affected if this has not also been adopted outside of the national borders: often, decisions are taken by “powerful groups which make decisions on themes that seem far away from water and the environment, but that in practice affect these elements and resources much more than the decision made in the narrow circle of water and environmental experts” (Dourojeanni, 2004: 136). He refers in particular to free-trade agreements, foreign investment and trans-border river basins.

Trade-offs

Perhaps one of the reasons there are so many criticisms with regard to the implementation of IWRM “is that it is presented as a ‘win-win’ situation” (GWP, 2003a: 11). In the definition promoted by the GWP, no mention is made to the hard choices and trade-offs it necessarily entails: “The lack of implementation of IWRM is therefore due to a large extent to the lack of attention devoted to understanding political, social and financial conflicts”, whose resolution requires empowerment of water stakeholders and effective partnerships (GWP, 2003a: 11).

For example, where trade-offs do not seem to be recognised: In the United Nations World Water Development Report, it is mentioned that although “the idea of Integrated Water Resources Management is widely accepted as the starting point for water policies […] there is also a need to ensure that developing integration is not done at the expense of meeting such pressing needs that may arise in one particular aspect of water management such as drinking water supply, improved irrigation or threatened ecosystem functions” (UN-WWAP, 2003a: 7).

Whereas "although some 'win-win' solutions may exist, it is likely that meeting the joint objectives of long-term environmental sustainability and poverty reduction will almost inevitably involve negative trade-offs" (Calder, 2005: 270).

While there should be precise, uniform and standardised criteria for evaluation of options in water management, these actually vary from one place to another, and with time: there is a need to deepen the criteria quality to reconcile evaluation principles (White, 1998).

Falkenmark, using the green and blue water classification[18] calculates that to increase the food production in order to meet future needs, the next generation will need additional green water equivalent to the total blue water today. To do this, trade-offs will have to be bargained between using water from the rivers, increasing the efficiency (more crop per drop) and expanding crops areas to use the green water currently used by natural ecosystems (Calder, 2005). Politics make trade-offs and balances between development and ecosystem functioning: participatory approaches are required to legitimise them (Falkenmark, 2003).

Tropp makes a distinction between countries having been through the Green revolution irrigation, facing population growth, urbanisation, industrialisation, changing lifestyles, with problems of over-exploited aquifers, polluted rivers, and where the challenge is the need to increase blue water productivity. Technological innovations enabling to use water more efficiently will not be sufficient to face increasing water demand: decision-making systems will increasingly have to deal with tough trade-offs between water for human demands and ecosystem needs. The application of pricing regimes for more efficient and equitable water use has proven difficult, while results of governance options such as decentralisation, participation, water rights, need to be strengthened and clarified. He recommends, for example, an enhanced involvement of user groups for rights clarification and enforcement of pricing mechanisms, inclusion of customary rights into national legislations, etc.

As for countries of semi-arid rain-fed agriculture, they must learn to tap green water potentials, i.e. increase green water productivity/soil moisture: "Affordable, small scale technologies and approaches for farmers hold tremendous promise for improving local livelihoods" and they need to support innovation, small-scale credit, intensify integrated land-soil approaches. In both cases, governance must be more transparent and provide for balanced decision-making, even though tough trade-offs will probably be inevitable (Tropp, in press).

[18] Green water is water going out by evaporation due to irrigation, while blue water are return flows from irrigation, industrial and domestic use in addition to natural flows.

Such refusal to acknowledge trade-offs reflects what Mollard and Vargas (2005a) very critically denounce: according to them, IWRM is a technocratic doctrine-to-be that ignores history and social sciences, as well as the importance of politics. This is particularly unrealistic, because, as highlighted in the last Human Development Report, "in practice it is difficult to balance the competing claims of different users for a resource that goes to the heart of power relationships in society –and to questions of political voice and institutional accountability" (UNDP, 2006: 153).

Similar echoes originate from panel of researchers that reviewed experiences of IWRM in projects of the European Union's International Scientific and Technical Cooperation Programme Results indicate that it is the ignorance of the political dimension of IWRM in the international discourse of its proponents –the World Water Council, the Global Water Partnership, the European Union, the World Bank and many bi-lateral donor agencies- that has led practitioners to understand IWRM as a purely technical and economic-based approach, thus leading to do business-as-usual under its cover (Gyawali et al., 2006).

Inside the GWP itself, this is recognised as one of the biggest challenges the organisation needs to come to terms with: "We are now more in the political and governance issue, but suffer from insufficient social science capacity. The same goes for the countries in which we work, so there is a mismatch between what we want to do, and the people we need to do it with: people working at the GWP are water experts, but are not always prepared with the skills needed to deal with the real world, such as negotiation, conflict resolution…This is a new world for water people, one of process-driven social change" (Alan Hall, GWP Network Director, personal communication".

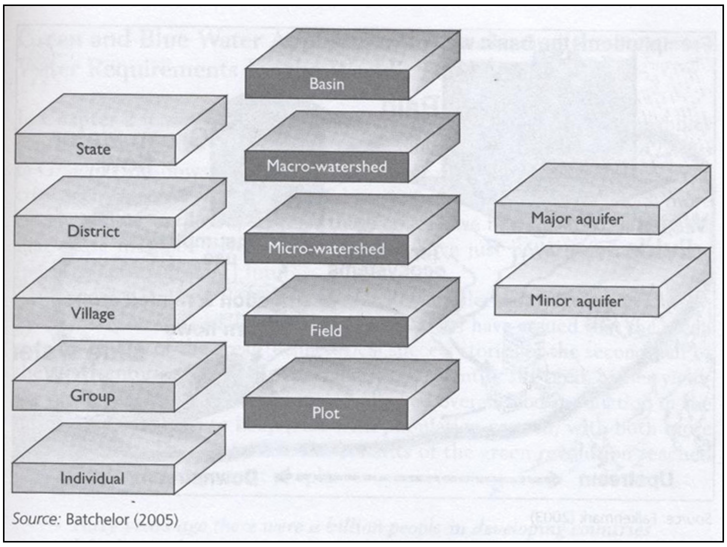
3. Repercussions at municipal level

As we have seen previously, IWRM, based on the Dublin principles, is promoted worldwide. According to principle 1, the large catchment or watershed (in thousands of km2) is the most effective management scale, corresponding to hydrological run-off; according to principle 2, there is a strong call for management at the lowest appropriate level (Smits and Butterworth, 2006). Indeed "the challenge of integrated land, water, and ecosystem management on a basin scale can only be met by management at the lowest possible levels. The national management level has certain responsibilities, the basin level has other responsibilities, and the local level has its contribution as well, be it community-based catchment management, irrigation users organizations, or urban water utilities. Reforms at the national level are needed to empower management at the other lower levels, including full cost pricing for all water service delivery" (Duda and El-Ashry, 2000: 124).

a. Scales of implementation of IWRM

Today, after some years of experience in the matter, we are faced with the following situation: "although it is widely recognised that the catchment level is the most appropriate for planning and management of water resources, this is increasingly challenged as being the best unit for implementation" (Smits and Butterworth, 2006: 11). This is because while the run-off takes place at the basin scale, most water uses, driven by socio-economic processes, take place within administrative boundaries (Smits and Butterworth, 2006). Several authors have highlighted the problems linked to the mismatch between hydrological and administrative boundaries (Calder, 2005; Brannstrom, 2004; Jouravlev, 2003; Pollard and Du Toit, 2004). So "clarification is needed for how a geographic-based agency relates to the mandate of the sectoral agencies and the administrative and political units which do not generally correspond to the basin boundaries" (WWC, 2000: 28).

Figure 10: Disjoints between hydrological and administrative boundaries need to be recognised by governance systems



Source: Calder, 2005: 271

A physical unit such as a catchment or watershed indeed usually encompasses different administrative entities, such as municipalities. As we will see hereafter, due to decentralisation processes, municipalities have a key role to play in water resources management. Thus all municipalities are also concerned with the application of IWRM: along with other actors, they share a responsibility in implementing the principles defined for the entire watershed.

b. Municipalities and IWRM

As part of the worldwide efforts started in the 1980s (World Bank, 2000), natural resources management has been at least partially decentralised in sixty countries (Larson and Ribot, 2004). Water is one such resource, identified as an issue of particular importance at the local scale: ten years after the Rio Conference, a survey to assess the implementation of Local Agendas 21 undertaken by ICLEI - Local Governments for Sustainability, shows that "water resource management is the common priority issue for municipalities in all world regions and regardless of economic situation" (ICLEI, 2002: 3).

Different categories exist, listing the various water-related functions in which municipalities can be involved as a result of such decentralisation processes (Smits and Butterworth, 2006).

According to Jouravlev (2003) for example, these range from local public services provision (water and sanitation, storm water management, solid waste management), to planning, promotion of development and control (spatial planning and employment creation): local governments play a double role of both big institutional water users, that affect and are affected by other users, along with that of promoters and managers of local socio-economic development.

In the framework of the European Union's 6th Framework Programme for Research and Technological Development, several projects are financed on the theme of the participation of local authorities to IWRM, among which the LoGoWater project ('Local Governments and Integrated Water Resources Management in Southern Africa'). Coordinated by the European Secretariat of ICLEI – Local Governments for Sustainability, this project brings together African and European researchers along with local governments from Southern Africa, to support these in improving water resources management in the Limpopo basin, between 2005 and 2008.

One of the project's objectives is to gain an overview of models and frameworks of local governments' participation in IWRM, and to highlight the constraints they face in fulfilling this role, to help them overcome such limits.

As part of the project's outputs[19], a literature review on local government and IWRM undertaken by Smits and Butterworth (2006) highlights three interests that local governments or municipalities have in relation to IWRM at the catchment level:

- "Ensuring access to water resources for basic human needs (water service delivery);

[19] The LogoWater project is also developing guidelines, with a methodology and a toolkit to support local government in actively participating in IWRM (ICLEI, 2006).

- Ensuring proper management of water and sanitation (including pollution impacts), and other water-related services such as storm water management and flood protection;

- Encouraging accountability of new catchment-level authorities (local governments represent a constituency and may be democratically elected) and alignment with the policies and priorities of local governments (i.e. development priorities)" (Smits and Butterworth, 2006: 39).

Four limits to implementing IWRM principles while fulfilling municipal functions are identified: the sub-sectoral fragmentation inside the water-related services; the weak accountability of both local authorities vis-à-vis water resources ones and vice-versa; the feeble community participation in water services; and the limited capacity of local governments both in terms of human and financial resources (Smits and Butterworth, 2006).

For local governments to overcome such challenges and better support the implementation of IWRM principles, the report advances two main approaches:

- Engage in new IWRM institutions, often at catchment level;

- Implement IWRM principles through local actions

These two approaches are not mutually exclusive but complementary: such a 'twin-track approach' is encouraged because in many developing countries, institutions at catchment level have not yet been set up (Smits and Butterworth, 2006).

They also correspond to the macro/micro levels recommendations made by ICLEI in its Local Government Implementation Guide for the Johannesburg Plan of Implementation (ICLEI, 2005). The Global Water Partnership also recognises that "local authorities can play an important role in overseeing the implementation of IWRM activities both within their boundaries and within the local and regional watersheds" (GWP, 2006c).

Hereafter we present these two approaches in more detail

Engaging in IWRM by being active in new water resources management institutions

These new institutions are those established to implement IWRM, along with the policy and legal reforms undertaken. Among the different forms reviewed, those enabling a municipal participation are catchment coordination bodies and municipal associations.

The first suffer from local governments' limited awareness, whose participation is not stimulated by "seeing this body as a slowly-progressing discussion forum, in which it does not need to take part, only to be an invited guest" (Smits and Butterworth, 2006: 29).

On the other hand, municipal associations have been developing, with a number of examples in Latin America inventoried by Jouravlev (2003). The examples mentioned are those of institutional arrangements purportedly organised to cover a watershed and overcome the limitations of water management at a municipal scale: firstly, the watershed is more appropriate for decision-making related to multiple uses, as it is the scale at which all interactions take place; the same can be said of the interactions between water, land and related natural resources; finally, it is also the scale at which these two socio-economic and physical-biotic systems interact (Jouravlev, 2003). In the case of such municipal associations, the problems include: the heterogeneity of municipalities, the frequent turnover in municipal authorities and its consequences in terms of administrative team changes, rivalry between municipalities of different political parties, and the subsequent important transaction costs to coordinate an important number of municipalities with varying characteristics and objectives (Jouravlev, 2003).

Engaging in IWRM by implementing its principles at the local level

Examples of local actions identified in which different sectors of local governments can implement IWRM principles include linking water services and livelihoods, reusing wastewater, and de-coupling storm water and wastewater (Smits and Butterworth, 2006). It is worthwhile mentioning here that it is only since the World Summit on Sustainable Development in 2002 that the issue of wastewater is considered jointly with that of water management. Previously, they had been separated since the 19th century when scientists discovered waterborne diseases, and treatment infrastructures were built far away from drinking water sources, whose distribution was centralised (Seacrest, 2005).

Smits and Butterworth (2006) give three examples where IWRM principles can be applied at the local level:

First, water for domestic and productive purposes are generally not provided together, and when the second comes to missing (for example for small scale irrigation), it is frequent for users to tap into the first. This can lead to overuse of the domestic water supply service, not designed for both purposes, while benefits of multi-use should be considered to avoid this.

Reusing wastewater is also identified as a possible local action to link various sectors (water, sanitation, agriculture). It enables to both reduce pollution and treatment costs, while also constituting an alternative source of irrigation water, even though precautions are needed to avoid health risks.

Finally, de-coupling of storm water and wastewater is also an important local action that is increasingly being considered in Europe, as it has been evaluated that it is cheaper to separate the flows and treat only the wastewaters, instead of having both flow into the sewage system.

In addition to these three examples, several series of guidelines have been drawn up to promote a sub-sectoral application of IWRM principles, either in the water, sanitation and hygiene sector or more broadly.

To summarise, in this chapter we have presented our conceptual framework through a historical and geographical overview of IWRM, its implementation tools and constraints, with a final specific focus on its implementation from a municipal point of view.

CHAPTER 2 – THE MEXICAN PATHWAY TO IWRM

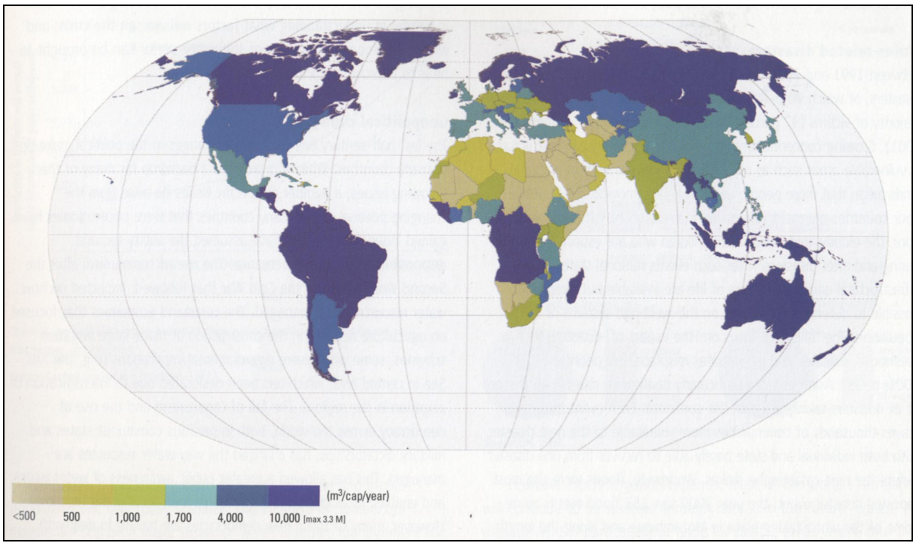
After having introduced the concept of integrated water resources management, the objective of this part is to give a broad picture of the main water issues in Mexico, and present the general water management framework of the country.

1. National level data

Mexico, covering 2 million km2, has a population of more than 103 million in 2005 (INEGI, 2005). With 4,360 m3 of water per capita in 2005, it is a country with medium water availability[1] (UN-WWAP, 2006b). In 1950, this figure was 11,500 m3 per capita, while it is projected to reach 3,800 m3 per capita by 2025 (Carabias et al., 2005).

In terms of comparison, water availability per capita was almost 28,000 m3 in 1997 on average in Latin America and the Caribbean[2], ranging from 2,804 m3 in the Greater Antilles (Cuba, Haiti, Jamaica and the Dominican Republic) to 191,422 m3 in the Guyana sub-region (Suriname and Guyana) (FAO, 2006).

Map 3: National internal renewable water resources per capita around 1995



Source: WWAP, 2003: 11

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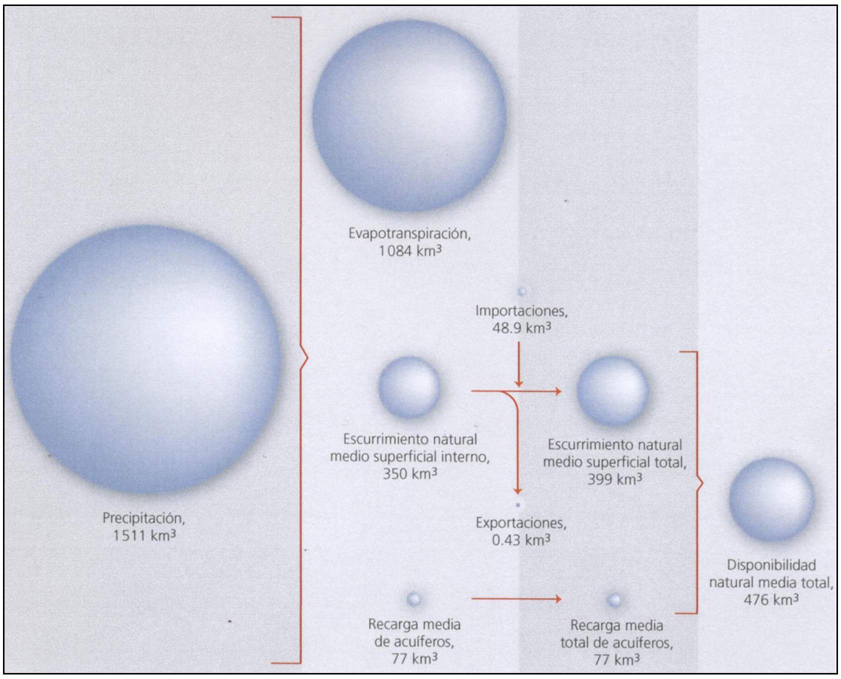
[1] The conventional threshold of 1,700 m3 per capita is that above which a country can meet water requirements for agriculture, industry, energy and the environment. Below, countries experience 'water stress'; below 1,000 m3 per person, they are faced with 'water scarcity', and below 500 m3 per person, with 'absolute scarcity' (UNDP, 2006).

[2] Even though at country level there might be a difference between the two, at regional level like here it is possible to use data provided for the Total Internal Renewable Water Resources, as they can be considered more or less the same as the Total Actual Renewable Water Resources, according to the FAO Aquastat communication office.

To calculate such data, a country's total water availability (476 km3 in Mexico) is first obtained by substracting evapotranspiration, water imports and exports from the annual rainfall. This figure, divided by the total population, then gives the average annual water availability per capita.

Figure 10: Mexican hydrologic cycle (average annual figures)



Source: Carabias, 2005: 24

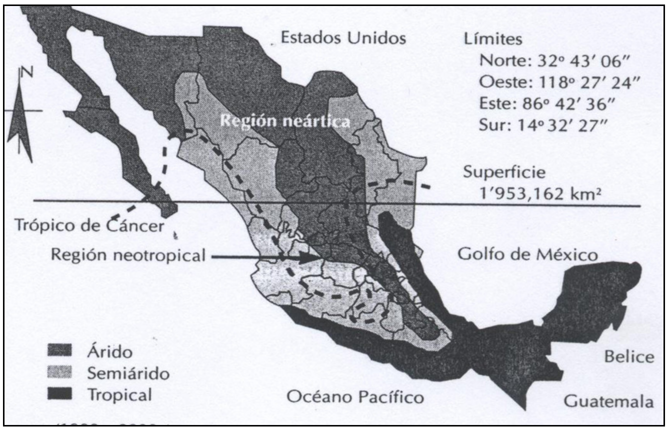
But this medium national water availability does not reflect the strong disparities in water runoff throughout the country, in both time and space[3] (Carabias et al., 2005).

First, in Mexico, rainfall is concentrated in a unique rainy season that runs from June to September. Its torrential characteristics make "the resulting runoff difficult to regulate" (Aldama, 2005: 307).

In addition, there is also an important spatial heterogeneity: due to its geographical features, Mexico is a country where all climates are found –except for the extreme cold ones (Carabias et al., 2005). Almost two thirds of Mexico is submitted to an arid or semi-arid climate (Palacios, 2004) while the rest ranges from temperate to tropical (Centro del Tercer Mundo para el Manejo del Agua, 2003).

[3] The Relative Water Stress Index, developed by Vorosmarty, attempts to overcome this limitation (WWAP, 2006: 116).

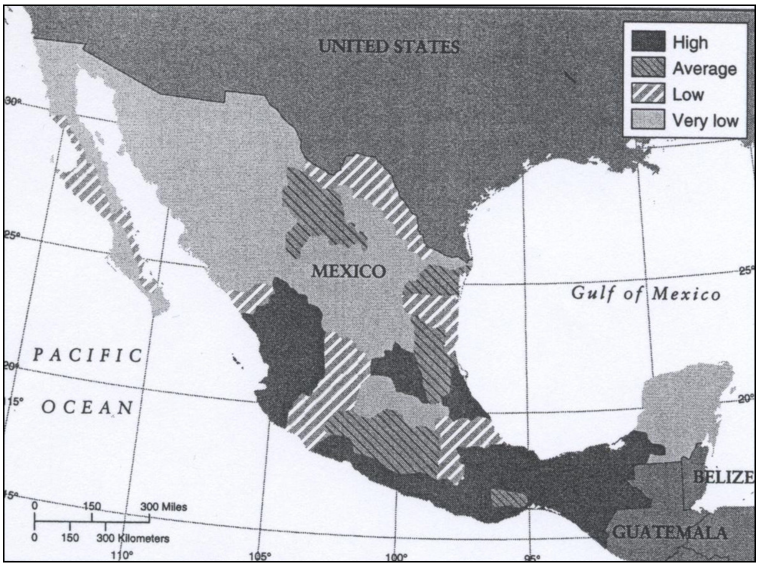
Map 4: Climatic variations in Mexico



Source: Centro del Tercer Mundo para el Manejo del Agua, 2003: 20

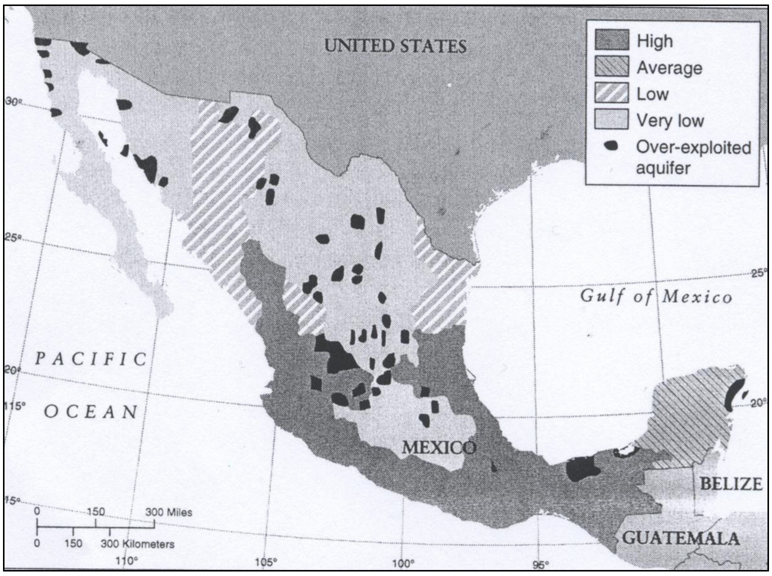
These climatic variations in turn have a strong impact on natural water availability: while 20% of the territory receives 40% of the rainfall, 40% of the territory receives 20% of the rainfall, impacting both surface and groundwater availability (Aldama, 2005).

Map 5: Variety in the runoff availability throughout Mexico



Source: Aldama, 2005: 307

Map 6: Variety in groundwater availability throughout Mexico



Source: Aldama, 2005: 308

The National Water Commission recognises that there is no knowledge of the exact quantity of water used in the country: the reference data is that of the Public Register of Water Rights (Repda, according to its Spanish acronym) which lists all water concessions[4] (CNA, 2005).

According to this official database, total water demand (225 km3 in 2005) is largely below total water availability (476 km3), representing only 47%. This is despite the fact demand has almost doubled in ten years, essentially for consumptive uses[5]. Inside these consumptive uses, agro-pastoral activities occupy the first rank with 76% of water use, largely in front of public supply (14%) and industry (10%). These consumptive uses still use up twice less water than non-consumptive uses (75 km3 and 150 km3 respectively) (CNA, 2005b). According to certain United Nations organisations, it is the fact total consumptive use represents only 16% of total available water that qualifies the country as having a moderate pressure on water resources (Carabias et al., 2005).

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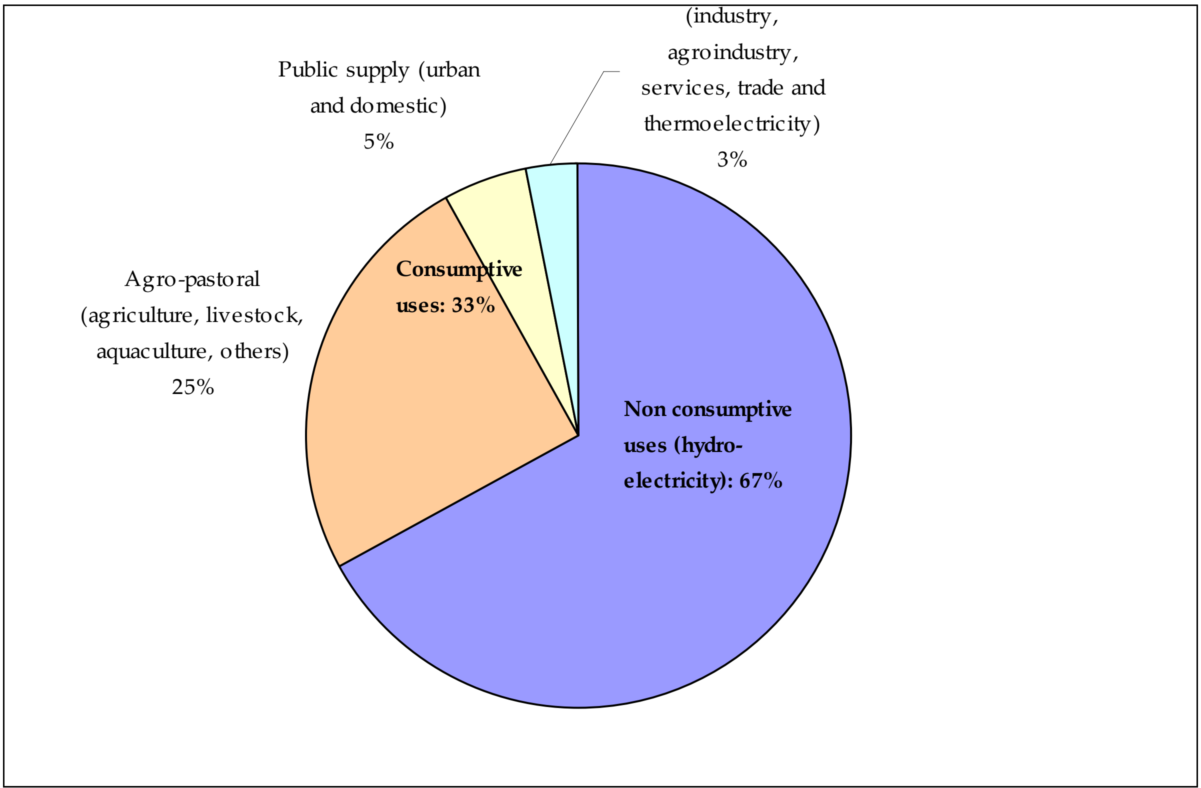
[4] According to studies undertaken in the framework of the Ayuquila-Armería Watershed Commission, the Repda severely underestimates the total water use (up to 40% is not registered). This is because it has never updated water use in small-scale irrigation systems (i.e. not included in larger irrigation districts), locally known as irrigation units (Paula Silva, Personal communication).

[5] Consumptive uses are those for which water is transported to the place of use and part of it does not return to the original water body, while non-consumptive uses are those for which water is used on-site or through a minimal diversion and totally returned to the water body (CNA, 2005b).

Figure 11: Consumptive and non-consumptive uses of water in Mexico (2004)



Source: Elaborated from CNA, 2005b

Consumptive and non-consumptive uses share superficial water as their main source (up to 64% for the first, 100% for the second). But inside consumptive uses, important variations exist: while groundwater is mostly resorted to for public supply, agro-pastoral and industrial activities preferably recourse to surface water.

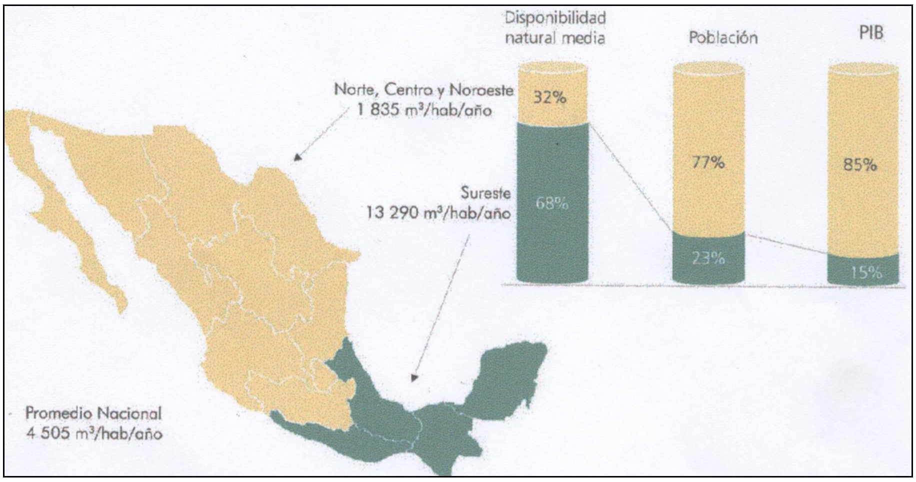
Table 1: Volume of water concessions for consumptive uses (in km3 in 2004)

Use	Origin		Total volume
	Surface water	Groundwater	
Agro-pastoral	38.7	18.7	57.4
Public supply	3.9	6.8	10.7
Auto-supplied industry	5.6	1.7	7.3
Total	48.2	27.2	75.4

Source: CNA, 2005b

In addition to the fact the official ample margin between total demand and availability is probably overestimated, it does not reflect the very distinct realities throughout the country. The problem resides in the fact that territorial distribution of population and economic activities is inversely related to that of water availability: 77% of the population lives and 84% of gross domestic product is generated where only 28% of the runoff occurs (Aldama, 2005; López, 2004)). Similarly, while 75% of the population lives more than 500 m above sea level, 80% of water storage structures are located at lower altitudes.

Map 7: Contrast between development and water availability



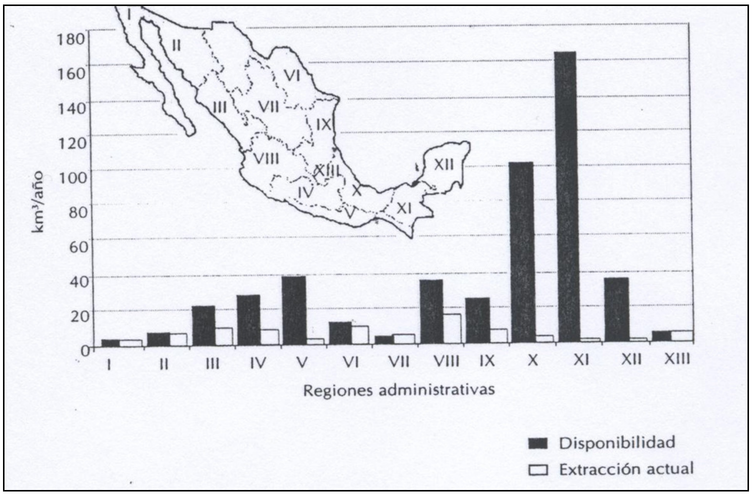
Source: CNA, 2005a: 27

Since the first National Water Plan in 1975, thirteen administrative regions based on hydrologic criteria have been established (themselves grouping 37 hydrological regions containing 314 hydrological basins). Each region is endowed with a regional coordinating agency of the water ministry. As a consequence of the above, some regions overexploit the resource while others under-utilise it (Tortajada, 2005).

In the northern part of the country, for example, the water availability is only 1,336 m3 per capita per year, while in the south-east State of Chiapas, it reaches 24,674 m3 per capita per year[6] (Carabias et al., 2005). Certain watersheds of the country, like that of Valle de Mexico or those in the state of Guanajuato are already under water stress (García, 2004; Aldama, 2004).

[6] According to Tortajada (2005), the fact the southern part is also the poorest of the country, despite the abundance of the resource, can be explained by the weak interest of successive governments in regional development impacts of sector-by-sector policies, mainly developed at federal level.

Map 8: Variable pressure exerted on the water resource[7]



Source: Centro del Tercer Mundo para el Manejo del Agua, 2003: 45

In order to face the disjunction between water supply and demand, massive efforts have been undertaken to develop the necessary infrastructure for the various water uses, mainly agro-pastoral activities and public supply.

Currently there are approximately 4000 dams, out of which 850 are considered as big dams. These were mainly built between 1910 and 1977 to provide for both urban and irrigation uses – starting 1946, multi-use dams also enabled to generate hydroelectricity and provide protection against floods (Centro del Tercer Mundo para el Manejo del Agua, 2003).

There are also 3,000 km of aqueducts (CNA, 2005c). In the 1960s and 1970s, basin-to-basin transfers were initiated, the most notorious being that from the Cutzamala and Lerma-Balsas basins to provide water for irrigation in the northwest, as well as additional water supply for the Metropolitan Area of Mexico City (Tortajada, 2005).

As a result, according to the census of 2000, potable water supply coverage reaches 87.8 % at national level (respectively 94.6% and 68% for urban and rural areas). In terms of sanitation, the figure is quite lower, 76.2% on average (respectively 89.6 % and 36.7 % for urban and rural areas) (CNA, 2005c: 56). This means that approximately 13 million people lack access to potable water and 27 million to sanitation (Aldama Rodríguez, 2004).

As for agriculture, there are 6.3 million ha under irrigation (CNA, 2005c), representing roughly a third of the total cropped area (Centro del Tercer Mundo para el Manejo del Agua, 2003). Up to 60% of the irrigated land is divided in 81 irrigation districts (managed by both

[7] It is calculated by dividing the total volume of water under concession by the average natural availability.

the government and water users' associations since the decentralisation process started in 1989), the remaining 40% corresponding to 30,000 irrigation units (managed solely by water users' associations) (Centro del Tercer Mundo para el Manejo del Agua, 2003).

Overall, the two main issues are groundwater overuse and the increase in water contamination (Aldama, 2005).

Groundwater, which represents only 36% of total water for consumptive uses, supplies almost two-thirds of domestic water and a third of the total irrigated area (Carabias et al., 2005). According to Carabias et al. (2005), close to 16% of aquifers are over-exploited – see map 10-, a figure that has tripled during the last thirty years. Uses exceed availability in at least four administrative regions –I, II, VII and XIII (Península de Baja California, Noroeste, Cuencas Centrales del Norte and Valle de México)- while this is close to being the case in regions III, VIII and IX (Pacífico-Norte, Lerma-Santiago-Pacífico,Golfo Norte) (Centro del Tercer Mundo para el Manejo del Agua, 2003).

The situation is worsened by the fact the aquifers do not recharge as fast as before, due to deforestation, land use changes as well as longer dry seasons due to climate change (Carabias et al., 2005). Where rainfall is low, recharge is particularly slow so if overuse is maintained on a long period, this can lead to the aquifer drying up: groundwater reserves are shrinking at a rhythm of 6% per year (Ibid.).

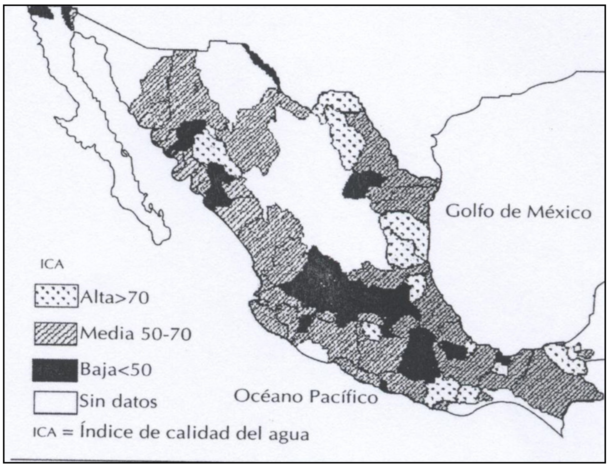
Using almost 70% in volume, agriculture is one of the main users of groundwater (CNA, 2005b). Its low efficiency can be explained by several factors. First, 90% of irrigation is realised by gravity (IMTA, 2002). Then, a common practice to limit the risks of lower productivity is that of over-irrigating, compared to the needs of the crop (Scott et al., 2004). Finally, while modernisation programmes were set up since the 1960s to increase productivity in the irrigation districts, the economic and financial crisis of the 1980s initiated several decades of infrastructure deterioration due to insufficient maintenance (Tortajada, 2005). The resulting low average efficiency of 46% translates by a "loss" of almost three times the total public water supply –where losses due to leakages already revolve around 40% (Carabias et al., 2005). Even though the irrigation "losses" usually either infiltrate back into aquifers or feed into other water bodies, the aquifer extraction is rarely totally compensated, explaining why one of the priorities is to increase irrigation efficiency (Carabias et al., 2005).

In addition to the transfer of irrigation districts to water users, one component of the modernisation programme started in 1989 was indeed to increase the water use efficiency (Johnson, 1997). By the end of 1996, 88% of the total gross area of the irrigation districts had been transferred to 386 water user associations, and out of 82 irrigation districts, 59 had been totally transferred and 13 partially transferred (Palacios, 1998). In terms of water efficiency, the programme is ongoing, with gravity irrigation progressively being replaced by underground channels or drip-irrigation.

Nevertheless, such technical programmes are not sufficient to curb the groundwater over-use, as the "savings" in water they enable are generally used to either extend the irrigated area, increase the number of harvests per year or cultivate water-thirstier crops (Carabias et al., 2005). There is also a need to change the regulation of concessions to provide incentives for a more efficient use of groundwater: under the current system, farmers are at the risk of losing their concession if they do not use all the water it includes. This could also be combined with regulating the demand between users of a same aquifer, using pricing tools or monitoring extractions more carefully (Carabias et al., 2005). In particular, as prohibitions to bore new wells are not always respected, a more effective incentive might be to increase the price of electric energy (for pumping) or restrict the number of new electric connexions (Scott et al., 2004).

The second biggest problem in Mexico is the contamination of water bodies: in 2001, 70% had some degree of contamination (Carabias et al., 2005).

Map 9: Quality of surface water (data from 1975-1992)



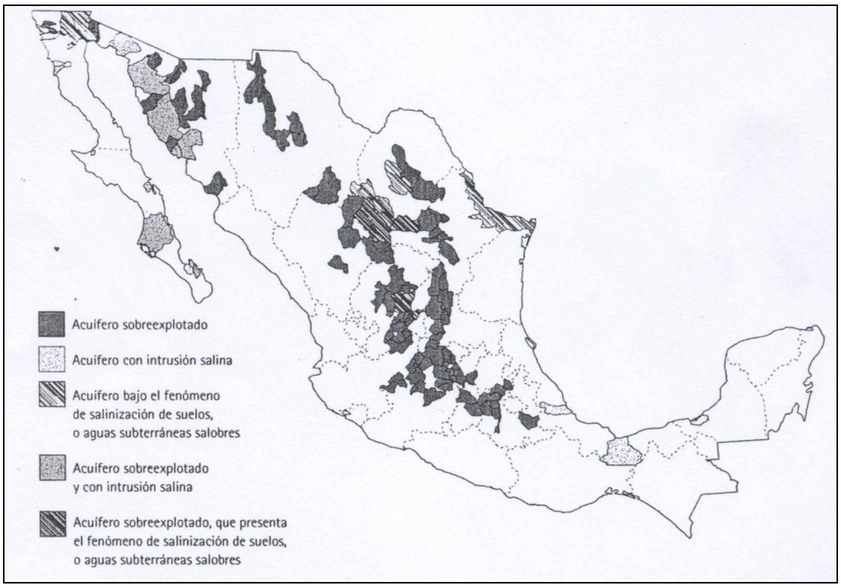
Source: Centro del Tercer Mundo para el Manejo del Agua, 2003: 146

There are three main sources of contamination: municipal, industrial and agricultural[8]. According to data from the Third World Centre for Water Management, only 19% of the total 7.54 km3 per year of municipal wastewater (also including industry connected to municipal sewage) receives a treatment. For industrial wastewaters not connected to the municipal public sewage (5.36 km3 per year), this proportion is only 16%. Diffuse pollution is more difficult to estimate, but studies have assessed a generation of 21.2 km3 per year of agricultural discharges (Centro del Tercer Mundo para el Manejo del Agua, 2003).

[8] In addition, groundwater suffers from saline intrusion in the case of coastal aquifers.

Solid and dangerous waste is also a major contamination factor: in 2000, 47% of municipal solid waste does not receive an adequate treatment (monitored landfill site or recycling process)[9]. Industrial waste is also a big issue, in particular that with toxic components, either chemical or petrochemical.

Map 10: Aquifers (in 2004): over-exploited, submitted to saline intrusion and/or land salinisation



Source: CNA, 2005a: 33

This contamination has important economic, environmental and health impacts, such as causing important gastrointestinal infections, the second cause of infant mortality, or leading to the resurgence of cholera at the end of the 20th century (Centro del Tercer Mundo para el Manejo del Agua, 2003). Combined with important water deviations, it also heavily affects aquatic biodiversity, such as humid zones, who play an important role in the hydrological cycle (Carabias et al., 2005).

While natural de-contamination of surface water can be rather quick, if the source of pollution is halted, this is much more of an issue in the case of groundwater, where such remediation can take several decades (Carabias et al., 2005). This is particularly preoccupying for arid areas, where groundwater is often the unique source of water. In any case, increasing contamination of both surface and groundwater leads to treatments that are more and more costly in order to be able to allocate such water for consumptive uses (Centro del Tercer Mundo para el Manejo del Agua, 2003).

[9] These data remain indicative only, as the sources are not always very consistent (Centro del Tercer Mundo para el Manejo del Agua, 2003).

In the following section we will see how the Mexican institutional framework has evolved in an attempt to face these pressing issues of overuse and contamination of water sources.

2. The regulatory and institutional framework: working towards an IWRM?

As Aldama (2005) recalls, water has been an important feature throughout the whole of Mexican history. The most well-known legacy of the pre-Hispanic civilisations –the Olmec, Teotihuacan, Toltec, Mexica (Aztecs) and Maya, who flourished from 2300 B.C until 1521 A.D.- are the irrigation and aqueduct systems in the Valley of Mexico (the floating gardens of Xochimilco are classified as a World Heritage cultural site). Then, during the three hundred years of Spanish colonialism until the Independence (declared in 1810 but completely realised in 1821), waterworks continued on being developed, in particular irrigation systems in the haciendas and aqueducts to supply colonial cities[10]. Since the Revolution of 1910-1917, and especially since the population increase in the 1930s, successive federal governments have supported the accelerated development of hydraulic infrastructure for irrigation, cities and industry across the 31 states and the Federal District (Aldama, 2005; Centro del Tercer Mundo para el Manejo del Agua, 2003). As reminded by Rodríguez (2004), the country is indeed officially a federation of independent states with autonomous municipalities, even though in practice centralism remains a preponderant characteristic of the Mexican governance system, as we will see throughout this section.

The modern water policy is anchored in the Constitution of 1917. Its article 27 defines all surface water previously declared as such as public property, while groundwater are the property of the landowner under which they are located; nonetheless, both sources can see their uses regulated by the federal government (García, 2004). Since then, the legal and institutional framework has undergone important reforms. Major milestones include the creation, in 1926, of the first water administration (the National Irrigation Commission) and of the Irrigation Law, in response to the necessity to increase food production and populate the northern border areas; the integration of water development and management in a unique central organ –the Ministry of Water Resources- in 1946, at a time when water demand for both industrial and urban uses was substantially increasing; the creation of River Basin Commissions in the 1940s and 1950s, to implement large scale waterworks and spur regional development[11]; in the 1960s and 1970s, national sectoral water plans for the

[10] At the time, water rights were delivered by far-away administrations or the King of Spain himself (Mollard and Vargas, 2005b).

[11] The territorial scale chosen for such regional development was the river basin, states being deliberately ignored in order to reduce their political power. But it was precisely such a technocratic approach that led these river basin organisations to collapse, under the pressure of the political-administrative forces in place (Mollard and Vargas, 2005b).

development of regions such as the northwest, and rehabilitation of irrigation districts to increase agricultural productivity; the National Water Law of 1972, which defined institutional responsibilities, created irrigation districts and led to the first National Water Plan in 1975; in 1976, the fusion of the Ministry of Water Resources and that of Agriculture, reflecting governmental priorities (only urban water supply stayed at the Ministry of Human Settlements and Public Works) (Aldama, 2005; Schmidt, 2005; Centro del Tercer Mundo para el Manejo del Agua, 2003).

With domestic water defined as a constitutional right, it was provided almost free of charge by the federal government (Pineda, 2004). Indeed, although potable water and sanitation had been defined as a municipal responsibility in the Constitution, the federal authorities were generally in charge of providing the services, at least during the period of municipal consolidation (Rodríguez, 2004). Irrigation water, the government's priority in the sector until the 1980s, was also almost free (Linck, 2006).

Such subsidising practices were not a problem during the forty years of economic growth that started in the 1940s[12], and contributed to reinforce the image of benefactor of the unique political party in power (Centro del Tercer Mundo para el Manejo del Agua, 2003). From the 1960s until the early 1980s, in a context of apparent financial abundance, large-scale basin transfers were devised to supply public and irrigation water, irrespective of the costs these entailed (Tortajada, 2005a).

As Linck (2001) explains, this period corresponds to the implementation of the green revolution in Mexico, resting on the occidental model of productivity and set up to feed an increasingly urban population (the figure of 50% is reached in the 1960s). Indeed, the development model chosen was one of industrialisation (based on import substitution), thereby contributing to urban concentration. The green revolution system, based on subsidised inputs and industrial equipment as well as standardised large-scale production, contributed to exclude all traditional small-scale agriculture (mainly producing rain-fed maize), thus initiating the beginning of the 'rural decline' and the end of self-sufficiency in maize[13]. To reverse this, towards the end of the 1970s, the subsidies were extended to include rain-fed agriculture but without helping the small farmers sell their products, thus leading to create what a following neoliberal government would qualify as "a low-efficient, assisted and deresponsiblised agriculture" (Linck, 2001: 59).

[12] Petrol exports enabled to boost growth and finance the industrialisation model. Nationalised since 1938, the petrol industry particularly benefited from the rise of petrol prices in the 1970s, with related income representing up to 80% of export-based income at the end of the decade (Bolay, 1985).

[13] In addition to damaging the small farmers' dignity and producer identity, the green revolution also generated important environmental impacts such as the destruction of ecosystems and the overuse of aquifers (Linck, 2006).

In terms of water, although the subsidies put in place for both potable and irrigation uses undeniably contributed to increase living standards, they also resulted in inefficient cost-recovery and incentives to waste (Tanaka, 2002). At the end of the 1970s, the idea of transferring the provision of potable water to states and municipalities was reinforced with the dissolution of the Ministry of Water Resources in 1976, delegating various sectors to different ministries.

An end was put to these subsidising practices with the major economic crisis that started in 1982 –a debt crisis[14], due to high international interest rates and which triggered the 'lost decade' in most of Latin America- later followed by a financial crisis due to the brutal devaluation of the peso in 1994 (Tanaka, 2002; Cordonnier and Santiso, 2001). Provoked by a general context of violence (the zapatist uprising, the assassination of the Institutional Revolutionary Party's candidate), the latter entailed a flight of capital, contended only by a massive financial support from the international community (Cordonnier and Santiso, 2001). In exchange, the country was submitted to strict structural adjustment by the lending agencies, mainly the World Bank and International Monetary Fund.

As a result, a restrictive budgetary policy was put in place (Ibid.). Budget constraints severely capped all water development projects, while insufficient subsidies did not allow for proper infrastructure maintenance anymore (Tortajada, 2005a). In spite of fiscal reforms, tax collection remained low (Saade, 1997). Also, while at the beginning of the 20th century, water was a priority for agricultural needs to feed a population which was mainly rural (75% in 1940), urbanisation trends changed this, also influenced by the hygienist discourse encouraging more water uses through personal facilities (Peña, 2003; Linck, 2001). So in the context of growing urbanisation, the government was confronted with its incapacity to respond to the increasing water demand (Pineda, 2004).

a. Encouraging road signs

After half a century, the revolutionary regime had not delivered its promises: with respect to the agrarian reform for example, fees owed to the central government by the irrigation administration were seldom paid, while limits to groundwater forage rarely respected (López et al., 2004).

To face this situation and implement significant cost savings, the federal government undertook four main policy actions: the restructuring of the legal and institutional framework, the promotion of decentralisation on one hand and of private sector involvement

[14] The fall of petrol prices combined with a high dependence on petrol exports led to a crisis of over-indebtedness (Mollard and Vargas, 2004b; Bolay, 1985).

on the other, and the design of new financing schemes (Saade, 1997). These initiatives illustrate the transition that took place during the 1980s, between the model of industrialisation by import substitution accompanied by a strong governmental involvement, to one of a more neoliberal tendency (Cordonnier and Santiso, 2001; Linck, 2001). As Schmidt (2005) recalls, two successive so-called 'technocratic' presidents undertook and consolidated this approach of free trade, deregulation and privatisation: Miguel de la Madrid (1982-1988) and Carlos Salinas de Gortari (1988-1994). They would be followed by the last PRI president, Ernesto Zedillo (1994-2000), before the election of Vincente Fox, from the National Action Party[15].

Hereafter we chronologically present the main highlights of these interdependent reforms in the water sector, some of which represent promising steps towards a process of integrated water resources management.

In 1980, a Presidential Agreement transferred the management of water supply and sanitation systems to the states; each state having the freedom to decide on the preferred configuration (state or municipal level operative organisms), this transfer gave way to a variety of institutional set-ups (Rodríguez, 2004). Investment in infrastructure, however, remained an exclusive federal responsibility (Pineda, 2004).

Then, in 1983, the 'municipalisation of potable water' started, through an amendment brought to Constitutional article 115 –which regulates municipal activities (Pineda, 2004). It allowed the transfer of spending power from state and federal level to municipal governments, assigning these a number of responsibilities among which that of providing potable water, drainage and sewerage systems (Moreno, 2004). However, in case of insufficient financial or technical means, state support could still be appealed to. The exploitation, use, distribution and control of national waters were nonetheless kept in the hands of the federal government (Centro del Tercer Mundo para el Manejo de Agua, 2003). The reform also enabled to increase municipal governments' ability to respond more effectively to local needs, by establishing their right to manage their own finances and specifically keep all revenues collected from property taxes and public services' provision (Edmonds, 1997).

The reform was implemented in several steps (Pineda, 2004). That same year, the construction and administration of hydraulic systems –which had been the responsibility of the Ministry of Water Resources and partially that of the Ministry of Human Settlements and Public Works since 1976- were transferred to the state governments. These could then decide

[15] V. Fox's election in 2000 represents the first change of political power in 71 years of PRI reign. Mexicans seem to want to pursue this path, as showed by the recent presidential elections of July 2006 where both the candidate of the same PAN (Felipe Calderón) and that of the Party of the Democratic Revolution (Andrés Manuel López Obrador) were largely ahead of the PRI candidate (around 35% of votes compared to 21%).

whether they downloaded them to municipalities or not, or as a third option, operated jointly. As a result, by 1988 eleven states had chosen the transfer option, and by 1996 this figure had doubled. Later, in 1999, another reform to Constitutional article 115 made the transfer mandatory, with exceptions being authorised only in case of municipalities' justified demand (García, 2004).

But the reforms have been severely criticised, because accompanied by insufficient means to guarantee their smooth implementation. Indeed, as of 1982, only municipalities that were also state capitals could eventually manage such operating systems in a financially auto-sufficient way (Rodríguez, 2004).

As a result, municipal drinking water and sanitation systems today still suffer from heavy criticism, the first problem being their lack of financial resources to provide a service of quality (Solanes and Gonzalez-Villareal, 1999).

As analysed by Joumard (2005), this can partly be explained by the mismatch between the highly centralised taxing powers since 1980 –a change operated to increase the efficiency of the system, very low in times of state taxes- and the decentralisation of spending responsibilities a few years later. Reflecting this, municipal level taxes in 2002 only account for 10% of their revenue. Moreover, inside such own tax revenue, 60% is generated by the real estate tax, limited by outdated land registers (their update is rarely undertaken as such operations entail short term political costs and benefits on the long run only). To compensate this fiscal unbalance, a system of revenue sharing was designed, requiring that 20% of transfers received by states from the federal government –in exchange for giving up their revenue raising powers- be allocated to municipalities (Joumard, 2005).

Another factor explaining the financial shortage of municipalities is their common clientelist attitude: fear of electoral reactions prevents them from raising water fees (Solanes and Gonzalez-Villareal, 1999). This is the prime factor, even before the population's capacity to pay (Rodríguez, 2004) but more generally, it is a complex web of social, judicial and political constraints that prevents operators from fixing fees enabling them to cover their costs: as a result, on average, out of the 60% of supplied water actually used –40% being lost in leakages- only half is paid for (Centro del Tercer Mundo para el Manejo del Agua, 2003). Thus, in the best of cases, fees cover operation costs, but are rarely sufficient for investment costs (to rehabilitate or extend the infrastructure) (Guerrero, 2004; Saade, 1997). Accordingly, municipal budgets usually only manage to cover salaries and other administrative expenses and the level of indebtedness of municipalities is extremely high: in 1994 around 84% of public investment was realised by the federal government, 13% by the states (Saade, 1997). At the end of the 1990s, the institutional setting of financial markets was reformed to encourage the access of municipalities and states to credit markets; but the initiative encountered limited success, in the absence of an accounting framework for their repayment capacity (Joumard, 2005).

