Water in Mexico

SUBDIRECCIÓN GENERAL DE PROGRAMACIÓN

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First English edition, March, 2006.
ISBN 968-817-730-X

Av. Insurgentes Sur 2416
Col. Copilco El Bajo
C.P. 04340
México, D.F.

www.cna.gob.mx

Printed in Mexico.

Distributed free of charge.

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Introduction

In Mexico, water is recognized as a strategic matter involving national security, and has become a central element of current environmental policies and, moreover, a key factor of social development and economic policies. For certain regions of the country, the possibility of achieving development depends crucially upon the availability of this precious resource, and water quality is a determinant for the population's health and well-being. Map 1

In this country, the water contained in rivers, lakes, and aquifers is the property of the nation, and its management falls to the Federal Executive Branch. To this end, Mexico has two major instruments:

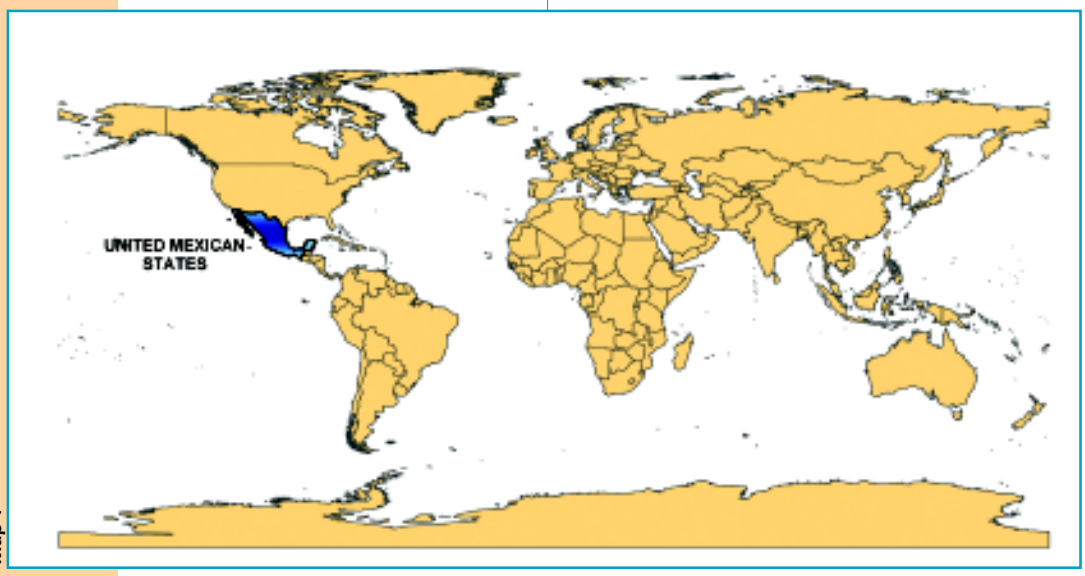
- The National Waters Law [Ley de Aguas Nacionales] (recently modified), which sets down principles and instruments for using and preserving water; and
- The National Water Commission [Comisión Nacional del Agua, or CONAGUA, its Spanish acronym], the agency responsible for managing this resource.

Furthermore, in our country a National Development Plan is prepared every six years. This plan includes the priorities, objectives, and strategies that the Federal Government has set for the ongoing six-year government administration. It outlines social, economic, domestic, and foreign policies, which all define the framework serving as a set of norms for government action.

In Mexico's current National Development Plan, the essential value of water is acknowledged as a strategic element for meeting the population's basic needs and providing an impulse to the country's economic activities within a framework that assigns a foremost place to caring for and preserving the environment, which it deems to be fundamental.

In this sense, Mexico's National Water Program for 2001-2006 has arisen as a sectoral program under the National Development Plan for the present federal administration. Included in it are the results of an unprecedented planning process for our country, involving broad participation on the part of users, local officials, non-governmental organizations, and organized society in defining problems, priorities, and alternatives for problem-solving in Mexico's watersheds and aquifers.

The National Water Program puts forward the present status of Mexico's water resources, reviewing the historical evolution of aspects such as water quantity, quality, uses, and their effects. It also analyzes possible long-term scenarios, and defines the vision of the water sector we aim to achieve, the objectives and goals to be met during this period, and the strategies and lines of action that will allow us to progress towards concrete and positive results.



Map 1

National panorama

Geographic and socio-economic context

Mexico, whose official name is Estados Unidos Mexicanos [United Mexican States], has a total area of 1 964 375 km^2 and 11 122 km of coastlines; it shares its northern border with the United States of America and its southern border with Belize and Guatemala; it is comprised of 32 Federal Entities [States], and the Federal District is the capital of the country. Map 2

The Tropic of Cancer runs through Mexico's territory. The country's climatic conditions vary from arid in the northern part of the country, warm humid and sub-humid climates in the southern-southeastern portion, and cold or temperate climates in elevated regions. In the north, on the U.S.-Mexico border, Mexico's territory is semidesert, with an arid climate. Towards the south-southeast, due to prevailing climatic conditions, there are tropical forests and swamp areas in the northern portion of the State of Tabasco.

The hydrological cycle takes place in basins or watersheds, which are the minimum units for water management. The country's basins and watersheds are grouped into 37 hydrological regions for the purpose of conducting hydrological research and studies on water quality. Map 3.

Map 2

Source: Instituto Nacional de Estadística, Geografía e Informática [National Institute of Statistics, Geography, and Informatics]

Map 3

Source: Technical Affairs Division, National Water Commission.

Map 4

Hydrological-Administrative Regions

Source: Prepared by the Planning Division, National Water Commission.

However, water management in Mexico is organized according to thirteen hydrological-administrative regions defined by the National Water Commission. Each of these regions has one or several watersheds. This ensures that watersheds are the basis for water management. Map 4

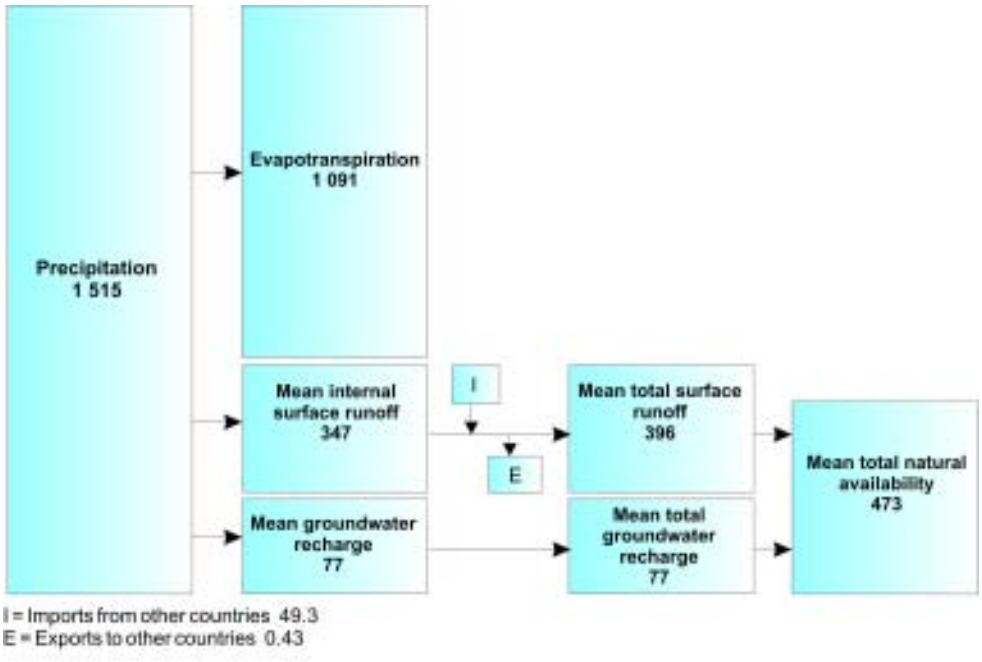
Components of the hydrological cycle

A little over 70% of rainwater in Mexico is evapotranspirated and returns to the atmosphere. The rest runs off in rivers and streams or infiltrates into the subsoil and recharges groundwater. Figure 1

Figure 1

Components of the hydrological cycle

(Mean annual figures, km^3)



Source: Technical Affairs Division, National Water Commission.

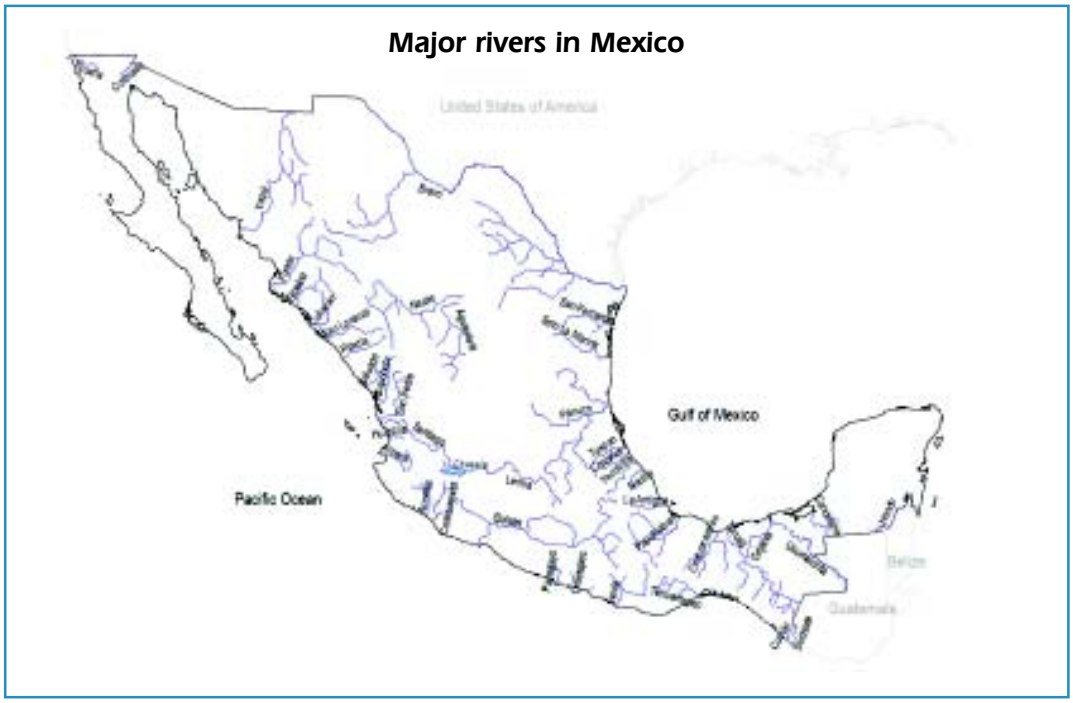
Surface waters

A volume of 396 km^3 of water per year flows through Mexico's rivers; that figure includes imports from other countries and excludes exports. Approximately 87% of this flow occurs in the 39 major rivers indicated below, whose watersheds cover 58% of the country's continental land area.

In this regard, a total of 65% of this flow (surface runoff) occurs in seven rivers: Grijalva-Usumacinta, Papaloapan, Coatzacoalcos, Balsas, Pánuco, Santiago, and Tonalá, whose total watershed area represents 22% of the country's total land area. The Balsas and Santiago rivers empty into the Pacific Ocean, while the other five empty into the Gulf of Mexico. Outstanding because of the area they cover are the watersheds of the Río Bravo and Balsas (18% of the country's total area). And the Río Bravo and Grijalva-Usumacinta are noteworthy due to their length. Map 5

Map 5

Major rivers in Mexico



Source: Prepared by the Planning Division, National Water Commission, based on information provided by the Technical Affairs Division, National Water Commission

Table 1

Major lakes in Mexico

No.	Lake	Area of the lake's basin (km^2)	Storage capacity (hm^3)	Administrative Region	State
1	Chapala	1 116	8 126	VIII	Jalisco and Michoacán
2	Cuitzeo	306	920*	VIII	Michoacán
3	Pátzcuaro	97	550*	VIII	Michoacán
4	Yuriria	80	188	VIII	Guanajuato
5	Catemaco	75	454	X	Veracruz
6	Tequesquitengo	8	16	IV	Morelos
7	Nabor Carrillo	10	12	XIII	México

Source: Manager's Office for Surface Waters and River Engineering, Technical Affairs Division, National Water Commission.
Note: * Data refers to mean volume stored. 2005.