A second criticism addressed to municipal potable water and sanitation systems is their lack of technical capacity and experience in the sector. Combined with insufficient resources, this reality explains why today, municipalities continue to depend on state and federal support to provide water and sanitation services (Moreno, 2004; Centro del Tercer Mundo para el Manejo del Agua, 2003). For instance, the federal government still finances 45% of water infrastructure (Joumard, 2005). As detailed by Rodríguez (2004), it is very difficult to break the vicious circle thus created: low tariffs and insufficient resources maintain a low service quality; thus the users are not willing to pay more and it is impossible to employ more and better qualified staff, therefore contributing to maintain a status quo.

Finally, municipal water administrations are criticised for certain practices induced by discontinuity in policies and programmes and the lack of accountability of sub-national governments: short term planning, lack of incentives for leakage control and tariff updating, and passing on the problems to the next administration (Saade, 1997). A characteristic of sub-national Mexican governments is indeed the no-re-election rule: governors of the 31 states and mayors of the 2,445 municipalities are elected for non-renewable six-year and three-year terms respectively, deterring elected authorities from investing in any programme with up front costs and long term benefits (Joumard, 2005).

The specific issue of municipal point-source pollution was raised in 1988, when the General Law for Environmental Protection and Ecological Equilibrium was promulgated. But at the time, wastewater treatment only became compulsory for large cities and those bordering the U.S.A. (Martínez et al., 2000a).

In parallel with these decentralisation efforts of the 1980s, maintained involvement of the central government for the planning and building of aqueducts created important coordination problems, which only aggravated those of scarcity, conflicting uses and pollution already existing in many watersheds (Aldama, 2005).

To resolve this, the National Water Commission (hereafter CNA, according to its Spanish acronym) was created in 1989. This represents a turning point in Mexican water management, as it enabled to streamline administration and financing of the water sector, previously dispersed among several institutions of the federal government (Tanaka, 2002; Saade, 1997). First an autonomous agency attached to the Secretariat of Agriculture and Water Resources, the CNA integrated the Ministry of Environment, Natural Resources and Fisheries in 1994 (which became the Ministry of Environment and Natural Resources in 2000).

As listed by Aldama, its responsibilities are to "define the country's water policies, and formulate, update, and monitor the implementation of the National Water Plan; measure water quantity and quality; regulate water use; allocate water to users and grant the corresponding licences and permits for both water withdrawals and water discharges; plan, design, and construct the hydraulic infrastructure, totally or partly financed by the federal government (with some exceptions, such as hydropower development); regulate and control river flows, as well as improve the safety of major hydraulic infrastructure; provide technical assistance to water users; define and, if necessary, implement financial mechanisms to support water development and the provision of water services for irrigation and urban water supply and for sewerage and sanitation" (Aldama, 2005: 310-311).

The CNA is in charge of regulating both urban water supply systems and irrigation districts, operated respectively by municipal or state authorities and water users' associations. In the specific sector of water supply, acknowledging the difficulties faced by municipalities –lack of technical capacity, very low service tariffs and tax recollection levels- it suggested to reinforce the operating organisms by encouraging states to reform their laws, organisational and financial procedures accordingly (Pineda, 2004). It specifically proposed to: create municipal water utilities in charge of water and sewerage services and disposing of tariff autonomy (i.e. not dependent on state legislation anymore); enforce suspension of service to penalise non-payers; establish a tariff inventory (according to types of uses, volume, types of service charges like sewage, wastewater treatment, connexion and meter installation); reinvest generated revenues into the same service; and provide fiscal credit to users' debts for water services (Pineda 2004; Tanaka, 2002). In short, the CNA started fashioning the operating organisms towards a more entrepreneurial management mode (Schmidt, 2005).

Six years later, each of these measures had been adopted by at least half of all states, but their actual implementation requires overcoming many obstacles, among which users' being accustomed to a long tradition of free water (even if this entails bad service) or the importance of political and electoral interests (Pineda, 2004; Tanaka, 2002).

Further, the creation of state water commissions through the reformed state water laws could have been a real step forward to reinforce federalism, had these commissions been attributed more than just the operation of potable water and sanitation or the coordination of investment programmes to enable this, and actually been in charge of improving water management in their respective state (García, 2004).

In order to readjust the legal system to the country's necessities, in 1992 a new National Water Law was designed, recognising the CNA as the sole federal water authority (Sánchez, 2006). According to the law, the CNA is in charge of the management of national waters, integration of planning and management, promotion of an efficient water use, design and construction of infrastructure for water provision and treatment, and institutional coordination of the three levels of government (Martínez et al., 2002b). Implementation procedures were specified by the law's Regulation of 1994.

The law was also designed so as to allow and foster private sector participation in the water industry, until then forbidden by the Constitution and the first water law of 1972 (Pineda, 2004; Saade, 1997). In addition, three other components were to be implemented in the guiding National Water Plans: institutional capacity building, decentralisation of functions and use of economic instruments (Centro del Tercer Mundo para el Manejo de Agua, 2003).

The National Water Law indeed reinforced decentralisation on a number of levels.

First, encouraged by lending conditions of international organisations such as the World Bank or the IMF, the neoliberal water reform reduced the role of the federal government in water management by decentralising both urban and agricultural water services, while emphasising the role of privatisation. In particular, the reform entailed: the transfer of urban water services to states and municipalities or private concessionaries; the transfer of water management to the water users' in the 81 irrigation districts; the evolution towards full-cost pricing so as to encourage financially-sufficient systems; the privatisation of water infrastructure financing and development; and the creation of water rights' markets for agriculture (Browning-Aiken et al., 2004). The process aimed at full cost pricing also included removing irrigation-targeted subsidies (covering 60-80% of total irrigation systems' costs) (Wilder, 2005).

Results of such initiatives have been uneven, the most positive being those of water management transfer to irrigation districts. Users have been able to participate in water administration, use and conservation, even though in some cases water concessions and fees remain arbitrarily controlled by the local notable of the irrigation district (García, 2004). The good cost-recovery that resulted from this transfer also enables a better maintenance in the infrastructure, although significant water savings still constitute the main weakness of this operation, generally speaking (López et al., 2004). Another drawback is that due to insufficient financial capacity to invest in their land (in a context of low agricultural prices in general) and to a lack of organisational structures, most small producers have not benefited from this process, thus constrained to sell their lands to bigger landowners and search for alternatives –mostly employment as daily workers or emigration (Centro del Tercer Mundo para el Manejo del Agua, 2003).

In terms of potable water and sanitation provision, state governments have the responsibility of planning and financing, although still under the control of the CNA (Third World Centre for Water Management, 2003; Tanaka, 2002). But as far as the operative level is concerned, several states still choose to ignore that it is a municipal attribution, under the pretext of municipalities' technical, administrative and financial capacity problems (Guerrero, 2004). This argument is nevertheless a justified one if these prevent a good service provision, and underlines the fact that the policy of municipalisation was too ambitious and undertaken without sufficient means (Pineda, 2004).

Officially, water tariffs are established in order to cover all operation, conservation and maintenance costs for urban areas, industries or irrigation districts (Centro del Tercer Mundo para el Manejo del Agua, 2003). As far as groundwater is concerned, urban/public and industrial users must pay for water rights in addition to the tariffs, variable according to the volume, and representing up to half of the CNA's income at national level (Scott et al., 2004). On the contrary, agricultural users do not have to pay for rights, even though they represent the major users of groundwater in absolute terms (Ibid.).

As for the private sector, although it was appealed to for its technical expertise and continuity in services' management (contrasting with municipalities), its practical involvement has been more important in processes of Build-Own-Transfer –especially for wastewater treatment plants- and aqueduct construction than in operating potable water systems, due to more constraining conditions such as important financial risks and political consequences in this area, as well as lack of experience, (Pineda, 2004; Centro del Tercer Mundo para el Manejo del Agua, 2003). The fact ownership of infrastructure and tariff setting is maintained a governmental prerogative is also put forward as a possible explanation (Tanaka, 2002).

Finally, the law fixed the conditions of water rights' exchanges, especially for transactions in irrigation districts or when agricultural uses compete with industrial and urban demand (Centro del Tercer Mundo para el Manejo del Agua, 2003). In this perspective, the law also established the Public Register of Water Rights that lists all water concessions, and is managed by the CNA. In order to update the registration of concessions, and specifically increase the participation in the process of regularisation of such water rights –many wells having been bored without authorisation[16]- the authorities fixed a deadline after which energy costs would not be subsidised anymore (Scott et al., 2004). The 1992 Energy for the Countryside Law, which had the ambition of limiting water extraction to that under concession, represented something of a challenge (Ibid.).

In addition to encouraging more decentralisation towards states, municipalities and irrigation districts, the new 1992 water law established that integrated water resources management constitutes the basis of the national water policy (Valencia, 2004). Therefore it also reinforced decentralisation at watershed level: river basins and aquifers are the

[16] This was the consequence of the fact that in the Constitution of 1917, groundwater was not considered as being part of public property, with its regulation thus being totally ignored (López et al., 2004).

hydrological units for planning and management, and watershed councils are to be created. Although in the country, interest in integrated river basin management exists since the 1940s –when the objective was to replicate the experience of the Tennessee Valley Authority, seen as a model to promote development and industrialisation- the new law makes Mexico one of the rare countries in Latin America, along with Brazil, to have legally mandated river basin organisations (Tortajada, 2005a; Dourojeanni, 2002). These filled up the institutional void left by the 1975 National Water Plan, which had set up a regional division based on hydrological criteria (the 13 administrative regions). The structure of these river basin coordinating bodies specifically includes: the Director General of the CNA, governmental voices from the states that are part of the watershed, and at least their corresponding amount of user representatives, from sectors such as urban, agriculture, industry, etc. (Martinez et al., 2002b). When several states are involved, there is exactly the same number of representatives for each, be it in terms of governmental voices or user representatives.

The watershed councils' functions range from: balancing supply and demand for the different uses; preventing and cleaning-up contamination; conserving, preserving and enhancing ecosystems; realising an efficient and sustainable water use; and stimulating a 'water culture' that considers water as a vital and scarce resource (Dourojeanni and Jouravlev, 2002). The councils approve river basin plans which, when integrated into the National Water Master Plan, become compulsory for the federal government and indicative for state and local government and water users (Tortajada, 2005a).

In order to implement the river basin councils' objectives, auxiliary supportive organisations were also created, to deal with particularly acute or complex problems at smaller scale: watershed commissions for sub-watersheds, watershed committees for micro-watersheds and groundwater technical committees (called COTAS) for aquifers[17] (Dourojeanni and Jouravlev, 2002).

Hereafter we briefly present the corresponding institutional evolution, reached by October 2004.

Twenty-five watershed councils have been created, dispersed all across the thirteen administrative regions (CNA, 2005e). The first one, that of the Chapala watershed, was established less than two months after the new law was enacted, due to its particular complexity –its administrative boundaries cross five states (Querétaro, Guanajuato, Michoacán, México and Jalisco)- and pressing environmental issues. On one hand, out-of-

[17] In the state of Guanajuato, the most advanced in terms of IWRM, these COTAS have the exceptional status of being committees for both micro-watersheds and aquifers (Rodríguez, 2004).

basin transfers at the headwaters supply Mexico City and Toluca for regional domestic, industrial and agricultural uses, while deforestation was leading to building up sedimentation. On the other hand, locally, aquifers were over pumped to irrigate 700,000 ha of intensive agriculture and to supply Guadalajara[18] in potable water. Combined, these processes had drastically affected Lake Chapala, located downstream in the watershed, by both reducing its size –it lost more than 80% of its volume in the last 20 years- and concentrating effluent discharges from domestic, industrial and agricultural sources. As a result, in 1989, 90% of Mexico's biggest lake had been classified as unacceptable for drinking or fishing (Castelan Crespo, 1999; Mestre, 1997). The major conflict in the watershed opposed Jalisco state on one hand, defending the lake, and Guanajuato state on the other, defending the farmers (Mollard and Vargas, 2004a).

Building on lessons learnt through this first experience of watershed council, amendments were made to the Regulation of the National Water Law, resulting in a more balanced distribution between federal authorities and users, in number and decision-making power (Martínez et al., 2002b). Apart from that of Valley of Mexico (created in 1993), the big majority of watershed councils were then created between 1999 and 2000.

Ten watershed commissions have also been established, at a more regular rhythm starting 1995, but with half of them concentrated in one administrative region only[19] (CNA, 2005e). In addition, starting 1999 and with an accelerated pace towards 2002-2003, 16 watershed committees were designed, mainly located in two regions of the southern part of the country[20]. Finally, a total of 66 groundwater technical committees have also been set up, at a regular rhythm of approximately ten per year since 1997, and distributed quite unevenly across the first ten regions only[21] (CNA, 2005e).

Next to these regulatory and negotiation-oriented instruments –the National Water Law, watershed councils and their auxiliary bodies- water management was also organised using economic instrument: the water law was complemented by the Federal Law on Water Rights, establishing that users must pay contributions for the rights to use the national waters (Sánchez, 2006). But as explained by Guerrero (2004), the lack of financial resources at federal level can be explained by a low recovery rate: the payment of water rights for urban and industrial concessions (rights being free for agricultural uses) and permits for discharges have not always been respected, especially in states with low water availability and thus high costs. In order to encourage such payments, a decree in 2004 cancelled all debts contracted on the condition of initiating payments, but did not give much result (among

[18] With a population of five million, it is the country's second largest city.

[19] The region VIII Lerma-Santiago-Pacífico also happens to be our region of study.

[20] Eight committees were set up in administrative region V Pacífico Sur, and five in region XI Frontera Sur.

[21] One quarter is in region I Península de Baja California, another quarter being in regionVIII Lerma-Santiago-Pacífico.

other things because the CNA failed to give the received money back, at it had promised to do so).

The reforms of 1992 coincided with other larger ones, also reflecting the liberalisation trend: the amendment of constitutional Article 27 allowing communal producers to rent or sell their land –thus making official practices that were until then illegal albeit common (Linck, 2001)- and the adhesion of Mexico to the North American Free Trade Agreement two years later (Browning-Aiken et al., 2004).

In addition to these legal and institutional reforms, which initiated decentralisation and private sector involvement, the government's fourth element of policy action was the promotion of new financing schemes. As part of these, the Infrastructure Investment Fund was created in 1995 to finance infrastructure projects, promote investment opportunities and develop foreign investment (Saade, 1997). But this system seems to have only exacerbated regional disparities, as foreign investment has mainly been attracted to regions already endowed with important human and infrastructure capital, in addition to the northern states benefiting from proximity with the United States (Joumard, 2005).

In 1996, small and medium-sized cities (20,000-50,000 inhabitants) were summoned to join bigger ones in efforts to treat municipal wastewaters, the law setting a deadline for 2005 (SEMARNAT, 1996). No specific system was imposed, and the state or central government was to provide funds to cover construction costs. As no detailed management plans for the operation costs were required, it is not rare to see treatment plants become obsolete before they are actually run. One element of explanation of this situation is the fact that local authorities in the South have one hundred to one thousand times less financial resources than the ones in the North –on average- but with comparable responsibilities (Hardoy et al., 2001). Another one might be the vicious circle linking weak capacity and/or willingness to pay for such services with inefficient management, which is a problem for both water supply and water treatment in the whole of the Latin American region (Peña and Solanes, 2002; WWC, 2000).

In the late 1990s, the end of the 70-year domination of the political scene by the Institutional Revolutionary Party coincided with more demands for autonomy at state and municipal levels (Joumard, 2005).

To overcome several shortcomings of the National Water Law such as the lack of explicit reference to decentralisation, and give it a more cooperative orientation (Sánchez, 2006), the law was profoundly reformed between 1992 and April 2004. The amended law now includes several paradigms promoted worldwide related to water management, such as watershed management, integrated water resources management, the consumer and polluter pays principles and social participation, as well as the subsidiary principle (Guerrero, 2004).

Specifically, the national water policy is based on an integrated water resources management organised by watersheds (Article 14 Bis 5), where 'integrated water resources management' is defined the same way (Article 3.XXIX) as in the Global Water Partnership's definition[22] (CNA, 2004).

One of the amended law's innovations was the creation of river basin organisms: these deconcentrated organs of the CNA with administrative and technical autonomy are to replace the CNA's thirteen administrative regions and state offices (López, 2005; Tortajada, 2005a).

At the river basin level, water management is still based on river basin organisations, which officially are not subordinated to either the CNA or the river basin organisms (Article 13) (CNA, 2004). River basin councils will continue to be coordinating bodies between the CNA –including the river basin organism in the territory of which they are located- and the federal, state and municipal level dependencies and entities, as well as representatives from users and civil society from the watershed or the region. But a more important participation in river basin councils will be possible: users, citizens and non-governmental actors must now represent a minimum of 50% of participants, while representatives of state and municipal governments are limited to 35%. The councils will be based on the operation of four complementary groups: a General Assembly of Users (water users' and civil society representatives), a Management Board, an Operations' and Control Commission and an Operative Office. In addition to the auxiliary river basin commissions and committees as well as the COTAS, a Consultative Water Council will also participate in the water planning.

Possibly, one of the biggest changes the reform will entail concerns the planning process: the river basin plans, elaborated by the river basin organisms along with the councils, commissions, committees and COTAS, will be the ones to determine the priorities, even though the National Water Plan elaborated by the CNA will remain the general framework (López, 2005).

As part of the implementation of the consumer and polluter pays principles, when the law's regulation is published, water banks should start operating, encouraging more users with water rights to buy or sell these, especially in areas where aquifers are being over-exploited or the resource is under pressure, and no new concessions will be allocated. During the period between 1992 and 2006, only a bit more than 1% of the 330,000 existing water rights were exchanged, mainly sold by agricultural users to industrial users; this practice should

[22] The Global Water Partnership does not work specifically with Mexico, as it is an OECD country and therefore cannot receive any funding. Further, the GWP's regional partnerships, such as that in Central America, does not want to include Mexico either. So an internal partnership is trying to be set up with the IMTA (define), but this is rendered difficult by the CNA's non-cooperative attitude (Alan Hall, GWP Network Director, personal communication).

now develop in the centre and northern part of the country, where water is scarce and demand for urban use is significant (Enciso, 2005). Further, the reformed law also increases fining charges and allows revocation of permits for releasing wastewater into rivers and lakes, suspension of activity in case of industrial discharges without permits and interest charging on unpaid water usage fees (Nido and Hutt, 2004).

b. Still a long way to go

As we have seen, the Mexican regulatory landscape underwent several important reforms, enabling the country to take some promising steps on the path towards an integrated water resources management: the creation of a sole agency in charge of water, and included in the Ministry of Environment and Natural Resources; the establishment of watershed councils and smaller-scale supportive institutions; the promotion of social participation in these coordinating bodies; and that of water resources' full-cost pricing. Nevertheless, as Aldama specifies: "Current challenges in Mexico's water resource management are to increase the effectiveness of the legal and institutional framework, the physical yield of water infrastructure and the efficiency of water use" (Aldama, 2005: 311).

In the following sub-section, we analyse the reasons that motivate many researchers working in the area of water in Mexico to be so critical of the reforms, from an IWRM point of view.

Recurrently put forward are the reforms' weak effectiveness and slow implementation. More specifically, criticisms span over several elements of the current water management set up: the absence of coordination between the different sectors using water; the lack of inclusion of resources other than water; the low degree of participation in watershed management; and the absence of real independence of watershed councils from the CNA.

Absence of coordination between different sectors using water

Work undertaken by the different actors of the water sector, at various governmental levels, is too individual and isolated (Guerrero, 2004). Traditionally, there has never been much coordination between the three levels of government, and the same is true inside each level itself, due to the different interests of each dependency (García, 2004; López, 2004). This can be particularly the case between the Ministry of Natural Resources and the CNA, for example.

In addition, other ministries also concerned by water problems, such as those of Finance, Agriculture and Education, should be more involved (Guerrero, 2004).

No inclusion of biodiversity or land inside water management

In 1994, the incorporation of the CNA into the Ministry of Environment and Natural Resources (SEMARNAT, according to its Spanish acronym) reflected a will to treat water as a natural resource with many uses –instead of focusing on its agricultural use only, as was previously the case (Saade, 1997).

But in practice, the two institutions remain very independent: each reports directly to the President of the Republic and the SEMARNAT has almost no control over the CNA (Centro del Tercer Mundo para el Manejo del Agua, 2003). The reason is that the CNA has much more money than the SEMARNAT, so it does not pay much attention to its 'home institution'.

As a result, like in the rest of Latin America, management at the river basin level is focused almost exclusively on water resources, instead of natural resources in general (Tortajada, 2005a). As Martínez and others (2002b) explain, rivers for example are treated exclusively as conduction canals of water for the various human uses, without much consideration for the fauna and flora of which they constitute the habitat. For these authors, this reflects the CNA's traditional engineering vision with respect to water, and explains why environmental flows are still inexistent in the country. Similarly, land is not much more taken into account of, in spite of the recognised interactions it has with water and the official protection it must receive, as specified in the watershed councils' objectives.

The reformed law of 2004, which includes the protection of ecosystems in its mandate and functions, should allow for a better management of natural resources in general, by enabling more participation of citizens and non-governmental actors (André de la Porte et al., submitted).

Limits to an effective participation in watershed management

The basis for participation had already been set out in 1988 with the General Law for Environmental Protection and Ecological Equilibrium, requiring public involvement in the design and execution of environmental and natural resources policy (Centro del Tercer Mundo para el Manejo del Agua, 2003). But the participatory process really started with the National Water Law of 1992 and the creation of watershed councils it spurred. Reinforcing this orientation, the National Water Plan of 2001-2006 was the first to specifically recognise the importance of involving users and civil society in the planning process (Centro del Tercer Mundo para el Manejo del Agua, 2003). It must nonetheless be kept in mind that compared to other strategic priorities, social participation received a considerably smaller portion of financial support (Guerrero, 2004).

Ten years after the participatory process was initiated, evaluations do not seem very optimistic: to overcome its weaknesses –which concern in particular environmental degradation- more social participation and decentralisation are required, detailing precisely the responsibility of both authorities and citizens (Mollard and Vargas, 2005b).

According to Guerrero (2004), centralised policy-making inherited from the anachronic Mexican Constitution of 1917, will only be overcome with politicians capable of seeing beyond their parties' political interests, and motivated to collaborate for the benefit of the country. For him, although the government uses the double language of federalism (reassignment of functions between different levels of government) and decentralisation (transfer of responsibilities to states and municipalities, so that decisions are taken at the same level at which problems are generated), the participation of states, municipalities and users still lacks effectiveness, due to the resistance of some CNA officials that dread such power-sharing. For example, priority watersheds focus the attention to the detriment of smaller ones, where preventive and local actions are dismissed to the advantage of top-down missions (Martínez et al., 2002b).

In terms of watershed management, participation of users, civil society and municipalities has up to now not been very important.

First, participation of water users in watershed councils is quite feeble. It seems that the question of the size of the institutional coverage has a lot to do with weak participation (users "pay with their money to be able to attend, while official representatives are paid to do so"), and it is hoped that this will be taken into account for the creation of the future watershed organisms and other watershed councils (Mejía, 2006). As Guerrero points out, participation is now increasing as representatives of the different sectors have realized that their participation is essential, if changes in the region are to be achieved (Guerrero, 2004), with "stakeholders [...] gradually becoming actors instead of being spectators as was mostly the case earlier" (Tortajada, 2005a: 311). According to some researchers, users must nevertheless organise themselves to work towards real representativeness, as in many cases user representatives are totally controlled by the CNA, or by powerful sectoral interests.

Secondly, civil society participation can only increase with the 2004 reformed law, as the 1992 law had given an important discretionary power to the CNA to decide whom to invite to the watershed councils or not (in terms of civil society, NGOs, educational institutions or research centres) (Centro del Tercer Mundo para el Manejo del Agua, 2003).

Finally, as far as municipalities are concerned, these are invited to participate in watershed council meetings but rarely do so, due to financial limits and limited decision-making power –apart from those bigger urban municipalities representing the urban water uses. Indeed, although municipalities are in charge of urban water and sanitation, they are not involved in decisions related to water management in the watershed, even when these resources are strongly related to their territory[23]. The municipalities' acceptance of the transfer of sovereignty implied by the creation of water basin organisations is nonetheless a crucial element of these institutions' success as it founds their legitimacy, which is why the municipalities' representation in such councils or commissions must be carefully designed (Mollard and Vargas, 2005b).

According to Pacheco-Vega (2004), it is the lack of spaces for dialogue and the mandatory aspect of participation that questions its effectiveness.

IWRM is indeed seen by some as a 'technocratic counter-attack' (Mollard and Vargas, 2005b), an instrument used by the water administration to justify its existence, and compensate the decreased solicitation it is now faced with, after periods of big hydraulic works and the transfer of irrigation systems to users. But endowed with an engineer culture, the administration is less well prepared to face the social dynamics entailed by the recognition of a finite resource –in other words, the need to share the water between various users.

Nonetheless, when assessing the ten-year experience of participation in river basin organisations, these authors conclude that in spite of the difficulties ahead, it seems that the country has now engaged in the path towards more participation –to both respond to the growing demand for more democracy and reap the potential benefits promoted by participation supporters, as well as avoid going back to the more interventionist era (Mollard and Vargas, 2005b). It seems this is indeed the only path forward for a country greatly impacted by decades of authoritarism, "to rebuild confidence, credibility, and legitimacy towards institutions and representatives" (Mollard and Vargas, 2004b).

The absence of real independence of watershed councils from the CNA

Until now, contrasting with the weak participation of users, civil society and municipalities, in watershed council meetings there is a preponderance of representatives coming from the CNA, central agencies or state authorities, which enables easy internal resolution of conflicts (Martínez et al., 2002b). Such an unbalance also enables to orient decisions towards objectives

[23] In particular, they have no say in terms of infrastructure for irrigation, which is one of the main economic activities in many municipalities of the country. This might create planning problems for municipalities where sources of potable and irrigation water coincide.

fixed beforehand in other instances (Centro del Tercer Mundo para el Manejo del Agua, 2003). It might be pertinent to ask whether those councils created in the 1990s or 2000s are any more effective than those of the 1940s, which had no other function than that of advising (Tortajada, 2005a). Indeed, lacking in any form of authority, the councils' results can only be based on the participants' good will (Guerrero, 2004).

In addition, watershed councils also lack in human and financial resources. Illustrating this, out of the 25 river basin councils created by 2005, only one is operational (the Lerma Chapala): the others have not yet benefited from the decentralisation of functions or funds: "In most cases, the councils still do not even have staff or offices, not to mention implementable plans, financial support, and technical and management expertise" (Tortajada, 2005a: 310-311).

The same can be said of the aquifers' Technical Committees for Groundwater, more virtual than anything else apart from a few exceptions (Guerrero, 2004). Indeed the over-exploitation of aquifers is likely to continue as long as the central authority, here again, is reluctant to give up decision-making power and grant the COTAS some legal authority (Tortajada, 2005a).

In Mexico there is a saying that goes: "In order not to solve problems, we create commissions" (Pedro Rubio, personal communication). Assessments to explain the absence of an integrated water resource management in Mexico have identified the need for capacity building, more specifically "the need to improve and make more efficient the management practices at the federal, central and local levels in the country" (Tortajada, 2001).

But it is not so much the lack of experience at local and state level than the fear, at the level of the CNA, of delegating power and decision-making regarding the resource (Centro del Tercer Mundo para el Manejo del Agua, 2003). As highlighted by a researcher working in the Ayuquila watershed: "The CNA does everything related to water… too much: it allocates concessions and sanctions, authorises wastewater discharges and distributes fines…this does not work". This is despite the fact the CNA is itself faced with a shortage of human and financial resources to implement its objectives, not restricted to infrastructure development anymore (Guerrero, 2004). The country is faced with a deficiency in good administration in terms of planning, management, supervision and control (García, 2004). The vertical planning and decision-making process needs to evolve so that watershed councils can really start to play their part (Centro del Tercer Mundo para el Manejo del Agua, 2003).

Even with the reformed law, watershed councils remain coordinating bodies with no decision-making power, which still resides in the central water authority (Tortajada, 2005a).

As stressed by Tortajada, Article 13 Bis 2 of the new law precises that "The basin councils will be organized and will work based on what this Law defines, as well as its regulation and the rules developed by the National Water Commission of Mexico. (…) the councils are neither entitled to develop any regulations, nor can they execute any administrative or legal action" (Tortajada, 2005a: 310). Worse still, their operational functions remain unclear. As a result: "The main institutional challenge for the future is how best to transform the basin councils, which in practice are advisory agencies with very little real authority, into river basins that govern, plan, organize, run, control and supervise water management at the river basin level" (Tortajada, 2005b: 6).

The CNA maintains its centrality even though it tries to camouflage this through the creation of river basin organisms (Sánchez, 2006; García, 2004). Indeed, as their directors will be subordinated to the director of the CNA, these organisms are really replicates of the past regional offices, making this institutional shift more a matter of deconcentration (delegation of attributions to lower and operational levels of the same dependencies) than of decentralisation (García, 2004). As Tortajada highlights: "It remains to be seen how and by whom the decisions will be taken, and to what extent the river basin organisms will be autonomous" (Tortajada, 2005a: 309).

Further, a modern conception of planning is required: although the reformed law speaks of bottom-up defined social priorities, it is not clear how this will be implemented in the general context of centralised decision-making (Sandoval, 2004). Water resources planning is indeed still extremely centralised and the CNA continues to concentrate so many functions that it will have trouble in realising them all, in particular to coordinate more with other levels of government and users for questions of control (García, 2004). The water administration, implementing staff reduction policies and also faced with human resources withdrawals due to internal conflicts, is unable to cope: to regain its credibility, it needs to separate the functions it exercises (control but not sanction, application of the law but not its elaboration) (Mollard and Vargas, 2005a).

Finally, the fact the 2004 regulation took several more months than the planned 18 months to be published has worked against the central authorities' credibility: "The Regulation of the Law of 2004 is still not published because, we Mexicans, are different, they told us the other day at a meeting, and for this reason it will take more time to publish. As a result, we live in a state of semi-law […]. A law that doesn't have a regulation in spite of the fact a deadline was fixed, and today, nothing is happening. What can you and I as citizens do, to push upfront the issue of water in Mexico if we don't even respect our laws, if the highest water authority doesn't respect the law; if the highest authority of the country, the president of the Republic, doesn't respect the law?" (translated from Vargas, 2006). Some point out that the presidential elections' in August 2006 had something to do with it, others that the CNA has been so slow because it is battling to try and keep financial control over all these new instances. Others, such as Mollard, are sceptical that it might change much as nothing is said about financing, which is the core issue (Eric Mollard, personal communication).

Chapter conclusion

In the 1980s and 1990s, the Mexican government, faced with increasing water issues (competing demand, generalised contamination, over-exploitation of aquifers, inefficiency of infrastructure) and limited in its moves by a context of economic and financial crisis, put in place a series of measures. Successive legal and institutional reforms led the country towards federalism and decentralisation: establishment of state water commissions, transfer of water and sanitation operations to states and municipalities, transfer of irrigation districts to users, and creation of watershed councils, commissions, committees and COTAS.

These decentralisation efforts, necessary basis for an integrated water resources management, have for the most encountered major difficulties in becoming really effective (except for the transfer of irrigation districts). This is essentially due to resistance inside the National Water Commission to abandon its pyramidal model –particularly strong in the management division where power is concentrated in the national offices, which impose their decisions to regional and state level-offices- and evolve towards a modern system entailing power sharing (García, 2004).

For this to happen, changes are required at all scales. Real autonomy must be enabled at state level, instead of the current fictitious federalism, otherwise due to the country's extension and regional variations, water issues will not be resolved (García, 2004). At both state and municipal level, decentralisation efforts, limited by a centralised tax system, discontinuous programmes and lack of accountability of elected officials, must also be accompanied by a larger change in citizens' mentality to accept higher water prices and the need to protect the environment (André de la Porte et al., submitted); also keeping in mind what Walsh (2004) recalls, i.e. that there should not be one sole model of 'water culture', based on efficiency and conservation values, but a recognition of the diversity of existing water cultures in the country. Finally, watershed councils, their smaller-scale auxiliaries and the COTAS need to be granted sufficient human and financial resources as well as decision-making power to become autonomous and sustain real participatory processes to avoid what Vargas and Mollard call the "Mexican model of directed participation" (translated from Vargas and Mollard, 2005: 74). Indeed, as emphasised by Biswas, it will only be by implementing social and environmental laws and reinforcing institutions at federal, state and municipal levels, that actors –the public and private, users and citizens- will take their responsibilities to stop the process of environmental degradation (Tortajada, 2004).

The excessive federal control Mexico is renowned for is the result of seven decades of uninterrupted domination of the political processes by the unique party and the president – both head of party and federal executive (Edmonds, 1998). The election of an opposition candidate in 2000 gave rise to much hope for more decentralisation, which, after a few years seems to have vanished.

Fox's administration did not bring sufficient in-depth changes to overcome the criticisms addressed to the previous legal framework. On the contrary, with the creation of river basin organisms, we might very well be in presence of what Sánchez (2006) calls: "an increased sophistication in the centralised control of the water policy in the country, by deconcentrating at regional level the presence of the central government with all water management attributions" (Sánchez, 2006: 21).

To resume: "Only time will tell if the new institutional arrangements in terms of partial decentralisation and continuous control by the central institutions will solve the present and future problems of the country through the implementation of the concept of integrated water resources management" (Tortajada, 2005a: 316).

According to Calvo-Mendieta's classification (2005), we might say that Mexico is close to being in a complex regime (almost taking into account all water uses – apart from that of the environment- but without sufficient coherence) and that the new 2004 reform might enable it to transit towards a more integrated regime (with more planning), even though several elements are still at an insufficient stage for the time being.

CHAPTER 3 – RESEARCH SITE AND STRATEGY

In this chapter we first present the fieldwork area: a detailed account of the context is necessary to introduce the actors who played an important role in the region's specific historical configuration; then follows a shorter but more in-depth presentation of our municipality of study in its various dimensions. In a second section, we explain the methodological steps followed during the research.

1. Description of area of study

a. A bird's eye view of the region

The Ayuquila-Armería watershed

Situated in the centre west of Mexico, the Ayuquila-Armería watershed covers 9,803 km2, among which 8,078 km2 are part of the State of Jalisco, while the remaining 1,725 km2 are in the State of Colima. Indeed the Ayuquila-Armería River has its two sources in Jalisco, but joins the Pacific Ocean in Boca de Pascuales, Colima.

Although the Ayuquila-Armería watershed is made up of three sub-watersheds (corresponding to the Ayuquila, the Tuxcacuesco and the Armería Rivers), the Ayuquila-Armería River in itself, about 240 km long, can be divided into two portions: the Ayuquila River on one hand (150 km, which is the main arm compared to the Tuxcacuesco River), and the Armería River on the other (90 km), starting at the junction between the Ayuquila and the Tuxcacuesco Rivers (Martínez et al., 2002a). More or less, the Ayuquila River corresponds to the part of the watershed in the State of Jalisco, the Armería to that in Colima.

Map 11: The Ayuquila-Armería watershed

Source: Graf et al., 2006: 300

The Ayuquila-Armería watershed is part of administrative region VIII Lerma-Santiago-Pacífico and of the hydrologic region XVI Armeria- Coahuayana. It is located in a complex physiographic area surrounded by various mountain chains: the Eje Neovolcánico, the Sierra Madre del Sur and the Sierra Madre Occidental (Comisión de Cuenca del Río Ayuquila-Armería, 2005).

The Mexican National Commission for the Use and Conservation of Biodiversity (CONABIO) considers the Ayuquila-Armería watershed as one of priority in terms of flora and fauna (Martínez et al., 2002a). Protected areas make up about 10% of the watershed: it includes more than 50% of the Sierra de Manantlán Biosphere Reserve, and partly four other protected areas (the national park Nevado de Colima, the forest reserve of Quila, the fauna reserve El Jabalí and the crocodile production programme in Boca de Pascuales on the Pacific Coast) (Martínez et al., 2005).

The watershed encompasses, partially or totally, the territories of 30 municipalities. According to the last census in 2000[1], the total population (approx. 492,391 inhabitants) is very unequally distributed between the two states: 37% (approx. 182,185) are located in the 21 municipalities of Jalisco (covering 82% of the watershed), while the nine municipalities in Colima concentrate 63% of the population (approx. 310,206) on 18% of the area. This is because Colima has several large cities, like the conurbation Colima (approx 119,639) - Villa de Álvarez (76,679) (INEGI, 2000). The part of the watershed in Jalisco, on the other hand, has only a few urban municipalities (i.e. with a capital of more than 2500 inhabitants) (Lomelí et al., 2003). Also to take into account is the fact that 79% of the Sierra de Manantlán which is included inside the watershed (55,038 ha out of 69,810 ha) is part of the State of Jalisco, making it all the more improper for human settlements.

The two sources of water in the watershed are as follows: in terms of surface water (the Ayuquila-Armería River as well as other sources), the total volume of recharge is 2,076 million m3 per year. Surface water is mainly used for agriculture (98%), among which:

- 60% is for the two irrigation districts (such as number 94 in the valley of Autlán-El Grullo, which was the first in terms of management transfer to the users), which get their water from big dams;
- 40% is for small-scale irrigation systems, locally known as irrigation units (corresponding to all land that is not part of an irrigation district), and where the users manage everything from the source (small dams, wells) to the distribution (canals) and which also represent 40% of the watershed’s 61,000 irrigated ha.

[1] Another census was realised in 2005 but the results were not published early enough to use in this study.

As for groundwater, there are eight aquifers in the watershed: five in Jalisco (Tecolotlan, Union de Tula, Tapalpa, Jiquilpan, Autlán) and three in Colima (Valle de Colima, Pueblo Juárez and Armeria-Tecoman- Periquillos). The corresponding total water recharge is 439 million m3 per year for both states, with a total extraction demand of 198 million m3 (of which 79% is used for agriculture, 20% for domestic use and 1% for industrial use).

Independently from the type of water source, the total water demand is 1,379 million m3 (96% for agriculture, 3% for domestic use and 1% for livestock, demand for industry and services being negligible): 1,258 Mm3 for Jalisco (468 for agriculture and 0.2 for domestic use) and 818 Mm3 for Colima (875 for agriculture, 37 for domestic water and 0.52 for industry).

In total, between both superficial and groundwater, the watershed supplies potable water to approximately 600,000 persons (both inside the watershed and outside), while irrigating 61,000 ha (28,000 in Jalisco and 33,000 in Colima) (El Informador, 2004), of which 60% are part of irrigation districts and 40% irrigation units.

Various sources of surface water contamination have been identified, ranging from solid waste, untreated wastewater from municipalities and industries, to agrochemicals being transported by irrigation flows returns. Three distinct zones appear, with the contamination increasing from upstream to downstream: the major part of the high watershed is not very contaminated, the medium part, starting Palo Blanco in the municipality of El Grullo, is considered contaminated, while further downstream, where the River Armería meets the Colima River, it is very contaminated (water index quality[2] below 30) (Comisión de Cuenca del Río Ayuquila-Armería, 2005). This is because the conurbation of Colima and Villa de Álvarez discharges its wastewaters into the Colima River.

The Ayuquila sub-watershed

Importance in terms of biodiversity

For the purpose of our case study, we narrow down our focus to the sub-watershed of the Ayuquila River, referred to hereafter as 'the Ayuquila watershed'.

It is more or less exclusively part of the State of Jalisco, where the hydraulic resources are under medium to strong pressure (CNA, 2003). Although the northern part of the state that neighbours the States of Nayarit, Zacatecas, Aguas Calientes and Guanajuato faces low availability, the southern part in which the Ayuquila flows benefits from abundant water

[2] The water quality index used to classify these areas ranges from 0-100 (the higher the level, the higher the quality of the water).

resources (as a state located in the middle part of the country, it reflects the national disparities quite well).

Before joining with the Tuxcacuesco River to form the Armería, the Ayuquila River, with a length of 150 km, drains a watershed of 3,900 km2 (Martínez et al., 2002a). The various tributaries of the Ayuquila are the Ayutla and the San Juan Cacoma Rivers, as well as the streams El Coajinque, El Colomo, La Yerbabuena and Manantlán (Martínez, 2003).

Due to its location in the abrupt transition between two biogeographic provinces (the Neartic and the Neotropical), the watershed has a very diverse array of ecosystems with associated flora and fauna (Martínez et al., 2000a). In particular, 595 km2 of the watershed are inside the Sierra de Manantlán Biosphere Reserve, with 40 km of the Ayuquila River constituting the northern border of the protected area (Martínez et al., 2002a). The Ayuquila River plays a critical role for the protection of habitat and species diversity in the Reserve (Henne et al., 2002). As part of the agreements signed between the UNESCO Man and Biosphere Programme, as well as the trilateral agreements related to migratory species in North America, Mexico has engaged in protecting the ecological integrity of this international reserve, and thus also that of the Ayuquila River (DRBSM and IMECBIO, 2001).

The Sierra de Manantlán[3] Biosphere Reserve (hereafter SMBR) is considered as the most important protected land in western Mexico, due to its biodiversity. It counts 2,900 species of vascular plants and 110 species of mammals, 336 birds, 85 reptiles and amphibians, 238 insect families and seven orders of arachnids (SEMARNAP, 2000). Such a variety is the result of the protected area's very important altitude range –from 400 to 2,860 metres above sea level- while it is also located at the crossroads between the two major mountain belts ranging along the west coast of Mexico (the Sierra Madre Occidental and the Sierra Madre del Sur).

Image 1: Aerial view of the SMBR

[3] Literally, the 'Mountains of Manantlán'.

The Sierra de Manantlán Biosphere Reserve was created due to an alliance between conservationists on one hand, and groups of local landowners on the other. The first wished to preserve the endemic specie they had discovered –that also happens to be one of Mexico's most important traditional symbols: in 1979, *Zea Diploperennis,* a wild relative of cultivated maize, was found in the forests of the Sierra de Manantlán. Having a much stronger resistance to maize's seven most dangerous diseases, it had a potential to breed genetically improved cultivated maize (Jardel, 1992). The local communal landowners on the other hand, had been fighting for years to protect their natural resources, illegally exploited by private forest logging companies linked to local political groups (Graf et al., 2001). This conflict had been going on since the beginning of the century, interrupted only by the Mexican revolution, and intensified since the 1970s (Jardel et al., 1996).

In order to protect the habitat of their recent discovery, the researchers from the University of Guadalajara (hereafter UdG) set up Las Joyas Research Station, with support from the State of Jalisco (Jardel et al., 1996): bought in 1984 by the State Government, it was decreed a scientific station in 1985. This monitoring station is set in the heart of the protected area, while the Manantlán Institute of Ecology and Conservation of Biodiversity (hereafter IMECBIO), a local branch of the UdG created to play an active role in conservation activities and also created that same year, was first set in Guadalajara. It was transferred to El Grullo in 1987, becoming the first institute of the University to be decentralised: the idea was to have the researchers immersed in the region's issues, inside the transition area of the SMBR. This helped define their work agenda according to the demands they were directly confronted with in their day-to-day life (for example, they probably would not have initiated their work on the Ayuquila River, presented hereafter, had they not been on the spot) (Eduardo Santana, personal communication).

El Grullo was chosen to host the IMECBIO for a combination of reasons: because of its social dynamic in terms of trade, because studies on environmental issues had already been realised there, and to strengthen the IMECBIO's identity by clearly distinguishing it from the UdG's Agronomy Institute which was already in Autlán. Then in 1994, the UdG underwent a decentralisation wave, and the Centre for the South Coast of the University of Guadalajara (CUCSUR, according to its Spanish acronym) was created in Autlán. This process eliminated independent institutes, so the IMECBIO then joined the CUCSUR (Eduardo Santana, personal communication).

Due to the conflictive context in which the establishment of the SMBR took place (between the logging companies and communal landowners), its realisation was made possible by the benefits each party expected from it (Graf et al., 2003).

On one hand, for the conservation strategy to work, it was recognised that the people whose livelihoods depended on these lands needed to receive some benefits from it –thus excluding the options of a strictly protected model, such as a national park or natural reserve. Although there are 7,000 dwellers within the actual boundaries of the reserve, its population is generally assimilated to the 33,000 people who live in communities with land inside the reserve (Jardel et al., 1996). These live mostly off subsistence agriculture –using the slash-and-burn method to convert forests into cultivated land. So to reduce such pressure on the natural resources, regional development had to be included by developing alternative livelihood strategies (Moran and Lloyd, 2004).

On the other hand, these local communities considered the set up of the Biosphere Reserve as an opportunity to make contact with the governmental agencies that had always ignored them, with the IMECBIO as a potential ally to recover their land rights (Jardel et al., 1996).

After the IMECBIO provided all the technical information necessary to propose the designation of a biosphere reserve and receive support from local to international levels, the SMBR was created on March 5th 1987, and one year later integrated the international network of biosphere reserves (Jardel et al., 1996). This implied classifying the area's 140,000 ha according to the zoning criteria established by the UNESCO Programme on Man and the Biosphere (MAB), located in Paris, France. Such a classification entails identifying one or several 'core areas', which due to the density or frailty of the species they host, are to be dedicated to monitoring and research activities only. Around or contiguous to these is a delimited 'buffer zone', which allows for more activities –although these should not be threatening to the conservation activities in the core area- such as education, training or tourism. The outer zone, called 'transition area', is not included in the actual territory of the protected area, but encompasses a surrounding region that has direct or indirect interactions with the biosphere reserve: human settlements and other more intensive activities take place, such as agriculture, industry, etc. (UNESCO-MAB, 2002).

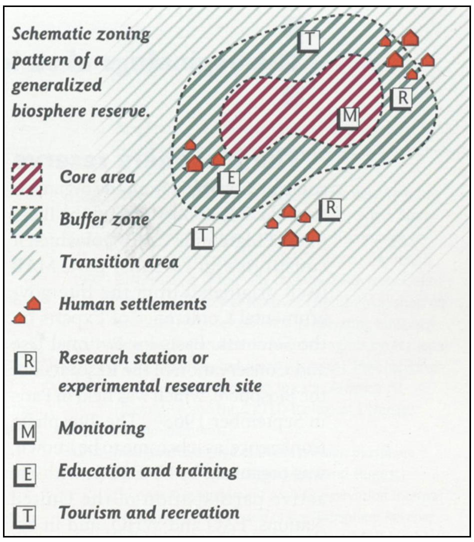


Figure 12: Basic zoning and activities in a biosphere reserve
Source: UNESCO-MAB, 2002: 17

Image 2: Zea Diploperennis

Source: IMECBIO-UdG

Image 3: …Emblem of the SMBR

Source: Directorship of the SMBR

The main idea behind the concept of a biosphere reserve –which emerged in 1970- is to go beyond the preservation approach that prevailed until then, to include the people living in the protected area, enabling both conservation of biological diversity and human development (UNESCO-MAB, 2002). The Sierra de Manantlán Biosphere Reserve's poster – the first in Mexico to include people in addition to biodiversity- perfectly illustrates this (image 3).

The three functions of a biosphere reserve are: conservation (of landscapes, ecosystems, species, and genetic variation), development (an economic and human development that is socio-culturally and ecologically sustainable) and logistics (to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development) (UNESCO-MAB, 2002).

According to its zoning plan (the technical study of which was realised by IMECBIO), the Sierra de Manantlán Biosphere Reserve is made up of land included in seven municipalities: Autlán, Casimiro Castillo, Cautitlán, Tuxcacuesco and Tolimán (in the State of Jalisco), as well as Comala and Minatitlán (in the State of Colima) (Rosales and Graf, 1995). So with 90% of the SMBR in one state and 10% in another, inter-state collaboration is required for its management (SEMARNAP, 2000).

Around the actual protected area, the 'transition area' of the SMBR is made up of 22 municipalities: Autlán, Casimiro Castillo, Cihuatlán, Cuautitlán, Ejutla, El Grullo, El Limón, La Huerta, San Gabriel, Tolimán, Tonaya, Tuxcacuesco, Unión de Tula and Zapotitlán de

Vadillo (in Jalisco) and Armería, Colima, Comala, Coquimatlán, Manzanillo, Minatitlán, Tecomán and Villa de Álvarez (in Colima). These are municipalities that are contiguous with the reserve and in some way have links with it, directly or indirectly, through natural or social interactions. In particular, the SMBR and its forests play an important role in the regional development, as providers of water resources for many of these municipalities (SEMARNAP, 2000). It is estimated that the protective function of the SMBR's forests is important for the production of water supplying a region encompassing 400,000 inhabitants (Graf et al., 2001).

But despite the recognised importance of this protected area for the rich biodiversity it hosts as well as its major role in terms of freshwater supply, it is faced with the same issues as other biosphere reserves regarding the difficulty to set up benefit-sharing mechanisms in favour of local populations (Graf et al., 2003; André de la Porte, 1998).

In some cases, the strict zoning regulations inside the protected area have been questioned. For example, these prevent taking the necessary measures to restore areas that were prone to fires or logging. Similarly, they do not recognise the compatibility of traditional low-impact activities such as blackberry and mushroom collecting, nor hunting –therefore encouraging poaching practices (Jardel et al., 1996). The risk of such rigidity in authorised activities is particularly important regarding the core zone, where the "conservation flagship" *Zea Diploperennis* can be found. Indeed it is highly probable that this species' genetic variety depends, precisely, on its interactions with social and cultural processes –in particular the traditional hybridisation and weeding in indigenous land-use practices (Gerritsen et al., 2001). This knowledge could encourage the development of more gradual options in the zoning of biosphere reserves.

Although the creation of the SMBR did not imply expropriations, it did entail important land use restrictions[4] (Jardel et al., 1996). As 60% of the Biosphere Reserve is communal land (while 39% is private and 1% governmental), the delimitation of the three core zones had severe impacts on those local communities whose forested lands were, in a way, confiscated. Restriction of use is not formerly compensated in any way, and ironically, these communities ended up protecting the forest and the water it produces for other people's use while being forbidden its access for their own use. This nurtured resentment, which was aggravated by the fact that the federal government did nothing to design a management plan or support the reserve through human or financial resources (Graf et al., 2001): "For almost seven years, it

[4] In Mexico, contrary to most countries, the Biosphere Reserve is not just a label in addition to the status of national park, without any additional restrictive measures. The 'Mexican modality' of biosphere reserves fills up an institutional gap, due to ineffective governmental involvement, inexistence of local populations' involvement in the protected area's management or of ecological criteria for such management (Graf et al., 2003).

was the classical example of a 'paper park' with no active management or formal community involvement" (Moran and Lloyd, 2004: 24).

It was the IMECBIO who filled the institutional gap, by playing the role of manager and consulting agency, holding participatory workshops to identify the priorities of the different communities and organising environmental education programmes. But it had neither the legal authority, nor the required financial or human resources to do so (Jardel et al., 1996). In particular, it was faced with the difficulty to implement the planned compensating schemes for those landowners with land inside the core zones (essentially due to land tenure conflicts), as well as to protect these areas effectively (Graf et al., 2001). The IMECBIO's fundraising –supported by the University of Guadalajara or the World Wildlife Fund- nonetheless allowed for the implementation of community development projects and the non-implosion of the whole biosphere reserve project (Moran and Lloyd, 2004).

The situation changed after more than seven years, triggered by major national events. In 1994, the Chiapas armed conflict, along with the creation of the SEMARNAP, grouping for the first time all natural resources as well as protected areas in one sole ministry, created favourable conditions that led the SMBR to receive more attention from the central government[5] (Graf et al., 2001). The Directorship of the Sierra de Manantlán Biosphere Reserve was created, with funds provided by the World Bank under the Global Environment Facility (Graf et al., 2003).

The first director of the SMBR was the IMECBIO coordinator of community development, which enabled him to not only involve local actors of the Biosphere Reserve in the process, but also develop projects in partnership with the IMECBIO, focusing on environmental education, prevention and control of forest fires and the Ayuquila River watershed management[6]. Interdisciplinary projects with the IMECBIO enabled to set up enhanced agro-pastoral systems, community forest management, diversification of products, and the organisation of cooperatives in marginal communities (Graf et al., 2001). Community development projects established include: the rehabilitation of a sawmill working in collaboration with a seedling nursery, the exploration of eco-tourism routes and infrastructure, local handicraft and marketing of forest by-products (Moran and Lloyd, 2004). In addition, organic farming programmes were also set up in certain communities (Jardel et al., 1996).

[5] On one hand because of the realisation that some very poor communities might be hosting *guerrilleros*, on the other hand because the manager of protected areas inside the SEMARNAT received considerably more power than was previously the case.

[6] Research undertaken by the IMECBIO enabled to generate most of the data on which the SMBR's management programme is based (Graf et al., 2001).

The SMBR's most important success is nonetheless the lengthy multi-stakeholder process it developed, involving people with conflicting interests, and which led to the ratification of a management plan (Moran and Lloyd, 2004). The stakeholders involved are the three levels of government, local communities, a local NGO, the University of Guadalajara and the funding agencies (Jardel et al., 1996). As a result, illegal logging in the core zones has been significantly reduced (Graf et al., 2003).

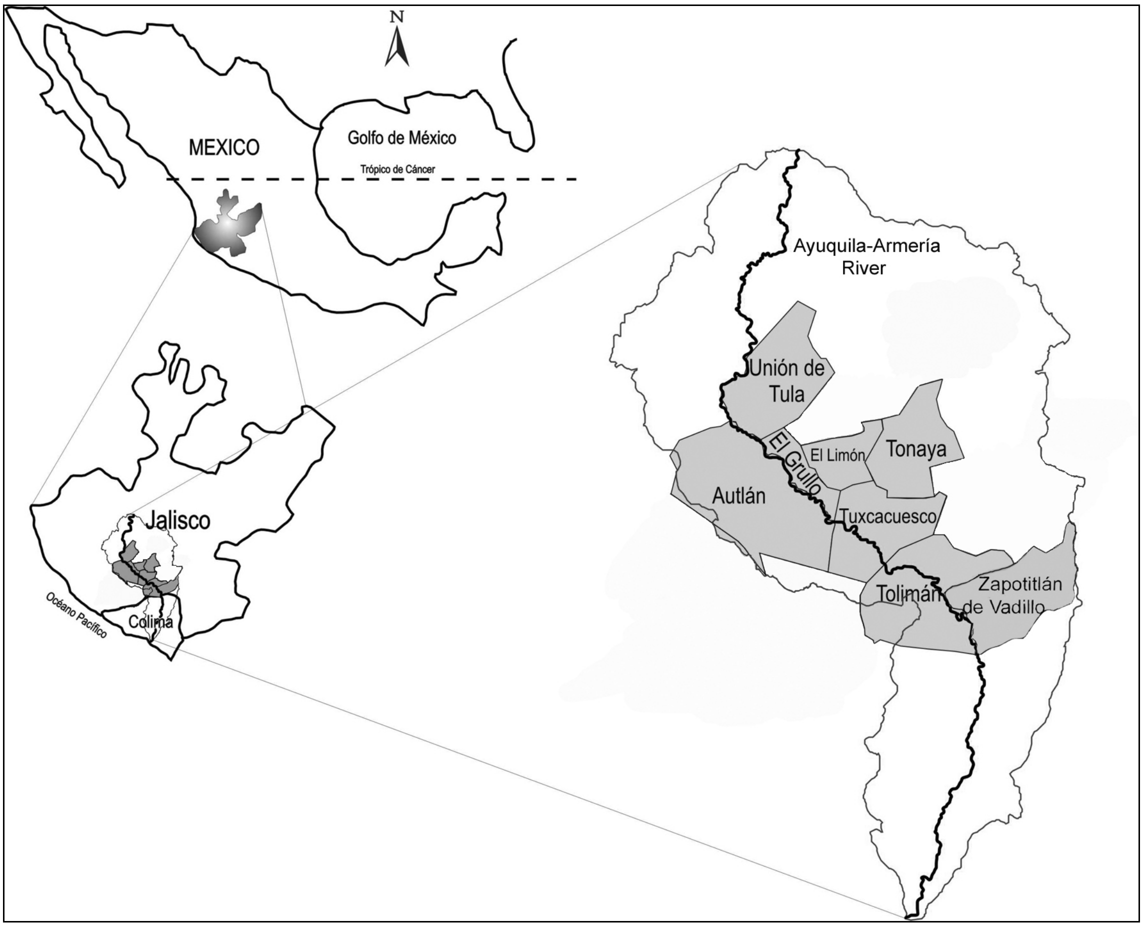
Nonetheless the most important problems encountered in the Biosphere Reserve still remain the transformation of forest cover to pastures and agricultural plots, erosion, illegal logging, excessive harvest of firewood, poaching, overgrazing, and forest fires (Jardel et al., 1996).