Mexico also has a great number of lakes. Lake Chapala is the country's largest inland lake, and is located in one of the American Continent's most recent areas, from a geological standpoint. Table 1

Mexico shares three watersheds (Colorado, Bravo, and Tijuana) with the United States of America (U.S.A.), four with Guatemala (Grijalva-Usumacinta, Suchiate, Coatán, and Candelaria), and one with Belize y Guatemala (Río Hondo).

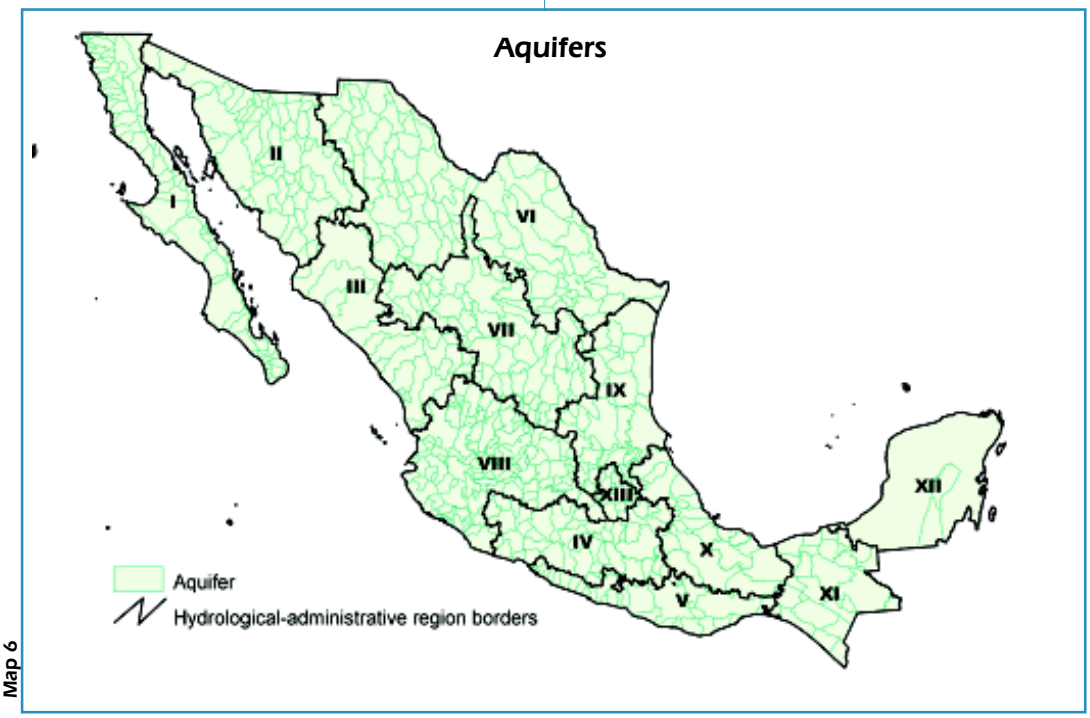
The waters of the Tijuana and Colorado rivers and the Río Bravo are shared in accordance with the stipulations included in the Treaty on the Utilization of the Waters of the Colorado and Tijuana Rivers and the Rio Grande, signed between Mexico and the United States of America in Washington, D.C. on February 3, 1944.

Groundwaters

The importance of groundwater is evidenced by the fact that it accounts for 64% of the volume for public water supply, 33% of all water used for agriculture and livestock, and 24% of water utilized by self-supplied industry. For the purposes of managing water, the country has been divided into 653 aquifers. Map 6

Aquifer recharge is on the order of 77 km^3/year, of which it is estimated that 27.5 km^3/year are utilized. Approximately 77% of all groundwater withdrawals are for irrigation.

Map 6



Source: Manager's Office for Groundwater, Technical Affairs Division, National Water Commission, 2005.

Water challenges in Mexico

Water-related challenges posed in Mexico are attributable to factors such as the following:

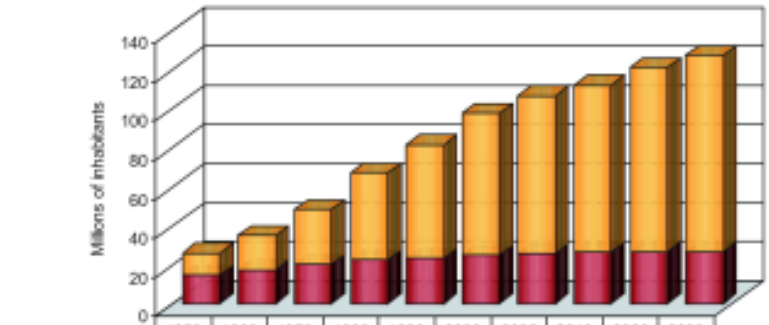
- Exponentially increasing demand derived from population growth and greater economic development.
- Unequal distribution of this resource throughout time and space.
- Lower real availability brought on by water pollution.
- Inefficient water use in different user sectors.

As regards the population, in the past five decades it has practically quadrupled, going from 25.8 million inhabitants in 1950 to 97.4 million in 2000. Naturally, this has an impact on water demands for human consumption and, perhaps to even a greater extent, on water demands for agricultural and industrial uses. Graph 1

Estimates for the year 2030 indicate that Mexico's population will grow by 84% compared to its current population, and that 50% of the population will be concentrated in 31 cities with over 500 000 inhabitants. Map 7

Graph 1

Population dynamics in Mexico



	1950	1960	1970	1980	1990	2000	2005	2010	2020	2030
Urban population	11.0	17.7	28.3	44.3	58.0	72.7	80.9	85.3	93.8	100.4
Rural population	14.8	17.2	19.9	22.5	23.2	24.7	25.6	26.4	26.8	26.8

Source: Based on General Population and Housing Censuses, National Institute of Statistics, Geography, and Informatics, and Population Projections, National Population Council (CONAPO), 2003.

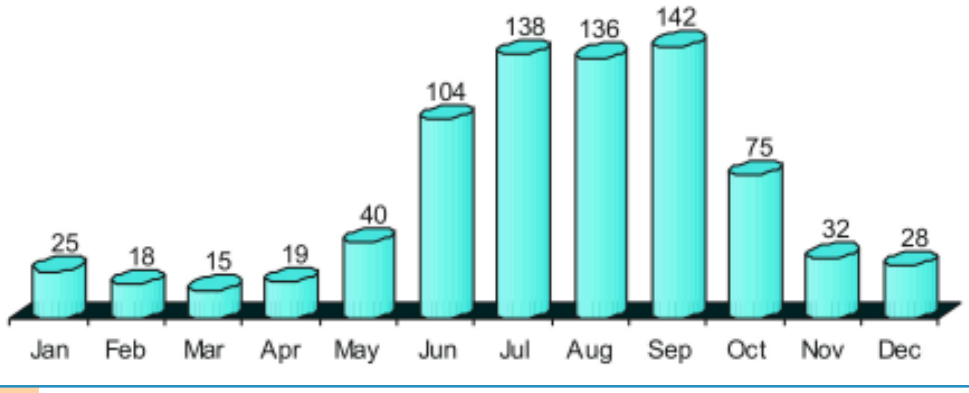
Map 7

Cities with over 500 000 inhabitants (Projection to the year 2030)

Source: Prepared by the Planning Division, National Water Commission, based on Population Projections from the National Population Council (CONAPO), 2003.

Graph 2

Historical mean monthly precipitation (mm)
(1941-2004)



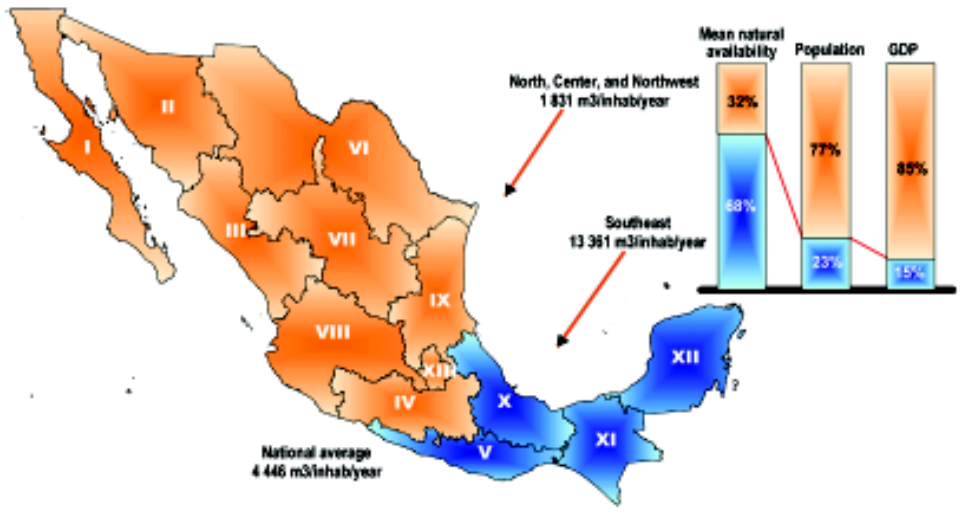
Source: Unit of the National Meteorological Service, Technical Affairs Division, National Water Commission.

Moreover, unequal distribution of water in terms of both time and space represents, per se, a challenge for the sustainable use of this resource. In Mexico as a whole, 77% of all precipitation occurs between June and October. Historical mean annual precipitation (1941-2004) is 773 mm. Graph 2

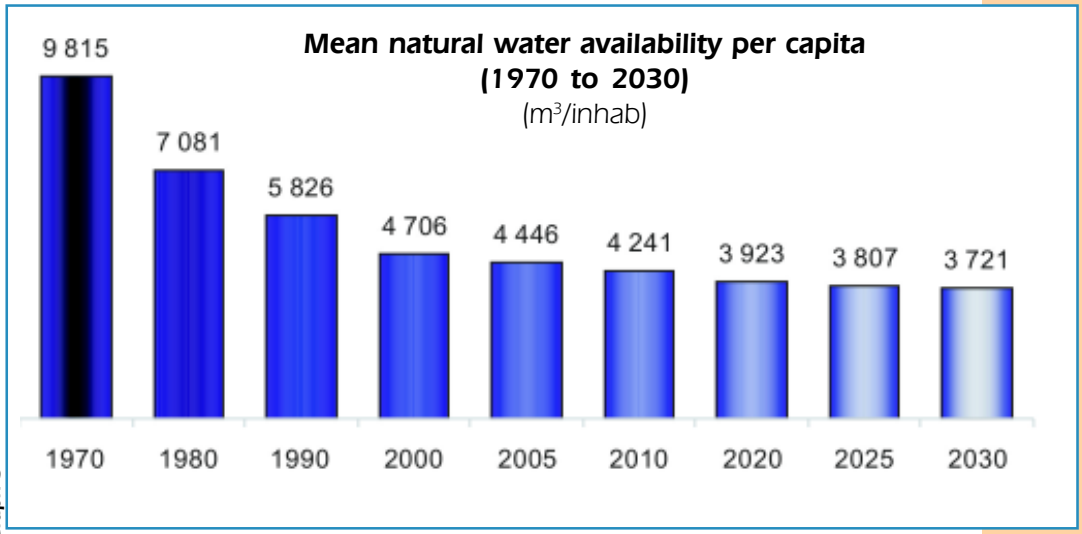
This challenge is heightened even further because, paradoxically, Mexico's population, economic activity, and higher growth rates are concentrated in its central and northern portions, where natural water availability is lower. Those areas, which only have a third of all natural availability, are home to three-quarters of the country's population and the site of about 85% of the Gross Domestic Product (GDP) (an indication of the degree of economic activity in this region). In contrast, Mexico's southern region, where two-thirds of all runoff occurs, houses just one-fourth of the population and accounts for only some 15% of the country's GDP. Map 8

Map 8

Contrast between development and water availability



Source: Prepared by the Planning Division, National Water Commission. 2005



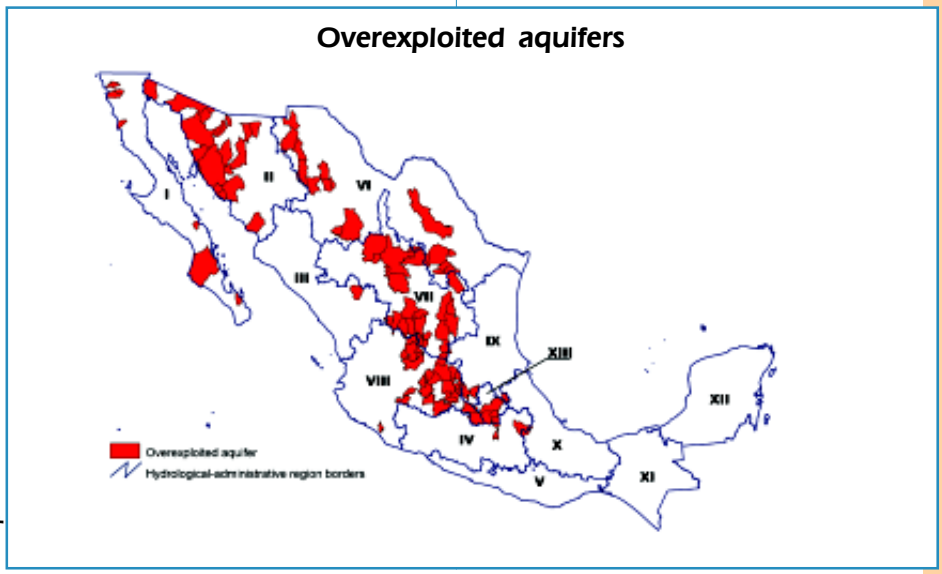
Graph 3

Source: 2000-2030 Population Projections, National Population Council (CONAPO), 2003; and *Estados Unidos Mexicanos: Cien Años de Censos de Población* [Mexico: One Hundred Years of Population Censuses], National Institute of Statistics, Geography, and Informatics; Technical Affairs Division, National Water Commission.

Thus, due to this population increase, mean natural availability of water per inhabitant in Mexico is expected to drop from 4 446 m³/inhab/year in 2005 to 3 721 m³/inhab/year by 2030. Graph 3

Water stress in high-demand zones with low availability has led to problems involving increasingly more serious overexploitation of watersheds and aquifers. To illustrate this point, we only need to mention that, as of the 1970s, the number of overexploited aquifers has been rising considerably: it went from 32 in 1975, 80 in 1985, and 97 in 2001, to 104 in 2004. It is important to note that nearly 60% of groundwater employed for all uses is withdrawn from overexploited aquifers. Map 9

Aside from overexploited aquifers, there are 17 with salt-water intrusion located in the states of Baja California, Baja California Sur, Colima, Sonora, and Veracruz. Some of these are Maneadero and San Quintín in Baja California; Santo Domingo in Baja California Sur; and Caborca, Costa de Hermosillo, and San José de Guaymas in Sonora.



Map 9

Source: Manager's Office for Groundwater, Technical Affairs Division, National Water Commission, 2005.

Another factor posing a challenge for sustainable water management in Mexico is that most of the country's surface water bodies receive untreated wastewater discharges of either municipal or industrial origin. This has led to varying degrees of pollution which limit the direct use of water in other activities. Only one-third of all municipal wastewater collected in sewerage receives some degree of treatment before being discharged.

Moreover, consumption patterns of the different water uses do not favor recovery of the country's water bodies.

According to the Public Registry of Water Rights (Registro Público de Derechos de Agua, or REPDA), as of September, 2005, the volume of water granted in concession was 76 km^3 for offstream uses. Graph 4. This volume represents 16% of the country's mean natural availability (mean surface runoff and aquifer recharge); according to the UN classification, water in Mexico is considered to be under moderate stress. However, in the central, northern, and northwestern regions of the country, this indicator reaches a value of more than 40%, for which reason water is subject to high stress and is a factor limiting development. Map 10

Urban centers (municipal discharges) produce:

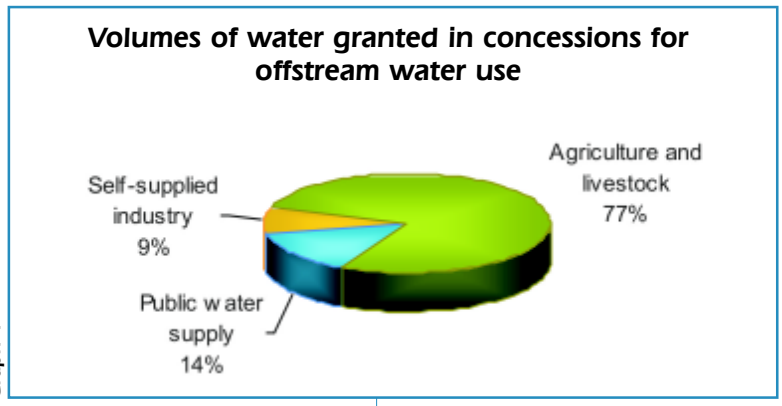
Wastewater:	8.05	km^3/year (255 m^3/s)
Collected in sewerage:	6.46	km^3/year (205 m^3/s)
Produced:	2.18	million tons of BOD_5 per year
Collected in sewerage:	1.75	million tons of BOD_5 per year
Removed in treatment systems:	0.5	million tons of BOD_5 per year

Non-municipal uses, including industry, produce:

Wastewater:	10.42	km^3/year (330 m^3/s)
Produced:	12.18	million tons of BOD_5 per year
Removed in treatment systems:	1.01	million tons of BOD_5 per year

Source: Urban Hydraulic Infrastructure Division and Manager's Office for Sanitation and Water Quality, Technical Affairs Division, National Water Commission, 2004.

Graph 4



Source: Manager's Office of the Public Registry of Water Rights (REPDA), Water Management Division, National Water Commission.
Note: Cumulative percentages as of 2005.

Map 10

Source: Prepared by the Planning Division, National Water Commission, 2005.

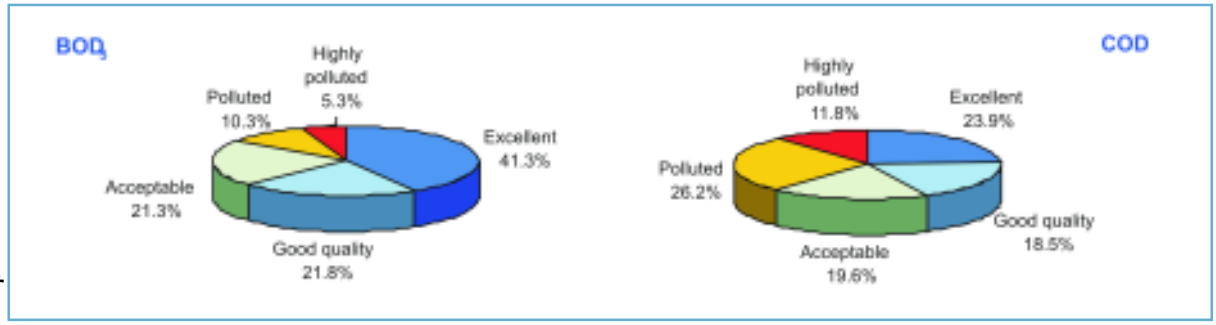
Water quality

This situation is mainly attributable to the fact that in over 80% of Mexico's irrigated land area, traditional irrigation methods are employed, and water losses are estimated at between 40% and 60%. In public urban use, losses range from 30% to 50% of all water withdrawn. Although industrial use is not a very high water consumer, it does represent a source of pollution three times greater than that of population centers.

The findings of a water quality assessment conducted in 2004 indicate that, according to the classification scales for Biochemical Oxygen Demand (BOD_5) and Chemical Oxygen Demand (COD), the watersheds with the highest levels of surface water pollution pertain to the following rivers: Atoyac, Lerma-Salamanca, Laja, Lerma-Toluca, Papaloapan, Nautla, and Moctezuma. Graph 5

Monitoring stations in surface water bodies in each BOD_5 and COD category

Graph 5



Source: Manager's Office for Sanitation and Water Quality, Technical Affairs Division, National Water Commission. 2004.

Water policies

The scenarios

In order to devise strategies for meeting challenges that arise when attempting to achieve integrated, sustainable water management in Mexico, the possible scenarios for water uses on the 2025 horizon have been evaluated. Among the scenarios studied, two show contrasts in terms of water use patterns.

In the first scenario, average conditions existing in the year 2000 are maintained (business-as-usual scenario), while in the second one (sustainable scenario), we find features involving greater efficiency. Table 2

In the sustainable scenario, the central focus of resource management is on demand management. As can be seen in the table above, even though a larger number of inhabitants will be supplied and the agricultural frontier will be extended –thanks to a reduction in losses associated with increased efficiencies–, in the year 2025, the demand for water would rise to a much lower level than that required within the business-as-usual scenario.

However, in the sustainable scenario, the investment required to ensure that the proposed goals are met would be 71.698 billon USD, which would entail a mean annual investment of 2.83 billion USD, more than double what was invested in the year 2000.

In view of current challenges and the great importance of water resources for Mexico's well-being and development, the vision of the water sector we wish to achieve was defined; thus, Mexico aspires to be:

"A nation that achieves security in the supply of water needed for its development, uses it efficiently, acknowledges its strategic and economic value, protects bodies of water, and preserves the environment for future generations."

In this sense, so as to progress toward the realization of this vision, a change of paradigm was proposed as a central element, i.e., **to work towards reducing demand rather than continuing with an approach geared to increasing supply.** This change of paradigm involves a realization of the fact that we can no longer continue indefinitely to follow an approach privileging a search for new sources of supply rather than one favoring more efficient use of the water we already have.

Table 2

Parameter	2000	Business-as- usual	Sustainable
Hectares of modernized land	0.8 million	1.1 million	5.8 million
New irrigated hectares	—	490 000	1 million
Irrigation losses	54%	51%	37%
Urban public use losses	44%	44%	24%
Drinking water coverage	88%	88%	97%
Sewerage coverage	76%	76%	97%
Percentage of wastewater treated	23%	60%	90%
Volume of water utilized (billions of cubic meters)	72* / 79	85* / 91	75* / 80
Annual investments in this sector (billions of pesos) (billions of USD)[1]	14 1.3	16 1.5	30 2.8

* With restrictions in irrigation demand due to droughts.

[1] An approximate exchange rate for the month of December, 2005 was considered. 1 USD = 10.60 Mexican pesos.

The planning process

To design water policies, a process was conducted using this change of paradigm as a point of departure, with five guiding principles:

- The country's development should take place within a sustainable framework.
- Water is a strategic resource affecting national security.
- The basic unit for managing water is the watershed or river basin.
- Natural resource management should be integrated.
- Decisions should be made with the involvement of users.

These principles constitute a synthesis of the outcomes of different international forums concerning water.

Therefore, water policies were designed on the basis of local perceptions, which were integrated on the national level, that is to say, a bottom-up design, covering the following phases:

- The country was divided into 13 hydrological-administrative regions.
- Basic data for each region was determined through water diagnoses and, with the consensus of users, strategic guidelines for water development in each region were established.
- Far-reaching regional water programs were formulated for the 2001-2025 period; work was done to synthesize and homologize the results of this regional process, leading to the first version of the 2001-2006 National Water Program, currently the document governing Mexico's water policies.
- Based on the 2001-2006 National Water Program, thirteen Regional Water Programs were developed; for each of the hydrological-administrative regions into which the country was divided, these programs identify the specific goals and actions that will help attain our national goals.