Several factors explain the particular increasing pressure to convert forests into pasture. On one hand, the vegetable market suffered a crisis, particularly acute in the first half of the 1990s (SEMARNAP, 2000). Then, in the context of NAFTA, the maize market is so depressed by competing American and Canadian exports that farmers have no incentive to continue cultivating their traditional maize land plots; instead, they convert forest cover and maize land to pasture land for cattle (Moran and Lloyd, 2004). Those who cannot afford to have their own cattle grow pasture to sell (Gerritsen, 2002). Cultivation of illegal drugs also developed inside the Biosphere Reserve (SEMARNAP, 2000), and in the village of Paso Real, leading to the mountain, it is not uncommon to see heavily armed police patrols go by.

Socio-economic importance of the Ayuquila sub-watershed

In addition to its importance for the rich biodiversity of the region, the Ayuquila watershed is also critical for human uses. Eight municipalities make up the medium part of the watershed area (see map below). On one hand, Unión de Tula, Autlán, El Grullo, Ejutla and El Limón are part of the intermountain valleys, while Tonaya, Tuxcacuesco, San Gabriel and Zapotitlán de Vadillo are part of the Big Valley and Tolimán is in the mountains.

Map 12: Municipalities of the lower Ayuquila watershed



Source: Gerritsen et al., 2005: 113

Different typologies of these municipalities have been realised –according to socio-demographic or urbanisation features- but all coincide in that the area is characterised by a duality where geographical disparities have generated socio-economic ones.

This has been intensifying since the pre-Hispanic period, when the municipalities located in the upper and relatively flat valley developed an intensive agriculture, while those located downstream in the mountainous regions were confined to auto-subsistence activities such as seasonal agriculture, extensive cattle-raising and fishing (Graf et al., 1996). This determined the very distinct population structuring as well, with high versus low population densities, and accordingly, disparate social welfare (Ibid.).

With more than 60% of their population living in an urban centre, today, Autlán, El Grullo and Unión de Tula are 'predominantly urban municipalities' (Gerritsen et al., 2005). The first two municipalities, with a population of approximately 50,000 and 22,000 respectively, concentrate 60% of the total population in the eight municipalities (Lomelí et al., 2003). These two municipalities benefited from the construction of the road Guadalajara-Barra de Navidad in 1941, as well as the development of irrigation and the installation of a sugarcane factory in the Valley of Autlán-El Grullo in the 1970s (Lomelí et al., 2003; Graf et al., 1996).

While only a fifth of the active population is employed directly in the primary sector, their small urban centres have developed around activities linked to agriculture and livestock rearing, while providing services, administrative and commercial functions for the region (Gerritsen et al., 2005). Being poles of attraction for labour coming from the mountain areas or other states of the country, they are the only ones to have a positive demographic balance. All other municipalities reflect the severe emigration phenomenon, generated most probably by the crisis in the agricultural sector, incapable of providing sufficient employment (Gerritsen et al., 2005).

Compared to El Grullo, Autlán in addition benefits from being located on the road between Guadalajara, the capital of Jalisco State and the coast, which makes it an important commercial regional centre, while also hosting the University of Guadalajara's South Coast campus (Moran and Lloyd, 2004).

These richer municipalities undertake major water withdrawals from the Ayuquila River and the aquifer for irrigation, domestic and industrial use.

For example, according to Martínez (2003), surface water of the watershed provides drinking water to 25,000 people in the valley Autlán-El Grullo (essentially from the Manantlán stream coming from the SMBR), while groundwater supplies more than 50,000 people. At the same time, the watershed also provides water for irrigation to 12,000 ha of the valley (expected to rise to 18,000 ha), this time from water stored in the two dams set on the Ayuquila River upstream from the valley (Martínez, 2003).

The valley indeed hosts irrigation district 094 that covers the three municipalities of Autlán, El Grullo and El Limón, as well as the Ingenio Melchior Ocampo (called 'IMO'), its sole industry, which is a sugar refinery. The IMO is located in the municipality of Autlán, along the road between the two towns just before the Ayuquila River, which is the municipal border between the two municipalities. It is the biggest regional employer, with 600 employees, rotating on three eight-hour shifts of 200 people each[7].

[7] This is in addition to the numerous indirect jobs it creates (for example the truck drivers which bring the sugarcane to the refinery are directly employed by the two sugarcane associations of the region).

Image 4: The IMO sugar refinery

The urban centres of Autlán and El Grullo also contaminate the River through the discharge of their untreated wastewater and solid waste[8] (Martínez, 2003). Until recently, Unión de Tula also disposed of its solid waste in an open-air discharge above the River (Gerritsen et al., 2005).

Image 5: Autlán's wastewater discharge in July 2003

[8] Autlán has since then finished building its treatment plant, as explained further on in this section.

Combined with important water withdrawals which reduce the River flow, these liquid and solid waste disposals have negative impacts for the riparian communities inside the municipality of El Grullo itself: particularly affected are the communities of El Tempisque, El Palo Blanco and El Aguacate, located directly downstream from the wastewater pipelines (Graf et al., 1996). While the whole Ayuquila River used to have the reputation of being an excellent fishery, the portion located between El Corcovado –the diversion station to irrigate the Valley- and El Aguacate has suffered from a reduction in fish species variety and abundance (Martínez et al., 2000a).

Although when the River enters the mountainous area of the SMBR, it has received back half of the diverted water for irrigation at the Corcovado (Mercado-Silva, 2001), the water withdrawals and point-source contamination in the 'upstream municipalities' of Unión de Tula, Autlán and El Grullo also affect 'downstream municipalities' (Martínez, 2003). The Manantlán stream coming down from the SMBR indeed more or less draws the limit between the municipalities of El Grullo and Tuxcacuesco. The municipalities located downstream from the junction between the two water bodies thus benefit from much improved River water quality, at least during the rainy season, when the Manantlán stream has an important flow. During the dry season, the water quality used to be very bad when the IMO discharged its organic or chemical residues, and the Manantlán stream is not important enough to 'clean' the Ayuquila (Graf et al., 1996).

These downstream municipalities, such as Tuxcacuesco and Tolimán, are poorer, mostly rural and dependent on work outside of the community (Martínez, 2003). Along with Zapotitlán de Vadillo, they are 'marginal municipalities', characterised by a relatively low urban population –Tuxcacuesco being exclusively rural. In addition, they work for more than 60% in the primary sector, mainly as daily workers in the Autlán-El Grullo valley, and poverty indexes are much higher than in the two other groups of municipalities (Gerritsen et al., 2005). Their population is highly dependent on the River to replace an inexistent potable water service (Henne et al., 2002). The River is also a crucial resource for their livelihoods, which also consist of subsistence farming, fishing (for auto-consumption and selling) and attempts to develop tourism to complement the family income (Martínez, 2003). As the River is the 'beach of the poor', their recreational activities are also impacted by upstream discharges (DRBSM and IMECBIO, 2001).

Images 6 and 7: Ayuquila River uses in Tuxcacuesco and Tolimán

As for El Limón and Tonaya, the two municipalities that do not have a direct access to the Ayuquila River, they are classified by Gerritsen et al. (2005) as 'intermediate municipalities'. Due to their hilly geography, they cannot benefit much from the irrigation infrastructures developed in the Autlán-El Grullo valley, but have nonetheless developed agricultural activities, and count 40% of their population in the primary sector. They are municipalities where the emigration rate toward the United States is very high (Gerritsen et al., 2005). Tonaya is in particular well known for its important mescal industry, a drink similar to tequila although it cannot benefit from the name as it lies outside the boundary of the area in which labelling of 'tequila' is authorised.

Images 8 and 9: Municipalities of El Limón and Tonaya

The fact the Ayuquila River crystallises many vested interests in the region has led it to become one of the main foci of research, along with the SMBR.

Previous to the establishment of the SMBR's Directorship, local riparian communities as well as the city council of El Grullo asked the IMECBIO to assess the Ayuquila River's contamination. In 1994, the Sierra de Manantlán Biosphere Reserve took the lead in promoting an environmental management of the River, following protests about its contamination by many communities located in the reserve itself. In order to "channel the dissatisfaction into institutional paths", it developed a project integrating diagnosis and monitoring, as well as local social and political organisation, thereby creating local committees in each riparian town. But due to federal and state elections that year, no agreement was found at a multi-stakeholder meeting which gathered the city councils, the sugar factory and sugarcane producers, state and federal agencies, the local river defence committees and the University of Guadalajara (Graf et al., 1996: 4).

In 1995, a series of events created a favourable climate for change: the Ministry of Environment, Natural Resources and Fisheries was created; the opposition party (National Action Party) won the state elections as well as the most important local municipalities; and the sugar factory was privatised (Graf et al., 1996).

In this context, that same year IMECBIO started a research project to document the River's pollution sources and their impacts, and undertake the adapted actions for their mitigation. From 1996 to 1998, regular monitoring of the River water quality was undertaken in nine sampling sites, strategically selected according to polluting sources along a portion of 50 km (Martínez et al., 2002a).

Since then, the monitoring expanded to 15 sites, covering approximately 100 km of the River. A traditional physical-chemical monitoring is realised monthly (down from bi-monthly during the two first years), while aquatic vertebrates are monitored every two months, and fish once per trimester (Aguirre et al., 2005). It is complemented by the use of one of the first Biological Integrity Indexes developed for rivers of western Mexico, including ten criteria[9].

Images 10 and 11: IMECBIO Watershed team monitoring session in July

Five years after the beginning of the monitoring, in 2000, the research results showed that in this portion of the River, the most degraded region of the watershed, various human uses accounted for the river's degradation: "The degradation of the Ayuquila River is a complex

[9] Biological indicators –number and variety of fish and aquatic invertebrate species- are very sensitive to organic pollution: they enable to follow not only the quality of the water but also that of the habitat, thus identifying illegal discharges even when these take place at times other than those of the monitoring (Olguín et al., 2005).

problem caused by a variety of human activities that include water storage and diversion, channelization, irrigation, point and non-point source pollution, sedimentation and changes in land use on the riparian area as well as in the upper watershed" (Martínez et al., 2000a: 178).

Among these main causes, three were of particular importance due to their ecological impacts on the riparian ecosystem: the urban wastewater discharges from Autlán and El Grullo, the industrial discharges from the sugarcane factory Ingenio Melchor Ocampo (IMO), as well as the storage and diversion of the River water for irrigation purposes (Martínez et al., 2000a; Martínez et al., 2002a). Indeed fertilisers (monitored by the IMECBIO) and pesticides (monitored by the CNA) were not considered as main polluters as their levels were considered sufficiently low (Luis Manuel Martínez, personal communication).

Indeed analysis of water quality showed among other things that dissolved oxygen levels were very low –under 5 mg per litre, the level required for fish survival- for 20 km downstream from the sugar mill wastewater discharges, and under 2 mg per litre until Aguacate, after the El Grullo sewage which is likely to be the reason for limited aquatic biota (Martínez, 2003). Although the River was historically rich both in terms of variety and quantity of fish, the 30 km of River downstream from El Grullo now host fish of little commercial value – although important for the riparian communities that live in the Sierra de Manantlán Biosphere Reserve (Martínez et al., 2000a).

The first cause of River pollution, the discharge of 200 l/s of wastewaters into the River by the municipalities of Autlán and El Grullo, was supposed to have been addressed in 2005, according to the Law on Ecological Equilibrium.

In practice, Autlán is the only municipality to have a wastewater treatment plant, built in 2003. It had trouble with its first year of operation (breaking down on a regular basis), but the process has now improved and enables a continuous operation, although it still suffers from technical problems[10] (Martínez et al., 2005). As for El Grullo, as of the first trimester of 2006, it is still identifying the best option to treat its wastewaters due to its specific local conditions, financially and technically speaking (this process is detailed in the first section of Chapter 4).

The second source of pollution –that created by the sugar factory- was finally recognised by the CNA after a lengthy process involving local communities, research institutions and the

[10] According to the researchers' monitoring results, it still does not treat the cities' wastewaters correctly, due to problems with the filters (it is a third-level type of treatment plant but only treats primary components, e-g sediments, instead of nutriments and coliforms as well) (Luis Manuel Martínez, personal communication).

SMBR. Until then, studies undertaken had used methods that averaged the results of water quality, thus minimising the reality of pollution peaks that coincided with the sugarcane processing season (Henne et al., 2002).

Sugarcane factory discharges of raw wastewaters are quite common in Mexico, where 40% of all discharges in water bodies are realised by the sugarcane industry (Olguín et al., 2005). In the region, the factory was owned by the State until 1995, which complicated matters for riparian populations asking the authorities for its wastewater treatment (Graf et al., 1996).

The factory used to realise two types of discharges into the River. The first type, water used to wash the sugarcane that had been burnt to facilitate the cutters' work[11], was realised 24/24h for the whole harvest period (Aguirre et al., 2005).

Image 12: Sugarcane washing process at the IMO

Image 13: Cutters during the harvest

[11] Until recently, sugarcane harvesting was purely manual, so to help the work of the cutters the sugarcane fields were always burnt beforehand.

The resulting important organic loads (a concentration of 600 mg/l of biochemical oxygen demand) suffocated the oxygen in the water along 30 km downstream (Martínez et al., 2002a). The magnitude of such discharges was much higher than any other source of organic pollution, like domestic or agricultural wastewaters (Henne et al., 2002). Although this discharge took place during only six months each year, due to its advanced deterioration, the River did not have the capacity to recover, preventing the development of fish and aquatic vertebrate (Martínez et al., 2000a).

The other discharge –chemical residues used for the maintenance and washing of the machines- took place twice during the harvest season, and systematically caused massive fish kills (Martínez et al., 2002a).

The chemical discharge stopped in 1997, by replacing the caustic soda with a system of highly pressurised water (Martínez et al., 2005). But the organic discharges continued, leading 11 municipalities to prioritise the cleaning up of the River in the framework of the Sierra de Amula region (Martínez et al., 2002a).

As explained by Martínez et al., the third main activity impacting the River was the storage of rainfall water in the Tacotán and Trigomil dams. This prevents the rainwater from flowing into the River, as it would naturally, thus limiting the River's geomorphologic changes and diversity. In addition, at the Corcovado station, water diversion for irrigation reduces the River flow downstream by 70% on average, reaching 97% during the irrigation season. Consequently, the River is regularly dried up along 2 km, which interrupts the aquatic ecosystem (in 2006 the University will start evaluating the impacts of this on fish populations that usually migrate). The absence of water also concentrates the pollution discharged in the riverbed (Martínez et al., 2000a).

In 2002, although the issue of minimum environmental flows (which guarantee a minimum flow in the River to maintain the ecosystem integrity) was mentioned in the reform to the National Water Law, approval of such an orientation and calculations to determine such a flow were still pending for the Ayuquila River (Martínez et al., 2002a). Early 2006, nothing has changed, the situation being blocked by the postponed publication of the law's Regulation. As commented by this researcher, keen to set such measures up for the Ayuquila River: "Election years do not favour agreements".

Until 1998, these environmental injustices between the upstream and downstream municipalities of the region (Friedrich, 2004), still coincided with their socio-economic disparities. That year, on March 28th, an accidental spill of 100 m3 of molasses at the IMO – the equivalent of 130 tons- provoked an environmental crisis on more than 70 km downstream (Martínez et al., 2000b; Martínez et al., 2002a). The CNA did not consider this as a priority to address, as it was already busy trying to face complex issues in the adjacent

Lerma-Chapala Basin. As a result, the municipality of El Grullo, impacted in its riparian areas, confronted the IMO directly. Autlán, in the boundaries of which the sugarcane factory is located, was less impacted by the pollution and worried about exerting pressure on one of its main tax sources (Graf et al., 1996).

Following a massive local uprising by downstream communities in both Jalisco and Colima States, the local and state authorities were forced to take action and fine the sugarcane factory. A low-cost solution was devised to manage the toxic wastewaters with the help of the Directorship of the Sierra de Manantlán Biosphere Reserve and the IMECBIO, leading the IMO to adopt a more collaborative approach (Graf et al., 1996).

The IMO then asked the IMECBIO to devise a programme of actions to restore the Ayuquila River by mitigating the impacts of the molasses accident. The document, produced in 2000, first offers a diagnosis of the situation: referring to monitoring results of the River prior to the accident (from June 1996 to December 1997), it was possible to precisely identify and quantify the impacts of the molasses spill. It then presents the detailed actions needed for this three-year programme to mitigate the impacts of the molasses accident, as well as the factory's structural discharges in the River and their costs. The three main axes were: improvement of aquatic habitat (which includes actions to reduce discharges); improvement and protection of the riverbanks (including reforestation programmes); and repopulation of native fish species (Martinez et al., 2000b).

In the end, a working group defined solutions for the management of the sugarcane factory's wastewaters, involving the University of Guadalajara, the Board of the National Water Commission's District 094, the irrigation district's Water Users Association, the Union of Cane Producers and the ejido Las Paredes.

By 2001, following the suggestions of the programme, the IMO had reduced its discharges in the River by 80%. To do so, it first increased its efficiency in water use for processing the sugarcane, thus reducing the quantity of water rejected. It also adopted a new recycling process, distinct for the three types of water uses it has: to wash the sugarcane, it replaced groundwater by canal water for irrigation, less concentrated in salts (Martínez et al., 2002a). Filters then enable to lower the sediment loads, and then this water is mixed with irrigation water to be directly reused. On the other hand, water used in the process to cool and clean the machines and wastewaters (effluents from the manufacture of the sugarcane syrup and water containing the products of combustion) first decant – to reduce sediments- in a pond before also being used for irrigation (Martínez et al., 2002a). Unfortunately this unique pond should be complemented by others, so albeit the presence of papyrus plants, which are typically planted to accelerate the process, the olfactory nuisances give away the wetland's dysfunctions[12].

Important to mention is the fact the population living in the community Las Paredes agreed to use these waters to irrigate their fields because a study had previously been undertaken by the University to demonstrate the absence of impacts this would have on the soils' properties (Martínez et al., 2005).

These measures have had a very positive impact on the quality of the River: by mid-2000 and even though this was right in the middle of the harvest period, fish were seen in the River again. Since mid-2002, the sugarcane factory does not discharge any more wastewater in the River (Martínez et al., 2002a). Towards the end of 2003, according to the values of its Index of Biological Integrity, the most affected site in the River had recuperated by 47% compared to the situation just after the spill (Olguín et al., 2005).

Consequently, since then, it seems that while the socio-economic duality still prevails between upstream and downstream municipalities, the River contamination seems to have less of an inter-municipal dimension, revealing that the Manantlán stream is sufficient to purify the current contamination (mainly the town of El Grullo's wastewaters, along with extensive agriculture runoffs and a few pig farms).

The focus is therefore more on an intra-municipal level: the riparian communities of the municipalities of Autlán and El Grullo which live directly downstream from the wastewater discharges are still affected by the consequent pollution.

To restore the Ayuquila River, the involvement of all actors who both benefit from and affect the River is crucial (Martínez et al., 2000a). Beyond the sugarcane factory's primary role, various other responsibilities need to be met: treating the urban wastewaters, increasing and maintaining a base-flow in the River, assessing and controlling the chemical contamination from pesticides and fertilisers, among many other actions (Martínez et al., 2000b).

An innovative plan for such an integrated management of the lower Ayuquila watershed was devised, which is presented in the second section of Chapter 4.

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[12] In addition to the prejudice this subjects the sugarcane factory employees living nearby to (low-income immigrants from other States of Mexico for the most), the location of the pond –along the road connecting Autlán to El Grullo- might also have developed a certain negative preconception against such natural treatment plants.

b. The municipality of El Grullo

Our study is focused on the municipality of El Grullo, located in the intermediate area of the Ayuquila watershed. Hereafter we present its most important features in terms of history, geography, demography, economy and politics.

Historical evolution

The first origins of the municipality of El Grullo date back to the 19th century. From a ranch in 1839, it later became the Hacienda de Zacate Grullo. In 1900 it entered the category of political and judiciary *Comisaría* as 'El Grullo', and was part of the municipality of Autlán (INAFED, 2000). Autlán is one of the oldest human settlements in the region, existing since 1524 –i.e. previous to the Spanish invasion- when it was the tenth canton of Mexico.

El Grullo wished to become independent in order to manage its own financial resources, so the State Congress created the municipality during the Mexican revolution, on December 3rd, 1912 (Rubio, 2001). Its heraldry was designed in 1987 for the celebration of the municipality's 75-year-anniversary (INAFED, 2000).

Image 14: The current municipal heraldry

Source: Municipality of El Grullo

Image 15: Santa María de Guadalupe Church

On the top of the heraldry, the towers are those of the parochial church Santa María de Guadalupe, the town's most ancient and representative construction. It is located in the central garden, a feature shared by all Mexican cities, towns or villages.

The legend *Salve Feraz Valle* is a salutation to the municipality's fertile soil, while the colours blue and gold are those of Jalisco State. In the upper left hand-side, the partition represents the musical vocation of the population, including laureate musicians. To the right are the products that traditionally sustain the economy, based on agriculture: maize, pumpkin and sugarcane. In the lower part, the plant in the water (commonly known as "grullo") gave the municipality its name (Martínez-Réding, 1992).

Although the explanation of the municipality's name still causes debate among experts, the most agreed upon version is that the inhabitants of the original settlement –the Hacienda Zacate Grullo- named the place due to the abundance of a Graminaceae (zacate) of an ash-grey colour, i.e. the colour of the cranes (Instituto Nacional para el Federalismo y el Desarrollo Municipal, 2000). For some, this was because of the similar colour, for others it was because the plant was the cranes' favourite food (Rubio, 2001). Originally, "grullo" is a Spanish word (i.e. not indigenous) with various meanings, such as the male of the female crane, a white-greyish horse, etc. (Pedro Rubio, personal communication). It is indeed possible that, although today only the great blue heron can be found, cranes were also part of the winter migratory birds that visited the valley in the 19th century, when the Hacienda Zacate Grullo developed (Santana, 2000).

The endemic plant, which grows in water and is used as fodder, can still be found in some irrigation canals, but it is now much scarcer than in the past, as the valley's humid areas were mostly drained (Santana, 2000). In 1950, a drain was built to dry up the land between El Grullo and the Ayuquila River, and develop irrigated agriculture, more productive than the traditional rain-fed maize. To build the canals and to have more lands, the valley was deforested: before there used to be *coamiles* in the hills (cultivation of maize in the forest), and there were lots of endemic species such as willows *(Salix humboldtiana),* shootbearing astianthus *(Astianthus viminalis)*, cartilagelike jungleplums *(Sideroxylon cartilagineum)*, plum leaf ficus (*Ficus pertusa*) and eartrees *(Enterolobium cyclocarpum)*: "The Ayuquila River was like it is now further downstream, in Tonaya"(Pedro Rubio, personal communication).

Image 16: The Ayuquila River in the past

Source: Rubio, 2001: 292

Image 17: Ongoing IMECBIO reforestation programme with endemic species

In 1962, the State Congress approved the municipal capital's classification as a city (Martínez-Réding, 1992).

Geographical data

The municipality of El Grullo is partly located in the valley of Autlán-El Grullo, the largest continuous alluvial valley of the watershed, which covers 160 km2 (Martínez, 2003).

It is situated at 19°48'06'' latitude north and 104°12'06'' latitude west. The semi-dry climate allows for clearly defined seasons, although feebly contrasted (the average being 24°C), and most of the territory benefits from an annual rainfall pattern of more than 800 mm. With a topography varying between 800 and 1,400 m above sea level, the vegetation varies: in the north, forests of oaks and pine abound in the mountainous areas, while in the centre and southern part, flatter, can be found species more characteristic of warm climate such as eartrees (*Enterolobium cyclocarpum*), DonnellSmith trumpettrees (*Tabebuia donell-smithii Rose*), palmer trumpettrees (*Tabebuia impetiginosa*), guamachil blackbead (*Pithecellobium dulce*) and plum leaf ficus (*Ficus pertusa*) (Rubio, 2001).

Image 18: Cactus with DonnellSmith trumpettrees in the background

The municipality is part of the transition area of the Sierra de Manantlán Biosphere Reserve, although it has no lands inside it. Its south-western border with the municipality of Autlán is delineated by the River Ayuquila, while the other bordering municipalities are: Unión de Tula and Ejutla to the north, El Limón to the east and Tuxcacuesco to the south-east.

Covering 144 km2, it is one of the smallest of the State of Jalisco (Rubio, 2001) and this is also true among the municipalities of the lower Ayuquila watershed. But despite, or perhaps due to this, it is also the first most important in terms of population and follows Autlán in terms of economic dynamism (Lomeli et al., 2003).

Socio-demographic information

According to the last published population census –the XIIth General Census on Population and Housing in 2000- the total population in the municipality of El Grullo is 22,499. Approximately 90% of these (i.e. 20,250 people) live in the homonymous municipal capital, which is the only urban human settlement in the municipality (according to national classification by the INEGI, the limit between rural and urban is 2,500 inhabitants). This is the only municipality in the region where more than 80% of its population is considered as urban since the 1930s (Lomeli et al., 2003).

The rest of the population is scattered in 38 rural communities, of which only 6 have close to or more than 100 inhabitants (Ayuquila: 1,214; La Laja: 416; El Aguacate: 261; Las Pilas: 185; Palo Blanco; 134; La Puerta de Barro: 95), while many are ranches with just a few people.

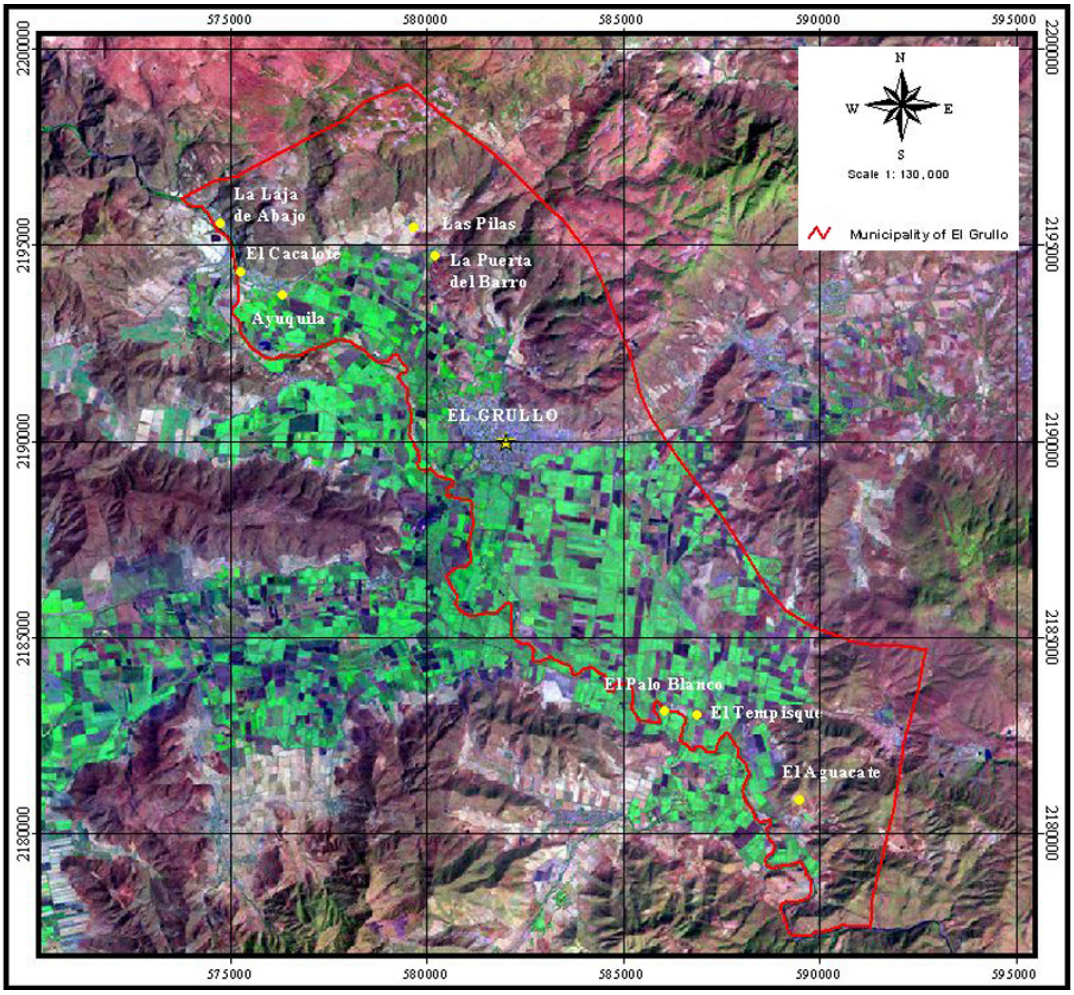
During the 20th century, the municipality underwent an exponential demographic progression, growing from a population of 1,724 in 1900 to 6,999 in 1950 to reach almost 23,000 in 2000 (Rubio, 2001). Nonetheless, during the second half of the century, the population growth fluctuated in accordance with the economic situation in the valley: from 2.5% in 1950 down to 1.3% in the 1960s, it increased back up to 4% in the 70s-80s, followed by a strong decrease in the 80s-90s (due to the melon plague in the valley, and the Mexican financial-economic crisis more generally speaking) (Lomeli et al., 2003).

More recently, between 1990 and 2000, it was the municipality that faced the most important demographic increase among the 8 municipalities of the lower Ayuquila watershed: 1.1% increase in population, 26% increase in the number of households, and a resulting density of 156.2 hab/km2 (in 2000) –high for the region (Gerritsen et al., 2005).

This is because unlike other municipalities in the region with which it shares a high level of emigration towards the USA (due to the current agricultural crisis), El Grullo also continues to attract immigrants in search of employment opportunities. The valley provides important seasonal jobs for people coming from mountain areas of the region and other states of Mexico, where such employment opportunities are much scarcer (Lomeli et al., 2003). The apparent contradiction is due to the fact most men from the valley refuse to be employed as daily workers in the sugarcane fields, because the manual harvesting is very difficult and they prefer to search for other opportunities up North.

This immigration tradition dates back to the initial settlement pattern, as the town grew from a ranch to the Hacienda del Zacate Grullo, to become an urban regional centre today.

Map 13: El Grullo municipality with most important localities and urban centre



Source: IMECBIO

Economic activities

The economically active population (36.7% of the total population) is distributed as follows: 24.1 % in the primary sector, 22.3 % in the secondary sector and 52.2% in the tertiary sector (1.3% not specified) (Lomeli et al, 2003). But many of the secondary and tertiary activities are linked to the agricultural production.

Historically, in the alluvial valley of Autlán-El Grullo, soils have always been apt for agriculture and intensive agriculture has prevailed since pre-hispanic times. From the 19th century through to 1950, the cultivation of maize, beans, cotton, sugarcane, coffee, palm, rice and livestock rearing were the most common activities (Ibid.), as well as courgette, chilli, papaya, watermelon and tobacco. The rain-fed agricultural products were destined for national consumption.

With the irrigation scheme of the 1950s, the valley underwent what is known as a model of agro-industrial development (Toledo, 2000). As highlighted in 1947 by General Marcelino García Barragán, Constitutional Governor of the State of Jalisco: "El Grullo, as part of the vast colonisation plan for our coasts, was one of the places that received a lot of support from my government […] the cultivation of maize, beans, peanuts and sugarcane are sources of production and the future looks radiant if the irrigation of this zone with water from the Tacotán dam succeeds" (translated from Rubio, 2001: 296).

New water-thirsty products such as melon (export-bound) and sugarcane replaced the rain-fed products. Cotton became more important than sugarcane in 1950, followed by tomatoes. In 1970, the installation of the Ingenio Melchor Ocampo marked the comeback of sugarcane, which dominated the melons as they contracted a plague. In the 1980s sorghum was important, as well as tomatoes (Lomeli et al., 2003). Since then, there is essentially sugarcane (especially in El Grullo), and to a smaller extent, maize (to be sold on the cob as *elote*), alfafa, chilli, tomato, onion, and courgette.

Image 19: Chilli pickers

Image 20: Maize, sugarcane and agave fields near the village of Aguacate

Extensive livestock rearing has developed since the 1950, encouraged by governmental subsidies, while fishing activities also take place in the Ayuquila River (Lomeli et al, 2003).

Although the Green Revolution model used in the valley for tomato and sugarcane production (with the use of high productivity varieties, machines and chemical products) has contributed to the economic dynamism that makes the valley a focal point for regional employment, such a development also generated many drawbacks, the first of which are its impacts on public health and the environment (Lomeli et al., 200). As seen previously, it is the structural contamination of the River that led to a regional awareness and to taking action. As always, point-source pollution (from the sugarcane factory as well as the municipal wastewaters) has been targeted as a priority. So as of today, few studies have been dedicated to evaluating the degree of pollution of the lands or aquifers, but studies are currently planned in the context of the watershed to evaluate the pesticides and chemical pollution due to such diffuse pollution in the River. Indeed, during the dry season, although the River is dried up on a few km due to the inexistence of ecological flows, when it goes out of the valley, the River has gained back most of its flow, mainly supplied by irrigation return flows (Martínez, 2003).

Today, the sugar industry is an important source of direct as well as indirect employment through businesses and services principally located in El Grullo (Graf et al., 1996). It is the only industry of the valley, and absorbs almost all the sugarcane production: "The IMO is almost all the economy, the basis of the economy" (Pedro Rubio, personal communication). This means it enables to sustain all the farmers of the valley.

The agricultural crisis the valley now faces is one of a nation-wide scale: it is more expensive to produce certain products in Mexico than to import them (such as maize from the USA or beans from Peru). This is linked to the NAFTA, but also to a specific problem of the Mexican agriculture. With the Revolution, the latifundias (extensive areas of private land) were nationalised, divided, and small plots were distributed to farmers without land. But the Mexican agrarian reform was slow to become operational: first mentioned in the Constitution in 1917, it was only in 1941 that a presidential decree limited the best lands to a maximum area of 150 ha, enabling to distribute the surplus. Today, the results of the reform are very mixed: this communal land tenure system, which concerns 75% of farmers in Mexico, has given rise to auto-subsistence agriculture with a low technological level, not always enabling to provide for the needs of those it originally intended to (Bolay, 1985).

This is because the parcels are so small (on average 6 ha) that they are not profitable. Also, boring deep wells is too expensive, so if the lands are not located near a source of superficial water for irrigation, the farmers can only resort to rain-fed agriculture. The fact the property is collective does not seem to play much of a role to help: although in some families that does mean that brothers will go and work each others' fields in rotation, according to El Grullo's chronicler: "In Mexico we are very individualistic, even in the ejidos: what's mine is mine and what's yours is yours, and if possible, what's yours is mine as well" (Pedro Rubio, personal communication). So today, even though families are much smaller than at the beginning of the 20th century (i.e. counting less than ten individuals), they still cannot live from their land's products only: in most households, the majority of those who can also work outside (Pedro Rubio, personal communication).

Alternatives to complete the household income include renting the land (when it is of sufficiently good quality) to rich neighbouring landlords –which can result in the farmer becoming a daily worker on his own land! Or, if the land is located in a peri-urban area, one can discreetly sell it to immigrants looking for a plot to build a house, thus participating in what Jean-Claude Bolay identifies as a phenomenon of illegal real-estate speculation (Bolay, 1985*)*.

Until recently, the privatisation of ejidal property was officially prohibited (a liberalisation attempt in 1980 by President J. Lopez Portillo was massively rejected) (Bolay, 1985). This changed in 1992 with the Agrarian Law, enabling either the transmission of the land or selling it as private property on the condition of obtaining the agreement of the other ejidal landowners (Gerritsen, 2002).

In El Grullo, historically, the most important hacienda –that of El Zacate-Grullo- was constituted during the 19th century by expropriating many indigenous people from their lands. This situation lasted until the 1950s (Lomeli et al, 2003). In 1932, 3,420 ha belonging to big landowners were expropriated to constitute the ejido of El Grullo (Snoep, 2004). Today communal land is still important (42%) even though 58% of the lands are private property and in terms of production units, the majority is private (67%) (Lomeli et al, 2003)**.**

The secondary sector is mostly manufacturing industry. Although the municipality has few industries, it produces huarache shoes (traditional leather sandals worn throughout Mexico), wooden furniture, ironwork, construction bricks, and maize leaves for exportation (Rubio, 2001).

As for the tertiary sector, El Grullo is one of the major commercial centres of the region (Gómez et al., 2003): its urban centre is a market for local goods but also a service provider for all municipal dwellers, urban or rural, through its health, education and administrative offices.

According to the urban classification of Arroyo et al. (1986)[13], El Grullo is indeed a "minor urban centre" along with Autlán and Unión de Tula (Lomeli et al., 2003). Similarly, it could also be coined as a "regional urban centre" (Bolay et al., 2004), although to a less extent than Autlán. These are centres whose economic dynamism rests mainly on rural production (usually destined for exportation), which itself feeds into the urban economy. By creating demand for machines, fertilisers, industry at pre-production stages as well as agribusiness of post-production stages, this makes the urban centre both a trade centre, in addition to being a service provider at the scale of the municipality, for administration, education and health. Favourable factors for such an economic dynamism include: climatic conditions, irrigation possibilities, but also transport and logistics, low-cost labour and inexistence or non-enforcement of environmental regulations (resulting in air or water contamination linked to intensive use of pesticides or fertilisers).

As put forward by the municipality's official chronicler during the ceremony of its 89th anniversary: "[The municipality] is small in area, has few villages (all connected), the land is fertile and irrigated, the density of the population is satisfactory, its people are hardworking; it is located at the crossroads between paved roads, its climate is not extreme, there is sufficient water in the river and underground, there are natural resources that we can benefit from, and its relative proximity to consumption centres such as Guadalajara, Manzanillo and Zapotlán, play in its favour. The municipality is potentially rich; we only need a bit of imagination and will to decide to diversify this potential and set up some industries, albeit small ones" (Rubio, 2001: 434).

Political-institutional organisation

Representative of a more general pattern at the national scale, in El Grullo, the National Action Party (PAN) was in power only twice: in 1950, when it was the first municipality of Jalisco to be governed by the opposition party –the second at national level- and then again in 1989. All the other municipal 3-year terms were led by the PRI, a "steamroller" which also wins because the PAN fails to propose any alternative programme (Pedro Rubio, personal communication). The current municipal authorities, elected for the period 2004-2006, are from the Institutional Revolutionary Party (and the next mandate 2007-2009 as well).

Common electoral campaign themes include: employment, services (such as extending the water network and supplying enough to all), education, culture, etc. In particular, they all promise water to everyone: as there is a strong demand, they take advantage of the situation because they know that "when is comes to water, everyone collaborates" (Luis Manuel

[13] According to these authors, only towns of more than 15,000 inhabitants can be considered as urban.

Martínez, personal communication). But they always stay at a very general level (nothing as specific as building a new tank is ever mentioned): "They all promise the same, to solve all the problems…In terms of electoral campaigns, in Mexico we have a very bad habit: we promise a lot and do nothing" (Pedro Rubio, personal communication).

2. Research strategy

Methodological principles

Following Yin (2003), several principles were followed to enhance the quality of research.

First, for the construct validity (objectiveness), we combined multiple sources of evidence.

To gather information related to water supply and sanitation in El Grullo, these were: administrative documentation from the Municipal Water Board, archival records (maps of plots in the town, maps of the municipality), interviews with key informants, as well as a mini-survey in 2003 in three riparian villages and another in 2004 with households from three villages and four urban neighbourhoods (as embedded units of analysis), and direct observation (from which photos were produced).

Information regarding the participation of El Grullo in regional initiatives was obtained through: documentation (administrative documents from both the Ayuquila Watershed Commission and the Inter-municipal initiative, as well as newspaper articles), semi-structured interviews with key informants and participants in the two regional initiatives, as well as one opportunity of direct observation during an exceptional meeting of the Watershed Commission during my last fieldwork[14], also producing photographs.

Secondly, as far as reliability is concerned (results should be the same if someone else did the study), although a case study protocol was not formally designed, the exercise required by the NCCR North-South to draft a proposal could be assimilated to such a document, highlighting the methodology, work plan, etc. On the other hand, a case study database was carefully constituted, listing notes, bibliography and tabular material for the small survey done in 2003 and the larger one done in 2004.

[14] On a normal basis, the meeting dates are generally decided less than a month in advance, so it was difficult to make our fieldwork coincide. In addition, previous to this last meeting, we had never been invited to join in.

Fieldwork operationalisation

Based in a Swiss institute in Lausanne, but with a fieldwork in Mexico, our research process implied several trips back and forth between the two (for periods ranging from one or two weeks to longer ones of several months). Apart from two short trips for specific meetings in the region, the fieldwork in itself had three major phases.

First phase: exploratory fieldwork

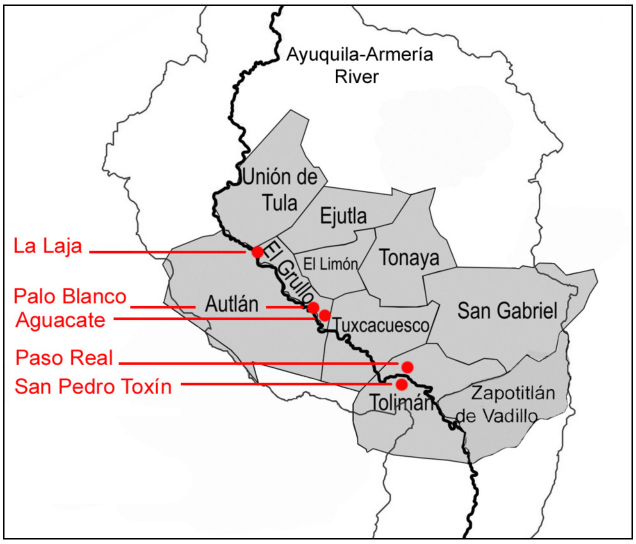
The first phase can be associated to what is generally called an 'exploratory fieldwork' and lasted three months and a half, from end of May to beginning of September 2003. It was the opportunity to personally discover the local issues, and from there refine our PhD proposal that had until then mainly been based on secondary sources.

Several meeting with researchers from the partner institution IMECBIO enabled to finalise the proposal, including the choice of the municipality of study, El Grullo. More secondary data was then collected and analysed, while semi-structured interviews with a recorder were held with key stakeholders in El Grullo (mayor, directors of municipal services of water and sanitation as well as solid waste, doctors and nurses from the health centre).

According to the literature on the research area, it had seemed there was an important impact of urban and richer municipalities –like El Grullo- on poorer ones located downstream – like Tuxcacuesco and Tolimán. But this was apparently outdated as some researchers told us the Manantlán stream was now sufficient to clean the River (as there had not been any other spill in addition to the sugarcane factory molasses spill a few years before).

In order to have a clearer idea, we visited different riparian villages along the Ayuquila River, located close to the monitoring points of the IMECBIO's Watershed Unit (i.e. directly upstream or downstream from the major water withdrawal points and point-source pollution sources). We accompanied the Watershed Unit in their monitoring tour for three days in a row, as most of these villages are of difficult access by public transport. In addition to Aguacate (in El Grullo municipality) and Zenzontla (in Tuxcacuesco municipality), Paso Real and San Pedro Toxín (in Tolimán municipality), this also took us to the junction between the Ayuquila River and the Manantlán stream. Limited on-site by the time the watershed team spent in each place, we only did a few structured interviews each time. We then completed by visiting La Laja, accessible by public transport.

Map 14: Villages visited during exploratory fieldwork



The results[15] confirmed that the contamination of the Ayuquila River by the urban wastewaters discharges in the Autlán-El Grullo valley did not have an important inter-municipal dimension, as the communities living downstream from the Manantlán stream were not impacted.

This led us to re-focus my our study of such impacts on the riparian villages located inside the municipality of El Grullo only, each one in a strategic spot with regards to the contamination sources, (useful for comparison purposes): La Laja (located above the Corcovado derivation station and the wastewater discharges), Palo Blanco (beneath Autlán's wastewater discharging point) and El Aguacate (beneath El Grullo's).

In terms of logistics, the three villages having a very variable accessibility by public transport[16], we contacted the public health centre in El Grullo (during our exploratory interviews, we had learnt that the municipal health centre has a mobile unit responsible for all the main villages, which it visits on a weekly basis). The doctor and nurse of the mobile unit agreed to take us with them, so we ended up travelling to these villages at the back of their green Volkswagen, next to the daily medical supply! This enabled to spend a few more hours in each locality than with the Watershed Unit, even though time was still constrained by the doctor's schedule.

[15] Due to the very small number of interviews, the results are purely indicative. Nevertheless, their validity is reinforced by the fact that in each locality, the interviewees had been living there at least 25 years (if not all their life), and had a good knowledge of the state of the River and its impacts on activities like fishing or recreation.

[16] La Laja is situated along the road between Autlán-El Grullo (through the Corcovado bridge), and thus benefits from a very regular bus service to and fro between the two towns. Palo Blanco and El Aguacate are on the other hand much more ex-centrered, located on the road that goes into the Biosphere Reserve and benefit from a much more reduced public transport schedule (one bus comes to the town of El Grullo early in the morning and goes back at 2 pm).

This time we undertook interviews with at least 10% of households[17] (the minimum rate for answers to be representative, according to one of our senior partners at the IMECBIO). We had designed a short questionnaire, largely inspired by the one used for the exploratory interviews, but also in order to be complementary with a Masters student, Carla Friedrich, also keen on working on water and related health problems (but concentrating on the poorer municipality downstream, Tuxcacuesco). The results are presented in Chapter 4.

Second phase of fieldwork: interviews and questionnaire on water supply and sanitation in El Grullo

The second phase of fieldwork lasted six weeks (November-December 2004). It was essentially dedicated to gaining more information about the water management design in the municipality of El Grullo, in particular to identify the actions taken towards an IWRM at local level, i.e. in terms of water supply and sanitation.

To do so, semi-structured interviews were held with key stakeholders of the municipality[18] (most of which had changed due to elections held in the meantime): the director of the Municipal Water and Sanitation Board, the responsible of the Manantlán water line, the president and the head of operations of the Water Users Association for Irrigation of Autlán-El Grullo, three canal managers working in the zone of El Grullo and the director of the Sierra de Manantlán Biosphere Reserve.

These interviews led to review the main questionnaire (see annex 6), which was then translated to Spanish and tested with a Mexican colleague. It was applied to 10% of households in three rural communities –Puerta del Barro, La Laja and Aguacate, the two latter having already been visited during the exploratory phase- as well as four urban neighbourhoods of the municipal capital (Oriente, Cerrito, San Pedro and Del Alamo)[19]. These seven units (see map below) had been selected with the help of key informants, in order to cover all different sources of potable water and have an overview of the situation[20].

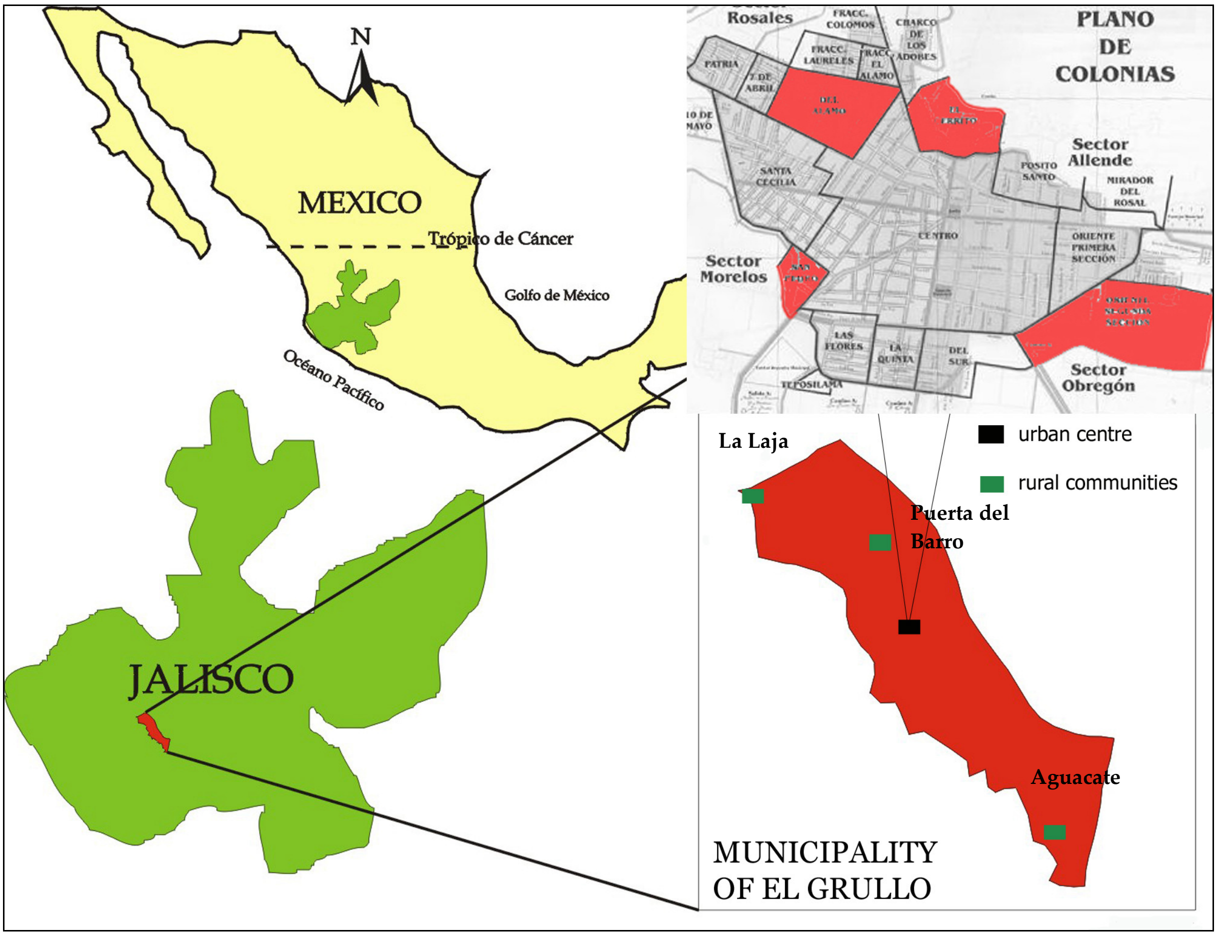
[17] In order to increase such representativity, we decided to do as many interviews as possible, which is why the number does not always correspond to 10 or 10% (see annex 5).

[18] These interviews were immediately transcribed, leading in some cases, to another interview with the same person to clarify or complete the information.

[19] Although 10% is perhaps not enough to qualify the results of "representative" as far as statistical use is concerned, it is still sufficient to describe a certain reality and the issues at stake.

[20] A more detailed explanation of the choice of the seven units is presented in Chapter 4.

Map 15: El Grullo municipality in Jalisco State, with 4 urban and 3 rural areas of study



The methodology of household selection was developed together with senior researchers from IMECBIO (in particular Peter Gerritsen and Luis Manuel Martínez). In order to cover 10% of households, the idea was to select one inhabited house out of ten[21].

In order to select the households in each of the seven areas of study, different mapping sources were used.

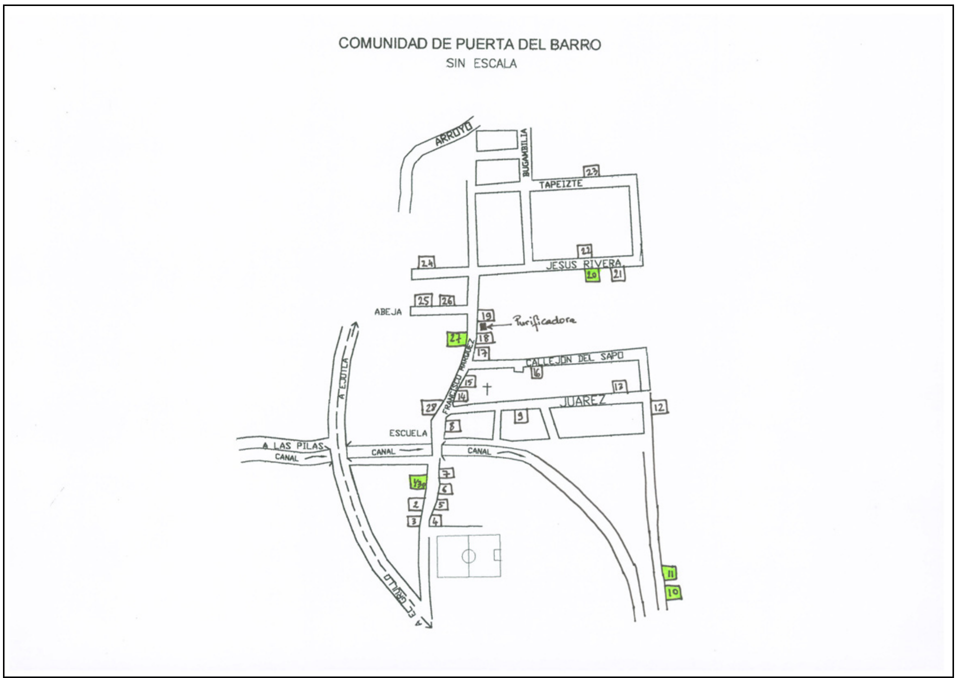
For the rural communities, the Cadastral registering office had no map at all, so in two of the three cases, local actors drew these maps with inhabited houses for me: the municipal representative in Puerta del Barro (even though we came across an official map several weeks later – see map below) and the health centre auxiliary in Aguacate. In La Laja, we drew the map ourselves, as the municipal representative was not very willing to help.