It is important to note that water policy design was effected with the unprecedented participation of users, local officials, non-governmental organizations, and the general public, mainly through two types of advisory bodies: Watershed Councils and the Water Advisory Council.

At present, water policies are aimed at achieving the following six major national objectives:

1. To promote the efficient use of water in agricultural production.

2. To foster a widening of coverage and an improvement in the quality of services for drinking water supply, sewerage, and basic sanitation.

3. To achieve integrated, sustainable water management in watersheds, basins, and aquifers.

4. To promote the technical, administrative, and financial development of the water sector.

5. To consolidate the participation of users and organized society in water management and to promote a culture for a proper use of this resource.

6. To diminish risks and attend to the effects of floods and droughts

Policy implementation

The guidelines for Mexico's water policies are put into practice by means of four types of mechanisms:

- Legal or regulatory,
- Economic,
- Social participation, and
- Technological.

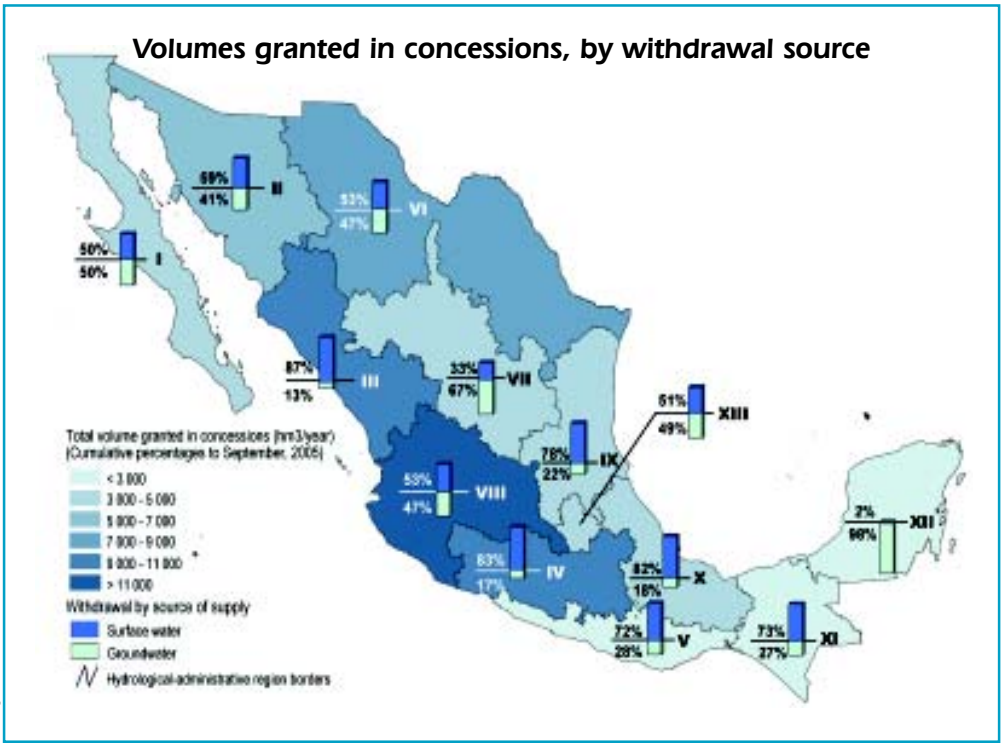
Legal mechanisms

The National Waters Law made it possible to implement a regulatory framework that seeks to encourage greater efficiency and a more accurate perception of the social, economic, and environmental value of this resource. Therefore, users of national waters operate within a framework of rights and obligations that are clearly defined in three basic instruments:

- Titles of concession or allocation, which establish the right to withdraw, use or enjoy in usufruct a specific volume of water. Maps 11 and 12
- Permits for wastewater discharges. This instrument establishes the conditions under which permittees must dispose of resulting wastewater.
- Enrollment in the Public Registry of Water Rights [Registro Público de Derechos de Agua, or REPDA] of both titles of concession or allocation and permits for discharging wastewater, which affords the rights granted to water users greater certainty and assurance from a legal standpoint.

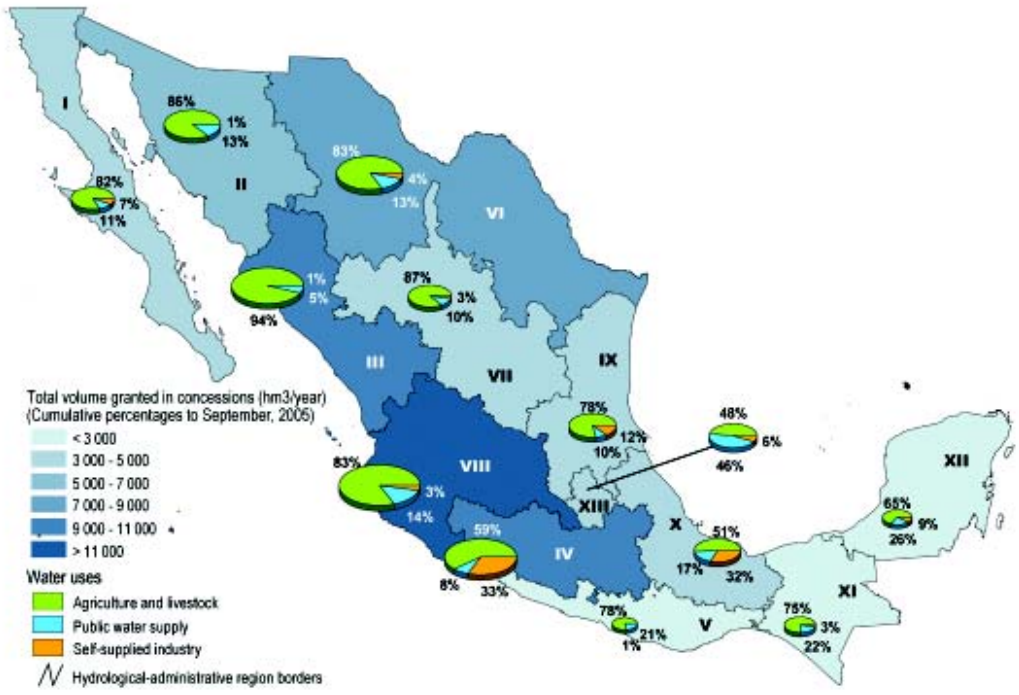
The National Waters Law sets down stipulations regulating concessions. In addition, the law contains various principles that govern actions taken by authorities and grant users greater certainty and assurance from a legal standpoint.

Map 11



Source: Manager's Office of the Public Registry of Water Rights. Water Management Division. National Water Commission 2005.

Volumes of water granted in concessions, for offstream water use[2]



Map 12

Source: Manager's Office of the Public Registry of Water Rights. Water Management Division. National Water Commission. 2005.

The rights granted for the withdrawal, use or usufruct of national waters are for the utilization of specific water sources, which provide a particular volume of water to meet an initial offstream use, subject to specific conditions regarding the quantity and quality of wastewater discharges.

Among the principles guiding integrated water management, besides regulating aspects involving quantity, special attention is given to preventing and controlling water pollution. As an initial step, the issuing of discharge permits was established; these permits are mandatory for all those responsible for wastewater discharges into receiving water bodies that are national property.

The greater mobility thus gained by water rights called for a mechanism to afford users improved conditions of assurance. Hence, the Mexican government instituted the Public Registry of Water Rights, in which all titles of concession or allocation are to be enrolled, and also the transfer operations effected. This registry is public, and can issue water rights certificates.

As a mechanism to see to it that water resources are employed for uses offering the greatest economic benefits, within a framework of equity and social benefit, the National Waters Law provides for the possibility of transferring rights covered by titles of concession or allocation with the prior authorization of the corresponding authority, who must look after the interests of third parties who might be affected by transfer operations and also the integrity of hydrological systems.

Discharge permits clearly define permittees' rights and obligations, and set the limits of the discretionary capacity of authorities, while it is

[2]Two types of use are defined:
· Offstream water uses, in which water is transported to the place where it is to be used, and all or part of it does not return to the water body.
· Instream water uses, in which water is used in the water body itself or with a minimal diversion, such as in the case of hydroelectric plants.

true that, at all times, authorities have the power to verify the due compliance with the stipulations of the corresponding permit. Water pollution prevention and control, quality control of water supplied for human consumption and other uses that could affect public health, as well as general protection of the environment and aquatic ecosystems, are all grounded on a set of standards that must be issued by different government agencies, including the National Water Commission, in accordance with the legal framework in force.

Economic mechanisms

Another central issue in Mexico's new water policies was the solution of financial problems society faces for meeting its water demands. The low financial capacity of both municipal drinking water and sewerage service providers and irrigation districts has also had a negative effect on their technical and administrative capacities, diminishing the possibility of achieving autonomous, sustainable management.

As a core issue in strategies to attain efficient, equitable, and environmentally acceptable water use, the concept of water as an economic good –substituting the concept of this resource as a free good– was reinforced. That is why Mexico's water policies include the introduction of pricing systems and other economic incentives.

Thus, water policies bring together two main approaches:

- Greater participation by society in financing the works and actions that benefit it, leading to more efficient water use through pricing and economic incentives.
- A set of policies and measures geared to make sound and strengthen the finances of user systems in order to achieve short- and medium-term financial self-sufficiency, mainly by means of pricing systems allowing for recovery of the total cost of the services provided.

The implementation of economic criteria in water management is based on the current Federal Duties Law, which stipulates the payment of duties for the use or usufruct of national waters, as well as the payment of duties for the use or usufruct of goods in the public domain such as water bodies receiving wastewater discharges. Two fundamental principles were introduced: first, that water has an economic value based on its availability, and second, that "he who pollutes pays."

As monies collected increase, we are able to consolidate a system allowing us to fund programs and actions in the water sector. This collection process favors a greater flow of funds by serving as a counterpart for credits agreed upon with development banks or rather, by being incorporated into financial packages including the participation of state and municipal governments, users or beneficiaries, and private enterprise.

Similarly, fiscal legislation defines the duties or fees to be paid by users of water services provided by the federal government. The intention is to achieve full recovery of operating, conservation, and maintenance costs associated with the supply of water to population centers, industries or irrigation districts.

Furthermore, the Law on Contributions towards the Improvement of Federal Public Water Infrastructure Works is the instrument for recovering federal investments in the sphere of water infrastructure that directly benefits individuals or corporations.

Participatory mechanisms

International experience has shown that evaluating and solving water problems can best

be achieved at the local level because the users themselves and local officials are the ones with the most accurate knowledge about their problems. Therefore, they are in a better position to propose, with appropriate technical assistance, the best alternatives for problem-solving, taking into account factors germane to the zone in question, such as its historical evolution, idiosyncrasies, and specific climatic condtions.

We also found that an essential element for ensuring the success of actions undertaken consists of continuity in the proposed programs, and total conviction on the part of users of the necessity of carrying out the actions there indicated and also of the benefits they will produce. Thus, user involvement is fundamental from the phase in which the problems of a particular zone are described and hierarchized up to the point when actions are taken to solve them.

Users represent the link that can lend the continuity needed for actions proposed to achieve the aims agreed upon. Institutions and officials change, but users remain. So, obviously, their participation is indispensable in this new water management scheme.

Mechanisms for technological development

In order to face the country's problems appropriately, we need to promote science and technology, placing them at the service of society so as to meet its needs. This is aimed at attaining efficient water use in both rural and urban areas, in large systems, and among individual users.

The National Water Commission has promoted a level of technological development that now allows users to make more efficient use of this resource. Different research and academic institutions have been taking part in the promotion of technology.

The National Water Commission and the Mexican Institute of Water Technology (IMTA, its Spanish acronym), are the agencies entrusted with the task of directing this scientific and technological effort, coordinating the participation of universities, research centers, and other entities. IMTA's mission is to conduct research; develop, adapt, and transfer technology; and provide technological services and train qualified human resources for water management, conservation, and rehabilitation, so as to contribute towards the country's sustainable development. Among its tasks are to correlate scientific and technological activities with problems confronted by users and by institutions in charge of some aspect involving water management.

Besides conducting basic research, the IMTA is dedicated to perfecting, updating, and transferring available technology in order to help solve problems faced by the water sector.

As regards training for this sector, aside from the IMTA the following are worthy of mentioning: the Mexican Center for Water and Sanitation Training (CEMCAS, its Spanish acronym), the National Center for the Transfer of Irrigation and Drainage Technology (CENATRYD, its Spanish acronym), and institutes and schools throughout the country, which are playing an increasingly more significant role in this task of capacity-building and conducting courses focused on their local problems.

Achievements

As outcomes of the definition and implementation of water policies in Mexico, it is important to highlight the following achievements within the framework of each of the six national objectives.

Objective 1. To promote efficient water use in agricultural production.

Hydro-agricultural infrastructure is an essential component for reaching national objectives in the spheres of food, increasing income, and improving the living standard of producers and inhabitants in rural areas.

For this reason, an attempt is made to attune national priorities by actions enabling us to maintain or enhance agricultural production levels and, at the same time, cut back the volumes of water used in this activity so that the volumes saved may be earmarked to meeting the demands of other water uses or reestablishing a hydrological balance in watersheds or aquifers that are already overexploited.

To this effect, the Mexican National Water Commission and the Mexican Ministry of Agriculture, Livestock, Rural Development, Fisheries, and Food (SAGARPA, its Spanish acronym) have jointly worked out programs benefiting irrigation districts and units. In these programs, the National Water Commission is in charge of rehabilitation of master waterworks, of canal networks up to the "between-farm or plot" level, and of wells or pumping systems. In turn, the SAGARPA is responsible for working at the on-farm or plot level, effecting actions aimed at improving the application of irrigation and conducting other processes within the productive chain.

Thus, Mexico currently has the following:

- 6. 3 million irrigated hectares.
- 2.8 million technified rain-fed hectares.
- 4 000 storage dams, of which 667 are classified as large dams according to the definition of the International Commission on Large Dams, or ICOLD. Fifteen of them are dams supplying irrigation water, and have a total storage capacity of over 1km^3. Map 13

Dams accounting for nearly 60% of the country's total storage capacity

Map 13

Source: Manager's Office for Surface Water and River Engineering, Technical Affairs Division, National Water Commission. 2005.

In addition, in Mexico:

- Average total irrigation efficiency per irrigation unit increased by 7.6%.
- Average gross land productivity per irrigation unit rose by 28%.
- Average gross water productivity per irrigation unit went up 47%.
- From agricultural year 2000-2001 to that of 2003-2004, water productivity went from 1.53Kg/m^3 to 1.68Kg/m^3, equivalent to a 4.5% annual increase.

Moreover, in order to achieve integral planning in irrigation districts, in August, 2004, a Coordination Agreement between SAGARPA and the National Water Commission was signed for issuing exclusive sowing permits with water rights; this scheme was set in place as of agricultural year 2004-2005.

Objective 2. To foster a widening of coverage and an improvement in the quality of services for drinking water supply, sewerage, and basic sanitation.

Coverage of drinking water, sewerage, and sanitation services constitutes one of the best indicators of a country's level of well-being and development. The lack of these services is directly correlated with a low living standard and with the occurrence of diseases that affect inhabitants' social, economic, and environmental milieu.

Up to the present, drinking water and sewerage service provision has represented one of Mexico's greatest social demands, along with sanitation measures allowing us to restore water quality in the country's surface waters and aquifers.

In rural areas, we find three-fourths of the nation's population that live under conditions of extreme poverty. This population is scattered in close to 200 000 localities throughout the country, and entail the settlements suffering from the most serious lag in terms of drinking water and basic sanitation coverage.

In this sense, actions geared to increasing drinking water and basic sanitation coverages in rural communities involve support in the form of subsidies for investments in infrastructure, assigning priority to the implementation of integrated projects for supplying drinking water and providing basic sanitation services in seriously marginalized zones. Similarly, the Clean Water Program is now being consolidated. This program includes actions aimed at supplying water of a quality suitable for human consumption and follows a decentralized approach.

In this regard, we should mention the Drinking Water Supply and Sanitation Sustainability Program [Programa para la Sostenibilidad de los Servicios de Agua Potable y Saneamiento en Comunidades Rurales, or PROSSAPYS, its Spanish acronym]. The objective of this program is to support the development process of the Water and Sanitation Subsector in the country's rural areas. This includes applying standards ensuring the quality of services, based on three components: institutional development, social attention and community participation, and drinking water and sanitation infrastructure.

In addition, in urban areas, the involvement of private enterprise in infrastructure design, construction, operation, and financing is a central element for fulfilling this objective. To that end, development mechanisms have been devised to grant greater financial support to those municipalities that choose to use more integrated private participation schemes, also taking into account the overall levels of efficiency involved. The Water Utility Modernization Program [Programa para la Modernización de Organismos Operadores de Agua, or PROMAGUA, its Spanish acronym] provides a precise definition of the percentages and conditions for having access to these resources.

PROMAGUA's objective is to serve as an additional source of funds, provided recipients engage in a scheme for structural change, so as to further strengthen water utilities; promote their physical and commercial efficiency; facilitate access to state-of-the-art technology; foster the necessary conditions so that they may achieve self-sufficiency; and encourage care for the environment with sanitation projects preferably associated with wastewater reuse. This program is aimed at giving preferential support to water utilities that serve localities with more than 50 000 inhabitants, which account for a little over 50% of the country's population.

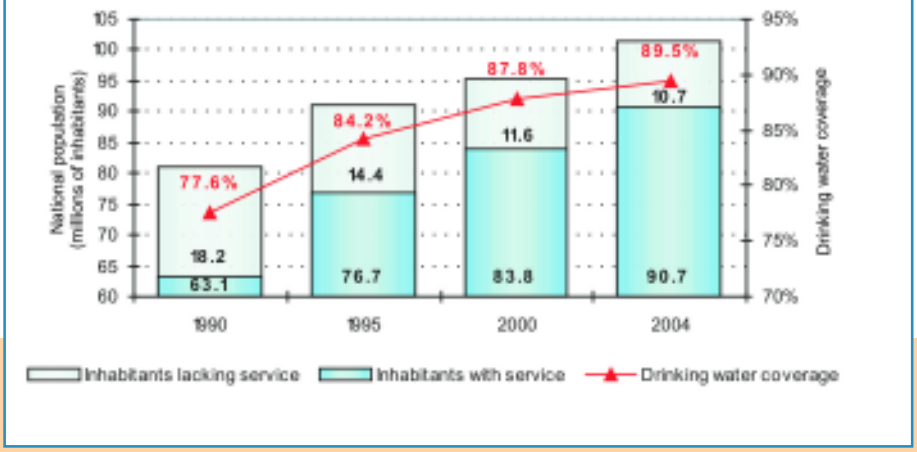
Similarly, impetus is provided to the Program for Reimbursing Duties [Programa de Devolución de Derechos, or PRODDER, its Spanish acronym], whose aim is to contribute towards the execution of actions to improve efficiency and infrastructure for drinking water and sewerage services, and wastewater treatment in municipalities by reimbursing drinking water and sanitation service providers for monies paid to the federal government in the form of duties for the withdrawal, use or usufruct of national waters.

Candidates eligible for inclusion in the PRODDER are all those service providers who, having paid federal duties for the use or usufruct of national waters, for urban public service, with populations of over 2 500, apply to join the program, submitting an Action Program in which they pledge to invest, along with the reimbursed federal duties, at least an amount equal to them. The Action Program provides for improvements in drinking water, sewerage, and wastewater treatment efficiency and infrastructure.

At present, thanks to Mexico's achievements, national drinking water coverage is 89.5% and sewerage coverage, 77.5%. Similarly, 95.9% of the water supplied to settlements is disinfected at least once, while 26.5% is purified at 482 plants currently in operation.Graphs 6 and 7. Maps 14 y 15.

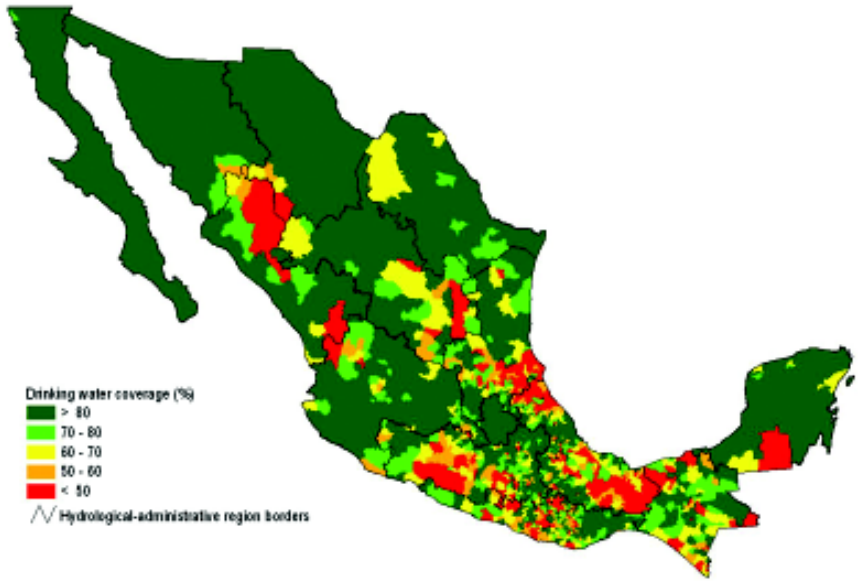
Graph 6

Evolution of drinking water coverage in Mexico



Source: Situación del Subsector Agua Potable, Alcantarillado y Saneamiento a diciembre 2004 [Status of the Drinking Water, Sewerage, and Sanitation Subsector as of December, 2004], Urban Hydraulic Infrastructure Division, National Water Commission.

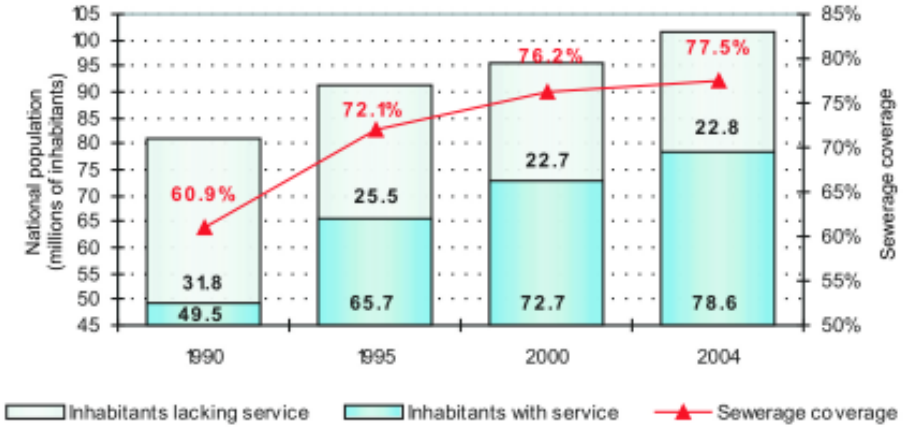
Drinking water coverage in Mexico, by municipality[3]



Map 14

Source: Prepared by the Planning Division, National Water Commission, based on the XII General Population and Housing Census, Mexican National Institute of Statistics, Geography, and Informatics [Instituto Nacional de Estadística, Geografía e Informática, or INEGI, its Spanish acronym], February, 2000.