[21] An exercise that was to prove more challenging than we first thought!

Results in the three villages:

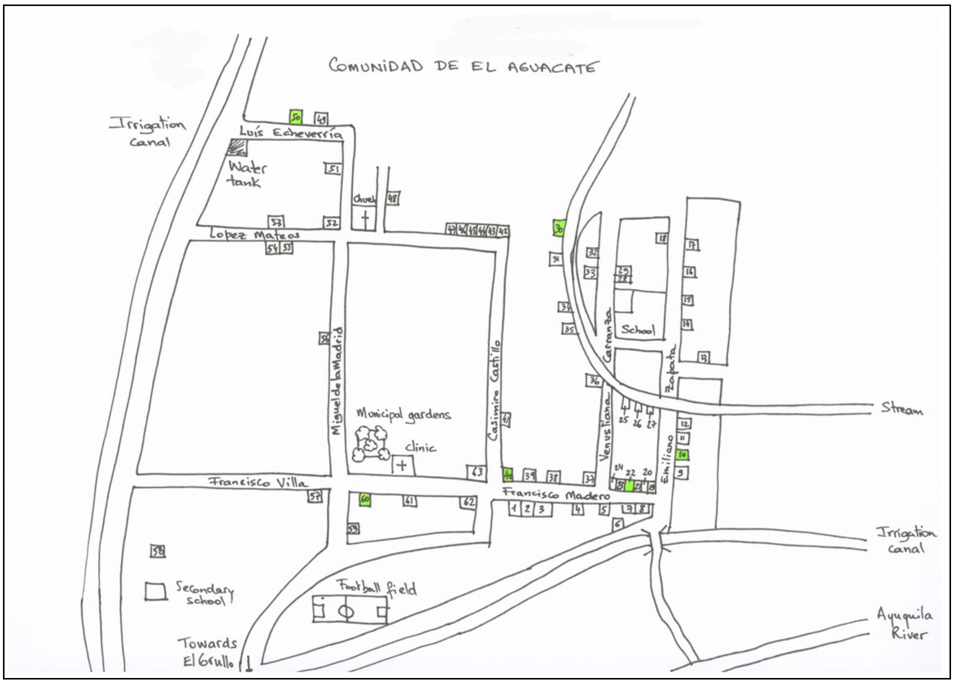
In Puerta del Barro there are 30 inhabited houses, so we did 5 interviews[22] (in green on the map).

Map 16: Interviewed households in the village of Puerta del Barro



In Aguacate, there are 63 inhabited houses, so 6 interviews were held:

Map 17: Interviewed households in the village of Aguacate



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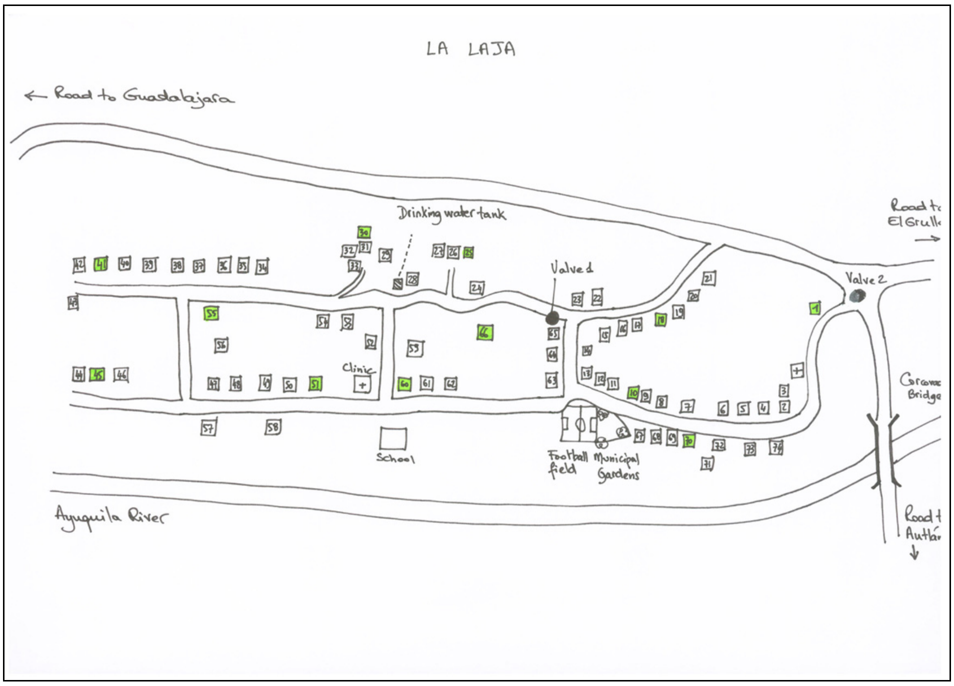
[22] Three interviews only seemed too little, so in this case we have a bit more than 10% of households.

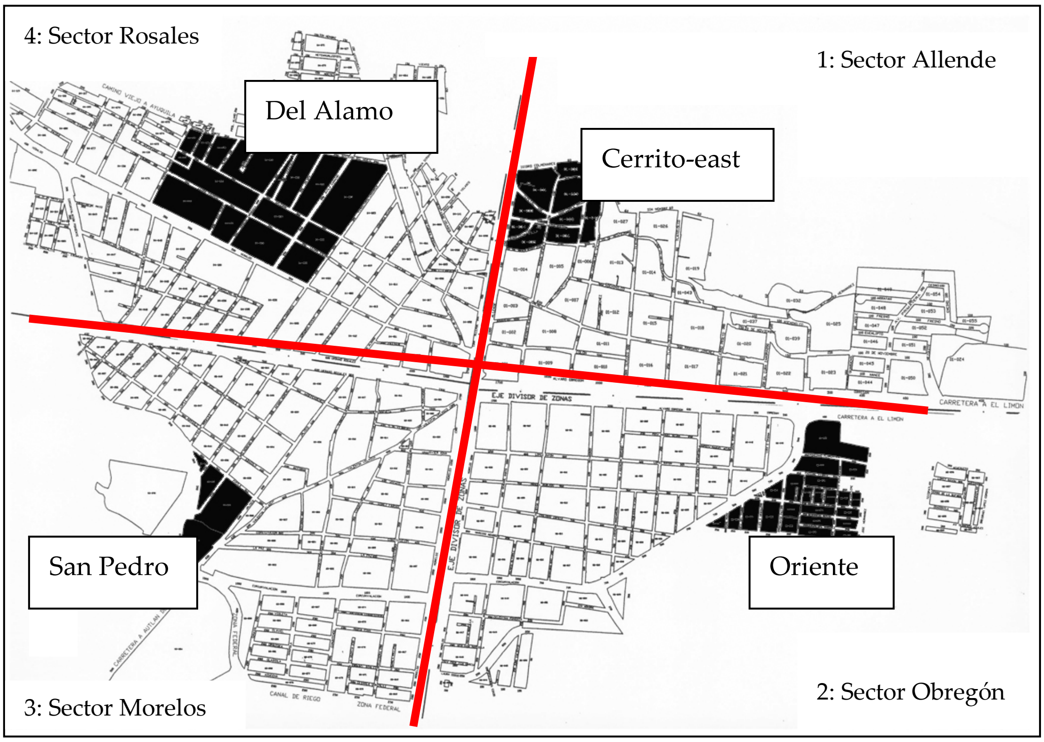
In La Laja, we identified 74 inhabited houses. But according to the municipal representative, there are 30 more, mainly located on the other side of the bridge, so to be sure to get a 10% household coverage, we did 12 interviews in total:

Map 18: Interviewed households in the village of La Laja



For the urban neighbourhoods, the Cadastral office had maps. Once we had selected the four neighbourhoods of interest (one in each of the town's official four zones, and according to their varying water sources), we went with such a map to the Cadastral Office.

Map 19: Four selected urban neighbourhoods for interviews



As there is no traditional neighbourhood classification, we needed to precise which groups of plots interested us in particular, so they could give us the corresponding detailed maps.

When we did obtain the maps with detailed plots, it turned out these were only plots of land and not specifically plots with built and inhabited houses. Up to then, data regarding houses had only been declared on a voluntary basis, and the registering of the actual inhabited houses was supposed to start a few months later by visiting all rural communities, according to the office Head[23].

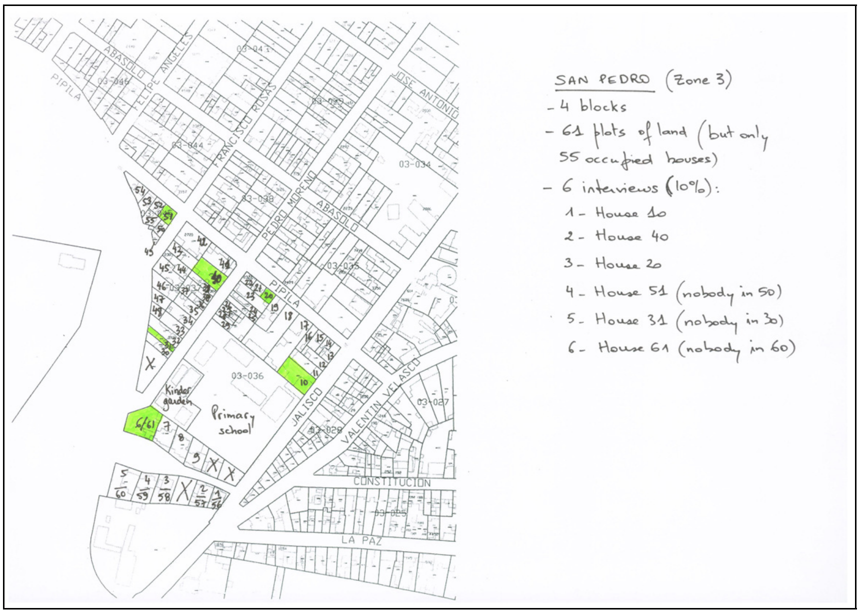
Therefore we worked on the basis of these maps of land plots, and in some cases had to substantially revise the maps to adjust the number of interviews and their localisation according to the actual inhabited houses, as some neighbourhoods are currently undergoing an important process of urbanisation, and still remain only very partially built (especially Oriente, and the western part of Del Alamo).

On the maps below we indicated by a cross the plots of land with no house, and by a number each inhabited house, selecting the interviewees each ten houses[24].

<u>Results in the four urban neighbourhoods:</u>

In the neighbourhood of San Pedro, no important revision of map was necessary: there were 55 built plots (out of 61), so we did 6 interviews:

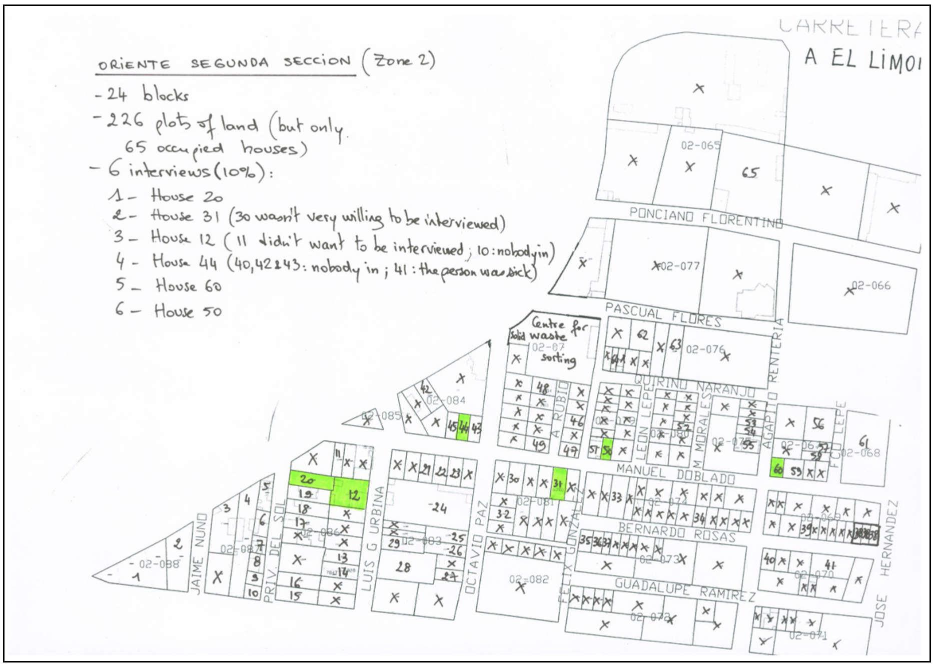
Map 20: Interviewed households in San Pedro neighbourhood



[23] According to another staff member, insufficient human resources would not allow for such an update.
[24] Or the one after, in case no one was in, or the one before, in case the one after was also empty.

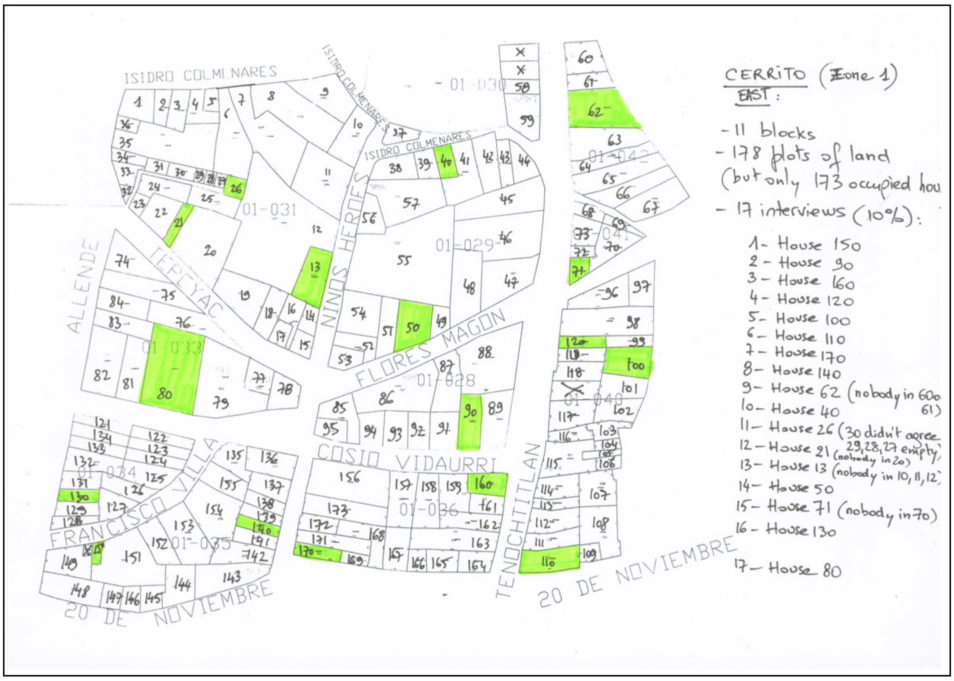
In the urban neighbourhood of Oriente, an important revision of the map was necessary as it is the most recently urbanised neighbourhood: 65 plots are built (out of 226), so we did 6 interviews as well (a bit less than 10%).

Map 21: Interviewed households in Oriente neighbourhood



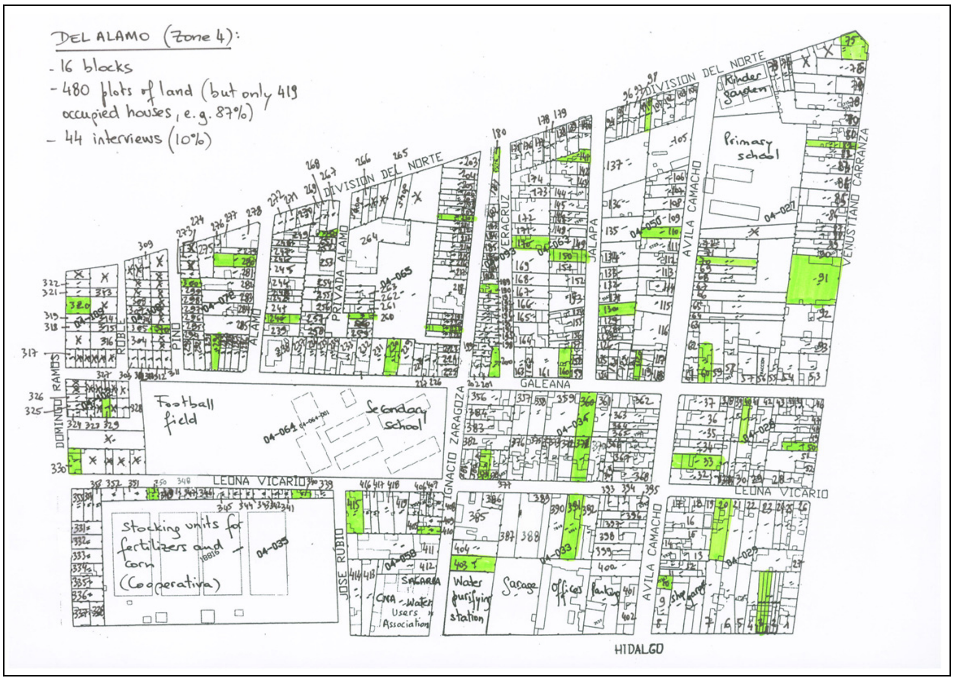
In the neighbourhood of Cerrito-East, almost no revision of the map was necessary: 173 plots are built out of 178, so we did 17 interviews.

Map 22: Interviewed households in Cerrito-East neighbourhood



In the neighbourhood of Del Alamo, the most densely populated of my four urban areas, the map was mostly reliable (419 built plots out of 480, i.e. 87%), except to the western end where many plots are still bare, as the area is currently undergoing urbanisation. We did 44 interviews:

Map 23: Interviewed households in Del Alamo neighbourhood



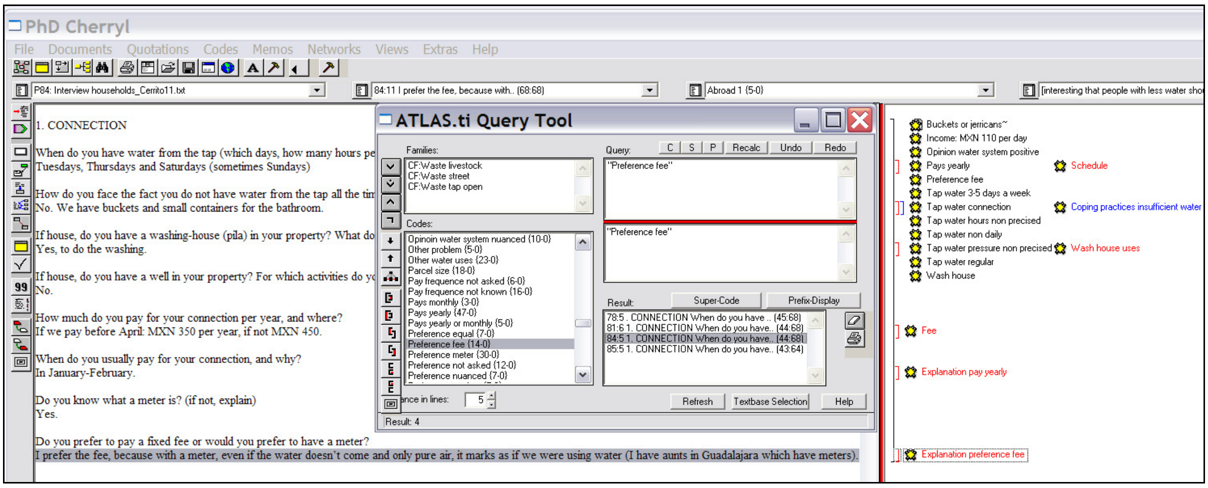
So in total, 23 interviews were held in the rural communities, and 73 in the urban neighbourhoods.

These 96 interviews were analysed with the qualitative analysis software Atlas t.i., which facilitated the work of coding (see list of codes as annex 7) and making queries (results are presented in chapter 4.1).

These queries can either be more quantitative –allowing to count, for example, the number of interviewees connected to the public water service (or not), those with a positive or negative opinion of the service, those preferring to pay a fee or in favour of meters, etc.- or more qualitative, enabling to list all the different answers given to explain such decisions, opinions or preferences.

For example, below is the result of a quantitative-oriented query made inside the family of interviews corresponding to the Cerrito neighbourhood (17 in total), to see how many households are in favour of fees (code "preference fee"): there are 4 such households (interview numbers 78, 81, 84 and 85).

Example of a "quantitative query"



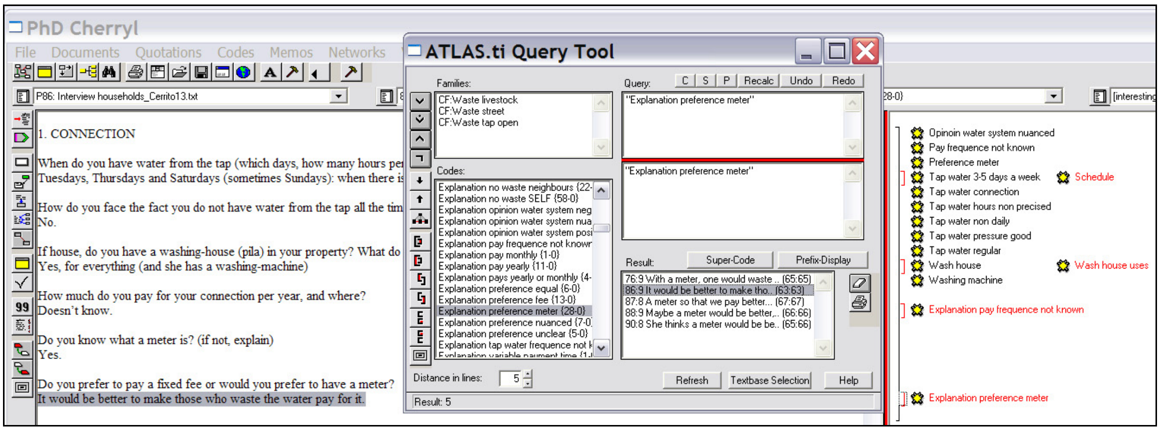
If we select any of the four identified interviewees (here, number 84 for example, which corresponds to the 11th interviewee in Cerrito), the specific corresponding interview appears in the background of the query tool. The questions and answers are on the left hand-side – here we see those for the theme "Connection"- while on the right hand-side of the screen the corresponding codes also appear. Each code is preceded by a small bracket identifying to which part of the text it is attributed, with colour codes varying from black –when a specific chunk of text has several attributed codes- to red or blue for those parts of text which only have one code.

We can then explore a more qualitative dimension by identifying this specific household's explanation for preferring the fee (the sentence in the interview highlighted in grey, corresponding to the code "explanation preference fee").

A more qualitative-oriented query could also list all the sentences corresponding to such a code (or any of the other qualitative answers, such as those explaining why people prefer to pay on a monthly or yearly basis, or why they don't have a connection, why their opinion of the public water service is positive or not, etc). This allows to identify which types of answers come back more frequently, and, as these queries can be realised for each specific area of study, to grasp whether there are any tendencies which vary according to the area, or on the contrary, are recurrent.

In the example above, for instance, the preference for the current payment system based on a fee (compared to a meter) is explained by a lack of trust in meters –as they have a reputation of accounting air in addition to water. This is one of the explanations most commonly put forward. On the other hand, a query focusing on those in favour of meters (such as below) enables to identify that recurrently mentioned is the meters' potential effect on those who waste the water, as well as the fact it would enable to guarantee a fairer payment of the water service: those who use more would pay more, those who do not get much water would pay less, whereas with the fee everyone pays the same according to housing features, and not according to the actual water service, which is very variable as we will see in Chapter 4.1.

Example of a "qualitative query"



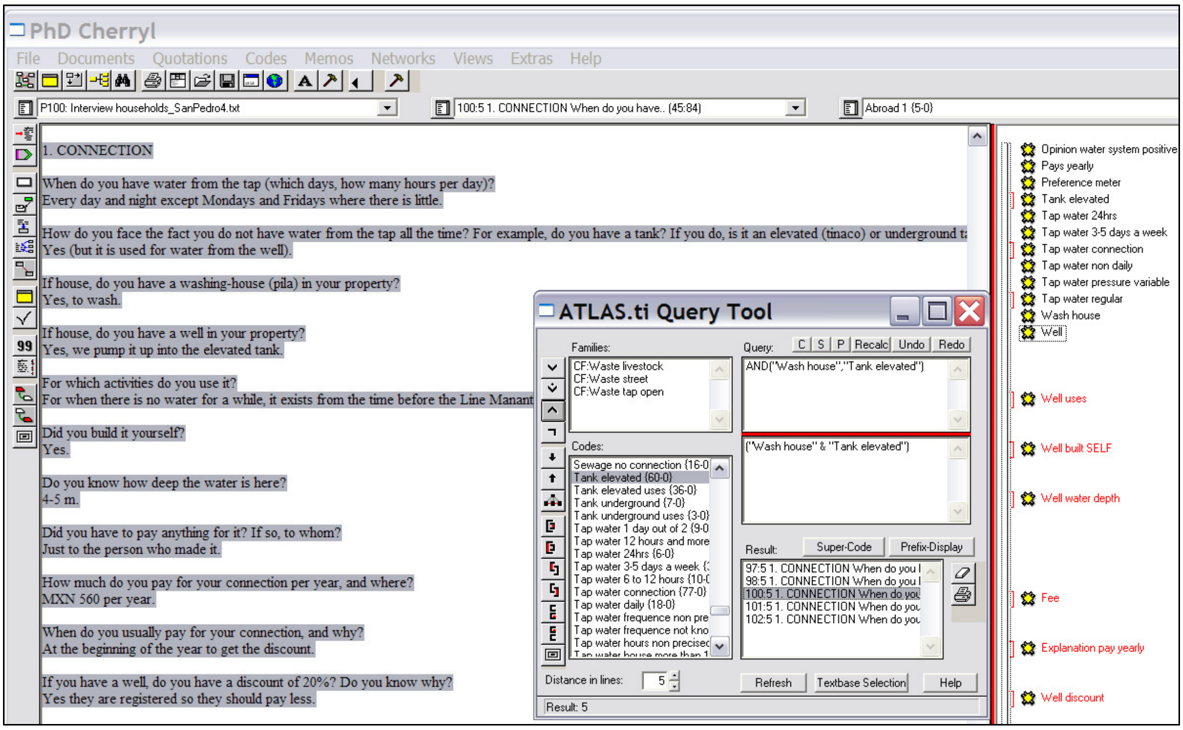
In addition to such rather simple queries, the software also allows to realise more complex ones, like identifying how many households respond a certain way to several criteria (instead of one only) and which kind of answers they formulate when the questions are of a more qualitative nature.

It is for such queries that it proved necessary to code chunks of text with various codes corresponding to the different questions I wanted to combine (i.e. the list of codes in black writing).

To illustrate, below is a query used to see whether any patterns exist in terms of storage practices in the different areas of study[25]. Here, in the neighbourhood of San Pedro, out of the 6 households interviewed, 5 have both a "wash-house" and an "elevated tank". As the query tool does not allow to combine more than two elements, to see whether such households also had either a well or an underground tank, it was then necessary to read through each interview separately and scan the list of codes I had entered, to count myself whether they were also coded "well" or "tank underground". In the example below, the third household (interview number 100 or San Pedro interview number 4) also has a well, but no underground tank.

[25] To simplify, this query is purely quantitative-oriented, but qualitative-oriented complex queries are presented in Chapter 4.1.

Example of a "complex query"



During the second phase of fieldwork, we also had the opportunity to visit the sugarcane factory, the neuralgic economic centre of the region that buys all the sugarcane produced inside the Irrigation District Autlán-El Grullo. Each year, during the 8-month process, 80,000 tons of sugarcane are refined into 99,000 tons of sugar.

Third phase of fieldwork: interviews with key stakeholders about regional water-related initiatives

The last phase of fieldwork took place during April 2006[26]. It was used to interview key informants about the second type of municipal efforts towards an IWRM: that of participating in regional initiatives. We interviewed staff from the Ayuquila Watershed Commission (with semi-structured interviews), as well as representatives from five municipalities participating in both the Commission and the Inter-municipal initiative (with structured interviews –see annex 8). It was also an opportunity to complete missing information from the previous fieldworks with other key informants from the municipality or the partner research centre. In this case, the interviews, like all the others realised with non-household types of interviewees, were not submitted to any specific analysis tool.

[26] Apart from a few specified exceptions, this represents the end of the timeframe for the analysis developed throughout this thesis.

CHAPTER 4 – DATA ANALYSIS AND RESULTS

In this chapter, we present our results, obtained by confronting our conceptual framework (IWRM at municipal level) with our fieldwork in the municipality of El Grullo and the larger Ayuquila watershed area.

As we saw in Chapter 1, municipalities can be involved in IWRM by undertaking two types of actions: those at their own level –ensuring potable water and sanitation supply without affecting local ecosystems- and those at a bigger scale, by participating in regional set ups with broader objectives, to have a stake in decisions that will affect their situation. The chapter organisation follows such a distinction: the first section relates to municipal efforts and constraints at local level, the second to regional-level initiatives and their difficulties.

1. Implementing IWRM principles at local level

In this section, we present the provision of potable water and sanitation in the municipality of El Grullo. Our analysis is based on interviews held with key stakeholders[1] as well as 10% of households in four neighbourhoods of the municipal capital and three villages.

In a first sub-section we present the characteristics of the municipal water and sanitation service: governance issues, sources of water, distribution routes and frequency, coverage and consequent social practices set up, payment of fees, as well as sanitation characteristics and their impacts. In a second sub-section we will present the factors that contribute to explain the current situation, and in a third sub-section, the ongoing efforts to enhance it.

a. Characteristics of the municipal water and sanitation service

In the state of Jalisco, the decentralisation of water, sanitation and wastewater treatment services to the municipal level was realised in 1992[2] (Graf et al., 2006). In the municipality of El Grullo, the public water management system is operated by the Municipal Board of Water

[1] During the three periods of fieldwork (in 2003, 2004 and 2006), two different municipal teams were in place (the change took place in January 2004 for a three-year mandate). To distinguish between the two, hereafter we refer to the "current" or "former water board director" (for example).

[2] In other words, just after the Law on National Waters devolved more responsibilities to municipalities and States.

and Sanitation, decentralised since 1993 from the State water agency SAPAJAL[3]. The Board manages potable water for both the municipal capital and the villages.

Short historical overview

Before any public water system existed, the inhabitants of El Grullo mostly resorted to personal wells[4]. But the water was not of good enough quality to do the washing so instead people went to the Colomo Stream during the rainy season (the Ayuquila River water being in a turmoil and the level too high) and to the River during the dry season –as the stream was then dried up. Drinking water was provided by a source close to the stream (which is still used by street vendors today) (Pedro Rubio, personal communication).

In 1947 the first pipes were installed in the streets and in 1955 the service began, after the first municipal deep well had been drilled. The municipal water board was totally dependent on the State water agency in Guadalajara, from which all the planning was realised.

But very quickly this source of water proved insufficient to supply the growing population, which has maintained a positive growth rate since the 1930s, oscillating around 1%[5] according to the economic conjuncture in the valley and the country (Gerritsen et al., 2005). As Rubio puts it: "The urbanisation of our population has been similar to that of most cities and towns of Mexico: irresponsible and requiring twice as much work [...] Once a few houses are built, the owners start to ask for or demand the basic services: water, electricity, sanitation, paved streets, etc., which creates serious problems for the authorities and the neighbours themselves" (translated from Rubio, 2001: 125).

The system today

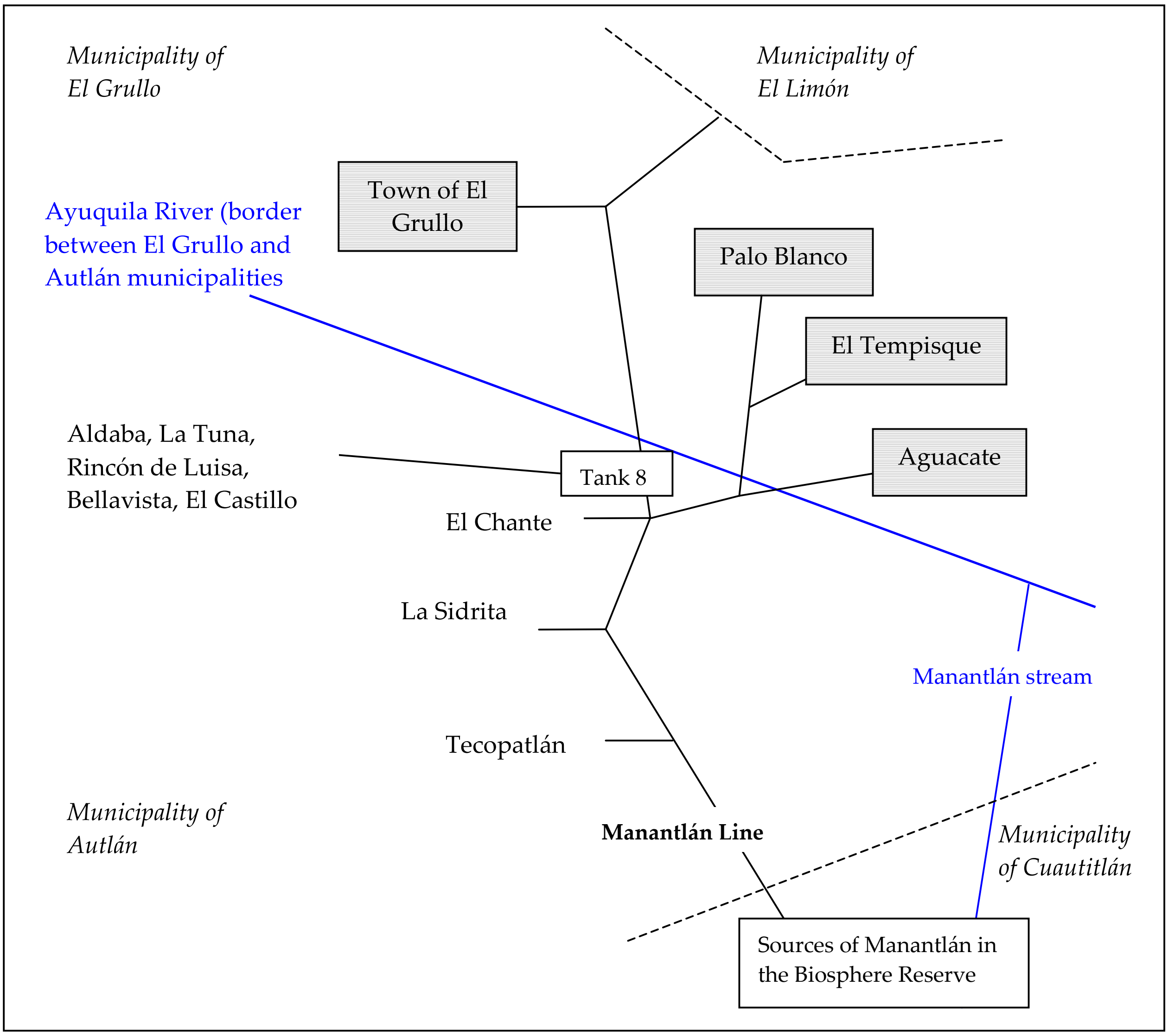
The current system was partially initiated in 1971, when El Grullo's water board established the first inter-municipal collaboration in the region with two contiguous municipalities (Autlán and El Limón), to share potable water coming from the Sierra de Manantlán Biosphere Reserve (Martínez et al., 2005). The 'Manantlán system', as it is called after its source (the Manantlán area, literally "the place which cries water") started operating in 1973.

[3] The objective was to get the water systems to be financially self-sufficient, because the State agency had never recovered the investments it made (Angel Aguirre, researcher at the IMECBIO-UdG, personal communication).
[4] The aquifer under the municipality is only about six meters deep (but at this depth the water is hard, charged in mineral substances; good quality water requires going 40 m deep).
[5] It reached a peak of 4% between 1970 and 1980.

As the water could be distributed all along by gravity, it was a cheaper way to get water than by drilling wells and having to pump it.

The Manantlán system covers 32 km, passing through four municipalities. From the two sources in Cuautitlán[6] where a small dam has been built to supply the main pipe, it goes down into the valley. It is first used by communities in the municipality of Autlán (Tecopatlán, La Sidrita, El Chante), then by those of El Grullo (Palo Blanco, Tempisque and Aguacate), then again by some in Autlán, to finally end up shared between the town of El Grullo and that of El Limón[7].

Figure 13: Schematic representation of the Manantlán system



[6] The Cuautitlán municipality does not use this water, which is why they are not part of the agreement.

[7] Payments for environmental services could potentially be set up between users in the valley and the landowners where the source is located (as is already the case with the city of Colima, on the other side of the Biosphere Reserve), but this first requires resolution of land tenure conflicts in Cuautitlán municipality (Sergio Graf, Director of MABIO Foundation, personal communication).

Image 21: Dam supplying the Manantlán system with pipeline

Source: El Grullo Water and Sanitation Board

For more than 20 years, El Grullo was the only municipality to financially invest in the Manantlán system's maintenance as a whole; as a result, it received more water than the other two (about 50% of the total, when its population represented around 26% of the total population). But it also administered the money that each supplied locality contributed for such maintenance. According to several of El Grullo's water board directors, in view of the increasing sums this represented[8], the other two municipalities "joined in for political reasons": they preferred to directly perceive their own localities' contributions and pay an independent organism for repairs, when necessary (on average, the pipeline breaks down twice a month, costing around MXN 5,000[9] each time in material and human resources, an insignificant sum when shared between the three municipalities compared to Autlán's communities' contribution of MXN 100,000 for instance...).

Consequently, in 1997 the three municipalities signed an agreement to have a yearly-rotating administration and a more equitable water distribution, to prevent conflicts[10]. The resulting public and independent organism called the 'Manantlán Inter-municipal System of Potable Water' (SIAPMA, according to its Spanish acronym) is in charge of operating, administering, conserving and improving the system.

[8] In the municipality of Autlán, the sole contributions of the big village El Chante represented 50% of those of El Grullo town.
[9] Costs are indicated in pesos, the Mexican currency (MXN 1 is equivalent to USD 0.10).
[10] According to the actual PRI-led municipal water board, the agreement was reached because at the time Autlán and El Grullo were both governed by the same party (the PAN).

Today, the Manantlán system –cheap because it works by gravity, but limited in terms of quantity of water[11]- only supplies a small portion of the municipal needs (15-20 l/s for the city according to the season, and 4 l/s for the rural communities of Palo Blanco, Tempisque and Aguacate).

The rest is provided for by groundwater (five wells supply 118 l/s for the city and 21 l/s for the villages):

Table 2: Quantity of potable water used in El Grullo municipality

Sources of water	Town of EG	Villages			Total quantity of water concessioned
		La Laja, Cacalote and Ayuquila	Puerta del Barro and Las Pilas	Palo Blanco, Tempisque and Aguacate	
Wells	118 l/s: wells #1,2, 6 (38, 20,60 l/s)	15l/s: well #5	6 l/s: well #3	-	139 l/s
Manantlán system	15-20 l/s	-	-	4 l/s	19-24 l/s
Both	133-138 l/s	15 l/s	6 l/s	4 l/s	158-163 l/s

Indeed several deep artesian wells were drilled in the same area[12] (see map on the next page): the first in 1978 when the Manantlán system broke down for a few weeks, then more in the early 1990s when the population growth required an increased water supply.

This is because the option of building wells resulted cheaper[13] than replacing the Manantlán system's pipelines (a project abandoned when the State of Jalisco retracted its financial support to face urgent reconstruction needs in Guadalajara instead, following the blowing up of sanitation pipes along 7 km).

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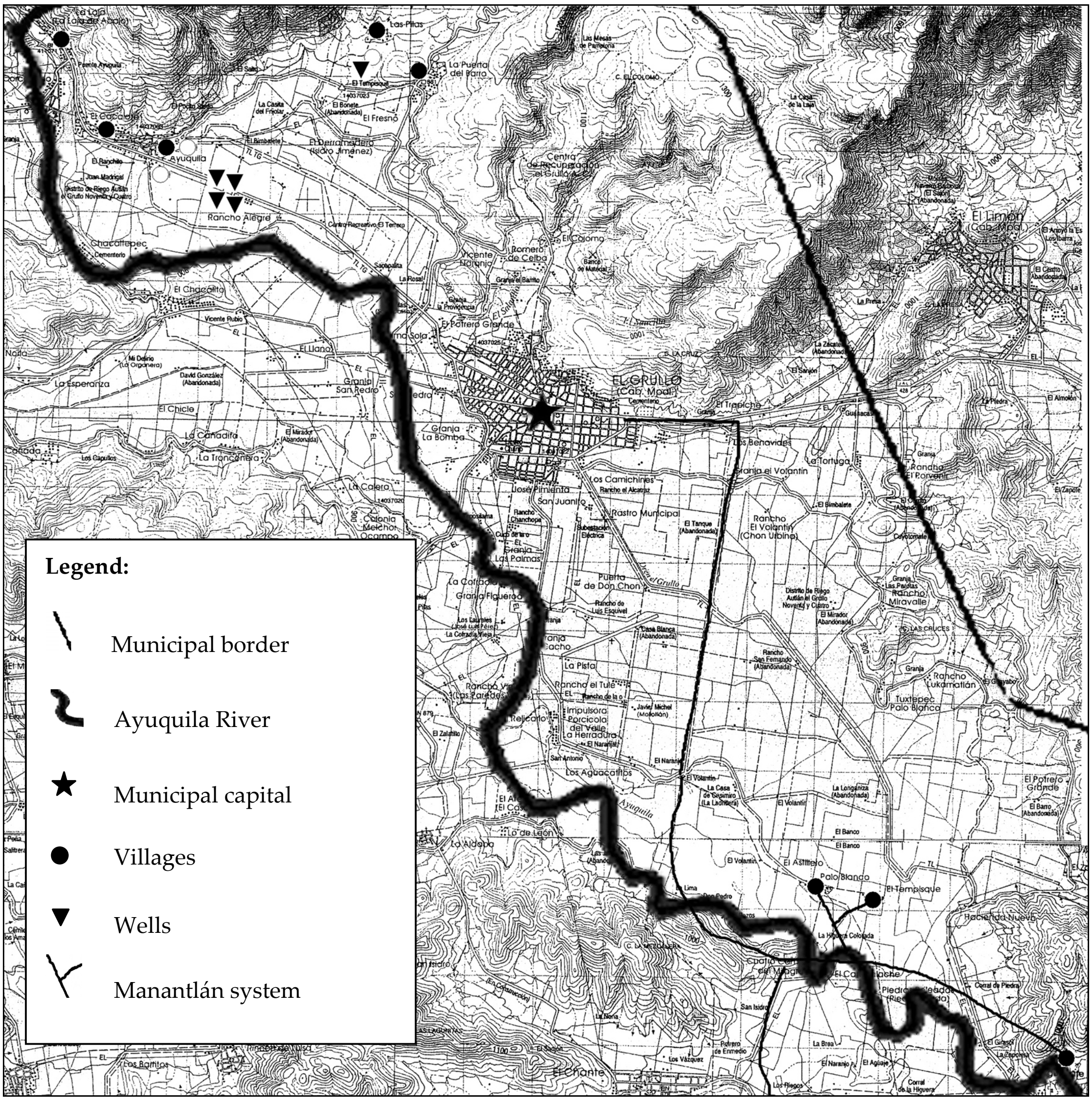
[11] No more concessions from the Manantlán stream will be authorised by the Jalisco State Ecological Commission, in order to preserve its flow (the stream plays a major role in purifying the River when it joins it, downstream from the major wastewater discharges).

[12] An underground stream called la Manga.

[13] Although its aquifer level has recently dropped by 1 m (Del Castillo, 2003), El Grullo benefits from a privileged situation compared to the municipality of Autlán, whose aquifer is 70 m deep, and becoming deeper. This is because 4000 ha of its agricultural lands are still irrigated with groundwater, while awaiting the (ongoing) extension of the irrigation canals.

Map 24: Municipality of El Grullo with potable water sources



Source: Modified from INEGI, 2000

Municipal water distribution routes

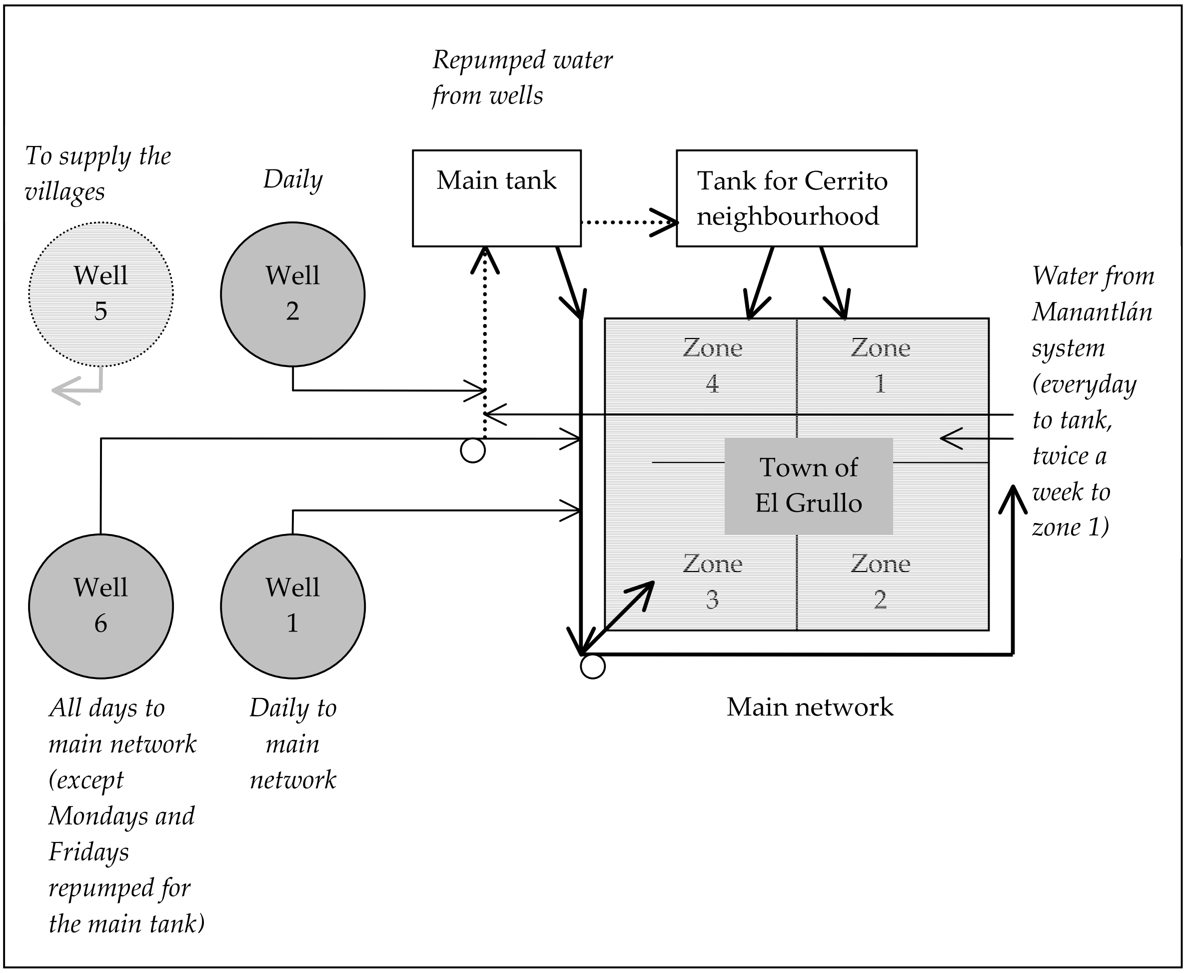
Hereafter, following this classification of groundwater/surface water source, we detail the distribution in each of the seven localities of study[14].

As far as groundwater is concerned, the municipal capital is supplied by wells #1, 2 and 6 [15].

[14] These are schematically represented as no map was available as such (the data for the town was being updated, and none existed for the villages).

[15] Two other wells are not used for different reasons: well #4 is out of service as the water quality was not satisfactory; well #7, which was built under the mandate of the PAN in 1995-1997, to increase the supply and offer a better service, has not been used since by the PRI teams which followed, for political reasons (Angel Aguirre, personal communication).

Figure 14: Schematic representation of the municipal water distribution in the town of El Grullo



The main network, which exists since 1997, is supplied directly by the two most important wells: well 1 (38 l/s) everyday and well 6 (60 l/s) everyday except Mondays and Fridays. The distribution then follows a main line that borders the town to the south. A stopcock enables to either supply the neighbourhoods in zone 3 and zone 4 (apart from Cerrito), or those of zone 2, further down the network. Because the distribution is realised by gravity, the water first goes down the distribution pipes to the lower parts of each neighbourhood. It is only when the population there starts using it less that the pipes can fill up backwards again and deliver to the lateral tubes towards the houses situated in the streets higher up[16].

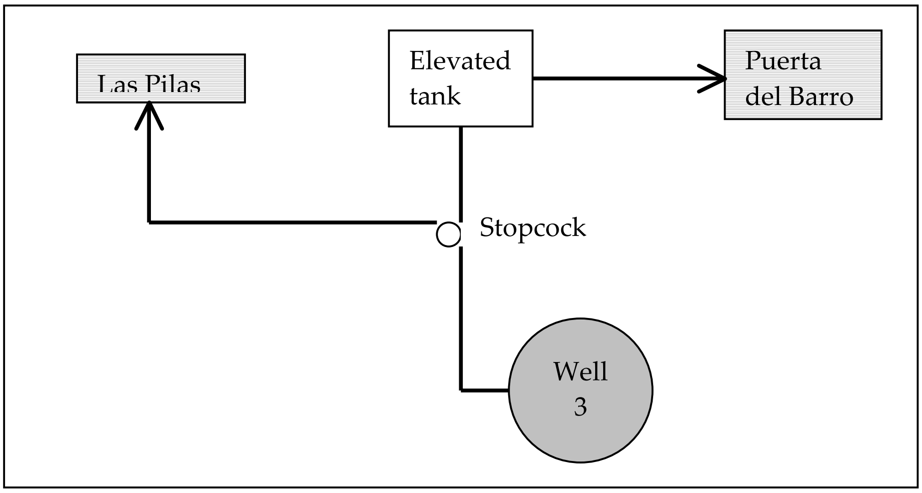
Another tank is located at the top of the hill, to distribute water to the Cerrito neighbourhood: it is supplied by water pumped from well 2 (20 l/s) everyday and from well 6 on Mondays and Fridays.

[16] In order to operate differently, costly valves would need to be installed (Angel Aguirre, personal communication).

As for the five villages in the western part of the municipality, they are supplied by two distinct wells.

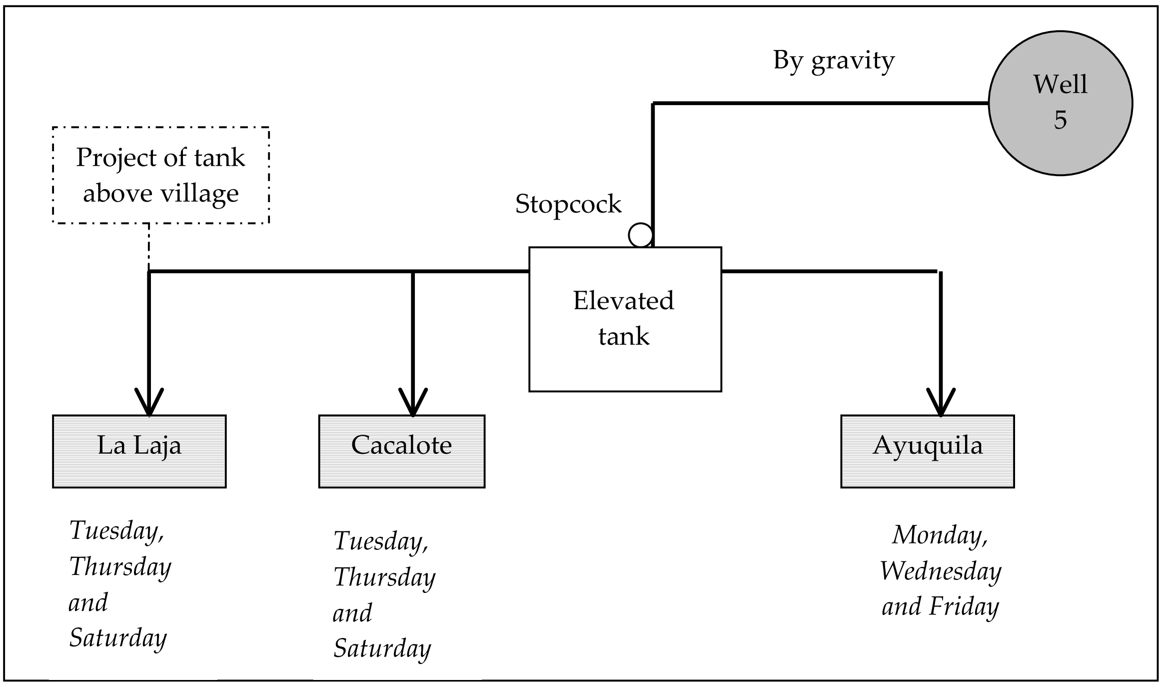
Well #3 supplies Las Pilas and Puerta del Barro: 6 l/s of water are pumped daily, 6 hours per day (3 in the morning, 3 in the afternoon):

Figure 15: Schematic representation of water distribution in Puerta del Barro



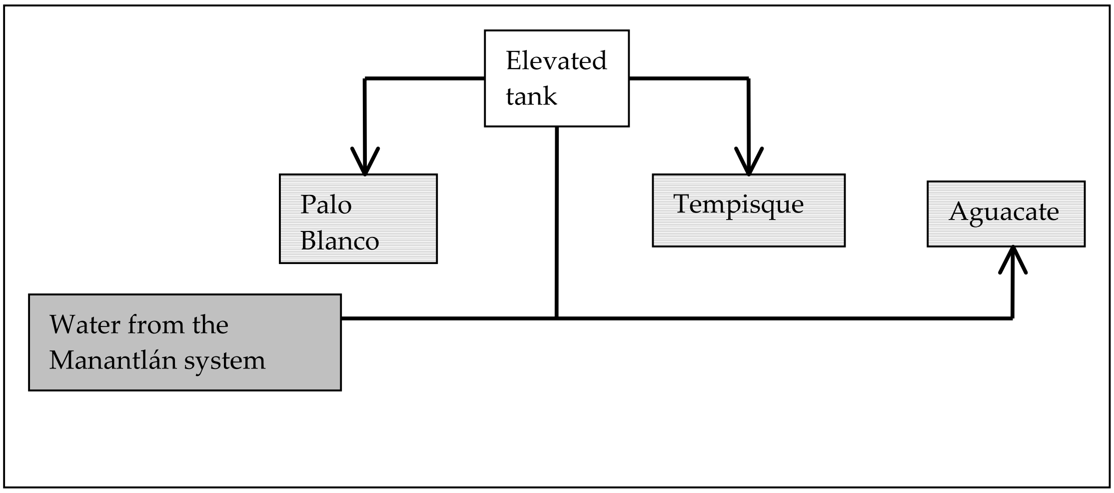
Well #5 provides water (15 l/s) to Ayuquila, Cacalote and La Laja, with an alternated schedule:

Figure 16: Schematic representation of water distribution in La Laja



As far as surface water is concerned, the three remaining villages are supplied every other day between 6-24 hours (regarding the urban distribution, refer to figure 14).