Evolution of sewerage coverage in Mexico

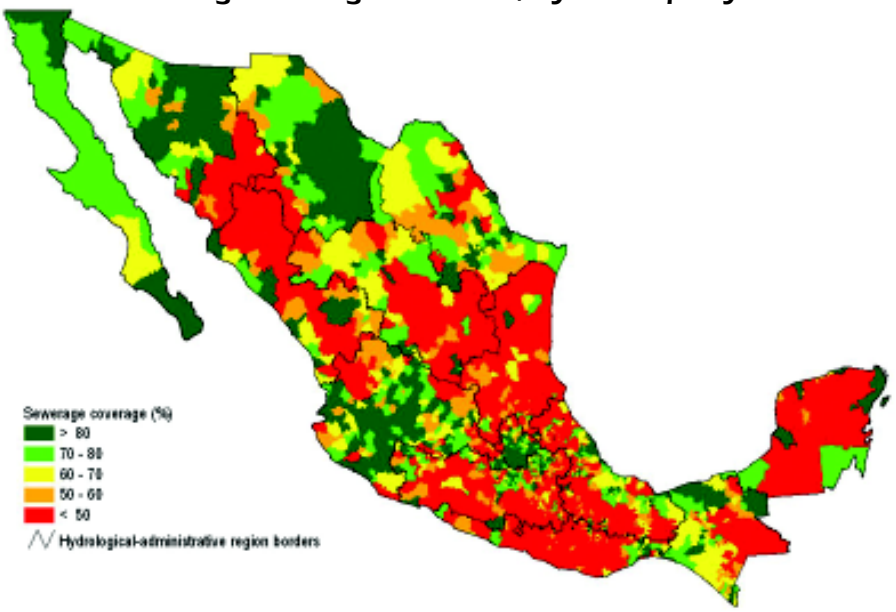


Graph 7

Source: Situación del Subsector Agua Potable, Alcantarillado y Saneamiento a diciembre 2004 [Status of the Drinking Water, Sewerage, and Sanitation Subsector as of December, 2004], Urban Hydraulic Infrastructure Division, National Water Commission.

[3]Coverages were calculated by dividing the number of occupants in private homes who have this service by the total number of occupants in private homes; given that consideration, this data may vary from other data published by the National Water Commission.

Sewerage coverage in Mexico, by municipality[4]



Map 15

Source: Prepared by the Planning Division, National Water Commission, based on the XII General Population and Housing Census, Mexican National Institute of Statistics, Geography, and Informatics [Instituto Nacional de Estadística, Geografía e Informática, or INEGI, its Spanish acronym], February, 2000.

Similarly, in Mexico more than 90 000 liters of wastewater per second are treated in:

- 1 300 municipal wastewater treatment plants now operating and
- 1 791 industrial wastewater treatment plants now operating.

Objective 3. To achieve integrated, sustainable water management in watersheds, basins, and aquifers.

In order to achieve integrated, sustainable water management in watersheds, basins, and aquifers, impetus is given to comprehensive analyses of problems and solutions related to natural resources within a sustainable development framework, seeking synergies in water resources management with forest and soil management.

In this regard, we should note the close relationship promoted between the Ministry of the Environment and Natural Resources (SEMARNAT, its Spanish acronym), the National Forestry Commission (CONAFOR, its Spanish acronym), and the National Water Commission for the purpose of achieving integrated management of associated natural resources at the watershed level.

In addition, the National Water Commission interacts with the other ministries and federal government agencies through the Mexican Committee for Sustainable Water Use.

This interinstitutional coordination facilitates progress towards sustainable development because it includes environmental considerations in planning, management, and execution of productive activities and services. The aim is for all the actions undertaken in the country to consider environmental conservation as a fundamental premise.

[4] Coverages were calculated by dividing the number of occupants in private homes who have this service by the total number of occupants in private homes; given that consideration, this data may vary from other data published by the National Water Commission.

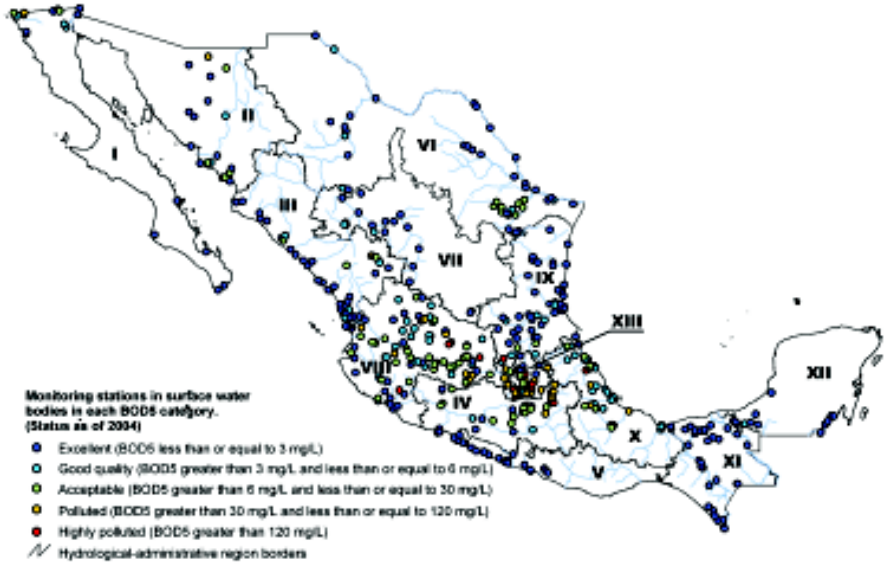
Without a doubt, the first step in advancing towards sustainable water management is to know how much water is available. To this end, the continuous operation and modernization of hydrometric, climatological, and water quality information networks are promoted, as well as studies permitting a more exact identification of variables in the hydrological cycle (precipitation, runoff, infiltration, etc.).

Availability of national waters at the regional, watershed, subwatershed or aquifer level is calculated according to parameters set down by the corresponding Official Mexican Norm [Norma Oficial Mexicana], and is published in the Diario Oficial de la Federación (DOF, the official government gazette). Thus, all Mexican citizens are informed as to how much water is available in each region of the country. To date, the availability of 202 aquifers has been published.

Furthermore, water quality monitoring offers more information on the quality indexes of surface water and groundwater. This is important because in order to conduct certain activities, specific quality levels are required. Although the necessary volume may be available, quality indexes may constrain its use.

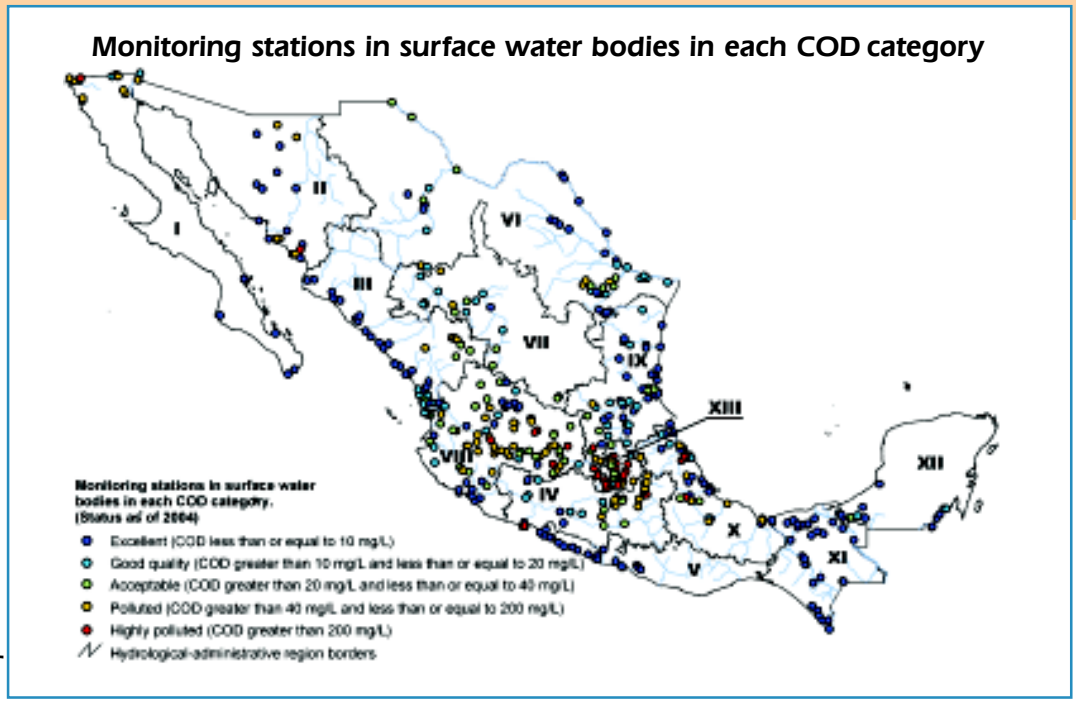
In order to assess water quality in Mexico, two indicative parameters are currently used, namely five-day Biochemical Oxygen Demand (BOD_5) and Chemical Oxygen Demand (COD). Maps 16 and 17

Monitoring stations in surface water bodies in each BOD_5 category



Map 16

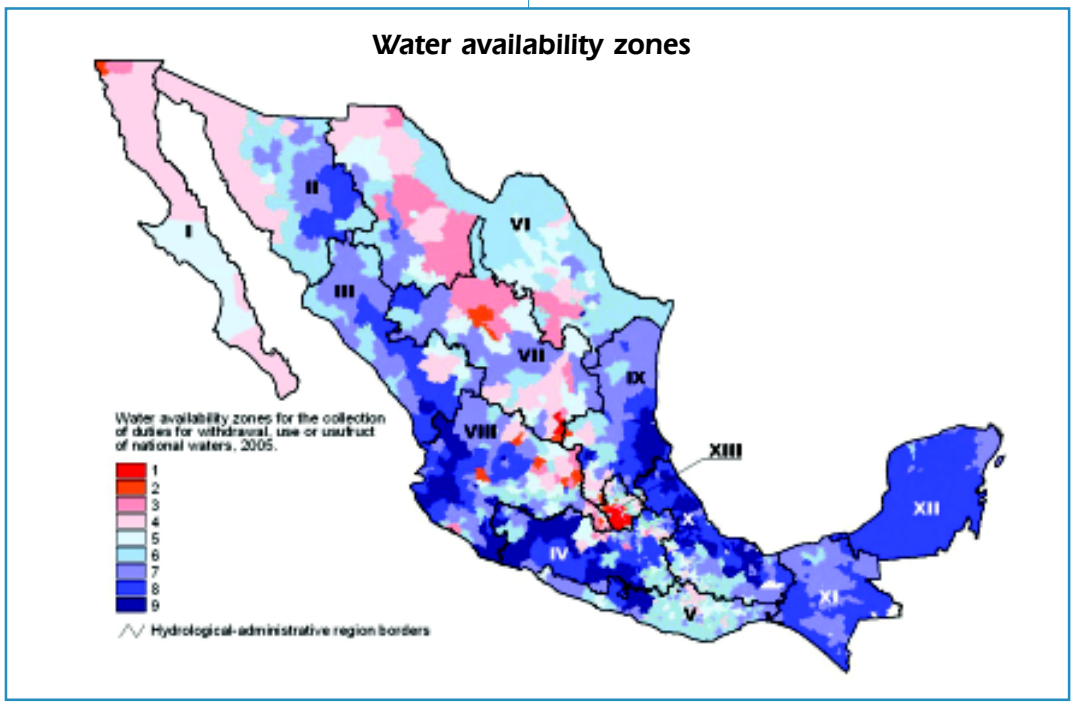
Source: Manager's Office for Sanitation and Water Quality, Technical Affairs Division, National Water Commission, 2004.



Map 17

Source: Manager's Office for Sanitation and Water Quality, Technical Affairs Division, National Water Commission, 2004.

The value of water increases in areas where it is scarce and decreases where it is abundant. That value is acknowledged by means of the water duties set down in the Federal Duties Law. To achieve sustainability of this resource, not only is the value of water recognized but, in addition, costs are covered to attend to the demand and ensure that the waters returning to receiving bodies comply with appropriate quality standards. Map 18



Map 18

Source: Federal Duties Law, National Water Commission, 2005.

Objective 4. To promote the technical, administrative, and financial development of the water sector.

In order to promote the technical, administrative, and financial development of the water sector, Mexico has been promoting and implementing actions to increase the magnitude and cost/benefit ratio of financial resources allocated to this sector; to consolidate the process carried out by the federal government to decentralize functions, programs, and resources towards the states, municipalities, and users; as well as to promote research and technological transfer and human resource training in this sector.

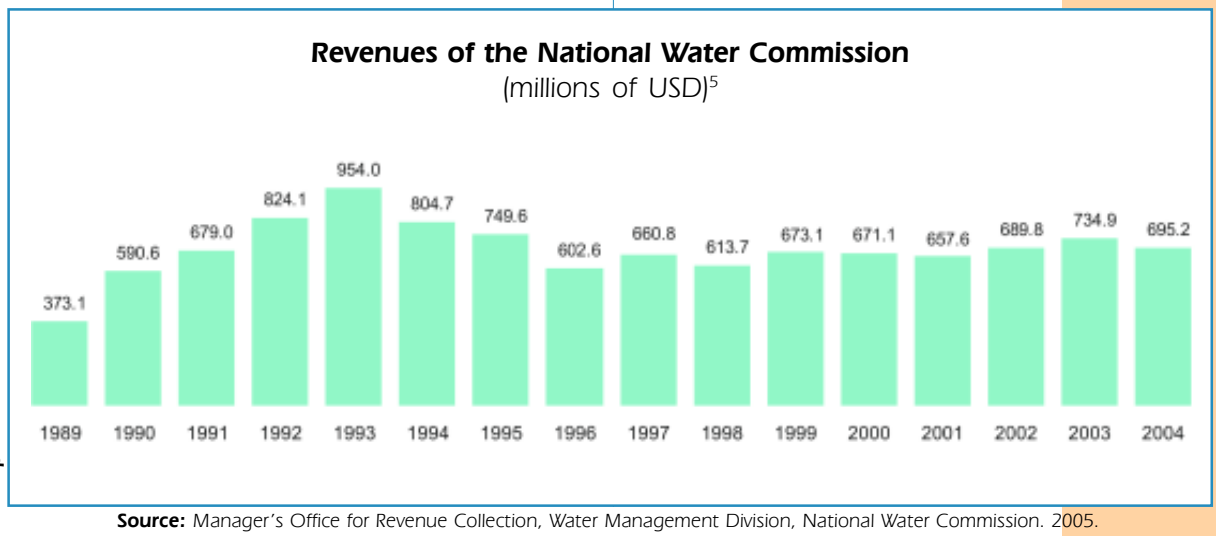
The strategy for increasing the magnitude and cost/benefit ratio of the financial resources allocated to the sector includes three different aspects: the first is directly related to the collection of monies by the National Water Commission for different items; the second involves promotional actions geared to achieving financial self-sufficiency among utilities providing drinking water, sewerage, and sanitation services or in irrigation systems; and, lastly, the third one is aimed at achieving broader participation by society in funding the works and actions that benefit it, by paying for the services received.

So as to increase the amount of monies collected by the National Water Commission for duties, rights, contributions to improvements, and taxes within its jurisdiction, actions are carried out such as periodical revisions of the Federal Duties Law; establishing support schemes so that utilities comply with the payment of duties for withdrawals and discharges; installing and maintaining an efficient system for collection of duties, payments for services, and registration and control of collection; strengthening promotional campaigns favoring the payment of duties and rights; and setting up mechanisms enabling the duties paid for water use and discharges to be allocated to the sector paying for them.

In Mexico, approximately 695 million dollars is collected each year for duties, rights, contributions for improvements, and taxes. Graph 8

Graph 8

Revenues of the National Water Commission
(millions of USD)[5]



Source: Manager's Office for Revenue Collection, Water Management Division, National Water Commission. 2005.

[5] Estimates at 2004 constant prices and an approximate exchange rate as of December 2004. 1 USD = 11.15 Mexican pesos.

Moreover, the most important feature of this strategy is to attain financial self-sufficiency among drinking water utilities and irrigation users' associations, to which end support is given to the establishment of fee schemes enabling them to cover their operating and maintenance costs and, to the extent possible, investment costs. Attempts are also made to help enhance these utilities' commercial efficiency and to implement mechanisms allowing for a suspension of services to those who fail to pay for them.

The prerequisite of the first two parts of this strategy is a significant cultural modification among the Mexican population: an acknowledgement of the economic and strategic value of this resource, which should be expressed in the form of paying for services received. For that reason, permanent informational campaigns are conducted to enable all citizens to familiarize themselves with the processes effected so they can have water in their homes or farm plots, the costs involved, and the consequences of not paying for services on time. Aside from this, efforts are made to see to it that information is made available on the revenues obtained from these different items, and how they are used to benefit them.

Moreover, mechanisms are set up to encourage private enterprise involvement in planning, constructing, operating, and financing water systems, among which PROMAGUA is worth mentioning. Modifications to the corresponding legal frameworks are also promoted to allow for private participation, establishing clear rules for regulating participation, avoiding discretionality in actions taken by municipal authorities or by private investors, and affording legal certainty to the persons involved: users, local officials, and private enterprise.

Similarly, negotiation with international organizations for different credits has been promoted to support investment programs, mainly in the drinking water, sewerage and sanitation, and hydro-agricultural subsectors.

With an aim towards achieving greater effectiveness when applying the funds allocated to water management, the National Water Commission fosters a decentralization of federal functions, programs, and funds towards state and municipal governments and organized users; and it supports the creation and reinforcement of State Water Commissions.

As a result of recent amendments to the National Waters Law, Mexico is in the process of establishing Watershed Organizations, which will be the specialized technical, administrative, and legal units in charge of integrated water resources management, including management of national waters and inherent public goods in their territorial jurisdictions.

To stimulate research and technological transfer, technical and financial impetus and support are given to research and development and also technological innovation, adaptation, and transfer in this sector. That effort is directed by the National Water Commission and the Mexican Institute of Water Technology, with the participation of universities, research centers, and independent researchers throughout the country.

A strong impetus is also provided to the design of information systems on water resources in Mexico and information systems for the management and administrative and operational control of the sector. To this end, it has been necessary to make use of and improve informational technology to sustain the substantive functions of the National Water Commission and local water-related institutions; to facilitate mechanisms for supporting and updating informational infrastructure; and to devise and set up a normative framework for information technology.

Examples of this are the National Information System on Water Quantity, Quality, Uses, and Conservation (SINA, its Spanish acronym) and the Regional Information Systems on Water Quantity, Quality, Uses, and Conservation (SIRA, its Spanish acronym), which are currently being created and developed.

Both of these systems lead to significant developments related to water management and data and other information concerning this resource at the national level. The National Waters Law clearly states that national water and watershed planning and programming will be grounded on an integrated network of those systems.

In addition, within the framework of the Statistical and Geographic Information Law (Ley de Información Estadística y Geográfica, or LIEG), the National Water Commission takes part in the Technical Committee on Statistics and Geographic Information of the Environment and Natural Resources Sector. This committee is presided over by the Minister of the Environment and Natural Resources.

For the purpose of organizing and coordinating activities geared to establishing the SINA, the Water Thematic Group was created. This group operates within the Technical Committee on Statistics and Geographic Information.

Within the Water Thematic Group, the composition of thematic working subgroups has been defined; these subgroups are dedicated to producing, compiling, and exchanging statistical and geographic information referring to surface waters, groundwater, climatology, water quality, hydraulic infrastructure, urban hydraulic infrastructure, and hydro-agricultural infrastructure.

The SIRAs and SINA will form an informational network to support water planning and programming. Figure 2

As regards fostering human resource development, this strategy contemplates three major action groups: users of irrigation systems throughout the country; drinking water, sewerage, and sanitation service providers; and staff from the National Water Commission.

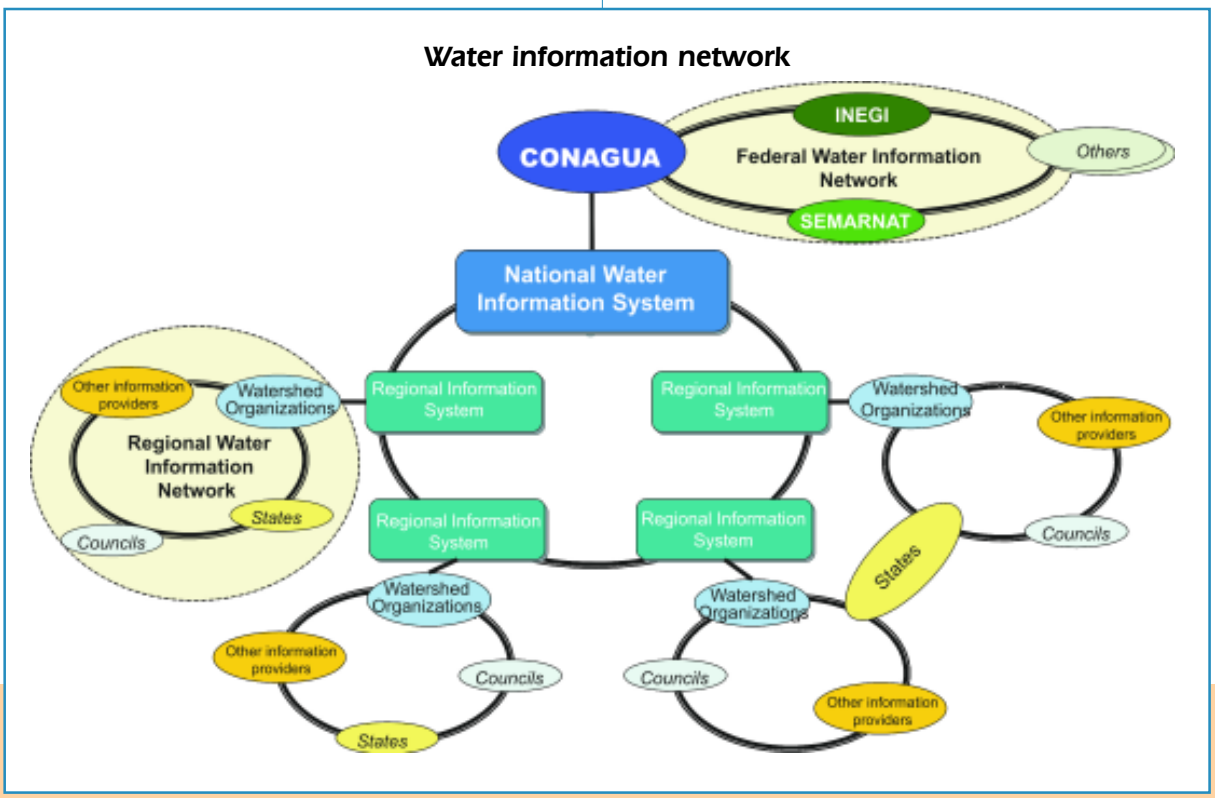


Figure 2

Source: Organización del manejo de datos e información sobre el agua en México a través de los Sistemas Nacional y Regionales de Información sobre cantidad, calidad, usos y conservación del agua, SINA y SIRA's [Organization of water data and information management in Mexico through the National and Regional Information Systems on Water Quantity, Quality, Uses, and Conservation, SINA and SIRAs], National Water Commission, 2004.

For training aimed at irrigation system users, support is provided to the operations of the National Center for the Transfer of Irrigation and Drainage Technology (CENATRYD, its Spanish acronym), whose objective is to promote training of technicians and managerial staff of irrigation districts and also of public or private firms.

Moreover, the Mexican Center for Water and Sanitation Training (CEMCAS, its Spanish acronym), arose in order to meet the need for better trained staff who could provide drinking water and sanitation services efficiently.

Objective 5. To consolidate the participation of users and organized society in water management and to promote a culture for a proper use of this resource.

To encourage participation by users and organized society in water management, we have continued with the process of strengthening the numerous social participatory mechanisms already in place, mainly the Watershed Councils, Water Advisory Council, and State Citizens' Councils for Water.