Figure 17: Schematic representation of water distribution in Aguacate



But the quantity of distributed water has varied along with the governance of the Manantlán system.

Before the 1997 agreement, El Grullo received 53% of the total 64 l/s supplied by the system (as it was the municipality who had realised most of it, although each municipality has his own version of this).

With a more important budget and increased contacts between the three municipalities, the tri-partite administration was meant to enable a more harmonious management and better resulting service of the Manantlán system[17]. The allocation was to depend on the quantity of money contributed by each municipality for the maintenance of the system, and on the number of supplied inhabitants. The data regarding the actual litres supplied to each locality is very variable, but according to the official SIAPMA document, the system supplies an average flow of 64 l/s, distributed as follows: about 14.5 l/s to the municipality of Autlán, 35.5 l/s to that of El Grullo, and 14 l/s to El Limón (respectively: 22.5%, 56% and 21.5% of the total).s According to several of El Grullo's water board directors, the reality is closer to 50%, 30% and 20% because in practice, the amount of water agreed upon is rarely respected, as allocation procedures (materialised through concessions) favour Autlán, resulting in downstream water shortages for the next two municipalities (Tanaka, 2002).

[17] Among other things, it was to establish studies to update the actual consumption patterns in the various localities supplies by the Manantlán system, for a more equitable distribution (in particular by reinforcing the control of illegal connections or uses such as giving potable water to livestock).

For example, according to the former Director of Municipal Public Services in El Limón in charge of the Manantlán Line from 2004-2005, the locality of Aguacate does not receive much water during the dry season partially due to an important number of unofficial connections between El Chante and El Aguacate (about 20), used to give water to livestock or irrigate orchards[18]. These were usually realised by well-informed persons, as they had to know when the service was cut to be able to add their connection (the service is regularly interrupted for maintenance reasons, in particular in a section with pipes older than 33 years tend to break down with the pressure).

Further, El Chante's tank tends to overflow when it is full, when those downstream could well do with more water. There have been attempts to install valves but these are systematically destroyed. To solve this, the municipalities of El Grullo and El Limón need to complain and pressurise that of Autlán, which does not control its inhabitants for electoral reasons.

In El Limón, at the far end of the system, the situation is even worse. According to interviews held there with households, the 'Manantlán water' is supplied on Sundays only, the rest of the week being supplied by water from the municipal well, which is of very poor quality. So to wash clothes, some women go to the irrigation canal (El Limón also being part of the irrigation district 94).

To summarize, according to the former municipal president of El Grullo, Armando Nuñez Ramos, this represents a lurking conflict between the municipalities involved, ready to explode as soon as someone uncovers it[19]. For him, the problem resides in the fact the line was developed in an informal way: more and more communities joined in, tanks were built, leading to less and less water available. He also explains this by the tradition in Mexico of not interfering in other municipalities' affairs, so this enables to preserve the status quo.

According to El Grullo's water board director, the financial contribution of each municipality to the SIAPMA was the following: between 1996 and 2004, each municipality paid a various sum (Autlán: MXN 7,000; El Grullo: MXN 6,000; El Limón: MXN 5,000). Then each contributed equally (MXN 6,000). Starting 2007, a new agreement will allow each municipality to pay according to the quantity of water received, which should enable to settle the conflicts.

For the time being, El Grullo has sufficient water to supply its growing population for another 20 years, according to various municipal representatives. Indeed, today, if we take

[18] The quantity of water also varies, with much less available towards the end of the dry season.
[19] This was clearly illustrated by the difficulty to obtain any coinciding data between the various municipalities!

the official data according to which 40% of the water is lost in leaks[20], this leaves enough water to adequately supply[21] the whole municipality's population: between 354 l/day/capita in town, to 376 l/day/capita throughout the whole municipality[22].

So even if the municipality population were to rise to 100,000 in two decades' time (a very high estimate considering the 1.1% population increase between 1990 and 2000), with the same concessions (and no more leaks) it would still be possible to provide 140 l/day/capita (the minimum quantity recommended for all household uses by the World Health Organisation is 70 l/day/person).

Table 3: Prospective calculations of water availability in municipality of El Grullo

	Municipal capital (population: 20,250)	Whole municipality (population: 22,500)	Hypothetical municipal population of 100,000 in 20 yrs
Concessioned water (litres per second) (maximum quantity)	138 l/s	163 l/s	163 l/s
Concessioned water (litres per day)	11,923,200 l/day	14,083,200 l/day	14,083,200 l/day
Concessioned water per day per capita	589 l/day/capita	626 l/day/capita	140l/day/capita
Supplied water after 40% lost in leaks	354 l/day/capita	376 l/day/capita	Without leaks

Nevertheless this points out that for the future, if the population increase continues, it will be necessary to find new sources. Several options have already been studied, including one cheaper than the drilling of new wells and undertaken jointly with Autlán (much more in a hurry to find new sources as its underground water costs more and more to extract).

But the plan to obtain concessions from the Trigomil dam above the valley –conditioned by the CNA to the building of a potabilisation plant- was rejected, because of the lack of financial support from federal and state levels (Armando Nuñez Ramos, former municipal president, personal communication).

[20] This is the average in Mexico but the maximum that was mentioned by former municipal authorities, as they tend to put forward a figure of 10% instead, which would mean even more available water per day per capita.

[21] Municipal officials estimate that 250 l/day/capita are adequate to satisfy household needs, although in reality much more is used, especially during the three –very warm- last months of the dry season (Tanaka, 2002).

[22] This data does not coincide with other sources, according to which the annual consumption was 64 cubic meters per capita in 2000, amounting to a much lower average of 175 l/day/capita (Tanaka, 2002).

So the objective of the current municipal president is to have independent wells during his mandate (currently wells 5 and 6 belong to a private landowner who rents them to the municipality)[23]. This would enable to extract more water at a cheaper price.

Drinking water

It is important to mention that there is no potabilisation plant, which would be too costly (approximately MXN 20 million) for such a small municipality. So the municipal water is chlorinated in the wells, under the supervision of the State Water and Sanitation Commission and the Ministry of Health, to limit risks of microbial infections and gastro-intestinal sicknesses and to kill the cholera bacteria[24].

According to the director of the water board, no other treatment is required as the quality is good and very low in salts, and the water is drinkable as the pipes (made of PVC) are not subject to infiltration risks. So in his opinion, people just don't drink it because they are not used to its taste. In the villages supplied by the Manantlán system, on the other hand, people seem to prefer drinking the tap water, sometimes for economic reasons but mostly due to personal preferences ("it tastes better"), suggesting this water might be of better quality then that from the wells.

The majority of the population indeed resorts to the very dynamic bottled water industry in El Grullo: six local companies are implanted in the vicinity of the town, taking advantage of its shallow and relatively good quality aquifer (Tecomates del Valle, La Amistad, El Colomo, Grullense, Rancho Alegre, Santa Tere as well as Santorini which is just starting)[25]. They all supply themselves at the same source, La Noria, to the north of the town, and purify the water using the much more expensive process of inversed osmosis.

For a household of five[26], the average consumption revolves around 2-4 containers of 20 l per week during the 'cold season' to a maximum of one per day during the 'warm season' (with costs ranging between MXN 9-16 per container according to the brand and the locality, and a few pesos cheaper in case one goes fetch it directly at the bottled water station).

[23] If they manage to find a place where another well could give them 60 l/s, this should be sufficient (Manuel Martes Calbán, director of water board, personal communication).

[24] There have been a few isolated cases, which is why monitoring is now realised on a daily basis in El Grullo. But in smaller municipalities, the frequency is reduced (Tanaka, 2002). In any case, this technique –the most common worldwide to disinfect potable water- practically does not exist anymore in richer countries, to avoid the risk of long-term chemically-induced affections due to the chlorination. New technologies are underway to suppress both microbial and chemical risks (such as pre-treating the water before its chlorination), with experiences based on solar treatment developed as alternatives to expensive technology (Pulgarin and Rincón, 2000).

[25] But not all distributors pass by in the villages.

[26] The most common situation in our interviews, along with those of two (even though the actual number of family members can rise up to 18, but many have emigrated).

Images 22 and 23: Options to buy drinking water (home delivery or directly at the shop)

Puerta del Barro constitutes an exception, as it benefits from an original community organisation: all households contributed financially to build a well and a purifying station. As a result, they now buy this water half to three times less than the bottled waters' commercial price (MXN 4 for the usual 20 l).

Sanitation

In terms of sanitation, La Laja is the only village of the municipality that does not have a public sewage system (each house thus has a latrine). This is partially because of its topography –as it is a rocky area, it would be too costly to dig pipes for the sewage- but also because it would not be possible to discharge its wastewaters into the Ayuquila River[27].

On the other hand, all other villages' as well as the capital town's wastewaters are discharged lower down into the River, as no treatment plant exists for the time being (the issue is discussed in more detail in the last sub-section of this chapter).

The town's sewage runs along a 10 km long open-air canal that follows the road leading to several villages; it then joins a secondary irrigation canal before reaching the Ayuquila River (Henne et al., 2002). In addition to the foul smells this creates for all villagers commuting to town, the discharge, which takes place immediately upstream from the village of Aguacate, disrupts the livelihoods and activities of this riparian community (Martínez et al., 2005).

According to the monitoring of the River quality realised in various sites by the University of Guadalajara, Aguacate is indeed the place with the most contamination, as it is situated both

[27] The village is located directly upstream from another village in the municipality of Autlán, very popular for swimming and which also hosts aquaculture activities.

downstream from the two town's wastewater discharges, as well as upstream from the Manantlán Stream (which has a purifying action).

Image 24: River Ayuquila flowing near La Laja

Image 25: Corcovado irrigation station

Image 26: Reforestation of River banks near bridge

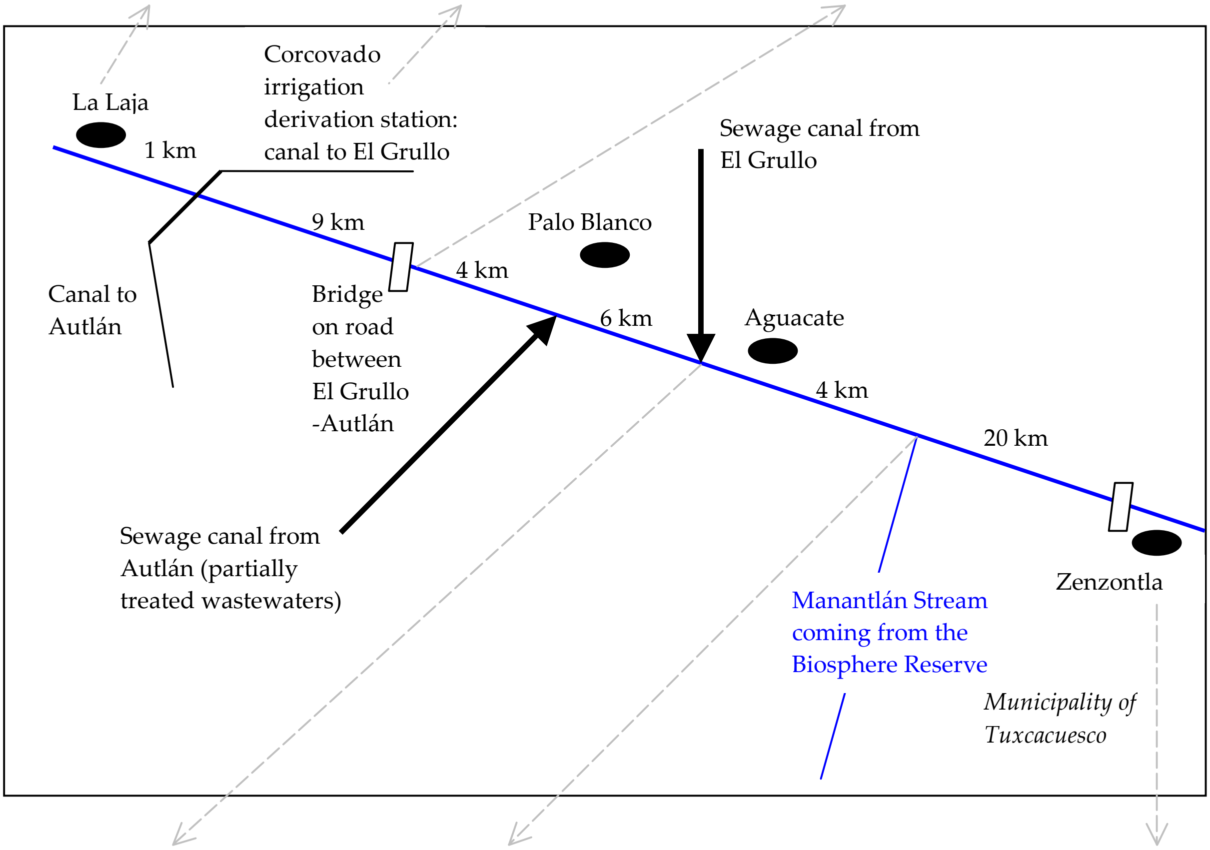


Image 27: El Grullo sewage discharge in the River

Source: Angel Aguirre, IMECBIO

Image 28: Manantlán stream joining the River

Source: Angel Aguirre, IMECBIO

Image 29: Fishermen in Zenzontla

This purely intra-municipal dimension of the Ayuquila River contamination by El Grullo's wastewaters was confirmed by the results of my exploratory interviews, showing both an important contamination at the level of Aguacate –which prevents many economic or recreational activities but does not have health impacts- and the disappearance of this problem in the villages of the Tuxcacuesco municipality, downstream from the junction between the River and the Manantlán stream.

So focusing more in-depth on the three riparian villages inside the municipality of El Grullo –La Laja, Palo Blanco and Aguacate- I realised another series of interviews there[28].

These showed that the further downstream the village, the more the River is characterised as contaminated. This is quite logic due to the location of each village, La Laja being upstream from the factory and the wastewater discharges, to the contrary of Palo Blanco and Aguacate. The common indicators used in the two villages downstream were the colour (black or white) and the bad smell of the River.

Despite the elderly in each village highlighting that the Ayuquila was much cleaner when they were small –some used to not only bathe in it, but also drink it, and most used to eat fish and shrimps that then disappeared- it was also was pointed out that this contamination had decreased in the past years (here again, in a much more accentuated way the more downstream the village). Indicators of this seem to be less strong smells and the fact there are now fish again in the River close-by to these villages.

This can be linked to the various sources of contamination invoked in each case, and which have been treated distinctively in the past years. For La Laja, the main source of contamination was the garbage dump and wastewaters of the village directly upstream, Unión de Tula, which has been at least partially with the closing of the dump. In both Palo Blanco and Aguacate, the main source of contamination was clearly the sugarcane factory, so the progresses it has made in the past few years are of course felt much more strongly in these two villages (although some interviewees also specified that it still discharges its wastewaters illegally, at the end of the sugar season or during the night). In Aguacate, the two towns' sewages were also mentioned, with El Grullo's unchanged situation.

Finally, although specific tools[29] could have been used to estimate the costs entailed by such contamination, it was decided not to undertake this, as it did not prove sufficiently relevant:

[28] Although the results cannot be taken as statistically representative, they are still indicative of certain tendencies in terms of opinions or actions, as in each case, at least three quarters of the interviewees have been living in the same village for more than 20 years (on average 30 years in La Laja, 41 years in Palo Blanco and 28.5 years in Aguacate), some for up to 60-70 years.

- There are very little health problems linked to the River, essentially due to avoidance of contact (except in La Laja, for washing, or swimming, where skin itches were mentioned).
- Economically speaking, there are very little fishermen and only some livestock-rearers seem to have modified their practices with regards to giving water to their cows (but they give them tap water or water from the wells instead, not entailing major costs either).
- Those who suffer from reduced opportunities for recreational activities do so essentially from a lack of trust in the water quality. Alternative practices (like fishing or swimming further downstream, or going to the swimming-pools in town) do not seem very common.

Water and sanitation service fees

In accordance with the Jalisco Water Law of 2000, each municipality disposes of tariff autonomy, inside the margins set by the State Congress in the Law of Municipal Income to establish a ceiling for yearly price increases (comprised between 10 to 15%) (Tanaka, 2002). Indeed in order for the water board's income to cover the expenses, the fees are adjusted according to socio-economic and infrastructure conditions: in particular the 3-4% yearly inflation in salaries and combustible prices –electric energy represents 40% of water boards' expenses on average (see annex 9). For example, between 2004/2005, the fee increase was of 7.86% (see annex 10), while between 2005/2006 it was of 4% (corresponding to an increase of MXN 4).

But this also varies according to the type of water source (as some municipalities are supplied only by surface water and thus have no extraction costs), as well as the depth of wells when these exist (80 m maximum in El Grullo but reaching 300 m in other municipalities).

Yearly inflation aside, the municipalities send proposals regarding the fees, but the Congressmen define them. In the State of Jalisco, water fees do not depend on meters (reflecting the exact consumption) but rather on the size of the property (with number of bedrooms as indicators of number of persons in the household and therefore of water consumption volume).[30]

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[29] The field of environmental economics offers various tools to estimate costs that cannot always be directly estimated owing to the absence of a market price (typically the case of negative externalities like in the case of a River contamination) (Barde, 1991).

[30] In comparison, in the neighbour state of Colima, pricing depends on the type of residential neighbourhood (high, medium or low-income, urban or rural), taking more specifically into account the users' economic situation (Tanaka, 2002).

This is the case in the urban centre of El Grullo municipality, while in the villages a unique fee prevails for all, which is 10-15% lower than the lowest urban fee –to reflect the average lower income as most employment opportunities are in agriculture (see annexes 11 and 12). In all cases, a small percentage of the fixed fee is added for infrastructure maintenance and 20% for the sanitation service.

There are several types of discounts: those to motivate the users to pay yearly before a certain date (15% before the 1st of March, 5% before the 1st of May); and those for certain categories of users (50% for persons above 60 years old or retired, provided they pay on a yearly basis; 20% for those with a well to compensate for their pumping costs and encourage them to take the pressure off the public network[31]; 97% for those with a well but no connection, for the sanitation service).

To illustrate, the fee varies from MXN 38/month in the villages to a minimum of MXN 43 in town when paid on a yearly basis, or a minimum of MXN 52.63 if paid per month (the minimum corresponding to a house with one bathroom and at most two bedrooms).

In the municipal capital as well as some communities (like Puerta del Barro), households pay directly at the water board office in town, whereas some villages (like La Laja and Aguacate) have a person in charge of collecting the fees and paying the water board.

According to our interviews in the urban neighbourhoods and villages, households with a connection to the public water service tend to pay yearly: 61 % across the seven localities, varying from a minimum of 50% in San Pedro, Oriente and Cerrito, to a majority in Del Alamo (many who do not know are renting or someone else from the household is in charge of paying the bill), Puerta del Barro and Aguacate[32]. These mention they are motivated by the discount, some also add it is more practical: "That way we don't have to think about the issue afterwards" (household in Del Alamo). Most of the others tend to pay according to their means, rather than monthly on a regular basis. As one household in La Laja stated: "It depends on the money available: if we can, we pay the whole year, if not, month per month".

[31] It is assumed that if they have a well, they do not use water from the public network as well (but from another source, for which they have to pay for as well). But the reduction does not seem to be always applied, as many of those interviewed with both a connection and a well complained to have to pay the same fee as those that do not have wells. According to one of the former water board directors, the municipality should not have this reduction at all, and on the contrary it should prevent the use of such wells, as the owners generally do not respect the Water Law, according to which they must have a permit delivered from the CNA authorizing them to extract water from the ground (Angel Aguirre, personal communication).

[32] In La Laja this question was not asked to almost half of the households with a connection, so the results are not presented here. This is because I used the questionnaire « without connection » (that did not include this question), when I should have used the questionnaire "with connection", even though in these cases the connection is located outside in the street and not inside the house itself.

This tendency is reflected in the water boards' particularly important incomes during the two first months of the year.

The public water service quality

Hereafter we often focus the analysis on our seven areas of study –villages or urban neighbourhoods, referred to as « localities ». We seize the opportunity to remind that these were selected in order to cover the variety of water sources: La Laja (well 5), Puerta del Barro (well 3), Aguacate (the Manantlán system); and in town: Cerrito (a specific tank). The other three neighbourhoods, supplied by the same wells, either encounter specific problems (Del Alamo, Oriente), or not many (San Pedro being taken as a reference neighbourhood with a good water service).

The results, which are more or less representative as based on 10% of households only in each case, nonetheless give a first impression of the local reality.

On average, 80% of interviewed households have been living in the same locality for more than 20 years, 65% in the same house for more than 10 years. Nonetheless, these figures do not reflect the specificities linked to certain localities, the two extremes being Del Alamo, the oldest of the urban neighbourhoods, where more or less 40% have been living in the same house from 20-40 years, while in the most recently urbanised neighbourhood –Oriente- more than 50% have been in the same house less than 5 years.

However, as most interviewees are situated in between these two extremes (in all localities at least 40% have lived in the same house from 10 to 40 years), stable/feebly mobile habitat practices seem to be more common than not. In itself, this guarantees the households' rather good knowledge of their water connections' characteristics, as well as a certain historical perspective of its evolution.

This is reinforced by the fact a majority of interviewees own the house they live in: 100% in the two villages of La Laja and Aguacate, 80% in the third village (Puerta del Barro) as well as the urban neighbourhoods Del Alamo and Cerrito, although this figure drops down to 50%-70% only in the other two urban neighbourhoods (Oriente and San Pedro). The ownership of the house is also importance for specific information related to payment of water bills (always the responsibility of the landlord).

Also important to mention is that the majority of the interviewees are women[33], as I did my interviews during the daytime, and women tend to stay home more with the children or because they do not automatically work. This also guarantees a good knowledge of the situation, as they tend to be the ones doing most of the household chores requiring water.

According to the municipal authorities in charge of water and sanitation, 90% of the households in the municipality have an in-house connection to the public water network (corresponding to 6,217 connections in 2004, including 760 in all the villages).[34] According to our interviews the rate is a bit lower, with 80% connected on average[35].

Table 4: Degree of connection to the public water service

	La Laja	Puerta del Barro	Aguacate	San Pedro	Del Alamo	Cerrito	Oriente	Total	%
Number of interviewed households	12	5	6	6	44	17	6	96	100 %
With connection	9	5	6	6	29	16	6	77	**80%**
Without connection	3	-	-	-	15	1	-	19	20%

The rate often reaches 100%[36], except in Cerrito (95%), La Laja (75%) and Del Alamo (66%).

Among those without a connection, a distinction is to be made between the unique case in Cerrito (where the house was undergoing construction) and the two other localities, where the reason is of a more structural nature. In La Laja, either households receiving no water at all asked to have the service shut down, either it was shut down by the municipal authorities because the user was not paying his bills.

In Del Alamo, which concentrates the majority of households who do not have a connection, two schemes prevail. Out of these 15 such households[37], six purportedly did not ask for a connection: four already had a well and two knew of the weak service quality so they preferred not to ask for a connection and dig up a well instead. Example of a couple living in

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[33] The rare men interviewed were shop-owners, retired or exceptionally coming back home to eat from their day of work, but in this case I did not stay unless they insisted.

[34] A bit less are connected to the sewage system (87.8%, varying between 90% in the urban centre and 72.5% in the rural communities) according to the Health Diagnosis of 2001 by the Health Secretariat of Jalisco.

[35] Another study realised in 2002 found a rate of connection of 75% (for the town), explaining that this is due to settlements on the outskirts not yet covered by the public network (Tanaka, 2002).

[36] This is the case for the four localities where the fewest interviews were held, which perhaps indicates the need to consider this figure with precaution.

[37] The last three gave other reasons for not having a connection, or did not precise whether they did not ask for one or had it closed down.

the neighbourhood for 39 years and in the house for eight years: "We used to live one street away, and there was almost no water, so when we moved here, we dug a well and didn't ask for a connection". Another six households on the other hand asked to have the connection closed down because of the bad service (including four who dug one up the well themselves, and two who already had one). Example of a couple living in the neighbourhood for 24 years (and in the house for 17): "We used to have a connection, but the water was frequently missing, so instead we dug a well and cancelled the connection". Example of a couple living in the neighbourhood for 39 years and in the house for ten: "During the dry season there is very little potable water, so we dug a well and closed the connection one year after settling down".

So in general we can explain the relatively low rate of connection to the public water service in Del Alamo by the fact the neighbourhood is the most ancient and benefits from a shallow aquifer: many plots had wells before the public service was set up in, enabling those who wish to resort to an alternative source of water to do so.

It is also interesting to look up with more detail the majority of households with a connection, as the binary "connectivity" actually encompasses a variety of situations.

What can first be said of the public water service is that its schedule (which days the water is delivered) is very regular in all localities except in Aguacate (where according to our interviews, it is half regular, half irregular).

Indeed, while in the rural communities, water is mostly distributed once every other day, for 6-24 hours (except in Puerta del Barro and Las Pilas, which alternate three hours each day), in town the distribution is organised in three areas:

- Those located in the higher areas (Charco de los Adobes, El Cerrito, Posito Santo and Mirador del Rosal) get water twice a week (Mondays and Fridays) for 24h;
- Those located in the eastern area (Oriente segunda seccion and Jardines de Manantlán), Wednesdays and Saturdays, 4-5 hours per day;
- All other (central) neighbourhoods get water three days in a row (Tuesdays, Wednesdays and Thursdays) all day, as well as the hours left on Wednesday and Saturday.

Map 25: Neighbourhoods in the town of El Grullo

Source: Municipality of El Grullo (1998-2000)

Image 30: Aerial view of El Grullo, built against the hill (to the north)

Source: Municipality of El Grullo map (2000)

Although there is sufficient water to supply the whole municipality, the authorities are rationing its distribution through an alternate schedule (called *tandeos:* "one day here, one day there").

Our interviews mainly confirm the official schedule, while bringing more details. Hereafter we refine our analysis regarding the frequency of water distribution.

Table 5: Variability of public water service (frequency)

	La Laja	Puerta del Barro	Aguacate	San Pedro	Del Alamo	Cerrito	Oriente	Total	%
Households with connection	9	5	6	6	29	16	6	77	**100%**
Daily	-	5	5	4	4	1	-	19	**25%**
Non daily, *including:*	9	-	1	2	21	15	6	54	**70%**
- 5 days a week	-	-	-	2	*13*	*1*	-	*16*	*21%*
- 3-5 days a week	*9*	-	-	-	*5*	*10*	-	*24*	*31%*
- less than 3 days	-	-	*1*	-	*1*	*4*	*6*	*12*	*15%*
- frequency not detailed	-	-	-	-	2	-	-	2	3%
Frequency not known	-	-	-	-	4	-	-	4	**5%**

On average, one connected household out of four has water daily, while almost three quarters do not. Nonetheless, among these, a fifth have water five days a week, a third between 3-5 days a week and a sixth less frequently still.

But distinctions are very important among the localities. La Laja, for example, is the only village with no daily water at all (but it does get water one day out of two), while Oriente is the only urban neighbourhood in that case, and receives water less than three days a week. In the other urban neighbourhoods –Del Alamo, Cerrito and San Pedro- between one to two thirds of households get water five days a week (San Pedro proportionally much more).

To be grasped more fully, the water service also needs to be refined according to the number of hours during which the water comes, and the pressure at which it flows.

Although the number of hours was specified in half the cases only[38], this enabled to catch a refined glimpse of the variety of the water service. If a sort of continuum were drawn: La Laja would be rather low, as almost half the households receive water less than 6 hours; Puerta del Barro, Aguacate, Cerrito and Oriente would be average (with a wide distribution between 6-24 hrs); San Pedro would be high as comparatively more households often have water 24hrs/24.

In case the pressure was mentioned (also half the interviews on average)[39], it was to underline a good one, mainly in Del Alamo ("The water goes up [to the tank] with the pressure, no need for a pump for the whole house: bathroom, kitchen…)" or a very feeble one, like in Aguacate ("[We have water] every day, but little: sometimes it does not go up to the tank on the roof"). In San Pedro, many get water daily but with a variable pressure (less water two days a week): "[We have water] every day and night except Mondays and Fridays where there is little").

In La Laja, few with a connection mention the pressure, but those without a connection on the higher street explain that it is because of the feeble pressure that they received no water (and had the connection closed down): "The water does not reach us, we are too high. The water is for the lower part in the morning and the higher part in the afternoon, so there is not enough water left for the pressure to come so high. When people are conscious, they close their taps, but most are not and then they don't have water, although they would need it".

The past tables illustrate the fact that a rather high rate of connections (80%) does not automatically mean a good water service: only 25% of interviewed households have water daily[40], with close to 50% having water less than five days a week. Moreover, out of the 50% of interviewees which detailed the number of hours or the water pressure, less than 8% have water 24/24 hours (while 9% have water less than six hours) and the water pressure seems to vary a lot according to the area of study, with a slight better in town than in the villages (at least as far as La Laja and Aguacate are concerned, as nobody in Puerta del Barro mentioned the issue). At least a stable schedule makes it easier for households to organise themselves, for instance to plan the weekly washing accordingly.

[38] In Del Alamo too few interviewees mentioned the number of hours to be relevant.

[39] In this case, households in Puerta del Barro, Cerrito and Oriente did not mention the water pressure.

[40] This data could be higher as 10% of interviewees either did not know the frequency or they were not asked the question.

Hereafter we quickly detail the situation in the seven areas of study, starting with the urban neighbourhoods:

San Pedro: this is one of the privileged neighbourhoods (potable water is supplied daily): as it is one of the lowest in town, it receives a lot of water due to the distribution by gravity.

Image 31: Recent housing development in San Pedro neighbourhood

Del Alamo: As it is located quite at the end of the water distribution chain, it has trouble receiving water. But the groundwater is shallower than elsewhere (5 m approximately) and as it is one of the oldest neighbourhoods that developed before the potable water supply system, the majority of inhabitants have a well.

Image 32: Interviewed household in Del Alamo neighbourhood

Cerrito: This relatively poor neighbourhood with many irregular settlements is located on the hill that dominates the rest of the town. The sewage is installed but they are still making connections to the public water distribution system (connected households get water twice a week). Access is not always easy as many trails are still not paved (one cement staircase leads the way to the chapel Nuestra Señora de Guadalupe).

Image 33: One of the many dirt trails in the Cerrito-East

Oriente segunda sección: Potable water supply is two to three days a week. Public services are currently being supplied (sanitation, electricity) to this neighbourhood undergoing urbanization: the landowner did not request the permission to divide his land, build and then install the services as is requested by the Law, he sold without having the services.

Image 34: Ongoing works to supply sanitation services in Oriente

In the villages, the situation is just as contrasted, but generally less well-off:

Puerta del Barro: Potable water is distributed seven hours per day, so people stock it in small tanks placed on the roof (to have pressure). They resort to the irrigation canal, which crosses the village, to water the plants or wash the car.

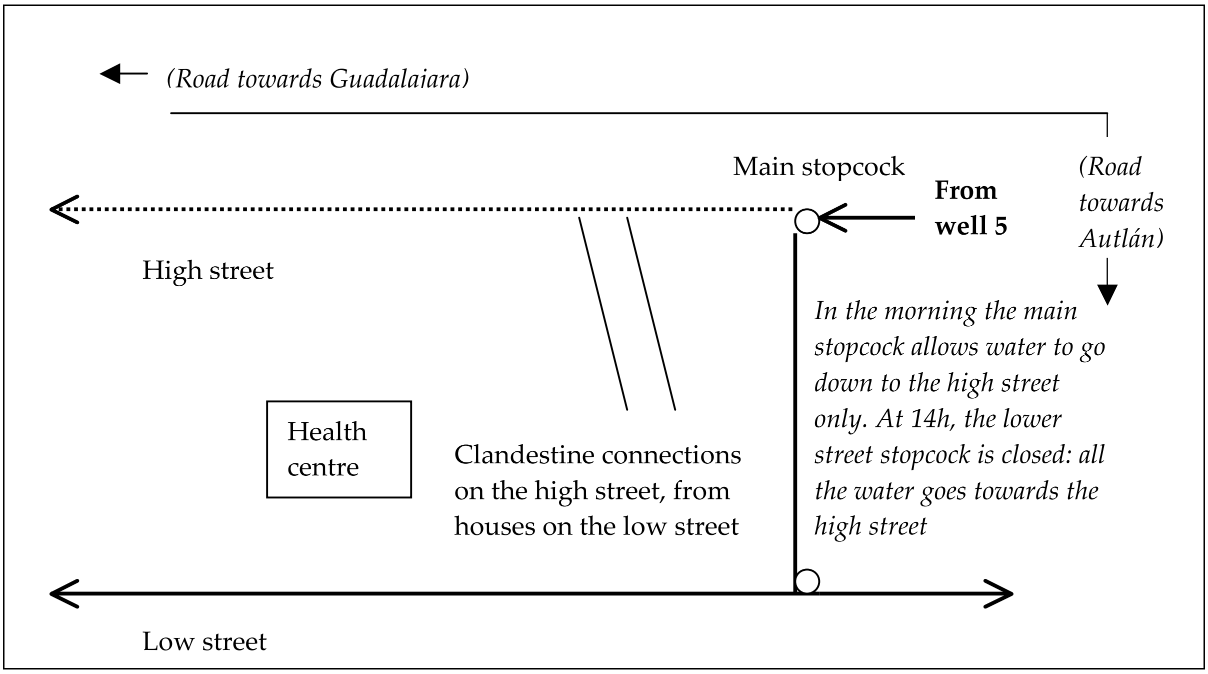
Image 35: Roof tank and irrigation canal in Puerta del Barro village

La Laja: This is one of the poorest localities of the municipality, as it is the only one with all agricultural lands outside of the irrigation unit of Autlán-El Grullo. As a consequence, landowners grow rain-fed maize mainly used for auto-consumption (although maize leaves are also sold to make specific dishes or for arts and crafts) and most men are daily workers in the valley plantations.

Image 36: Interviewed household and workers sorting corn leaves in La Laja village

The specificity of the place is the way the water distribution is organised (one day out of two) according to the two main and parallel streets: the lower street gets water in the morning, the elevated one in the afternoon.

Figure 18: Water distribution in the village of La Laja



This creates two types of tensions:

- There are many houses located in the lower zone at the beginning of the village that have illegal water connexions in the high zone (as they are located between the two streets, they have access to the two underground canals), so they have water all day long. This prevents those in the back part of the village situated higher up (starting from the health centre) from receiving water with sufficient pressure, in addition to the fact they say those from the low zone do not take care in moderating the quantities they use;
- Those from the higher zone never paid their water very well, so those from the lower zone (which did pay regularly) do not want the water to reach them.

The problem is explained by the fact that before, most of the population was in the lower zone, and recently the village has grown –in particular in the western part, both in the low and the high zone (many are illegal settlements in the federal zones along the road or the River Ayuquila, but the water board has to provide them with the water service anyway). When the water network was designed, such an extension had not been planned (or else they would have built a tank in the hill above La Laja, as well as installed pipes with larger diameters).

Aguacate: Here as well, due to the fact the village is expanding towards lands that are located a bit higher than the rest of the original village (towards the irrigation canal situated next to the tank –see Chapter 3), the water pressure is insufficient to supply the houses in these new sectors. They thus organise themselves by having wells, or withdrawing water from the irrigation canal.

Image 37: Main street in Aguacate

As a whole, the seven areas of study illustrate the important heterogeneity of the public water service. The water board recognised this inequitable water distribution exists because the infrastructure hasn't evolved sufficiently to follow the population growth and the town's physical expansion (be it in pure horizontal terms or to face the expansion of illegal settlements located in altitude).

Overcoming the strong disparities that exist –inside the urban centre itself, due to growing and spatially spread-out population, as well as between the urban and rural areas, usually less well-off- is one of the local authorities' priorities. Indeed such a situation generates complaints, as with the system of a fixed fee, with equivalent house characteristics, those which do not get much water pay the same as those that get water daily.

Storage practices and alternative sources to face water system deficiencies

To face this very irregular water supply, various storage practices have been set up, ranging from roof or underground tanks to washhouses and containers, depending on households' financial means. Indeed, be it in town or in the villages, social practices linked to water installations depend on the financial comfort of the household.

In those of more modest means, the water connexion is realized through a tap, which then supplies the washhouse through a pipe. From there, the necessary water for the kitchen, the bathroom or the toilets is collected through small containers.

Then, in houses benefiting from medium-level means, the pipe is instead connected to a tank on the roof, which enables to have more pressure in the different rooms it supplies. The cost of a tank indeed varies between MXN 1000 (totalling, with installation costs, MXN 5,000, i.e. one hundred days of work of a minimum salary of MXN 50) and MXN 10,000-15,000 (for a tank of 5,000l, which covers five days for a family of five requiring five times 200 l/day –i.e. three hundred days of work). An expensive well requiring electricity also costs around MXN 5,000.

In the most modern houses (more or less common according to the neighbourhood), there is an underground and generally bigger tank, which supplies, through internal connections, the kitchen and other rooms using water.

Image 38: Elevated tank (Cerrito)

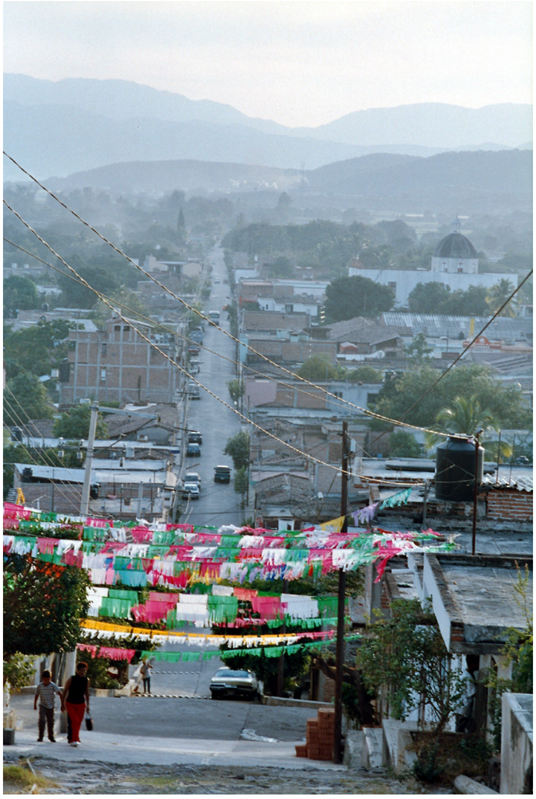


Image 39: Wash-house in La Laja

Image 40: Buckets in Cerrito

When available, alternative sources of water are also resorted to, such as wells, the Ayuquila River or irrigation canals.

Some patterns seem to prevail in each locality in terms of storage practices or alternative sources of water (especially in case of no connection), to face the necessities of everyday life.

When we compare households with a connection to the public water service, certain specificities emerge[41]:

- In La Laja: wash-house and/or sometimes buckets;
- In Puerta del Barro and San Pedro: elevated tank and wash-house, rarely an underground tank;
- In Aguacate: wash-house and well or elevated tank;
- In Cerrito: wash-house and sometimes elevated tank;
- In Del Alamo and Oriente: elevated tank and wash-house, and sometimes well.

Storage practices vary a lot in the two neighbourhoods which count several households without a connection: in La Laja, due to the geography, only wash-houses are possible to store water brought from the River or the hose lent by a neighbour who has a source. In Del Alamo, due to the fact this was an old neighbourhood existing before the water service, and the shallowness of the aquifer (on average 6 m) many wells exist.

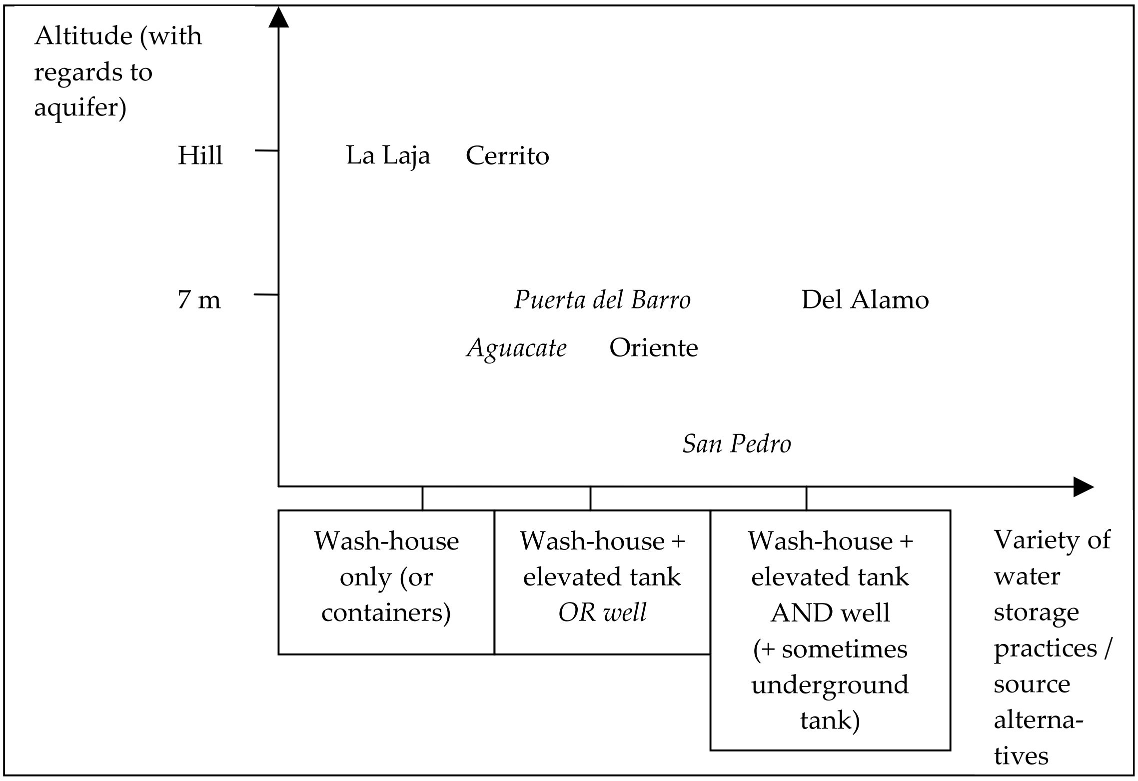
Table 6: Storage practices and alternatives to public water service

Area Storage practice	La Laja	Puerta del Barro	Aguacate	San Pedro	Del Alamo	Cerrito	Oriente
Interviews	12	5	6	6	44	17	6
Wash-house	10	3	5	6	33	16	4
AND elevated tank OR well	-	3	2	5	27	6	3
AND elevated tank AND well	-	-	2	2	19	-	1
OR underground tank	-	-	-	1	3	1	-

Basing ourselves on the results of our interviews, the seven areas can be broadly categorised in five different types of areas, which vary according to both the altitude and the variety of storage practices they resort to.

[41] One important characteristic to point out is that in the visited localities, a majority of people live in individual houses (and not in apartments), which explains the recurrence of wash-houses, usually set in the courtyard.

Figure 19: Variety of water storage practices according to altitude



The first difference is between those sites located at a certain altitude (La Laja and Cerrito) and the others. La Laja is situated on the hill between the River and the road to Guadalajara, while Cerrito is on the hill against which the town of El Grullo is built. Due to this geographical constraint, the two are limited in their alternatives to the public water system as far as wells are concerned: those in La Laja resort to the River, while those in Cerrito are better off as almost all have a connection (including three quarters three to five times a week).

But inside this first category there is also a difference between the two: while La Laja is strictly limited to either a wash-house or containers, households in the Cerrito sometimes also have an elevated tank (one third of our interviews). This is due to the fact that the water supplied to La Laja comes from another village and the resulting pressure seems insufficient to be able to store the water in elevated tanks. Cerrito, on the other hand, benefits from a tank located specifically above the highest houses.

The second difference concerns the five other sites located low enough with regards to the aquifer to be able to have wells (a water depth of 7 m seems to be the most common depth in all five sites, the lowest average being 4 m in San Pedro). Here the distinction is between those that have just two types of storage practices (either wash-house and elevated tank or wash-house and well) like Puerta del Barro and San Pedro and those that have more, Aguacate being between the two.

Comment from first interviewee in San Pedro: “Underground tanks are only for the rich because they cost more. Before the neighbourhood used to be inhabited only by engineers, big landowners, so their houses all had underground tanks”.

More generally, La Laja was one of the poorest of the areas of study, and it seems here that their poverty is accentuated by the poor water service quality and limited resort to various storage practices. Indeed a wash-house, contrary to an elevated tank, means being limited in the installation for a shower or the kitchen, while it is also dependent on the tap water service frequency to be filled, contrary to a well. Other poor places such as Cerrito or Aguacate at least benefit from the fact they have either an elevated tank for the first or that they have the aquifer at less than 10 m for the second, and thus the possibility to have a well (although this also incurs electricity costs).

On the other extreme of the spectrum, the richest houses visited were either in San Pedro, in the recently constructed modern compound, or in Del Alamo. In both cases, such houses had underground tanks (of 1,000 l) in addition to most other storage practices (from 300-1,100 l elevated tanks or wash-houses) –even though these were not always automatically used, like in the case of having a washing machine.

By analysing the well uses in the five localities that count some, we see that there is a big difference between those with a connection and a well, and those with a well but no connection. Indeed, having a connection makes the wells’ uses more variable, while not having one makes the well the only source of water supply, which thus covers all household uses (usually the well has a pump to supply tanks for both the kitchen and the bathroom, while also supplying the wash-house or washing-machine, although there are fewer number of wash houses and elevated tanks when there is no connection, compared to when there is).

Those with both a connection to the public water service and a well can be broadly distinguished between those who frequently resort to the well (which they generally built themselves), either because they usually don’t have much water, and:

1. They use the well all the time for all uses (something more common in Del Alamo), leading to situations where sometimes they don’t know the schedule of the public water service anymore. As one interviewee noted: “I don’t realize when there isn’t [tap water] because I have a pump in the well, to water the plants, the courtyard, the street and to fill the elevated tanks for the bathroom and kitchen”;

2. Or they use the well both regularly for specific uses (generally the garden, wash-house or to water the street) and for everything when there is no water, because the service is not daily, like in San Pedro, or the pressure is very weak, like in Aguacate or both combined, like in Oriente;

Or (more rarely), they frequently use the well because although they have a rather good water service, it is still not sufficient for their needs (in both examples set in the villages of Puerta del Barro and Aguacate, the interviewees either grow fruit trees for selling purposes, or rear animals).

Those resorting to the well only on a much more occasional basis and who often have relatively a lot of water (either daily, or with good pressure or long hours, and where the well was more often already built before they moved in) use it only when the water service breaks down. As one household in Del Alamo put it: "We don't use [the well] anymore because now there is more water at the tap, and we don't have the money to buy the pump. We use it only when there is no tap water for weeks". Indeed, according to the water board director, in spite of the fee reduction they are granted many of these well owners have stopped using them (representing only 5% of those with a connection), because of the incurred electricity bills for pumping.

In any case, the irony is that these central areas that have wells "just in case" and benefit from a particularly shallow aquifer level (3-4 m), are not the ones that suffer most from irregular water distribution.

Indeed, here again, when combining the tables related to water supply, storage practices and alternative water service, La Laja is really the worst off: the bad service in the higher street cannot be compensated by resorting to a well. Fortunately, they are close to the River and located upstream from both the urban wastewater discharges as well as the irrigation return flows. In addition one of the village's benefactors lends his hose to those with no water at all at the top end of the high street. On the other side of the spectrum are San Pedro and Del Alamo, which combine both a rather good water service and sourcing alternatives.

Said differently, as distinguished by De Certeau, we can talk of *strategies* in the case of those in Del Alamo which have enough power to decide to not have a connection and use a well instead, while those in La Laja resort to *tactics,* in the absence of much choice – and thus power- to cope with the situation they are subjected to (Pedrazzini et al., 2005).

b. How can the current situation of the water and sanitation service be explained?

"In spite of having sufficient water in the River and underground, providing water to the population and the municipality has been, and is still today, a major issue for all the administrations that have attempted to do so. With the construction of the potable water system Manantlán-El Grullo twenty-one years ago, we thought everything was settled for good, but the numerous villages, the natural population increase and fewer water sources, in addition to the problems of a system which works by gravity only, have proven otherwise. Deep wells have been drilled, that have not resolved anything" (Rubio, 2001:130).

In this second sub-section we analyse the reasons for the municipal board's difficulties to ensure an equitable water service while treating the wastewaters (illustrating the theoretical difficulties presented in Chapter 2): financial, political, technical, and socio-cultural (all of which are closely interlinked).

Money, money, money… and politics

The decentralisation of the water board from the State agency in 1993 gave the municipality total independence in terms of decision-making, planning and operating. Now the board is completely autonomous to manage all the income (the collected fees) as well as the expenses (electricity, administrative costs, material), whereas before it had to ask the agency in Guadalajara for permission to make any investment.

To this day, El Grullo remains the only municipality of the region to also have, on its own initiative, administratively separated the water board from the municipal treasury. Like the other municipal services, the board operates on the basis of the fees it collects, in accordance with the provision of the Jalisco Water Law for the State and its Municipalities of 2000, which recommends reinvestment in the same service (Tanaka, 2002). Such a set-up indeed guarantees that the resources (the collected water fees) are actually used to offer a better service, instead of being spent in other areas by the municipal treasury.

This has given the water board even more freedom (even if all decisions are signed by both the head of the water board and the municipal president). It also makes the board more responsible, more aware of the necessity to spend the money correctly. According to the former municipal president, this 'entrepreneurial policy' is one he tried to develop in all his departments: "They get what they tariff".

So the water board's costs for operation, maintenance and administration are to be covered by the water fees paid by the users. Although the municipal authorities do not always frankly admit it, this does not seem to be the case.

Sometimes it is mentioned that the municipality or higher levels of government are also solicited: "Of course there are works for which they do not have the economic capacity, we also help" (Antonio Mendoza Olivares, current municipal president). But this tends to be "for specific and punctual but important works", like installing the sewage system, for which they got a loan from the State Congress and the federal government (Manuel Martes Calbán, current water board director).

The only official data we managed to obtain regarding the board's budget seemed to confirm the coverage of expenses by income[42], even though the former director of the water board who provided it also warned against using it as being indicative of any average, because the expenses greatly vary according to the public works undertaken each year.

According to him, the budget is structurally in deficit, which is why they have to subscribe fiscal credits to cover their debts. And according to the former municipal president: "Nothing seems to indicate this will change promptly".

This would be less surprising, given the number of factors that play against their financial self-sufficiency.

First, a very common problem is the need to increase fees[43]: "To really have 100% sufficient resources, we would need to make people pay double, have them pay more to be more conscious of what water really costs. We have made publicity so that they don't waste but those that do insult us if we tell them it is not the right thing to do. Also, this would help us to better the service and change the old pipes, to better the whole infrastructure" (Manuel Martes Calbán, personal communication).

Indeed fees rarely reflect the real price of water: supplying 1 m3 of water can cost up to MXN 8-8.5, while water fees are sometimes as low as MXN 3.23 /m3 (Aceves, 2004) or even MXN 1.6/m3 (Guillén, 1999).

In El Grullo, due to the shallowness of the aquifer, extraction costs are probably less important. Nonetheless, as shown by a study undertaken in 2002 on cost-recovery in El Grullo, fees are too low to even start approaching partial cost-recovery. Although the information is to be taken with precaution as it is based on State-level sources due to "limited disclosure of financial information at municipal level" (Tanaka, 2002: 13), the results show that in 2000, revenue collected was MXN 0.96/m3 (e.g. half of the State average), enabling to reach a cost recovery of 67% only, and leading to the conclusion that municipal water supply is highly dependent on senior government subsidies (Tanaka, 2002).

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[42] Expenses amounted to MXN 239,000/month, mainly for operation and maintenance, as well as perforation costs shared with the CNA (which grants free concessions to municipalities for 25 years). The income was much more variable, according to users' payment of water fees.

[43] Very cheap water is a worldwide reality and it will probably take many more decades before this changes. As an example, in France, the 'model of basin-based water management', water unavailability in the south-west during the past summers seems to be due not only to meteorological conditions, but also excessive withdrawals for irrigation. These are encouraged by agricultural subventions allocated to the most intensive productions – which are also water intensive- like maize. Water agencies have failed to use their power to increase the water fees: in total contradiction with the consumer-pays and polluter-pays principles, they are lower in these dry-prone areas (EUR 0.23/m3), compared to other non-affected basins (EUR 1.14-1.5/m3) (Bronner and Galus, 2005).

The problem is that it is the State Congress which sets the price of water[44], and that political considerations also interfere (for example, if the PAN is in power and wants to increase the fee, the PRI opposed the initiative (Luis Manuel Martínez, personal communication). As resumed by Tanaka: "Pricing is likely to be based on political priorities rather than costs incurred by operation […] The policy reforms [providing legal tools for municipal water utilities to collect fees] are expected to have limited influence on water prices. Given that the State governments cap the price increase allowed per year, and the political agenda favours low prices, the prices of water are destined to remain low. As a result, potable water provision in the Mexican case is heavily subsidised" (Tanaka, 2002: 22). This is unlikely to change as the conflict that would result from a price increase is avoided and the non-resolved situation conveniently passed on from one Congressman to the next (Marie et al., 2005). So to circumvent this perpetuated tradition, municipal boards ask for an increased independence of municipalities, such as that existing in the neighbour State of Colima, where municipal boards are free to set the prices (Tanaka, 2002).

Fees discounts could also be revised, either by increasing the fee paid by those without a connection but with a well (as 97% of the fee seems very little to pay for the sanitation service only), or by changing the conditions of the 50% discount (postponing the age limit or combining both retirement status and age limit).

Finally, also important is the need to update the users' census, in order to register all households and house characteristics to avoid non-payment (or payment of fees lower than what should be paid). To a certain extent, this depends on cadastral information, which is not always very up-to-date. Indeed in 1993, the transfer of power entailed by the decentralisation process to perceive land or property taxes –the main source of local finances- was not accompanied by a corresponding transfer of experience and the land registration is still being updated (Llop Torné, 2005). In El Grullo, this was exactly the situation in November-December 2004, with the cadastral office planning to start such an update in January 2005. According to the former water board director though, in 2001 they had updated the data regarding public water consumption (to compare house characteristics with paid fees, and control illegal connections), but in the villages only.

To summarize, even though due to contradictory information, it is not very clear whether El Grullo's water board's budget is in structural deficit or not[45], what is clear, on the other hand, is that it is too limited to allow for investments in "secondary" domains such as fixing leaks (40% of water usually disappears through such obsolete infrastructure) or building a treatment plant. Another consequence of the water board's limited financial resources is its

[44] This is the case in Jalisco, but varies according to the States (Pineda, 2004).

[45] The varying points of view could depend on whether the authorities are towards the end of their mandate but with past elections (so little pressure), or towards the beginning of it and still wanting to make a good impression.

lack of technically qualified staff, which also indirectly contributes to increasing its expenses[46] (Luis Manuel Martínez, personal communication).

Indeed, today, the water board's first priority is to extend the service, something it already has trouble doing in a self-sufficient way.

Technical consequences

First, insufficient financial resources prevent good operation and maintenance. The non-renewal of the equipment, frequently in a poor state (old pipes are affected by the chlorine used to disinfect the water), creates leaks. As stated by the water authorities: "We need to revise and monitor the piping systems, which are very old. We need to correct the distribution systems to prevent water loss" (Tanaka, 2002: 31).

This is worsened by the fact that due to the size of the municipality (insufficient staff, lack of qualified personnel and of financial resources), it is not always possible to fix a leakage within less than a few days' time (Tanaka, 2002).

In addition to such important water losses, the incurred leakages themselves lead to dirt infiltration, which affects the water quality.

According to the former water board director though, these leaks should not represent more than 10% of the pumped water, as they rehabilitated the conduction lines[47] (the pipes between the pumps and the distribution tubes, which are those with the biggest diameter). Indeed, according to the former mayor, detecting these leakages was a priority in order to repair or replace the distribution pipes accordingly. For him, the leakages would explain why they do not have enough water to reach all the neighbourhoods in a satisfactory way, as in theory they should be able to.

But the fact the water board does not dispose of a sufficient budget also contributes to limit its power of control over illegal connections (or 'voluntary leaks'). As mentioned earlier, this has been particularly problematic in two villages: La Laja, where certain houses dispose of two connections in order to have water all day, and Aguacate, where the water quantity has sometimes been significantly reduced due to illegal connections located 'upstream' in the network: "They say it is because there are clandestine connections, as well as imperfections

[46] Although it could not cover all municipalities, the former centralised State operator realised good quality studies and planning; today, the municipal water board is dependent on third parties, to whom it must subcontract such studies.
[47] The rehabilitation of such lines for well 1 cost them MXN 1,767,000 (Sergio Llamas Gutiérrez, personal communication).

and lack of attention (the same Manantlán pipeline has now existed for 30 years). In addition, sometimes when there is not enough water, they say that it is because in El Chante, they use it up to give to their livestock" (Household in Aguacate).

Then, limited financial means have historically contributed to set up a distribution realised by gravity. Today, this complicates the extension of the network to follow the extension of settlements, be it the municipal capital or in the rural communities. Indeed, in both cases, the most recent neighbourhoods are located on formerly non-constructed lands –e.g. generally higher than the municipal water tanks.

In town, in order to supply the very densely populated neighbourhood of El Cerrito, composed mainly of illegal settlements, the problem has been solved by repumping water from the main tank to a secondary tank located at the top of the hill.

As this problem has not yet been solved in the villages of La Laja and Aguacate, the very weak resulting pressure for such areas is especially obvious (according to our interviews, the most affected households have indeed been living there, on average 10 years less than those in the rest of the villages).

But the gravity distribution creates another problem in the town of El Grullo: it privileges the neighbourhoods located at the bottom of the network, towards which all the water flows, to the detriment of those located higher up. This is why, in 1997, before handing over the municipality to the PRI, the PAN-led team suggested reorganising the water distribution through three tanks –instead of one main tank only- in order to each supply a third of the town from uphill to downhill, thus with increased pressure, a proposal which was, of course, rejected (Angel Aguirre, personal communication).

In addition insufficient financial means have, up to now, prevented the municipality from equipping itself in meters. This entails that the users pay for a service –corresponding at most to the extraction, distribution and maintenance costs- but not for the actual quantity of water they consume. In addition to being an incentive to waste water, it contributes to create a climate of mistrust between neighbours when they pay the same fee for quite a differing water service quality. Also, it puts an additional strain on the water board's budget.

The former water board director said they would start setting them up meters for those who agreed to pay for the installation and the meter (e.g. those who did not trust the current system, who thought they were being charged excessively compared to their effective consumption), but the former mayor had many doubts about this, due to the costs of the operation. He also mentioned this could only be done once everyone receives water regularly and with the same pressure.

Finally, as it is possible for the board to resort to the funds reserved from water fees to build and operate wastewater treatment plants (20% of the fee), these are used to cover other expenses, such as electricity bills for water extraction and the maintenance of sanitation pipes[48]. This partially explains why El Grullo still has no treatment plant[49]. According to the former mayor, who was head of the water Board in 1992 (e.g. when the law of 1990 introducing such a reserve came into practice), they never had sufficient resources for the water supply, so they decided to favour it to the detriment of wastewater treatment, in order to avoid trouble with the population: "The first priority is to have clean water, then we worry about wastewater. So the 20% of the fee that should be kept to build the treatment plant is used for the provision of potable water" (Armando Nuñez Ramos, personal communication). According to him, this is the same in all municipalities of Jalisco.

He regrets that the federal government undertook this regulatory approach without offering to help these lower governmental levels, and fears it will work against more natural solutions such as the one he favoured: "It has taken me 3 years of training [by the inter-municipal initiative] to know what a constructed wetland is. So, in January 2004, the new municipal president is going to say: 'I only have 1 year left, so I'll go and see Fox and see if he gives me a normal treatment plant" (Armando Nuñez Ramos, personal communication).

Socio-cultural factors

The fact there are no water meters leads to another problem: between 15-20% of the population does not pay its water bills[50]. Out of these, one third does not pay because they have no money, but two thirds because they do not want to (Tanaka, 2002).

These are generally well-off citizens aware of regulatory evolutions: "We know who they are because they have been identified and defend themselves. They do not pay because they pretext they do not trust the bill to reflect their effective consumption" (Armando Nuñez Ramos, personal communication); "The people that do not pay are educated: they are lawyers, they have a bachelor's degree…We have less overdue payments with the destitute than with those which have the means to pay. The poorer do not know the law as well, and

[48] This explains why one of the water board's priorities was to buy more efficient pumps, as was done in 2003.
[49] Another reason which might explain why there is still no wastewater treatment plant might be the fact it is perhaps more interesting – in electoral terms - to invest in more visible infrastructures such as roads, etc.
[50] According to the former director of the water board, this level has fallen from 35-40% in 2000, and is due to the fact people pay better when there is a good service.

are more afraid of sanctions. The legislators are trying to see what can be done to avoid this problem"[51] (Sergio Llamas Gutiérrez, former director of the water board).

Indeed, since 2000, the State of Jalisco Water Law prohibits service suspension for non-payers in the case of domestic water use[52]: the board is only allowed to reduce the amount of water supplied (to 200 l per day) (Tanaka, 2002). The problem is that as they have no meters, the municipal team has no way of reducing precisely the quantity of water. Knowing this provides an incentive to the free riders to continue 'business-as-usual' (some of the richer ones have not paid since 2 to 15 years). On the contrary, the poorer try to pay as fast as possible, as the discount of 15% represents an important sum for them.

"Here at the water board we try to pass on the message: 'If you don't pay the telephone bill, your line is suspended, same thing for the electricity…so it should be the same for the water which is much more vital than the phone or electricity'[53]. But they know we can't do that because of the law, so this is why we have the plan of installing valves to reduce the quantity of water they get this year. This will also help us get a better recovery, and make the people see we want everyone to fill in their responsibilities, as they ask us to supply a good service quality, they have to help us in doing that by meeting up to their responsibilities" (Manuel Martes Calbán, personal communication).

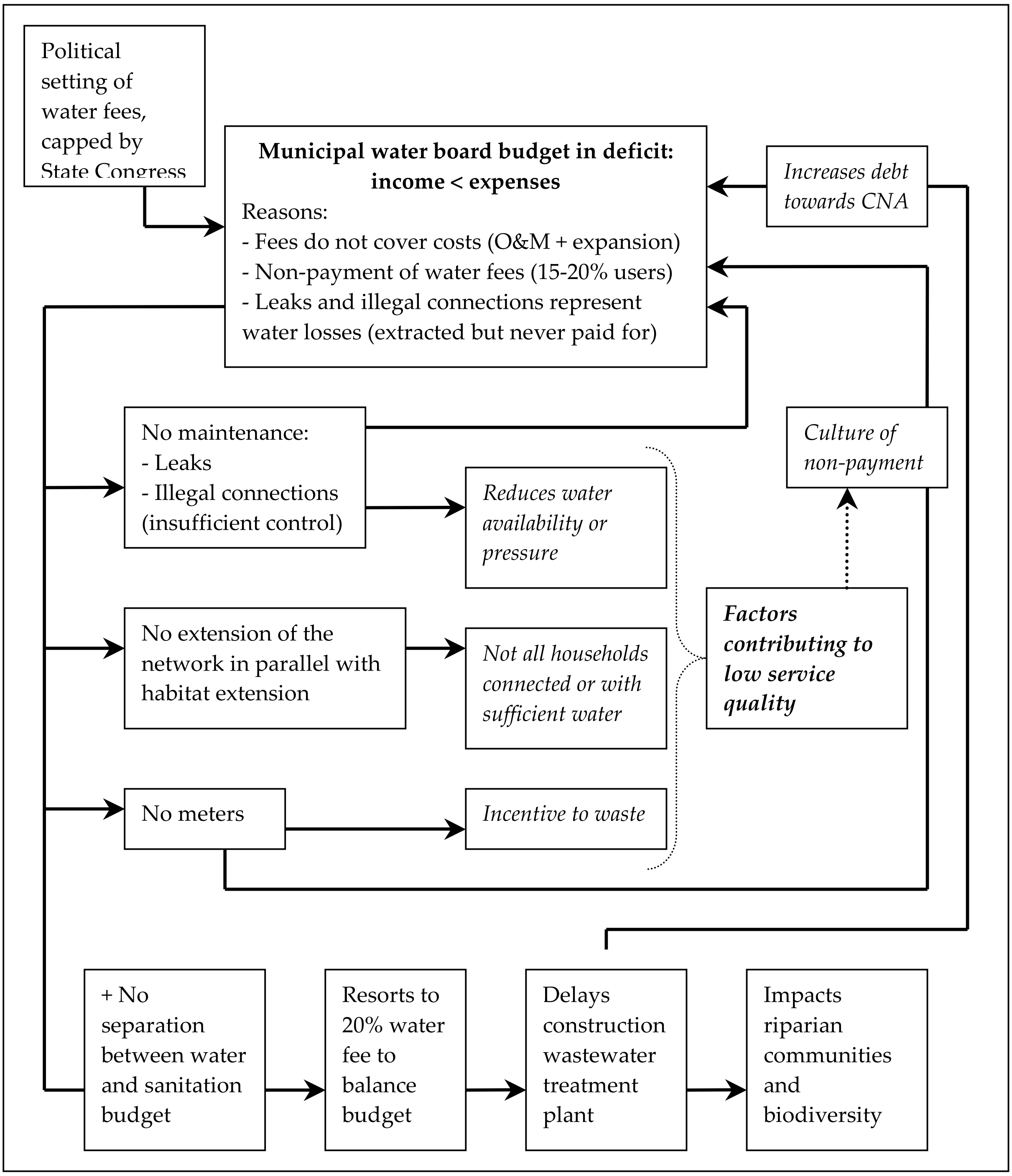
As a means to resolve this free-riding problem, the municipality wishes to install water meters, which will have to be paid for by the users themselves (the current situation is detailed in the last sub-section).

Vicious circle

Hereafter we represent the links between these four dimensions, and the vicious circle they lead to in our view:

[51] Non-payers are rarely sanctioned through fines because some have no means, and it would be difficult to fine only a certain category of non-payers (the richer ones).
[52] In any case, such unpopular measures would never be taken for domestic connections, while in the case of commercial uses (where this is legal) the board has already cut off non-payers' water connections.
[53] Quite surprisingly, it is not uncommon that the more vital the service, the less willingness to pay for it. Indeed these vital services – such as water distribution- are protected by laws, whereas other less vital ones aren't (Roche, 2005).

Figure 20: Vicious circle explaining bad quality municipal water service



Even though the problem is quite complex, the political setting of prices is one of the core issues, as it prevents fees to be sufficiently high to cover the water board's costs (operation and maintenance as well as expansion). The imbalanced resulting budget prevents supplying a good quality service to all, as it has specific technical consequences (leaks, difficulty to extend the network at the same pace as the settlement extension, absence of meters), most of which only reinforce the budget unbalance. In particular, the fact there are no meters, conjugated to a culture of non payment (people are used to being patronised)[54] sometimes justified by a very low quality… leads to further non payment of fees.

Moreover, insufficient resources combined with the fact the budget is not separated between water and sanitation enables to use the 20% fee destined to the operation of a treatment plant to cover other expenses (indeed a treatment plant is rarely as urgent as providing water). This contributes to maintain the situation of raw wastewater discharges, and the consequences for nearby populations or ecosystems, while increasing the water board's deficit (through its indebtedness towards the CNA).

According to the current water board, as fees cannot be modified by the municipality the other solution is to reduce costs: the current municipal president had the objective of reducing extraction costs by resorting to wells owned by the municipality only.

If this resulted in a better budget balance, it could then contribute to extract more water (and thus abandon the alternated schedule), as well as repair the necessary pipes or expand the infrastructure to follow the urban expansion, and install meters. Indeed, according to several experts in the region, the poor water service is explained by the fact an insufficient amount of water is distributed, even though the region is very rich in water.

c. Efforts to increase the water supply and protect the ecosystem

In this third sub-section we present ongoing efforts undertaken by the municipal board to overcome its difficulties in providing a water and sanitation service of quality while preserving the ecosystem, e.g. positive local initiatives from an IWRM point of view.

Repairing leaks

In terms of leaks, important investments were undertaken regarding underground water sources during the mandate of the former team (to change the conduction lines of well 1).

It seems that the current team's priority is the project of changing the pipes of the Manantlán system (replacing 3 km of the asbestos cement pipes with PVC, approximately 1 km downstream from the dam): "Currently all three municipalities are participating to finance a project to rehabilitate all the pipes that are more than 33 years old, in a section where we

[54] The situation of non-payment by users is quite common in developing countries, and is tolerated by the public services in charge, by passing the non-paid fees onto citizens' taxes (Roche, 2005). But in the case of El Grullo, this is impossible to do as the water and sanitation board budget is independent from the general municipal treasury.

have the most problems: what happens is that due to the topography in the mountain, with the pressure, the pipes break down. To repair this we need one or two days, as we have to get the machinery over there and one or two days for each municipality without this water…. Well, the time the water fills up all the underground tanks before it reaches the end part of the system, a week can have gone by" (Antonio Mendoza Olivares, personal communication).

Adapting the infrastructure to the habitat expansion

Another project the water board had for this year[55] was to send all groundwater extracted for the town through a steel pipe to the main tank. Water from well 1 is particularly concerned, which is sent directly to the town without being stocked. Once the missing portion of pipe is completed (270 m as of April 2006), this water will be sent to the tank, while that from well 6 will be sent directly to town in exchange. As it is daily and has a bigger capacity (60 l/s compared to 38l/s for well 1), this will avoid having to resort to alternated schedules and guarantee the water arrives faster to all.

In the two villages where water is insufficient, there are also plans to either build a new tank (in La Laja) or enlarge the current one (in Aguacate).

Like all such public works (such as the rehabilitation of streets for example, which is quite a common sight in El Grullo), the municipal service in charge can ask the neighbourhood to participate financially (the work is conditioned to their paying 20% of the cost)[56]. In El Grullo, this is particularly important for the various services as they are separated from the municipal treasury and really need the extra financial resources.

In La Laja, in order to increase the pressure with which the water is distributed, a tank will be built just above from the crossroads. But according to the water board director, the situation is blocked by the fact those from the higher zone and the back have not paid, under the influence of a policeman living in the neighbourhood. When I suggested that perhaps some don't want to pay until they see the actual water come to their house, he replied that if they do not pay they cannot expect to require anything.

Indeed several arguments were presented when I realised my interviews with households in the village:

[55] It is important to recall 2006 was an election year at federal but also municipal level, thus the numerous projects that are advertised, even though they will perhaps not be achieved in their announced deadline.

[56] At the beginning of the 1980s the government of De La Madrid established such financial participation, sometimes replaced by workforce, to reduce the paternalistic tradition maintained until then (Luis Manuel Martínez, personal communication).

- "Until they build the new tank, I will not pay the MXN 380, I want to see the tank finished first. I offered to have it built in my property, which is the highest up, below the road to Guadalajara, but the ones from the street below are afraid that we will drink it all up, so they didn't agree".
- "In my house we paid for the new tank but not all did, as MXN 350 per family can be quite expensive for some".

Even if they inverted the schedule of distribution throughout the day (something we suggested as it appeared more logical to start with those from the high street as those from the low street would automatically get a bit more pressure due to the difference in level between the two), they still need a tank to store the water for the current population. If after that it still does not arrive with sufficient pressure, perhaps they will re-pump it for distribution (instead of distribute it simply by gravity).

In Aguacate, the problem is similar: those from the higher zone do not receive enough water because the village developed towards the irrigation canal situated next to the tank (see map in Chapter 3), as a result of which the new houses are higher than the tank.

In this case the tank is planned to being extended, although here again it is not clear as to when this will materialize: "They came to ask us for *cooperación* (MXN 200 per house, with the municipality completing the other half) to extend the tank, a task already planned for 1st October 2005, date which has already gone by…".

Installing meters

According to the reform of the Law on National Waters, in Mexico the users are supposed to set up a meter in their water source, in order to implement the consumer pays principle. The fact very few comply with this reflects a certain lack of will to change their habits and participate in bringing up solutions to the problems (Guerrero, 2004).

In El Grullo, municipal personnel are aware that there is a need for metering as providing incentives to avoid wasting water[57] (Tanaka, 2002).

[57] Meters could also help resolve the conflict regarding the quantity of water received by each locality from the Manantlán system, as they would enable to know exactly how much water each community consumes and make them pay correspondingly (Angel Aguirre, personal communication).

In 2003, the director of El Grullo's water board mentioned that the year after they wished to install meters in the municipal capital for those households that agree to pay for the meter and its installation (e.g. those that think they pay more than they receive).

Indeed, although the former mayor recognized that the fact people do not get water everyday makes them a bit more aware of the need to be careful ("People start to think about it only once they miss it"), educating the population to avoid such waste was his second priority[58], not made any easier by the absence of meters.

The water board directors concur on the importance of such education: "We have the quantity of water we need. But unfortunately we have a very bad culture, and don't know how to use this vital resource. Because if we were conscious, we would only use it for human uses and we would be fine. Whereas lots of people use it to water their plants and gardens, give water to the livestock…" (Manuel Marquez Calbán). This is the case even though the law prohibits such uses of the public water: People must have their own wells for such purposes, there is control and sanctions" (Sergio Llamas Gutiérrez).

Along with that of meters, the issue of waste was thus one I raised during my interviews with the households, to have their side of the story and see whether they thought they (or their neighbours) wasted water, and what types of water uses they considered as waste.

Waste habits

Three quarters replied that they themselves do not waste, several explaining they use another source of water (mainly the well) to water the street or the garden: "No, we take care of it. I water my garden with the water from the washing machine. Perhaps if one wastes, another doesn't have any water left" (household in Cerrito).

Less than one sixth recognises they do waste water, in which case this varies in equal proportion between: watering the street (household in Aguacate: "Yes, of course we waste it to water the street, but do we have an option? Many cars go by and with the earthen streets, this makes lots of dust), the garden (household in San Pedro: "Yes, for the garden, I use 2.5 hours per day") or leaving the tap open (household in Cerrito: "Sometimes we go out and forget to close the water, then it overflows the washing-house").

[58] The first priority was to supply water to all daily (Armando Nuñez Ramos, personal communication).

Image 41: A common practice: watering the street to keep the dust down

The question regarding waste habits seems more easily to answered when asked about the neighbours[59]: the proportion of those who think their neighbours waste water is very close to those who don't (around one third in each case)[60], e.g. twice the proportion of those who think they waste water themselves.

Those who consider their neighbours waste water mention this is a relatively frequent problem. In La Laja: "The majority do". In the other two villages, in addition to watering the street, certain rural specificities appear: "Many of them give potable water to their livestock" (Puerta del Barro); "I know of 3 neighbours who have both a connection and a well, and put the water from the system into the well to make the water better, but they will never admit that to you […] In addition to the fact those with wells also use water from the system, is the fact some people fill up tanks with the same water, to supply their livestock with it" (Aguacate).

In town it is mostly to water the street: "The street is paved, they water it every 2-3 days to keep the dust low. In the centre they do it more every day, so they fill the washing-houses and leave the tap open" (Del Alamo); for the garden: "Behind they have a hose which is always open to water the garden" (Oriente); or by leaving the tap open: "One [neighbour] does waste it because she leaves her tap open all day, as she works far away" (Cerrito). San Pedro is the only neighbourhood where nobody considers their neighbour wastes the water

[59] A colleague had recommended diverting the question, as it enables to capture the interviewee's previously developed typology of his neighbours' practices, and smoothens the dialogue in case of sensitive issues. Nonetheless, I also encountered situations where it was clear that some people felt ill at ease –perhaps as if I was asking them to denounce their neighbours- so that might have introduced a bias in their answers. This reflects the importance of formulating questions in the most neutral possible way.
[60] The last third were not asked.

(which could confirm an inverse correlation between the quantity of water available and the care taken not to waste it).

Preference fee versus meter

According to the water board, the solution to such waste would be to set up meters, but they are convinced the population does not want this. According to my interviews, this is far from being true.

Table 7: Preference fee or meter according to locality

	La Laja	Puerta del Barro	Aguacate	San Pedro	Del Alamo	Cerrito	Oriente	Total	%
With connection	9	5	6	6	29	16	6	77	100%
Preference fee	-	2	-	-	6	4	1	13	17%
Preference equal	-	2	-	1	-	-	-	3	4%
Preference meter	3	-	4	2	13	5	3	30	39%
Preference qualified	-	-	1	2	3	3	-	9	11.5%
Does not know	-	-	1	-	5	3	-	9	11.5%
Preference not asked	6	1	-	1	2	1	2	13	17%

The meter seems twice as much popular on average (almost 40%, to which must be added most of those with a qualified opinion[61] -e.g. a good additional 10%- and this is without counting those 17% that were not asked their preference), compared to 17% only in favour of the fee. The only exception is in Puerta del Barro, where the fee is preferred.

Those who prefer meters put forward three main reasons:

- For a majority, this would reduce the waste of water, which is common according to them: "Maybe a meter would be better, because one would try not to use so much; now, one just wastes it without thinking" (household in Cerrito).

[61] Generally in favour of the meter but cautious with regards to the expenses it would entail compared to the fee.

- For some, a meter would enable to be charged for the quantity of water one actually uses: "A meter would be better because some people use more water, but we all pay the same fee" (household in Del Alamo).
- For others, meters might lead to service improvement: "If there were meters, at least perhaps they would try to offer a service. Because now, there is no water, but still one has to pay for it, or one has already paid for it for the whole year. The person in charge of receiving the money doesn't solve the problems" (household in Aguacate).

Those with a qualified point of view usually recognise that water is wasted and that meters would be better; on the other hand they prefer to maintain a status quo, especially in terms of costs: "It would be good to have a meter, because it would make people more conscious about the water, on the condition that it be at a reasonable price" (household in Cerrito).

As for those in favour of keeping the actual fee system, their reasoning mainly revolves around two quite different points of view that have in common the desire to avoid paying more:

- Half of them are wary of the meter's bad reputation, according to which meters make you pay even when you do not use the water (a rumour perhaps spread by those with relatives living in big cities like Guadalajara, which are currently the only places with meters): "The meter is worse because with the pressure from the air, it keeps on counting, this is what they say" (household in Del Alamo).

- A fourth of the fee proponents want to avoid having to pay proportionally to the quantity of water they use: "We prefer to pay with the fixed fee because with the meter it would be like electricity: the more we use it, the more we have to pay" (household in Puerta del Barro).

- The remaining fourth did not give any explanation.

So perhaps it is not so much that the households do not want a meter than the fact they do not want to (or cannot) pay for it, as well as its installation. Among the few households who were asked about their willingness to pay[62], some mentioned they would be willing to pay partially, but would like to be supported for the costs (MXN 600, i.e. the weekly salary of a daily worker in the fields).

[62] This question was not asked in a very thorough way as after a few interviews, reactions led us to think perhaps people were feeling as if the results would then be used by the municipal water board to force them to pay for the meter, according to their positive answers.

In addition to this financial constraint, two other conditions need to be fulfilled before water meters can be installed: having a good pressure, and clean water. For the time being, the water pressure is that obtained by gravity. As for the water quality, neither are there filters for the water coming from the Manantlán stream, nor are the storage tanks clean, which would risk blocking the meters and preventing them from working correctly[63] (Angel Aguirre, personal communication).

Public water service quality

After some interviews regarding this question of fee versus meter, I started asking myself whether there seemed to be any direct link between the preferences expressed and the quantity of water actually received (or what I hereafter call the "water service quality"). To check whether this was indeed the case or a totally wrong intuition, I first needed to determine how to describe such a "water service quality".

It seemed this could be expressed by the relationship between a household's opinion of the service and the service's characteristics (frequency, hours and pressure).

Before anything else, a simple query was made regarding opinions by locality[64]. In general, the opinion of the water service is more positive (61%) than otherwise, especially taking into account the fact those with a qualified opinion (14%) mainly answered positively[65]. Nonetheless, the extent of such a position varies greatly between the localities. In Puerta del Barro, the only village with water daily, the opinion is 100% positive. In San Pedro, Del Alamo and Cerrito, two-thirds are positive, frequently putting forward the historical evolution:

- "Now it is better, before (more than 4 years ago) there was frequently not enough, there wasn't any water on Mondays and Fridays" (San Pedro);
- "Since I have been living in this house [1 year], the service has been much better. I used to live in the same street and before it used to go missing for weeks, now there is water almost all the time" (Del Alamo);
- "Well yes, because before we didn't have any, when we arrived here, we had to go to the irrigation canal [which passes behind the hill]" (Cerrito).

[63] This could perhaps be an element of explanation giving reason to those who are suspicious of the meters' technical reliability.
[64] Only those households with a connection to the public water service were asked their opinion about it.
[65] An opinion was considered as qualified when the reply was either: "Yes, but…" or " I think so" or "No, but…".

The opinion is only 50% positive in the villages of La Laja and Aguacate, highly correlated with the service variations between those located higher or lower:

- Household in La Laja: "There is not enough in the high street, and when the pump breaks down, the person in charge gives the preference to those on the lower street: they get water from 07-13h (i.e. 6 hours) and supposedly those on the higher street should get it for 6 hours from then, until 7 pm. But sometimes it only arrives at 3 or 4 pm and then is cut at 7 pm anyway, or even at 5pm and we did not have time to do the washing and fill the containers".
- Household in Aguacate: "As far as I am concerned, yes, but when I see the situation of those living 'higher', no".

Finally, only one sixth of the opinions are positive in Oriente, where the process of water and sewage connections is still ongoing: "No, because if there were water more regularly we wouldn't need to plan everything according to when the water comes or not, and with the water from the well, the washing is not as well done".

The query was then refined, by adding the element of service characteristics[66] (see table 8):

[66] In the software Atlas t.i., that meant making a query by locality, then searching for those with a tap water connection and a positive opinion (for example), and then counting which ones among these had water daily, five days a week, etc.

Table 8: Opinion according to water service frequency, hours or pressure

Opinion	Locality[67]	Number of house-holds	Frequency of public water service						
			Daily	5 days a week	3-5 days ≥6hrs or good pressure	3-5 days but no details on hrs/ pressure	3-5 days <6hrs or feeble pressure	Less than 3 days	Not known
Positive Total: 47	LL	5	-	-	4	-	1	-	-
	PB	5	5	-	-	-	-	-	-
	AG	3	3	-	-	-	-	-	-
	SP	4	3	1	-	-	-	-	-
	AL	19	4	10	-	1	1	-	3
	CE	10	1	-	4	4	-	1	-
	OR	1	-	-	-	-	-	1	-
Nuanced Total: 11	LL	-	-	-	-	-	-	-	-
	PB	-	-	-	-	-	-	-	-
	AG	-	-	-	-	-	-	-	-
	SP	1	1	-	-	-	-	-	-
	AL	6	-	2	2	1	-	-	1
	CE	2	-	1	1	-	-	-	-
	OR	2	-	-	-	-	-	2	-
Negative Total: 17	LL	3	-	-	1	-	2	-	-
	PB	-	-	-	-	-	-	-	-
	AG	3	2	-	-	-	-	1	-
	SP	1	-	1	-	-	-	-	-
	AL	4	-	1	-	-	-	1	2
	CE	3	-	-	-	-	-	3	-
	OR	3	-	-	-	-	-	3	-
Not asked Total: 2	LL	1	-	-	1	-	-	-	-
	PB	-	-	-	-	-	-	-	-
	AG	-	-	-	-	-	-	-	-
	SP	-	-	-	-	-	-	-	-
	AL	-	-	-	-	-	-	-	-
	CE	1	-	-	-	1	-	-	-
	OR								

The results enable to establish a sort of threshold to see what a 'good' or a 'bad' water service corresponds to. Without counting those who did not specify their frequency sufficiently to be relevant (corresponding to the columns "3-5 days but no details on hrs/pressure" and "Not known"), we find that:

[67] Each locality is coded through its initials (LL: La Laja; PB: Puerta del Barro; AG: Aguacate; SP: San Pedro; AL: Del Alamo; CE: Cerrito; OR: Oriente).

- Out of the 39 corresponding positive opinions, 35 (e.g. 90%) are from households receiving water either daily or 5 days a week or 3-5 days with more than 6 hours or a good pressure (inside the greyish area in the top-middle part).
- Conversely, out of the 15 corresponding negative opinions, 10 (e.g. 67%) receive water less than that (either 3-5 days less than 6 hours or a feeble pressure, either less than 3 days) (inside the greyish area in the lower right hand-side).

When investigating more in detail, several other tendencies stand out:

- Those with a positive opinion despite a relatively poor water service always mentioned either an alternative source of water (River or well) or a storage practice enabling them to face the situation: "Yes [I have a wash-house] and containers that I fill for the afternoon and the following day. But to wash the clothes I go to the River" (household in La Laja).
- Similarly, those with a negative opinion in spite of receiving water relatively frequently always explain their dissatisfaction by very few hours of service or a weak pressure, or a problem linked to storage facilities (a weak pressure prevents from storing water or they have no storage facility like a tank or wash-house, or it leaks): "There isn't sufficient pressure for the water to go up to a tank, and this is the case for all living starting the street Miguel de la Madrid. So I have two jerricans for the bathroom. From the tap I have a hose. Also when there is no water, there is a tap in the street in front of the church where there is water" (household in Aguacate with water daily).

Interestingly, most of those with a nuanced opinion are also households with relatively lots of water, pointing out either a specific problem such as the fact the system breaks down regularly once a year, or that there is not always water, or that it is thanks to their organisation (either storage practices, either well) that they are satisfied: "Well, yes, organising ourselves we don't lack water, right?" (household in Del Alamo who stores water in the washing house, which is then pumped up to a tank for the bathroom). Two exceptions stand out in Oriente, where the interviewees have water less than 3 days a week, one having a particularly comprehensive point of view: "It seems little 2 days a week, but this is a problem the majority of municipalities have around here, and other neighbourhoods have a better service. We organise ourselves with storage facilities".

So the satisfaction seems to depend on both the frequency of the water service and the storage practices or alternative to other water sources.

Paying mechanism preferences according to water service: results

A more complex query within the same elements enabled to refine these results, showing the link between these preferences and the quality of the water service. Such a quality depends on the frequency per week, number of hours per day and/or pressure of the tap water, and categories were established between a 'good' service (either water daily, 5 times a week or 3-5 times a week for more than 12 hours) and a 'bad' one (either water 3-5 times a week less than 12 hours, or less than 3 times a week).

According to such a threshold distinguishing the service quality, we then confronted our premise according to which those with a good service would tend to be in favour of the fee, while those with a bad one would prefer the meter.

Table 9: Preference fee or meter according to service quality

	La Laja	Puerta del Barro	Aguacate	San Pedro	Del Alamo	Cerrito	Oriente	Total	%
WITH connection	9	5	6	6	29	16	6	77	
Preference fee	-	2	-	-	60	4	1	13: **- 9 good** - 2 bad - 2 ND[68]	100%: **- 70%** - 15% - 15%
Preference equal	-	2	-	1	-	-	-	3: - 3 good	100%
Preference meter	3	-	4	2	13	5	3	30: **- 17 good** **- 7 bad** - 6 ND	100%: **- 57%** **- 23%** - 20%
Preference nuanced	-	-	1	2	3	3	-	9: **- 6 good** - 2 bad - 1 ND	100% **- 67%** - 22% - 11%
Does not know	-	-	1	-	5	3	-	9: - 6 good - 1 bad - 2 ND	100% - 67% - 11% - 22%
Preference not asked	6	1	-	1	2	1	2	13: - 6 good - 6 bad - 1 ND	100% - 46% - 46% - 8%

We were right to a certain extent only. Although those in favour of the fee largely tend to have a relatively good water service (70%), the opposite is not automatically true. More than half (57%) of those in favour of the meter have a good service quality while less than a quarter (23%) have a bad one.

[68] ND stands for "Not determined" and encompasses all cases where the frequency was not sufficiently detailed.

It is nonetheless important to mention that almost 40% of those with a poor service quality prefer the meter, e.g. twice as much as the fee. Further, those with a bad service tend to be under-represented, as only a third were asked their preference (the question was particularly omitted in La Laja, where the service tends to be rather poor).

Table 10: Preference fee or meter according to service quality

Number of households (77 with connection)	Service quality	Preference	Proportion (%)
47	Good	Fee: 9	19%
		Equal: 3	6%
		Meter: 17	36%
		Nuanced: 6	13%
		Does not know: 6	13%
		Not asked: 6	13%
18	**Bad**	Fee: 2	11%
		Equal: -	-
		Meter: 7	**39%**
		Nuanced: 2	11%
		Does not know: 1	6%
		Not asked: 6	33%
12	Service not determined	Fee: 2	17%
		Equal: -	-
		Meter: 6	50%
		Nuanced: 1	8%
		Does not know: 2	17%
		Not asked: 1	8%

A possible explanation could be that the meter has the favour of both those with a poor water service, who wish to pay according to their modest water consumption and make those that waste change their attitudes, and those which have a good service but are aware of the problem of water waste, either for other users or regarding the resource in general.

This reveals a rather good conscious about the problem of wasting water, contrary to what many officials think. Indeed, these tend to highlight a lack of 'water culture' (understood as resources' conservation and efficient use), which is now an official programme of the CNA[69].

There is also the need to consider the fact that some with a 'good service' (specifically in Aguacate) have water only a few hours each day and usually with a very weak pressure, so it is quite normal that they should favour the meter as well[70].

[69] But as highlighted by Walsh (2004), this is often to cover the unsustainable system they have set up, without recognising the sustainability of numerous water cultures already existing.

Further, 67% of those with a qualified opinion have a good service. This is not very surprising as the qualified opinions tend to be in favour of the meters, but do not want to increase their expenses: we can assume that the meter is not as vital for them as it is for those with a poor service, or that they are perhaps less environmentally conscious or financially comfortable than those with a good service and in favour of the meter.

So it seems to us that if the water board really wishes to install water meters, it should not be so difficult to do – due to this rather important water consciousness- provided it explores alternatives enabling to share the costs of the meters and their installation.

A public-private partnership for municipal wastewater treatment?

The last type of initiative undertaken by the municipality concerns the well being of both downstream communities and the surrounding ecosystem, as it involves stopping the discharge of 30 l/s[71] of untreated wastewaters into the Ayuquila River.

Indeed, since 1996 and like other towns and cities of more than 20.000 inhabitants, El Grullo is under the obligation to have an operating treatment plant –the deadline was end of 2005[72] (SEMARNAT, 1996). As Autlán more or less complied with its obligation[73], El Grullo remains the major public pollutant in the region of study.

But the municipality refuses to build a classic treatment plant like the one in Autlán because of the corresponding operating costs: it wants to develop a long-lasting solution (Martínez et al., 2005). Indeed, for a town the size of El Grullo, the corresponding yearly operating costs would revolve around MXN 1.2 million, e.g. a big part of the municipality's total annual investment budget in municipal services (MXN 2 million)[74]. As the law does not include any financial support to help cover such costs –while State and federal support can be obtained to build the plant- the municipality has studied various other options which might have expensive construction costs but low maintenance ones.

[70] This would probably not had been the case had we refined our table even more, in order to show the opinions according to the specific number of hours or water pressure of those which receive water daily.
[71] This is an average figure, as the volume varies greatly according to the time of the day and the season.
[72] Until then, the General Law for Environmental Protection and Ecology Equilibrium had only targeted large cities and those bordering the U.S.A. (Martínez et al., 2000). Urban centres with a population under 20,000 have until 2010 to comply (SEMARNAT, 1996).
[73] Although Autlán's treatment plant has been built since March 2003, it is still not treating the wastewaters adequately, as the University of Guadalajara's regular water quality monitoring shows. In addition to a problem with the filters, the fact that wastewater and stormwater are not separated creates an additional burden and lowers the treatment effectiveness (Luis Manuel Martínez, personal communication).
[74] The total budget revolves around MXN 25 million (Manuel Martes Calbán, personal communication).

In 2003, El Grullo's preference was for a constructed wetland. Feasibility studies showed that the chosen location site (near Tempisque) was adequate and that building and maintenance costs would be much lower than those of a traditional plant. But this option requires overcoming a major problem, which is that of finding sufficient land to build the plant in a medium-term perspective (15-20 years): up to now, only 1.5 ha is available, so negotiations are taking place to be able to complete with the additional 18.5 ha required. Although they are concentrating on lands with no agricultural value, they have encountered a strong resistance, one strategy being to increase the price to a level the municipality cannot afford (MXN 300,000/ha, which would require close to MXN 6 million).

The former municipal president thought the fideicomiso (the financial set up of the inter-municipal initiative, presented in the next section) could play an important role in this, by financially supporting the municipality[75] (Armando Nuñez Ramos, personal communication). The option of municipal pre-emption (expropriation) for public utility constructions is one that is carefully avoided, due to the unpopularity of the measure[76].

If this land issue were to be solved, a possible solution could then be met as a public-private partnership is under negotiation, in accordance with the Jalisco Water Law for the State and its Municipalities that enables municipalities to devolve the water and sanitation service to the private sector (Tanaka, 2002). This Build-Operate-Transfer agreement would entail the building of a constructed wetland and its operation during 20 years by Lemna International, an American firm from Minneapolis. This would represent a substantial saving for the municipality as building costs represent MXN 50-70 million, while operating the concession for 20 years, MXN 1.2 million per year[77]. The private company plans to recover its investment by selling the treated water, either for irrigation or urban uses (municipal gardens) according to the quality obtained, thus enabling to free the corresponding amount of water for irrigation or public uses.

Another option would be to use the topography and the drainage canals, and make the water decant before it reaches the River: "According to all the information they have, [the team of the watershed commission working on this topic] will present us a proposal. Each municipality has different conditions: in El Grullo, there is a natural drainage along 5 km, before joining another drainage and then reaching the River […]: along this drainage of 4-5 km, the solids in the wastewater reduce, and the water oxygenates…so after these 4-5 km,

[75] Although he was cautious as he knew it is not meant to finance the municipalities' legal obligations.
[76] The typical counter-example given to illustrate this was that of V. Fox's government's awkward manoeuvre in 2001-2002 to offer a ridiculous compensation to buy lands and build a second airport near Mexico City, a project that has been abandoned due to resistance of land-owners.
[77] But the firm can also decide to undertake only the operational aspect, in which case the municipality would have to support the building costs. This would be possible only through a CNA loan, or if the State of Jalisco agrees to advance the money it allocates the municipality each year.

the water is potable! […] We have been counselled to take advantage of this condition to have a cheaper and more ecological treatment system, which would not generate so many operative costs […]. Some of them counselled us to plant some species of trees, to absorb, retain the solids" (Antonio Mendoza Olivares, personal communication). The problem is this approach would fill the drainage and make the aquifer level rise, which would have negative impacts as it has lots of salts (Luis Manuel Martínez, personal communication).

As highlighted by the current water board director, the problem is that in three years' time (e.g. the length of a municipal mandate) it is impossible to start putting in place activities related to a wastewater treatment plant, which require a much longer time frame. As resumed by the current mayor: "The idea is to have this proposal for the treatment plant ready this year, it is one of the priorities, to leave it for the following administration".

As the operations of the treatment plant had not started by 2005, El Grullo should be paying a fine to the CNA, proportionate to the volume of wastewaters[78]. Nothing has been paid so far, because according to the water board director, they were about to start building the plant last year, when the Chiapas was hit by a hurricane (so the State and federal government sent the planned resources there instead)[79].

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[78] Like most municipalities in its case, El Grullo is indebted towards the CNA, as it has not paid the fee corresponding to its discharges. But even if the CNA sends fines to the municipalities, these do not pay them on account of a past system which proved counter-productive: they prefer to invest in their infrastructure directly (Luis Manuel Martínez, personal communication).

[79] The CNA takes into account the efforts undertaken by the municipalities when it calculates their debt (Juan de Dios Martinez, chief of district 94 at the regional agency).

2. Engaging in IWRM institutions

In this second section, we analyse El Grullo's involvement in regional initiatives established to implement IWRM (watershed coordination bodies or municipal associations).

As highlighted by Álvaro Garnes Díaz, Treasurer of Autlán municipality: "It is part of the charge of the municipal president, it is neither compulsory nor voluntary: the municipal presidents need to participate in different projects that have an impact at the regional level, not only at the scale of their municipality".

The information is thus organised around two main regional initiatives in which El Grullo participates, and is based mainly on interviews held with key stakeholders participating in both: municipal presidents or their representatives from five municipalities (Unión de Tula, Autlán, El Grullo, El Limón and Tuxcacuesco, staff from the Ayuquila-Armería Watershed Commission or researchers participating as civil society.

The first sub-section presents the Ayuquila-Armería Watershed Commission, its organisational set-up, achievements and the criticisms it is subjected to. The second sub-section focuses on the inter-municipal initiative, and follows the same structure.

a. The Ayuquila-Armería Watershed Commission

Organisational set-up

History

In the Ayuquila-Armería watershed, the problem that led to the creation of the Ayuquila-Armería Watershed Commission[1] (hereafter referred to as 'the Commission') was not one of water scarcity or difficult access, but of contamination (Martínez et al., 2005). As seen in Chapter 3, the upper part of the River corresponding to the Ayuquila portion, had been structurally contaminated by the Ingenio Melchor Ocampo sugar refinery, as well as raw wastewater discharges by the towns of Autlán and El Grullo. This had severely impacted human health and biodiversity since the beginning of the 1980s. But it was the specific molasses accident on 28th of March 1998 that sparked off an important social mobilisation,

[1] Although the Ayuquila-Armería is a watershed, a commission was created (instead of a council) because the future structure of a council was already planned at the time: the Centre Pacific Coast Council will be at the level of the State of Colima, and integrate the three commissions for the three watersheds it includes.

leading to the creation of the Commission[2] (Martínez et al., 2002b). Although its creation had already been solicited and symbolically announced the previous year, in the framework of the Sierra de Manantlán Biosphere Reserve's ten-year anniversary (DRBSM and IMECBIO, 2001), the spill accelerated the course of things. To respond to the citizen uprising which grouped riparian communities living downstream –in both Jalisco and Colima States- the CNA created the Ayuquila-Armería Watershed Commission on October 15, 1998.

It is to be a coordination and negotiation platform bringing together stakeholders with one common objective: to improve the state of the watershed.

Members and meetings

The Commission is composed of representatives from the CNA, the States of Jalisco and Colima and six water uses[3] (agriculture, aquaculture, public and urban, industrial, services, livestock-raising). More precisely, its 19 members are made up of two presidents (the constitutional governors of both States), a honorary president (the managing director of the CNA), a technical secretary (the regional manager of the CNA for the Lerma-Santiago Pacífico region[4]), two governmental representatives (one from the Ministry of Rural Development for Colima, and one from the CEAS in Jalisco), the head of the Commission's management board, and 12 user representatives (one for each use in each State) (see annex 14). The governmental representatives are constant functions, while the users must elect their representatives. Decisions are approved by vote (by a majority).

Also invited to attend the meetings (but without right to vote) are all the governmental dependencies, at federal level (CNA, SEMARNAT, SAGARPA, SEDESOL, CONAFOR, PROFEPA) and State level (Urban and rural development agencies, Ministry of Public Education, Ministry of Health), as well as the municipal presidents or their representatives, universities, higher education institutes and NGOs.

The Commission started operating in 2000, and has since held sessions once every two months more or less (according to the progression of the working groups), officially set in alternating municipalities in the two states, for integration's sake[5].

[2] In that sense we can almost say that the spill was positive, as it triggered a process of consultation and planning in the watershed, which might evolve into something more effectively participatory (Luis Manuel Martínez, personal communication).

[3] These are identified as the main water uses by the 2002 Law on National Waters.

[4] He will be the president of the future watershed organism.

[5] In practice this is not always the case, among other things because of the costs such sessions would impose to small municipalities.

The Commission has four annex working groups, which provide support for specific themes, each focusing on one of the watershed's main problems:

- Lack of water availability, with demand higher than supply in the high part of the watershed, and balanced in the lower part (Working Group Water planning);
- High contamination due to three sources: the wastewater discharges, weak management of solid waste, and excessive use of agrochemicals (WG Sanitation);
- Loss of forest cover due to urbanisation and increase in land use for livestock-raising and extensive agriculture, which leads to less rain, erosion and river contamination (WG IWRM);
- Problem of practices, lack of culture with regard to water and forests (WG Culture).

It seems there is a difference of implication between the two States, both in meetings as well as implementation of concrete actions. For example, Colima is much more active in terms of promoting water efficiency, as it is located downstream and thus depends on how those in Jalisco manage the water (Colima is located downstream from all three watersheds it is part of, which explains why the watershed organism will have its headquarters there). This also played a role in the establishment of the Commission's management board.

Financing and operating

As the Watershed Commission has no juridical personality, it cannot manage finances, nor have a staff, nor sign agreements. This is why it created a management board (in October 2004), to provide technical and administrative support to the Commission, as well as follow-up on the agreements signed between its members. It was an experimental initiative as it was the first such board to be created at national level[6], the objective being to generalize this to all watershed organisations.

Appointed by the state governor of Colima and with headquarters in the homonymous state capital[7], the Commission's management board is in charge of planning water use at the scale of the watershed. As such, it is a major actor in preventing future conflicts between the two States (Martínez et al., 2005). Indeed, Colima is anxious about the fact the Autlán-El Grullo irrigation district is expanding,[8] as well as being technically equipped to use water more

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[6] This was because the conditions were adequate, as the Commission was working in a very regular way (Arnoldo Vogel, personal communication).
[7] This location was decided on common agreement between the two States (for Colima, this watershed is the most important, so the stakes are higher than for Jalisco, where it is the second most important watershed) (Arnoldo Vogel, personal communication).
[8] Currently only 12,000 ha in the valley are irrigated, while 6,000 more are already planned to be included in the municipality of Autlán by extending the irrigation canals.

efficiently, because part of the extra water[9] Colima gets, provides from the irrigation returns into the River.

To finance its operations, the management board was first to resort to a fiduciary fund supplied by the federal and state governments[10]. Other possible financial sources include the CNA regional office and the FIDERCO (Fiduciary Fund for the Development of the Central Occidental Region), which finances regional projects in environmental and natural resources' conservation.

Achievements

Interviewees coincide in that the relationships between the various stakeholders participating in the meetings are harmonious, and this is highlighted as being one of the greatest achievements of the Commission by the head of its management board. The fact the watershed is only shared by two states should indeed be a strength, compared to other bigger such institutions, like in the Lerma Chapala watershed (Arnoldo Vogel, personal communication).

Indeed, the Commission has enabled to reinforce the links between Jalisco and Colima, enabling each state to see itself as part of a whole: "I think that the principal success of the watershed commission is to put us all together, all the participants, all the water users, and get us to accept that we are all part of the same watershed, which we can decide to either take care of, or destroy" (Álvaro Garnes Díaz, Autlán municipality Treasurer).

Hereafter we briefly present the achievements of each working group.

Working Group on Water planning

One of the first working groups to be created (in 2001), it is working on the update of a water balance and availability study in surface water financed by the CNA[11]. The previous study showed that the five upstream sub-watersheds in Jalisco are in deficit, while that in Colima is still in balance, although tending towards deficit. This is because Colima receives more recharge –62% of the total- and is more urban than Jalisco, so it also uses more groundwater

[9] In addition to its concessions from the Basilio Badillo dam on the Tuxcacuesco River.
[10] But this option proved too expensive, so now they have a common account (Luis Manuel Martínez, personal communication).
[11] Published in 2001 and covering the period 1960-1997.

than surface water. Such results led the CNA to decide not to attribute any new water concessions (Tania Román Guzmán, personal communication).

The update, which covers the period 1960-2004, will probably not differ much. As the water demand has not increased (since no new concessions can be attributed), the results are explained by a deficit in rainfall (Arnoldo Vogel, personal communication).

The working group's other major product has been the update of the inventory of water concessions in irrigation units in four municipalities (two in Jalisco, two in Colima)[12]. By confronting the information from different sources – on one hand, the Public Register of Water Rights (REPDA), i.e. the CNA's official inventory, on the other hand the local uses witnessed by the Centres of Support for Rural Development, located in the field- the outcomes show that only 60% of actual water concessions have officially been registered (both for surface and groundwater).

This is because when the CNA was created in 1989, nothing was specified with regards to whom would be in charge of these small irrigation units, and no staff was available to follow-up either. So be it surface or groundwater, many users did not ask for a concession. In the case of groundwater, individual wells were bore by the users without the CNA's help, so these are solely responsible of not having asked for permission and being registered, while in terms of surface water the responsibility is shared, because in most cases the CNA had built the small dams used to store the water (Paula Silva, personal communication).

The possibility of regularization was in general declined, as many unregistered users feared being fined. The consequent status quo might lead the CNA to act as if there is corresponding water availability – attributing concessions even though the corresponding water is being used- that might, in turn, lead to social conflicts. In order to prevent such conflicts, one of the Commission's objectives is going to be to base its decisions on the actual quantities of water used and devise a strategy for a more effective regularisation of non-registered users (Tania Román Guzmán, personal communication).

The working group's hopes are that the CNA integrate this updated database into the REPDA, but nothing is guaranteed, as it has not been formally recognised[13]. Indeed they also think such an update is important for IWRM, as knowing the total quantity of water being used is insufficient: there is also a need to identify the main users and enable them to feel recognised as part of the watershed (Paula Silva, personal communication).

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[12] Similar updates are taking place in three other municipalities.

[13] For the current update of the water availability balance for example, it is compulsory, by Law, to use the REPDA only, so the deficit observed by the working group will not appear.

Working Group on Sanitation

Also created in 2001, this group focuses on treating the wastewaters, a priority for governments at local, state and federal level [14] (Ávalos Verdugo, 2005a). Indeed most municipalities crossed by the River Ayuquila-Armería (18 in Jalisco, 6 in Colima) discharge their wastewaters into it and increasingly feel the pressure to comply with the law prohibiting such practices.

Studies show that to treat all wastewater still lacking treatment in the watershed (e.g. 1,508 l/s out of a total of 1,853 l/s of wastewater produced by both urban and rural areas, e.g. towns and villages), there is an investment need of MXN 114 million for those in Jalisco and MXN 319.6 million for Colima.

A study was undertaken to identify which kind of treatment plant each municipality should set up (Martínez et al., 2005). In 2005, representatives of the working group visited the main towns –including El Grullo- and discharging points in the watershed. They decided to keep only nine monitoring sites out of the 15 initial (in the State of Jalisco: the Corcovado, El Aguacate, the Tuxcacuesco River before its confluence with the Ayuquila and the Ayuquila after the confluence) (Ávalos Verdugo, 2005b).

For example in El Grullo it should be a constructed wetland with mechanic airing, to avoid requiring too much surface (14 ha will be necessary for 800 l/s of wastewaters): "It is like a consulting agency, giving us recommendations with regards to the project for the wastewater treatment" (Manuel Martes Calbán, current director water board of El Grullo).

As a result, the Governor of the State of Colima has invested in a wastewater treatment plant to treat the wastewaters from the conurbation Colima-Villa de Álvarez, until now discharged in the Armería (Ibáñez Lopez, 2005).

In addition, a project to monitor the quality of the River for heavy metals and agrochemicals was to be realised in 2006.

Working group on Integrated Management of the watershed

It emerged in 2002, because of observed land use dynamics (loss of forest cover due to the extension of the agropastoral frontier and of urbanisation, or activities leading to the Tuxcacuesco River's sedimentation). These result not only in loss of biodiversity and

[14] Only 27% of wastewaters in the watershed are treated.

deterioration of the ecosystems but also in creating an unbalance in the local hydrological cycle, leading to less rain (Comisión de Cuenca del Río Ayuquila-Armería, 2005).

Emphasizing that the watershed could not be reduced to water resources only, the working group explores dimensions ignored by the two previous ones: how to increase the water recharge (by promoting efficiency and avoiding deforestation), to obtain more water for irrigation in order for farmers to agree to leave more water in the River for the natural systems; and a broader understanding of the processes leading to the River contamination, in particular agrochemicals that had been ignored until then. Its topic being integration – between water, forests, soil, biodiversity- it is the working group which keeps all the others focused and linked (Tania Román Guzmán, personal communication).

Coordinated by the two representatives of the SEMARNAT in Colima and Jalisco since 2002[15], it is composed of various representatives of state dependencies as well as universities, the Commission's management board and the inter-municipal initiative, through the Biosphere Reserve Directorship and the MABIO Foundation[16].

In April 2006, having finished drafting the terms of reference of a plan for the integrated management of the watershed, the working group was going to submit it to the various actors of the watershed to check whether it adequately reflects their points of view[17] (Tania Román Guzmán, personal communication).

The plan's three phases consist of: first, the description of the actual state of the natural resources, socio-demography and economic activities of the territory. From this database, areas under pressure that require protection as well as environmental conflicts will then be identified with specific analytical maps (such as the water demand per sector, quality of water and sources of contamination, conflicts of use, basic services' coverage in households, etc.). Finally, in a third step, priority areas will be defined, as well as proposals to solve the issues they are confronted with.

This was realised among other things through contacts with the National Institute of Ecology in Mexico City (and in particular Helena Cotler, the person in charge of the integrated management of watersheds), entailing visits on both sides and counselling with regards to the management plan[18]. So with respect to integrated water resources management, the

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[15] The idea is to have a representative from each state for each entity, when possible.

[16] In addition to the Ministry of Environment and the University of Guadalajara, these latter three conform the planning group that defined the programme's terms of reference.

[17] Similar workshops were already held in 2004-2005 to identify the main problems, their causes and solutions.

[18] Although at the beginning of the process, the other working groups were doubtful on the integrated management working group's capacity, and thus asked for such federal support, their participation at the 4th World Water Forum in March 2006 enabled them to realise they were on the right track and gain trust from the other working groups (Tania Román Guzmán, personal communication).

process was far from being a top-down one, diffused at national level by the CNA – on the contrary, the CNA has always been quite resistant to topics other than water resources. For this working group, the definition of IWRM is thus not specifically that promoted by the Global Water Partnership[19], although it does express the same spirit in different words: "It is being aware of the interactions occurring through the management of the territory, of the interactions between water, vegetation, soil, and human beings inside the limits of a certain territory" (Tania Román Guzmán, personal communication). According to the head of the Commission's management board, the tri-partite definition of the Global Water Partnership "is nothing different than harmonizing the objectives of all in favour of one unique: enable the watershed to continue providing environmental goods and services […] and it is this plan that will give us the orientation for that, the integration, articulation, union that we need to coincide all together".

But from a management plan, that for the Ayuquila-Armería Watershed switched to being a strategic plan, e.g. describing the situation, the actions lines and priority locations, without defining implementation procedures as well: "This is what we want, that is stays at this level of generality, as an orientation. Why? Because we saw that the watershed is not an operational scale, at least the watershed taken in its whole territory. The proof was given to us by the work realised by the Inter-municipal initiative, which managed to do a quantity of things with a level of detail that would have been very costly to implement at the scale of the watershed. So we said: 'No, we do our macro plan, and implement it through the municipalities, the inter-municipal initiatives, regions of the watershed, according to their situation of the moment'" (Tania Román Guzmán, personal communication).

This is thus justified by the higher degree and more detailed knowledge of inter-municipal platforms with respect to the problems: "You plan and define priorities at the level of the watershed commission, but you act and make them operational at the level of municipalities or micro-watersheds. At the level of municipality associations –one municipality alone cannot do anything- we see it as very feasible and it has to be reinforced, because that is where the possibility to solve the problems is, as that is where they hurt first and foremost. They must thus be included in the process of elaboration of the management plan" (Tania Román Guzmán, personal communication).

The working group is now identifying priorities for investment –which studies need to be undertaken to complement what already exists- to guarantee continuity in the financial support it receives (Luis Manuel Martínez, personal communication).

[19] The GWP does not work with the CNA, but with the IMTA (the Mexican Institute of Water Technology, a State-owned organisation coordinated by the Ministry of the Environment and Natural Resources); in fact Mexico is not one of the GWP's member countries because of the resistance of other countries in the region (Alan Hall, Global Water Partnership, personal communication).

Working Group on Water and forest culture

The last working group to be created (in 2003) is in charge of information diffusion about the watershed (through various media), while also being the focal contact in the commission.

As part of promoting water culture, they are encouraging the implementation of the user-pays principle. The objective is to motivate people to use new irrigation techniques, such as drip irrigation, supported by the program Alliance for the countryside (financed by the federal and state governments) (Ibáñez Lopez, 2005). Indeed, most irrigation systems in irrigation units are inefficient, because canals, either earthen or made out of sand, tend to lose a lot of water. They are trying to cement these canals or diffuse pressurized irrigation.

Challenges

The difficulties faced by the Ayuquila-Armería Watershed Commission coincide with those of other watershed commissions or councils throughout the country.

Absence of coordination between different sectors using water

Although water management responsibilities are shared between municipalities or water users' associations in the case of irrigation districts, the CNA does not encourage any wide discussions between the different sectors, as it prefers to manage everything directly on a one-to-one basis. So despite the set up of the Commission to provide a platform for discussions, management is still very much sector-based[20]: "And what's more: the CNA does not want that to change. For example, allocation of concessions are not discussed widely, the CNA is the only one to decide" (Luis Manuel Martínez, personal communication).

Another example illustrating the lack of willingness to discuss issues openly was the fact it was not the CNA which called for an extraordinary session of the Commission, when in March 2006, the sugarcane factory was found guilty of having discharged its wastewaters into the River during one whole day, on the contrary: "The CNA came to sample the water five days later…by then the contamination had disappeared of course. …We have to fight the CNA so that they fight those who contaminate!" (Luis Manuel Martínez, personal communication).

[20] Contrary to the cases seen in Chapter 2, where several institutions are in charge – leading to conflicts regarding limits of responsibility- one institution does not guarantee any more an integrated water resources management, as it can lead to even more sector-by-sector management by preventing negotiations.

The event was bound to happen[21], as the agreement with the ejido Las Paredes had been terminated without the factory setting up any alternative system[22]. The very important load in organic material the discharge led to caused oxygen depletion and the death of fish on 10 km (see annex 15). The IMECBIO researchers happened to be monitoring the River, and confronted the factory, which called for an extraordinary session of the Commission. The researchers hoped it would force the IMO to react and take its responsibility to avoid such further events in the future, by finally building its treatment plant (something it has been delaying since 1998, when they had helped set up a provisional agreement with the ejido Las Paredes). According to Tania Román Guzmán, coordinator of the IWRM working group, this event represents the Commission's "ordeal by fire": the Commission's institutions need to be stricter. The problem being that the sugarcane factory, owned by ZUCARMEX, one of the main sugar producers in Mexico, is very strong both economically and politically.

Images 42 and 43: Extraordinary session of the Commission in April 2006

[21] It represents the "chronicle of an announced discharge", as described ironically by Sergio Graf, Director of MABIO Foundation.

[22] The ejido did not want to receive the factory's wastewaters for irrigation purposes anymore, as it was replacing its canals by tubes, in the framework of the ongoing modernisation programme in the valley.

Lack of inclusion of resources other than water

Like watershed councils on a bigger scale, Commissions like the one for the Ayuquila-Armería have the objective of providing a more integrated management of natural resources in the area they cover. But focused on water planning, the Commission was not endowed with such a vision (Martínez et al., 2002; Graf et al., 2003). At the start, its only preoccupation was supplying water for irrigation in the two states, the important elements being the dams and the irrigation districts: "This is why is was useful that the working group on IWRM was created, even though it has only drafted the terms of reference of the management plan up till now, due to insufficient financial resources to do anything else" (Luis Manuel Martínez, personal communication).

Another element illustrating the fact resources other than water are not much taken into account is that ecological uses of water have not yet been identified among the most important uses, thus requiring a user representative. This will nevertheless come into effect once the regulation of the law is published, and it is the president of the inter-municipal initiative who will occupy that function (Luis Manuel Martínez, personal communication).

It is in this context that researchers from the IMECBIO are working on setting up minimum environmental flows, by realizing a historical analysis of the River flows[23], to restore its natural flow. Indeed, at the time of the building of the dams, the concept of environmental flows did not exist (according to some, they have not been necessary due to the recharge of the River by irrigation return flows, nonetheless these are bound to decrease with the expansion of the irrigation district in Autlán). Nevertheless the CNA is planning to keep 5-10% for biodiversity needs, based on a study undertaken by the IMTA[24], but this is dependent on regulation's publication.

So meanwhile, the abrupt variations in the water flow due to dams and derivation systems for irrigation provoke the opposite result than natural variations would: during the dry season there is more water (water being released from the dams to irrigate) than during the rainy season (when water is on the contrary stored in the dams).

For example, in the case of the Autlán-El Grullo valley, during the dry season (from November to May), i.e. when the crops need to be irrigated, water is released from the Tacotán and Trigomil dams, and "canalised" through the Ayuquila River. When it reaches the El Corcovado diversion station with a flow of 10m3/s, it is diverted through two main canals, one towards Autlán, the other towards El Grullo and El Limón. This reduces the river flow volume by 97% on average, resulting in a dried up riverbed along a portion of 3 to 5

[23] By comparing the flow for each season before and after the building of the Tacotán and Trigomil dams.
[24] According to Dr. Martínez, the regional expert, this figure is not based on any preliminary scientific study.

km. Then with irrigation return flows and sewage waters from Autlán and El Grullo, the riverbed fills back up, reaching five m3/s at Palo Blanco and eight m3/s at Aguacate. On the contrary, during the rainy season –from June to October- there is no irrigation and no use of water by the sugarcane factory, but the flow is not very important either before the Autlán sewage discharge, because of water storage in the Trigomil Dam (to prepare the future irrigation season) (Martínez, 2003).

These totally artificial processes affect the River's biodiversity, a typical example being the shrimps that regularly die due to the drying up of the River during the dry season, when they migrate. This happens both in the Ayuquila and the Armería Rivers.

Image 44: Dried up River after Corcovado in Jalisco

Image 45: Bridge over the Armería River in Colima

Source: Tania Roman Guzmán, SEMARNAT-Colima

In order to calculate the minimum environmental flows that would be required to avoid such problems, the IMECBIO team is also working with a Mexican Long Term Ecological Network initiated by the UNAM, to determine the water needs of different ecosystems (River, forests...). Indeed, as highlighted by Niasse et al (2004), it is frequently the informational gaps linked to ecosystem water needs that lead to bypassing the environmental dimension in the holistic approach of IWRM.

Low degree of participation in watershed management

Like all other watershed councils or commissions in Mexico, the Ayuquila-Armería Watershed Commission is criticised for the feeble participation of the multiple social actors present on the corresponding territory.

This is due, on the one hand, to a very restrictive admission. Only the six identified water users have a right to vote, while fishermen are ignored[25]. Similarly, "water producers", as Martínez et al. (2005) call the landowners situated in the upper part of the watershed, are not considered either in the management process (this is officially justified by the fact only water users are considered).

Further, civil society participation is very low as well, as neither universities, nor municipalities, public nor private organisations have a right to vote (although they have a right to talk):

"I have concentrated on the inter-municipal initiative, because in the Commission I know that I can't obtain more concessions, I know I have no right to vote, there are lots of reasons…so I can't stop working on important things for the municipality to just go and listen. […] There is a good participation but not many outcomes. […] There are good intentions, but there is a lot of conformity, nothing much can be done, […] there is not much room for change" (Jaime Almaráz Garibay, municipal president of Tuxcacuesco).

"As a municipality, one can go, but you seldom have a right to speak. You just attend, you listen because you aren't part of it like them. They just invite you because you are a municipality part of the watershed. And well, when you ask for it, yes, they give you the right to speak, but more than anything you go to be aware of what is going on in the Commission" (Ernesto Guerrero García, general secretary of Unión de Tula municipality).

Three other reasons explain why participation of users or municipalities (or both) is feeble.

[25] According to the head of the Commission's management board, they are barely starting to ask to be included, but they are frequently organised in fishing groups, which should help to elect a representative.

The first is a lack of communication. Municipalities located in the upper part of the watershed (in the Sierra de Quila and Sierra de Tapalpa) are not even aware of the Commission's existence. Its meetings have been attended only by the representatives of two municipalities, Autlán and El Grullo, which are both regional leaders (respectively for the region of the South and the region Sierra de Amula), so they have more financial resources for that and in addition have been sensitised to the importance of the Commission through the inter-municipal initiative.

The second factor has to do with logistics: the fact the watershed involves two states makes it more complicated in terms of administration. This is true both to elect user representatives – the users fail to organise themselves for this purpose, so these are usually designed by the CNA[26]- or to attend the Commission's meetings. These take place alternatively either in Colima (in the cities of Colima or Comala) or Jalisco (in Autlán or El Grullo), which entails important travelling costs for those users who do not have the budget for it –e.g. all, apart from the Water Users' Association: "All municipalities of the watershed are invited, and have a right to attend. But when the meetings are held in Colima, the distance is what explains that many municipalities don't go (they don't even send anyone), in addition to the many engagements we already have" (Ernesto Guerrero García, general secretary of Unión de Tula municipality).

Indeed, time-wise, municipal presidents also rarely have the freedom to participate to all the meetings they are invited to: they attend the Commission's meeting when these take place in their municipality, otherwise they give priority to those where they can negotiate financial resources for their municipality[27]. Another option being to send the deputy: "There has been a slowing down in the municipal participation: when they are first elected they have to go, to get to know the Commission better, and to get known as well, but then when they really start to implement their municipal programmes, they don't have enough time to go and send the deputy representative instead". For example, in this Commission, Autlán's municipal president is the representative of urban use for the municipalities of the State of Jalisco, but it is essentially El Grullo's water board director who has participated in the meetings (replacing his municipal president, the deputy for such uses).

Finally, a third factor is the fact that up to now, the users who have participated have not seen any effective benefit resulting from their attendance[28]: like in other such commissions or

[26] In the particular case of the urban users, it is very complex to get the 20 municipal presidents from the State of Jalisco to meet to elect a representative (it is already difficult with the ten participating in the inter-municipal initiative!) (Luis Manuel Martínez, personal communication).
[27] In some cases meetings dealing with natural resources can also bring them financial resources.
[28] And unless this changes, they will continue to consider such meetings as a waste of time (Luis Manuel Martínez, personal communication).

councils, the participatory component of the meetings is more a question of formal consultation than of real decision-making (Martínez et al., 2002b).

Indeed, during the watershed council meetings, no discussion takes place around what the priorities of the watershed are, although officially, each working group presents their project and corresponding budget, and the Commission presents these projects and asks the different institutions for corresponding resources. In practice, decisions related to investments are usually made prior to the meetings, by the actual decision-makers –the abundant representatives coming from the CNA, central agencies or State authorities (Luis Manuel Martínez, personal communication). These decisions are simply announced during the meeting, and in any case, these institutions have the power to influence the vote with respect to investment decisions. By disregarding so openly the very principle of participation the Commission is supposed to encourage, the CNA reveals the little importance it gives to such institutions, considered little more than its appendixes. The watershed's future management plan should enable to counter this, by canalising financial resources where the watershed's actual priority needs are (Luis Manuel Martínez, personal communication).

The situation is of course even worse for those without right to vote, like the municipalities:

The working groups should communicate more with the municipalities, because the municipality knows the water issue very well: "Although we have received invitations, the truth is we have had little motivation to go: 'Ah… an invitation from the watershed. I go, I listen, and the truth is that they talk about themes I don't even know about and that have no implication for my municipality. The only theme for me that is a problem is that of wastewater treatment and they haven't given much follow-up, so this doesn't interest me much […] They need to involve the municipalities more, motivate them…show us that our problem is being solved" (Ernesto Guerrero García, general secretary of Unión de Tula municipality).

This situation is supposed to change with the innovations brought by the reform to the Water Law in 2004. It is expected to reinforce user participation (reaching a minimum of 50% of attendees) and lower that of governmental representatives, from the three levels (to a maximum of 35% of participants). More municipal participation is expected as the municipalities are going to have both right to speak and vote (in watershed commission and councils), while they are also going to be part of the future watershed organisms, through the consultative council. These watershed councils are going to be a way to suppress some of the sub-directories of the CNA, centralized in Mexico, as they will be established on a regional basis, enabling better and faster results than the ones we have now (Arnoldo Vogel, personal communication). Further, non-governmental actors will be given the right to participate and vote (it is through this category that the inter-municipal initiative hopes to be able to participate onwards, as for the time being it had obtained a right to speak and vote, as representative of ecological uses under the scheme in place prior to the reform).

Absence of real independence of watershed councils from the CNA

As clearly illustrated by the way decisions are taken during the meetings, the Commission is a medium for discussions where agreements of good faith are signed, but which has no real decision power as such. The fact it has no say in the way water is allocated is the utmost proof of this: "Due to the hierarchy, those which are the representatives of the States, the CNA, the CEAS, can have more decision-making power, they say: 'I can obtain this or that'"(Manuel Martes Calbán, director of El Grullo water board).

Another deficiency of the Commission is the fact that it drastically lacks in human, material and financial resources.

"The Commission…needs to undertake more studies. […] I know they lack financial resources, so that complicates things a little. We have visited watersheds in the USA where the management is totally different and in Canada as well. They exploit the watershed for tourism, agriculture, to supply domestic water in cities, and they have a lot of money, so this helps to have a very good management" (Jaime Almaráz Garibay, Municipal president of Tuxcacuesco).[29]

They have many problems to finance their operations, as the budget they have to negotiate each year enables to cover the salaries of the management board employees, its operational costs and the studies they have contracted, but it barely leaves anything else to operate. There is a lot of competition for the financial resources attributed by the various dependencies that participate in the Commission, so they need to promote the watershed's problems.

Since 2004, the yearly budget reached MXN 1 million: the CNA transfers MXN 500,000, matched by the two states' MXN 250,000 each. But the money arrives late (in April 2006 it had still not arrived for the coming year from the CNA, which mainly invests in the Lerma-Chapala watershed) and is insufficient.

[29] Every three years, as part of the 'initiation' of the newly elected municipal presidents, the Inter-municipal Initiative finances trips to visit inter-municipal activities in both Canadian and American watersheds, to observe the different options in place related to local watershed management, which include mechanisms for solid waste recycling, water treatment at different scales, institutional linkages, citizen participation and protected areas (Graf et al., 2006).

They hope that with the future change in the structure of the CNA, once the watershed organism exists (in Guadalajara), there will be no need to go ask the CNA's offices in Mexico City. It should be easier to obtain more, and thus contract other persons to undertake the studies (Arnoldo Vogel, personal communication).

b. The Inter-municipal Initiative for the Integrated Management of the Ayuquila River Basin

Organisational set-up

History

In 2001, the weak capacity demonstrated by the Commission to respond to municipal priorities (in particular the restoration of the River quality) led to the creation of another regional governance mechanism for environmental management[30] (Graf et. al., 2006).

Acknowledging the importance of including municipal governments and developing inter-municipal networks in the framework of watershed management – in particular between municipalities sharing the same ecological and socio-economic issues (Martínez et al., 2005; Martínez et al., 2002b)- the Inter-municipal Initiative for the Integrated Management of the Ayuquila River Basin (hereafter the Inter-municipal Initiative) was created on 25 July, 2001[31].

Such an institutional platform for discussion and decision-making resulted from a workshop held at the IMECBIO to support regional development, and was jointly developed with the Directorate of the Sierra de Manantlán Biosphere Reserve. It results from a ten-year process of trust building among the stakeholders in the region (Martínez et al., 2005; DRBSM and IMECBIO, 2001). El Grullo played an active role in its informal consolidation, as it was there that the programme on solid waste separation was initiated and that the researchers from the University lived. It has since maintained this position of regional leader (along with Autlán), stimulating other smaller municipalities to join in.

The idea of the inter-municipal collaboration is to explore how to incorporate various elements for an integrated management on a portion of the watershed (Graf et al., 1996). Coordinated actions are to increase their efficiency, by enabling more results with less investment for each municipality. The objective is to incorporate sustainability criteria in

[30] The Commission's priority was the distribution of irrigation water between the states of Jalisco and Colima, and did not address the river pollution, which was the local population's priority (Graf et al., 2006).
[31] It was originally called the "Local initiative for an integrated management of the lower Ayuquila watershed", as these municipalities are all located in the medium part of the Ayuquila-Armería watershed, which corresponds to the lower part of the Ayuquila watershed.

local governmental planning: emphasis is placed on sound environmental planning in order to improve the life standards in the basin, while increasing the productive capacity of the natural resources in order help municipalities in their task and develop a more participative management of natural resources (DRBSM and IMECBIO, 2001; Graf et. al., 2003).

Its six specific objectives are to:

- Improve the living conditions of the local population, through an adequate environmental management that increases the productive capacity of the natural resources in the Ayuquila watershed;
- Promote the conservation, restoration, and sustainable use of water, soils, forests and biodiversity in the Ayuquila watershed;
- Strengthen the institutional capacities of the municipal governments and of the local citizen organisations and academic institutions for an integrated management of the Ayuquila watershed;
- Support the coordinated participation of the three levels of government and local actors for an integrated management of the Ayuquila watershed;
- Stimulate processes of environmental education that enable the adequate public participation in the management of the Ayuquila watershed;
- Manage the links with governmental and non-governmental instances of local, national and international level, for economic and other types of support for the projects of integrated management of the Ayuquila watershed (IIGICRA, 2003).

Members and meetings

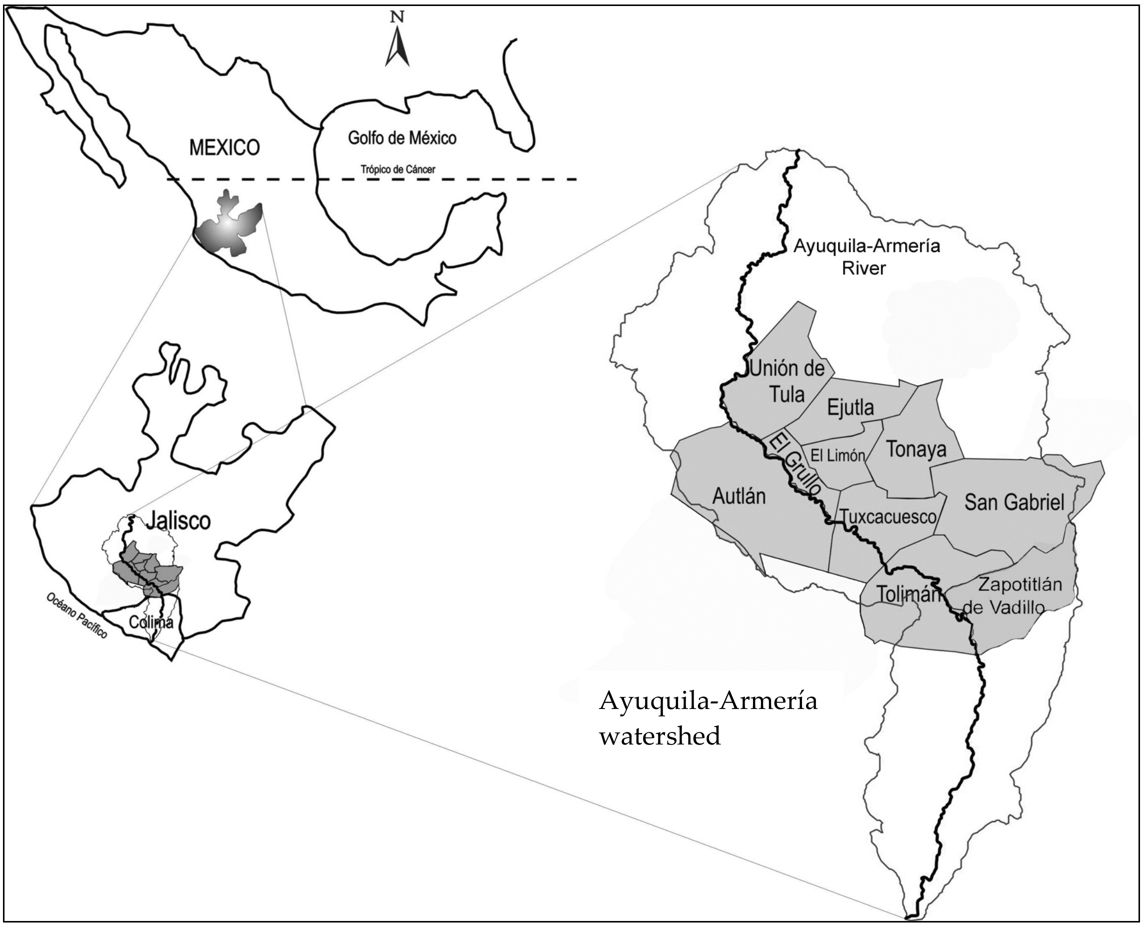
Originally grouping eight municipalities (Unión de Tula, Autlán, El Grullo, El Limón, Tonaya, Tuxcacuesco, Tolimán and Zapotitlán de Vadillo), the Inter-municipal initiative currently convenes two more (Ejutla and San Gabriel), all part of the Ayuquila watershed, i.e. in the State of Jalisco (see map 25). Also participating are representatives from the federal government, such as the Sierra de Manantlán Biosphere Reserve and the Jalisco State Rural Development Secretariat, academic institutions like the IMECBIO, and a local NGO, the Manantlán Foundation for the Biodiversity of Western Mexico (Graf et al., 2006). These 14 members whom compose the technical committee have a right to speak and vote, and hold meetings every month approximately[32]. They are in charge of defining the Initiative’s long-term strategy, deciding on priority actions and evaluating their implementation.

[32] The President of the initiative is supposed to change every six months, but it lasts on average a year to follow-up the activities.

The fact the representatives from the University of Guadalajara, the Sierra de Manantlán Biosphere Reserve and the MABIO Foundation participate in the Commission's meetings as well as in those of the Inter-municipal Initiative, might explain why small municipalities part of the Initiative do not feel the necessity to go to the Commission's meetings (in addition to their financial restrictions or their lack of motivation to go). These three major actors indeed tend to act in the benefit of the municipalities during these meetings, while also giving them feedback of the Commission's meetings during the Initiative's meetings:

"The Commission played an important role, helped us embark on many problems that we needed to solve, but the most direct way to do it is through those from MABIO, the SMBR and the UdG, who participate in the Commission, they are our spokesmen (and have vote), because they know our issues, and they give us follow-up, they have helped us to inform the Commission of what is going on in our municipalities. If they didn't participate, there wouldn't be any benefit for the municipalities. As they are both part of the Commission and the Initiative, they know us well, and then we are informed of what is going on in the Commission" (Ernesto Guerrero García, General Secretary of Unión de Tula).

Map 25: The 10 municipalities part of the Inter-Municipal Initiative cover the medium part of the Ayuquila-Armería watershed



In addition to these 14 members, any other organisation can participate in the meetings, although without right to vote. This is the case of the head of the Ayuquila-Armería Watershed Commission's management board (the Initiative has been formally accepted as part of the Commission).

Among the various national and international collaborators the Inter-municipal Initiative counts are the Universities of Wisconsin (USA) and Guelph (Canada), as well as the Credit Valley Watershed Authority from Ontario.

Financing and operating

Financially speaking, working on a regional basis through an inter-municipal agreement has two advantages: on one hand, it enables to capture more support and financial resources, on the other it enables to realise much more, with reduced costs for each municipality[33] (Luis Manuel Martínez, personal communication).

So to finance the very specific priorities identified by the participating municipalities, a trust fund was set up one year after its creation, with the support of the federal and state governments and the municipalities, which contribute an equal amount each (25% of what they receive back) (IIGICRA, 2004). It has increased each year, starting off with MXN 1 million (USD 100,000) in 2003 to reach MXN 4 million (USD 400,000) in 2006 (Graf et al., 2006).

Each municipality receives the same amount back for its specific uses in its municipality, but part of the money is spent on collective expenses. For example, in 2005, each municipality put in MXN 20,000 and received MXN 80,000 back to reinforce its infrastructures, while MXN 700,000 were spent on the Geographical Information System, environmental education, anti-fire brigades, for all ten municipalities.

In addition, if one specific municipality is impacting all the others, it is also possible to concentrate resources to help it resolve the issue: "They will try and resolve the problems of the involved municipalities in an upstream-downstream way, starting with Unión de Tula's problem with solid waste and wastewaters, then Autlán's, and so on. Of course, in practice it might not be possible to follow exactly the order of the municipalities from upstream to downstream, because of political problems impeding an upstream municipality to undertake

[33] For example, in 2006 all municipalities belonging to the Initiative have contributed to contract two anti-fire brigades, which go where is needed in the ten municipalities (something the municipalities alone could probably not finance, especially the small ones).

what it wants (such as buying land for the constructed wetland in El Grullo)" (Armando Nuñez Ramos, former municipal president of El Grullo).

Preference has been given to those polluting more and impacting those downstream: "Here MXN 12-15 millions more are necessary to finish the constructed wetlands and we don't have the money. This was discussed in the meetings of the Inter-municipal Initiative and the Commission, but Autlán was helped first even though Unión de Tula is more upstream, because Autlán is bigger and pollutes more (Ernesto Guerrero García, General Secretary of Unión de Tula municipality).

Achievements

According to the interviewed municipal presidents or their representatives, the Inter-municipal Initiative is very successful, and has generated very important results for the region. It provokes enthusiasm, illustrated by a high rate of participation among them.

The results range from improvements in the Ayuquila River quality, the implementation of municipal solid waste separation and recycling programmes, greater citizen awareness and implication through environmental education programmes, as well as information made available regarding environmental and socio-economic links (Graf et al., 2006).

"As the name shows, it was an initiative of the people, but supported by the institutions, especially, in the first phases, by the SMBR and the UdG. And although it has suffered a series of…let's say, attacks…the results are really impressive, for those who lived and knew the problems, there are huge changes! Personally, I am very lucky because I have seen the River when it was clean, when it got contaminated and now that it is clean again" (Daniel Ramírez Sánchez, municipal president of El Limón). Previously, the River was indeed comparable to a 'wastewater canal' (Martínez et al., 2005).

"It is an interesting success…it is a group of municipalities preoccupied by the health of the Ayuquila River. And they have managed to realise quite interesting things, because if the State Congress is supporting us financially –and increasingly- this means that there are results, doesn't it?" (Antonio Mendoza Olivares, municipal president of El Grullo).

The first priority themes were the Ayuquila River quality, and solid waste management. In March 2003 a workshop was held during which the 8 municipal presidents agreed that the issue of solid waste management was the most urgent to be dealt with, and it came out of the studies used for this workshop that in all the municipalities, on average 50% of the solid waste is organic, e.g. can be used by the municipalities for compost, whereas 24% is recyclable (9% cardboard, 8% plastic, 6% glass and 1% steel).

Image 46: Workshop on solid waste management in 2003

Source: IMECBIO

This topic was chosen because it was one where there were already some advances that could be shown (the separation programme in El Grullo started in 1994), to encourage more participation from other municipalities (and avoid making the same mistakes[34]).

"This year [2003] the municipalities will spend MXN 65,000 to rehabilitate their centres to store separated solid waste (except for Autlán whose centre is already modernized, with a cement ground). They need to do this to show something concrete to the municipal counsellors, so that they see that the fund is worth the effort" (Armando Nuñez Ramos, former municipal president of El Grullo).

"We perceive [the financial support] more [than that of the Commission] because municipalities receive direct financial support. Probably the Commission manages more money, of course, also because the States are there, but as a municipality you receive more, even if it is little, it represents more, because the Commission doesn't give you financial resources. For instance they have received money to build their separation centre for solid waste and prepare a truck for the collection, and consulting to restore a site. This does not interest the Commission as much, as they are more interested by water and wastewaters" (Ernesto Guerrero García, General Secretary of Unión de Tula municipality).

A certain asymmetry has emerged, regarding the municipalities' implications in the two themes: "For El Grullo and Autlán, the River is a recreational area, whereas more downstream the communities are much more dependent on the River, for them it is an area vital for their survival. So the value of the River is not the same: upstream they are more active with regards to the solid waste, while downstream they are more active with respect to the River contamination[35]" (Sergio Graf, personal communication).

[34] For example, in El Grullo, the fact of giving out little presents to encourage household separation of solid waste will not be replicated in the other municipalities due to the abuses this led to.

[35] Even though the production of solid waste is of the same type, with similar consumption trends such as soft drinks, which produce a lot of plastic bottles (Sergio Graf, personal communication).

With regards to environmental education, some highlight changes of attitude in terms of awareness, of collaboration

Six strategic actions have been identified at a workshop: spatial planning, public participation, strengthening the institutional capacity of local government, solid waste management, restoration of the headwaters of the Ayuquila watershed and environmental conservation in the upper part of the basin (Graf et al., 2006). Now that the initiative has been reinforced, the theme of water has started to be incorporated as well[36].

Among the activities planned for 2005 were:

- Database on land use changes and capacity-building for each municipality;
- Public awareness through the development of a web page for the initiative, the creation of a citizen council (a technical group that will be part of the municipalities without changing with electoral changes) and the programme of environmental education based on various media (visits to schools, radio emissions, songs, theatre, regional art contest, etc.);
- Better institutional capacity in the municipalities through their regulatory and legislative frameworks (design of environmental programs for each municipality, enhance the regulations (ecological regulations, to have the same context for all), workshop on strategic environmental planning, workshop on new legislative framework for water and watershed;
- Reduction of water contamination and further river health activities and restoration of the Ayuquila riverbed (diagnosis on the municipal water and sanitation system in the municipalities which mostly contaminate e.g. Autlán, El Grullo and Tonaya) and supervise the payment of taxes by the sugarcane factory.
- Correct management of the solid waste (improve the waste collection centres in Autlán and El Grullo, provide basic equipment for those in Tonaya and Toliman, and build such centres in Tuxcacuesco, El Limón, Zapotitlán de Vadillo and Unión de Tula).
- Prevent forest fires and promote the Programme on Payment for environmental services as an incentive to protect the forests.
- Integrate new municipalities in the initiative and the trust fund: those of Ejutla and San Gabriel (IIGICRA, 2005)

The link between the Inter-municipal Initiative and the Watershed Commission is quite positive as well: "Now it is very good because there is starting to be a link between a higher territorial scale, and a more operational and functional one, and we need to reinforce this

[36] For example, in 2006 a study was led to assess the coverage of water and sanitation service in the watershed, and efforts made to have municipalities consider water as a human right, to guarantee its supply in small communities (Graf et al, 206).

relation. How? By getting the 14 institutions from the two States and part of the Commission to support the Inter-municipal Initiative, answering its questions, looking for financial resources or ideas and by communicating information. At the beginning the two were without any interaction, now they have both seen that it is possible to work together "(Tania Román Guzmán, personal communication).

"There is mutual support, we share information, capacity building workshops. I feel the Initiative is part of the team. They already have numerous successes and for us this is very positive, as the more they take care of the water upstream, the more water we have here downstream. So we see it as something necessary, important, that we must support" (Arnoldo Vogel, head of the Commission's management board).

Illustrative of such concrete beneficial processes it helped implement, in 2005 the Initiative won a prize at national level[37] that distinguished five finalists out of 440 environmental projects, which should help bring more money in addition to more recognition: "An interesting aspect of the Inter-municipal Initiative is that they are starting to be known throughout the country: in July 2005 municipal presidents from Yucatán State came to visit, and then they went to visit in exchange, and in February of this year people from Sinaloa State came to our last meeting to see how it works. The initiative has helped make our experience be known. And the prize will help to diffuse this" (Álvaro Garnes Díaz, Treasurer of Autlán municipality).

Challenges

Despite all these very positive results, the Inter-municipal Initiative is faced with several challenges:

First, it must increase visibility to capture more resources. Indeed, the main weakness of the Initiative is that it remains highly dependent on political alliances for financial support (in particular at State level).

Then, it needs to ensure continuity despite the very short three-year term municipal mandates, and the political changes these often lead to[38].

"The people who are behind this initiative (those from the IMECBIO) work very hard, but unfortunately each three years the municipal presidents go away. On the contrary, the former stay, give continuity to the project on a long term, so they lose a lot of time to come

[37] The Mexican National Award for Local Government and Management (financed by the Centre for Economic Research and Education, along with the Ford Foundation) (Graf et al, 2006).
[38] Such changes often lead to abandoning all the projects undertaken by the past team in place (Graf et al, 2006).

back, raise awareness, convince again of the necessity to be part of it" (Antonio Mendoza Olivares, municipal president of El Grullo).

To do so it is important to institutionalise the Initiative, so it tries to gain citizens' acknowledgment of its concrete outcomes for their everyday life (as is the case with the programmes for solid waste separation and recycling or forest fire prevention), in order to be seen as a positive electoral issue by all candidates, whatever the political party.

"[That the next municipal presidents follow in the Initiative]… this is the most difficult part. The better it is known, the more difficult it will be to stop it. So these days, we have to work to make it well known. So that if a new municipal president arrives saying: 'I'm not interested' – 'Oh no?' Well, the population is going to tell you differently'" (Armando Nuñez Ramos, personal communication).

"With the solid waste programme in which we are already working on […] I think that with this, the President that will be elected [in July] will have to go on, because the population is already asking why we aren't already doing this, so if they realise that this initiative will bring them a lot of benefits, they are going to oblige the new President, whoever he is, to continue" (Ernesto Guerrero García, General Secretary of Unión de Tula).

They are careful not to interfere in the political agendas of the parties, and work with them only once they have won the elections (Luis Manuel Martínez, personal communication): "After the elections, there are meetings with the new presidents to inform them of what the initiative is doing, already giving them follow up. And here important is the fact the people working in the UdG, SMBR and MABIO don't leave, they stay, they involve the Presidents so that they continue. This is what happened to us, and they managed to capture our attention to continue the programme. […] In the beginning the first meetings you don't know anything about it, it is a totally new issue, you don't know what it is there for, but as they don't leave you alone, they keep on inviting you, on informing you, it captures your attention, they keep on inviting you until you understand the ideas and suggestions, and then you go on, because they are truly great!" (Ernesto Guerrero García, General Secretary of Unión de Tula).

Usually they try and leave the politics out of the Initiative:

- "Here the political parties stop existing" (Daniel Ramírez Sánchez, municipal president of El Limón).
- "It is something that has been working very well: there are three political parties in the 10 municipalities (PAN, PRI and PRD) but independently from the political parties, there is a good connection, a good disposition towards the others: the colours of the parties stays aside. […] Because in the end, we all live here, now we [the PAN] are here, and they [the PRI and PRD] are there, but sooner or later it will be the

opposite, so the relationships are going to have to go on" (Álvaro Garnes Díaz, Treasurer of Autlán).

- "This is the most important: they are like one great family, uniting different parties through peaceful meetings and they have managed to sign agreements" (Antonio Mendoza Olivares, municipal president of El Grullo).
- "It is something very interesting. Currently there are 3 political parties participating, through the municipal presidents involved in the Initiative, but there is a lot of respect, we don't embark on political themes, there are no political interests, instead there is a strong support and friendship that has enabled us to coordinate with each other with regards to these themes and others" (Ernesto Guerrero García, General Secretary of Unión de Tula).

The candidates are conscious that the environmental theme must be included more (Luis Manuel Martínez, personal communication). It seems they have already started to realise this challenge: in 2003, in spite of the change of party in five municipalities, the new mayors decided to pursue the implication of their predecessors in the Initiative (Graf et al., 2006):

"It got stronger with the past administrations, and none of the current MPs hesitated about incorporating it, all wanted to, we all entered with a lot of enthusiasm, to give it continuity. And I am sure that the presidents that are going to start next year will also want to give continuity to this programme…Because unfortunately, in Mexico, we do not have such a culture: if the PRI wins, it manages its programme, then if the PAN wins, it changes it 100%. This is a very serious issue. On the contrary, this programme of the Inter-municipal Initiative has been something that has been given continuity. In the initiative, there have been presidents of the three most important political parties, and all three have been president of the initiative. And now the current candidates, those that don't involve themselves in this programme, will not be supported by the population" (Daniel Ramírez Sánchez, municipal president of El Limón).

But frequently it was also mentioned that a few municipalities are not very implicated: "Some are really not very interested in the initiative: 50% are very involved, 30% more or less and 20% very little" (Jaime Almaráz Garibay, municipal president of Tuxcacuesco).

Another path currently under exploration is that aiming to increase municipal capacity building for environmental management, through the employment of "specialist civil servants without affiliation to political administrations" (Graf et al., 2006: 306). This would enable these to "remain in post through several successive political administrations, which would give continuity to public policies for environmental and natural resources management in each municipality" (Graf et al., 2006: 311).

3. Summary of chapter

In the first section of this chapter, we saw that municipal efforts towards an IWRM at local level are especially constrained by the lack of independence of municipal water boards to fix the water fees. This problem is at the core of the vicious circle then generated: an unbalanced budget prevents ensuring good maintenance and extension of the infrastructure, thus a good quality service. Combined with the system of payment by fee, this can result in even less cost recovery for the water board budget, while delaying the treatment of wastewaters which continue to impact downstream riparian communities and aquatic biodiversity.

Efforts are nonetheless being undertaken at different levels to face this, either by fixing leaks, co-financing new tanks with communities, or setting up a public-private partnership to cover the operation costs of a natural treatment plant. We think the municipality's separation of services from the municipal treasury plays a crucial role in encouraging the development of such a demand management approach (fixing leaks, metering, recycling of wastewaters) along with a more traditional supply-oriented one, because it seeks to suppress all un-necessary costs more actively than if it needn't finance its operations through its fees. Therefore such an administrative scheme can be seen as a stepping-stone on the path towards an IWRM from a local point of view, even though more decentralisation is required to entail substantial progress.

In the second section, we focused on the realisations and difficulties faced by two regional initiatives El Grullo is part of, designed to implement an integrated water or natural resources management on two different scales inside the Ayuquila-Armería watershed.

If the Ayuquila-Armería Watershed Commission seems quite criticised for the lack of interest it imparts municipalities (as well as other users or the civil society), there is hope this might change once the reform of the National Water Law of 2004 –which recognises them as stakeholders- is made effective. The reform should also allow for a better inclusion of natural resources other than water, encouraging for instance the set up of minimum environmental flows in the River. Indeed, although in this respect the Commission has made progress due to the influence of its working group specifically dedicated to IWRM, it is still limited in the work it can actually carry out due to its limited financial resources. Most important, for the Commission to evolve towards an effective integrated management requires that it enable for a 'real planning' to take place, i.e. that decisions related to priority investments in the watershed be discussed between all its members, instead of being defined beforehand by the investing institutions as is the case today.

As for the Inter-municipal Initiative, smaller scale and more flexible than the Commission, it has managed to implement more activities with effective results (a cleaner River, the promotion of a greater environmental awareness, the diffusion of solid waste separation and recycling programmes among others). Closer to the municipalities' preoccupations, it seems to have now gathered sufficient momentum to secure its existence in the long run, even though this remains one of its main challenges, due to important political turnover every three years in the municipalities.

Confirming its success, it is beginning to be nationally known. Also very interesting is the fact the Commission, acknowledging the difficulty to implement IWRM at the scale of the watershed itself, has the project of replicating the Initiative's experience so as to have four such municipal associations covering the watershed[39], as more operational levels of implementation.

Finally, we can say that both initiatives, although to different extents –both geographically and in-depth-wise- have enabled to set up efforts entailing an evolution from what Calvo-Mendieta (2005) calls a 'passive and forced upon solidarity (due to geographical proximity)' to an 'active solidarity and an organisational proximity', allowing to better overcome interest conflicts with regards to water uses, and thus playing a positive role in terms of IWRM.

[39] There would be two in the higher part (regional municipal committees have already been set up to protect the forests Sierra de Tapalpa and Sierra de Quila), one in the medium part (the Inter-municipal Initiative) and one downstream, in Colima (see map 25).

CONCLUSION

Main findings

In this concluding chapter, we first wish to answer the questions that guided our work. As a reminder, the general objective of this research was to analyse the concept of integrated water resources management (IWRM), in order to identify the necessary local conditions for its practical implementation. The guiding research questions were the following:

Research question 1: In what respect is an IWRM innovative compared to traditional water management?

Research question 2: How is the potable water management system designed in the municipality of El Grullo, Mexico?

Research question 3: What are the local and necessary conditions to implement an IWRM?

We first questioned the innovative components of IWRM, compared to traditional water management. In Chapter 1, we presented an overview of the various theoretical approaches to IWRM, designed to overcome the problems of water management that have led to the global water crisis we are faced with today, by being more inclusive of various water uses – human or not. The concept's evolution reflects that of the relationship between humankind and natural resources during the past century, and currently embodies the values of our post-industrial society: integration, participation/negotiation, awareness of limited resources and management.

Despite the growing worldwide promotion of the concept, it still encounters major applicability problems: resistance to integration and cooperation between institutions maintains status quo and preserves sector-by-sector management; moreover, the environment is often the weak link of IWRM due to insufficient scientific knowledge regarding its needs in terms of water, and because of a lack of political commitment to undertake the necessary reforms. Indeed, the most important obstacle to implementing IWRM is perhaps the fact it entails making trade-offs between water for human uses or for the environment, hard choices which are far from the ideal conferred by its most well-known definition today, promoted by the Global Water Partnership.

Our second research question led us to investigate the public water management in the municipality of El Grullo.

After having broadly presented the region of study and the municipality in Chapter 3.1, in Chapter 4.1, we presented this system, operated by the municipal water board, in charge of supplying water and sanitation to the capital town as well as the villages. In spite of being a municipality rich in water resources, the public water service is of very unequal quality, leading most households to resort to a variety of water storage practices, as well as alternative sources of water –like wells- whenever possible. Combined with a payment system of fixed water fees, the disparities between neighbourhoods in terms of frequency, hours and water pressure contribute to create an unfair system. As far as sanitation is concerned, the water board's financial constraints and the lack of political priority attributed to the issue of wastewater have up to now upheld the building of a treatment plant, despite increasing legal pressure. Consequently, those riparian communities living downstream from the municipal capital's wastewater discharge continue to be subjected to opportunity costs, in terms of fishing or recreational activities.

Our third research question focused on defining the local and necessary conditions required to be able to implement an IWRM in the municipality of El Grullo.

As highlighted in Chapter 4.1, to better implement IWRM at a local level, i.e. through its provision of water and sanitation services, the municipality needs to acquire more independence to be able to determine its water fees –with water pricing based on costs and not on political considerations anymore, as is the case in State Congress. But the municipal board's cost-recovery will also be enhanced by pursuing the demand-oriented water management it has initiated: fixing leaks, metering water to entail better payment while encouraging a culture of payment, and eventually using recycled wastewater for municipal gardens.

Chapter 4.2 illustrated what changes must be brought to the regional initiatives El Grullo is actively involved in, at both watershed and sub-watershed scale, to allow for an effective integrated water or natural resources management. First, the Ayuquila-Armería Watershed Commission, which during its first eight years of existence has stimulated a rather weak participation of users, municipalities or NGOs, must start considering these as stakeholders as such, instead of submitting them to a process of formal consultation only. Combined with insufficient financial resources and its feeble –yet growing- interest in natural resources other than water, it is not surprising that the Commission has not obtained many effective results for the time being. It is expected that the reform to the National Water Law of 2004 will enable to counter these obstacles to an IWRM.

Created in reaction as a more responsive and smaller scale set-up, the Inter-municipal Initiative for the Integrated Management of the Ayuquila River Basin has for its part been much more successful. Based on a ten-year old process of trust building in the region, it has generated concrete results: the River Ayuquila has regained the quality it had previous to the installation of the sugarcane factory in the valley (confirmed by the reappearance of a bigger fish population), fire brigades have been set up to fight against the yearly hazards that threaten the Sierra de Manantlán Biosphere Reserve, and each municipality is developing its own solid waste separation programme in the framework of regional environmental education activities. Illustrating the extent of its effectiveness is the fact that the Ayuquila-Armería Watershed Commission is now exploring the possibility of replicating the experience in order to cover the whole watershed with such platforms, judged more operational to implement an IWRM. This should allow combining the advantages of both scales: designing a regional vision through a strategic management plan for the watershed, and implementing it through more flexible units. The Inter-municipal Initiative is nonetheless still confronted to the necessity of increasing its visibility in order to attract more financial resources, and of institutionalising its activities so as to guarantee their long-term implementation.

The difficulties encountered by the municipality to undertake efforts towards an IWRM, at both local and regional level, highlight the important centralisation that still prevails in Mexico, despite the various decentralisation attempts to change this. Indeed, be it the potable water-pricing policies –prerogative of the State of Jalisco- or the lack of effective decision-making power of participants in the Ayuquila-Armería Watershed Commission, these difficulties reflect those encountered more generally throughout the country (presented in Chapter 2). They very clearly illustrate the resistance to change and develop more power-sharing inside governmental institutions at state and federal level, endowed with a historically vertical structure, and stress the importance of reinforcing the decentralisation efforts initiated twenty years ago. They also highlight the centrality of politics in the reality of water management in Mexico, something that those promoting IWRM wish to ignore, preferring an unrealistic approach based on technical solutions with little political interference, as they already did in the 1940s[1] (Mollard and Vargas, 2005b). Water has on the contrary become (in certain states), a political tool for state governors to acquire national calibre[2], with water basin organisations in particular crystallizing the tensions between state governors or these and the water administration (Mollard and Vargas, 2004b).

[1] It is precisely by refusing to recognise the historical reality of IWRM efforts in the country and assess the past errors, that the promoters of IWRM are most likely bound to repeat these (Mollard et al., 2005a).
[2] This was the case of V. Fox, former governor of the State of Guanajuato, which is part of the Lerma-Chapala basin.

The non-re-election rule for state governors also has a role to play, as it does not encourage any sort of long-term responsibility (Marie et al., 2005). This would be necessary for decisions such as an increase in water prices to be taken. Equally important to emphasise is the particularity of Mexican municipalities' very short and non-renewable mandates of three years, which represents another obstacle to their efforts towards an IWRM at both local and regional level. Indeed this prevents the realisation of many activities requiring long term efforts, such as potable water and sanitation supply, wastewater treatment or solid waste management, because at best one or two years of the new team are dedicated to such works – the rest being used for political campaigns. Further, in case of alternative political orientations, all previous programmes are generally abandoned to set up fresh new ones, and all administrative employees are changed, a drastic and very counter-productive Latin American specificity.

Limits of the exercise

This concluding chapter is also the opportunity to explicit certain choices made in terms of topic delineation or to recall the difficulties we did not manage to overcome.

Using the lens of a municipality to approach IWRM can seem surprising, as the officially recognised scale of implementation is that of the watershed. Nonetheless, for practical reasons, it seemed more realistic to take this small-scale approach rather than undertake the study of the whole watershed. Personal preferences for a micro-level analysis –enabling for example to interview households, which would not have been possible otherwise- were also determinant in this decision.

The choice of such an entry also restricted the analysis of IWRM strictly speaking, as it meant leaving aside one of the most important water users in the region, i.e. agriculture (some elements are nonetheless provided throughout Chapter 4.2).

Finally, due to a lack of time, not all entries of the municipal theoretical framework were explored: as part of a municipality's approach towards IWRM at a local scale, we concentrated on water and sanitation services, leaving aside the issue of storm-water and wastewater de-coupling. Albeit not included in this framework, we also chose not to specifically explore the issue of land use planning, a municipal tool that also has important impacts on water resources, and this for the same reason of time restriction.

It is also important to highlight that obtaining information in Mexico is not always easy, and generally more time-consuming than originally planned: very often « the available information is contradictory, vague or inexistent, leading to rumours both absurd and counter-productive » (translated from: Marie et al., 2005: 245), which complicates the task of the researcher trying to establish useful –and usable- information.

Finally, even though throughout this thesis we recognise the major role played by politics in Mexican water management, it was not our purpose to investigate this aspect in much detail. Many articles and books exist, however, for those who wish to look this aspect up (in particular, we suggest the reading of López et al., 2004; Mollard and Vargas, 2004a and 2004b).

New questions

It also seems interesting to list a few new research questions that emerged following this study, which might constitute potential tracks for future research:

Specifically regarding the municipality of El Grullo:

- Which potable water pricing structure would enable the municipal water board to reach full cost-recovery while guaranteeing basic needs throughout the municipal communities, and how could this be set up and effectively implemented?
- How could a system of cost-sharing be devised in order to allow for the installation of meters for all households in the municipality?

More generally speaking:

- To which extent can the coordination of several inter-municipal platforms inside one watershed allow for a better implementation of IWRM?

Reflections for ongoing debate

Hereafter we wish to open up in generality and contribute elements to certain debates concerning IWRM.

Triggering elements

First, it seems important to highlight that in the region of study, the crucial factor that triggered the two initiatives aiming at a more sustainable natural resources management –be it the Ayuquila-Armería Watershed Commission or the Inter-municipal Initiative- was the exceptional involvement of a group of researchers from the University of Guadalajara, who teamed up with a federal dependency (the Sierra de Manantlán Biosphere Reserve). Initially, they responded to a social demand expressed by the riparian communities affected by the Ayuquila River contamination, and have since managed to give real continuity to this bottom-up process and generate concrete positive changes for the area. Such ties, enabling to combine scientific knowledge with regulatory power to respond to local demands, should be encouraged whenever possible. Also important to mention is the role of international academic links and exchanges between the IMECBIO of the University of Guadalajara and other universities with more experience in ecological restoration (the University of Wisconsin-Madison) or watershed management (that of Guelph).

Scale of implementation of IWRM

Then, the results of this thesis feed into the debate that questions the watershed as the best unit to implement IWRM. This is a rather young theme, as experiences of watershed-based IWRM are sometimes only barely starting: as highlighted by Tortajada (2005), it is only once the results of the current Latin American wave of IWRM and its implementation through watersheds are available and comprehensively analysed, that it will be possible to compare these with results of "alternative institutional arrangements", and draw conclusions "as to which should be the preferred option and under what conditions" (Tortajada, 2005: 314).

Choosing the watershed as a management unit requires integrating other scales of management, where other institutions manage agriculture, environment, etc., and thus the integration might depend on the degree of decision-making power and financial resources of the river basin institutions (Tortajada, 2005). A "major failure" of many developing countries seems to have been to consider the establishment of river basin organizations as a trendy "end by itself, and not the means to an end, the end being a more efficient, decentralized, participative process where needs and requirements of the several stakeholders (including the environment) are identified, analysed objectively, and then rational decisions are made within a social-economic-environment framework" (Tortajada, 2005: 315). Such institutions are thus created and expected to work, without any support or resources.

Watershed organizations indeed "perfectly reflect the traditional powers and will of openness", as the watershed is the place where institutional innovation determines the type of regulation and of participation that will be set up (Mollard and Vargas, 2005b: 18).

As highlighted by Barraqué (1994), local consensuses such as those of the waterings in the Netherlands or the Tennessee Valley Authority –the founding examples of an IWRM- highlight to which extent integrated water resources management is a socio-political problem that can lead to more bottom-up public decision processes. For the time being, this has not yet materialised, as we saw through our case of the Ayuquila-Armería Watershed

Commission, but it is possible that the reforms brought to the Mexican legislative framework work in favour of less top-down decision-making.

It is increasingly recognised that IWRM should be planned at the level of a watershed, but can only be implemented at a smaller scale. Illustrative of the current importance of this theme was the interest, expressed during the 4th World Water Forum in Mexico City in March 2006 (which stressed the importance of local authorities in managing water), in the experience of multi-level implementation as is being explored in the Ayuquila-Armería watershed (Tania Román Guzmán, personal communication). Similar initiatives of municipal associations or local government consortiums have developed in several countries of the region, such as Brazil, Honduras, Nicaragua, Peru and the Dominican Republic. They also demonstrate that they are more successful than individual municipalities in ensuring technical capacity development and financial viability for water supply and sanitation, environmental protection or watershed management (Brannstrom, 2004; Jouravlev, 2003).

National specificities to approach IWRM

Also being questioned is the possibility of implementing a 'one-size-fits-all' approach. As commented by C. Tortajada, the transfer of the French model of integrated river basin management to Latin America is, for example, limited in Mexico by the highly centralized water management, and the fact it might not be possible to replicate the basis of the French system's relative success, i.e. its financing by taxation. More tailored-specific implementation procedures are required, such as, for example, smaller scale initiatives capable of circumventing the still highly centralised water management system in Mexico.

Jonch-Clausen insists that while essential elements in IWRM need to be identified to help stakeholders undertake reforms in water resources management towards more integrated approaches, sufficient flexibility must be left to each country to find its path according to its national context: "Water as a resource and its development and management is specific to the geographical, historical, cultural and economic context of any country. Hence IWRM processes will differ from country to country, and there is no 'one size fits all'. To assure political interest and public support, the initial focus should be on crucial, urgent issues. (...) For the poorest countries of the world the national IWRM planning processes may well focus strongly on how to attain the UN Millennium Development Goals (…). For the richer countries of the world, progress towards IWRM may be pursued by focusing on environmental maintenance and restoration" (Jonch-Clausen, 2004: 9).

Applicability problems of IWRM

As we have seen throughout this thesis, despite its growing presence on the international water agenda, the concept of IWRM remains extremely criticised. Presented as 'the' solution to the world's water management problems, its actual implementation still remains to be seen.

Along with the concept of sustainable development, despite a global acceptance, it faces numerous shortcomings, among which: inadequate institutional and legal frameworks, centralized decision-making, absence of political will to make the change, lack of qualified staff and financial resources, in addition to the complexity of the task due to the important number of sectors related to the water sector, and feeble effects of decentralisation (Tortajada, 2005).

The implementation of these approaches requires such important radical changes that to facilitate these, resisted by many for fear of losing their advantages, it is recommended to experiment IWRM on small scales, through incremental steps, by staying pragmatic and context-specific (Chéret, 2004). "The need for an integrated water resources management framework will require major policy reforms and a far higher level of policy coordination than is found in most countries. […] Creating these levels of synergy is far from easy, and perhaps the most pragmatic approach is to develop them incrementally, with each step having a clear purpose and demonstrable benefits" (UN-WWAP, 2001: 34).

Further, IWRM risks not being considered as a serious and reliable doctrine, unless it accepts to critically balance out its past experiences, such as the Mexican experience highlights (Mollard et al., 2005a).

According to many authors (Gyawali et al., 2006; Mollard and Vargas, 2005a), by avoiding to recognise the ideological feature of this concept, its promoters are trying to make it sound simpler than it really is. In reality, the use and interpretation of such a concept are highly influenced by political relations: "IWRM professionals have to decide whom and what they want to serve" (Mostert, submitted: 1). As previously highlighted, the difficult task of making trade-offs also needs to be made clearer (Falkenmark, 2003).

In both cases, there is a need to take and give time: "The advocacy phase for the idea has been carried out according to the Johannesburg decision, but very few people, particularly in terms of stakeholders on the ground, know what this is all about and this remains the case even in the richest countries in the world" (Chéret, 2004: 8). In addition, each person must take his responsibility to play his part in this process: "All actors, at all levels, must look at the water-related aspects of their activities" (Chéret, 2004: 10).

Brüschweiler clearly resumes the challenges faced by those which promote the diffusion of IWRM: "How can such an ideal concept be realized, when so many changes are required that it is difficult to know where to start? Without a doubt, IWRM represents a highly challenging and complex approach. In fact, this is why it so well suits the nature of water. IWRM is not a product, but a process that offers a flexible framework with several points of entry, like a puzzle in which each move represents a further step on the way to sustainable integrated management" (Brüschweiler, 2003: 5). The future will tell us whether the promoters of an IWRM succeed in this quest, and through which modalities.

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Annex 1: A relatively recent explosive institutional "mushrooming" around water issues

Unlike the secretariats that exist for the United Nations Convention on Biological Diversity or the United Nations Framework Convention on Climate Change, water management is not the unique focus issue of any one institution belonging to the United Nations agencies. On the contrary, due to its cross cutting feature, not less than 62 UN institutions deal with water (such as those in charge of the programmes on education, agriculture, security, etc…) (Crié, 1992). Many have developed specific programmes and units dedicated to water.

For example, the **International Hydrological Programme (IHP)** is UNESCO's **intergovernmental scientific programme in water resources** (www.unesco.org/water/ihp). Based in Paris, France, it was first initiated as the International Hydrological Decade (1965-1974) to become the IHP in 1975. It is a long-term programme organised along 6-year periods. IHP-VI, covering 2002-2007 and dedicated to "Water interactions: systems at risk and social challenges", reflects the growing importance of the social science component, only recently incorporated to more traditionally technical approaches.

Then in 1978, the United Nations Environment Programme (UNEP) created the **Global Environmental Monitoring System for Water Programme (GEMS/Water)** (www.gemswater.org). Its mandate is to **collect data and information on inland water quality** (both surface and groundwater) **for environmental assessments at regional and global levels.** Country-by-country data banks are accessible in GEMS/Water's Annual Reports, while data at regional level is presented in the GEO Yearbooks. Since March 2005, all this information is also accessible through an online searchable database called Gemstat (www.gemstat.org), result of the "Great water quality data drive", a global call in 2004 for water quality monitoring and data.

But the transversal dimension of water across the UN institutions is particularly reflected by more recent set ups, such as the **World Water Assessment Program (WWAP)** (www.unesco.org/water/wwap), whose secretariat is housed in the UNESCO Division of Water Sciences in Paris. Established in 2000, it is a joint effort by 24 UN agencies **to develop tools –essentially key indicators- and skills to improve global water supply and quality**. It promotes an integrated approach to management, with river basins and watersheds as the natural hydrological unit, and policies designed to take account of full-cost pricing and stakeholder needs and expectations. Its priorities are to assess the state of the world's freshwater resources and ecosystems worldwide and evaluate progress made since Rio towards achieving specific targets, identifying gaps and assisting countries in improving their own water management policies and practices, through local capacity development.

Results of this ongoing assessment process are presented every three years in the World Water Development Reports, while information to decision-makers and other stakeholders is also provided through the world water portal developed with other partners (www.unesco.org/water).

Since 2003, **UN-Water** (www.unwater.org) has been set up as the **official UN inter-agency mechanism for follow-up of the water-related decisions taken at the World Summit for Sustainable Development and the Millennium Development Goals.** In addition to providing support at global, regional and country level in this respect, it is responsible for organising the UN World Water Day and the UN Decade on Water 2005-2015.

Alongside these UN programmes and mechanisms, many new organisations fully dedicated to water have developed. Although some already existed in the first half of the 20th century, many were created during a very short time span in the 90s, illustrating the growing importance water has taken recently. Each one each of these institutions, with its specific approach, now plays a major role in the international arena.

The International Association of Hydrological Sciences (IAHS) (www.cig.ensmp.fr/~iahs) is the oldest and foremost international nongovernmental organisation that deals with hydrology and water resources. In 1922 it was part of the larger International Union of Geodesy and Geophysics, of which it distinguished itself increasingly as of 1948, to take its present name only in 1971. It is made up of 8 International Commissions (on surface water, groundwater, continental erosion, water quality, water resources systems, remote-sensing, coupled land-atmosphere system, tracers and formerly snow and ice). Working in close collaboration with UNESCO since the International Hydrological Decade launched in 1965, as well as the World Meteorological Organization, the three organisations award the International Hydrology Prize annually since 1981.

Established in 1950, **the International Council on Irrigation and Drainage (ICID)** (www.icid.org) is a scientific, technical and voluntary not-for-profit nongovernmental international organisation based in New Delhi, India. It is **dedicated to enhancing worldwide food supply** and fibre for all, through research, development and capacity building in the fields of water and land management and increased productivity of irrigated and drained lands.

The International Water Resources Association (IWRA) (www.iwra.siu.edu) was created in 1972. A non-profit organisation, it promotes a more sustainable management of water resources through **networking**, mainly in the forms of **dialogue, education and research.** Based at the Southern Illinois University, it publishes the *Water International Journal*, sponsors regional conferences and convenes the World Water Congress each three years.

Almost twenty years later, in 1990, **the Water Supply and Sanitation Collaborative Council (WSSCC)** (www.wsscc.org) took over international coordination of the various agencies since the end of the International Drinking Water Supply and Sanitation Decade. Existing since 1988 (as the ESA Collaborative Council), this international NGO aims at accelerating the achievement of **sustainable water, sanitation and waste management services** to all, through collaboration between developing countries and donor agencies. The World Health Organisation in Geneva, Switzerland, hosts its secretariat. One of its most notorious actions has been the WASH campaign, to raise awareness and bring about the necessary changes in structure and behaviours in the fields of Water, Sanitation and Hygiene.

In 1991, **the International Office for Water** (www.oieau.fr) was founded. This non-profit making association based in Paris, is a network of 149 partner organisations from all over the world and all sectors, involved in water resources management and protection. It provides professional training as well as information and documentation for **capacity building for a better water management**. Among its numerous activities, it presents databanks and international networks, such as the Aqualingua project, a free multilingual and online dictionary of technical terms and expressions financed by the European Community with the aim of breaking down linguistic barriers between the member countries (available at http://scripts.oieau.fr/aqualingua).

The **International Network of Basin Organizations (INBO)** was created in 1994 (www.inbo-news.org). Its technical secretariat is the International Office for Water. With currently 125 member organisations in 42 countries, the INBO works to "**support the creation and development of basin organizations throughout the world**". Its four guiding principles are: "For major basins, organization of integrated water resources management and environmental management, aiming at optimal satisfaction of all legitimate requirements; participation of local government and all user categories when determining water policy, mainly through river basin committees; Formulation of basin master plans with medium and long-term objectives and their implementation under five-year priority action programs; Implementation of targeting funding systems based on the 'user-polluter-pays' principle, so that 'water pays for water'" (French Water Stakeholders, 2000). Aquadoc-Inter, a network of national information centres on water, is the result of cooperation between INBO member organisations to establish an international portal on water management in river basins (www.aquadocinter.org).

Two new non-governmental organisations have brought the international debate on IWRM further: the **Global Water Partnership** and the **World Water Council**. Although both were founded in 1996 with similar objectives, the first is a facilitator of IWRM projects (tools for IWRM at catchment or local level), while the second promotes itself as a 'think-tank' on

IWRM issues (global and policy issues) and works to both develop a global water inventory, while identifying water-related problems and proposing solutions (Calder, 2005).

In 1996, **the World Water Council (WWC)** (www.worldwatercouncil.org) was established in Marseille, France, as a "common umbrella to unite the disparate, fragmented, and ineffectual efforts on global water management" by "water specialists, the academic community and international organizations". Since then, in order to **raise awareness** in the political spheres as well as across society, this international water policy think-tank financed by the World Bank and where the water industry is very present, organises the World Water Forums jointly with a host country each three years (Comision Nacional del Agua and World Water Council, 2004). Further, as the INBO's Aquadoc-Inter does not provide information on water uses, another database was set up by the World Water Council and the French Ministry of Ecology and Sustainable Development in April 2005, as the Water Monitoring Alliance website (www.watermonitoringalliance.net).

In 1996, **the Global Water Partnership (GWP)** (www.gwpforum.org) was set up by the World Bank, the United Nations Development Program and the Swedish International Development Agency **to provide coordinated assistance to developing countries specifically on integrated management of water resources**. It facilitates the exchange of information and experiences relative to IWRM. This new holistic and participative approach to water management was identified as a necessity after the Dublin and Rio Conferences. Working closely with the INBO to promote basin organisations, the partnership integrates all types of institutions involved in water management, from public to private and from governmental to multilateral development agencies. As way of promotion and implementation, it has developed a Toolbox for IWRM (see Chapter 2).

Since 1997, **the Stockholm International Water Institute (SIWI)** (www.siwi.org), a **policy think-tank**, "**links water experts to decision-makers** so that progressive policies and scientifically sound, water-cycle solutions to water-related problems can be elaborated. […] SIWI stresses that water is a key to socio-economic development and quality of life, and that through integrated water resources management (IWRM), barriers which hinder increased food production, pollution prevention and poverty reduction can be overcome".

Each year in August, SIWI administers the Stockholm Water Symposium (or World Water Week), the main annual global platform for dialogue, whose objective is to develop "practical solutions and strategies that will help to alleviate the world water crisis" (SIWI, 2005). From 2003-2007, the framework theme is "Drainage Basin Security: Prospects for Trade Offs and Benefit Sharing in a Globalised World". Sub-themes range from "Balancing production, trade and water use" (2003), "Regional Approaches for Food and Urban Security" (2004), to "Hard and Soft Solutions in Regional Development" (2005). In 2005, several seminars referred to IWRM: “Scenario building as approach for IWRM”, “IWRM- Do we practice it in the North?”, “Harnessing Uncertainty: Taking Complexity and Vulnerability Seriously in IWRM”, “Benefit Sharing from Integrated Land and Water Use in River Basins”.

Also in 1997, the European Commission’s Directorate General for Research launched the **Environment-Water Task Force** (ec.europa.eu/research/tf-wat1.html), which also includes the Development and the Environment branches, and identifies 10 priority action lines.

In 1999, **the International Water Association (IWA)** (www.iwahq.org.uk) was the result of the merger between the International Association of Water Quality and the International Water Supply Association. It is an **international professional membership association** “committed to furthering sustainable and holistic resource management and service provision, built on the concept of the complete water cycle”. Its members range from individuals to countries or regions. Founder member of the World Water Council, it is involved in the Global Water Partnership and the Water Supply and Sanitation Collaborative Council. Founder of the International Water Associations Liaison Committee, bonding the principal international water associations, it also has an important publishing branch (which includes *Water 21*). IWA organises the annual IWA World Water Congress, as well as leading edge and regional conferences.

Supported by the Consultative Group on International Agricultural Research with funding from the World Bank and 30 other donors, **the International Water Management Institute (IWMI) (**www.iwmi.cgiar.org) is a non-profit scientific **research organisation** with headquarters based in Colombo, Sri Lanka. In 2000, it evolved from the International Irrigation Management Institute, created in 1983 by the Democratic Socialist Republic of Sri Lanka. It works with partners in Africa and Asia to help them **develop tools and methods to eradicate poverty through a more effective management of their water and land resources.** Its four main activities –water productivity and poverty mapping, analysing high potential interventions and assessing impacts - are organised around its four new research themes (Basin water management; Land, water and livelihoods; Agriculture, water and cities; Water management and environment).

At the **World Bank, the Water Resources Management Group** exists since 2000. It has members from the main stakeholder groups (water supply and sanitation, hydropower, irrigation and environment).

The International Water History Association (IWHA) (www.iwha.net) was founded in 2001 as “a forum for the widest possible debate”, aimed at **fostering research on the links between water and humankind.**

The International Water and Sanitation Centre (IRC) (www.irc.nl) was established as the International Reference Centre for Community Water Supply in 1968 by an agreement between the World Health Organization (WHO) and the Dutch Government, to become the hub of a network of some 32 National WHO Collaborating Institutions in both developed and developing countries. Its aim is to **provide knowledge and information to enable the poor to meet their water and sanitation needs in a sustainable, efficient and affordable manner.** It is based in Delft, Netherlands.

Since 2003, **the UNESCO-IHE Institute for Water Education (UNESCO-IHE)** (www.unesco-ihe.org) was created. The mandate given by UNESCO to IHE (the International Institute for Infrastructural, Hydraulic and Environmental Engineering in Delft University, Netherlands) is to "**strengthen and mobilise the global educational and knowledge base for integrated water resources management and meet the water related capacity building needs of the developing and countries in transition**".

The CGIAR (Consultative Group on International Agricultural Research), an alliance of countries, international and regional organisations and private foundations set up the **Challenge Program on Water and Food** (www.waterforfood.org) in 2003, to take up **the water productivity challenge**: growing more food with less water. Its main and interrelated research themes are: Crop water productivity improvement; Water and people in catchments; Aquatic ecosystems and fisheries; Integrated basin water management systems; Global and national food and water systems.

The Third World Centre for Water Management (www.thirdworldcentre.org), based in Mexico, aims at generating and **synthesising new knowledge, applying existing knowledge and disseminating information.** It works extensively with the numerous networks it belongs to around the world.

Annex 2: Anecdotes from fieldwork

The following anecdotes result from impressions gathered all along the fieldwork, which oscillated between pure enchantment and "feeling at home", to strong urges at times to… go back home!

While my study focused on the municipality of El Grullo, I was based in the neighbouring municipality of Autlán. Its eponymous capital is a small urban centre of 40,000 inhabitants that hosts the University of Guadalajara's Centre for the South Coast. Autlán is located approximately 200 km to the south of Guadalajara –Mexico's second biggest city- in the State of Jalisco. This is a state from which originate many of the symbols traditionally associated to Mexican folklore: mariachi musicians, tequila, *jaripeo* (a form of rodeo), *charro* (the typical representation of the Mexican man, whose costume varies from a more countryside to a more festive version) and *palenque* (gambles on cockfights).

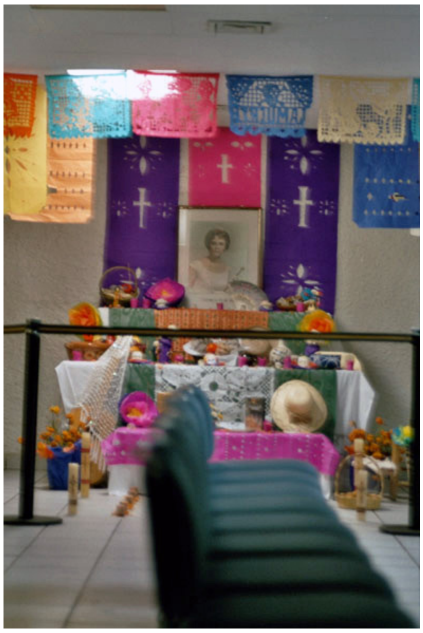
In Autlán, for example, cowboys are a common sight. Some work in the rodeo-shows, which enable them to earn quite a lot more money than working in the fields. I went to see a performance once, in a small-scale local bullring, and it was a sort of digest of the many festive qualities which make life in Mexico so lively: an orchestra was playing typical –and loud- music in the background, families and groups of youngsters formed the audience, and in the end, everybody danced on the platforms of the small stadium, between buckets of empty beer bottles!

Along with such informal events that take place on a regular basis, other festivities, common throughout the country, punctuate each season, giving the impression there is always an opportunity to celebrate: the Carnival (in February in Autlán), official dates like Independence Day (15 September) or the Day of the Revolution (20 November), as well as the numerous traditional Christian celebrations all year long, along with more specific events like the day of the Virgin of Guadalupe, the most famous saint in Mexico (12 December).

Day-to-day life is very lively, for several reasons.

The climate, for one, is generally very nice (except in April-May, when it tends to get unbearably hot!). Whatever the season, it is sunny everyday –even during the rainy season, when it rains mostly in the afternoons. So it is common for some of the inhabitants to gather in the central plaza in the evenings to have a chat with a corn on the cob or an ice cream – each Mexican town, as little as it may be, always has its central plaza with a well-attended garden and a bandstand. Unfortunately, the romantic custom (single girls walking one way around the plaza, single boys the other) has now been modernised, replaced by the latter driving by in four-wheel drives with the loudest possible music to attract attention!

Another characteristic is the colourfulness, embedded in the culture, be it to celebrate specific events –like the Day of the Dead (see picture below, in a bank) or other festivities- or reflected in the traditional clothing and architecture



The simple journey by bus between Autlán and El Grullo is also thrilling. Landscapes give a complete change of scene, ranging from the huge cactus bordering agave fields, to views of bougainvillaea and Jacarandas in the sun, set against the Sierra de Manantlán mountains in the background. But seasonal differences are very marked, with the lush vegetation of the surrounding hillsides undergoing complete transformation during the dry season.

The food is also amazing –unfortunately the one served in 'Mexican restaurants' in Europe tends to concentrate on a few landmark dishes and leaves out the more traditional recipes. My big favourites turned out to be the appetizers (cucumber with lemon and chilli, or tacos with tomatoes, coriander and lemon), but also Jalisco specialities like the *posole* soup, *nopales* and all the home-cooked dishes of Juliana and Gisela from across the university campus! Going to the market every Saturday was a real treat in terms of fresh fruit smells in addition to the bubbly atmosphere of noisy sellers.

Mexico is not a bad place to work alone in, because it's difficult to feel lonely very long: you just need to go out and talk with people on the street (shopkeepers, shoe-shiners, you name it). One aspect that always made me regret coming back to Europe was the contrast in terms of informal daily relationships. Mexicans talk very easily, even when they don't know each other: if someone in the bus sneezes, people usually say "*salud*"; when you get off, the driver says “*que le vaya bien*” or “*adios*”. Each time I came back to Switzerland I experienced a sort of cultural shock, disappointed to be once again surrounded by people wary of ‘the other’.

The kindness and hospitality of the Mexicans is also a rather constant trait, although this might be more specific to rural areas, as is often the case. On a regular basis, during my interviews with households, interviewees gave me a fruit or offered to share some tortillas – or whatever they were having for breakfast or dinner.

Finally, my last –but not least- thrill was the discovery of the traditional dancing: I had the opportunity to see various performances of the local ballet group (which has existed for 30 years and won several prizes at national level), showcasing dances from many States of Mexico. Each time, I was swooped away by incredible scenes and performances, the variety of rhythm and costumes illustrating the country’s very rich cultural diversity.

Some funny things happened too.

Due to the fact I was far from being totally fluent in Spanish when I started out, I did have some problems getting myself understood at first. One day I went to buy basil to put in my spaghetti, and explained I was going to use it to put in my “pasta”…not knowing this also has the more common significance of toothpaste. When I left the shop with my pot of basil, I overheard the owner telling his wife that I was going to use it to brush my teeth…They cracked up, and I cracked up too, imagining them imagining me!

Another time, during an interview with two elderly people in the urban neighbourhood of Del Alamo, in El Grullo, the man started telling me jokes about the old times: he used to work for the train company and would travel quite a bit. Once, as a present, he bought his wife some nice shoes: apparently he has been drunk during the purchase, because when she opened the present, there were two shoes of a different colour, and for the same foot! It was very touching to see this old man who cares tenderly for his wife (now losing her memory), so pleased with this hilarious recollection.

In December 2004, I witnessed the setting up of the first-ever Christmas decorations in Autlán's central plaza –a luxurious testimony of the general increased well-being in the municipality. There was both an artificial Christ child's crib, as well as a live one, with sheep and ducks. One of the ducks managed to get loose and the municipal employees started chasing him, with no luck, as he flew away in circles to always come back to his mate. The scene went on forever, and I left without knowing the outcome.


Although I was extremely fortunate to experience all this, there were times when things were not as rosy.

For one thing, I had to get used to the noise. Mexicans love loud music, loud advertisement, loud conversations, and Autlán, the biggest town in the region, is renowned for this. Fortunately, the Sierra de Manantlán Biosphere Reserve, a very peaceful and quiet place close-by, once provided a perfect escape for a weekend!

Then, I had lots of trouble with the treatment of pet animals, especially dogs, generally free to roam around and usually very badly treated.

But the worst of it all was the poverty. The region has been severely impacted by the agricultural crisis following the North American Free Trade Agreement, explaining why frequently at least one family member emigrated to work in the United States. Family support is often the only resort for the elderly or handicapped, whose pensions –when they exist- are rarely sufficient. Some of the interviews had sad moments, when people talked about how their lack of means prevented them from going to school, or from buying medical treatments for their children.

Moreover, the valley attracts immigrants seeking employment, originating from other Mexican States such as Oaxaca or Guerrero, where the economic situation is even worse. On the road between Autlán and El Grullo, one is generally struck by a small village, in the middle of which shacks with aluminium roofs house seasonal workers during the sugarcane harvest; young children in rags play in the mud in front of this small local favela. These workers are indigenous people, and are often despised by the locals coming from Jalisco (generally descendents of intermarriages with the Spanish).

But difficult and enthusiastic moments taken together, to sum up, the whole experience was very enriching, enabling me to discover a small part of a country I had a lot of preconceived ideas about, and which will now stay forever as my second home: "*Aqui tienes tu casa*" ("your house is here") as they say.

Annex 3: List of various definitions related to 'IWRM' (Biswas, 2005)

326 *Water Resources Management in South and South-East Asia*

thus its recommendations, whatever they were, were never approved by any government, irrespective of the claims to the contrary of the individuals and institutions that were mostly responsible for the organization of this conference.

Extensive and intensive analyses of literature on integrated water resources management published during the past decade indicate two somewhat unwelcome developments. First, there is no clear understanding of what exactly integrated water resources management means. Accordingly, different people have interpreted this concept very differently, but under a very general catch-all concept of integrated water resources management. Absence of any usable and implementable definition has only compounded the vagueness of the concept, and has reduced its implementation potential to a minimum. Second, because of the current popularity of the concept, some people have continued to do what they were doing in the past, but under the currently fashionable label of integrated water resources management in order to attract additional funds, or to obtain greater national and international acceptance and visibility.

An analysis of even the issues that should be integrated under the IWRM level, indicates a very wide divergence of opinions. It should be noted that this refers only to what should be integrated, and not to other equally important fundamental issues like how these issues can be integrated (even they can actually be integrated since many of the issues are mutually exclusive), who will do the integration and why, what processes will be used for integration (do such processes currently exist?), or will the integration, if at all it can be done, produce the benefits that proponents now claim. Regrettably, none of these questions are now being even seriously asked, let alone having objective and definitive answers.

Analyses of existing literature indicate that the authors concerned have considered different issues that need to be integrated under this concept. Thus, depending upon the author(s) concerned, integrated water resources management means integration of:

- objectives which are not mutually exclusive (economic efficiency, regional income redistribution, environmental quality and social welfare);
- water supply and water demand;
- surface water and groundwater;
- water quantity and water quality;
- water and land-related issues;
- different types of water uses: domestic, industrial, agricultural, navigational, recreational, environmental, and hydropower generation;

Integrated Water Resources Management: A Reassessment 327

- rivers, aquifers, estuaries, and coastal waters;
- water, environment, and ecosystems;
- water supply and wastewater collection, treatment, and disposal;
- macro, meso, and micro water projects and programmes;
- urban and rural water issues;
- water-related institutions at national, regional, municipal, and local levels;
- public and private sectors;
- government and NGOs;
- timing of water release from the reservoirs to meet domestic, industrial, agricultural, navigational, environmental, and hydropower generation needs;
- all legal and regulatory frameworks relating to water, not only directly from the water sector, but also from other sectors that have implications on the water sector;
- all economic instruments that can be used for water management;
- upstream and downstream issues and interests;
- interests of all different stakeholders;
- national, regional, and international issues;
- water projects, programmes, and policies;
- policies of all different sectors that have implications for water, both in terms of quantity and quality, and also direct and indirect (sectors include agriculture, industry, energy, transportation, health, environment, education, gender, etc.);
- intra-state, interstate, and international rivers;
- bottom-up and top-down approaches;
- centralization and decentralization;
- national, state, and municipal water policies;
- national and international water policies;
- climatic, physical, biological, human, and environmental impacts;
- all social groups, rich and poor;
- beneficiaries of the projects and those who pay the costs;
- service providers and beneficiaries;
- present and future generations;
- national needs and interests of donors;
- activities and interests of donors;
- all gender-related issues;
- present and future technologies; and
- water development and regional development.

Annex 4: Countries classified as having made "good progress" in first GWP survey

Region/Country	IWRM status and prospects (from survey in 2003)
Eastern Africa	
Uganda	Excellent framework for IWRM Plans and achievement of MDGs related to water
Northern Africa	
Egypt	Water sector reform ongoing. IWRM Plan prepared. Stakeholder involvement in the IWRM Plan development and participation of the stakeholders in modifying and updating the IWRM. Participates in Nile Basin Initiative. 2005 Target of IWRM Plan likely to be met.
Southern Africa	
South Africa	Water sector reform is advanced. There is a comprehensive water policy and updated legislation in place. Some implementation has started. Existing processes and outputs can merely be repackaged for meeting targets by 2005.
Zimbabwe	Water sector reform progress is advanced. There is a comprehensive water policy and updated legislation in place. Some implementation has started. Existing processes and outputs can merely be repackaged for meeting targets by 2005. Limited financial support may be required. Support required for implementation of water act.
West Africa	
Burkina Faso	IWRM action plan already adopted by the Government. The main challenge and task for the country remains implementing PAGIRE [IWRM action plan] with the support of partners.
Ghana	IWRM action plan already adopted by the Government. The main task for the country remains implementing IWRM action plan with the support of development partners.
Central Asia and Caucasus	
Kazakhstan	Kazakhstan is the country best prepared in the region to realise an IWRM Plan.
Kyrgyz Republic	Governance system of Kyrgyz Republic is developing rapidly. Most elements in place for an IWRM Plan. Potential for impact is great.
Asia	
China	Although there has been no definite IWRM National Plan until now, China has been applying an IWRM approach and methodology in all the fields of water resources management while receiving experiences and lessons. Water resources issues rank high on the governmental agenda. An institutional and legal framework for IWRM has been established, and focused efforts are being made to achieve IWRM approach. The near future is a critical period for China to translate the principles of IWRM, in light of the new Water Law, into specific measures and instruments and overcome the identified challenges.
Pacific	
FrenchPolynesia	EU regulations apply to French Territory. Therefore has to meet EU deadlines and criteria.
New Caledonia	EU regulations apply to French Territory. Therefore has to meet EU deadlines and criteria.
Central America	
Costa Rica	The process is underway and will culminate with an IWRM Plan needing financing. Both the political leadership and the Costa Rican society at large show a growing awareness about the urgent need to define and move towards IWRM.
Nicaragua	A Water Resources National Management Plan that needs to be updated. Besides, a national commitment to implement the plan is required. Nicaragua has some instruments and basic organization for IWRM but still lacks some of the legal, technical and financial resources to implement it. Capacity building must be pursued at the national level and integrated management needs to be further promoted among decision makers and at the basin level.
South America	
Brazil	The National Water Agency of Brazil – ANA- was established in 2000. The establishment of ANA was mandated by the National Water Resources Policy, which along with the National Water Resources Management System was legally created in 1997. (…) Brazil is a federation and almost all of its states have their own water legislation and legal mechanisms. (…) ANA is establishing the IWRM's principal mechanisms that were forecast in Brazilian law: basin committees and basin water agencies in federal basins. The Paraiba's Basin Committee started to charge water use. States are in different levels, but mostly financial support is needed for programs like: water use rationalization, sewage and water quality.

Source: GWP, 2004a

Annex 5: Calculating interviews to be held in the three riparian villages

	Total population (census 2000)*	Households (census 2000)*	10% of households (rounded off)	Number of interviews realised	Coverage in terms of households
Municipality of El Grullo	22.499	5145			
El Grullo town	19984	4536			
La Laja	416	88	9	9	10%
Palo Blanco	134	38	4	10	26%
El Aguacate	261	71	7	10	14%

* INEGI, XII Censo General de Población y Vivienda, 2000

Annex 6: Interview guide with households (November-December 2004)

Place of interview:
Type of habitat:
Date of interview:
Interview number (House number):
GENERAL INFORMATION
M / F
Name (but confidentiality guaranteed in results):
Age:
Place of birth:
Number of years living in this locality:
Number of years living in this house/apartment:
Number of persons in the family:
Number of persons living in the house:
Number of persons living abroad:
Is this your house/apartment or do you rent it?
Do you have a connection to the public service of water inside your house/apartment?
Professional occupation of household head: Agriculture/Commercial/Livestock-rearer/Other (specify)
INFORMATION RELATED TO DOMESTIC USE
1.1 WITH CONNECTION TO WATER SUPPLY PUBLIC SERVICES
When do you have water from the tap (which days, how many hours per day)?
How do you face the fact you do not have water from the tap all the time? For example, do you have a tank? If you do, is it an elevated or underground tank?
If house, do you have a washing-house in your property? What do you use it for?
If house, do you have a well in your property? For which activities do you use it?
Did you build the well yourself?
Do you know how deep the water is here?
Do your neighbours also have wells for the same purpose?
How much do you pay for your connection per year, and where?
When do you usually pay for your connection, and why?
If you have a well, do you have a discount of 20%? Do you know why?
Do you know what a meter is? Do you prefer to pay a fixed fee or would you prefer to have a meter?
1.2 WITHOUT CONNECTION TO WATER SUPPLY PUBLIC SERVICES
Why don't you have a connection to the public service of water inside your house?
What are the problems that this creates?
In particular, has this created health problems in your family?
How do you face the problem of not having water?
Do your neighbours have the same problems and react the same as you do?
If house: do you have a well in your property? For which activities do you use it?
Did you build it yourself?
Do you know how deep the water is here?
Did you have to pay anything for it? If so, to whom?
What about your neighbours, do they also have a well for the same reason?
Although you do not have tap water, do you have to pay something to the Municipal water and sanitation Board?

Why and how much?
2. DRINKING WATER
Where does your drinking water come from?
If you buy it: How many garrafones (capacity= 1 gallon or 20l) do you buy per week?
And how much to do you pay per garrafon?
3. SAVING/WASTING HABITS
In your use of water for domestic use, do you think you waste water?
What about your neighbours?
4. OPINION ABOUT THE WATER SYSTEM
Are you satisfied with this water system?
If there are any problems: according to you, what are the causes of these problems?
What would be required to reduce the problem?
INFORMATION RELATED TO PROFESSIONAL USE
1. COMMERCIAL ACTIVITY
What is your commercial activity?
How much do you earn per day, week or year?
Is this your only source of income? If you have others, how much do you earn in total?
Do you have a connection to the public service for commercial use of water?
If you do not have water all the time, what are the problems that this creates and how do you face them?
How much do you pay for your connection per year, and where?
When do you pay it and why?
In your use of water for commercial use, do you think you save or waste water?
What about your neighbours, do they all have the same attitude?
Are you satisfied with this water system for your commercial use?
Does it allow you to make the maximum economic benefits?
If there are any problems: According to you, what are the causes of these problems?
What would be required to reduce the problem?
2. IRRIGATION ACTIVITY
LANDOWNER OR DAILY WORKER WITH PARCELS
Are you a member of the Water Users' Association?
Where is/are your parcel(s) located?
How big is/are your parcel(s)?
What types of crops are there in your fields?
Why did you decide to cultivate such a crop?
How much does/do your parcel(s) let you earn per day, week or year?
Is this your only source of income? If you have others, how much do you earn in total?
What technology do you use to irrigate?
If canal irrigation: would you like to become a beneficiary of the tube technology, and why/why not?
If tube irrigation: why did you decide to become a beneficiary of the tube technology?
If groundwater irrigation: Why do you irrigate with groundwater?
Do you use drip-irrigation? If not, why not?
How much water does your concession allow you to have?
Are there any problems related to receiving the right quantity of water?
If there are, how do you react to solve them?

Do your neighbours have the same problems and react the same as you?
How much do you pay for this concession, to whom and when?
If groundwater irrigation: Why do you irrigate with groundwater?
In your use of water for irrigation, do you think you save or waste water?
What about your neighbours, do they all have the same attitude?
Are you satisfied with this water system for your agricultural use?
Does it allow you to make the maximum economic benefits?
If there are any problems: According to you, what are the causes of these problems?
What would be required to reduce the problem?
DAILY WORKER WITHOUT PARCELS
Where is/are the parcel(s) you work in located?
How big is/are the parcel(s)?
What type of soil is it/are they?
What types of crops are there in the fields?
Do you know why the landowner decided to plant this crop?
How much does your work in other people's parcels let you earn per day, week or year?
Is this your only source of income? If you have others, how much do you earn in total?
What technology is used to irrigate?
If it is tube irrigation, do you know why the landowner wanted to be a beneficiary?
If it isn't tube irrigation: do you know whether the landlord would like to be a beneficiary?
According to you, what are the advantages or drawbacks of this new system?
If groundwater irrigation: is there drip-irrigation?
If canal, tube or groundwater technology: Are there any problems related to receiving the right quantity of water?
If there are, how does the landowner react to solve them?
Do the neighbours have the same problems and react the same?
Do you think that in the use of water for irrigation, the water is wasted?
Are you satisfied with this water system for agricultural use?
If there are any problems: According to you, what are the causes of these problems?
What would be required to reduce the problem?
3. LIVESTOCK-REARING ACTIVITY
How much livestock do you own?
How much does your livestock enable you to earn per day, week or year?
Is this your only source of income? If you have others, how much do you earn in total?
What is the source of water for livestock?
Do you have a concession for this water?
If yes: How much water does this concession allow you to have?
Are there any problems related to receiving the right quantity of water?
How do you face these problems?
Do your neighbours have the same problems and react the same as you?
How much do you pay for this concession and to whom?
In your use of water for livestock drinking purposes, do you think waste the water?
What about your neighbours, do they all have the same attitude?
Are you satisfied with this water system for your use for livestock?
Does it allow you to make the maximum economic benefits?

If there are any problems: According to you, what are the causes of these problems?
What would be required to reduce the problem?
INFORMATION RELATED TO THE ENVIRONMENTAL IMPACTS OF WATER MANAGEMENT
1. GENERAL ENVIRONMENT
According to you, does the current water management create any problems for the environment?
In particular, what do you think of the water taken from the River for the irrigation canals?
What about the contamination of the river by El Grullo's wastewaters?
2. SANITATION SYSTEM
Do you have a connection to the sewage system?
If yes, do you know where your wastewaters go after going out of the house?
If not, what type of sanitation system do you have?
Do you know that part of the water fee you pay is to treat these wastewaters?
ANY OTHER THEME, PROBLEM, ASPECT RELATED TO THIS DISCUSSION YOU WISH TO DISCUSS

Annex 7: List of codes used in Atlas t.i. to analyse household interviews

Number of years living in locality: <5<10<20 years	
Number of years living in house: <5<10<20 years	
Number of family members	
Number of family members living in house	
House: owned/rented	
Professional occupation	
Water connection: yes/no	
With connection:	Without connection:
Schedule of water service: - Daily/non daily - Regular/irregular - <6<12 hours per day - Weak pressure/strong pressure	Explanation no connection
Storage practices: tank elevated/tank underground/wash-house	Coping practices
Pays: yearly/monthly (explanation why + fee)	
Pay preference: fee or meter or equal (+ explanation why)	
Alternative sources: well (well built self, well uses, well water depth)	
Drinking water: - Source (bottled water, tap water, privately built tank, purified well, several) (+ explanation) - Quantity - Price	
Waste water self/no waste self explanation	
Waste water neighbours/no waste neighbours explanation	
Opinion municipal water system: positive, negative, equal, nuanced (+ explanation why)	
River Ayuquila contaminated: yes/no and characteristics	
Connection sewage: yes/no	

Annex 8: Interview guide with municipal presidents (April 2006)

GENERAL INFORMATION
Interviewee:
Date:
Place:
1. IWRM
Have you already heard the expression "IWRM", if so where?
What does it mean for you?
Do you think that the definition promoted by the GWP (remind) is something that can be implemented at the scale of the watershed?
How do you see the role of a municipality in such an IWRM?
What can a municipality bring to IWRM?
Inversely, what would IWRM bring to your municipality?
Municipal level
In your municipality, what is the situation in terms of supplying water to all?
What are the main problems in water supply in your municipality? How can these be overcome?
If mayor of Autlán or El Limón: the Manantlán system (SIAPMA)
What were the conflicts that existed between the 3 municipalities before the signature of the agreement to create the SIAPMA in 1996?
As El Grullo was the only one investing financially in the maintenance of the system, what were the advantages for the other two municipalities to join in the agreement in 1996?
Today, what is the situation?
2. Ayuquila-Armería Watershed Commission
Members
How would you define this institution?
How would you describe the role of El Grullo in this institution?
Does your municipality participate?
If yes, who goes?
As representative of which water use?
What is the period for which they are elected for this function?
What motivated your municipality to join?
So far, have the expected advantages materialised? If not, why not?
Do you feel well represented by those who go? Why/why not?
Meetings
Are meetings between water users organised with the representative before each meeting of the Commission to discuss common priorities?
Are meetings held afterwards to inform of the outcomes?
How are decisions taken about priorities of investment?
Do you feel that each representative has the same decision-making power as the others?
Achievements
As belonging to a water user group, what have been the main objectives of your group inside the Commission?
What have been the outcomes?
What are the Commission's biggest successes?
What main advantages has the Commission brought your municipality?
Has it contributed to making it more active to solve environmental problems? Which ones?
Has it contributed to create more awareness of interrelationships between municipalities in terms of water? How?
Has it contributed to preventing conflicts in the region by developing dialogue?
In your opinion, has it contributed to creating a regional solidarity between municipalities with more means and those with less?
Problems
What are the main problems of the Commission? How do you think these could be overcome?
Sectoral water management
Has the Commission enabled more communication between different water users?

What are the remaining problems that you see? How could these be overcome?
Problems of priority of economy over social and environmental problems
Has the Commission enabled to bring higher on the agenda the social and environmental problems in the watershed?
What are the remaining problems that you see? How could these be overcome?
What is the situation in terms of participation in the Commission?
What are the remaining problems that you see? How could these be overcome?
3. Inter-municipal initiative
How would you define this institution?
How would you describe the role of El Grullo in this institution?
Members
Are you the person attending from your municipality?
What motivated your municipality to join?
What are the advantages you expected for your municipality? Have these materialised?
Are there alliances between municipal presidents in the Initiative? According to what?
Does the political party play a role in these alliances?
Meetings
How are decisions taken about priorities of investment?
Do you feel that each municipality has the same decision-making power as others?
Achievements
What are the Initiative's biggest successes?
What major advantages has the Inter-municipal initiative brought your municipality?
Has it contributed to making it more active to solve environmental problems? Which ones?
Has it contributed to create more awareness of interrelationships between municipalities in terms of water? How?
Has it contributed to preventing conflicts in the region by developing dialogue?
In your opinion, has it contributed to creating a regional solidarity between municipalities with more means and those with less?
Problems
What are the main problems of the Inter-municipal initiative? How could they be overcome?
4. Inter-institutional links
In your opinion, do the two regional initiatives influence one another? How?

Annex 9: Electricity costs represent 40% of water board's expenses

JUNTA MUNICIPAL DE AGUA POTABLE Y SANEAMIENTO
SISTEMA EL GRULLO-MANANTLAN

GASTOS FIJOS REQUERIDOS POR EL MANTENIMIENTO, OPERACIÓN Y ADMINISTRACION DE LA JUNTA MUNICIPAL DE AGUA POTABLE Y ALCANTARILLADO

Energía Eléctrica % que representa
Enero a Junio / 2003.

40.86%

Gasto promedio mensual (6 meses, energía eléctrica)	$ 97,657.33
Gasto promedio mensual (6 meses, gasto global)	239,005.13

Recursos Humanos % que representa
Enero a Junio / 2003.

19.71%

Gasto promedio mensual (6 meses, recursos humanos)	$ 47,103.04
Gasto promedio mensual (6 meses, gasto global)	239,005.13

Gastos Generales % que representa
Enero a Junio / 2003.

39.43%

Gasto promedio mensual (6 meses, gastos generales)	$ 94,244.76
Gasto promedio mensual (6 meses, gasto global)	239,005.13

VALENTIN VELAZCO No. 57 TEL: 387-22-62 C.P. 48740 EL GRULLO, JAL.

Annex 10: Inflation rate

JUNTA MUNICIPAL DE AGUA POTABLE Y SANEAMIENTO
SISTEMA EL GRULLO-MANANTLAN

Inflación anual

Energía eléctrica	11 %
Recursos humanos	7 %
Gastos generales	5 %

% de AJUSTE
7.86 %

% Ajuste = EE x I EE + RH x I RH + GG x I GG

sustitución:

0.41 x 0.11 + 0.20 x 0.07 + 0.39 x 0.05 = 7.86%

VALENTIN VELAZCO No. 57 TEL: 387-22-62 C.P. 48740 EL GRULLO, JAL.

Annex 11: Municipal water fees for urban residents

TARIFA ANUAL 2003
EL GRULLO, JALISCO

	1R 1B 2R 1B	3R 1B 2R 2B	4R 1B 3R 2B	5R 1B 4R 2B	6R 1B 5R 2B	7R 1B 6R 2B
CUOTA FIJA	516.00	588.00	660.00	732.00	804.00	876.00
2% INFRAESTRUCTURA	10.32	11.76	13.20	14.64	16.08	17.52
20% SANEAMIENTO	105.26	119.95	134.64	149.33	164.02	178.70
15% BONIFICACION	94.74	107.96	121.18	134.40	147.61	160.83
TOTAL	536.85	611.76	686.66	761.57	836.48	911.39

TARIFA ANUAL 2003
BONIFICACION 50%
EL GRULLO, JALISCO

	1R 1B 2R 1B	3R 1B 2R 2B	4R 1B 3R 2B	5R 1B 4R 2B	6R 1B 5R 2B	7R 1B 6R 2B
CUOTA FIJA	516.00	588.00	660.00	732.00	804.00	876.00
2% INFRAESTRUCTURA	10.32	11.76	13.20	14.64	16.08	17.52
20% SANEAMIENTO	105.26	119.95	134.64	149.33	164.02	178.70
50% BONIFICACION	315.79	359.86	403.92	447.98	492.05	536.11
TOTAL	315.79	359.86	403.92	447.98	492.05	536.11

TARIFA MENSUAL 2003
EL GRULLO, JALISCO

	1R 1B 2R 1B	3R 1B 2R 2B	4R 1B 3R 2B	5R 1B 4R 2B	6R 1B 5R 2B	7R 1B 6R 2B
CUOTA FIJA	43.00	49.00	55.00	61.00	67.00	73.00
2% INFRAESTRUCTURA	0.86	0.98	1.10	1.22	1.34	1.46
20% SANEAMIENTO	8.77	10.00	11.22	12.44	13.67	14.89
TOTAL	52.63	59.98	67.32	74.66	82.01	89.35

Annex 12: Municipal water fees for rural residents

TARIFAS 2003
POBLACIONES

	ANUAL 15%	ANUAL 50%	MENSUAL
CUOTA FIJA	456.00	456.00	38.00
2% INFRAESTRUCTURA	9.12	9.12	0.76
20% SANEAMIENTO	93.02	93.02	7.75
15% BONIFICACION	83.72	279.07	
TOTAL	474.42	279.07	46.51

Annex 13: Directory of Ayuquila-Armería Watershed Commission

OMISIÓN NACIONAL
EL AGUA

Comisión de Cuenca
Del Rio
Ayuquila - Armería

COMISION DE CUENCA DEL RIO AYUQUILA -ARMERIA

DIRECTORIO

PRESIDENTES

J. Silverio Cavazos Ceballos
Gobernador Constitucional del Estado de Colima

Francisco Javier Ramírez Acuña
Gobernador Constitucional del Estado de Jalisco

PRESIDENTE HONORARIO
Cristóbal Jaime Jaquez
Director General CNA

Secretario Técnico
Raúl Antonio Iglesias Benítez
Gerente Regional Lerma, Santiago Pacífico

Vocal Gubernamental Colima
Carlos Salazar Preciado
Secretario SEDER Colima

Vocal Gubernamental Jalisco
Enrique Dau Flores
Director General CEAS Jalisco

Gerente Operativo de la Comisión de Cuenca Ayuquila-Armería
Arnoldo Vogel Guzmán

REPRESENTANTES

Uso Agrícola Colima
Francisco Javier Ibáñez López
Uso Acuícola Colima
Carlos Hernández Solórzano
Uso Público Urbano Colima
Rodolfo Valdez Valdez
Uso Industrial Colima
Javier Maurer Ortiz Monasterio
Uso en Servicios Colima
Carlos Enrique Izquierdo Espinal
Uso Pecuario Colima
Mariano Morales Gómez

Uso Agrícola Jalisco
José Ángel Fletes Venegas
Uso Acuícola Jalisco
León de la Rosa Hernández
Uso Público Urbano Jalisco
Carlos Luis Meillon Johnston
Uso Industrial Jalisco
Genaro Páez Morales
Uso en Servicios Jalisco
Gustavo Andrade Mejía
Uso Pecuario Jalisco
Gustavo Adolfo Méndez Llamas

Source: Gazette of the Ayquila-Armería Commission, No. 4, June 2005

Annex 14: Local newspaper announcing the discharge and investigation of April 2006

Semanario Costeño

Voz e Imagen de Costalegre

AÑO XIII EDICIÓN 602

08 DE ABRIL DE 2006

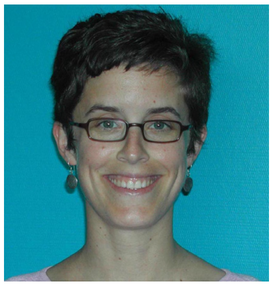
*PROFEPA inspecciona ingenio y río

Denuncian Contaminación

La línea roja representa el flujo que siguió la descarga hasta el río

P/4

Cherryl ANDRE DE LA PORTE



French and Dutch, born on 27.05.1975
16 Avenue Juste-Olivier, 1006 Lausanne, CH
+ 41(0) 79 537 14 88 / cherryladlp@gmail.com

Professional experience

2002-2007	**Research assistant at the Laboratory of Urban Sociology, Swiss Federal Institute of Technology Lausanne (LaSUR-EPFL)** - Co-responsible for information management: reorganised internal information and promoted the team's research in campus events - Participated in organising, writing up and editing annual reports - Attended and partially organised workshops in the Caribbean region
2001-2004	**Junior researcher at LaSUR-EPFL** in the project 'Urban-rural interface in Ecuador: Towards integrated territorial development'. - Edited research reports - Made presentations related to Local Agendas 21 - Replaced project director for 4 months
2001-2002	**Research assistant at the World Business Council for Sustainable Development, Geneva** - In charge of editorial research for the book *Walking the Talk, The Business Case for Sustainable Development* - Produced the report "*Business and Biodiversity, The Handbook for Corporate Action*", published with Earthwatch Europe and IUCN-The World Conservation Union
2001 (3 months)	**Consultant at the International Research Center on Environment and Development, Paris** Co-author of the report "*Comparison of incentive measures/good practices between France and other European countries with regards to the reduction of greenhouse gas emissions*": Analysed decentralised measures to limit CO2 emissions and best practices at urban level
1998 (4 months)	**Internship at the UNESCO/Man and the Biosphere Programme** Produced report "*Elements of a framework for MAB case studies on local community participation in biosphere reserve management*": Assessed the institutional and economic mechanisms to involve local communities in the management of biosphere reserves
1996 (3 months)	**Internship with De Chazal du Mée (Arthur Andersen), Mauritius** Report on the Mauritian environmental legislation

Education

2002-2007	**Ph.D. "Integrated water resources management: limits and potential in the municipality of El Grullo, Mexico"**, EPFL
1999-2000	**B.Sc. in Ethnology**, University of Paris V- René Descartes
1998-1999	**Ph.D. coursework in Environmental and Natural Resource Economics**, French Institute of Forestry, Agricultural and Environmental Engineering, Ecole des Hautes Etudes en Sciences Sociales, Institut National Agronomique-Paris Grignon, University of Paris X-Nanterre
1996-1998	**Postgraduate degree in Land Use and Local Development Economics and M.Sc. in Economic Analysis and Policy**, University of Paris I-Panthéon Sorbonne
1993-1996	**B.Sc. in Economic Analysis and Policy and undergraduate degree in Economics**, University of Nice Sophia-Antipolis

Personal details

- **Language skills**: fluency in French and English, working knowledge of Spanish

- **Countries of residence**: Tunisia, Senegal, United States, Nepal, Madagascar, Mali, France

- **Hobbies**: photography, travelling (Spain, Brazil, Mauritius Island, Italy, The Netherlands, Mexico, Scotland, Kenya, Morocco and Canada), sports (bicycle-riding, swimming, yoga, jogging, trekking, skiing), motorcycle-riding

- **Volunteer-based activities**:

- Teamwork to set up the project « A bet against global warming at the Cité Internationale Universitaire of Paris » (energy efficiency, solar heating)

- Secretary of the committee of the Asian House in 1997-1999 (sensitizing residents to solid waste recycling, organisation of campus-wide parties)

- Participated in the WWF-France campaign on climate change in 2000

- French Red-Cross punctual operations;

- Donator of Sheldrick Foundation in Kenya, UNICEF's « Desert Flower » operation and Médecins Sans Frontières

Publications

As author

André de la Porte C., Martínez L.M., Gerritsen P. (submitted) 'Decentralisation and sustainable water management: a case study from the municipality El Grullo, western Mexico', in Rist S. and Geiser U. (eds) *Decentralisation, Social Movements and Natural Resource Management.* Berne: NCCR North-South.

Gilotte L., André de la Porte C., Buclet N. et D. Demailly (2003) *Responsabilisation des collectivités locales et lutte contre l'effet de serre*. Rapport préparé pour l'Agence de l'Environnement et de la Maîtrise de l'Energie en France. Nogent-sur-Marne: CIRED

As editor

Bolay Jean-Claude, Rabinovich Adriana and André de la Porte Cherryl (eds.) (2004) *Interface urbano-rural en Ecuador: Hacia un desarrollo territorial integrado*. Cahier du LaSUR No.5, Lausanne: LaSUR-EPFL

Bolay Jean-Claude, Rabinovich Adriana and André de la Porte Cherryl (eds.) (2003) *Interface urbano-rural en Ecuador: Hacia un desarrollo territorial integrado*. Cahier du LaSUR No.4, Lausanne: LaSUR-EPFL

Earthwatch Europe, IUCN – The World Conservation Union and the World Business Council for Sustainable Development (2002) *Business and Biodiversity: The Handbook for Corporate Action*. Earthwatch Institute (Europe), IUCN, WBCSD

As editorial researcher

Holliday C., Schmidheiny S. and P. Watts (2002) *Walking the Talk: The Business Case for Sustainable Development*. Sheffield, United Kingdom: Greenleaf Publishing

CIRAD, CIRED, SOLAGRAL (2001) *Analyse comparative des instruments économiques pour la mise en oeuvre des Accords Multilatéraux sur l'Environnement dans les pays de la Zone de Solidarité Prioritaire*. Série "Etudes". Paris: Ministère des Affaires Etrangères

Conferences

- United Nations World Habitat Day, 4 October 2004, in Geneva, on the theme "Cities – engines of rural development": presentation of the research 'Urban-rural interface in Ecuador: Towards integrated territorial development'
- National workshop in Quito, Ecuador, 27 March 2003: presentation of 'Elements to define and implement Local Agendas 21'
- Local workshop in Naranjal, Ecuador, 31 May 2002: presentation of 'Local Agendas 21: from theory to implementation'