Watershed Councils are agencies for coordination, agreements, support, consultations, and advice between the National Water Commission; federal, state, and municipal entities; and representatives of users of the watershed in question. Their aim is to draw up and execute programs and actions leading to better water management, the development of hydraulic infrastructure and related services, and the preservation of watershed resources.

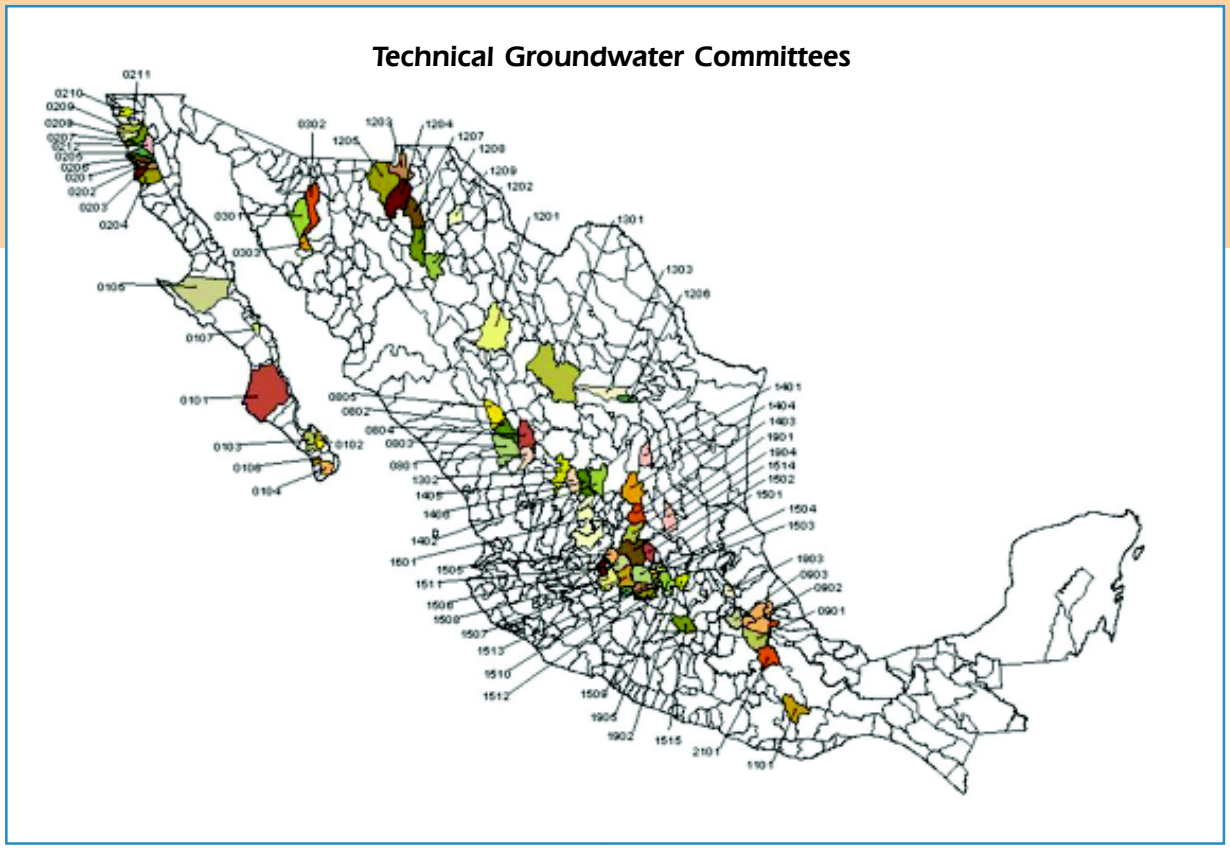
To operate properly, Watershed Councils may rely on auxiliary organizations at the subwatershed, microwatershed, and/or aquifer level, respectively called: Watershed Commissions, Watershed Committees, and Technical Groundwater Committees (COTAS, their Spanish acronym).

To this effect, by September 30, 2005, a total of 25 Watershed Councils, 14 Watershed Commissions, 17 Watershed Committees, and 71 Technical Groundwater Committees had been set up. Maps 19 and 20

Watershed Councils

Map 19

Source: Manager's Office for Watershed Councils. Regional Manager's Offices Division, National Water Commission, 2005.



Map 20

Source: Manager's Office for Watershed Councils. Regional Manager's Offices Division, National Water Commission, September, 2005.

For its part, the Water Advisory Council is a body of distinguished citizens who aid the National Water Commission in its efforts to create a new water culture among Mexican society through the Coalition for Water Conservation.

State Citizens' Councils for Water are participatory channels at the local level. They work towards disseminating water information conducive to encouraging people to care for this resource and use it in a sustainable way. By 2005, a total of 29 State Citizens' Councils for Water had been created.

Objective 6. To diminish risks and attend to the effects of floods and droughts.

So as to cut back risks and attend to the effects of floods and droughts, Mexico has been promoting actions for prevention rather than mere reaction to these disasters. Some of these actions are: the strengthening of information systems and hydro-meteorological event warning systems, as well as the implementation of plans for preventing and responding to floods.

To this end, the actions conducted include: installation and consolidation of monitoring systems based on observation networks and a geographic information system; provision of equipment and staff for hydrometric, meteorological, and climatological networks to prepare hydrological and meteorological prediction models, as well as dissemination of weather forecasts through the telecommunications network.

Mexico now has a modern National Meteorological with the following infrastructure for its operations:

- A surface synoptic network comprised of 72 meteorological observatories.
- A high-altitude synoptic network with 15 radiosounding stations.

- A network of 12 meteorological radars throughout the country.
- A ground station for receiving satellite images.

In addition, Mexico strives to design plans for preventing hydro-ecological emergencies and attending to victims, documenting events and working out statistics that serve as the basis for developing new preventive measures.

To respond to emergencies caused by hydro-meteorological events, Mexico has 12 Regional Emergency Response Centers (CRAE, their Spanish acronym). Maps 21 and 22

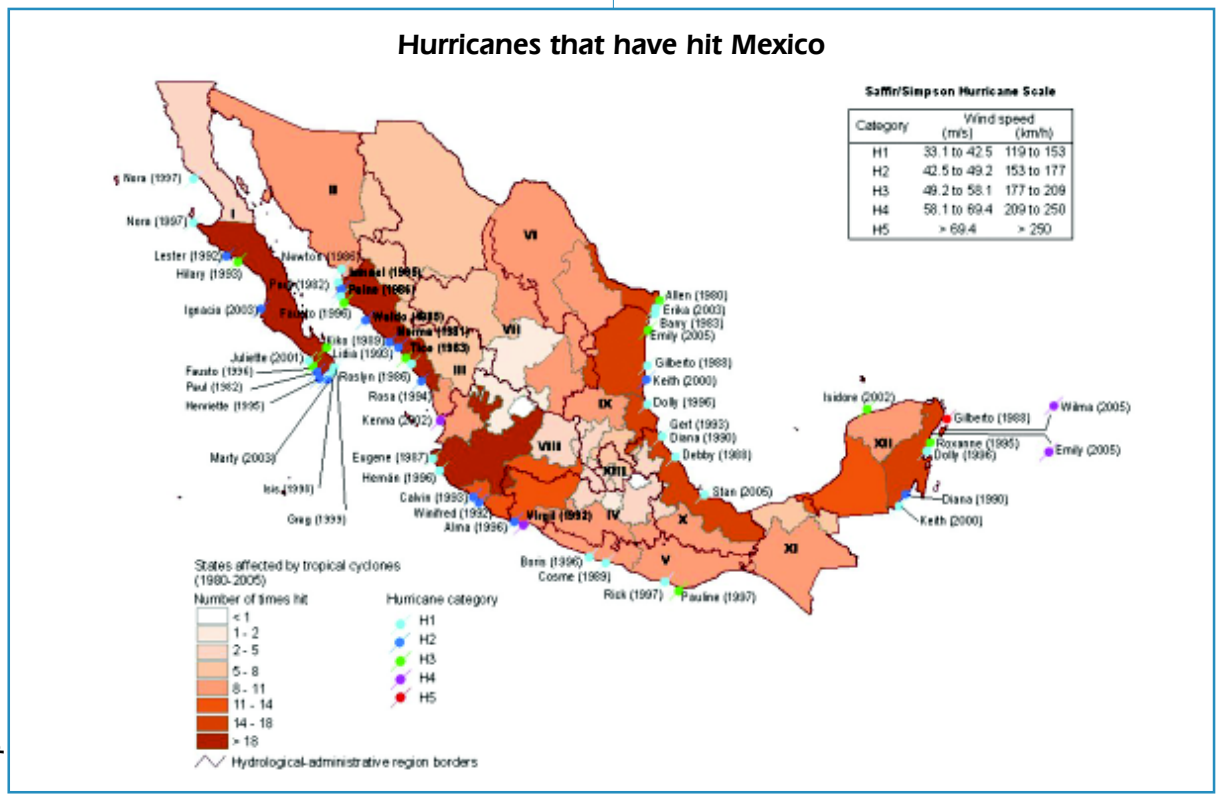
These centers have staff trained to respond to emergencies, as well as machinery and equipment that is normally used to provide immediate emergency attention due to floods, for example, portable water purification plants, electric power plants, and/or pumping equipment of varying capacities

Location of Regional Emergency Response Centers

Map 21

Source: Urban Hydraulic Infrastructure Division, National Water Commission, 2004.

Hurricanes that have hit Mexico



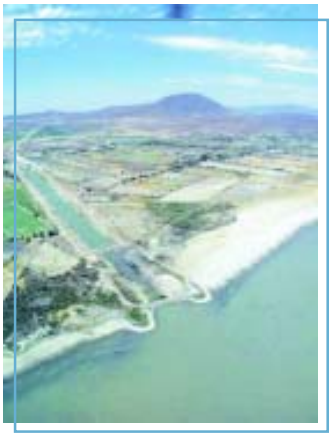
Map 22

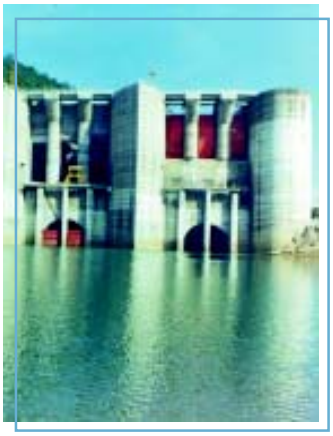
Source: National Meteorological Service Unit, Technical Affairs Division, National Water Commission, 2005.

Concluding reflections

Whereas the 2001-2006 National Water Program outlines the principles, objectives, and strategies derived from a modern water planning and management process, in order to meet water-related challenges in Mexico, it is also acknowledged that the complexity of this sector calls for constant revision and consolidation of water management policies.

The next steps in this process are focused on progressing from this sector's vision to real actions with the participation of all actors at different levels, on the basis of a shared view of water-related problems, priorities, and solutions, with regional coordination grounded on support for local actions and favored by growing social participation based on reliable, accessible information.



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This document has been prepared thanks to the information provided by various Divisions of the National Water Commission. It would be virtually impossible to mention the names of all those persons involved; however, we would like to acknowledge and thank the cooperation of:

Antonio Acosta, Eduardo Acosta, Martha Bustamante, Josafat Caballero, Araceli Chávez, Guillermo Chávez, Valentina Davydova, Alejandro Díaz, Javier Espinosa, Antonio Fernández, Jesús García, Alejandro González, Iván Guadarrama, Eric Gutiérrez, Alberto Hernández, Óscar Islas, Gilberto Jácome, Juan José Jiménez, Jorge Juárez, Carlos Marsch, Enrique Mejía, Gaspar Monterrosa, Suraya Padua, Francisco Javier Ponce, Mario Alberto Rodríguez, Fernando Rosales, Michel Rosengaus, Alfonso Salinas, Roberto Sención, Judith Vásquez, Luz del Carmen Velázquez, and Mirna Vida.

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This edition comprises 15 000 copies and it was printed in March, 2006 at: