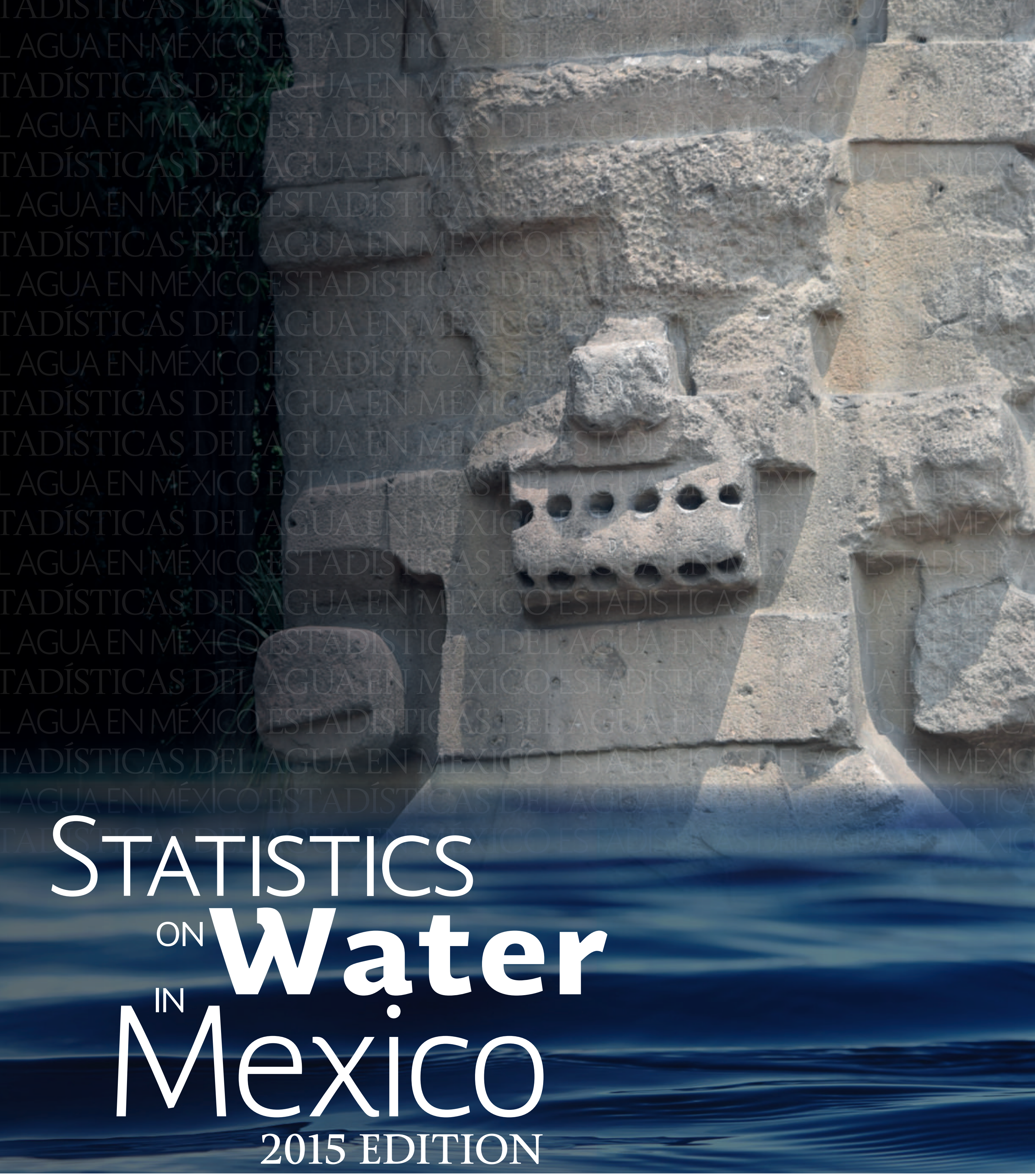

# Statistics on Water in Mexico

2015 EDITION

MÉXICO
GOBIERNO DE LA REPÚBLICA

ESTADOS UNIDOS MEXICANOS

SEMARNAT
SECRETARÍA DE
MEDIO AMBIENTE
Y RECURSOS NATURALES

CONAGUA
COMISIÓN NACIONAL DEL AGUA

# Statistics on Water in Mexico, 2015 Edition

National Water Commission

December 2015
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Statistics on Water in Mexico, 2015 edition

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## Annexes

The document Statistics on Water in Mexico, 2015 edition is part of the National information system on water quality, quantity, uses and conservation (Sina) and is an effort from the National Water Commission of Mexico (Conagua) to present an integral panorama of the water sector in our country.

With the aim of clearly presenting the data included in this publication, the tables and graphs generally speaking show the last ten years of information. For the reader interested in looking into the details, the original data for the tables and graphs conserve the whole period of annual statistics available. Throughout the text you may identify them by their first letter, the number of the chapter and a consecutive number: table 7.1, graph 4.9. You may also find maps and figures which may be identified in the same way: map 4.2 and figure 2.3.

An electronic version of this publication is available for download and can be viewed on the web page http://www.conagua.gob.mx/ConsultaPublicaciones.aspx, where it is possible to have access to this original data and find the records on the theme of each chapter, in the Sina with the indication [Reporteador: <Name of the theme in Spanish>], as well as the complementary tables, graphs and maps, with the indication [Adicional: <key>].

Thirteen hydrological-administrative regions (HARs) are the basis for the federal administration of water issues, hence their territorial division is presented in most of the maps in this document. Their characteristics are listed in the map on page 234.

The calculation of renewable water resources (RWR) is proposed as an important indicator for the sector. This edition presents the calculation of RWR with the latest available studies of catchments and aquifers.

With the intention of guiding the reader, there are notes identified with numbers (**[1]**) in the footnotes, as well as notes under the tables, graphs or maps. Annex F includes some brief methodological notes on relevant issues. The sources are identified by references within the text, such as Inegi (2015a), and a complete bibliography can be found in annex G.

# Statistics on Water in Mexico, 2015 Edition

National Water Commission

# Chapter 1

## Geographical and socio-economic context

# Geographical and socio-economic context

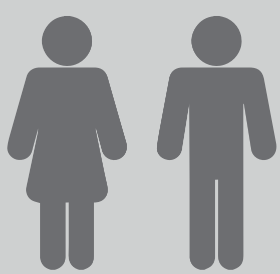
## Geographical and demographic aspects

Territorial surface
**1.964**
millon km²

Political division
**32**
states

**2457**
municipalities

Projection **2014**
**119.7**
million inhabitants



Projection **2030**
**137.5**
million inhabitants

**Dynamics:** Population increase and concentration in cities

In **2014**
Mexico has
**59**
metropolitan
areas

**56.9%**
of the population of the country
is concentrated in metropolitan areas

**11.4**
million people in
extreme poverty

## Hydrological-administrative regions

**13 regions for water administration**


N

Less available water

Higher population

Greater contribution to the GDP

S

More available water

Lower population

Lower contribution to the GDP

# Economy

**2014** Inflation
**4.08%**

**2014** GDP per capita
**$114 493**

Total **2014** GDP
**$13 760 185**
million pesos

## Contribution to the GDP by sectors

| | 1950 | 2014 |
|---|---|---|
| **Primary** (agriculture and livestock) | 19.2% | 3.1% |
| **Secondary** (industry) | 26.5% | 34.4% |
| **Tertiary** (services) | 54.3% | 62.4% |

# 1.1 Geographical and demographic aspects

[Reporteador: Ubicación geográfica de México, Población]

The territorial extension of the United Mexican States includes 1.964 million km$^2$, of which 1.959 million km$^2$ correspond to the **continental surface** and the rest to the island area. The Exclusive Economic Zone (EEZ) should also be considered, defined as a strip, 370 kilometers wide[1] measured from the coastal baseline,[2] the extension of which is estimated at approximately three million km$^2$, as shown in table 1.1.

**Table 1.1** Location and territorial extension of Mexico

| Territorial extension | |
|---|---|
| Territorial area | 1 964 375 km$^2$ |
| Mainland | 1 959 248 km$^2$ |
| Island-based | 5 127 km$^2$ |
| **International borders of the mainland territory** | |
| United States of America | 3 152 km |
| Guatemala | 956 km |
| Belize | 193 km |
| **Coastline** | |
| Total length | 11 122 km |
| Pacific Ocean | 7 828 km |
| Gulf of Mexico and Caribbean sea | 3 294 km |
| **Extreme geographical coordinates** | |
| To the north: 32° 43´ 06" latitude North. Monument 206 on the border with the United States of America. | |
| To the south: 14° 32´27" latitude North. At the mouth of the Suchiate river, at the border with Guatemala. | |
| To the east: 86° 42´36" longitude West. Mujeres Island. | |
| To the west: 118° 22´00" longitude West. Guadalupe Island. | |

**Source:** Inegi (2015a).

1 Internationally defined as 200 nautical miles, in the United Nations Convention on the Law of the Sea. One nautical mile is the equivalent of 1.852 km.

2 Defined as the low tide line along the coast.

There are different factors which determine Mexico's climate. As a result of its **geographical** location, the southern part of the country is in the inter-tropical area of the globe, whereas the northern part is located in the temperate area. Mexico is situated at the same latitude as the Saharan and Arabian deserts, as can be appreciated in map 1.1.

The second factor is the geographical accidents which characterize Mexico's **relief**, which are illustrated in figure 1.1. The geographical location and the relief have a direct impact on the availability of water resources.

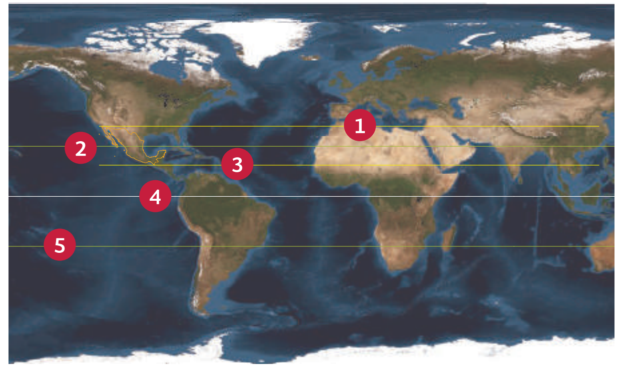
Two thirds of the territory is considered **arid** or **semi-arid**, with annual precipitation of less than 500 mm, whereas the southeast is **humid** with average precipitations of over 2 000 mm per year. In the majority of the territory, the rainfall is more intense in the summer, when it is occasionally torrential.

Mexico is made up of 31 states and one Federal District (Distrito Federal or D.F. in Spanish, which we shall refer to as Mexico City for the purpose of this publication), made up of 2 441 municipalities and 16 delegations respectively, giving a total of 2 457 municipalities and delegations.[3]

Since the mid-20th century, the population has shown a marked trend towards abandoning small rural localities and congregating in urban areas. From 1950 to 2010, the country's population quadrupled, and went from being predominantly rural to mainly urban, as can be observed in graph 1.2.[4]

According to the results of the 2010 General Census on Population and Housing, in Mexico that year there were 192 247 inhabited localities, spread out according to their size as shown in figure 1.2. 53.2% of the population of Mexico lived in areas over 1 500 meters above sea level, as can be observed in the same figure.

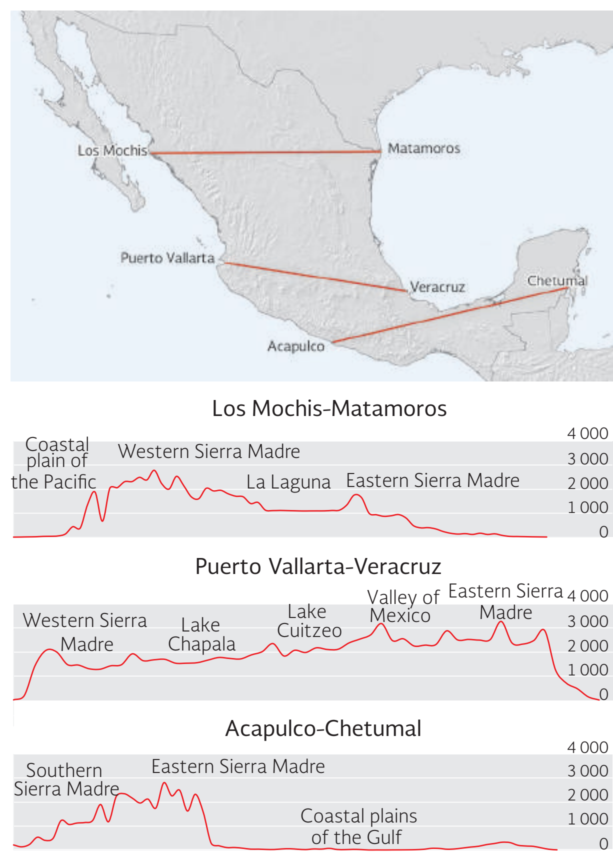
**Map 1.1** Geographical location of Mexico




1 Northern latitude of Mexico 32° 43' 06" N
2 Tropic of Cancer 23° 26' N
3 Southern latitude of Mexico 14° 32' 27" N
4 Equator
5 Tropic of Capricorn 23° 26' S

**Source:** Produced based on NASA (2015).

**Figure 1.1** Elevation profiles (MASL)




**Source:** Produced based on USGS (2015a).

3 According to Inegi (2015b), as of 2014 there were 2 457 municipalities and delegations with geographical representation.

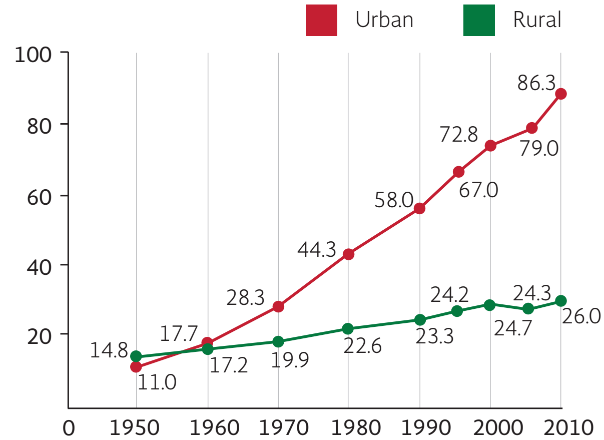
4 The 2010 General Census of Population and Housing, at the time it was carried out, found 112.3 million inhabitants. For the calculation of the 2010-2050 population projections, the National Population Council, Conapo (2015) carried out a demographic conciliation over the 1990-2010 period, which allowed it to establish that the population halfway through 2010 was 114.3 million inhabitants. The Conapo population projections consider 137.5 million inhabitants by 2030.

**Figure 1.2** Evolution in and distribution of the population

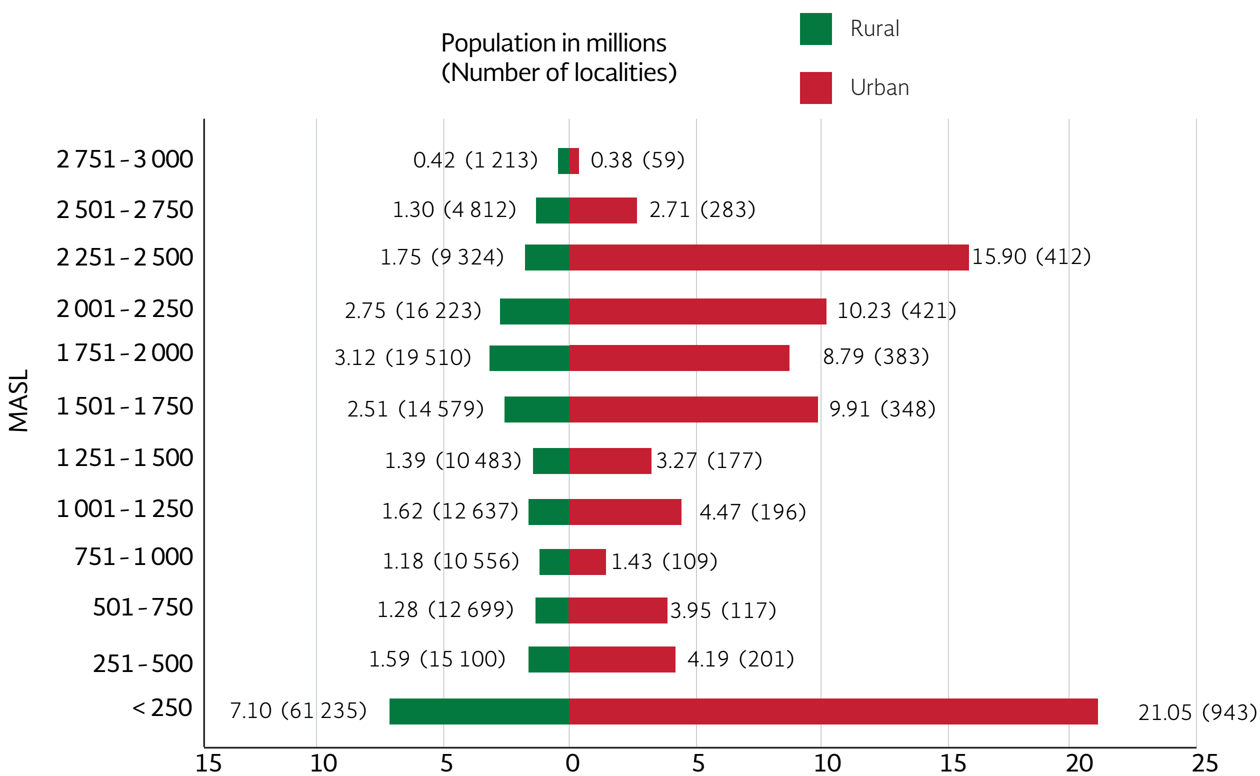
### Distribution of the population by size of locality, 2010

| Range (inhabitants) | Number of localities | Population (millions of inhabitants) | Percentage of the population |
|---|---|---|---|
| 500 000 or more | 36 | 31.19 | 27.8 |
| From 50 000 to 499 999 | 181 | 28.42 | 25.3 |
| From 2 500 to 49 999 | 3 434 | 26.68 | 23.7 |
| From 100 a 2 499 | 49 440 | 23.67 | 21.1 |
| Less than 100 | 139 156 | 2.38 | 2.1 |
| **Total** | **192 247** | **112.34** | **100.0** |

### Evolution in the urban and rural population (millions of inhabitants)




### Distribution of the population and localities by ranges of altitude, 2010




**Note:** Data as of the date of the Census. In 2010, there were 227 localities (225 rural and 2 urban ones) with a total of 57 821 inhabitants, located at over 3 000 meters above sea level. Rural localities are defined as those with less than 2 500 inhabitants.

**Source:** Inegi (2015c), Inegi (2015d).

## 1.2 Population centers

[Reporteador: Población]

Based on data from the 2010 General Census on Population and Housing, 59 Metropolitan Areas (MAs) were defined,[5] in which the National Population Council (Conapo) estimated the population in 2014 at 68.2 million inhabitants, thus constituting 56.9% of the total population projected for 2014 by that institution. Up to the same date, additionally there were 36 localities of more than 100 000 inhabitants in localities that are not part of MAs, adding up to 8.4 million people and 7% of the national population.

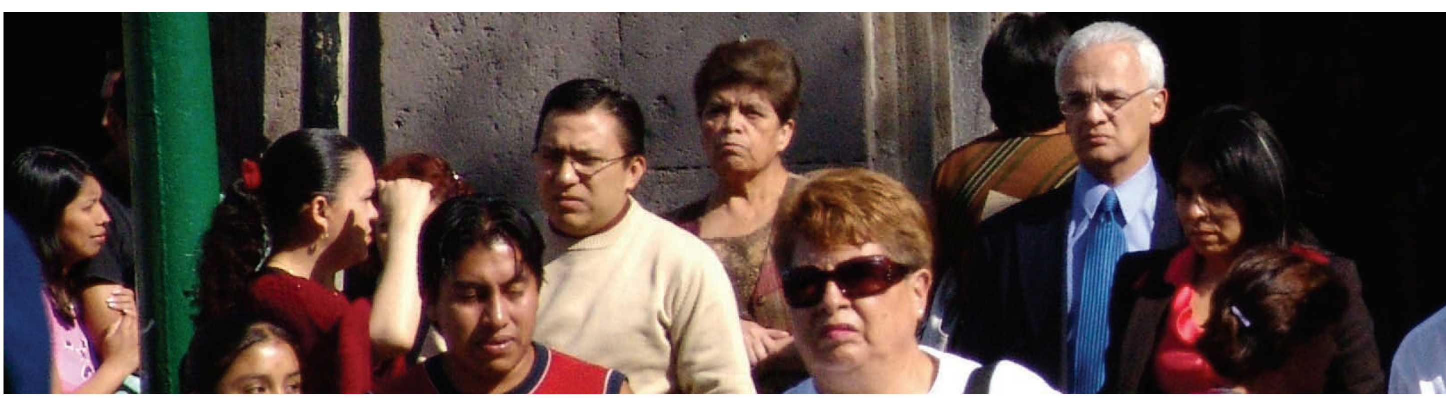
Of these MAs, 32 have more than 500 000 inhabitants, making a total of 60.8 million people and 50.8% of the national population at that point. Three localities that are not part of an MA (Hermosillo, Victoria de Durango and Culiacan Rosales) had more than 500 000 inhabitants in 2014. In map 1.2 those population centers are shown.

The concentration and the accelerated growth of the population in urban localities have led to stronger pressures on the environment and on institutions, due to the increasing demand for services.

The Conapo estimated that in 2014, in the 14 MAs with a population of more than one million inhabitants, 39.3% of the total population of Mexico was concentrated, or 47.1 million inhabitants.

**Mexico** has
**59**
Metropolitan
areas

In them the
population is
**68.2**
millions of
inhabitants



5 An MA is defined as the sum of two or more municipalities including a city of 50 000 or more inhabitants, and the urban area, functions and activities of which go beyond the limits of the municipality that it was originally part of, incorporating as part of the municipality or of its area of direct influence mainly urban neighboring municipalities, with which they maintain a high degree of socio-economic integration. That definition also includes those municipalities which, due to their particular characteristics, are relevant for urban planning and politics of the metropolitan areas in question (Sedesol et al. 2012).

**Map 1.2** Main population centers, 2014


**Note**: Includes both MAs and localities outside them with a population of more than 500 000 inhabitants
**Source:** Produced based on Conapo (2015), Inegi (2015d), Sedesol et al. (2012).

## 1.3 Economic indicators

[Reporteador: Indicadores económicos]

According to the Bank of Mexico (Banxico), (2015a), the first half of 2014 presented worldwide signs of moderate recovery, through the dynamism of some advanced economies such as the United States and the United Kingdom. However, for the second half of 2014 there was a weakening of the recovery, complicated by the fall in the price of oil and the appreciation of the dollar against the majority of currencies, phenomena that are foreseen to be long-term. Throughout the year, the Mexican economy showed some improvement induced by external demand, as well as through light increases in internal demand. An annual growth of 2.1% in the Gross Domestic Product (GDP) was registered (Inegi 2015e). The annual inflation was 4.08% (Inegi 2015f). The five- year trend can be observed in figure 1.3.

Throughout the 20th century, the contribution of agriculture and livestock activities, silviculture and fishing to Mexico's GDP has progressively decreased, as opposed to industry and services which have grown, as can be observed in figure 1.3. This change is also more evident in the population occupied by economic sector,[6] with a significant reduction in the Mexicans occupied in the primary sector (from 58.3% to 13.7% in the 1950-2014 period), and the corresponding increase in those occupied in the tertiary sector (from 25.7% to 61.8% in the same period). The population occupied in Mexico up to the fourth trimester of 2014 was 49.8 million people.

In 2014
the GDP grew
**2.1%**
in Mexico

The population
occupied was
**49.8**
million people

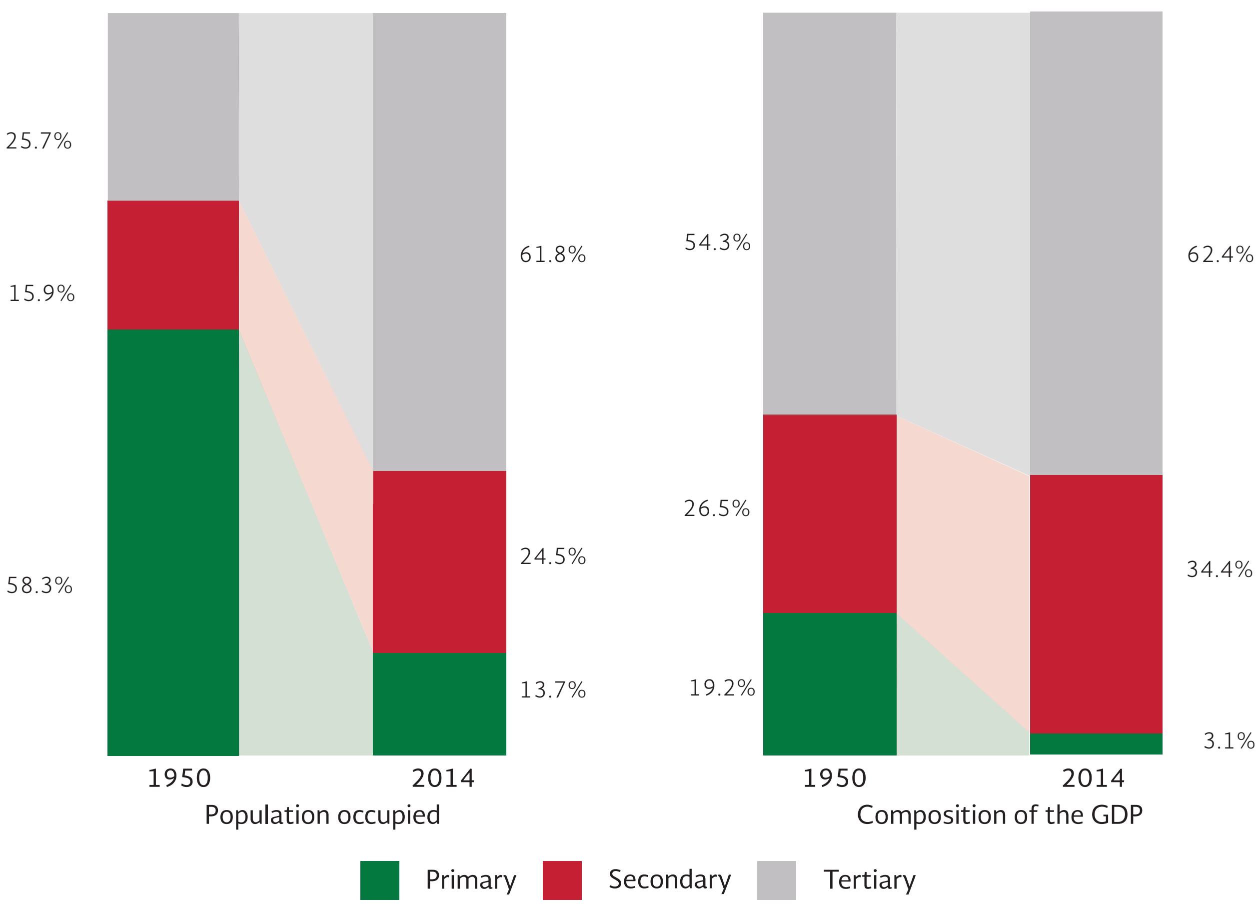

6 The primary sector includes agriculture and livestock, silviculture and fishing activities. The secondary sector considers mining, the manufacturing industry, construction and electricity, gas and water. The tertiary sector includes trade, restaurants and hotels, transport, storage and communications, financial services, insurance, real estate and renting activities, community, social and personal services.

**Figure 1.3** Main economic indicators

Main economic indicators in Mexico, from 1995 to 2014

| Year | Indicators | | |
|---|---|---|---|
| | Gross Domestic Product (GDP) (Billions of pesos, constant 2008 prices) | Per capita GDP (pesos, constant 2008 prices) | Annual inflation based on the National Consumer Price Index |
| 1995 | 8 026.90 | 84 949.40 | 51.97 |
| 2000 | 10 288.98 | 101 976.30 | 8.96 |
| 2005 | 11 160.49 | 104 156.67 | 3.33 |
| 2010 | 12 277.66 | 107 457.87 | 4.40 |
| 2014 | 13 760.19 | 114 942.92 | 4.08 |

Composition of the economic activity by sector, 1950 and 2014




**Note:** For illustrative purposes only, the calculation of the percentage of the population occupied by sector of economic activity does not consider the "Others" category, which represents 0.6% of the average population occupied in 2014. Along the same lines, the representation of the charges allocated for banking services was simplified, representing indirectly measured financial intermediation services, with a negative sign.

**Source:** Produced based on Conapo (2015), Inegi (2014a), Inegi (2015g), Inegi (2015h), Inegi (2015i).

# 1.4 Socio-demographic conditions

[Reporteador: Rezago social, Marginación social, Desarrollo humano]

According to the General Law of Social Development, it is the responsibility of the National Council for the Evaluation of Social Development Policies (Coneval) to establish the guidelines and criteria to define, identify and measure poverty in Mexico. The objective is to provide elements to improve public policies aiming to overcome this condition. The estimation both nationwide and by state is carried out every two years, the latest one being from 2014. At the municipal level it is carried out every five years, since it is calculated based on nationwide Censuses.

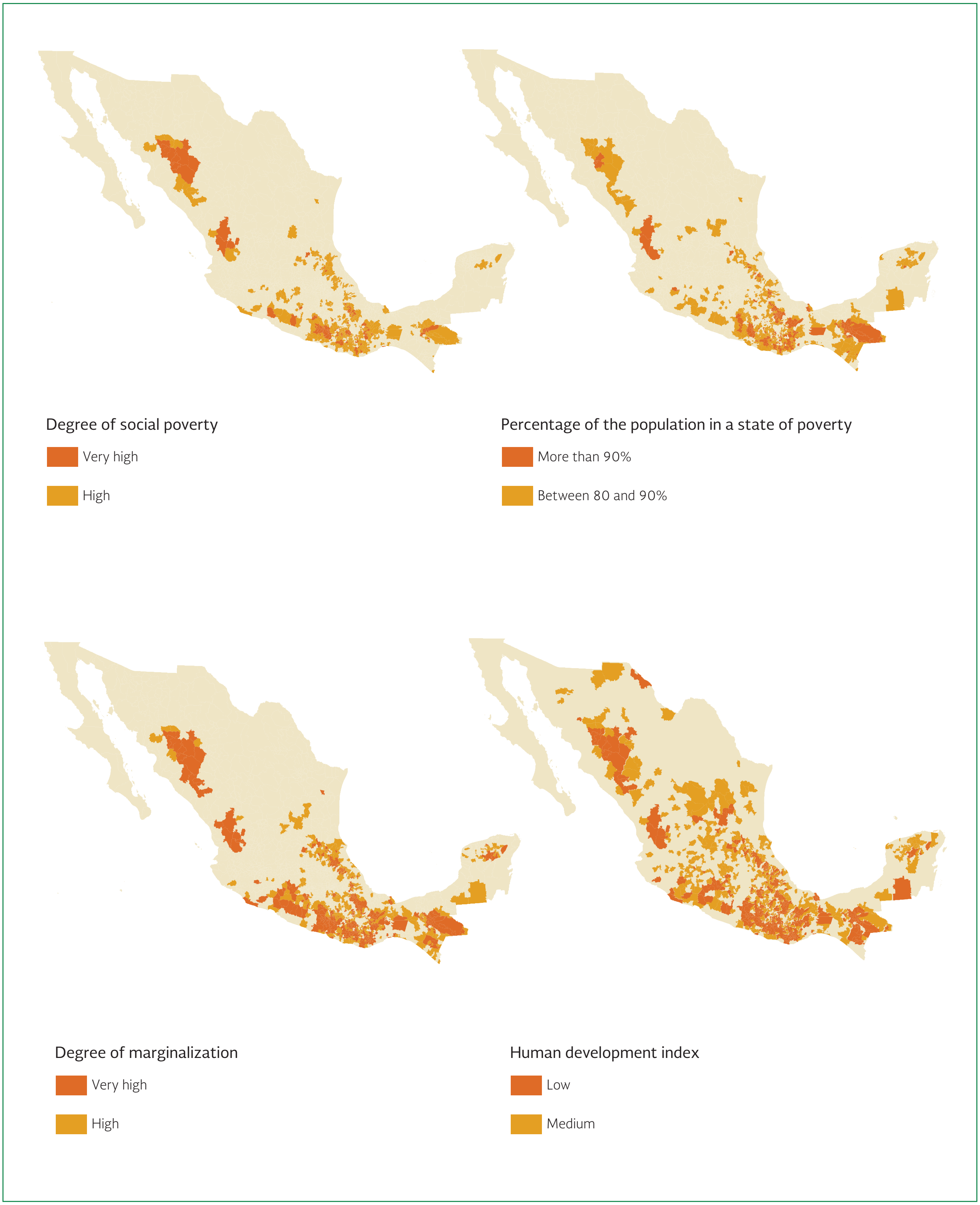
In 2014
**11.4**
million people were in a state of **extreme poverty**

The measurement of poverty includes the indicators of income, educational lag, access to health services and social security, living quality and spaces, access to food and degree of social cohesion, since poverty is considered a multi-dimensional manifestation of shortages. In 2014 nationwide, it is estimated that 46.2% of the population (55.3 million people) are in a state of poverty. Of these, 11.4 million are in a state of extreme poverty.

A complementary measurement is the index of social poverty, also produced by the Coneval. This measurement includes indicators of education, assets in the home and quality and services in the house. Also complementary are the indexes of marginalization, produced by Conapo, which considers aspects of education, housing, income from work and distribution of the population; as well as the human development index, calculated by the United Nations Development Programme (UNDP), based on the measurement of decent standard of living, education (literacy, enrollment in primary, secondary and high school, as well as the number of years of mandatory education), and life expectancy at birth.

Figure 1.4 presents these four indicators at the municipal level, highlighting the municipalities in unfavorable socio-demographic conditions. The concentration of municipalities in these conditions in the south and along the Western Sierra Madre stands out.

**FIGURE 1.4** Socio-demographic indicators at the municipal level, 2010




**Source**: Produced based on CONEVAL (2011a), CONEVAL (2011b), CONAPO (2011), UNDP (2014).

# 1.5 Hydrological-administrative regions (HARs) for water management

[Reporteador: División hidrológico-administrativa]

For the purpose of the management and preservation of Mexico's water resources, the country has been divided into thirteen HARs, which are made up by grouping together catchments, considered the basic units for water resources management. The limits of the HARs respect municipal divisions, so as to facilitate the integration of socio-economic information.

The National Water Commission of Mexico (Conagua), an administrative, standard-bearing, technical and consultative agency in charge of water management in the country, carries out its functions through 13 river basin organizations, the scope of competence of which are the HARs (see the map on the back inner flap).

The Conagua has **13** river basin organizations

The characteristics of the HARs are shown in table 1.2. It should be mentioned that the calculation of the contribution to the national GDP is based on the GDP by state, the latest data on which is from 2013.

The municipalities that make up each one of these HARs are indicated in the Territorial Constituency Agreement for River Basin Organizations, published in the Official Government Gazette on April 1, 2010. In addition, the Conagua has 20 local offices in the states in which no river basin organization has its headquarters.

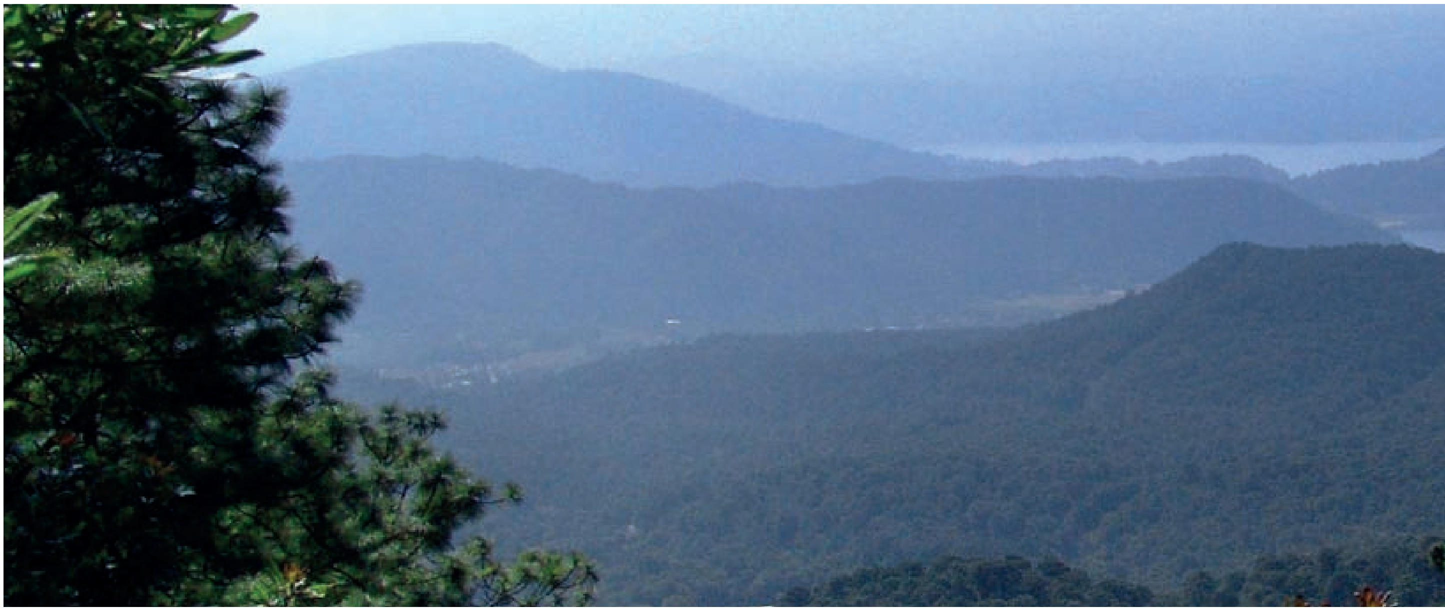
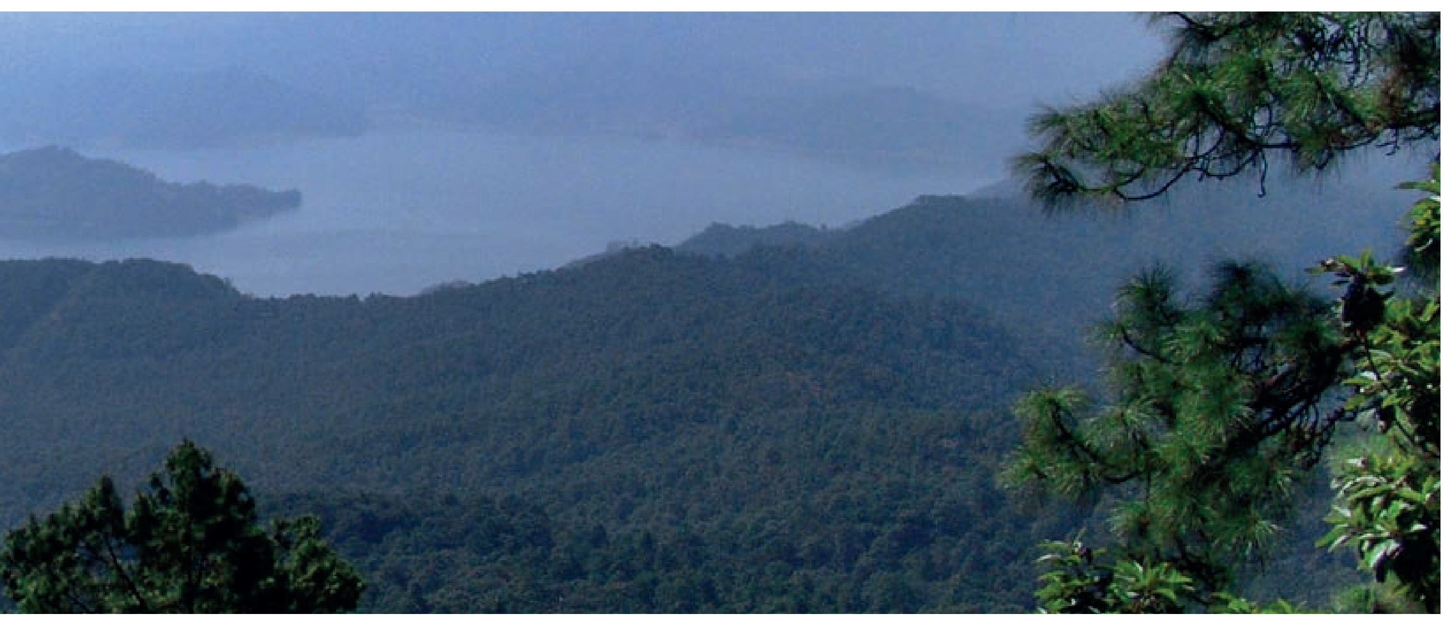


**Table 1.2** Characteristics of the HARs

| HAR | Mainland surface (km²) | Renewable water resources 2014 (hm³/year) | Population as of mid-2014 (millions of inhabitants) | Per capita renewable water resources 2014 (m³/inhabitant/year) | Contribution to the national GDP 2013 (%) | Municipalities or delegations of Mexico City (number) |
|---|---|---|---|---|---|---|
| I | 154 279 | 4 958 | 4.37 | 1 135 | 3.77 | 11 |
| II | 196 326 | 8 273 | 2.80 | 2 951 | 2.96 | 78 |
| III | 152 007 | 25 596 | 4.47 | 5 730 | 2.81 | 51 |
| IV | 116 439 | 22 156 | 11.69 | 1 896 | 6.11 | 420 |
| V | 82 775 | 30 565 | 5.02 | 6 084 | 2.20 | 378 |
| VI | 390 440 | 12 316 | 12.15 | 1 014 | 14.32 | 144 |
| VII | 187 621 | 7 849 | 4.52 | 1 738 | 4.08 | 78 |
| VIII | 192 722 | 35 093 | 23.89 | 1 469 | 18.24 | 332 |
| IX | 127 064 | 28 085 | 5.23 | 5 366 | 2.21 | 148 |
| X | 102 354 | 95 129 | 10.48 | 9 075 | 5.67 | 432 |
| XI | 99 094 | 144 459 | 7.57 | 19 078 | 5.00 | 137 |
| XII | 139 897 | 29 324 | 4.52 | 6 494 | 7.83 | 127 |
| XIII | 18 229 | 3 458 | 23.01 | 150 | 24.81 | 121 |
| **Total** | **1 959 248** | **447 260** | **119.71** | **3 736** | **100.00** | **2 457** |

**Source:** Produced based on Conapo (2015), Inegi (2008), Inegi (2015j), Conagua (2015a).



# 1.6 Regional contrast between development and renewable water resources (RWR)

[Reporteador: División hidrológico-administrativa, Agua renovable]

The aggregate national values, such as population, renewable water resources (RWR) or GDP, conceal the great regional diversity in Mexico.

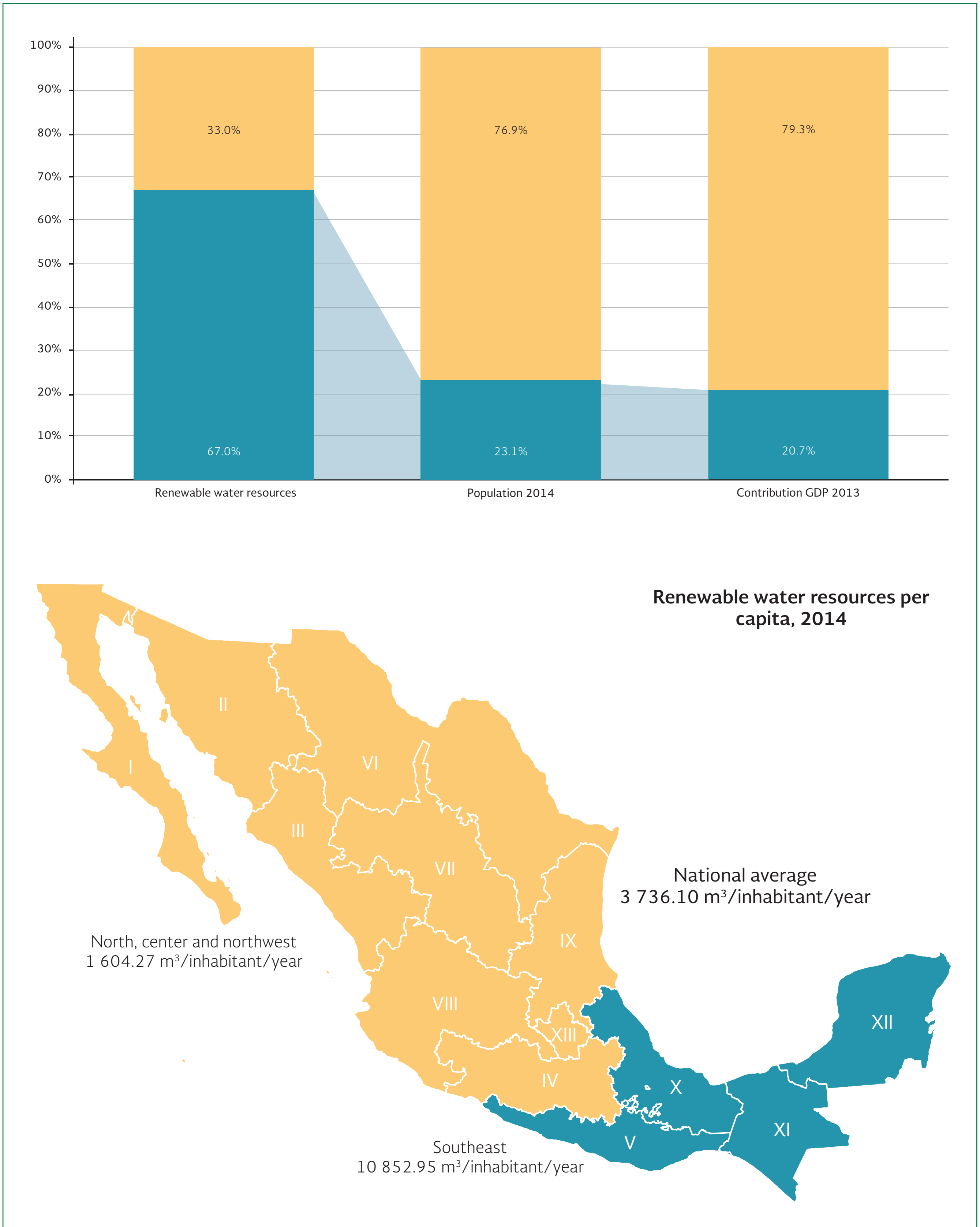
There are significant variations between regional characteristics. If the HARs regions V, X, XI and XII are grouped together, in the south-east of the country, they can be contrasted with the remaining regions. The regions in the south-east present two thirds of the country's RWR, with one fifth of the population which contributes one fifth of the national GDP. The regions in the north, center and northwest have one third of the country's renewable water resources, four fifths of the population and of the regional contribution to the national GDP. Considering the per capita renewable water resources, the value available in the regions of the south- east is seven times higher than that available in the rest of Mexico's HARs.

The southeast of the country has

**2/3**

of the renewable water resources

**Figure 1.5** Regional contrast between renewable water resources and development




**Source:** Produced based on Conapo (2015), Inegi (2008), Inegi (2015j), Conagua (2015a).

# 1.7 Summary of data by state

[Reporteador: División hidrológico-administrativa]

The main demographic and socio-economic data and on renewable water resources (RWR) by state are presented in the following table.

**TABLE 1.3** Demographic and socio-economic data by state

| Code | State | Mainland surface area (km²) | Renewable water resources 2014 (hm³/year) | Population at mid-2014 (millions of inhabitants) | Per capita renewable water resources 2014 (m³/inhabitant/year) | Contribution to the national GDP 2013 (%) | Municipalities or delegations of Mexico City (number) |
|---|---|---|---|---|---|---|---|
| 01 | Aguascalientes | 5 618 | 515 | 1.27 | 406 | 1.12 | 11 |
| 02 | Baja California | 71 446 | 2 994 | 3.43 | 872 | 2.92 | 5 |
| 03 | Baja California Sur | 73 922 | 1 266 | 0.74 | 1 709 | 0.76 | 5 |
| 04 | Campeche | 57 924 | 14 330 | 0.89 | 16 027 | 4.81 | 11 |
| 05 | Coahuila de Zaragoza | 151 563 | 3 160 | 2.93 | 1 080 | 3.33 | 38 |
| 06 | Colima | 5 625 | 2 138 | 0.71 | 3 008 | 0.58 | 10 |
| 07 | Chiapas | 73 289 | 113 002 | 5.19 | 21 787 | 1.75 | 118 |
| 08 | Chihuahua | 247 455 | 11 910 | 3.67 | 3 242 | 2.86 | 67 |
| 09 | Federal District | 1 486 | 480 | 8.87 | 54 | 17.09 | 16 |
| 10 | Durango | 123 451 | 13 380 | 1.75 | 7 660 | 1.19 | 39 |
| 11 | Guanajuato | 30 608 | 3 868 | 5.77 | 670 | 3.98 | 46 |
| 12 | Guerrero | 63 621 | 21 108 | 3.55 | 5 951 | 1.42 | 81 |
| 13 | Hidalgo | 20 846 | 7 267 | 2.84 | 2 556 | 1.59 | 84 |
| 14 | Jalisco | 78 599 | 15 671 | 7.84 | 1 999 | 6.26 | 125 |
| 15 | Mexico | 22 357 | 5 201 | 16.62 | 313 | 9.08 | 125 |
| 16 | Michoacan de Ocampo | 58 643 | 12 563 | 4.56 | 2 753 | 2.29 | 113 |
| 17 | Morelos | 4 893 | 1 801 | 1.90 | 949 | 1.19 | 33 |
| 18 | Nayarit | 27 815 | 6 397 | 1.20 | 5 326 | 0.64 | 20 |
| 19 | Nuevo Leon | 64 220 | 4 291 | 5.01 | 856 | 7.35 | 51 |
| 20 | Oaxaca | 93 793 | 55 369 | 3.99 | 13 890 | 1.56 | 570 |
| 21 | Puebla | 34 290 | 11 486 | 6.13 | 1 873 | 3.20 | 217 |
| 22 | Queretaro | 11 684 | 2 035 | 1.97 | 1 031 | 2.06 | 18 |
| 23 | Quintana Roo | 42 361 | 8 033 | 1.53 | 5 251 | 1.57 | 10 |
| 24 | San Luis Potosi | 60 983 | 10 606 | 2.73 | 3 888 | 1.93 | 58 |
| 25 | Sinaloa | 57 377 | 8 690 | 2.96 | 2 937 | 2.05 | 18 |
| 26 | Sonora | 179 503 | 7 035 | 2.89 | 2 432 | 3.01 | 72 |
| 27 | Tabasco | 24 738 | 31 086 | 2.36 | 13 175 | 3.24 | 17 |
| 28 | Tamaulipas | 80 175 | 8 933 | 3.50 | 2 550 | 3.07 | 43 |
| 29 | Tlaxcala | 3 991 | 911 | 1.26 | 722 | 0.55 | 60 |
| 30 | Veracruz de Ignacio de la Llave | 71 820 | 50 901 | 7.99 | 6 374 | 5.15 | 212 |
| 31 | Yucatan | 39 612 | 6 960 | 2.09 | 3 328 | 1.45 | 106 |
| 32 | Zacatecas | 75 539 | 3 873 | 1.56 | 2 478 | 0.93 | 58 |
| | **Total** | **1 959 248** | **447 260** | **119.71** | **3 736** | **100.00** | **2 457** |

**Source:** Produced based on CONAPO (2015), INEGI (2008), INEGI (2015j), CONAGUA (2015a).

# Chapter 2

## State of water resources

# The state of water resources

## Climate

Precipitation

Normal 1981-2010

**740 mm**

2014

**831 mm**

Hydro-meteorological phenomena

**Hurricanes:** cyclones with a wind speed equal to or more than a 119 km/h

**Droughts:** rainfall lower than the normal levels of a region

## Renewable water resources

Water that can feasibly and sustainably be used in a region

Mexico 2014:

**447 260 $hm^3$**

per year

## Parameters of water quality

**BOD₅** — Biochemical Oxygen Demand
Measures biodegradable organic matter
Caused by municipal wastewater discharges

**COD** — Chemical Oxygen Demand
Measures organic matter
Caused by industrial wastewater discharges

**TSS** — Total Suspended Solids
Caused by wastewater discharges, agricultural waste and erosion

## Water quality

**5 000** monitoring sites operated by the CONAGUA

## Surface water

**731** watersheds for surface water management

**51** main rivers

**87%** of runoff

**65%** of the territory is covered by their catchment areas

**8** transboundary watersheds

## Groundwater

**653** aquifers for groundwater management

contribute **38.7%** of the volume for offstream uses

**106** in conditions of overdrafting

**31** with the presence of saline soils and brackish water

**15** with saltwater intrusion

# 2.1 Mexico's catchments and aquifers

[Reporteador: Regiones hidrológicas, Cuencas-disponibilidad]

In the hydrological cycle, a significant proportion of precipitation returns to the atmosphere in the form of evapotranspiration, whereas the rest runs off into the country's rivers and streams, grouped together in watersheds, or filters through to aquifers.

Watersheds are natural territorial units, defined by the existence of a continental divide as a result of the conformation of the relief. For the purpose of the management of the nation's water resources, especially the publication of availability,[1] the Conagua has defined 731 watersheds. Up to December 31, 2014, the availability of the 731 watersheds had been published, in conformity with the standard NOM-011-CONAGUA-2000.

The country's catchments have been organized into 37 hydrological regions shown in figure 2.1, which are in turn grouped into the 13 hydrological-administrative regions (HARs) mentioned in the first chapter.

As regards groundwater, the country is divided into 653 aquifers. The names of the aquifers were published in the Official Government Gazette (DOF) on December 5, 2001. In the 2003-2009 period their geographical limits were published (map 2.1), whereas the publication of their availabilities and their updates were carried out between 2003 and the present.

**1** Availability of surface water: the value obtained from the difference between the mean annual volume of runoff from a catchment downstream and the current annual volume committed downstream.

## **Figure 2.1** Hydrological regions


| Number | Name of hydrological region | Number | Name of hydrological region |
|---|---|---|---|
| 1 | Baja California Northwest | 20 | Lower Guerrero Coast |
| 2 | Baja California Central-West | 21 | Oaxaca Coast |
| 3 | Baja California South-West | 22 | Tehuantepec |
| 4 | Baja California North-East | 23 | Chiapas Coast |
| 5 | Baja California Central-East | 24 | Bravo-Conchos |
| 6 | Baja California South-East | 25 | San Fernando-Soto La Marina |
| 7 | Colorado River | 26 | Panuco |
| 8 | Sonora North | 27 | North of Veracruz (Tuxpan-Nautla) |
| 9 | Sonora South | 28 | Papaloapan |
| 10 | Sinaloa | 29 | Coatzacoalcos |
| 11 | Presidio-San Pedro | 30 | Grijalva-Usumacinta |
| 12 | Lerma-Santiago | 31 | Yucatan West |
| 13 | Huicicila | 32 | Yucatan North |
| 14 | Ameca River | 33 | Yucatan East |
| 15 | Jalisco Coast | 34 | Closed Catchments of the North |
| 16 | Armeria-Coahuayana | 35 | Mapimi |
| 17 | Michoacan Coast | 36 | Nazas-Aguanaval |
| 18 | Balsas | 37 | El Salado |
| 19 | Greater Guerrero Coast | | |

**Source:** Conagua (2015a).

**MAP 2.1** Limits of aquifers


**Source:** CONAGUA (2015a).

The Conagua has 3 153 stations in operation to measure **climate** variables, including temperature, precipitation, evaporation, wind speed and direction. Of these, 79 are meteorological observatories, which transmit meteorological information in real time. Stream gages measure the flow of water in rivers, as well as the extraction of water through dam intakes. In Mexico there are 861 stream gages, including some automatic ones. On the other hand, hydro-climate stations measure climatic and hydrometric parameters.

CONAGUA has
**3 153**
**climate**
stations

**TABLE 2.1** Number of climate stations and stream gages in Mexico, 2014

| Type of station | Number of stations |
|---|---|
| Climate stations | 3 153 |
| Stream gages | 861 |

**Source:** CONAGUA (2015a), CONAGUA (2015h).

## 2.2 Renewable Water Resources[2]

[Reporteador: Ciclo hidrológico, Agua renovable]

Every year, Mexico receives around 1 449 471 million cubic meters of water in the form of precipitation. Of this water, it is estimated that 72.5% evapotranspirates and returns to the atmosphere, 21.2% runs off into rivers and streams and the remaining 6.4% naturally filters through to the subsoil and recharges aquifers.[3] Taking into account the water outflows to and inflows from neighboring countries, every year the country has 447.26 billion cubic meters of renewable freshwater resources.

Every year **Mexico** has
**447.26**
billion cubic meters of
renewable freshwater

Figure 2.2 shows the components and values that make up the calculation of renewable water resources.

The inflows represent the volume of water which runs off to Mexico, generated in the transboundary watersheds Mexico shares with its neighboring countries (United States of America, Guatemala and Belize). The outflows represent the volume of water that Mexico is bound to deliver to the United States of America under the 1944 "Water Treaty"[4]

Renewable water resources should be analyzed from three perspectives:

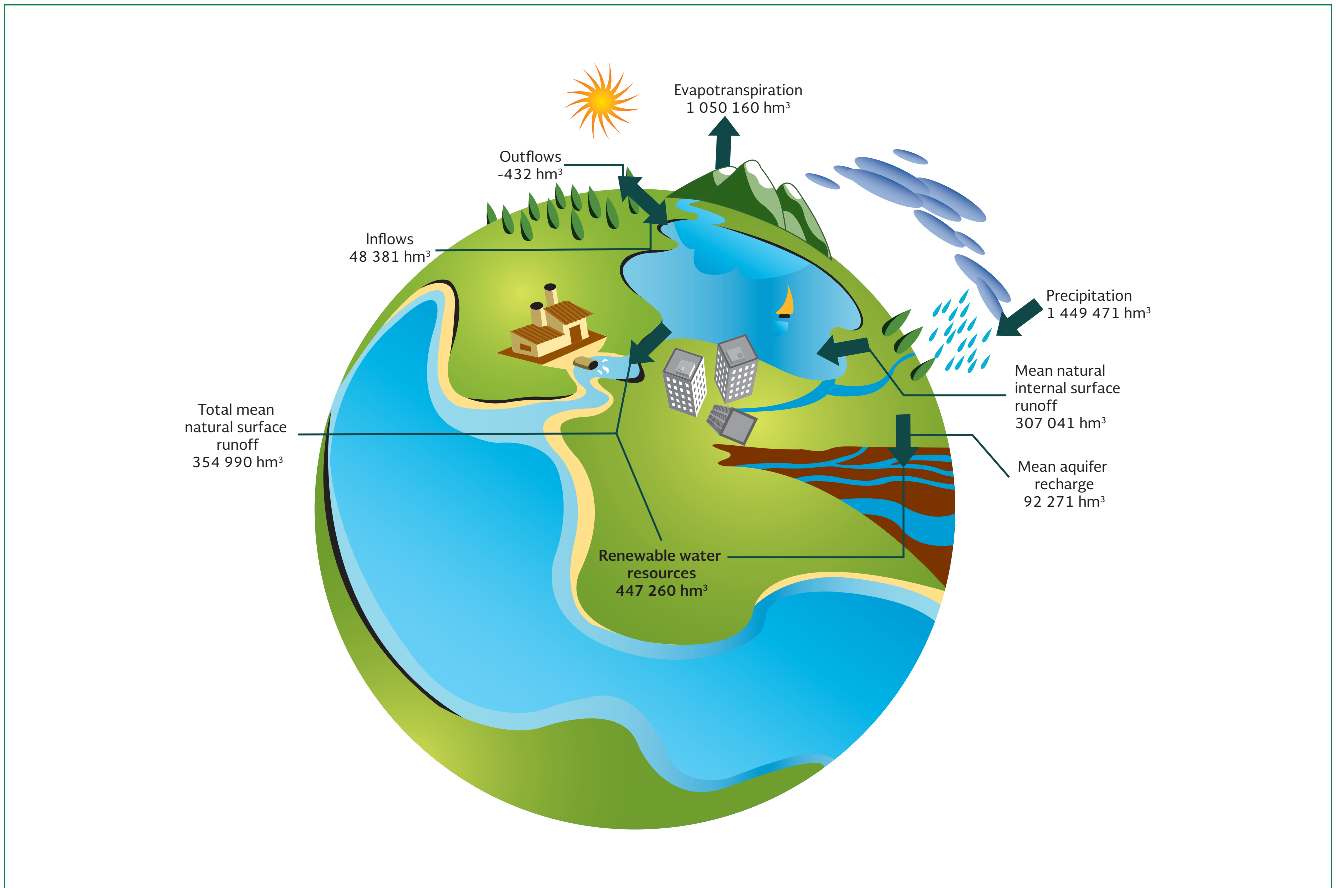
- Distribution over time: In Mexico there are significant variations in renewable water resources throughout the year. The majority of the rainfall occurs in the summer, and the rest of the year is relatively dry.
- Distribution in space: Some regions of the country have abundant precipitation and low population density, whereas in others exactly the opposite occurs.

**2** The maximum quantity of water that can feasibly be used in a region, meaning the quantity of water that is renewed by rainfall and the water that comes from other regions or countries (inflows). It is calculated as the mean natural annual internal surface runoff, plus the total annual recharge of aquifers, plus the water inflows, minus the water outflows to other regions (Gleick 2002).

**3** Some aquifers have renewal periods, understood as the rate of their estimated storage divided by their annual recharge, which are exceptionally long. These aquifers are thus known as non-renewable ones.

**4** "Treaty between the government of the United Mexican States and the government of the United States of America on the distribution of international water resources in the Colorado and Tijuana Rivers and the Rio Grande, from Fort Quitman, Texas, to the Gulf of Mexico".

**FIGURE 2.2** Mean annual values of the components of the water cycle in Mexico, 2014




**Source**: Produced based on CONAGUA (2015a).

**TABLE 2.2** Per capita renewable water resources, 2014

| HAR number | Renewable water resources (hm³/year) | Mid-year population (millions of inhabitants) | Per capita renewable water resources (m³/inhabitant/year) | Total mean natural surface runoff (hm³/year) | Total mean aquifer recharge (hm³/year) |
|---|---|---|---|---|---|
| I | 4 958 | 4.37 | 1 135 | 3 300 | 1 658 |
| II | 8 273 | 2.80 | 2 951 | 5 066 | 3 207 |
| III | 25 596 | 4.47 | 5 730 | 22 519 | 3 076 |
| IV | 22 156 | 11.69 | 1 896 | 16 805 | 5 351 |
| V | 30 565 | 5.02 | 6 084 | 28 629 | 1 936 |
| VI | 12 316 | 12.15 | 1 014 | 6 416 | 5 900 |
| VII | 7 849 | 4.52 | 1 738 | 5 529 | 2 320 |
| VIII | 35 093 | 23.89 | 1 469 | 25 423 | 9 670 |
| IX | 28 085 | 5.23 | 5 366 | 24 016 | 4 069 |
| X | 95 129 | 10.48 | 9 075 | 90 424 | 4 705 |
| XI | 144 459 | 7.57 | 19 078 | 121 742 | 22 718 |
| XII | 29 324 | 4.52 | 6 494 | 4 008 | 25 316 |
| XIII | 3 458 | 23.01 | 150 | 1 112 | 2 346 |
| **Total** | **447 260** | **119.71** | **3 736** | **354 990** | **92 271** |

**Note:** for the hydrological-administrative region XIII, Mexico City's wastewater is considered.
**Source**: Produced based on CONAGUA (2015a), CONAPO (2015).

- The **area** of analysis: Water problems and their resolution are predominantly local in scale. Indicators calculated at a large scale may hide some strong variations which exist throughout the country.

In some HARs, such as I Baja California Peninsula, VI Rio Bravo, VII Lerma-Santiago-Pacific and XIII Waters of the Valley of Mexico, the per capita renewable water resources are alarmingly low. In table 2.2 the mean values of renewable water resources in each of the regions of the country are shown.

## Precipitation

[Reporteador: Precipitación]

Mexico's **normal precipitation** in the period from 1981 to 2010 was 740 millimeters. According to the World Meteorological Organization (WMO), the normal values correspond to average measurements calculated for a uniform and relatively long period, which must include at least 30 years of data collection, considered as a minimum representative climate period. Furthermore, that period should start on January 1 of a year ending in one, and end on December 31 in a year ending in zero.

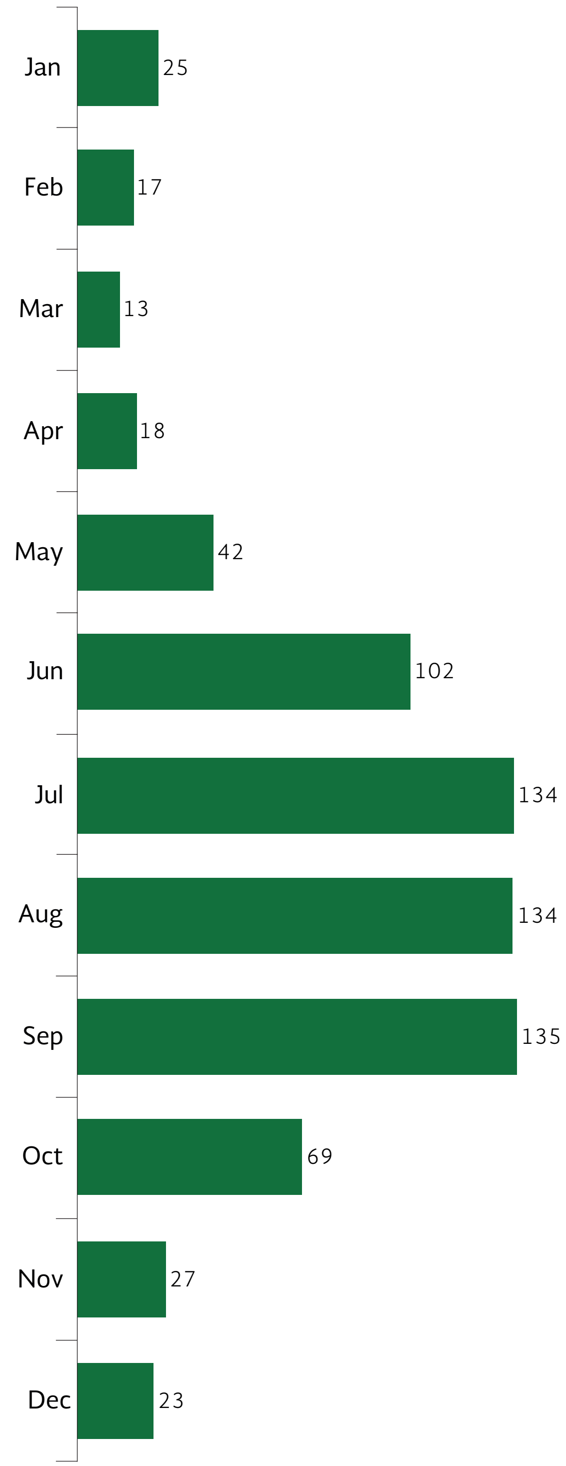
Table 2.3 presents the normal precipitation by HAR in the period from 1981 to 2010 (consult the data by state in [Adicional: Table 2.A]). In the majority of Mexico, precipitation mainly occurs between June and September.

It is important to mention that the monthly distribution of precipitation accentuates the problems related with the availability of water resources, since 68% of the normal monthly precipitation falls between the months of June and September, as can be observed in graph 2.1.

It may be observed, for example, that in the hydrological-administrative region XI Southern Border, which receives the greatest quantity of rain, the normal annual precipitation for 1981-2010 was eleven times higher than in the hydrological-administrative region I Baja California Peninsula, the driest one. This regional variation in the normal precipitation is highlighted in figure 2.3 and figure 2.4.

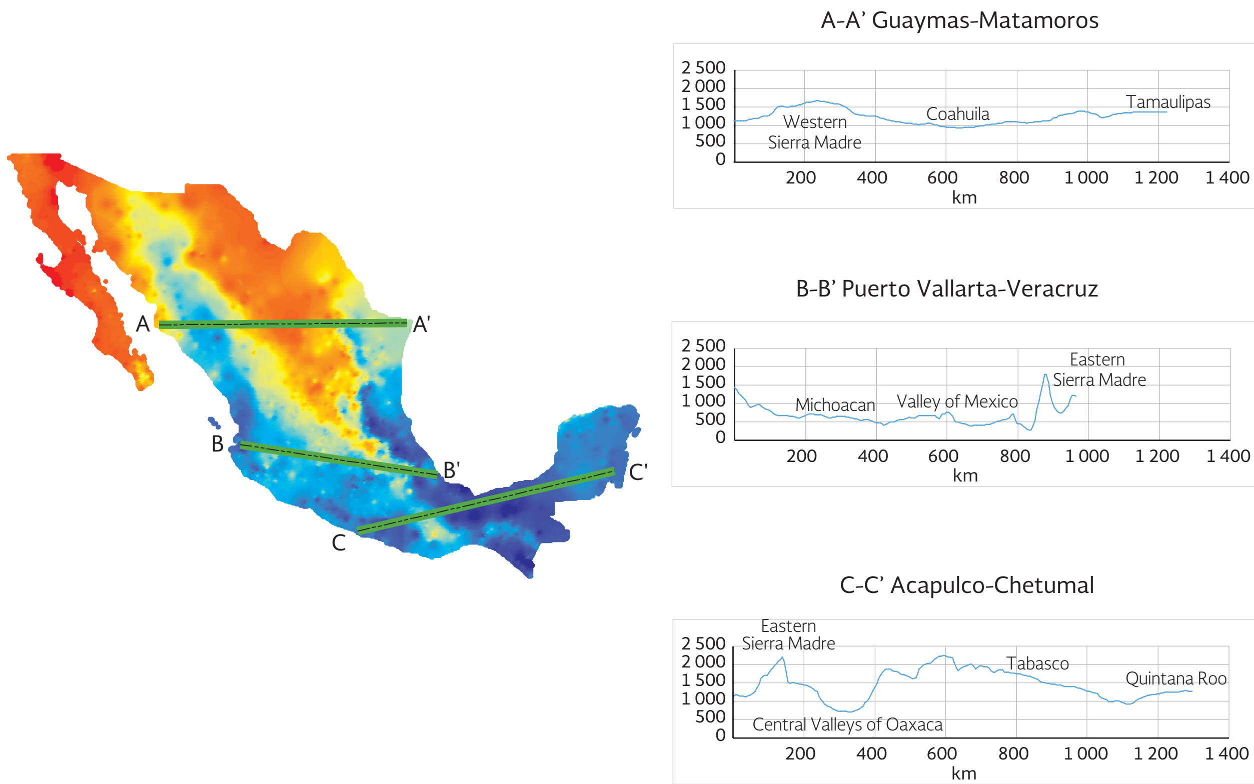
To illustrate the regional variation in rainfall, figure 2.3 shows three cross-sections that allow the precipitation profiles to be visualized in Guaymas-Matamoros (A-A'), Puerto Vallarta-Veracruz (B-B') and Acapulco-Chetumal (C-C'). The graphs show in blue the profile of the variation in the normal precipitation over the 1981-2010 period, throughout these cross-sections.

**Graph 2.1** Monthly normal precipitation in Mexico, 1981-2010 (mm)




**Source:** Conagua (2015h).

## **Figure 2.3** Normal annual precipitation profiles, 1981-2010 (mm)




**Source**: Produced based on Conagua (2015h).

## **Table 2.3** Normal monthly precipitation, 1981-2010 (mm)

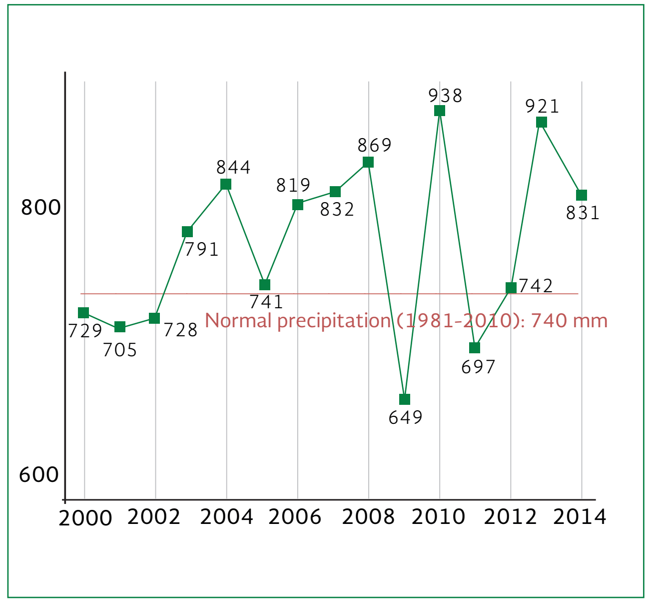
| HAR number | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 20 | 19 | 14 | 4 | 1 | 1 | 10 | 26 | 32 | 11 | 10 | 20 | 168 |
| II | 24 | 21 | 12 | 6 | 4 | 19 | 108 | 103 | 58 | 25 | 17 | 31 | 428 |
| III | 31 | 16 | 8 | 6 | 9 | 66 | 194 | 188 | 142 | 52 | 26 | 29 | 765 |
| IV | 12 | 8 | 6 | 11 | 48 | 179 | 199 | 197 | 194 | 84 | 15 | 6 | 962 |
| V | 26 | 20 | 19 | 38 | 67 | 120 | 137 | 119 | 166 | 89 | 30 | 23 | 855 |
| VI | 8 | 8 | 6 | 15 | 71 | 230 | 200 | 219 | 242 | 113 | 20 | 7 | 1 139 |
| VII | 19 | 11 | 11 | 17 | 28 | 40 | 63 | 61 | 64 | 32 | 12 | 15 | 372 |
| VIII | 18 | 9 | 6 | 12 | 27 | 56 | 79 | 71 | 67 | 29 | 11 | 13 | 398 |
| IX | 22 | 11 | 4 | 6 | 23 | 131 | 197 | 180 | 153 | 60 | 13 | 10 | 808 |
| X | 51 | 40 | 30 | 43 | 84 | 222 | 261 | 264 | 293 | 179 | 97 | 64 | 1 626 |
| XI | 65 | 54 | 36 | 49 | 135 | 276 | 223 | 265 | 331 | 224 | 109 | 76 | 1 842 |
| XII | 45 | 35 | 31 | 39 | 90 | 167 | 153 | 173 | 208 | 147 | 72 | 49 | 1 207 |
| XIII | 11 | 11 | 12 | 28 | 51 | 109 | 126 | 115 | 110 | 57 | 13 | 6 | 649 |
| **Total** | **25** | **17** | **13** | **18** | **42** | **102** | **134** | **134** | **135** | **69** | **27** | **23** | **740** |

**Source:** Produced based on Conagua (2015h).

Figures 2.3 and 2.4 illustrate the characteristics of the distribution of precipitation in 2014 and its relation to the 1981-2010 normal precipitation. It is possible to compare the 2014 precipitation with the 1981-2010 normal values. Map 2.2 shows the anomaly, meaning the difference between both precipitations. The scale of colors goes from red, which means annual rain in 2014 lower than the 1981-2010 normal values, to blue in which the annual rainfall was higher than the normal one. As can be observed in the map, precipitation lower than the normal value occurred in general along the Western Sierra Madre, with a significant area of the Tehuantepec Isthmus, whereas precipitation higher than the normal values occurred generally in the Gulf of Mexico.

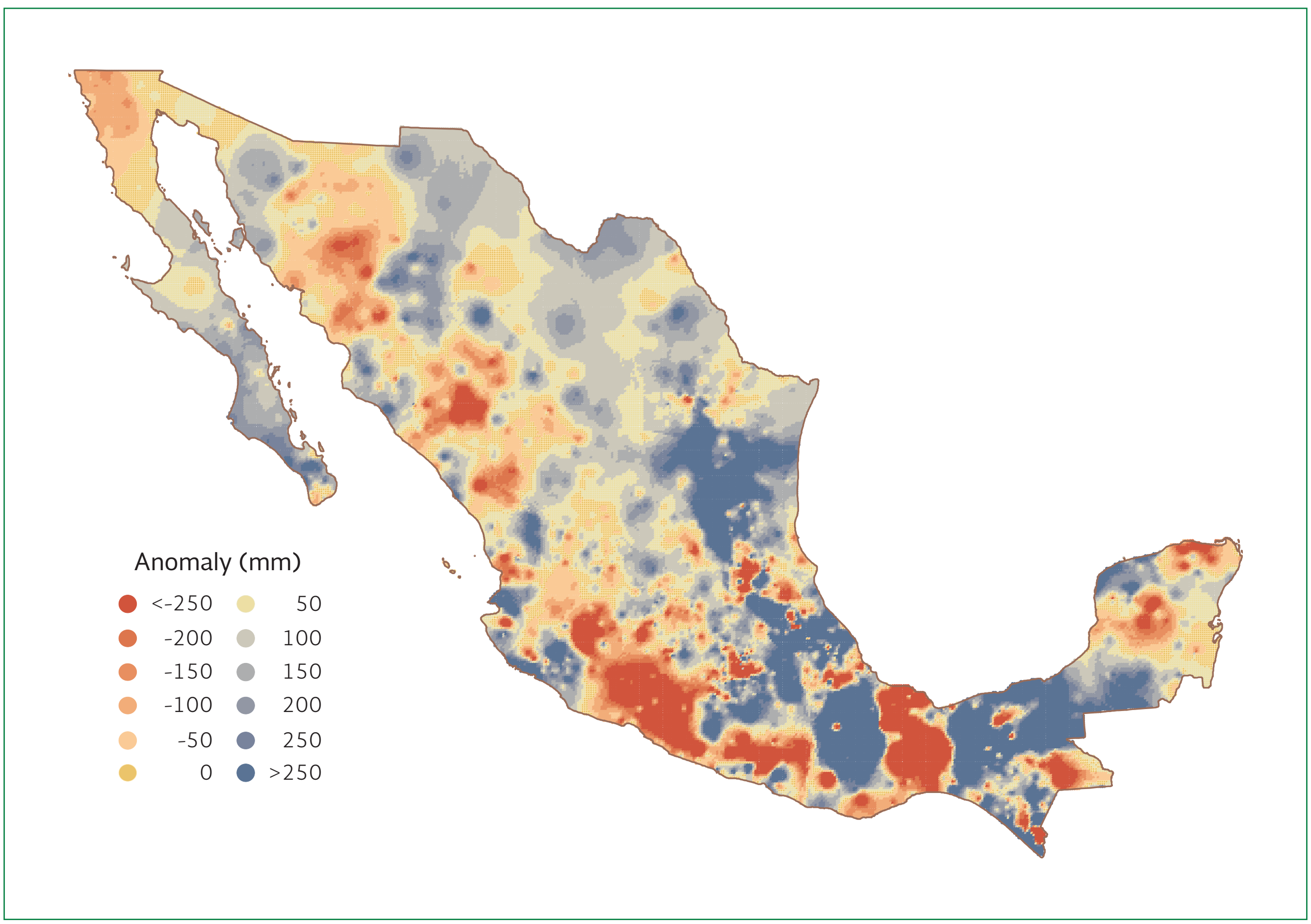
The accumulated precipitation in the Mexican Republic from January 1 to December 31, 2014, reached a sheet of 831 mm, which was 12% higher than the normal value for the 1981-2010 period (740 mm). The 2000-2014 annual series of accumulated precipitation is shown in graph 2.2.

**Graph 2.2** Annual precipitation, 2000-2014 (mm)



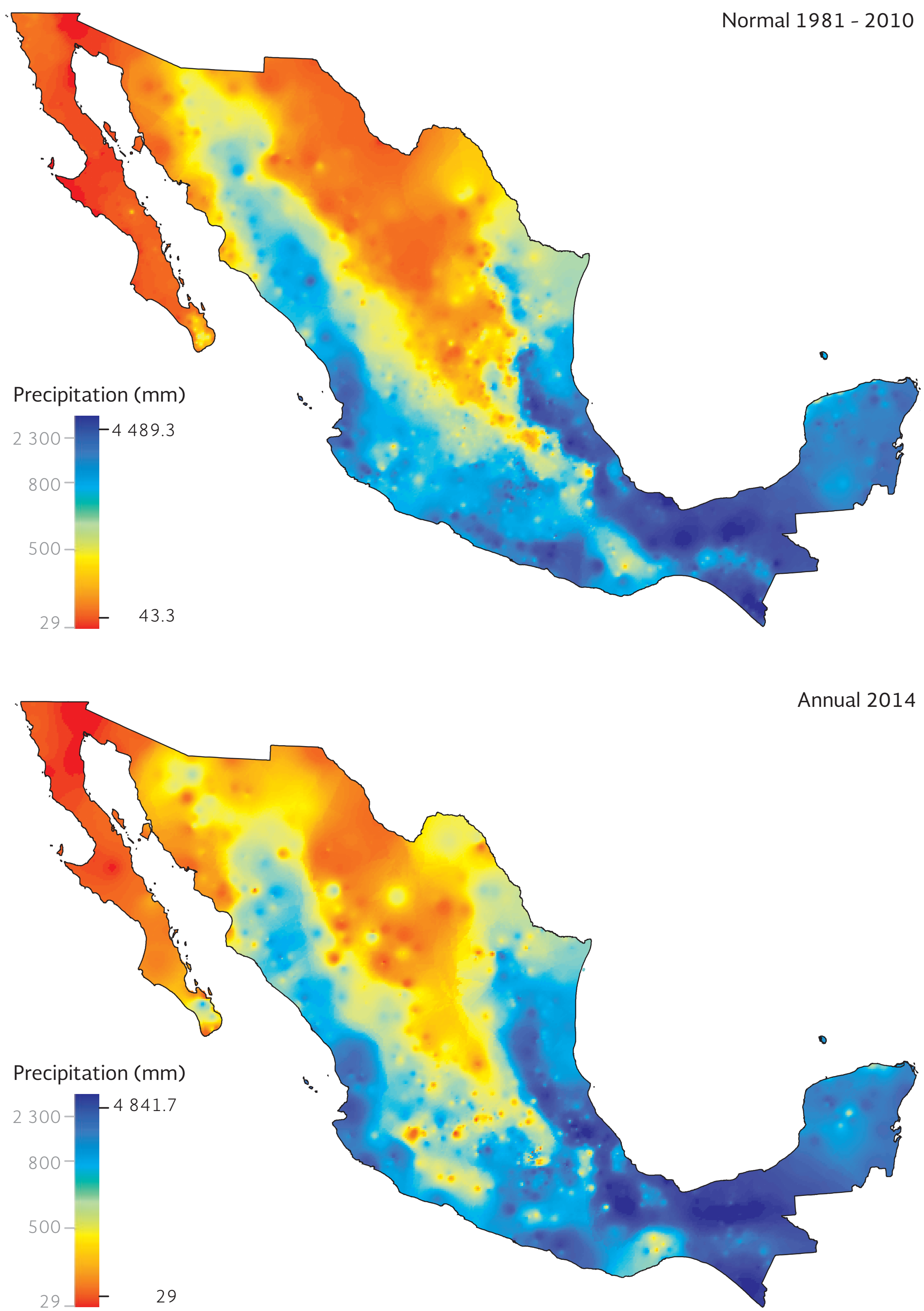

**Source**: Conagua (2015h).

**Map 2.2** Precipitation anomaly 2014




**Source:** Conagua (2015h).

**FIGURE 2.4** Distribution of precipitation




**Source**: Produced based on CONAGUA (2015h).

# 2.3 Hydro-meteorological phenomena

## Tropical cyclones

[Reporteador: Huracanes y ciclones]

Tropical cyclones are natural phenomena that generate most of the movement of sea humidity to the semi-arid zones of the country. In several regions of the country, cyclonic rains represent the majority of the annual precipitation.

Cyclones are classified according to the intensity of the maximum sustained winds. When the latter are lower than 62 km/h they are designated as tropical depressions (TD), when they are between 62 km/h and 118 km/h, they are called tropical storms (TS); and when they are stronger than 119 km/h, they are referred to as hurricanes (see table 2.4). In the latter case, the cloudy area covers an extension of between 500 and 900 km of diameter, producing intense rains. The eye of the hurricane normally reaches a diameter that varies between 24 and 40 km, however, it can be anything up to 100 km. Hurricanes are classified through the Saffir-Simpson scale.

Between 1970 and 2014, 220 tropical cyclones hit the coasts of Mexico [Adicional: Graph 2.A]. Table 2.5 presents their occurrence on the Atlantic and Pacific oceans, from which it can be observed that a greater number of cyclones have hit the Pacific coast.

In map 2.2 [Adicional: Table 2.B], the hurricanes that occurred in Mexico between 1970 and 2014 are shown. The intense hurricanes during this period (categories H3-H5) are identified with a label. In the 2014 hurricane season, the highest category that hit the Mexican coast was Odile (H3).

Between
1970 and 2014,
**220**
tropical cyclones
hit Mexico

**Table 2.4** Hurricanes and the Saffir-Simpson scale

| Category | Maximum winds (km/h) | Storm tide that it normally generates (m) | Characteristics of the possible material damage and floods |
|---|---|---|---|
| H1 | From 119 to 153 | 1.2 a 1.8 | Small trees toppled; some flooding on the lowest-lying coastal highways. |
| H2 | From 154 to 177 | 1.8 a 2.5 | Additionally: Rooftops, doors and windows damaged; trees uprooted. |
| H3 | From 178 to 208 | 2.5 a 4.0 | Additionally: Cracks appear in small buildings; flooding in low-lying and flat grounds. |
| H4 | From 209 to 251 | 4.0 a 5.5 | Additionally: Household roofs come loose; significant erosion on beaches and river and stream channels. Imminent damage to drinking water and sanitation services. |
| H5 | Greater than 252 | Greater than 5.5 | Additionally: Very severe and extensive damage to windows and doors. Total failure of roofs in many residences and industrial buildings. |

**Source**: Produced based on Conagua (2014), Conagua (2015k).

## **Table 2.5** Tropical cyclones that hit Mexico between 1970 and 2014

| Ocean | Tropical depressions | Tropical storms | Moderate hurricanes (H1 and H2) | Intense hurricanes (H3-H5) | Total |
|---|---|---|---|---|---|
| Atlantic | 27 | 31 | 14 | 12 | 84 |
| Pacific | 31 | 49 | 45 | 11 | 136 |
| **Total** | **58** | **80** | **59** | **23** | **220** |

**Source**: Conagua (2015h).

## **Map 2.3** Hurricanes 1970-2014


**Source**: Produced based on Conagua (2015h).

# Droughts

[Reporteador: Sequías]

Drought is when rainfall is significantly lower than the levels normally registered, which causes serious hydrological imbalances that jeopardize agricultural production systems. When rainfall is scarce and infrequent and the temperature increases, it becomes more difficult for vegetation to develop. Droughts are the most costly natural disasters, since they affect more people than any other form of natural disaster.

In addition drought may be associated with phenomena of soil degradation and deforestation. In the drought season, the risk of forest fires increases (Inegi 2013a).

In partnership with the United States and Canada, Mexico takes part in the "North American Drought Monitor" (NADM), which analyzes the climate conditions in order to continuously monitor drought at a large scale in North America. .

A moment of interest in the year is the month of May, when the dry season generally ends and the rainy season starts. In May 2014 (figure 2.5), the meteorological conditions caused important precipitations, meaning that this month was the second rainiest May since 1943. The rain was distributed over approximately two thirds of the national territory, however the states in the northwest were very warm and with below average precipitations.

The distribution of droughts occurred mainly in the northwest, with isolated areas in the center and south of the country. The areas with D2 droughts (severe), D3 (extreme) and D4 (exceptional) occurred in small isolated areas, close to the border with the United States. 86 634 hectares were declared disaster zones due to forest fires from January to May 2014 (NADM 2015a).

Another interesting moment to review the evolution of drought is the month of November, when the rainy season generally finishes and the dry season starts. An improvement or disappearance is expected in the drought conditions that existed before the precipitation started.

In November 2014 (figure 2.5), precipitation occurred in the north, northeast and center-west of the country, which helped to reduce or resolve the abnormally dry areas (D0) in Nayarit, Sinaloa, Jalisco and Durango. However, the northwest of the country continued to be lacking in rainfall. The presence of an area affected by drought between Michoacan and Guerrero should be mentioned, which received below normal rainfall in the summer.

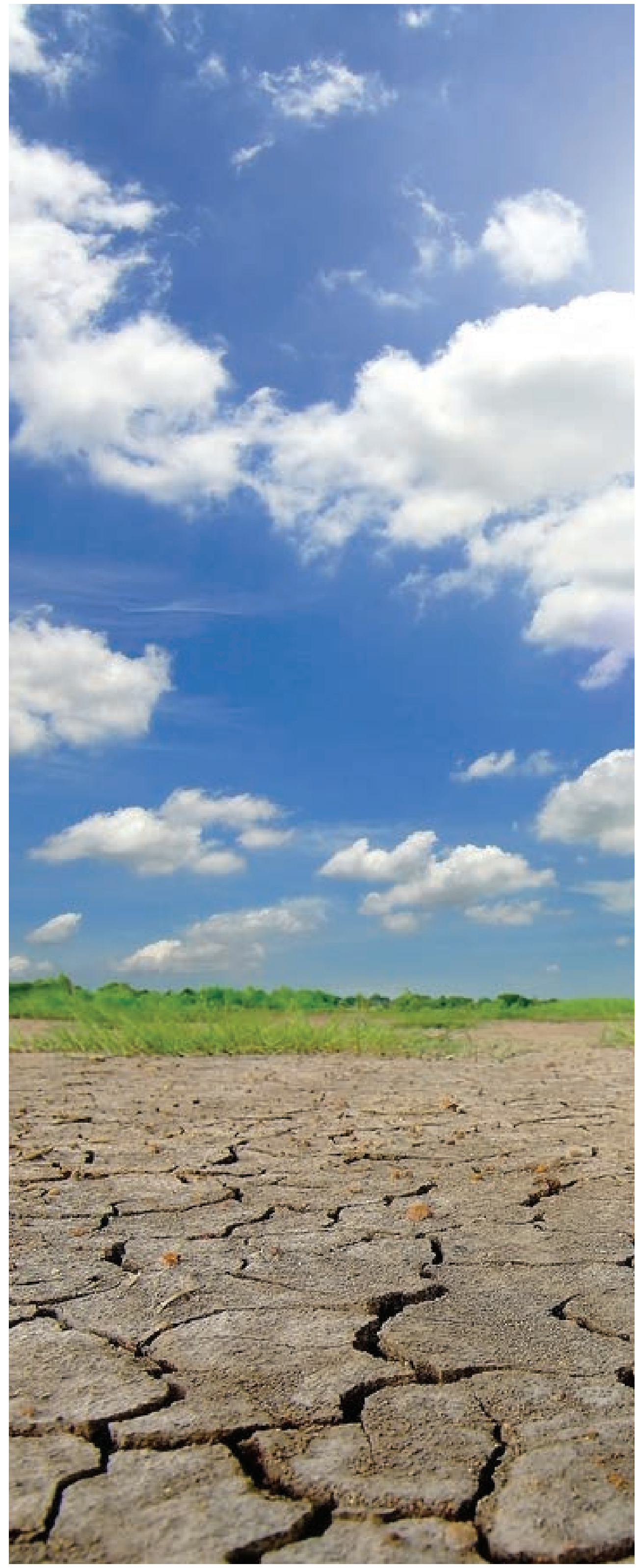
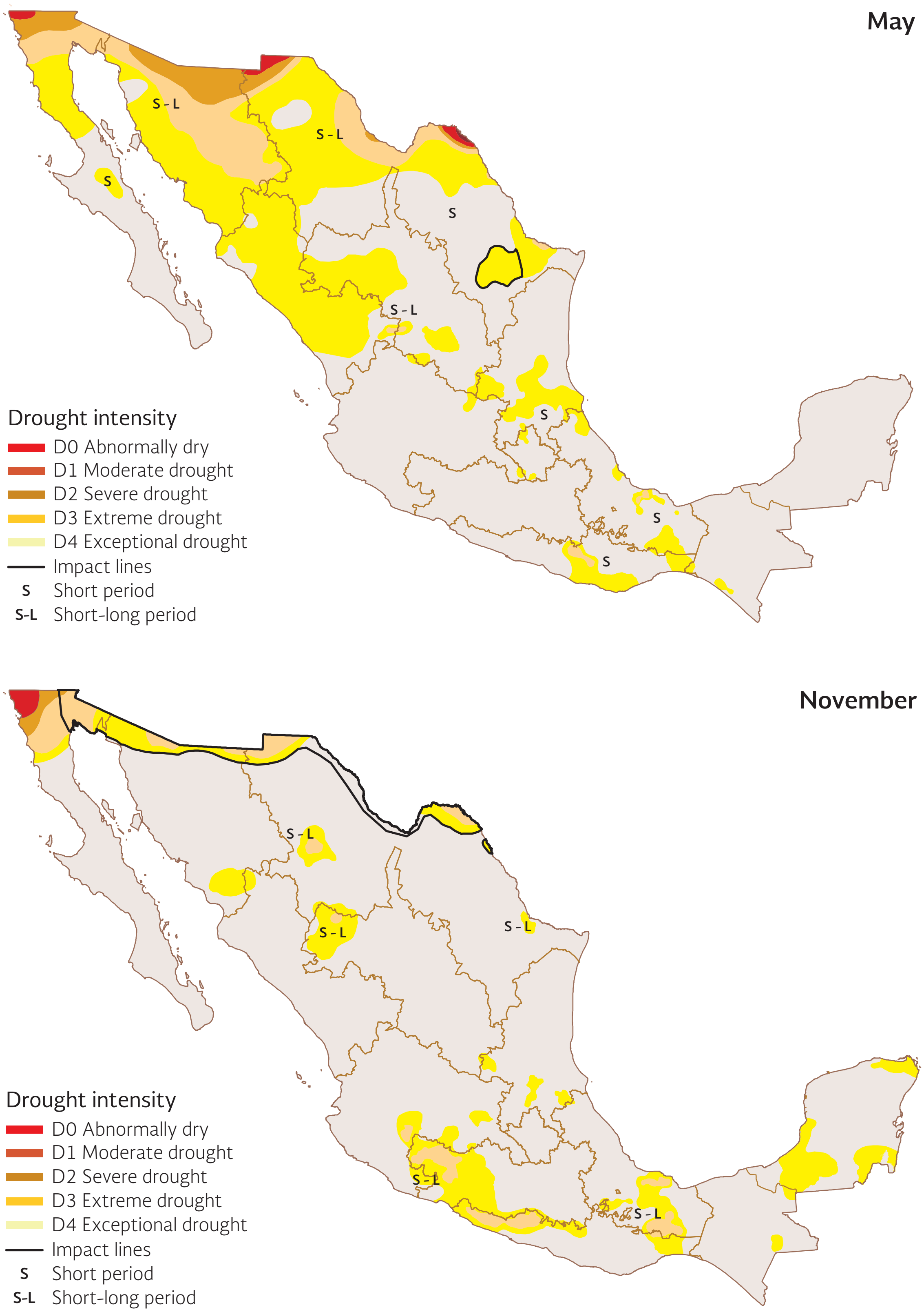


**FIGURE 2. 5** Drought conditions, 2014




**Source**: Produced based on CONAGUA (2015h), NADM (2015a), NADM (2015b).

The mean temperature in November was below the normal value (1971-2000), making it the seventh coldest November since 1971, with regional variations. The National Forestry Commission (Conafor) reported an area affected by forest fires of 155 129 hectares accumulated from January to December 4 (NADM 2015b).

As can be seen, when the situation at the start of the 2014 rainy season (May) is compared to the end of that season (November), the areas in drought conditions fell considerably.

Area affected by forest fires

**155 129**

hectares, from January to December 2014

## Effects

Both drought and intense precipitation, as well as factors such as topography, soil use and the status of vegetation cover, may cause impacts on society and economic activities.

Considering the effect of global phenomena such as "El Niño-Southern Oscillation"[5] and climate change, within the framework of the National Program against Drought (Pronacose), climate vulnerability at the municipal level was analyzed, as the combination of physical factors (the location of the municipality), social ones (the population and its marginalization characteristics), economic ones (the possible loss of income) and ecological ones (the degradation of natural resources). Map 2.4 shows the climate vulnerability at the municipal level.

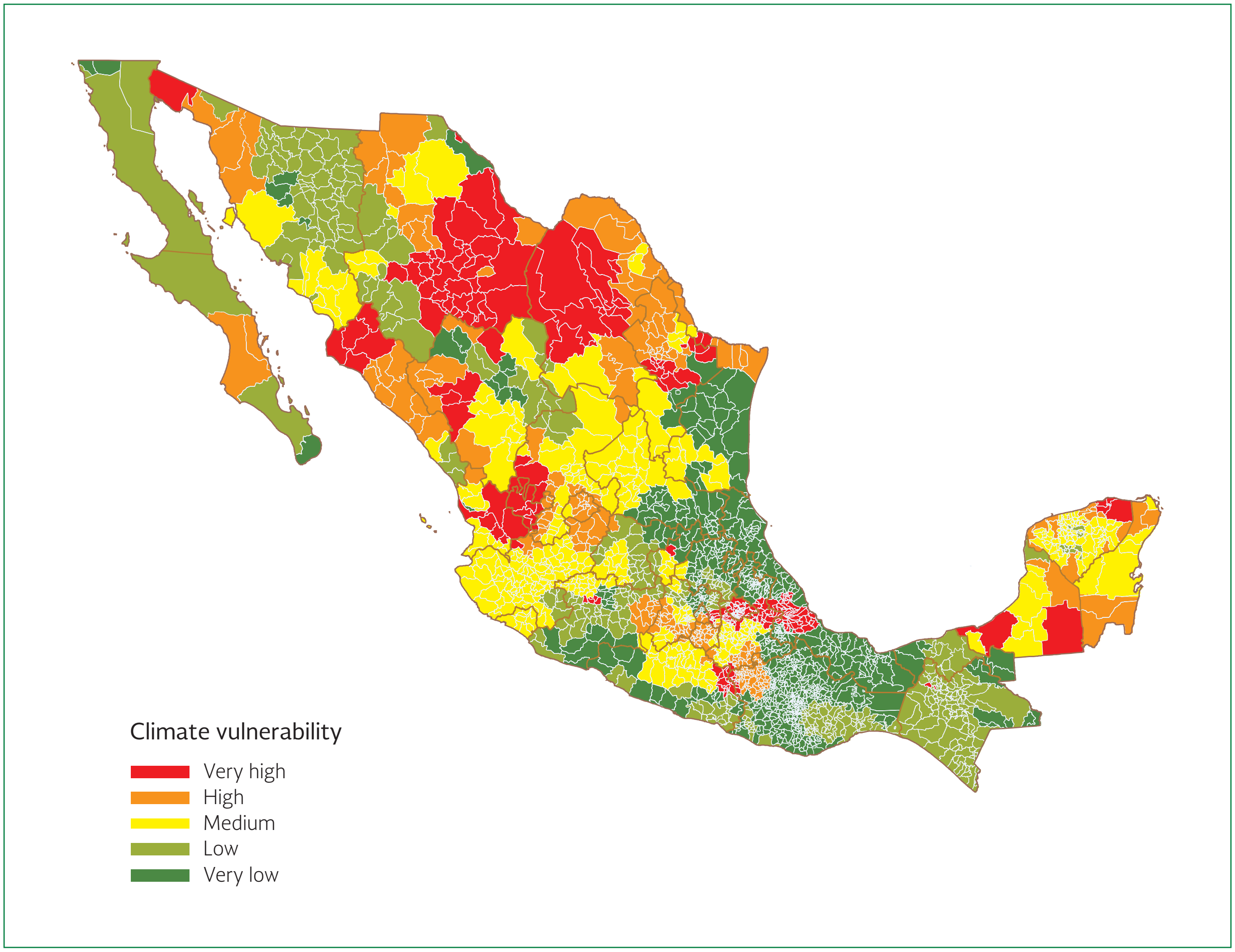
In Mexico there are procedures in place for the issuing of declarations[6] as a result of these phenomena of drought[7] or intense precipitation, in categories which describe their effects. Climate contingencies are affectations on productive activities, emergencies imply risks to life and public health, whereas disasters focus the state's and society's resources on the reconstruction of the affected areas.

5 The term "El Niño" originally applied to the warming of the sea surface temperature (TSS) on the coasts of Peru and Ecuador, close to Christmas time. It has been observed that this warming affects an extensive region of the Pacific along the Equator, modifying global climate patterns. Now referred to as "El Niño-Southern Oscillation" (ENSO), it presents three phases: warm (El Niño), cold (La Niña) and neutral(Conagua 2015j).

6 The declarations make it possible to employ resources from public programs to attend these affectations.

7 It is worth mentioning that the drought reported in the NADM is established with a different methodology to the one used for the declarations.

**Map 2.4** Climate vulnerability at the municipal level




**Source**: Conagua (2015a).

## 2.4 Surface water

### Rivers

[Reporteador: Ríos principales]

Mexico's rivers and streams constitute a 633 000 kilometer long hydrographic network, in which 51 main rivers stand out, through which 87% of the country's surface runoff flows, and whose catchments cover 65% of the country's mainland surface area (map 2.5).

For their surface area, the catchments of the Rio Grande and Balsas river stand out, as do the Rio Grande and Grijalva-Usumacinta river for their length. The Lerma and Nazas-Aguanaval are inland-flowing rivers. In tables 2.6, 2.7 and 2.8, the most relevant data on Mexico's main rivers is shown, according to the water body into which they flow. It should be mentioned that the mean natural surface runoff represents the mean annual value of its historical registry and the maximum stream order was determined according to the Strahler method. In the case of transboundary catchments, the area and length of the river correspond to the Mexican side of the watershed, strictly speaking the catchment itself.

Rivers and streams contitute a

**633 000**

km long hydrographic network

**Map 2.5** Mexico's main rivers


**Source**: Conagua (2015b).

**Table 2.6** Characteristics of the main rivers that flow into the Pacific and Gulf of California, ordered by their mean natural surface runoff, 2014

| Nº | River | HAR number | Mean natural surface runoff ($hm^3$/year) | Catchment area ($km^2$) | Length of the river (km) | Maximum order |
|---|---|---|---|---|---|---|
| 1 | Balsas | IV | 16 279 | 117 406 | 770 | 7 |
| 2 | Santiago | VIII | 7 423 | 76 416 | 562 | 7 |
| 3 | Verde | V | 6 046 | 18 812 | 342 | 6 |
| 4 | Ometepec | V | 5 100 | 6 922 | 115 | 4 |
| 5 | El Fuerte | III | 5 024 | 33 590 | 540 | 6 |
| 6 | Papagayo | V | 4 288 | 7 410 | 140 | 6 |
| 7 | San Pedro | III | 3 347 | 26 480 | 255 | 6 |
| 8 | Yaqui | II | 3 179 | 72 540 | 410 | 6 |
| 9 | Culiacan | III | 3 122 | 15 731 | 875 | 5 |
| 10 | Suchiate | XI | 1 584 | 203 | 75 | 2 |
| 11 | Ameca | VIII | 2 205 | 12 214 | 205 | 5 |
| 12 | Sinaloa | III | 2 100 | 12 260 | 400 | 5 |
| 13 | Armeria | VIII | 1 805 | 9 795 | 240 | 5 |
| 14 | Coahuayana | VIII | 1 732 | 7 114 | 203 | 5 |
| 15 | Colorado | I | 1 928 | 3 840 | 160 | 6 |
| 16 | Baluarte | III | 1 830 | 5 094 | 142 | 5 |
| 17 | San Lorenzo | III | 1 665 | 8 919 | 315 | 5 |
| 18 | Acaponeta | III | 1 433 | 5 092 | 233 | 5 |
| 19 | Piaxtla | III | 1 406 | 11 473 | 220 | 5 |
| 20 | Presidio | III | 1 084 | 6 479 | NA | 4 |
| 21 | Mayo | II | 1 222 | 15 113 | 386 | 5 |
| 22 | Tehuantepec | V | 901 | 10 090 | 240 | 5 |
| 23 | Coatan | XI | 934 | 605 | 75 | 3 |
| 24 | Tomatlan | VIII | 1 166 | 2 118 | NA | 4 |
| 25 | Marabasco | VIII | 503 | 2 526 | NA | 5 |
| 26 | San Nicolas | VIII | 487 | 2 330 | NA | 5 |
| 27 | Elota | III | 463 | 2 324 | NA | 4 |
| 28 | Sonora | II | 412 | 27 740 | 421 | 5 |
| 29 | Concepcion | II | 113 | 25 808 | 335 | 2 |
| 30 | Matape | II | 89 | 6 606 | 205 | 4 |
| 31 | Tijuana | I | 95 | 3 231 | 186 | 4 |
| 32 | Sonoyta | II | 20 | 7 653 | 311 | 5 |
| 33 | Huicicila | VIII | 470 | 1 194 | 50 | NA |
| | **Total** | | **79 455** | **565 128** | | |

**Note:** The length of the Suchiate River belongs to the border between Mexico and Guatemala. The runoff from the Colorado River considers the inflow as per the 1944 Water Treaty.

**NA:** Not Available.

**Source**: Conagua (2015a).

Table 2.6 describes the rivers which flow into the Pacific and Gulf of California. For the transboundary catchments (Colorado, Suchiate, Coatan and Tijuana) the mean natural surface runoff includes the inflows from other countries, except for the Tijuana river, the runoff from which only corresponds to the Mexican share.

Table 2.7 describes the rivers that flow into the Gulf of Mexico and the Caribbean Sea. For the transboundary catchments (Grijalva-Usumacinta, Grande, Candelaria and Hondo), the mean natural surface runoff includes the inflows from other countries, except for the Rio Grande and Hondo River, the runoff from which only corresponds to the Mexican share.

Table 2.8 describes the inland-flowing rivers. Lerma River, which flows out into Lake Chapala, is one of these rivers.

With a length of
**1 521 km**
**Grijalva-Usumacinta**
river is Mexico's longest

**Table 2.7** Characteristics of the main rivers that flow into the Gulf of Mexico and Caribbean Sea, ordered by their mean natural runoff, 2014

| Nº | River | HAR number | Mean natural surface runoff (hm³/year) | Catchment area (km²) | Length of the river (km) | Maximum order |
|---|---|---|---|---|---|---|
| 34 | Grijalva-Usumacinta | XI | 101 517 | 83 553 | 1 521 | 7 |
| 35 | Papaloapan | X | 42 887 | 46 517 | 354 | 6 |
| 36 | Coatzacoalcos | X | 28 679 | 17 369 | 325 | 5 |
| 37 | Panuco | IX | 19 673 | 84 956 | 510 | 7 |
| 38 | Tecolutla | X | 6 098 | 7 903 | 375 | 5 |
| 39 | Bravo | VI | 5 588 | 225 242 | NA | 7 |
| 40 | Tonala | X | 3 955 | 5 679 | 82 | 5 |
| 41 | Nautla | X | 2 218 | 2 785 | 124 | 4 |
| 42 | La Antigua | X | 2 145 | 2 827 | 139 | 5 |
| 43 | Tuxpan | X | 2 072 | 5 899 | 150 | 4 |
| 44 | Jamapa | X | 2 055 | 4 061 | 368 | 4 |
| 45 | Soto La Marina | IX | 1 999 | 21 183 | 416 | 6 |
| 46 | Candelaria | XII | 1 861 | 13 790 | 150 | 4 |
| 47 | Cazones | X | 1 712 | 2 688 | 145 | 4 |
| 48 | San Fernando | X | 1 573 | 17 744 | 400 | 5 |
| 49 | Hondo | XII | 576 | 7 614 | 115 | 4 |
| | **Total** | | **224 608** | **549 810** | | |

**Note:** The length of the Hondo River reported belongs to the border between Mexico and Belize.
**NA:** Not Available

**Source**: Conagua (2015a).

**Table 2.8** Characteristics of the main inland-flowing rivers, ordered by the mean natural surface runoff, 2014

| Nº | River | HAR number | Mean natural surface runoff (hm³/year) | Catchment area (km²) | Length of the river (km) | Maximum order |
|---|---|---|---|---|---|---|
| 50 | Lerma | VIII | 4 742 | 47 116 | 708 | 6 |
| 51 | Nazas-Aguanaval | VII | 2 085 | 89 239 | 1 081 | 7 |
| | **Total** | | **6 827** | **136 355** | | |

**Source:** Conagua (2015a).

## Mexico's transboundary catchments

Mexico shares eight catchments with its neighboring countries: three with the United States of America (Grande, Colorado and Tijuana), four with Guatemala (Grijalva-Usumacinta, Suchiate, Coatan and Candelaria) and one with both Belize and Guatemala (River Hondo), the data on which is presented in figure 2.6 and table 2.9. The data on mean natural surface runoff and the catchment area in table 2.9 was obtained from available hydrological studies

The waters of the Colorado and Tijuana rivers and the Rio Grande are shared between Mexico and the United States of America, according to the indications of the "Water Treaty" signed in Washington, D.C. on February 3, 1944.

In the case of the Colorado River, the treaty specifies that the United States of America should deliver 1.85 billion cubic meters (1.5 million acre feet) every year to Mexico. The annual series of this delivery from 1945 to 2014 is shown in graph 2.3.

**The United States of America**
should deliver
**1.85**
billion cubic meters to the Colorado river every year

**Table 2.9** Characteristics of the main rivers with transboundary catchments, 2014

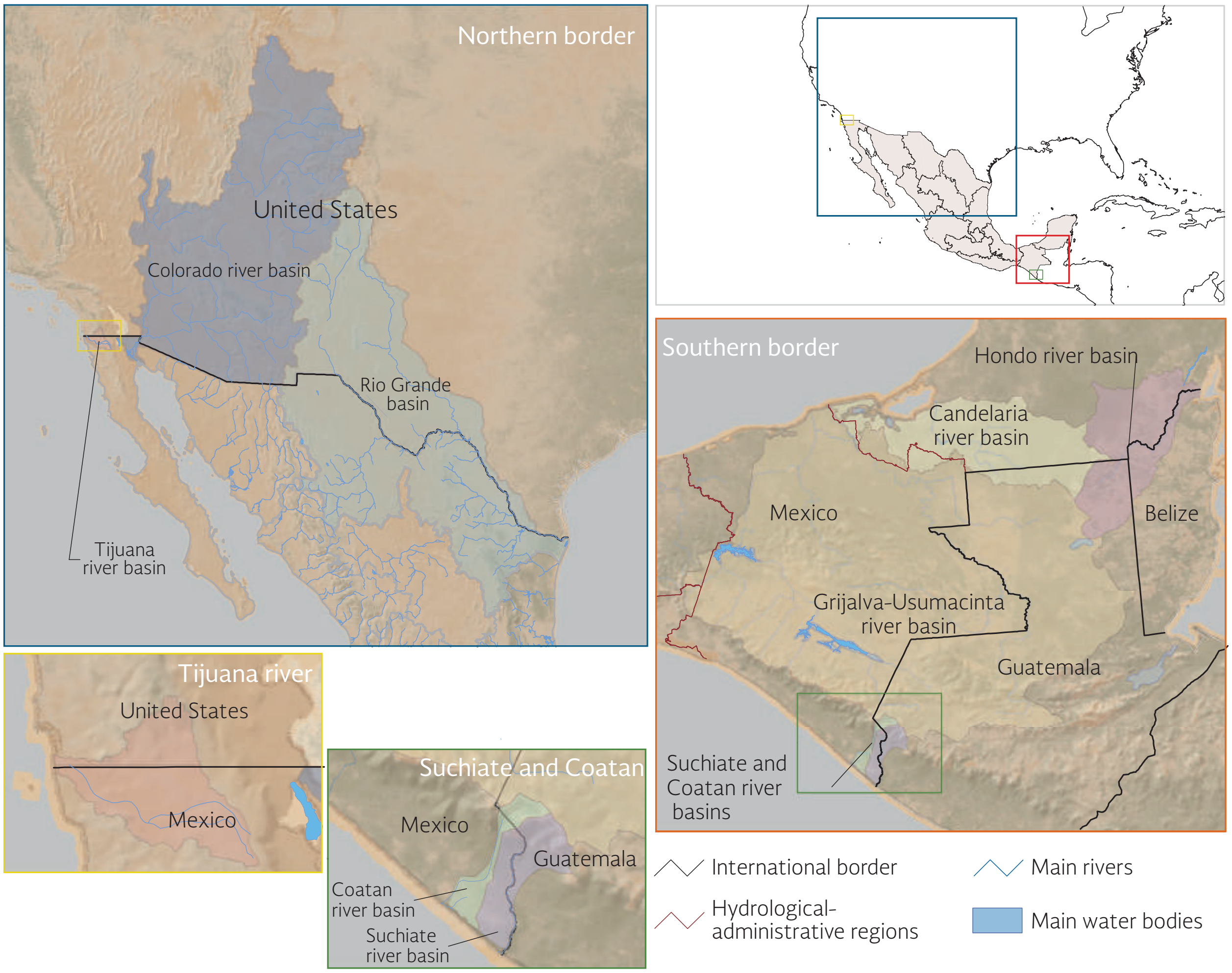
| Nº | River | HAR number | Country | Mean natural surface runoff (hm³/year) | Catchment area (km²) | Length of the river (km) |
|---|---|---|---|---|---|---|
| 1 | Suchiate | XI | Mexico | 291 | 203 | 75[a] |
| | | | Guatemala | 1 294 | 1 084 | 60 |
| 2 | Colorado | I | Mexico | 78 | 3 840 | 160 |
| | | | USA | 1 850* | 626 943 | 2 140 |
| | | | Bi-national | NA | NA | NA |
| 3 | Coatan | XI | Mexico | 642 | 605 | 75 |
| | | | Guatemala | 292 | 280 | 12 |
| 4 | Tijuana | I | Mexico | 78 | 3 231 | 186 |
| | | | USA | 17 | 1 221 | 9 |
| 5 | Grijalva-Usumacinta | XI | Mexico | 57 697 | 83 553 | 1 521 |
| | | | Guatemala | 43 820 | 44 837 | 390 |
| 6 | Bravo | VI | Mexico | 5 588 | 225 242 | NA |
| | | | USA | 74* | 241 697 | 1 074 |
| | | | Bi-national | NA | NA | 2 034 |
| 7 | Candelaria | XI | Mexico | 1 600 | 13 790 | 150 |
| | | | Guatemala | 261 | 1 558 | 8 |
| 8 | Hondo | XII | Mexico | 533 | 7 614 | 115[b] |
| | | | Guatemala | NA | 2 873 | 45 |
| | | | Belize | NA | 2 978 | 16 |

**Note:** [a] The 75 km belong to the border between Mexico and Guatemala. [b] The 115 km belong to the border between Mexico and Belize.

* Volumes delivered to Mexico. NA: Not Applicable.

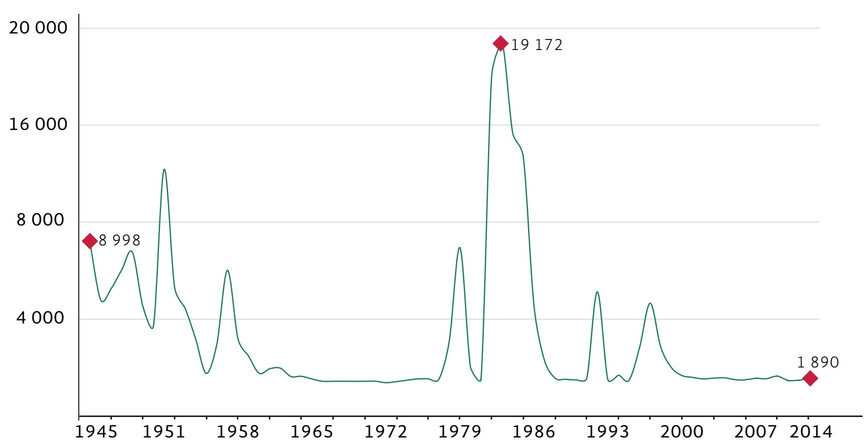
**Source**: Conagua (2015a).

**FIGURE 2.6** Transboundary catchments




**Source**: CONAGUA (2015a).

**GRAPH 2.3** Volume delivered in the Colorado river ($hm^3$)




**Source**: CONAGUA (2015a).

For the **Tijuana** River, the treaty only establishes that both countries, through the International Boundary and Water Commission (IBWC), will make recommendations for the equitable sharing of its waters; will draw up projects for storage infrastructure and flood control; and estimate the costs and build the infrastructure that is agreed upon, sharing the construction and operation costs equitably.

As regards the Rio **Grande** (called the Río Bravo in Mexico), table 2.10 describes the distribution of its waters as defined in the treaty.

Three considerations are established regarding the six Mexican channels previously referred to, which should be highlighted:

1. The volume that Mexico should provide to the United States of America, as part of the third of the volume in the six aforementioned Mexican channels, shall not be less on the whole, as an average amount and in cycles of five consecutive years, than 431.72 million cubic meters (350 000 acre feet) per year, the equivalent of supplying a minimum volume of 2.16 billion cubic meters (1 750 000 acre feet) in each cycle.

2. In the event of extraordinary drought or serious accident in the hydraulic systems on the measured Mexican tributaries, making it difficult for Mexico to make available the run-off of 431.72 million cubic meters annually, any shortfall existing at the end of the aforesaid five-year cycle shall be made up in the following five-year cycle with water from the aforementioned tributaries.

3. If the capacity assigned to the United States of America in the international reservoirs shared by both countries (La Amistad and Falcon) is filled with waters belonging to the United States, the five-year cycle shall be considered as terminated and all volumes pending delivery fully covered, whereupon a new five-year cycle shall commence.

In terms of the capacities in these reservoirs, the allocations by country are shown in table 2.11.

The minimum volume of each cycle is

**2.16**

billion cubic meters

**Table 2.10** Distribution of the waters in the Rio Grande according to the 1944 Treaty

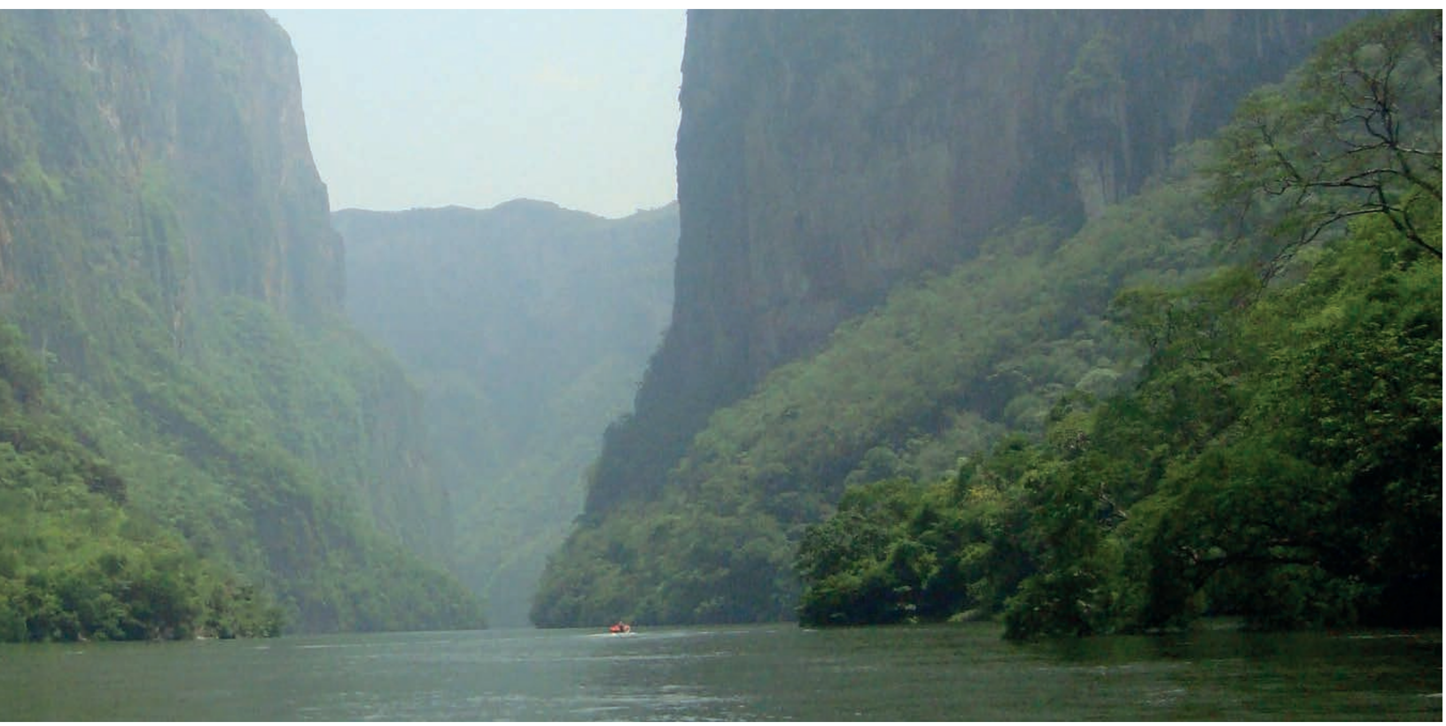
| The United Mexican States' share | The United States of America's share |
|---|---|
| All of the runoff from the San Juan and Alamo rivers | All of the runoff from the Pecos and Devils rivers, Goodenough spring and Alamito, Terlingua, San Felipe and Pinto streams. |
| Two thirds of the water that flows into the main channel of the Rio Grande from the following six Mexican channels: the Conchos, San Diego, San Rodrigo, Escondido and Salado rivers and the Las Vacas stream. | One third of the water that flows into the main channel of the Rio Grande from the following six Mexican channels: the Conchos, San Diego, San Rodrigo, Escondido and Salado rivers, and the Las Vacas stream. |
| One half of all unassigned flows in the Treaty that reach the main channel, between Quitman and Falcon. | One half of all unassigned flows in the Treaty that reach the main channel, between Quitman and Falcon. |
| One half of the runoff from the Rio Grande watershed, downstream from Falcon. | One half of the runoff from the Rio Grande watershed, downstream from Falcon. |

**Source**: IBWC (2015).

**Table 2.11** Capacities assigned in international reservoirs ($hm^3$)

| Country | La Amistad | Falcon |
|---|---|---|
| Mexico | 1 770 | 1 352 |
| United States of America | 2 271 | 1 913 |

**Source**: Conagua (2015a).



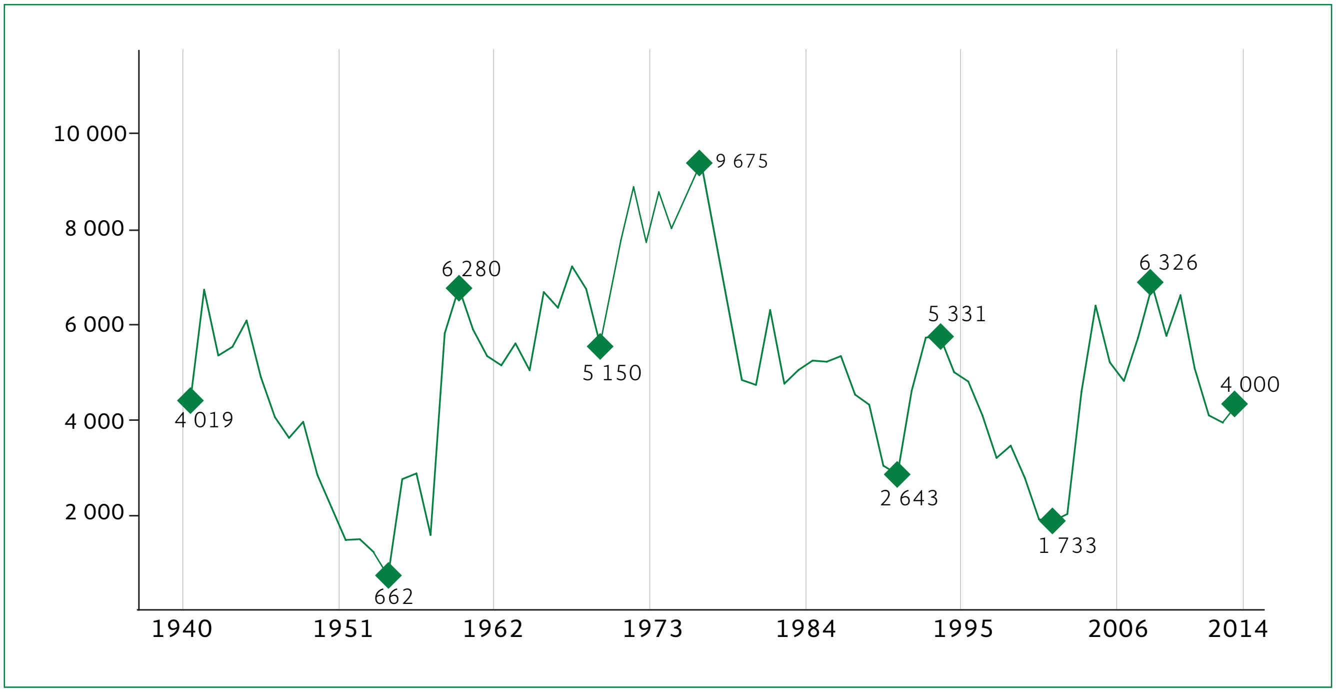
## Mexico's main lakes

[Reporteador: Lagos principales]

Figure 2.7 shows some of Mexico's main lakes in the central area of the country, according to the extension of their own catchment [Adicional: Table 2.C]. The data presented corresponds to the available hydrological studies and the catchment area corresponds to the water bodies' own catchment. Lake Chapala is the biggest inland lake in Mexico, with a depth that varies between four and six meters. Its importance lies in the fact that it constitutes one of the main sources of supply for the Metropolitan Area of Guadalajara. The behavior of its volumes stored per year is shown in graph 2.4.

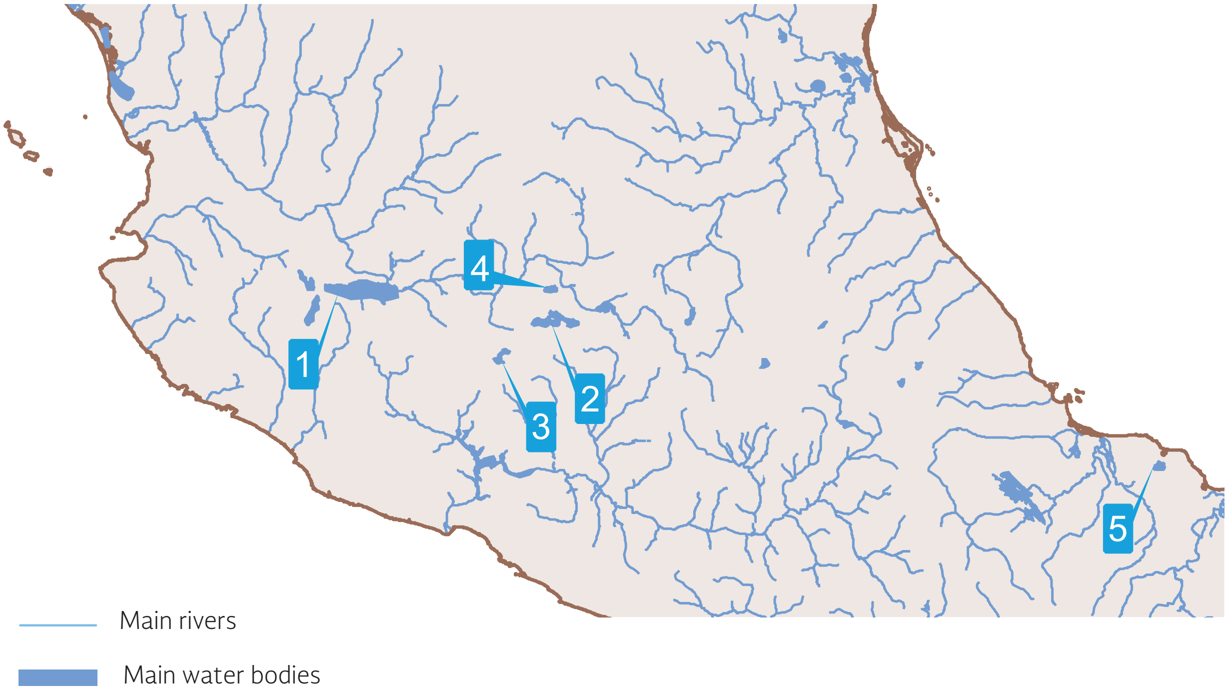
Lake **Chapala** has a
**1 116 km²**
catchment area

**Graph 2.4** Volume stored in Lake Chapala (hm³)




**Note**: The values indicated are as of December 31 each year.
**Source**: Conagua (2015a).

**Figure 2.7** Main lakes in the central area




| Number | Name | Catchment (km²) | Capacity (hm³) |
|---|---|---|---|
| 1 | Chapala | 1 116 | 8 126 |
| 2 | Cuitzeo | 306 | 920 |
| 3 | Patzcuaro | 97 | 550 |
| 4 | Yuriria | 80 | 188 |
| 5 | Catemaco | 75 | 454 |

**Source**: Conagua (2015a).

# 2.5 Groundwater

[Reporteador: Acuíferos]

Groundwater plays an increasingly important role in the country's socio-economic growth, due to its physical characteristics which allow it to be used for a number of different purposes, since it works as a storage dam and distribution network, it being possible to extract water at any point of the year from practically any point of the surface above the aquifer. It also works as a purifying filter, preserving water quality.

The importance of groundwater is manifest due to the magnitude of the volume employed by the main users. 38.7% of the total volume allocated for offstream uses (32.9 billion m$^3$ per year in 2014) comes from groundwater sources. As already mentioned, for the purpose of groundwater management, the country has been divided into 653 aquifers, the official names of which were published in the DOF on December 5, 2001.

From that point onwards a process of outlining and studying the aquifers initiated, in order to officially make their mean natural availability public, following the official Mexican standard NOM-011-CONAGUA-2000. As of December 31, 2014, the availability of groundwater in all 653 aquifers had been published in the DOF.[8] It is worth highlighting the publication on December 20, 2013 of the updated calculation of availability of all the nation's aquifers.

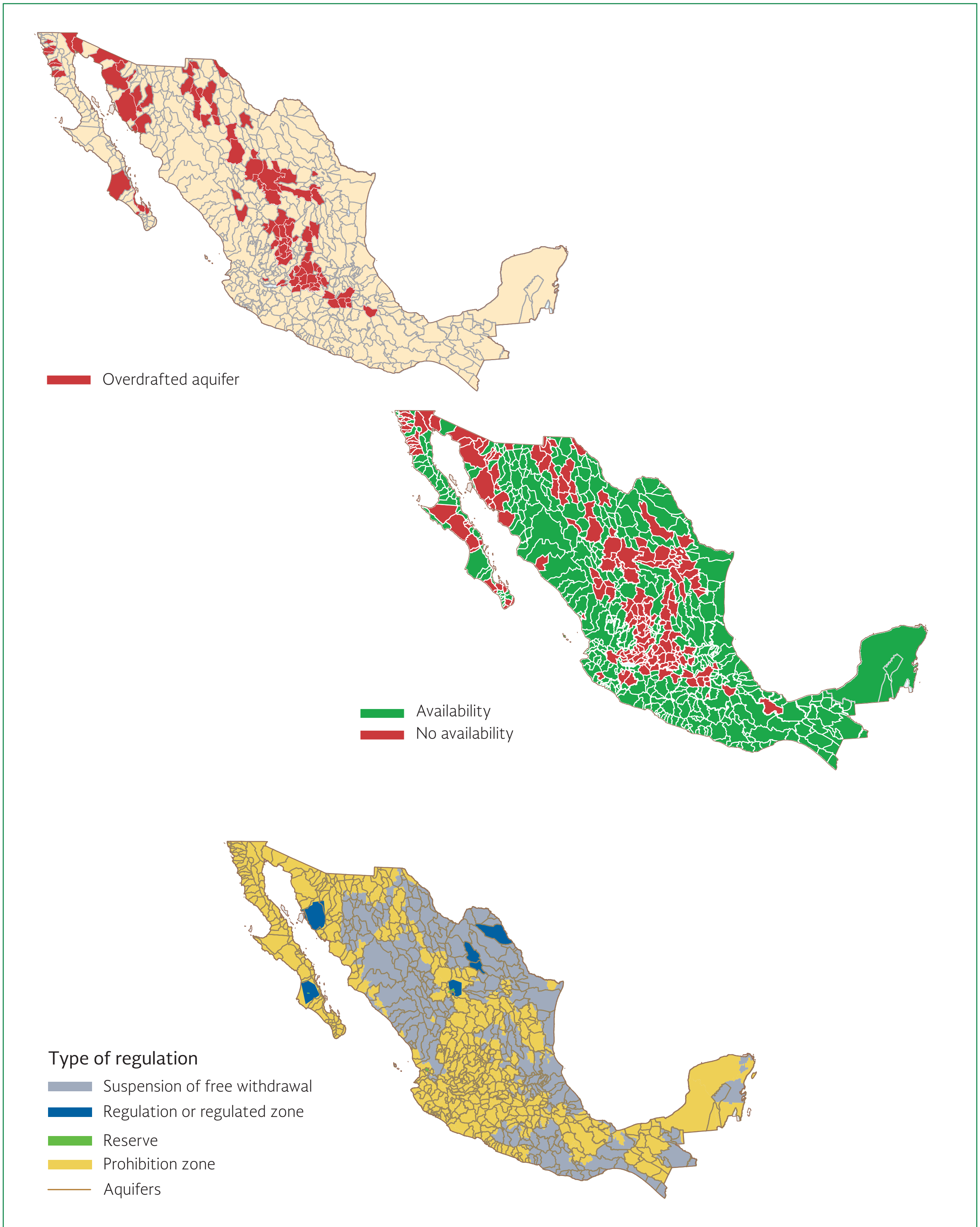
Availability is a basic indicator for the preservation of the resource through the management of the nation's water resources, through the instruments of concession or allocation of rights for the use of the nation's water resources, as well as regulatory measures for the use of aquifers such as prohibition zones, regulations, regulated zones and reserve zones (figure 2.8 and section 5.2 "Legal framework for the use of water in Mexico"). 458 aquifers in Mexico have a condition of availability.

## Overdrafting of aquifers

Based on the process of identification, outlining, studying and calculation of availability, which started in 2001, the number of overdrafted aquifers has varied every year from 100 to 106. As of December 31, 2014, it was reported that there were 106 overdrafted aquifers (figure 2.8). According to the results of

8 Availability of groundwater: The mean annual volume of groundwater that can be withdrawn from a hydrogeological unit for different uses, in addition to the extractions already allocated and the natural discharge committed, without jeopardizing the balance of ecosystems.

**FIGURE 2.8** Aquifers, 2014




**Source**: CONAGUA (2015a).

recent studies, it is defined whether aquifers are considered overdrafted or cease to be so, based on the **extraction/recharge** ratio. The statistics on aquifers are presented in table 2.12.

## Aquifers with saltwater intrusion and/or suffering from the phenomena of soil salinization and brackish groundwater

Soil salinization and the presence of brackish groundwater occur as a result of high indices of evaporation in areas with shallow groundwater levels, the dissolution of evaporite minerals and the presence of high-salinity connate water. Brackish water occurs specifically in those aquifers located in geological provinces characterized by sedimentary formations that are ancient, shallow, of marine origin and evaporite, in which the interaction of groundwater with the geological material produces the higher salt content.

Up to the end of 2014, 31 aquifers with the presence of saline soils and brackish water had been identified, mainly located in the Baja California Peninsula and in the Mexican Plateau, which combine conditions of limited precipitation, high indices of solar radiation and thus evaporation, as well as the presence of connate water and easily-dissolved evaporite minerals.

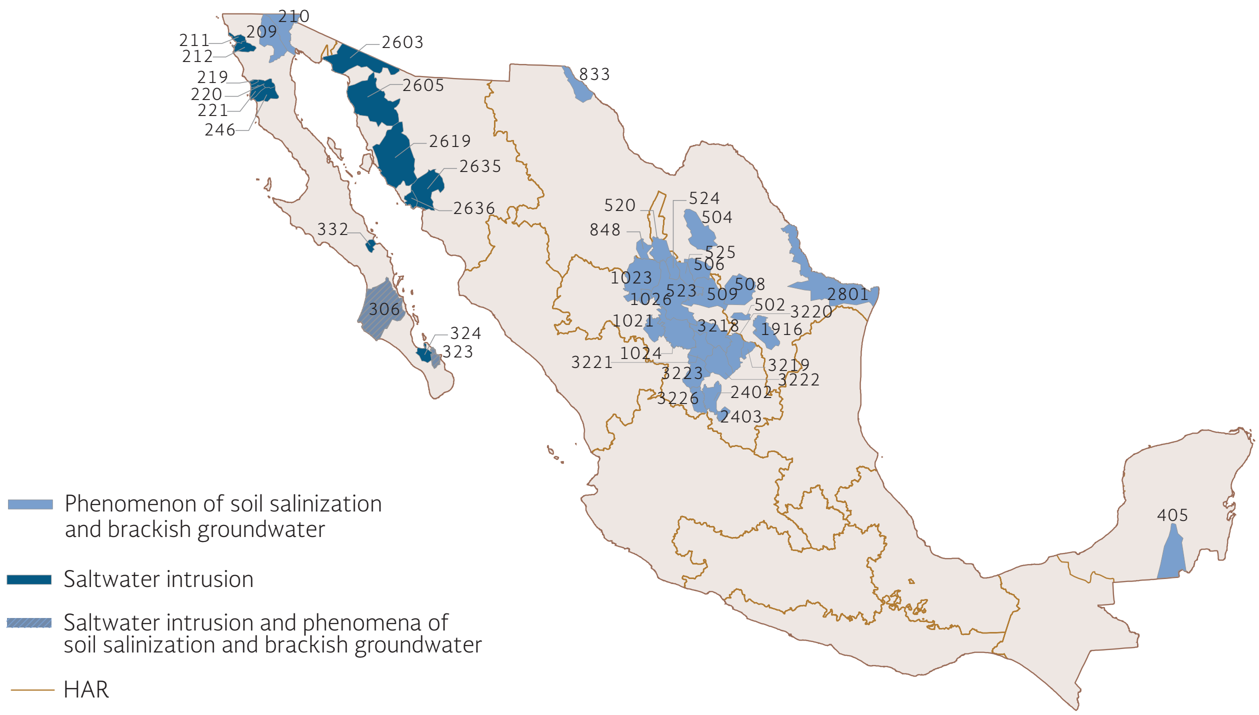
In the same year, saltwater intrusion had occurred in 15 coastal aquifers nationwide, as shown in figure 2.9.

**Table 2.12** Mexico's aquifers, 2014

| HAR | Number of aquifers | | | | Mean recharge (hm³) |
|---|---|---|---|---|---|
| | Total | Overdrafted | With saltwater intrusion | Under the phenomena of soil salinization and brackish groundwater | |
| I | 88 | 15 | 10 | 4 | 1 658 |
| II | 62 | 10 | 5 | | 3 207 |
| III | 24 | 2 | | | 3 076 |
| IV | 45 | 1 | | | 5 351 |
| V | 36 | | | | 1 936 |
| VI | 102 | 18 | | 8 | 5 900 |
| VII | 65 | 23 | | 18 | 2 320 |
| VIII | 128 | 32 | | | 9 670 |
| IX | 40 | 1 | | | 4 069 |
| X | 22 | | | | 4 705 |
| XI | 23 | | | | 22 718 |
| XII | 4 | | | 1 | 25 316 |
| XIII | 14 | 4 | | | 2 346 |
| **Total** | **653** | **106** | **15** | **31** | **92 271** |

**Source**: Conagua (2015a).

**FIGURE 2.9** Aquifers with saltwater intrusion and/or soil salinization and brackish groundwater, 2014




| Code | Aquifer |
|---|---|
| 209 | Salada Laguna |
| 210 | Mexicali Valley |
| 211 | Ensenada |
| 212 | Maneadero |
| 219 | Camalu |
| 220 | Colonia Vicente Guerrero |
| 221 | San Quintin |
| 246 | San Simon |
| 306 | Santo Domingo |
| 323 | Los Planes |
| 324 | La Paz |
| 332 | Mulege |
| 405 | Xpujil |
| 502 | Cyearn del Derramadero |
| 504 | Cuatrocienegas-Ocampo |
| 506 | El Hundido |
| 508 | Paredon |
| 509 | La Paila |
| 520 | Laguna del Rey-Sierra Mojada |
| 523 | Principal - Lagunera Region |
| 524 | Acatita |
| 525 | Las Delicias |

| Code | Aquifer |
|---|---|
| 833 | Juarez Valley |
| 848 | Palomas Laguna |
| 1021 | Pedriceña-Velardeña |
| 1023 | Ceballos |
| 1024 | Oriente Aguanaval |
| 1026 | Vicente Suarez |
| 1916 | Navidad-Potosi-Raices |
| 2402 | El Barril |
| 2403 | Salinas de Hidalgo |
| 2603 | Sonoyta-Puerto Peñasco |
| 2605 | Caborca |
| 2619 | Hermosillo Coast |
| 2635 | Guaymas Coast |
| 2636 | San Jose de Guaymas |
| 2801 | Lower Rio Grande |
| 3218 | Cedros |
| 3219 | El Salvador |
| 3220 | Guadalupe Garzaron |
| 3221 | Camacho |
| 3222 | El Cardito |
| 3223 | Guadalupe de las Corrientes |
| 3226 | Chupaderos |

**Source**: Produced based on CONAGUA (2015a).

# 2.6 Water quality

[Reporteador: Calidad del agua, Sitios fuertemente contaminados, Calidad del agua en playas]

## Monitoring of water quality

In 2014, the National Monitoring Network had 5 000 sites, distributed throughout the country, as described in table 2.13.

In addition to the physical-chemical and microbiological parameters monitored by the network, biological monitoring has been carried out since 2005 in some regions of the country, which allows water quality to be evaluated, using simple low-cost methods, such as the benthic organism diversity index. The results of these activities as of 2014 are shown in table 2.15.

## Evaluation of water quality

The evaluation of water quality is carried out by using three indicators: five-day Biochemical Oxygen Demand ($BOD_5$), Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS).

$BOD_5$ and COD are used to determine the quantity of organic matter present in water bodies, mainly from municipal and non-municipal wastewater discharges.

$BOD_5$ determines the quantity of biodegradable organic matter, whereas COD measures the total quantity of organic matter. The increase in the concentration of these parameters has an impact on the decrease of the dissolved oxygen content in water bodies with the consequent affectation of aquatic ecosystems.

Additionally, the increase in COD indicates the presence of substances coming from non-municipal discharges.

TSS originate in wastewater and soil erosion. The increase in the levels of TSS results in the water body losing its capacity to support the diversity of aquatic life. These parameters allow gradients to be recognized that vary from a relatively normal condition or with no influence of human activity, to water that shows significant signs of municipal and non-municipal wastewater discharges, as well as areas with severe deforestation.

In 2014, the National Monitoring Network had

**5 000**

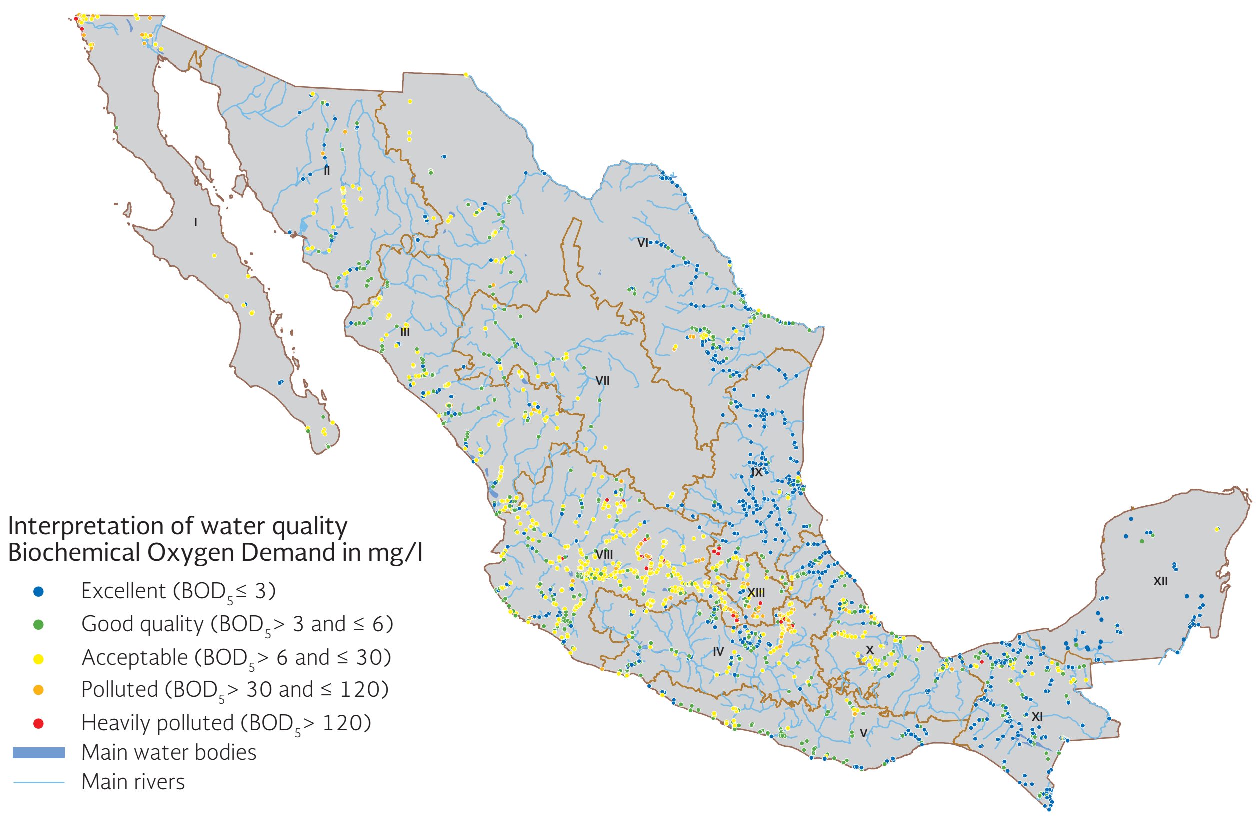
**sites**

**Table 2.13** Sites in the National Monitoring Network, 2014

| Network | Area | Sites (number) |
|---|---|---|
| Surface water | Surface water bodies | 2 514 |
| Groundwater | Groundwater bodies | 1 084 |
| Special studies | Surface water bodies | 35 |
| | Groundwater bodies | 0 |
| Coastal | Coastal zones | 1 053 |
| Surface water discharges | | 301 |
| Groundwater discharges | | 13 |
| **Total** | | **5 000** |

**Source:** Conagua (2015a).

## **Map 2.6** Water quality: Biochemical Oxygen Demand ($BOD_5$), 2014




**Source**: Conagua (2015a).

## **Table 2.14** Percentage distribution of monitoring sites in surface water bodies by HAR, according to the $BOD_5$ indicator, 2014

| HAR number | Excellent | Good quality | Acceptable | Polluted | Heavily polluted |
|---|---|---|---|---|---|
| I | 3.9 | 10.5 | 51.3 | 28.9 | 5.3 |
| II | 31.5 | 31.5 | 34.2 | 2.7 | 0.0 |
| III | 18.4 | 32.5 | 48.1 | 1.0 | 0.0 |
| IV | 25.1 | 28.0 | 28.7 | 13.7 | 4.6 |
| V | 32.4 | 46.5 | 19.0 | 2.1 | 0.0 |
| VI | 45.5 | 35.2 | 16.8 | 2.5 | 0.0 |
| VII | 15.2 | 47.8 | 37.0 | 0.0 | 0.0 |
| VIII | 9.4 | 23.4 | 57.2 | 6.6 | 3.4 |
| IX | 74.5 | 11.9 | 11.1 | 1.2 | 1.2 |
| X | 26.5 | 30.1 | 36.1 | 6.4 | 0.8 |
| XI | 62.0 | 26.0 | 10.4 | 1.2 | 0.4 |
| XII | 90.6 | 7.5 | 1.9 | 0.0 | 0.0 |
| XIII | 13.4 | 32.0 | 35.1 | 17.5 | 2.1 |
| **National** | **31.4** | **27.1** | **33.6** | **6.0** | **1.8** |

**Source**: Conagua (2015a).

It should be mentioned that the water quality monitoring sites are situated in areas with a high anthropogenic influence. The water quality classification scale is shown in [Adicional: Table 2.D].

The evaluation for 2014 of the water quality indicators was carried out according to the terms established in table 2.16, with the results recorded in maps 2.6, 2.7 and 2.8 and tables 2.14, 2.17 and 2.18.

According to the results of the water quality evaluations of the three indicators ($BOD_5$, COD and TSS) applied to the monitoring sites in 2014, it was determined that 187 sites were classified as heavily polluted in one, two or all three of these indicators. These sites are shown in map 2.9 [Adicional: Table 2.E].

**187**

sites are **heavily polluted**

**Table 2.15** Samples for biological monitoring, 2014

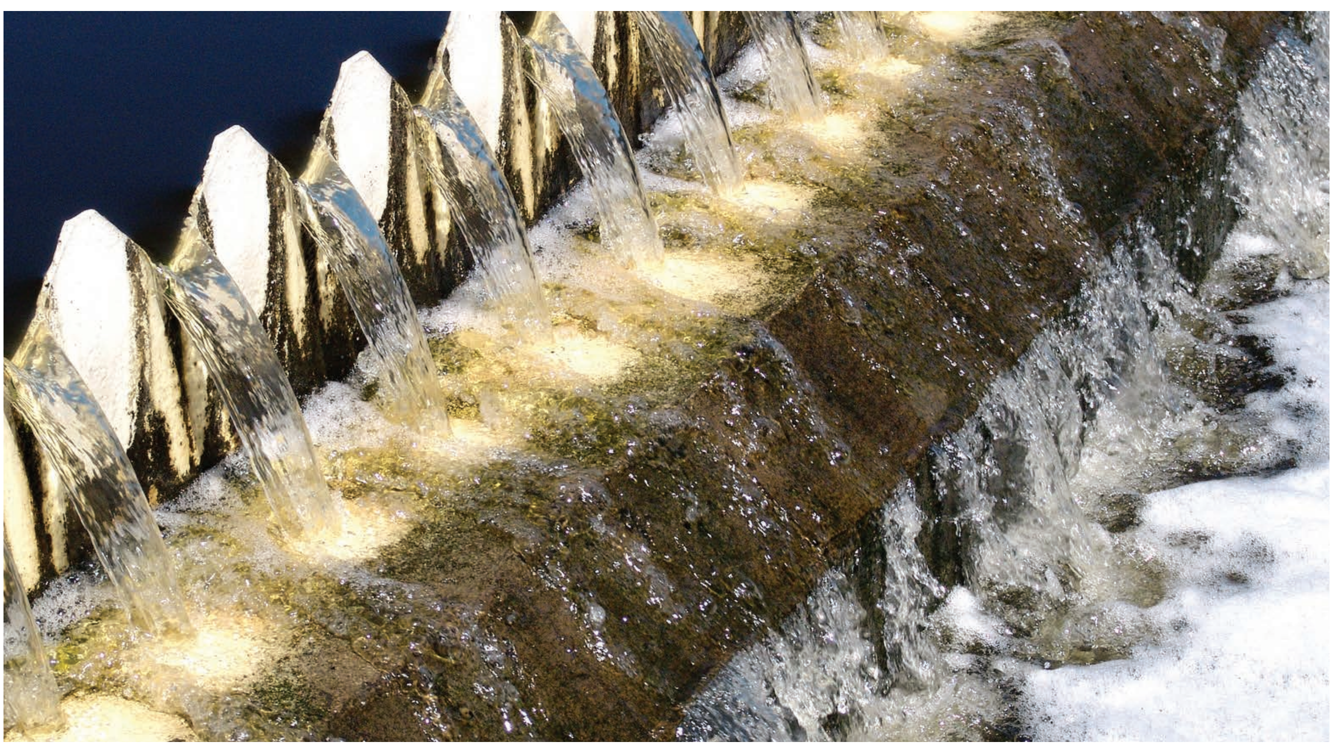
| | HAR | Number of samples |
|---|---|---|
| IV | Balsas | 98 |
| VI | Rio Bravo | 3 |
| VII | Central Basins of the North | 10 |
| IX | Northern Gulf | 3 |
| X | Central Gulf | 5 |
| **Total** | | **119** |

**Source**: Conagua (2015a).

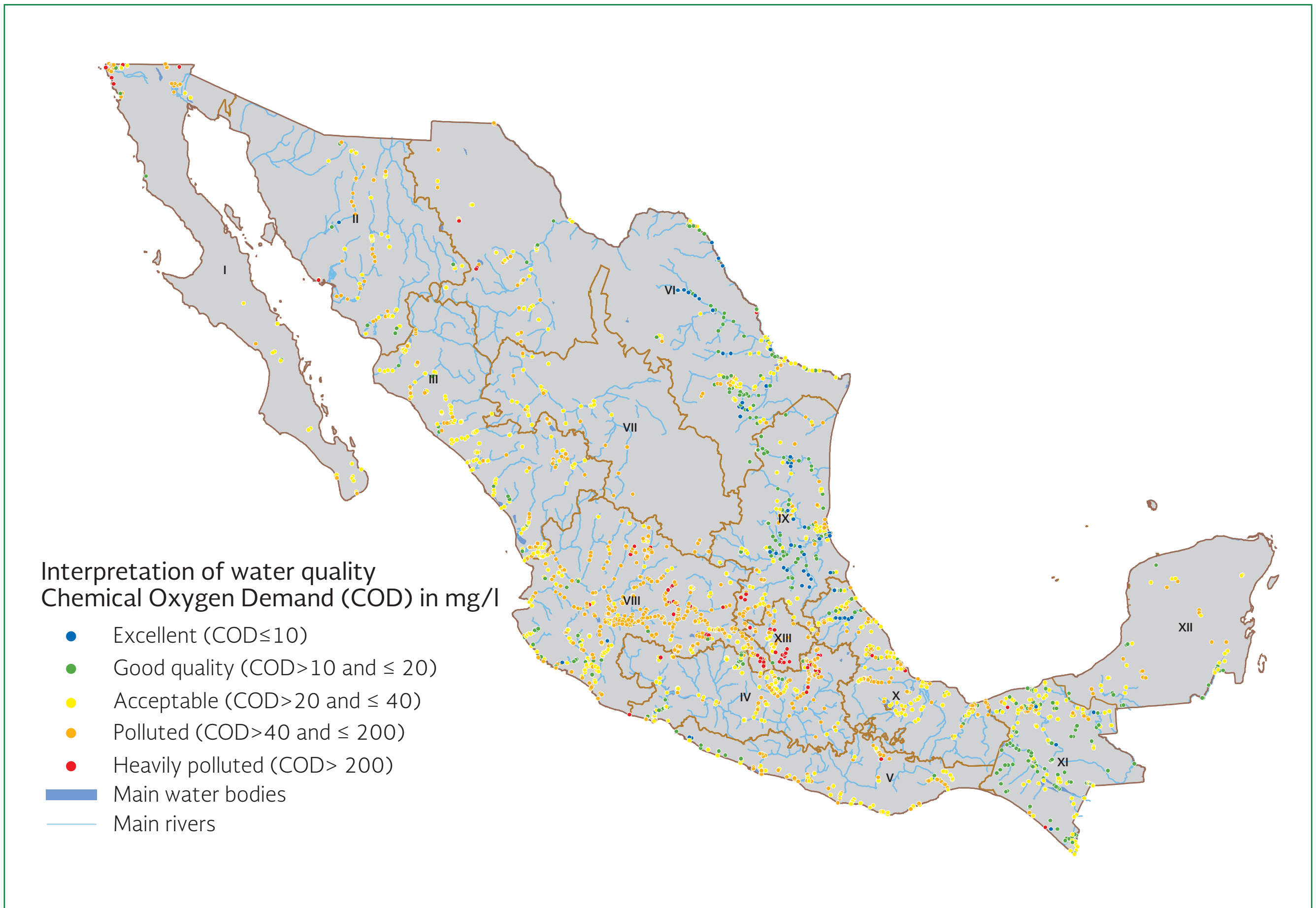
**Table 2.16** Number of monitoring sites with data for each water quality indicator, 2014

| Water quality indicator | Number of monitoring sites |
|---|---|
| Biochemical Oxygen Demand ($BOD_5$) | 2 636 |
| Chemical Oxygen Demand (COD) | 2 635 |
| Total Suspended Solids (TSS) | 3 607 |

**Source**: Conagua (2015a).



**Map 2.7** Water quality: Chemical Oxygen Demand (COD), 2014




**Source**: Conagua (2015a).

**Table 2.17** Percentage distribution of monitoring sites in surface water bodies by hydrological-administrative region, according to the COD indicator, 2014

| HAR number | Excellent | Good quality | Acceptable | Polluted | Heavily polluted |
|---|---|---|---|---|---|
| I | 1.3 | 10.5 | 32.9 | 44.7 | 10.5 |
| II | 1.4 | 9.6 | 45.2 | 42.5 | 1.4 |
| III | 0.0 | 7.3 | 61.2 | 31.6 | 0.0 |
| IV | 1.3 | 13.0 | 35.5 | 38.4 | 11.7 |
| V | 1.4 | 9.2 | 41.5 | 47.2 | 0.7 |
| VI | 10.2 | 27.0 | 39.3 | 20.9 | 2.5 |
| VII | 0.0 | 0.0 | 56.5 | 43.5 | 0.0 |
| VIII | 1.5 | 4.8 | 21.2 | 65.7 | 6.8 |
| IX | 14.9 | 31.8 | 30.2 | 21.1 | 2.1 |
| X | 3.2 | 8.4 | 40.6 | 44.6 | 3.2 |
| XI | 4.0 | 44.8 | 38.8 | 11.2 | 1.2 |
| XII | 0.0 | 34.0 | 41.5 | 24.5 | 0.0 |
| XIII | 0.0 | 1.0 | 34.0 | 43.3 | 21.6 |
| **National** | **3.7** | **15.5** | **35.6** | **40.2** | **5.0** |

**Source**: Conagua (2015a).

## Summary of water quality

Up to 2014 there were 5 000 sites of water quality monitoring, the result of a trend in recent years to increasing this measurement, as can be observed in graph 2.5.

For the 2011-2014 period, the water quality results are presented regionally, summarized in table 2.19, which indicates for each hydrological-administrative region, parameter ($BOD_5$, COD or TSS), and year, the observations with the interpretation of water quality (excellent, good quality, acceptable, polluted and heavily polluted) through a mini graph, as well as the total number of observations with data. Figure 2.10 has an example of the interpretation of table 2.19 data.

## Groundwater quality

One of the parameters that allows groundwater salinization to be evaluated is the total solids. According to their concentration, groundwater is classified as fresh (<1 000 mg/l), slightly brackish (1 000-2 000 mg/l), brackish (2 000-10 000 mg/l) and saline (>10 000 mg/l).

The limit between freshwater and slightly brackish water coincides with the maximum concentration indicated by the modification of the official Mexican standard NOM-127-SSA1-1994, which "establishes the maximum permissible limits that water should comply with for human consumption and treatment as regards water quality for human consumption".

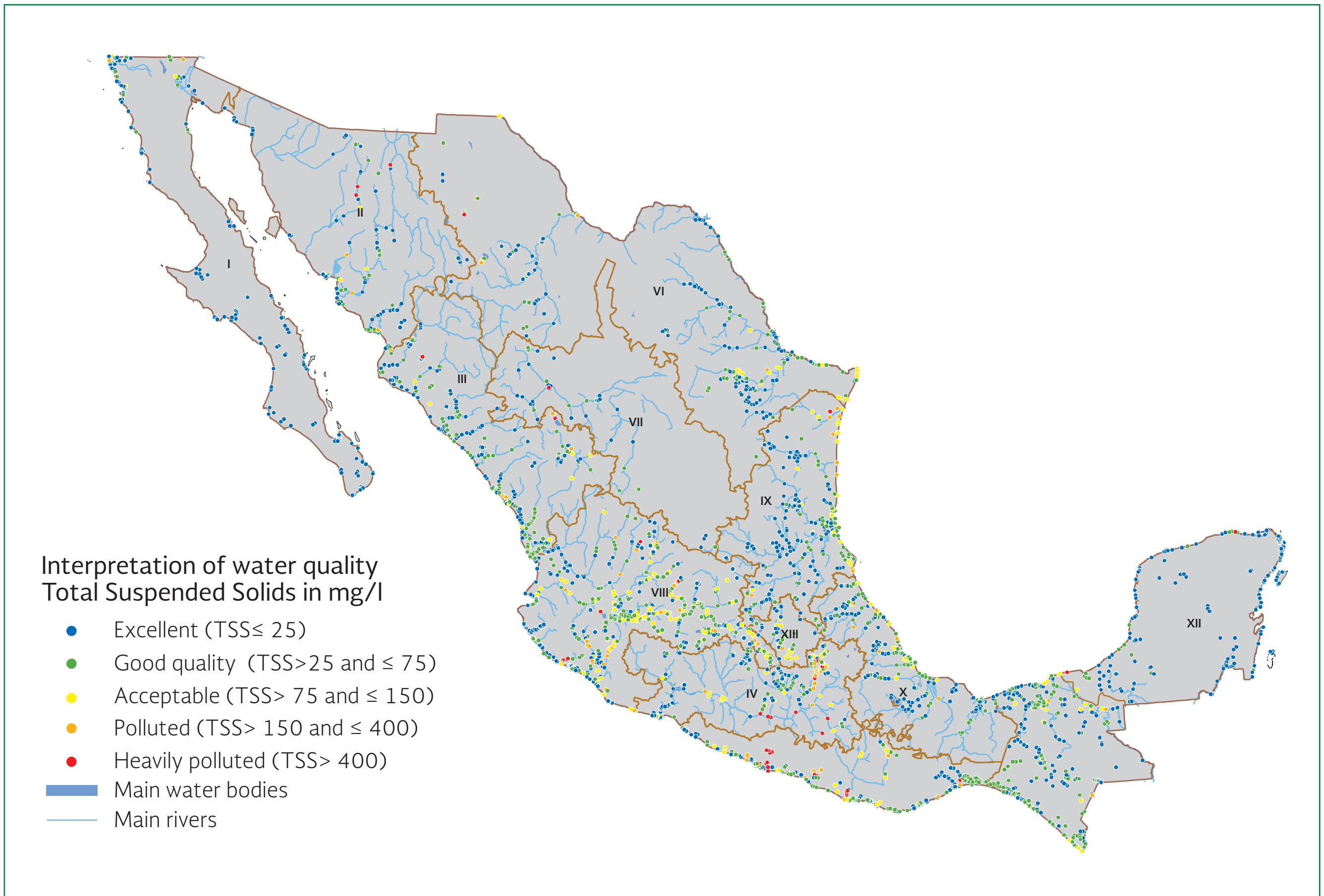
## Water quality on beaches

Through the Clean Beach Program, the cleaning up of beaches and their associated catchments and aquifers is promoted. The finality of the program is to prevent and redress the pollution of Mexico's beaches, respecting the native ecology, making them competitive as well as raising the quality and standard of living of the local population, and increasing tourism.

For the development of the program, clean beach committees have been set up, which are chaired by the President of the municipality and have the active presence of representatives of Semarnat, Profepa, Semar, Sectur, Cofepris and the Conagua, as well as representatives of associations and the private sector.

In order to evaluate water quality on beaches, the bacteriological indicator of *enterococcus faecalis* is used, which is considered the most efficient means of evaluating seawater quality for first-contact recreational use.

**MAP 2.8** Water quality: Total Suspended Solids (TSS), 2014




**Source**: CONAGUA (2015a).

**TABLE 2.18** Percentage distribution of monitoring sites in surface water bodies by hydrological-administrative region, according to the TSS indicator, 2014

| HAR number | Excellent | Good quality | Acceptable | Polluted | Heavily polluted |
|---|---|---|---|---|---|
| I | 79.2 | 12.9 | 3.0 | 4.5 | 0.5 |
| II | 63.0 | 24.4 | 3.9 | 5.5 | 3.1 |
| III | 49.7 | 40.5 | 3.6 | 4.6 | 1.6 |
| IV | 51.9 | 20.3 | 12.7 | 10.4 | 4.7 |
| V | 33.8 | 46.9 | 6.1 | 6.4 | 6.7 |
| VI | 56.1 | 29.0 | 10.2 | 3.5 | 1.2 |
| VII | 69.6 | 28.3 | 0.0 | 0.0 | 2.2 |
| VIII | 41.2 | 34.5 | 15.7 | 7.5 | 1.2 |
| IX | 60.5 | 25.7 | 10.1 | 3.4 | 0.3 |
| X | 50.5 | 39.2 | 6.8 | 3.2 | 0.3 |
| XI | 45.8 | 46.4 | 6.3 | 1.4 | 0.0 |
| XII | 89.1 | 9.4 | 0.5 | 0.0 | 1.0 |
| XIII | 51.5 | 30.9 | 14.4 | 2.1 | 1.0 |
| **National** | **52.2** | **32.3** | **8.7** | **4.9** | **1.9** |

**Source**: CONAGUA (2015a).

For the above reason, the Ministry of Health, in accordance with studies carried out by the World Health Organization (WHO), determined that a level of enterococcus of 200 MLN[9]/100 ml is considered the maximum limit for recreational use.

## Water quality classification criteria on beaches:

• 0-200 MLN/100 ml, the beach is considered SUITABLE for recreational use.

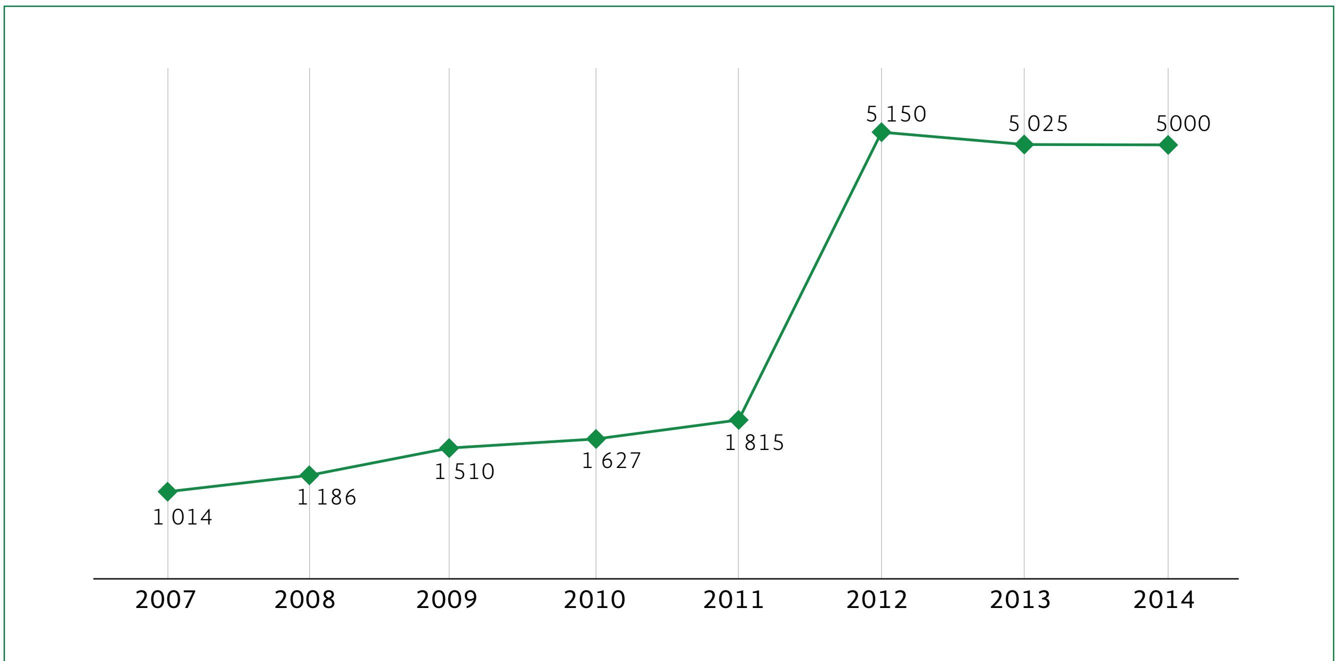
• > 200 MLN/100 ml, the beach is considered UNSUITABLE for recreational use.

According to the findings in the National Information System on Water Quality on Mexican Beaches, the bacteriological monitoring on beaches, carried out by the Ministry of Health through its state representations and published on the website of Cofepris, water quality on Mexico's beaches tended to improve between 2005 and 2014, as shown in graph 2.6. For 2014, the graph shows the data corresponding to the latest monitoring campaign from that year.

In map 2.10 bacteriological quality on beaches of tourist destinations is shown for 2014.

A level of enterococcus of **200 MLN/100 ml** is considered the maximum limit for recreational use

**Graph 2.5** Stations of the National Monitoring Network, 2007-2014



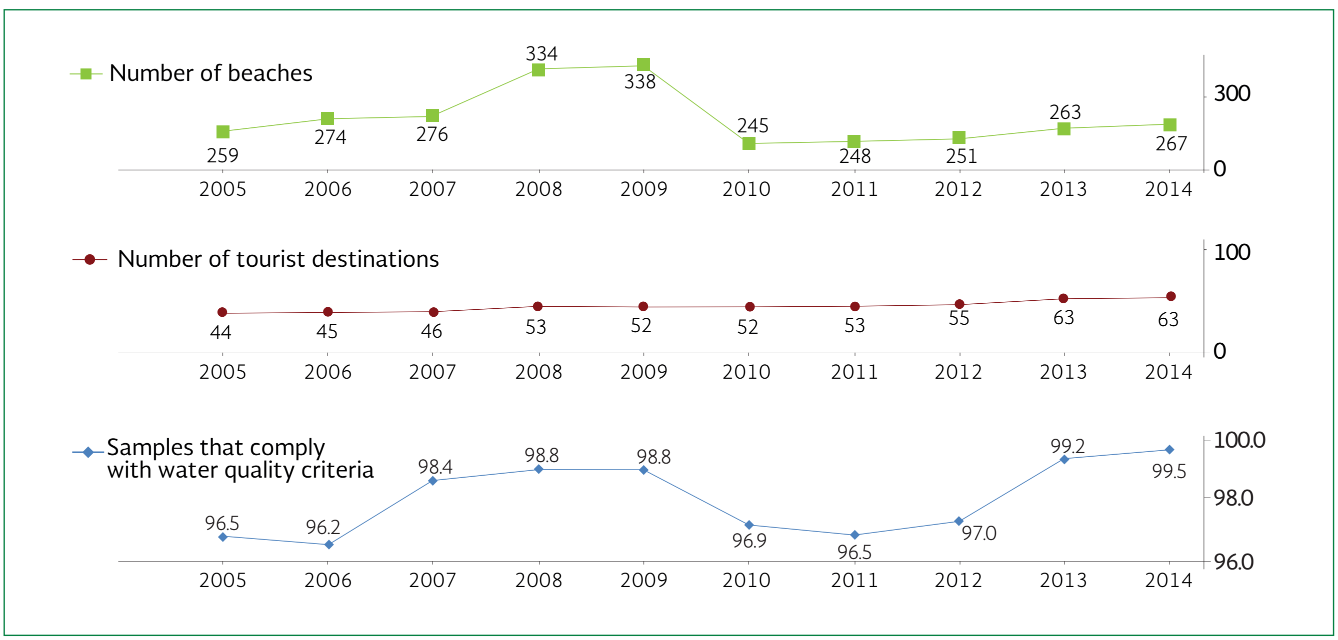

**Source**: Conagua (2015a).

9 MLN (most likely number).

**Map 2.9** Monitoring sites classified as heavily polluted for $BOD_5$, COD and/or TSS, 2014


**Source**: Conagua (2015a).

**Graph 2.6** Results of the water quality monitoring program on beaches, 2005-2014

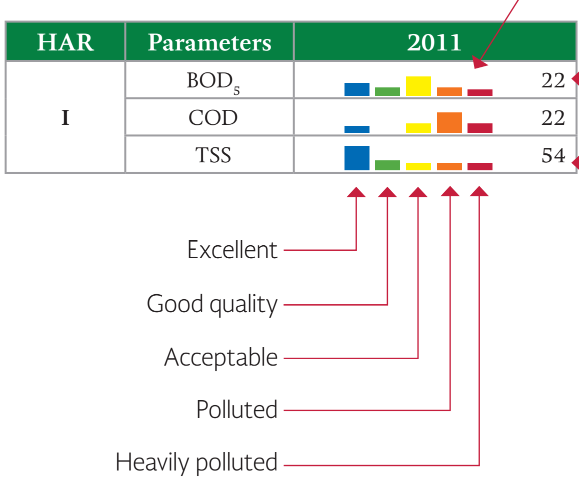



**Source**: Semarnat et al. (2015).

## **Map 2.10** Bacteriological quality in beaches, 2014


**Source**: Conagua (2015a).

## **Figure 2.10** Code to interpret table 2.19



| HAR | Parameters | 2011 |
|---|---|---|
| I | $BOD_5$ | 22 |
| | COD | 22 |
| | TSS | 54 |



Mini graph of results of observations. Shows the proportions of the results as regards the total of observations in the year, for the hydrological-administrative region, the quality parameter and the year in question.

Total number of observations for the quality parameter in the hydrological-administrative region and the year in question.

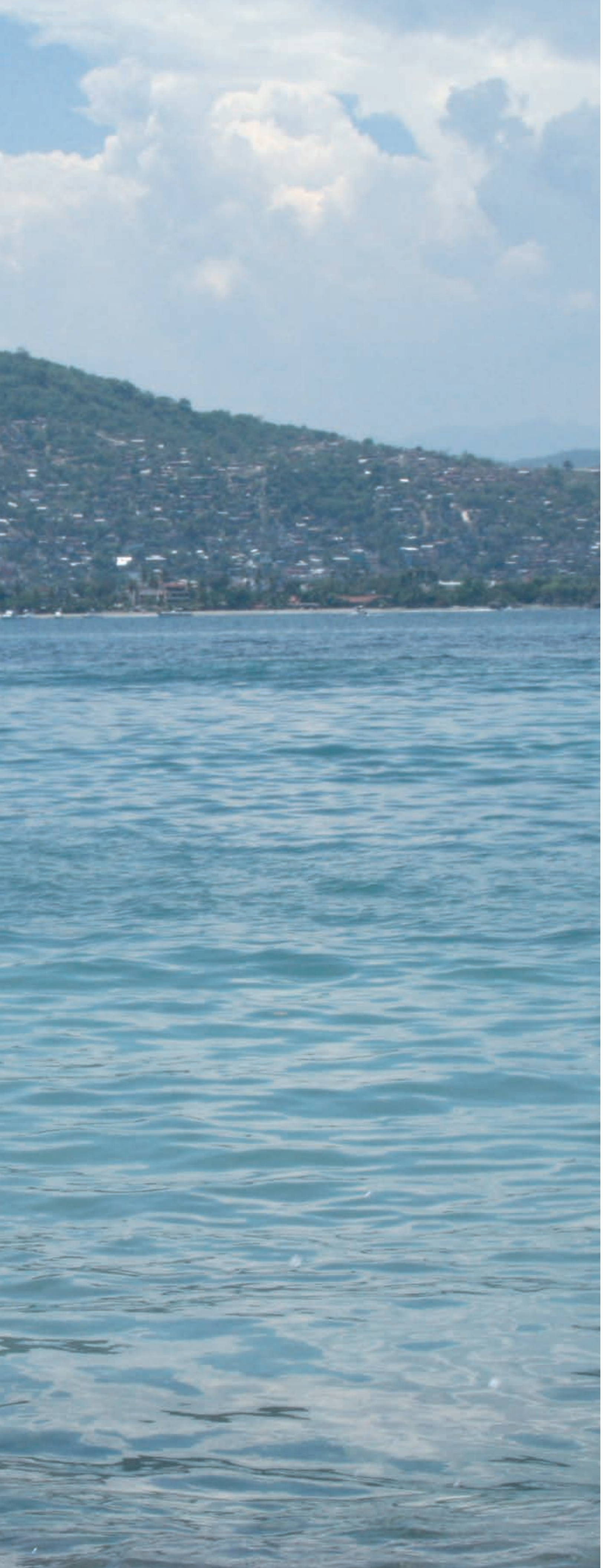
Example: for hydrological-administrative region I Baja California, in 2011, there were 54 observations for the TSS parameter, the majority of which were interpreted as Excellent. The second most numerous group was Good quality. There were approximately the same number of observations interpreted as Acceptable, Polluted and Heavily polluted.

**Source**: Conagua (2015b).

## Table 2.19 Summary of water quality 2011-2014

| HAR number | Parameter | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| I | $BOD_5$ | 13 | 85 | 84 | 76 |
| | COD | 18 | 85 | 84 | 76 |
| | TSS | 45 | 239 | 210 | 202 |
| II | $BOD_5$ | 36 | 71 | 76 | 73 |
| | COD | 53 | 71 | 76 | 73 |
| | TSS | 52 | 116 | 128 | 127 |
| III | $BOD_5$ | 41 | 195 | 215 | 206 |
| | COD | 30 | 184 | 215 | 206 |
| | TSS | 41 | 269 | 303 | 306 |
| IV | $BOD_5$ | 179 | 337 | 312 | 307 |
| | COD | 180 | 338 | 312 | 307 |
| | TSS | 184 | 349 | 325 | 316 |
| V | $BOD_5$ | 0 | 116 | 122 | 142 |
| | COD | 71 | 142 | 122 | 142 |
| | TSS | 84 | 373 | 361 | 358 |
| VI | $BOD_5$ | 81 | 221 | 286 | 244 |
| | COD | 88 | 222 | 287 | 244 |
| | TSS | 88 | 233 | 293 | 255 |
| VII | $BOD_5$ | 20 | 43 | 46 | 46 |
| | COD | 20 | 43 | 46 | 46 |
| | TSS | 20 | 44 | 46 | 46 |
| VIII | $BOD_5$ | 160 | 672 | 639 | 650 |
| | COD | 165 | 671 | 641 | 650 |
| | TSS | 179 | 773 | 733 | 746 |
| IX | $BOD_5$ | 43 | 235 | 242 | 243 |
| | COD | 57 | 235 | 243 | 242 |
| | TSS | 57 | 306 | 292 | 296 |
| X | $BOD_5$ | 54 | 238 | 249 | 249 |
| | COD | 46 | 232 | 249 | 249 |
| | TSS | 54 | 285 | 306 | 309 |
| XI | $BOD_5$ | 33 | 253 | 256 | 250 |
| | COD | 34 | 256 | 256 | 250 |
| | TSS | 33 | 350 | 353 | 347 |
| XII | $BOD_5$ | 22 | 67 | 53 | 53 |
| | COD | 22 | 67 | 53 | 53 |
| | TSS | 37 | 225 | 199 | 202 |
| XIII | $BOD_5$ | 20 | 55 | 67 | 97 |
| | COD | 20 | 55 | 67 | 97 |
| | TSS | 20 | 55 | 67 | 97 |
| Nal. | $BOD_5$ | 702 | 2588 | 2647 | 2636 |
| | COD | 804 | 2601 | 2651 | 2635 |
| | TSS | 894 | 3617 | 3616 | 3607 |

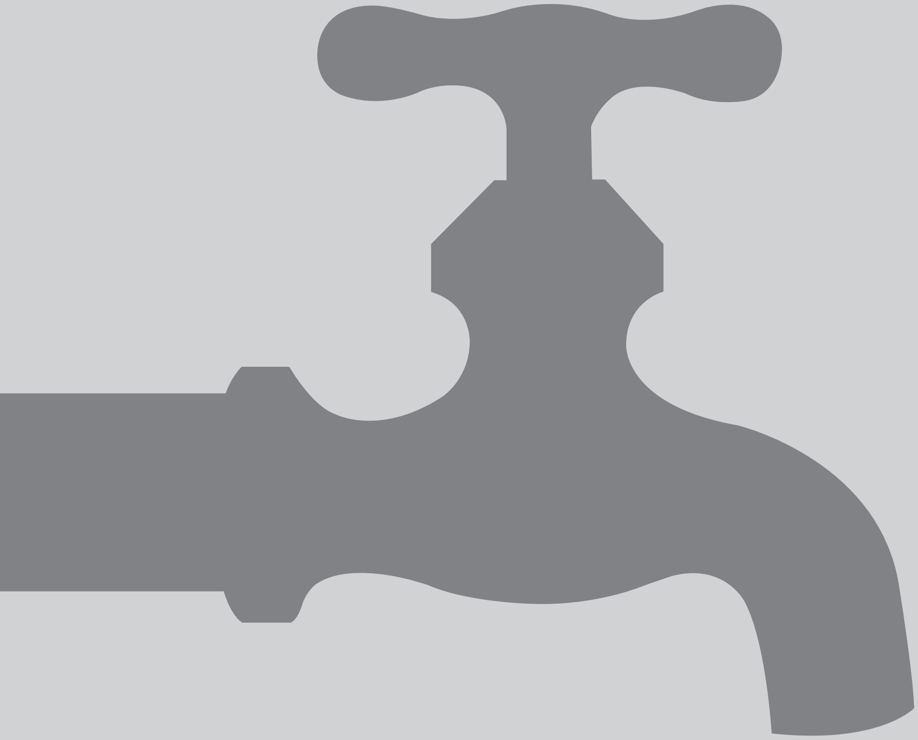
**Source**: Produced based on Conagua (2015a).



# Chapter 3

Uses of water

# Uses of water



## Uses in Mexico

### Classification

**Offstream**

Difference between the volume extracted and the discharge once an activity has been completed

**Instream**

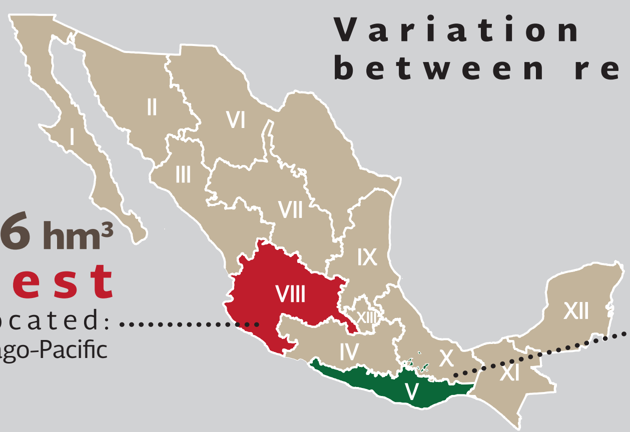
The activity does not modify the volume

### Sources

Surface water:
**61.3%**
of offstream uses

Groundwater:
**38.7%**
of offstream uses

### Variation between regions




**15 291.6 hm³**
**Greatest**
volume allocated:
**VIII** Lerma-Santiago-Pacific

**1 539.4 hm³**
**Lowest**
volume allocated:
**V Southern Pacific**

## Grouped offstream uses

| Agriculture | Public supply | Self-supplying industry | Energy generation excluding hydropower |
|---|---|---|---|
| 76.7% | 14.2% | 4.2% | 4.9% |

# Water and the economy

## Environmental and economic accounting

- Relates the environment with the economy
- Facilitates comparisons and decision makings

### Virtual water

Quantity of water employed in the productive process of a good

Virtual water exchanges due to product trade

**Mexico:**
Net importer of virtual water
**22 259 hm³**
in 2014

## Degree of water stress

Volume allocated for offstream uses / Renewable water resources

More than **40%** is considered a **high** or **very high** degree of water stress

**Mexico:** **19%** (low)

**Regions:**

| Highest stress | Lowest stress |
|---|---|
| XIII Waters of the Valley of Mexico | XI Southern Border |
| **138%** (Very high) | **1.6%** (No stress) |

# 3.1 Classification of the uses of water

[Reporteador: Usos del agua]

Water is used in different ways in all human activities, be it to meet basic needs or to produce and exchange goods and services.

The volumes allocated or assigned[1] to the users of the nation's water are registered in the Public Registry of Water Duties (Repda). The Repda has the uses of water classified in different categories. In this chapter, the term **grouped use** will be used, with the categorization shown in table 3.1, which also distinguishes between **offstream** and **instream** uses.[2] It should be mentioned that in 2014, a new instream use was added: ecological conservation, with a volume allocated of 9.46 $hm^3$/year.

Throughout this chapter, the data on volumes allocated for 2014 are those as of December 31, 2014. It should be mentioned that the regionalization of volumes was carried out based on the location of the use as registered in the Repda, rather than the jurisdictional area of the respective deeds.

Graph 3.1 shows the evolution in the volume allocated for offstream uses, in the period from 2005 to 2014. As may be appreciated, 61.3% of the water used for offstream uses comes from surface water sources (rivers, streams and lakes), whereas the remaining 38.7% corresponds to groundwater sources (aquifers). There are both increases and decreases in the volumes allocated throughout time. Compared to 2005, the first year in the graph, in 2014 the volume of surface water allocated was 18.6% higher, whereas the groundwater allocated was 6.7% higher.

**1** In the case of volumes destined for public urban or domestic use.

**2** Offstream use: The volume of water of a given quality that is consumed during the implementation of a specific activity, and which is determined as the difference between the volume of a given quality that is extracted, minus the volume of a given quality that is discharged, and which is shown in the respective deed (National Water Law).

The greatest volume allocated for offstream uses is for the grouped use for agriculture, mainly for irrigation, as can be observed in table 3.2 and graph 3.2. It is also important to mention that Mexico is one of the countries with the most substantial irrigation infrastructures in the world (see chapters 4 and 8).

As regards hydropower generation, which represent an instream use of water resources, 133.0 billion cubic meters of water (or 133 km³) were used nationwide in 2014. It should be pointed out that, for this use, the same water is used for plants and counted several times, in all the country's plants.

**263 551 hm³**
were allocated in 2014

**Table 3.1** Grouping of uses in the Repda classification

| Code | Headings of the Repda classification | Volume allocated (hm³) | Grouped offstream uses | Definition | Volume allocated (hm³) |
|---|---|---|---|---|---|
| A | Agriculture registered and pending | 58 434 | Agriculture | A+D+G+I+L | 65 155 |
| B | Agro-industry | 4 | Public supply | C+H | 12 052 |
| C | Domestic | 40 | Self-supplying industry | B+E+F1+K | 3 572 |
| D | Aquaculture | 1 114 | Energy generation excluding hydropower | F2 | 4 150 |
| E | Services | 1 426 | | Subtotal offstream | 84 929 |
| *F1* | *Industrial* | 2 142 | **Grouped instream use** | | |
| *F2* | *Thermoelectrics* | 4 150 | Hydropower | J | 178 622 |
| G | Livestock | 202 | | Subtotal instream | 178 622 |
| H | Public urban | 12 013 | | **Total** | **263 551** |
| I | Multiple | 5 405 | | | |
| K | Trade | 0.1 | | | |
| L | Others | 0.5 | | | |
| | Subtotal offstream | 84 929 | | | |
| J | Hydropower | 178 622 | | | |
| | Subtotal instream | 178 622 | | | |
| | **Total** | **263 551** | | | |

**Note:** The F1 and F2 classification was added in order to distinguish the offstream generation of electricity (in thermoelectric plants) from instream generation (hydropower).
**Source**: Produced based on Conagua (2015c).

**Table 3.2** Grouped offstream uses according to the type of source, 2014

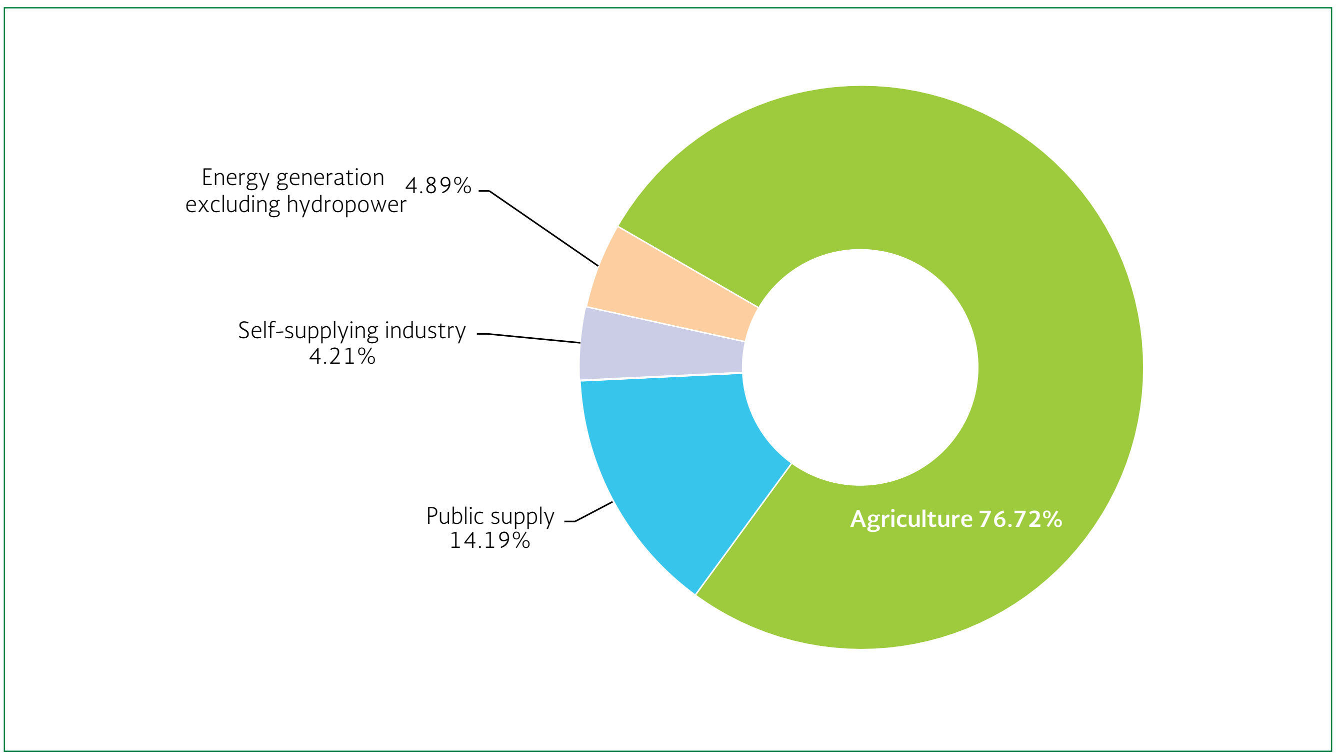
| Grouped use | Origin | | Total volume (thousands of hm³) | Percentage of extraction |
|---|---|---|---|---|
| | Surface water (thousands of hm³) | Groundwater (thousands of hm³) | | |
| Agriculture | 42.00 | 23.16 | 65.15 | 76.7 |
| Public supply | 4.76 | 7.29 | 12.05 | 14.2 |
| Self-supplying industry | 1.57 | 2.01 | 3.57 | 4.2 |
| Energy generation excluding hydropower | 3.70 | 0.45 | 4.15 | 4.9 |
| **Total** | **52.02** | **32.91** | **84.93** | **100.0** |

**Source**: Conagua (2015c).

**Graph 3.1** Volume allocated for offstream uses by type of source, 2005-2014 (thousands of hm³)


**Source**: Produced based on Conagua (2015c).

**Graph 3.2** Distribution of the volumes allocated for grouped offstream uses, 2014




**Note**: Agriculture includes 1.3 km³ of water corresponding to irrigation districts that are awaiting registration.
**Source**: Conagua (2015c).

# 3.2 Distribution of uses throughout Mexico

[Reporteador: Usos del agua]

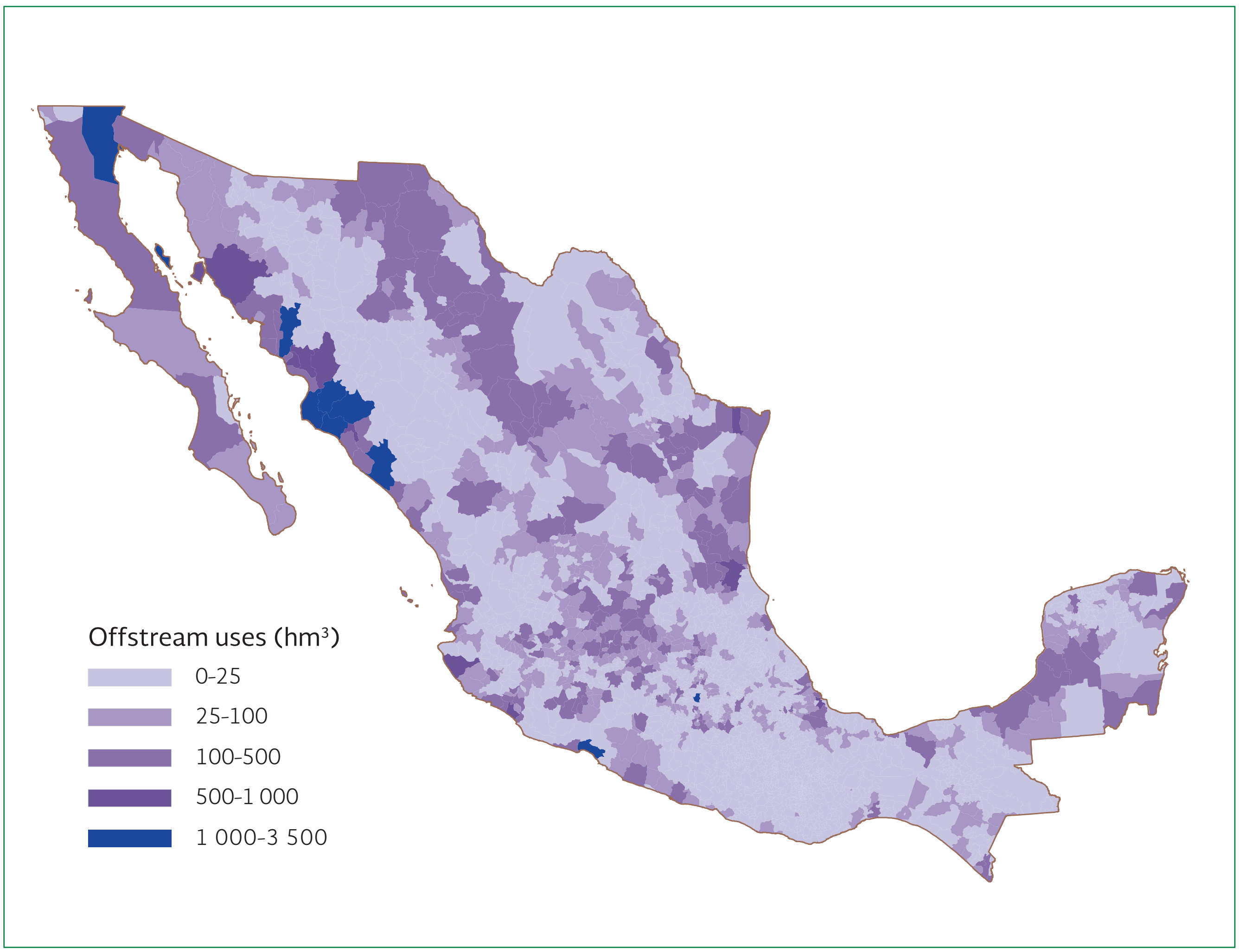
Map 3.1 shows the volume allocated for offstream uses in 2014 by municipality, and map 3.2 shows the predominant or main **source** for the volumes allocated in each municipality, be it surface or groundwater. When there is a difference of less than 5% between surface and groundwater sources, it is considered that there is no predominant source, and they are referred to as similar sources.

The grouped uses in agriculture and public supply represent 90.9% of the volume allocated nationwide. Their distribution is shown in figure 3.1

**90.9%**

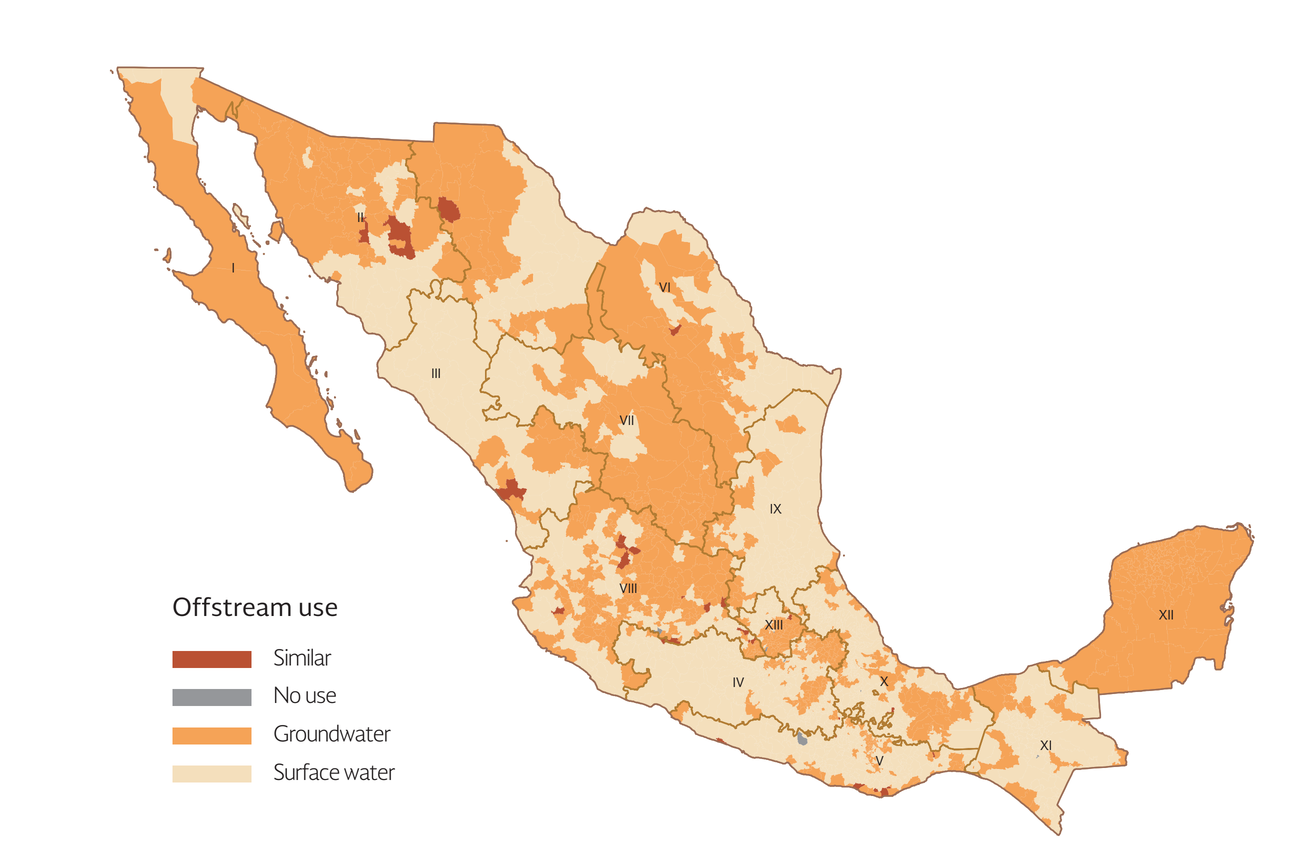
of the volume allocated nationally consists of the grouped uses in agriculture and public supply

**Map 3.1** Intensity of offstream uses by municipality, 2014



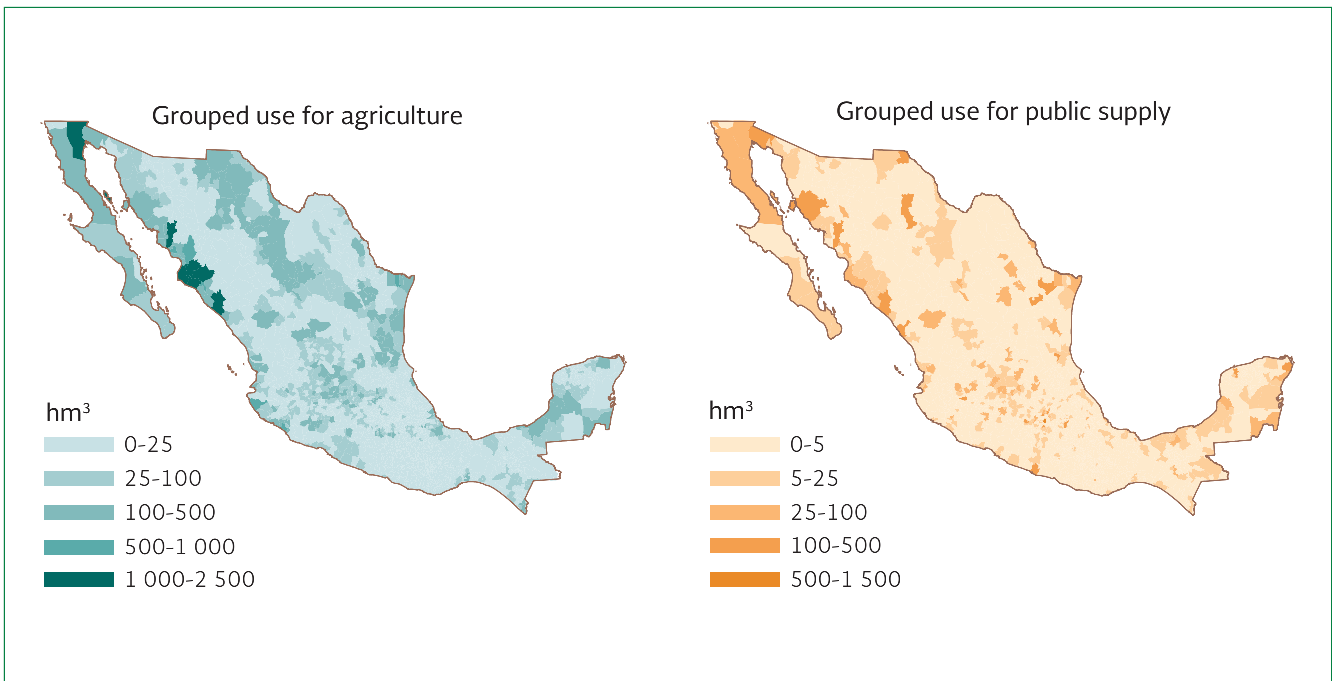

**Source**: Produced based on Conagua (2015c).

**Map 3.2** Predominant source for offstream uses by municipality, 2014




**Source**: Produced based on Conagua (2015c).

**Figure 3.1** Main grouped offstream uses, 2014



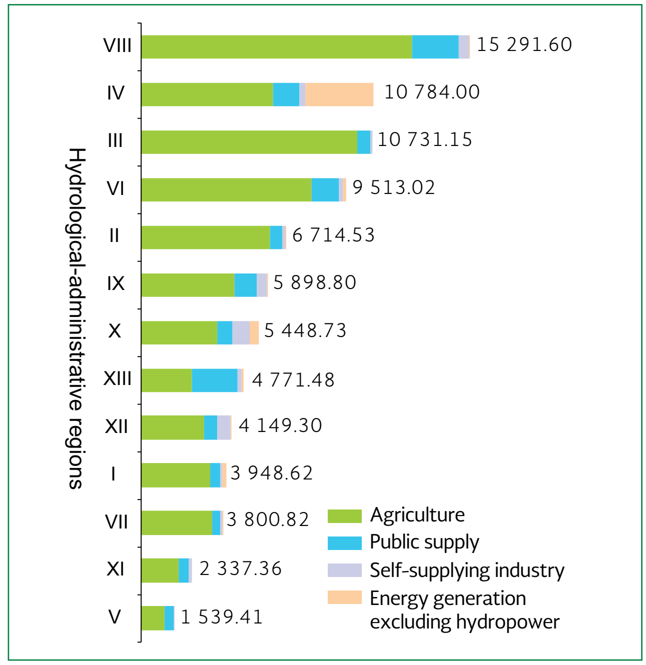

**Source**: Produced based on Conagua (2015c).

The distribution of uses can also be visualized over time according to the evolution of volumes allocated. Map 3.3 compares the volume allocated or assigned by municipality in 2014 compared to the volume in 2005, in order to indicate if it increased or decreased.

Graph 3.3 [Adicional: Table 3.A] shows how volumes of water have been allocated for grouped offstream uses throughout the country. The hydrological-administrative regions (HARs) with the greatest allocation of water are as follows: VIII Lerma-Santiago-Pacific, IV Balsas, III Northern Pacific and VI Rio Bravo. It is worth noting that agriculture accounts for over 80% of the total allocations in these HARs, with the exception of IV Balsas, where the Petacalco thermoelectric plant, located near the estuary of the Balsas river, uses a significant volume of water.

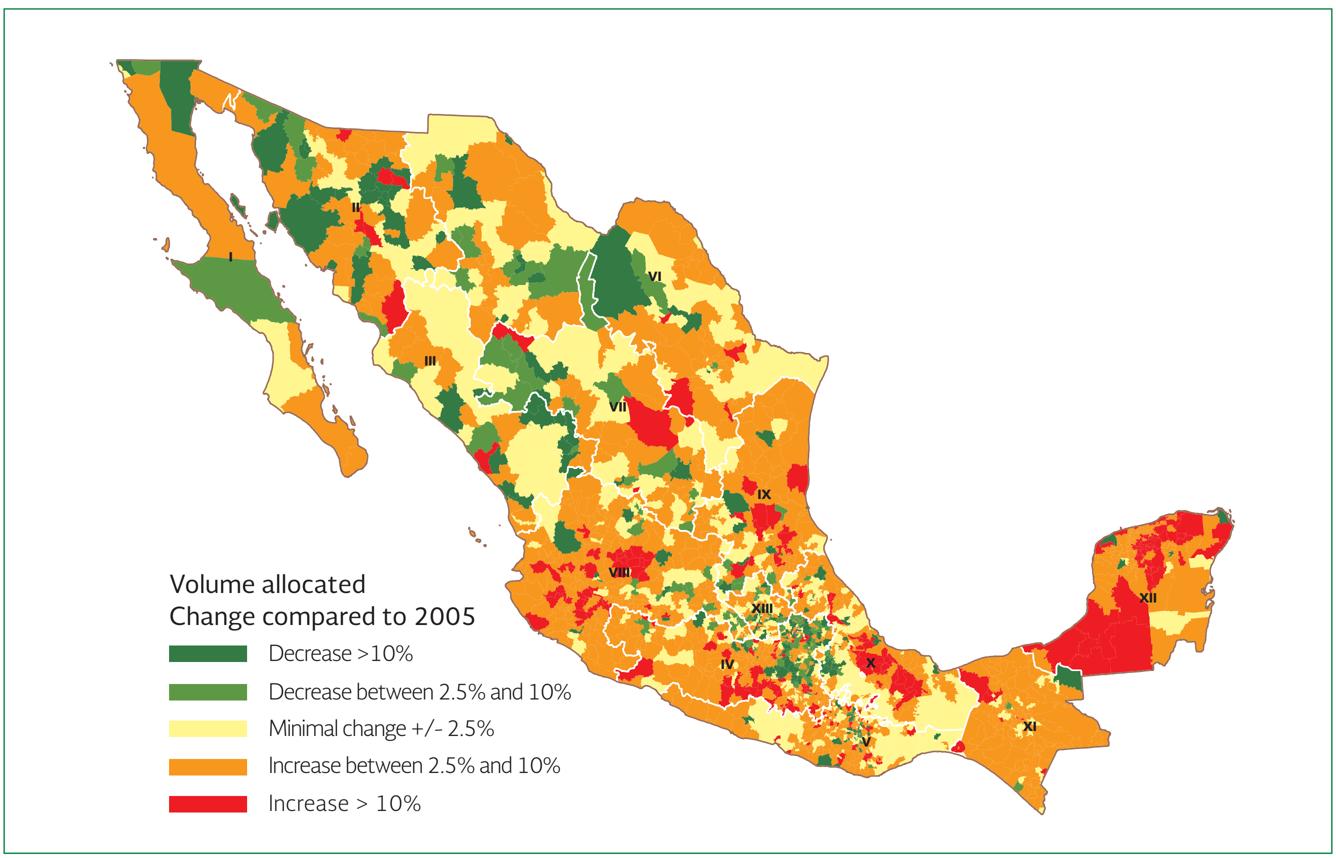
Table 3.3 [Adicional: Graph 3.A] shows the information on the volumes of water allocated by state, among which Sinaloa and Sonora stand out, due to their large areas under irrigation.

**Graph 3.3** Volumes allocated for grouped offstream uses, 2014 ($hm^3$)




**Source:** Produced based on Conagua (2015c).

**Map 3.3** Evolution in offstream uses by municipality, 2005-2014 comparison




**Source:** Produced based on Conagua (2015c).

**TABLE 3.3** Volumes allocated for grouped offstream uses, 2014 (hm³)

| Code | State | Volume allocated | Agriculture | Public supply | Self-supplying industry | Energy generation excluding hydropower |
|---|---|---|---|---|---|---|
| 1 | Aguascalientes | 622.2 | 479.9 | 127.1 | 15.1 | 0.0 |
| 2 | Baja California | 3 048.2 | 2 586.2 | 187.9 | 82.6 | 191.5 |
| 3 | Baja California Sur | 415.5 | 334.3 | 63.0 | 13.9 | 4.3 |
| 4 | Campeche | 1 284.1 | 1 111.6 | 144.3 | 24.5 | 3.6 |
| 5 | Coahuila de Zaragoza | 2 038.1 | 1 648.0 | 240.0 | 75.2 | 74.9 |
| 6 | Colima | 1 784.5 | 1 660.7 | 97.0 | 26.8 | 0.0 |
| 7 | Chiapas | 1 843.6 | 1 506.2 | 299.5 | 37.8 | 0.0 |
| 8 | Chihuahua | 5 149.6 | 4 578.4 | 489.8 | 53.9 | 27.5 |
| 9 | Federal District | 1 122.6 | 1.2 | 1 089.6 | 31.8 | 0.0 |
| 10 | Durango | 1 545.2 | 1 362.5 | 153.7 | 17.4 | 11.5 |
| 11 | Guanajuato | 4 083.1 | 3 443.8 | 546.9 | 71.9 | 20.5 |
| 12 | Guerrero | 4 422.3 | 893.0 | 382.7 | 24.5 | 3 122.1 |
| 13 | Hidalgo | 2 390.8 | 2 099.2 | 176.2 | 32.8 | 82.6 |
| 14 | Jalisco | 4 672.9 | 3 710.6 | 764.2 | 198.0 | 0.1 |
| 15 | Mexico | 2 708.7 | 1 156.8 | 1 342.6 | 178.6 | 30.6 |
| 16 | Michoacan de Ocampo | 5 418.8 | 4 775.6 | 372.0 | 223.0 | 48.2 |
| 17 | Morelos | 1 311.8 | 985.7 | 278.3 | 47.7 | 0.0 |
| 18 | Nayarit | 1 270.0 | 1 094.0 | 114.8 | 61.2 | 0.0 |
| 19 | Nuevo Leon | 2 069.1 | 1 473.6 | 511.9 | 83.4 | 0.2 |
| 20 | Oaxaca | 1 301.6 | 1 005.2 | 261.9 | 34.4 | 0.0 |
| 21 | Puebla | 2 118.2 | 1 610.9 | 428.2 | 72.6 | 6.5 |
| 22 | Queretaro | 1 007.2 | 637.1 | 304.5 | 59.9 | 5.7 |
| 23 | Quintana Roo | 983.8 | 239.7 | 212.3 | 531.7 | 0.0 |
| 24 | San Luis Potosi | 2 039.1 | 1 320.2 | 653.4 | 34.4 | 31.0 |
| 25 | Sinaloa | 9 525.8 | 8 973.9 | 509.2 | 42.6 | 0.0 |
| 26 | Sonora | 7 010.3 | 6 100.4 | 769.8 | 123.6 | 16.5 |
| 27 | Tabasco | 456.3 | 197.6 | 182.7 | 76.0 | 0.0 |
| 28 | Tamaulipas | 4 177.2 | 3 670.7 | 334.8 | 116.2 | 55.5 |
| 29 | Tlaxcala | 268.4 | 161.2 | 90.0 | 17.2 | 0.0 |
| 30 | Veracruz de Ignacio de la Llave | 5 388.9 | 3 381.5 | 546.1 | 1 053.6 | 407.8 |
| 31 | Yucatan | 1 881.5 | 1 573.7 | 254.2 | 44.6 | 9.1 |
| 32 | Zacatecas | 1 569.8 | 1 381.5 | 123.5 | 64.8 | 0.0 |
| | **Total** | **84 928.8** | **65 155.0** | **12 052.3** | **3 572.0** | **4 149.5** |

**Source**: CONAGUA (2015c).

# 3.3 Grouped use for agriculture

[Reporteador: Usos del agua]

The largest use of water in Mexico is in agriculture. According to the VII Agricultural, Livestock and Forest Census from 2007 (the latest one available nationwide), the surface area in agricultural production units was 30.2 million hectares, of which 18% was for irrigation and the remainder was rainfed.

The area harvested every year (considering the agricultural year and perennial crops, under both irrigated and rainfed regimes) varied between 21.8 and 22.1 million hectares during the 2008-2012 period.[3]

Every year the area harvested in this same period (considering the agricultural year and perennial crops, under both irrigated and rainfed regimes) varied between 18.1 and 20.5 million hectares per year.[4] At constant 2008 prices, the contribution of the agriculture, livestock, forest use, fishing and hunting sector to the Gross Domestic Product (GDP) in 2014 was 3.1%.[5]

According to the National Inquiry of Occupation and Employment (ENOE), the population occupied in this sector of primary activities (agriculture, livestock, forest use, fishing and hunting) up to the fourth trimester of 2014 was 6.8 million people, which represents 13.4% of the economically active population.[6]

The yield in tons per hectare of irrigation agriculture is 2.2 to 3.6 times higher than in areas under a rainfed regime (see chapter 4).

Mexico is in seventh place worldwide in terms of the area with irrigation infrastructure, with 6.4 million hectares, of which just over half corresponds to 86 irrigation districts and the remainder to more than 39 000 irrigation units (see glossary).

35.5% of the water allocated for the grouped use for agriculture is of groundwater origin, as can be observed in graph 3.4. Taking into account that there are annual variations, the volume of groundwater allocated for this grouped use is 20.8% higher than in 2005, the reference year of the graph.

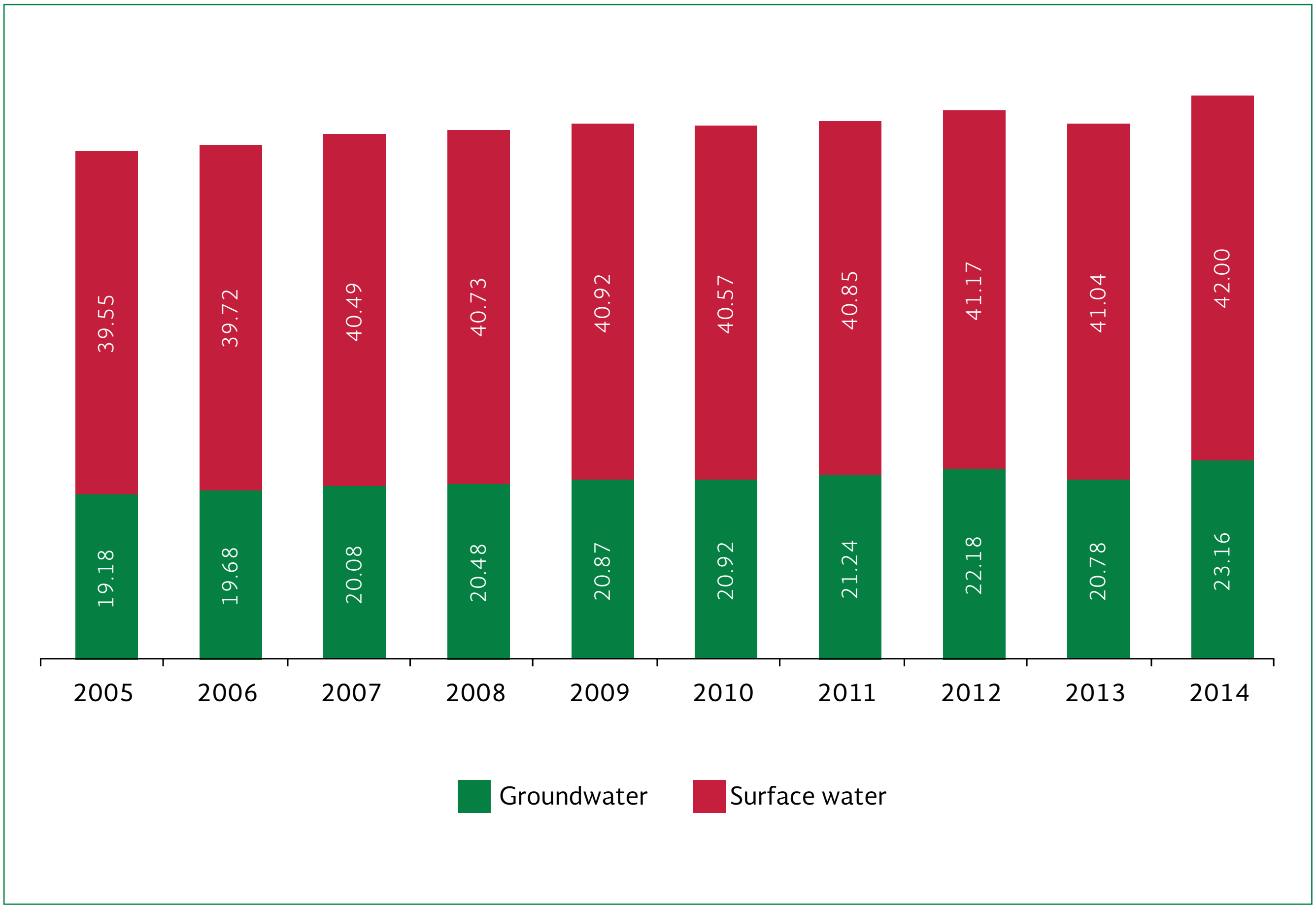
**Mexico** has a surface area of

**6.4**

million hectares with irrigation infrastructure

3 SIAP (2014).
4 INEGI (2015h).
5 INEGI (2015i).

**GRAPH 3.4** Evolution in the volume allocated for grouped use for agriculture by type of source, 2005-2014 (thousands of $hm^3$)




**Source:** Produced based on CONAGUA (2015c).

# 3.4 Grouped use for public supply

[Reporteador: Usos del agua]

The grouped use for public supply consists of the water delivered through drinking water networks, which supply domestic users (homes), as well as different industries and services.

Having access to water of sufficient quantity and quality for human consumption is one of the basic needs of the population, since it has a direct influence on their health and general wellbeing. This characteristic is recognized by the guiding tools for national planning: the 2013-2018 National Development Plan and the 2014-2018 National Water Program.

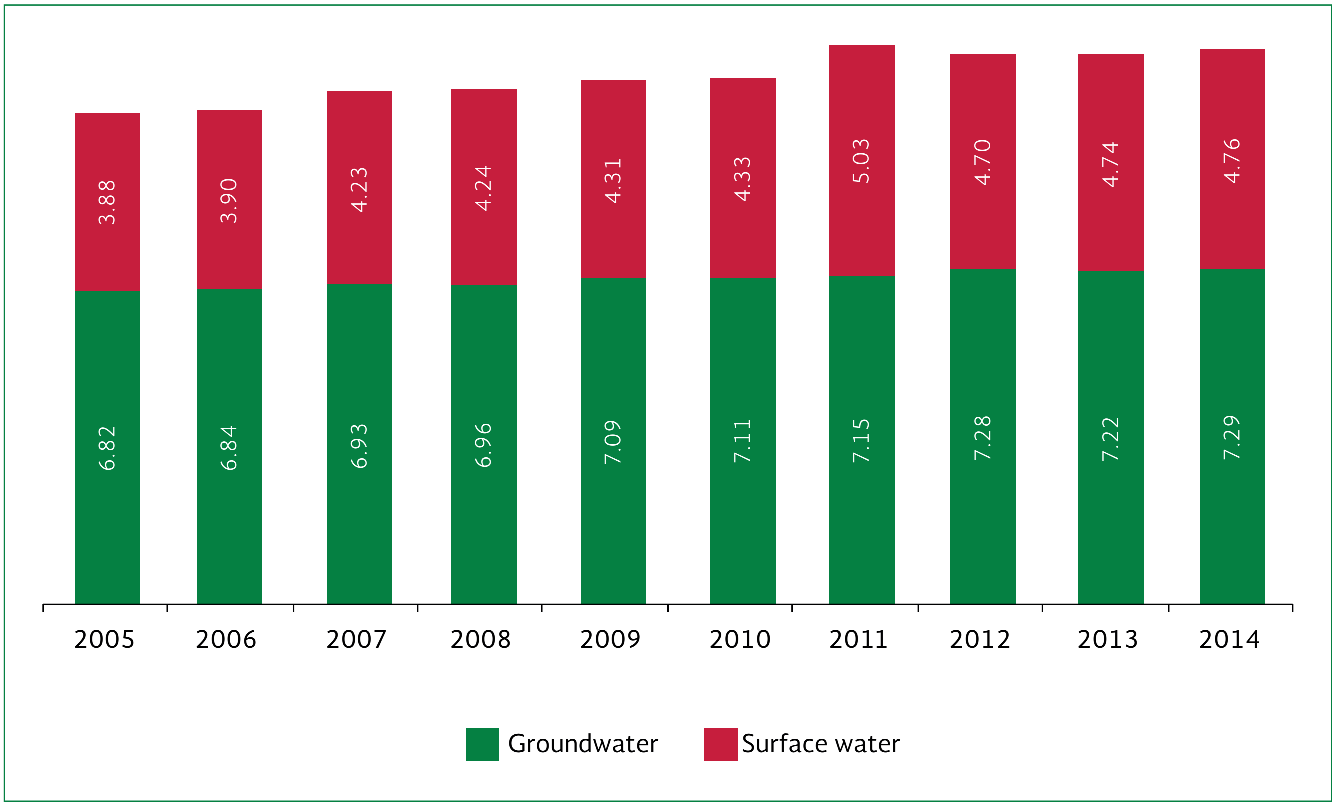
In the grouped use for public supply, the predominant source is groundwater, with 60.5% of the volume, as can be appreciated in graph 3.5. It is worth noting that between 2005 and 2014, the surface water assigned for this use increased by 22.8%.

From **2005** to **2014,** the surface water assigned to the grouped use for public supply grew by

**22.8%**

In Mexico, drinking water services, sanitation, sewerage, wastewater treatment and disposal are under the responsibility of municipalities, generally speaking through water utilities.

**Graph 3.5** Evolution in the volume allocated for grouped use for public supply by type of source, 2005-2014 (thousands of $hm^3$)




**Source**: Produced based on Conagua (2015c).

# 3.5 Grouped use for self-supplying industry

[Reporteador: Usos del agua]

This grouped use includes the industry that takes its water directly from the country's rivers, streams, lakes or aquifers.

According to the North American Industrial Classification System (NAICS), secondary activities, known as "industry", are made up of the mining, electricity, water and piped gas sectors of supply to end users, as well as the construction and the manufacturing industries.[7] It should be added that the classification of uses in the REPDA does not exactly follow this classification, although it is considered that there is a reasonable degree of correlation.

Although it only represents 4.2% of the total use of water, the grouped use for self-supplying industry presents the growth trend shown in graph 3.6. It should be mentioned that in the 2005-2014 period, the volume allocated from groundwater sources increased significantly, with a growth of 57.9% in that period, whereas the allocation from surface water fell by 1.7%.

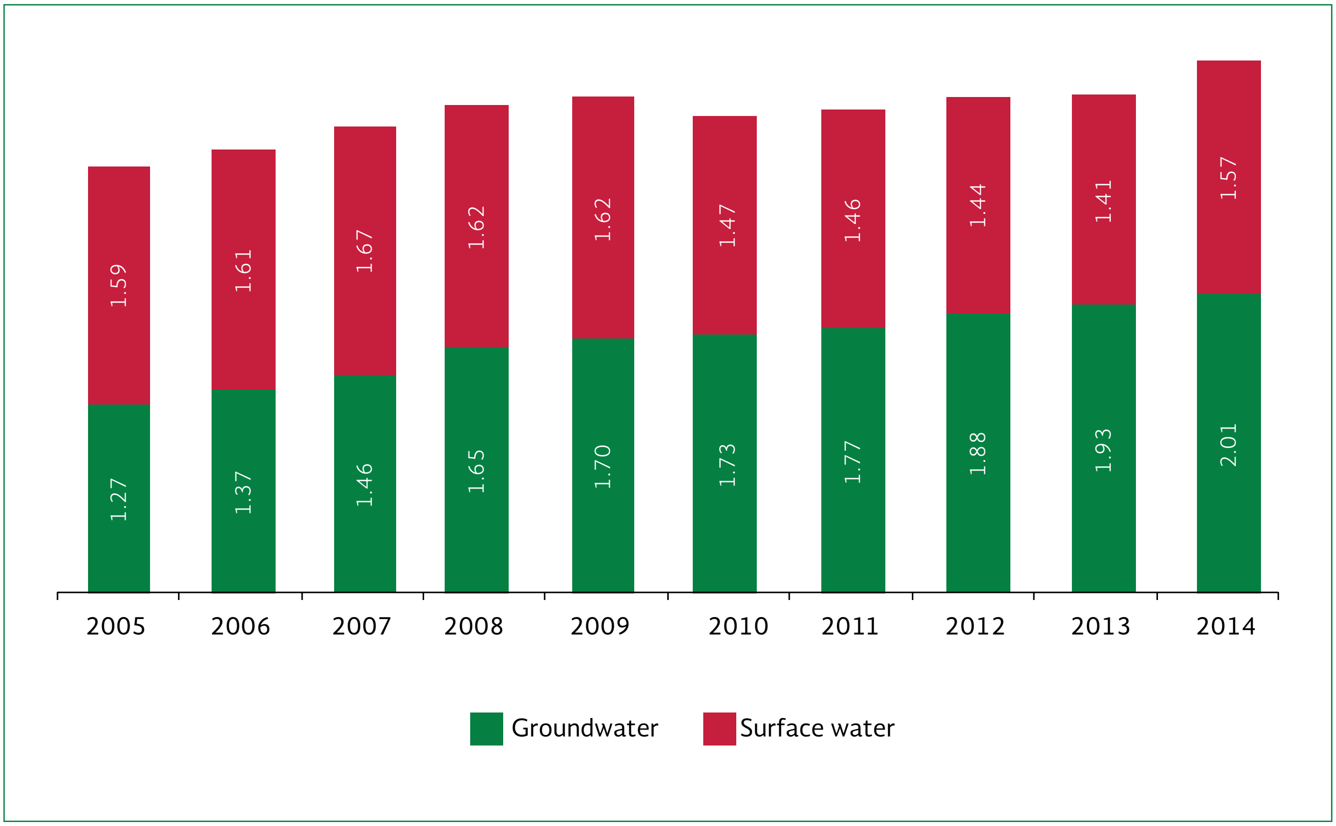
Grouped use for self-supplying industry was

**4.2%**

of the volume allocated for offstream uses

7 INEGI (2013b).

**GRAPH 3.6** Evolution in the volume allocated for the grouped use for self-supplying industry by type of source, 2005-2014 (thousands of hm$^3$)




**Source**: Produced based on CONAGUA (2015c).

# 3.6 Use in energy generation excluding hydropower

[Reporteador: Usos del agua, Generación de energía]

This grouped use refers to dual steam, coal-electric, combined cycle, turbo-gas and internal combustion plants, which are offstream uses of water, and includes renewable technologies (wind, photovoltaic solar and geothermal). Hydropower is excluded since it represents an instream use of water resources.

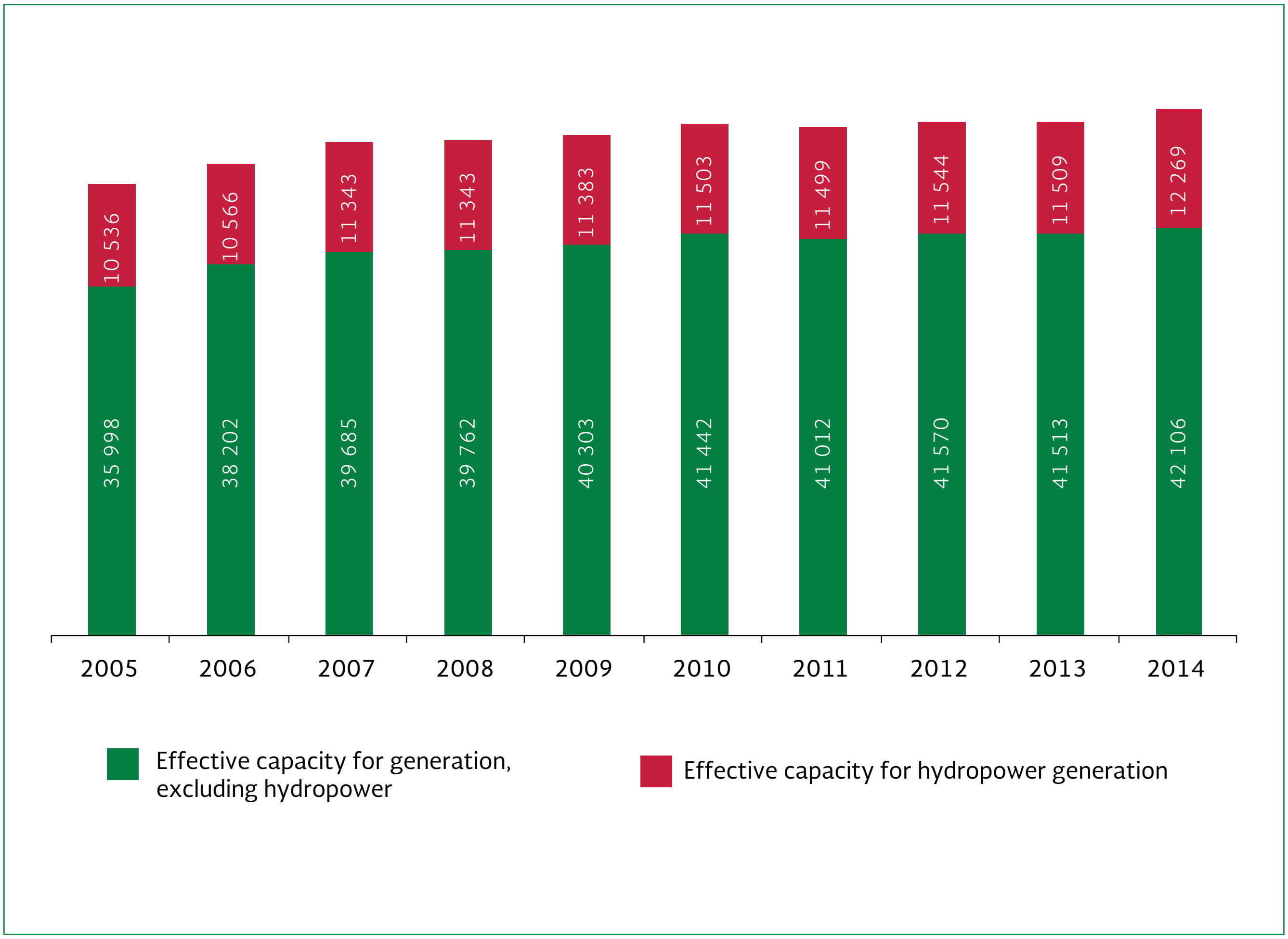
According to the findings of the Ministry of Energy (Sener 2015) and the Federal Commission for Electricity (CFE 2015), in 2014 CFE's plants considered in this use, including External Energy Producers (EEPs) for public service, had an **effective capacity** of 42 106 MW, which represented 77.4% of the national total. The gross generation of these plants was 213.4 TWh, or 85.1% of the national total.

In 2014 gross generation in **CFE**'s plants was **213.4 TWh**

It should be noted that 75.2% of the water allocated for this use correspond to the coal-electric plant in Petacalco, situated on the Guerrero coast, close to the estuary of the Balsas river.

Graph 3.7 shows the annual evolution in the effective capacity of generation under this use in the period from 2005 to 2014, whereas graph 3.8 shows the gross generation for this same period.

**Graph 3.7** Effective capacity for energy generation, 2005-2014 (MW)




**Source**: Produced based on CFE (2015), Sener (2015).

# 3.7 Use in hydropower plants

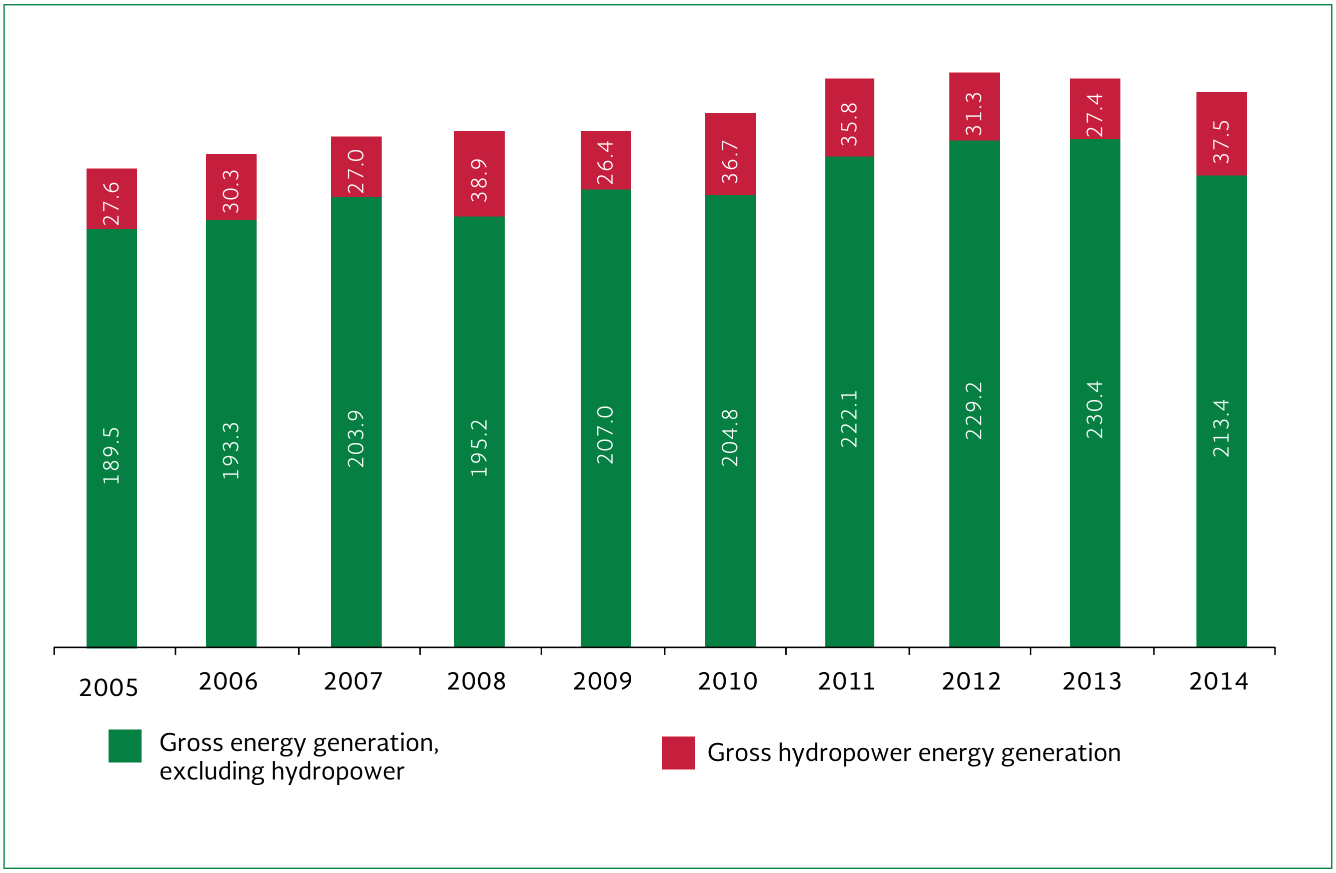
[Reporteador: Usos del agua, Generación de enrgía, Volúmenes declarados]

Nationwide, the HARs XI Southern Border and IV Balsas are those which have the greatest allocation of water for this use, since they are home to the rivers with the heaviest flows and consequently the country's largest hydropower plants, as shown in table 3.4. The volume allocated for this use nationwide is 178.6 billion cubic meters (Conagua 2015c), of which variable quantities are used every year.

The volume allocated for use in hydropower is **178.6** billion $m^3$

In 2014, hydropower plants used 133.0 billion cubic meters of water, which allowed 37.5 TWh of electricity to be generated, corresponding to 14.9% of Mexico's total generation. The installed capacity in these hydropower plants was 12 269 MW, which corresponds to 22.6% of Mexico's installed capacity (see graphs 3.7 and 3.8).

**Graph 3.8** Gross energy generation, 2005-2014 (TWh)




**Source**: Produced based on CFE (2015), Sener (2015).

**Table 3.4** Volumes declared for the payment of duties for hydropower production, 2005-2014

| Number of HAR | Volume of water declared (hm³) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
| I | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| II | 3 250.8 | 2 928.6 | 3 350.7 | 3 404.7 | 3 127.7 | 4 140.6 | 3 416.5 | 3 032.7 | 2 627.2 | 2 456.3 |
| III | 11 598.4 | 10 747.0 | 11 183.9 | 13 216.7 | 11 405.1 | 11 912.1 | 11 100.3 | 5 176.6 | 6 127.9 | 7 475.4 |
| IV | 32 141.0 | 21 820.3 | 31 099.4 | 30 572.8 | 28 059.6 | 34 487.9 | 35 539.9 | 32 177.7 | 28 126.2 | 29 688.3 |
| V | 1 890.3 | 1 949.1 | 2 139.6 | 2 244.7 | 2 063.4 | 3 528.0 | 16 313.8 | 2 028.2 | 1 716.9 | 26.3 |
| VI | 2 073.6 | 2 262.7 | 2 889.6 | 1 967.7 | 2 960.4 | 2 987.7 | 3 350.1 | 3 771.8 | 2 556.8 | 2 125.5 |
| VII | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| VIII | 7 361.0 | 4 657.8 | 10 516.6 | 13 516.9 | 9 030.9 | 11 764.6 | 7 741.4 | 5 733.5 | 5 598.0 | 10 693.3 |
| IX | 1 487.8 | 809.7 | 1 105.3 | 2 912.1 | 1 441.0 | 1 525.9 | 1 243.0 | 1 312.4 | 1 273.5 | 1 225.7 |
| X | 13 978.5 | 17 835.0 | 14 279.1 | 14 040.5 | 13 673.7 | 15 029.1 | 4 254.6 | 17 286.7 | 16 463.1 | 12 319.4 |
| XI | 41 573.3 | 77 245.7 | 46 256.8 | 68 793.3 | 64 304.7 | 49 406.9 | 81 813.4 | 85 197.3 | 48 325.9 | 67 007.6 |
| XII | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| XIII | 31.0 | 39.1 | 10.6 | 0.0 | 18.8 | 0.5 | 0.0 | 0.0 | 0.3 | 0.5 |
| **Total** | **115 385.8** | **140 294.9** | **122 831.6** | **150 669.4** | **136 085.3** | **134 783.3** | **164 773.0** | **155 716.9** | **112 815.9** | **133 018.3** |

**Source**: Conagua (2015c).

# 3.8 Degree of water stress

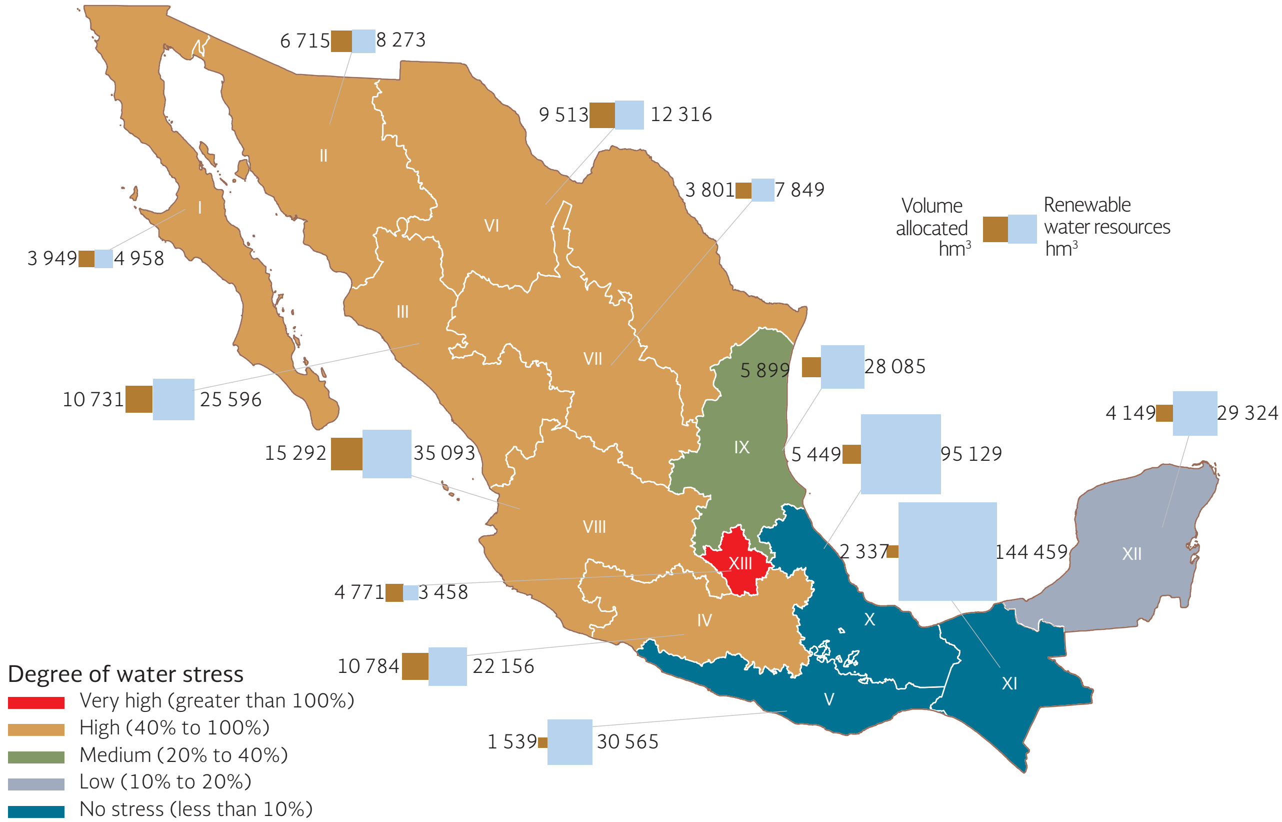
[Reporteador: Grado de presión, Usos del agua, Agua renovable]

The percentage of water used for offstream uses as compared to the renewable water resources is an indicator of the degree of **water stress** in any given country, catchment or region. The degree of water stress can be very high, high, medium, low and with no stress. It is considered that if the percentage is greater than 40%, there is a high or very high degree of water stress (see the scale of water stress in map 3.4).

Nationwide, Mexico is experiencing a degree of water stress of 19%, which is considered low; however, the central, northern and northwestern areas of the country are experiencing a high degree of water stress. In table 3.5 and map 3.4, this indicator is shown for each of the country's HARs.

Nationwide, the degree of water stress in 2014 was
**19%**
which is considered **low**

## **Map 3.4** Degree of water stress, 2014




**Source**: Produced based on CONAGUA (2015a), CONAGUA (2015c).

## **Table 3.5** Degree of water stress, 2014

| Number of HAR | Total volume of water allocated 2014 (hm³) | Renewable water resources 2014 (hm³/year) | Degree of water stress (%) | Classification of water stress |
|---|---|---|---|---|
| I | 3 949 | 4 958 | 79.6 | High |
| II | 6 715 | 8 273 | 81.2 | High |
| III | 10 731 | 25 596 | 41.9 | High |
| IV | 10 784 | 22 156 | 48.7 | High |
| V | 1 539 | 30 565 | 5.0 | No stress |
| VI | 9 513 | 12 316 | 77.2 | High |
| VII | 3 801 | 7 849 | 48.4 | High |
| VIII | 15 292 | 35 093 | 43.6 | High |
| IX | 5 899 | 28 085 | 21.0 | Medium |
| X | 5 449 | 95 129 | 5.7 | No stress |
| XI | 2 337 | 144 459 | 1.6 | No stress |
| XII | 4 149 | 29 324 | 14.2 | Low |
| XIII | 4 771 | 3 458 | 138.0 | Very high |
| **Total** | **84 929** | **447 260** | **19.0** | Low |

**Source**: Produced based on CONAGUA (2015a), CONAGUA (2015c).

# 3.9 Virtual Water in Mexico

[Reporteador: Agua virtual/Huella hídrica]

Virtual water is defined as the total quantity of water used by or embedded in a product, good or service. For example, one kilogram of wheat in Mexico requires an average of 1 860 liters of water (Mekonnen and Hoekstra 2010a), whereas a kilogram of beef requires 15 415 liters (Mekonnen and Hoekstra 2010b); these values vary between countries.

As a result of Mexico's commercial exchanges with other countries, in 2014 Mexico exported 9.14 billion cubic meters of virtual water (VWE), and imported 31 395 (VWI), meaning that it had a net virtual water import (NVWI) of 22.26 billion cubic meters of water. In graph 3.9 [Adicional: Table 3.B] the evolution in the 2005-2014 period is shown.

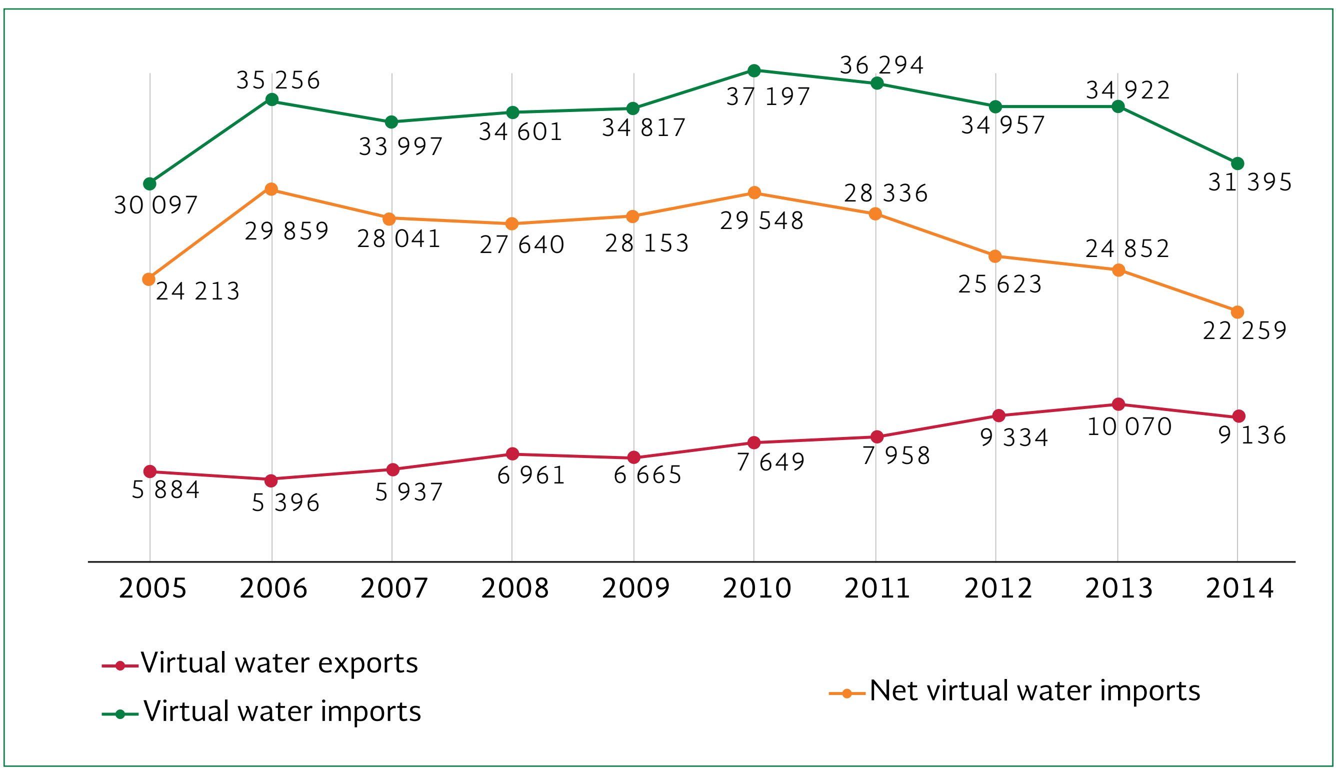
Of the resulting net virtual water import (NVWI), the evolution registered in recent years shows relevant variations, with a trend towards the reduction in the import of agricultural products, which affects a similar reduction in the total importation, as can be observed in graph 3.10.

One kilogram of wheat in **Mexico** requires an average of

**1 860**

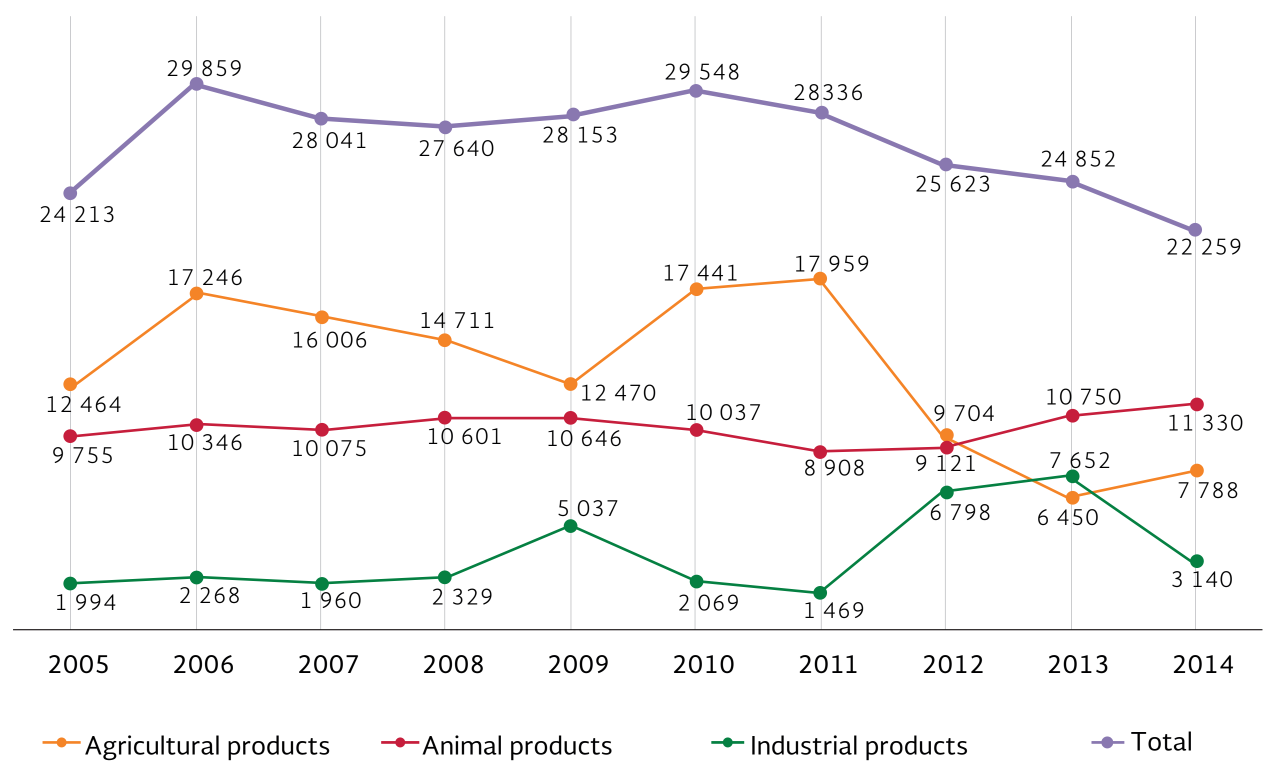
liters of water

**Graph 3.9** Virtual water imports and exports in Mexico 2005-2014 (hm³)




**Source**: Produced based on Economía (2015a).

**Graph 3.10** Net virtual water imports 2005-2014 (hm³)




**Source**: Produced based on Economía (2015a).

## **Box 3.1** Environmental-economic accounts in Mexico

Through international collaboration, the System of Environmental-Economic Accounting (SEEA) has been developed, as a series of tables, accounting rules, classifications, definitions and standard concepts, the objective of which is to produce comparable statistics at the international level about the environment and its relationship with the economy. It follows an accounting structure similar to the System of National Accounts in order to facilitate the integration of environmental and economic statistics.

In Mexico, INEGI leads the inter-institutional effort to put together environmental and economic accounting, part of which are the integrated environmental and economic water accounts. As a result of the integration of these accounts, aspects of the economic valuation of the environmental impact as a consequence of the production, distribution and consumption of goods and services have been identified.

In this way, the annual depletion of groundwater can be quantified in monetary terms, which for 2012 was estimated at 29.48 billion pesos, or the equivalent of 1.5 times the household expenditure in health care. Another relevant comparison is the estimation of the cost of treating the untreated wastewater in 2012, for 64.63 billion pesos.

This information provides context for public policy decisions. In 2012 the total costs for the depletion and degradation of the environment (985.06 billion pesos) were almost seven times more than the expense for environmental protection for that year (143.07 billion pesos).

**Source**: INEGI (2014b), Unstats (2012), Unstats (2014).

# Chapter 4

## Water infrastructure

# Water Infrastructure

# 2014

## Drinking water and sanitation infrastructure

**20** regional emergency attention centers

| | Drinking water (estimated coverage) | Sanitation (estimated coverage) |
|---|---|---|
| National | 92.4% | 91.0% |
| Urban | 95.1% | 96.3% |
| Rural | 82.9% | 72.8% |

**Cutzamala System**

**17%** of the Valley of Mexico's supply → **477 $hm^3$**

## Reservoirs and berms

More than
**5 163**

Total approximate
storage
**150 000 hm³**

**181**
main reservoirs
represent
**80%**
of the storage

## Water treatment

**Drinking water treatment**

**779**
drinking water treatment
plants in operation
**96.3 m³/s**
treated

**Wastewater treatment plants in operation**

**2 337**
**municipal**
(population centers)
**111.3 m³/s** treated

**2 639**
**industrial**
**65.6 m³/s** treated

## Hydro-agricultural infrastructure

**6.4**
million hectares
of irrigation

**86**
irrigation districts

More than
**39 000**
irrigation
units

**2.9**
million technified
rainfed hectares

**23**
technified
rainfed
districts

# 4.1 Water infrastructure

The water infrastructure available within the country to provide the water required by the various national users includes the following:

More than 5 163 reservoirs and water retention berms[1]

6.4 million hectares with irrigation.

2.9 million hectares with technified rainfed infrastructure.

779 drinking water treatment plants in operation.

2 337 municipal wastewater treatment plants in operation.

2 639 industrial wastewater treatment plants in operation.

More than 3 000 km of aqueducts.

**Box 4.1** Main water infrastructure projects, 2014

- Sanitation of the Valley of Mexico: Atotonilco wastewater treatment plant (35 $m^3/s$) and El Caracol (2 $m^3/s$ in stage 1); Eastern Drainage Tunnel (TEO) for 150 $m^3/s$, Western Drainage Tunnel II for 112 $m^3/s$ and General Canal Tunnel for 20 $m^3/s$.
- Monterrey VI: 372 km aqueduct to supply 5 $m^3/s$ to Monterrey.
- El Zapotillo: Reservoir and 140 km aqueduct to supply Guadalajara, Leon and Los Altos de Jalisco.
- El Purgatorio: Reservoir and infrastructure to make use of 5.6 $m^3/s$ in conjunction with El Zapotillo to supply the Guadalajara metropolitan area.
- Cutzamala: third line of the system (12 $m^3/s$ and 77.6 km) to offer greater security in the supply to the Valley of Mexico.
- Vicente Guerrero-Ciudad Victoria: Aqueduct under review, 54.5 km and 1.25 $m^3/s$ to supply water to Ciudad Victoria.
- Puebla: Extension of Puebla Treatment Plant 4 to treat 3.15 $m^3/s$.
- Riviera Veracruzana: Aqueduct under review, 25 km and 1.5 $m^3/s$ for supply.
- La Paz: Treatment plant for 0.7 $m^3/s$ in the first stage.
- La Paz: Desalinization plant under review, with a flow of 0.2 $m^3/s$ in the first stage.
- Picachos-Mazatlan: under review, with a flow of 0.75 $m^3/s$ in the first stage to supply Mazatlan.
- Ensenada: Desalinization plant with a flow of 0.25 $m^3/s$.

**Source**: Produced based on Conagua (2015l).

1 An approximate number, due to the insufficient registry of berms.

# 4.2 Reservoirs and berms

[Reporteador: Principales presas]

There are more than 5 163 **reservoirs and water retention berms** in Mexico, some of which are classified as large dams, according to the definition of the International Commission on Large Dams.[2]

There is an incomplete registry of water retention berms. Efforts are currently underway to register these small storage works, mainly made of soil.

The storage capacity in the country's reservoirs is approximately 150 billion $m^3$. This edition presents statistics on the 181 reservoirs that represent 80% of the national storage capacity. The annual volume stored in these 181 reservoirs in the period from 2005 to 2014 is shown at the national scale in graph 4.1 and regionally in [Adicional: Graph 4.A]. This volume depends upon the precipitation and runoff in the different regions of the country, as well as the reservoirs' operation policies, determined by their storage purposes for various uses and flood control. Graph 4.1 shows the volume stored as of December 31 each year, with the reference of the normal pool elevation (NPE).

Their location is shown in map 4.1 and their main characteristics in table 4.1. The localization of those reservoirs follows, among other factors, the hydrological regime of the current, the topography and the geological characteristics of the site, as well as the uses for which they were intended, among them electricity generation, public supply, irrigation and flood control. Table 4.1 employs the abbreviations of G: Electricity generation. I: Irrigation. P: Public supply. C: Flood control; the code corresponds to the one used in the inventory of the Conagua's Deputy Director General's Office for Technical Affairs.

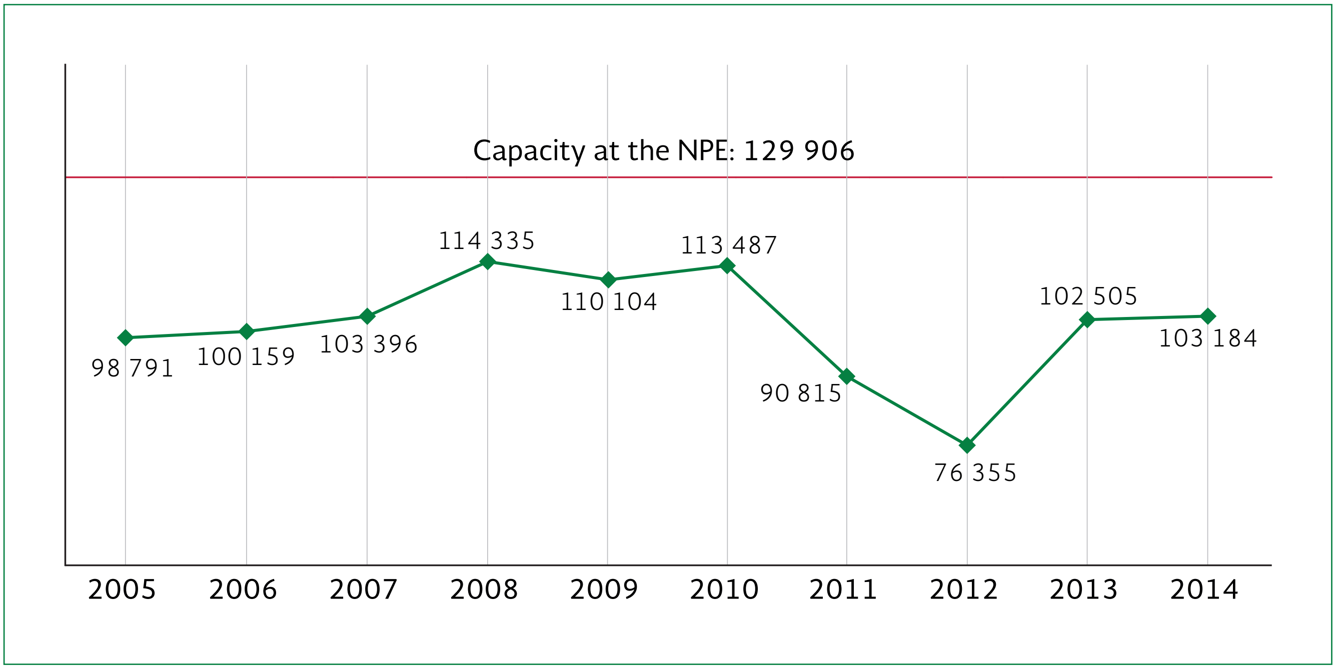
In Mexico there are more than

**5 163**

**reservoirs and water retention berms**

2 The reservoir should be at least 15 meters high; or between 10 and 15 meters high with a storage volume of more than 3 $hm^3$ (ICOLD 2007).

**Graph 4.1** Volume in the 181 main reservoirs (hm³)




**Source**: Conagua (2015a).

**Table 4.1** 181 Main reservoirs, 2014

| Nº | SGT Code | Official name | Given name | Capacity at the NPE (hm³) | HAR | Uses |
|---|---|---|---|---|---|---|
| 1 | 693 | Dr. Belisario Domínguez | La Angostura | 15 549.20 | Southern Border | G |
| 2 | 706 | Netzahualcóyotl | Malpaso or Raudales | 12 373.10 | Southern Border | G, I, C |
| 3 | 1453 | Infiernillo | Infiernillo | 9 340.00 | Balsas | G, C |
| 4 | 1810 | Lago de Chapala | Chapala | 8 126.41 | Lerma-Santiago-Pacific | I, P |
| 5 | 2754 | Presidente Miguel Alemán | Temascal | 8 119.10 | Central Gulf | G, I, C |
| 6 | 2516 | Aguamilpa Solidaridad | Aguamilpa | 5 540.00 | Lerma-Santiago-Pacific | G, I |
| 7 | 345 | Internacional La Amistad | La Amistad | 4 174.00 | Rio Bravo | G, I, P, C |
| 8 | 3617 | General Vicente Guerrero Consumador de la Independencia Nacional | Las Adjuntas | 3 910.69 | Northern Gulf | P, I |
| 9 | 3440 | Internacional Falcon | Falcón | 3 258.00 | Rio Bravo | P, C, G |
| 10 | 3148 | Adolfo López Mateos | El Humaya or Varejonal | 3 086.61 | Northern Pacific | G, I |
| 11 | 3243 | Álvaro Obregón | El Oviachic | 3 023.14 | Northwest | G, I, P |
| 12 | 3218 | Miguel Hidalgo y Costilla | El Mahone | 2 921.42 | Northern Pacific | G, I |
| 13 | 3216 | Luis Donaldo Colosio | Huites | 2 908.10 | Northern Pacific | G, I |
| 14 | 750 | La Boquilla | Lago Toronto | 2 893.57 | Rio Bravo | G, I |
| 15 | 1084 | Lázaro Cárdenas | El Palmito | 2 872.97 | Central Basins of the North | I, C |
| 16 | 3320 | Plutarco Elías Calles | El Novillo | 2 833.10 | Northwest | G, I |
| 17 | 2742 | Miguel de la Madrid | Cerro de Oro | 2 599.51 | Central Gulf | I |
| 18 | 3210 | José López Portillo | El Comedero | 2 580.19 | Northern Pacific | G, I |
| 19 | 2538 | Leonardo Rodríguez Alcaine | El Cajon | 2 551.70 | Lerma-Santiago-Pacific | G |
| 20 | 2519 | Ing. Alfredo Elías Ayub | La Yesca | 2 292.92 | Lerma-Santiago-Pacific | G |
| 21 | 3203 | Gustavo Díaz Ordaz | Bacurato | 1 737.33 | Northern Pacific | G, I |
| 22 | 1463 | Ing. Carlos Ramírez Ulloa | El Caracol | 1 458.21 | Balsas | G |
| 23 | 1679 | Ing. Fernando Hiriat Balderrama | Zimapan | 1 390.11 | Northern Gulf | G |
| 24 | 701 | Manuel Moreno Torres | Chicoasen | 1 384.86 | Southern Border | G |

| Nº | SGT Code | Official name | Given name | Capacity at the NPE ($hm^3$) | HAR | Uses |
|---|---|---|---|---|---|---|
| 25 | 494 | Venustiano Carranza | Don Martin | 1 312.86 | Rio Bravo | P, C, I |
| 26 | 2689 | Cuchillo-Solidaridad | El Cuchillo | 1 123.14 | Rio Bravo | P, I |
| 27 | 688 | Ángel Albino Corzo | Peñitas | 1 091.10 | Southern Border | G |
| 28 | 3241 | Adolfo Ruíz Cortines | Mocuzari | 950.30 | Northwest | G, I, P |
| 29 | 1436 | Solís | Solís | 800.03 | Lerma-Santiago-Pacific | I, C |
| 30 | 3490 | Ing. Marte R. Gómez | El Azucar | 781.70 | Rio Bravo | I |
| 31 | 2708 | Presidente Benito Juárez | El Marques | 720.32 | Southern Pacific | I |
| 32 | 3302 | Lázaro Cárdenas | La Angostura | 703.38 | Northwest | P, I |
| 33 | 3229 | Sanalona | Sanalona | 673.47 | Northern Pacific | G, I, P |
| 34 | 2206 | Constitución de Apatzingán | Chilatán | 601.19 | Balsas | I, C |
| 35 | 3557 | Estudiante Ramiro Caballero Dorantes | Las Animas | 571.07 | Northern Gulf | I |
| 36 | 2257 | José María Morelos | La Villita | 540.80 | Balsas | G, I |
| 37 | 3211 | Josefa Ortíz de Domínguez | El Sabino | 513.86 | Northern Pacific | I |
| 38 | 1710 | Cajón de Peña | Tomatlan or El Tule | 466.69 | Lerma-Santiago-Pacific | P, I |
| 39 | 3693 | Chicayán | Paso de Piedras | 456.92 | Northern Gulf | I |
| 40 | 2382 | Tepuxtepec | Tepuxtepec | 425.20 | Lerma-Santiago-Pacific | G, I |
| 41 | 3154 | Ing. Aurelio Benassini Vizcaíno | El Salto or Elota | 403.90 | Northern Pacific | I, C |
| 42 | 1825 | Manuel M. Diéguez | Santa Rosa | 403.00 | Lerma-Santiago-Pacific | G |
| 43 | 1477 | El Gallo | El Gallo | 400.04 | Balsas | I |
| 44 | 2126 | Valle de Bravo | Valle de Bravo | 394.39 | Balsas | P |
| 45 | 813 | Francisco I. Madero | Las Vírgenes | 355.29 | Rio Bravo | I, C |
| 46 | 49 | Plutarco Elías Calles | Calles | 350.00 | Lerma-Santiago-Pacific | I |
| 47 | 1045 | Francisco Zarco | Las Tortolas | 309.24 | Central Basins of the North | I, C |
| 48 | 2826 | Manuel Ávila Camacho | Valsequillo or Balcón del Diablo | 303.70 | Balsas | I |
| 49 | 2631 | José López Portillo | Cerro Prieto | 300.00 | Rio Bravo | P, I |
| 50 | 3202 | Ing. Guillermo Blake Aguilar | El Sabinal | 294.56 | Northern Pacific | I, C |
| 51 | 825 | Ing. Luis L. León | El Granero | 292.47 | Rio Bravo | I, C |
| 52 | 1507 | Vicente Guerrero | Palos Altos | 250.00 | Balsas | I |
| 53 | 1782 | General Ramón Corona Madrigal | Trigomil | 250.00 | Lerma-Santiago-Pacific | I |
| 54 | 1035 | Federalismo Mexicano | San Gabriel | 245.43 | Rio Bravo | P, C, I |
| 55 | 3478 | Presidente Lic. Emilio Portes Gil | San Lorenzo | 230.78 | Northern Gulf | I |
| 56 | 4365 | Solidaridad | Trojes | 220.81 | Lerma-Santiago-Pacific | I |
| 57 | 3239 | Abelardo Rodríguez Luján | Hermosillo | 219.50 | Northwest | P, C, I |
| 58 | 2167 | El Bosque | El Bosque | 202.40 | Balsas | P, C |
| 59 | 2286 | Melchor Ocampo | El Rosario | 200.00 | Lerma-Santiago-Pacific | I |
| 60 | 1328 | Laguna de Yuriria | B. de Tavamatacheo | 187.97 | Lerma-Santiago-Pacific | I |
| 61 | 2136 | Villa Victoria | Villa Victoria | 185.72 | Balsas | P |
| 62 | 3662 | Canseco | Laguna de Catemaco | 185.70 | Central Gulf | G |
| 63 | 1583 | Endhó | Endhó | 182.90 | Waters of the Valley of Mexico | I, C |
| 64 | 1315 | Ignacio Allende | La Begoña | 150.05 | Lerma-Santiago-Pacific | I, C |
| 65 | 1926 | Tacotán | Tacotán | 149.24 | Lerma-Santiago-Pacific | I, C |
| 66 | 1702 | Basilio Vadillo | Las Piedras | 145.72 | Lerma-Santiago-Pacific | I |
| 67 | 3747 | El Chique | El Chique | 139.95 | Lerma-Santiago-Pacific | I |
| 68 | 1203 | Santiago Bayacora | Bayacora | 130.05 | Northern Pacific | I |
| 69 | 3308 | Ing. Rodolfo Félix Valdéz | El Molinito | 130.04 | Northwest | I, C |
| 70 | 1499 | Revolución Mexicana | El Guineo | 126.69 | Southern Pacific | I, C |
| 71 | 917 | El Tintero | El Tintero | 125.08 | Rio Bravo | I, C |
| 72 | 2011 | Huapango | Huapango | 121.50 | Northern Gulf | I |

| Nº | SGT Code | Official name | Given name | Capacity at the NPE ($hm^3$) | HAR | Uses |
|---|---|---|---|---|---|---|
| 73 | 3790 | Gobernador Leobardo Reynoso | Trujillo | 118.07 | Central Basins of the North | I |
| 74 | 1365 | La Purísima | La Purisima | 110.03 | Lerma-Santiago-Pacific | I, C |
| 75 | 1459 | Andrés Figueroa | Las Garzas | 102.50 | Balsas | I |
| 76 | 3197 | Lic. Eustaquio Buelna | Guamuchil | 90.06 | Northern Pacific | P, C, I |
| 77 | 731 | Abraham González | Guadalupe | 85.44 | Northwest | I, C |
| 78 | 1887 | El Salto | El Salto | 85.00 | Lerma-Santiago-Pacific | P |
| 79 | 2202 | Cointzio | Cointzio | 84.80 | Lerma-Santiago-Pacific | P, I |
| 80 | 1057 | Presidente Guadalupe Victoria | El Tunal | 84.75 | Northern Pacific | I |
| 81 | 5133 | Derivadora Las Blancas | Las Blancas | 84.00 | Rio Bravo | I, C |
| 82 | 836 | Las Lajas | Las Lajas | 83.27 | Rio Bravo | I, C |
| 83 | 1800 | Ing. Elías González Chávez | Puente Calderon | 80.00 | Lerma-Santiago-Pacific | P |
| 84 | 237 | Abelardo L. Rodríguez | Rodriguez or Tijuana | 76.90 | Baja California Peninsula | P, C |
| 85 | 1040 | Francisco Villa | El Bosque | 73.26 | Northern Pacific | I |
| 86 | 3807 | Miguel Alemán | Excame | 71.61 | Lerma-Santiago-Pacific | G, I, C |
| 87 | 2886 | Constitución de 1917 | Presa Hidalgo | 69.86 | Northern Gulf | I |
| 88 | 711 | Juan Sabines | El Portillo II or Cuxquepeques | 68.15 | Southern Border | I |
| 89 | 2113 | San Andrés Tepetitlán | Tepetitlan | 67.62 | Lerma-Santiago-Pacific | I |
| 90 | 2359 | San Juanico | La Laguna | 60.48 | Balsas | I, C |
| 91 | 2005 | Guadalupe | Guadalupe | 56.70 | Waters of the Valley of Mexico | I |
| 92 | 4677 | Ing. Juan Guerrero Alcocer | Vinoramas | 55.00 | Northern Pacific | P, C, I |
| 93 | 3562 | República Espyearla | Real Viejo or El Sombrero | 54.78 | Northern Gulf | I |
| 94 | 3639 | San José Atlanga | Atlanga | 54.50 | Balsas | I |
| 95 | 2931 | San Ildefonso | El Tepozán | 52.75 | Northern Gulf | I |
| 96 | 1639 | Requena | Requena | 52.42 | Waters of the Valley of Mexico | I |
| 97 | 4531 | Ing. Guillermo Lugo Sanabria | La Polvora | 51.70 | Lerma-Santiago-Pacific | I |
| 98 | 867 | Pico del Águila | Pico del Aguila | 51.21 | Rio Bravo | I |
| 99 | 2408 | Zicuirán | La Peña | 50.00 | Balsas | I |
| 100 | 1602 | Javier Rojo Gómez | La Peña | 50.00 | Waters of the Valley of Mexico | I |
| 101 | 461 | San Miguel | San Miguel | 47.30 | Rio Bravo | I |
| 102 | 2782 | Yosocuta | San Marcos Arteaga | 46.80 | Balsas | P, I |
| 103 | 981 | Caboraca | Canoas | 45.00 | Northern Pacific | I |
| 104 | 1918 | Ing. Santiago Camarena | La Vega | 44.00 | Lerma-Santiago-Pacific | I |
| 105 | 1666 | La Laguna | Tejocotal | 43.53 | Central Gulf | G |
| 106 | 1664 | Taxhimay | Taxhimay | 42.80 | Waters of the Valley of Mexico | I |
| 107 | 3267 | Cuauhtémoc | Santa Teresa | 41.47 | Northwest | I |
| 108 | 241 | El Carrizo | El Carrizo | 40.87 | Baja California Peninsula | P |
| 109 | 2668 | Rodrigo Gómez | La Boca | 39.49 | Rio Bravo | P |
| 110 | 514 | Laguna de Amela | Tecoman | 38.34 | Lerma-Santiago-Pacific | I |
| 111 | 4559 | Guaracha | San Antonio | 38.20 | Lerma-Santiago-Pacific | I |
| 112 | 2024 | José Antonio Alzate | San Bernabe | 35.31 | Lerma-Santiago-Pacific | I |
| 113 | 3782 | Ing. Julián Adame Alatorre | Tayahua | 34.48 | Lerma-Santiago-Pacific | I |
| 114 | 1120 | Peña del Águila | Peña del Aguila | 31.73 | Northern Pacific | I |
| 115 | 3524 | Pedro José Méndez | Pedro Jose Méndez | 31.26 | Northern Gulf | P, I |
| 116 | 1995 | Danxhó | Danxhó | 31.05 | Northern Gulf | I |
| 117 | 1505 | Valerio Trujano | Tepecoacuilco | 31.01 | Balsas | P, I |
| 118 | 1757 | El Cuarenta | El Cuarenta | 30.60 | Lerma-Santiago-Pacific | I |
| 119 | 1945 | El Tule | El Tule | 30.00 | Lerma-Santiago-Pacific | I |

| Nº | SGT Code | Official name | Given name | Capacity at the NPE (hm³) | HAR | Uses |
|---|---|---|---|---|---|---|
| 120 | 2829 | Necaxa | Necaxa | 29.06 | Central Gulf | G |
| 121 | 2458 | La Laguna | El Rodeo | 28.00 | Balsas | I |
| 122 | 3827 | Ramon López Velarde | Boca del Tesorero | 27.00 | Lerma-Santiago-Pacific | I |
| 123 | 3739 | El Cazadero | El Cazadero | 26.85 | Central Basins of the North | I |
| 124 | 2848 | Tenango | Tenango | 26.82 | Central Gulf | G |
| 125 | 2840 | Los Reyes | Omiltepec | 26.05 | Central Gulf | G |
| 126 | 1237 | Villa Hidalgo | Villa Hidalgo | 25.00 | Central Basins of the North | I, P |
| 127 | 363 | El Centenario | El Centenario | 24.68 | Rio Bravo | I |
| 128 | 1357 | Peñuelitas | Peñuelitas | 23.83 | Lerma-Santiago-Pacific | I |
| 129 | 2282 | Malpaís | La Ciénega | 23.74 | Lerma-Santiago-Pacific | I |
| 130 | 777 | Chihuahua | Chihuahua | 23.38 | Rio Bravo | P |
| 131 | 2298 | Los Olivos | Los Olivos | 21.75 | Balsas | I |
| 132 | 1799 | Hurtado | Hurtado | 21.73 | Lerma-Santiago-Pacific | I |
| 133 | 1337 | Mariano Abasolo | San Antonio de Aceves | 21.42 | Lerma-Santiago-Pacific | I |
| 134 | 381 | La Fragua | La Fragua | 21.17 | Rio Bravo | I |
| 135 | 1107 | Los Naranjos | Naranjos | 20.93 | Central Basins of the North | I |
| 136 | 1673 | Vicente Aguirre | Las Golondrinas | 20.80 | Northern Gulf | I |
| 137 | 2013 | Ignacio Ramírez | La Gavia | 20.50 | Lerma-Santiago-Pacific | I |
| 138 | 2671 | Salinillas | Salinillas | 19.01 | Rio Bravo | I |
| 139 | 3661 | La Cangrejera | La Cangrejera | 18.84 | Central Gulf | I |
| 140 | 2161 | Aristeo Mercado | Wilson | 18.34 | Lerma-Santiago-Pacific | I |
| 141 | 1487 | Laguna de Tuxpan |  | 17.65 | Balsas | I |
| 142 | 2045 | Ñadó | Ñadó | 16.80 | Northern Gulf | I |
| 143 | 152 | El Niágara | El Niagara | 16.19 | Lerma-Santiago-Pacific | I |
| 144 | 3297 | Ignacio R. Alatorre | Punta de Agua | 16.16 | Northwest | I |
| 145 | 2 | Abelardo L. Rodríguez | Abelardo L. Rodríguez | 15.99 | Lerma-Santiago-Pacific | I |
| 146 | 2144 | Agostitlán | Mata de Pinos | 15.95 | Balsas | I |
| 147 | 2194 | Tercer Mundo | Chincua | 15.58 | Lerma-Santiago-Pacific | I |
| 148 | 1078 | José Jerónimo Hernández | Santa Elena | 15.10 | Northern Pacific | I |
| 149 | 142 | Media Luna | Media Luna | 15.00 | Lerma-Santiago-Pacific | I |
| 150 | 1950 | Vicente Villaseñor | Valle de Juárez | 14.44 | Lerma-Santiago-Pacific | I |
| 151 | 1879 | La Red | La Red | 14.25 | Lerma-Santiago-Pacific | I |
| 152 | 2400 | Urepetiro | Urepetiro | 13.00 | Lerma-Santiago-Pacific | I |
| 153 | 2037 | Madín | Madín | 12.95 | Waters of the Valley of Mexico | P |
| 154 | 2830 | Nexapa | Nexapa | 12.50 | Central Gulf | G |
| 155 | 1989 | La Concepción | La Concepcion | 12.11 | Waters of the Valley of Mexico | I |
| 156 | 2263 | Laguna del Fresno |  | 12.08 | Lerma-Santiago-Pacific | I |
| 157 | 3850 | Santa Rosa | Santa Rosa | 11.36 | Central Basins of the North | I |
| 158 | 118 | Derivadora Jocoque | Derivadora Jocoque | 10.98 | Lerma-Santiago-Pacific | I |
| 159 | 1935 | Tenasco | Boquilla de Zaragoza | 10.50 | Lerma-Santiago-Pacific | I |
| 160 | 2253 | Jaripo | Jaripo | 10.20 | Lerma-Santiago-Pacific | I |
| 161 | 1354 | El Palote | El Palote | 10.01 | Lerma-Santiago-Pacific | P |
| 162 | 3780 | José María Morelos | La Villita | 10.00 | Lerma-Santiago-Pacific | I |
| 163 | 2003 | Francisco José Trinidad Fabela | Isla de las Aves o El Salto | 9.93 | Lerma-Santiago-Pacific | I |
| 164 | 2321 | Pucuato | Pucuato | 9.58 | Balsas | I |
| 165 | 3019 | Ing. Valentín Gama | Ojo Caliente | 9.51 | Central Basins of the North | I |
| 166 | 1462 | La Calera | La Calera | 9.39 | Balsas | I |
| 167 | 2903 | La Llave | Divino Redentor | 9.31 | Northern Gulf | I |

| Nº | SGT Code | Official name | Given name | Capacity at the NPE (hm³) | HAR | Uses |
|---|---|---|---|---|---|---|
| 168 | 2881 | El Centenario | El Centenario | 8.99 | Northern Gulf | I |
| 169 | 2847 | La Soledad | Apulco or Mazatepec | 8.99 | Central Gulf | G |
| 170 | 2039 | El Molino | Arroyo Zarco | 7.70 | Northern Gulf | I |
| 171 | 1762 | Cuquío | Los Gigantes | 7.50 | Lerma-Santiago-Pacific | I |
| 172 | 881 | El Rejón | El Rejon | 6.53 | Rio Bravo | P |
| 173 | 2207 | Copándaro | Copandaro de Corrales | 6.50 | Lerma-Santiago-Pacific | I |
| 174 | 1773 | El Estribón | El Estribon | 6.40 | Lerma-Santiago-Pacific | P, I |
| 175 | 1307 | La Golondrina | La Golondrina | 6.00 | Lerma-Santiago-Pacific | I |
| 176 | 67 | La Codorniz | La Codorniz | 5.37 | Lerma-Santiago-Pacific | I |
| 177 | 2347 | Sabaneta | Sabaneta | 5.19 | Balsas | I |
| 178 | 1585 | La Esperanza | La Esperanza | 3.92 | Northern Gulf | I |
| 179 | 242 | Emilio López Zamora | Ensenada | 2.73 | Baja California Peninsula | P |
| 180 | 2954 | La Venta | La Venta | 2.48 | Northern Gulf | I |
| 181 | 158 | Derivadora Pabellón | Derivadora Potrerillos | 2.04 | Lerma-Santiago-Pacific | I |
| | | **Total** | | **129 906.23** | | |

**Source**: Conagua (2015a).

## **Map 4.1** Main reservoirs in Mexico, 2014


**Note:** The reservoirs with a capacity greater than 1 000 hm³ are named.
**Source:** Conagua (2015a).

# 4.3 Hydro-agricultural infrastructure

In Mexico, the area with infrastructure that allows irrigation is approximately 6.4 million hectares, of which 3.4 million correspond to 86 irrigation districts (IDs) and the remaining three million to more than 39 thousand irrigation units (IUs).

IDs and IUs considered the prevailing technology at the time of their design for the application of water to plots by means of gravity. In many cases, only the networks of channels and main drains were built, with the construction on the plots the responsibility of the users. This situation, along with the deterioration of the infrastructure, which has worsened over decades through the insufficient economic resources for their conservation and improvement, has brought about a decrease in the overall efficiency of water management.

It should be mentioned that the yield in areas under irrigation regimes is greater than in areas using rainfed agriculture. In 2013, for the main crops by area harvested -corn grain, sorghum grain and beans-, the yield in areas under irrigation, measured in tons/ha, was 2.2 to 3.3 times higher than in rainfed areas (produced based on SIAP 2014).

## Irrigation Districts (IDs)

[Reporteador: Distritos de riego]

IDs are irrigation projects developed by the federal government since 1926, the year in which the National Irrigation Commission was created, and include various works, such as storage basins, direct diversions, pumping plants, wells, channels and pathways, among others.

The existing IDs are shown in map 4.2 and table 4.2. It should be mentioned that the ID 113 Alto Río Conchos was inaugurated on January 27, 2012, meaning that there are now 86 IDs. In [Adicional: Table 4.A], data is presented by the IDs, whereas graph 4.2 illustrates the evolution of water used in the IDs for the agricultural years 2004-05 to 2013-14. The agricultural year in Mexico includes the period from October to September of the following year.

## **Map 4.2** Irrigation districts, 2014


**Source:** Conagua (2015f).

## **Table 4.2** Irrigation districts by hydrological-administrative region, 2014

| Number of HAR | Number of irrigation districts | Total surface area (ha) | Users | Physical surface irrigated (ha) | Volume distributed (hm³) 2014 |
|---|---|---|---|---|---|
| I | 2 | 245 678 | 18 457 | 220 674 | 2 556 |
| II | 7 | 466 272 | 30 007 | 398 036 | 3 933 |
| III | 9 | 806 643 | 94 121 | 735 291 | 7 428 |
| IV | 9 | 199 396 | 71 549 | 150 796 | 2 127 |
| V | 5 | 71 927 | 12 749 | 32 883 | 594 |
| VI | 13 | 469 451 | 49 639 | 359 949 | 2 311 |
| VII | 1 | 71 964 | 38 016 | 47 845 | 796 |
| VIII | 14 | 501 196 | 120 187 | 322 226 | 3 518 |
| IX | 13 | 257 993 | 38 534 | 110 877 | 822 |
| X | 2 | 41 416 | 8 987 | 30 559 | 536 |
| XI | 4 | 36 180 | 7 223 | 27 095 | 338 |
| XII | 2 | 18 490 | 4 867 | 14 787 | 73 |
| XIII | 5 | 97 950 | 52 151 | 87 311 | 1 463 |
| **Total** | **86** | **3 284 555** | **546 487** | **2 538 325** | **26 496** |

**Source:** Conagua (2015f).

Water is employed in IDs by means of gravity or pumping. In turn, the surface water source may be a dam, diversion or pump directly from the current; whereas the groundwater source is used by pumping wells. The volume distributed by each type of use is shown in [Adicional: Table 4.B].

The productivity of water in IDs is a key indicator to evaluate the efficiency with which water is used for food production, and depends upon the piping from the supply sources to plots and its use there. The evolution in this aspect is shown in graph 4.2, which shows the gross volume used corresponding to the vegetative cycle, which is why it does not coincide with the annual volumes used.

Graph 4.3 shows the evolution in productivity (within the scope of irrigation districts, considering only irrigated and not rainfed crops) for the period of agricultural years from 2004-05 to 2013-14.

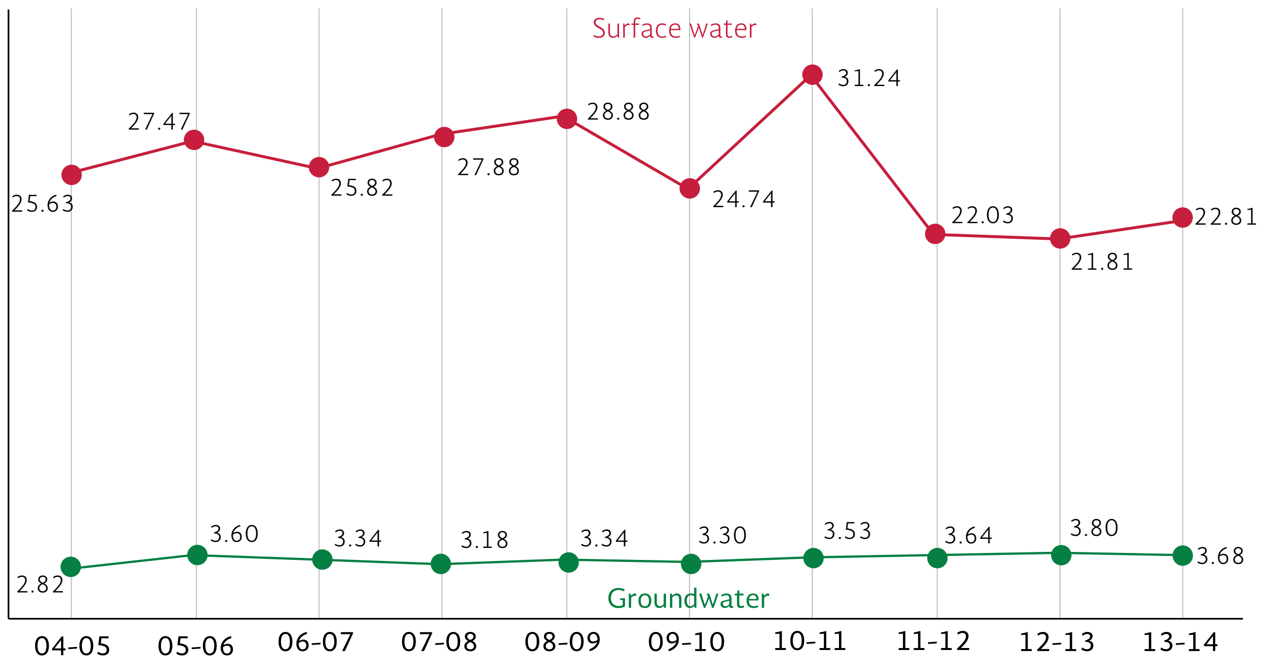
In the current environment in which a decrease in availability is predicted as a result of climate change, it is imperative to increase piping efficiencies. It should be mentioned that water productivity may fluctuate greatly according to the meteorological conditions, as well as the phenological characteristics of each crop.

For the 2013-14 agricultural year, the main crops according to the area harvested were corn grain and wheat grain, which together represented 41.9% of the surface area. It should be mentioned that these two crops combined were 20.4% of the production in tons and 27.9% of the value of production. The main crops are shown in [Adicional: Table 4.C].

The transfer of IDs to the users commenced with the creation of the Conagua in 1989 and the passing of the new National Water Law in 1992, with the support of a program of partial rehabilitation of the infrastructure that was allocated via irrigation modules to irrigation user associations.

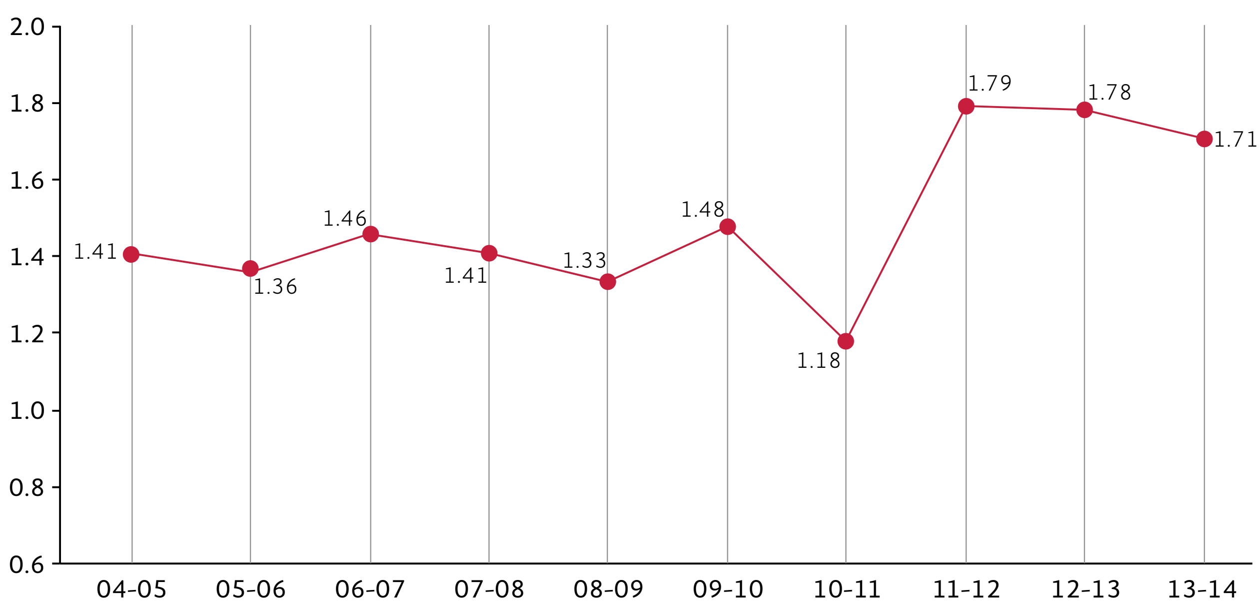
Up to December 2014, more than 99% of the total surface of the IDs had been transferred to the users. Up to that date, only two districts had not been totally transferred to the users, as shown in [Adicional: Table 4.D].

**Graph 4.2** Volume employed in IDs by source and agricultural year (thousands of hm³)




**Source**: CONAGUA (2015f).

**Graph 4.3** Productivity of water in IDs by agricultural year (kg/m³)




**Source**: CONAGUA (2015f).

## Irrigation Units (IUs)

[Reporteador: Distritos de riego]

IUs, also known as URDERALES in Spanish, are operated by members of cooperatives and small landholders, who in some cases are organized within these units. Annual statistics were generated from the 2004-2005 cycle. The data from the 2011-2012 agricultural year is shown in table 4.3.

## Technified Rainfed Districts (TRDs)

[Reporteador: Distritos de temporal y unidades de riego]

In Mexico's tropical and subtropical plains, which have an excess of humidity and constant floods, the federal government has established TRDs, in which infrastructure has been built to remove the excess volumes of water.

Table 4.4 lists the main characteristics of the TRDs. Similarly to the irrigation districts, the TRDs have gradually been transferred to organized users.

In **Mexico** there are **23** technified rainfed districts

**Table 4.3** Area harvested, production and yield of irrigation units by hydrological-administrative region, 2011-2012 agricultural year

| Number of HAR | Area harvested (ha) | Production (ton) | Yield (ton/ha) |
|---|---|---|---|
| I | 37 857 | 1 400 957 | 37.01 |
| II | 130 196 | 2 773 990 | 21.31 |
| III | 178 641 | 3 222 881 | 18.04 |
| IV | 356 934 | 8 388 421 | 23.50 |
| V | 94 554 | 1 270 249 | 13.43 |
| VI | 586 700 | 10 116 336 | 17.24 |
| VII | 305 139 | 9 810 342 | 32.15 |
| VIII | 870 791 | 21 371 261 | 24.54 |
| IX | 289 840 | 7 253 031 | 25.02 |
| X | 109 477 | 4 224 262 | 38.59 |
| XI | 32 677 | 1 479 263 | 45.27 |
| XII | 60 655 | 1 137 750 | 18.76 |
| XIII | 82 831 | 2 728 637 | 32.94 |
| **Total** | **3 136 292** | **75 177 380** | **23.97** |

**Source**: Conagua (2013).

**Table 4.4** Characteristics of the technified rainfed districts, 2014

| No | Code | Name | Number of HAR | State | Area (thousands of ha) | Users (number) |
|---|---|---|---|---|---|---|
| 1 | 1 | La Sierra | XI | Tabasco | 32.1 | 1 178 |
| 2 | 2 | Zanapa Tonala | XI | Tabasco | 106.9 | 6 919 |
| 3 | 3 | Tesechoacan | X | Veracruz de Ignacio de la Llave | 18.0 | 1 139 |
| 4 | 5 | Pujal Coy II | IX | San Luis Potosi, Tamaulipas and Veracruz de Ignacio de la Llave | 236.0 | 9 987 |
| 5 | 6 | Acapetahua | XI | Chiapas | 103.9 | 5 050 |
| 6 | 7 | Centro de Veracruz | X | Veracruz de Ignacio de la Llave | 75.0 | 6 367 |
| 7 | 8 | Oriente de Yucatan | XII | Yucatan | 667.0 | 25 021 |
| 8 | 9 | El Bejuco | III | Nayarit | 24.0 | 2 261 |
| 9 | 10 | San Fernando | IX | Tamaulipas | 505.0 | 13 975 |
| 10 | 11 | Margaritas-Comitan | XI | Chiapas | 41.9 | 5 397 |
| 11 | 12 | La Chontalpa | XI | Tabasco | 91.1 | 10 344 |
| 12 | 13 | Balancán-Tenosique | XI | Tabasco | 115.6 | 4 289 |
| 13 | 15 | Edzna-Yohaltun | XII | Campeche | 85.1 | 1 120 |
| 14 | 16 | Sanes Huasteca | XI | Tabasco | 26.4 | 1 321 |
| 15 | 17 | Tapachula | XI | Chiapas | 94.3 | 5 852 |
| 16 | 18 | Huixtla | XI | Chiapas | 107.6 | 6 010 |
| 17 | 20 | Margaritas-Pijijiapan | XI | Chiapas | 67.9 | 4 712 |
| 18 | 23 | Isla Rodríguez Clara | X | Veracruz de Ignacio de la Llave | 13.7 | 627 |
| 19 | 24 | Zona sur de Yucatan | XII | Yucatan | 26.1 | 880 |
| 20 | 25 | Río Verde | XII | Campeche | 134.9 | 1 984 |
| 21 | 26 | Valle de Ucum | XII | Quintana Roo | 104.8 | 1 739 |
| 22 | 27 | Frailesca | XI | Chiapas | 56.8 | 3 083 |
| 23 | 35 | Los Naranjos | X | Veracruz de Ignacio de la Llave | 92.6 | 6 045 |
|  | **Total** |  |  |  | **2 826.7** | **125 300** |

**Source**: Conagua (2015f).

# 4.4 Drinking water and sanitation infrastructure

## Drinking water coverage

[Reporteador: Cobertura universal]

In the Conagua it is considered that drinking water coverage includes all those who have tap water in their household, outside their household, but within their grounds, from a public tap or from another household. The calculation of the coverage is carried out from different censuses on population. For the years without any type of census, the Conagua carries out an estimation.

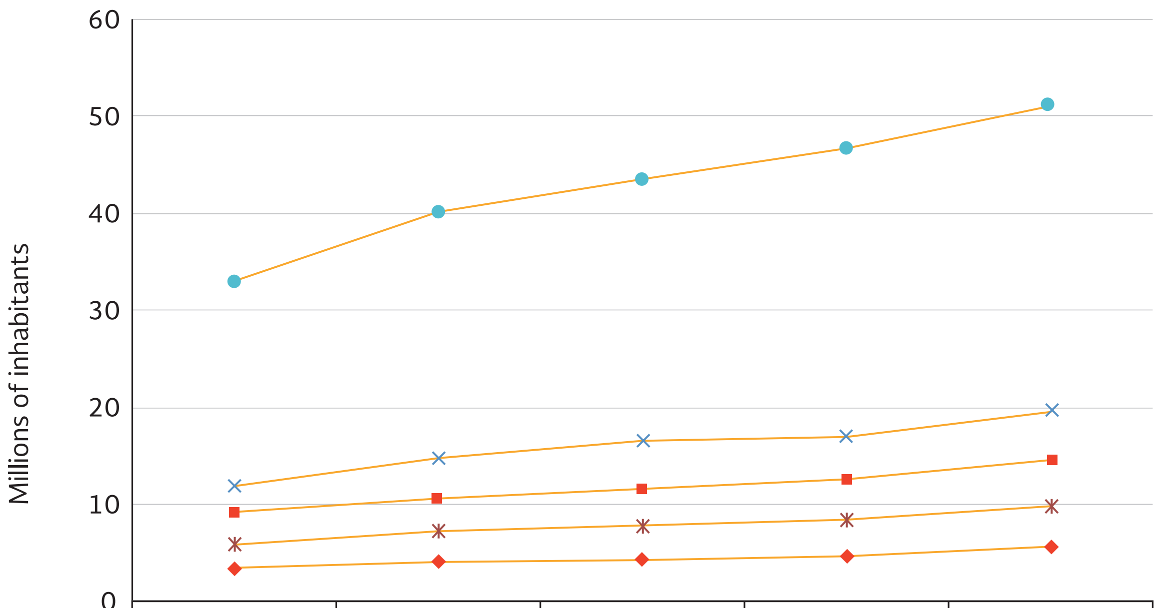
At the end of 2014
**92.4%**
of the population had drinking water coverage

Taking into account the aforementioned definition and the results of the 2010 Census on Population and Housing, up to June 25 that year, 90.9% of the population had drinking water coverage. In [Adicional: Table 4.E] the evolution in the country's drinking water coverage is shown, which has been calculated from the different censuses. The Conagua estimates that by the end of 2014, the drinking water coverage was 92.4%, which breaks down as 95.1% in urban zones and 82.9% in rural areas. The evolution in the percentages of coverage should be considered in line with population growth and urban concentration, meaning that the percentages in successive years increasingly represent greater numbers of inhabitants: just maintaining the percentage of coverage actually implies providing these services to more inhabitants.

The evolution in the population with coverage is differentiated according to the population range in the locality. The coverage for populations in large localities (more than 100 000 inhabitants) increases more rapidly than in smaller localities, as can be observed in graph 4.4, which shows the population at the time of the Censuses.

However, it should be taken into account that the increase in the population is greater in urban localities, whereas in rural localities the population is growing at a slower pace. Graph 4.5 illustrates the evolution in the population with drinking water coverage and the total population, considering in both cases both their rural and urban components.

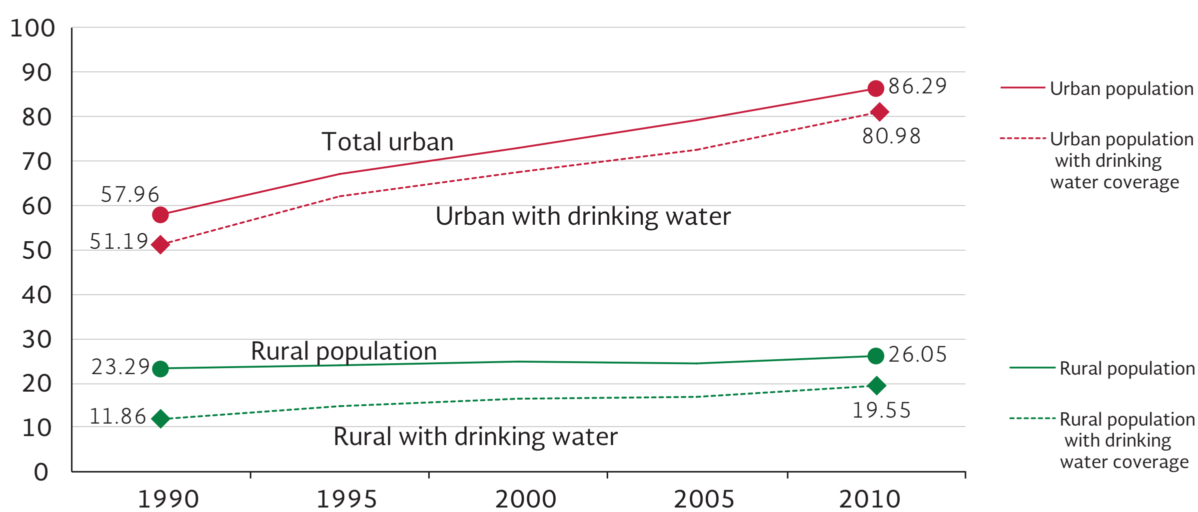
**GRAPH 4.4** Population with drinking water coverage, by population ranges




| | 1990 | 1995 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|
| 1-2 499 | 11 864 664 | 14 724 552 | 16 466 341 | 16 914 253 | 19 554 527 |
| 2 500 -14 999 | 9 117 904 | 10 675 524 | 11 671 967 | 12 545 001 | 14 550 482 |
| 15 000-49 999 | 5 760 112 | 7 182 064 | 7 892 887 | 8 421 362 | 9 818 678 |
| 50 000-99 999 | 3 402 524 | 4 053 299 | 4 278 454 | 4 649 524 | 5 536 132 |
| 100 000 and above | 32 910 338 | 40 103 489 | 43 459 153 | 46 693 611 | 51 070 728 |

**Source**: Produced based on CONAGUA (2007), CONAGUA (2015m), INEGI (2015c).

**GRAPH 4.5** Evolution in the rural and urban population with drinking water coverage (millions of inhabitants)




**Source**: Produced based on CONAGUA (2007), CONAGUA (2015m), INEGI (2015c).

## Sanitation coverage

[Reporteador: Cobertura universal]

On the other hand, the Conagua considers that sanitation coverage includes those citizens connected to the sanitation network or a septic tank, wastepipe, ravine, crevice, lake or sea. Similarly to drinking water coverage, for sanitation it is calculated based on the different censuses of the population. For years without any form of census, the Conagua carries out an estimation.

It should be mentioned that for the purpose of this document, sanitation and sewerage are considered as synonyms. Taking into account that definition and the results of the 2010 Census on Population and Housing, up to June 25 of that year, 89.6% of the population had sanitation coverage.

The Conagua estimates that by the end of 2014, sanitation coverage was 91%, composed of 96.3% coverage in urban areas and 72.8% in rural zones. [Adicional: Table 4.F] shows the composition of the sanitation coverage nationwide, calculated based on the different censuses. As was commented for drinking water, the percentages of coverage in successive years increasingly represent greater numbers of inhabitants: just maintaining the percentage of coverage actually implies providing these services to more inhabitants.

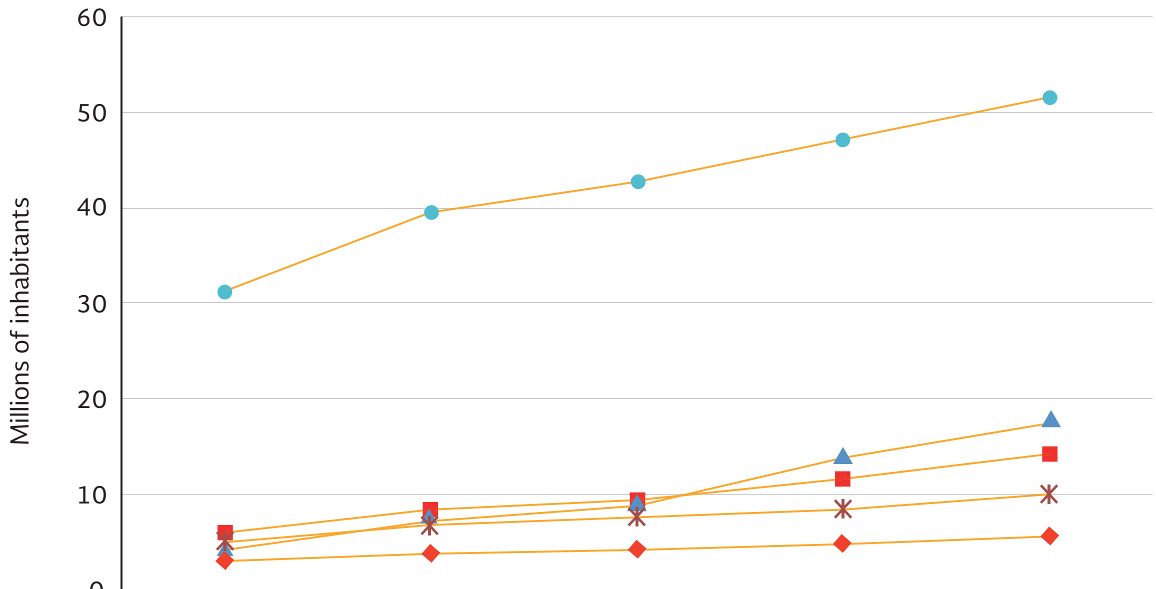
At the end up 2014

**91%**

of the population had sanitation coverage

As in the case of drinking water, the evolution in the population with sanitation coverage is also differentiated as regards the size of the population in each locality. In this case, the population with sanitation coverage in rural localities increased significantly from 2000 onwards, as can be appreciated in graphs 4.6 and 4.7.

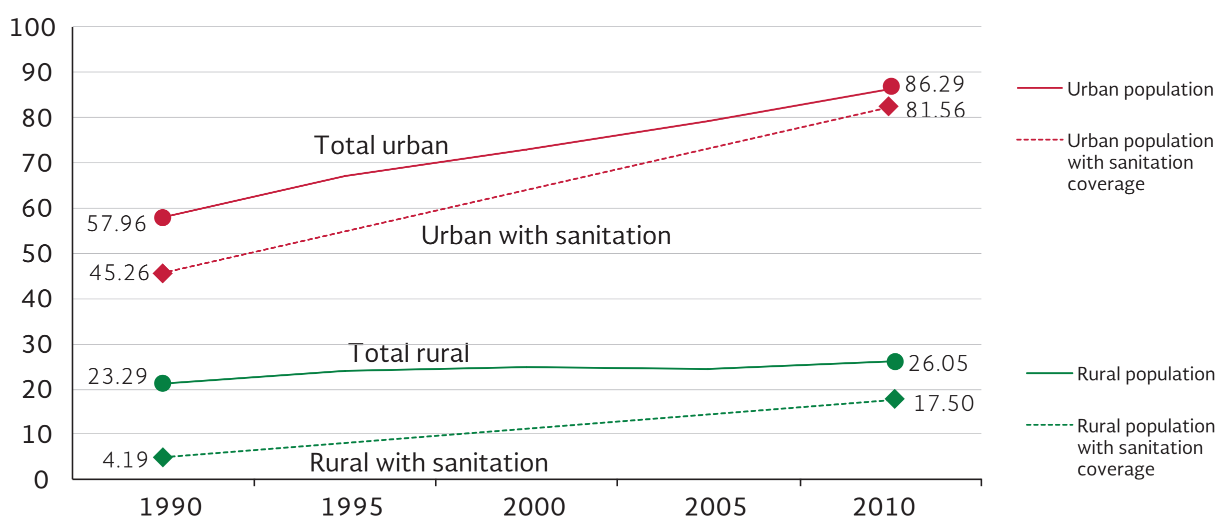
**Graph 4.6** Population with sanitation coverage, by population ranges




| | 1990 | 1995 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|
| 1-2 499 | 4 192 850 | 7 128 147 | 8 895 698 | 13 758 528 | 17 499 695 |
| 2 500-14 999 | 5 997 188 | 8 375 040 | 9 372 637 | 11 528 523 | 14 179 960 |
| 15 000-49 999 | 4 976 324 | 6 810 300 | 7 516 231 | 8 508 107 | 10 057 011 |
| 50 000-99 999 | 3 028 547 | 3 846 956 | 4 097 097 | 4 713 634 | 5 661 924 |
| 100 000 and above | 31 259 792 | 39 528 700 | 42 772 718 | 47 132 386 | 51 660 243 |

**Source**: Produced based on Conagua (2007), Conagua (2015m), Inegi (2015c).

**Graph 4.7** Evolution in the rural and urban population with sanitation coverage (millions of inhabitants)




**Source**: Produced based on Conagua (2007), Conagua (2015m), Inegi (2015c).

The evolution in coverage both for drinking water and sanitation, considering the urban and rural contexts, is illustrated in table 4.5.

In table 4.6 the drinking water and sanitation coverage and in table 4.7 the sanitation coverage are shown by hydrological-administrative region (HAR). It can be observed that the regions with the greatest backlogs in drinking water are V Southern Pacific, IX Northern Gulf, X Central Gulf and XI Southern Border; whereas for sanitation the greatest backlogs are concentrated in the regions V Southern Pacific, IX Northern Gulf, X Central Gulf and XII Yucatan Peninsula.

The states with the greatest backlogs in drinking water coverage are: Guerrero, Oaxaca and Chiapas; whereas in terms of sanitation it is Oaxaca, Guerrero and Yucatan, as shown in [Adicional: Table 4.G].

**Table 4.5** Coverage of the national population with drinking water and sanitation, by urban and rural scopes, series of Census years from 1990 to 2010

| Population | 1990 Census (%) | 1995 Census (%) | 2000 Census (%) | 2005 Census (%) | 2010 Census (%) |
|---|---|---|---|---|---|
| | 12/03/1990 | 5/11/1995 | 14/02/2000 | 17/10/2005 | 25/06/2010 |
| **Drinking water** | | | | | |
| Rural | 51.19 | 61.23 | 67.95 | 70.66 | 75.69 |
| Urban | 89.41 | 93.00 | 94.60 | 95.03 | 95.59 |
| **Total** | **78.39** | **84.58** | **87.83** | **89.20** | **90.94** |
| **Sanitation** | | | | | |
| Rural | 18.09 | 29.64 | 36.71 | 57.48 | 67.74 |
| Urban | 79.05 | 87.82 | 89.62 | 94.47 | 96.28 |
| **Total** | **61.48** | **72.40** | **76.18** | **85.62** | **89.61** |

**Source**: Produced based on Inegi (2015c).

**Table 4.6** Coverage of the population with drinking water services (years of Censuses)

| Number of HAR | Drinking water | | | | |
|---|---|---|---|---|---|
| | 12/03/1990 | 5/11/1995 | 14/02/2000 | 17/10/2005 | 25/06/2010 |
| I | 81.89% | 87.83% | 92.35% | 93.10% | 95.46% |
| II | 89.58% | 93.04% | 95.04% | 94.58% | 96.28% |
| III | 78.68% | 85.58% | 88.82% | 89.04% | 91.29% |
| IV | 72.66% | 81.11% | 83.27% | 84.70% | 85.76% |
| V | 60.07% | 69.49% | 73.68% | 73.49% | 75.60% |
| VI | 91.25% | 93.95% | 95.75% | 95.84% | 97.00% |
| VII | 84.49% | 89.07% | 91.74% | 94.10% | 95.04% |
| VIII | 84.01% | 90.18% | 92.14% | 93.31% | 94.86% |
| IX | 58.05% | 67.92% | 75.40% | 80.76% | 84.94% |
| X | 58.81% | 64.58% | 71.92% | 77.23% | 81.24% |
| XI | 56.71% | 65.44% | 73.29% | 74.42% | 78.51% |
| XII | 73.87% | 84.79% | 91.80% | 94.03% | 94.22% |
| XIII | 92.18% | 96.02% | 96.71% | 96.43% | 96.79% |
| **Total** | **78.39%** | **84.58%** | **87.83%** | **89.20%** | **90.94%** |

**Source**: Produced based on Inegi (2015c).

**Table 4.7** Coverage of the population with sanitation services (years of Censuses)

| Number of HAR | Sanitation | | | | |
|---|---|---|---|---|---|
| | 12/03/1990 | 5/11/1995 | 14/02/2000 | 17/10/2005 | 25/06/2010 |
| I | 65.41% | 75.22% | 80.51% | 88.89% | 93.08% |
| II | 62.23% | 71.94% | 76.33% | 83.94% | 88.08% |
| III | 51.65% | 63.94% | 69.89% | 82.65% | 87.45% |
| IV | 48.44% | 62.80% | 67.42% | 81.38% | 86.87% |
| V | 34.67% | 47.58% | 48.51% | 64.12% | 72.55% |
| VI | 73.21% | 83.23% | 87.66% | 93.34% | 95.42% |
| VII | 57.17% | 67.20% | 75.03% | 86.94% | 90.72% |
| VIII | 67.82% | 79.62% | 82.36% | 89.96% | 93.05% |
| IX | 34.55% | 42.59% | 50.55% | 65.68% | 72.98% |
| X | 46.04% | 56.06% | 60.26% | 74.94% | 81.60% |
| XI | 45.51% | 62.28% | 67.70% | 80.74% | 85.61% |
| XII | 45.03% | 57.54% | 63.12% | 76.37% | 84.48% |
| XIII | 85.26% | 92.57% | 93.86% | 96.81% | 97.82% |
| **Total** | **61.48%** | **72.40%** | **76.18%** | **85.62%** | **89.61%** |

**Source**: Produced based on Inegi (2015c).

## Aqueducts

[Reporteador: Acueductos principales]

There are more than 3 000 kilometers of aqueducts in Mexico that convey water to various cities and rural communities around the country, with a total capacity of more than 112 cubic meters per second. The main ones, as regards their length and flow, are listed in table 4.8.

## **Table 4.8** Main aqueducts in Mexico, 2014

| Nº | Aqueduct | Region | Length (km) | Design flow (l/s) | Year of completion | Supplies | Operator |
|---|---|---|---|---|---|---|---|
| 1 | Colorado River-Tijuana | I Baja California Peninsula | 130 | 4 000 | 1982 | Cities of Tijuana and Tecate and the village of La Rumorosa in Baja California. | Comisión de Servicios de Agua del Estado de Baja California (Cosae). |
| 2 | Vizcaino-Northern Pacific | I Baja California Peninsula | 206 | 62 | 1990 | Localities of Bahia Asuncion, Bahia Tortugas and the fishing villages of Punta Abreojos in Baja California | Organismo operador del municipio de Mulegé, B.C. |
| 3 | Cutzamala System | IV Balsas and XIII Waters of the Valley of Mexico | 162 | 19 000 | 1993 | The Metropolitan Area of the Valley of Mexico with water from the Valle de Bravo, Villa Victoria and El Bosque reservoirs, among others | Conagua |
| 4 | Linares-Monterrey | VI Rio Bravo | 133 | 5 000 | 1984 | The Metropolitan Area of the city of Monterrey, Nuevo Leon, with water from the Cerro Prieto reservoir | Servicios de Agua y Drenaje de Monterrey, I.P.D. |
| 5 | El Cuchillo-Monterrey | VI Rio Bravo | 91 | 5 000 | 1994 | The Metropolitan Area of the city of Monterrey, Nuevo Leon, with water from the Cuchillo reservoir | Servicios de Agua y Drenaje de Monterrey, I.P.D. |
| 6 | Lerma | VIII Lerma-Santiago-Pacific and XIII Waters of the Valley of Mexico | 60 | 14 000 | 1975 | Mexico City with water from the aquifers located in the upper area of Lerma River | Sistema de Aguas de la Ciudad de México. |
| 7 | Armeria-Manzanillo | VIII Lerma-Santiago-Pacific | 50 | 250 | 1987 | Manzanillo, Colima. | Comisión de Drinking water, Drenaje y Sanitation de Manzanillo, Colima. |
| 8 | Chapala-Guadalajara | VIII Lerma-Santiago-Pacific | 42 | 7 500 | 1991 | The Metropolitan Area of the city of Guadalajara with water from Lake Chapala | Sistema Intermunicipal para los Servicios de Drinking water y Sanitation (Siapa). |
| 9 | Vicente Guerrero reservoir-Ciudad Victoria | IX Northern Gulf | 54 | 1 000 | 1992 | Ciudad Victoria, Tamaulipas, with water from the Vicente Guerrero reservoir | Comisión Municipal de Drinking water y Sanitation (CoMap Victoria). |
| 10 | Uxpanapa-La Cangrejera | X Central Gulf | 40 | 20 000 | 1985 | 22 industries located in the southern part of the state of Veracruz | Conagua |
| 11 | Yurivia-Coatzacoalcos and Minatitlan | X Central Gulf | 64 | 2 000 | 1987 | Coatzacoalcos and Minatitlan, Veracruz with water from the Ocotal and Tizizapa rivers. | Comisión Municipal de Agua y Saneamiento de Coatzacoalcos Ver. (Cmaps Coatzacoalcos). |
| 12 | Aqueduct II Queretaro | VIII Lerma-Santiago-Pacific and IX Northern Gulf | 122 | 1 500 | 2011 | Santiago de Queretaro, Queretaro | Comisión State-wide de Aguas - Controladora de Operaciones de Infraestructura S.A. de C.V. (ICA). |
| 13 | Huitzilapan River-Xalapa | X Central Gulf | 55 | 1 000 | 2000 | Xalapa-Enriquez, Veracruz | Comisión Municipal de Agua y Saneamiento de Xalapa (CMAS Xalapa). |
| 14 | Chicbul-Ciudad del Carmen | XII Yucatan Peninsula | 122 | 390 | 1975 | Sabancuy, Isla Aguida and Ciudad del Carmen, Campeche | Sistema Municipal de Drinking water de Ciudad del Carmen, Campeche. |
| 15 | Conejos-Medanos | VI Rio Bravo | 25 | 1 000 | 2009 | Ciudad Juarez, Chihuahua | Junta Municipal de Agua y Saneamiento de Ciudad Juárez, Chihuahua - Administradora de Proyectos Hidráulicos de Ciudad Juárez, S.A. de C.V. (Grupo Carso). |
| 16 | Independencia | II Northwest | 135 | 2 380 | 2013 | Hermosillo, Sonora | Conagua |
| 17 | Paralelo Chicbul-Ciudad del Carmen | XII Yucatan Peninsula | 120 | 420 | 2014 | Sabancuy, Isla Aguida and Ciudad del Carmen, Campeche | Sistema Municipal de Drinking water de Ciudad del Carmen, Campeche. |
| 18 | Lomas de Chapultepec | V Southern Pacific | 34 | 1 250 | 2014 | Acapulco, Guerrero | Comisión de Drinking water, Sanitation y Saneamiento del Estado de Guerrero (CAPASEG) |
| | **Totales** | | **1 645** | **83 752** | | | |

**Source**: Conagua (2015e), Semarnat (2010), CAPASEG (2014), Gobierno de la República (2014).

## Cutzamala System

[Reporteador: Sistema Cutzamala]

The Cutzamala System, which supplies 11 delegations of the Federal District (Mexico City) and 11 municipalities of the State of Mexico, is one of the biggest drinking water supply systems in the world, not only for the **quantity** of water that it supplies (approximately 450 million cubic meters every year –see table 4.9–), but also because of the difference in **elevation** (1 100 m) that it overcomes. It contributes 17% of the supply for all uses in the Valley of Mexico catchment, calculated at 88 m³/s, which is complemented by the Lerma System (5%), groundwater extraction (68%) and rivers and springs (3%) and water reuse (7%) (WB 2013).

The Cutzamala System is made up of seven diversion and storage reservoirs, six pumping stations and one treatment plant with the characteristics indicated in [Adicional: Table 4.H]. The evolution in storage in the main reservoirs is shown in graph 4.8.

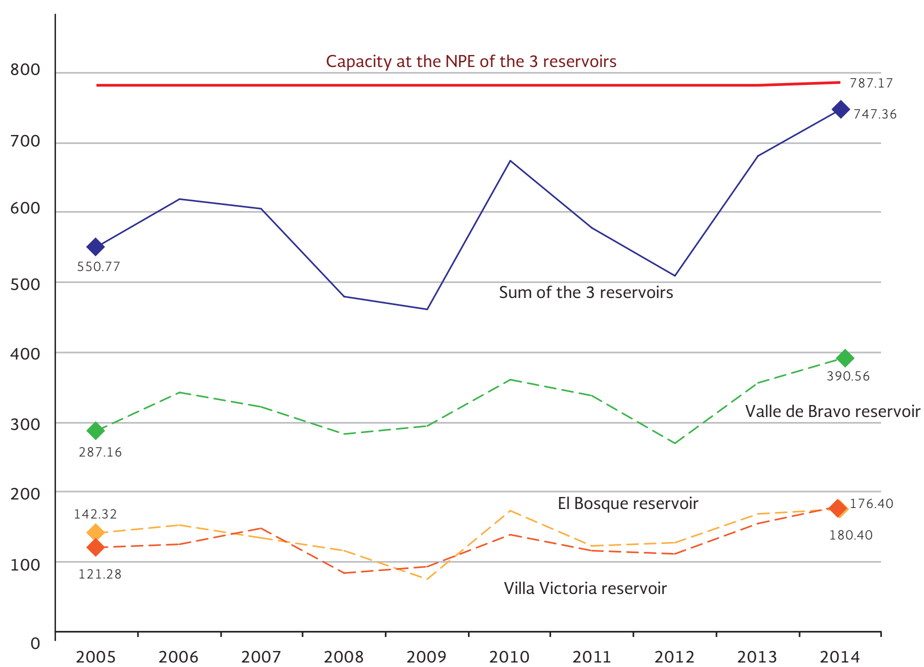
Figure 4.1 shows the location of the system and the difference in elevation that has to be overcome from the lowest point of Pumping Plant No. 1 to convey water to Oscillation Tower No. 5 and subsequently by gravity to the Metropolitan Area of the Valley of Mexico.

**Table 4.9** Volumes and flows supplied by the Cutzamala System (hm³)

| Year | Supplied to Mexico City | Supplied to the State of Mexico | Total |
|---|---|---|---|
| 2005 | 310.39 | 182.80 | 493.19 |
| 2006 | 303.53 | 177.26 | 480.79 |
| 2007 | 303.90 | 174.56 | 478.46 |
| 2008 | 306.25 | 179.47 | 485.72 |
| 2009 | 244.60 | 155.38 | 399.97 |
| 2010 | 266.85 | 165.84 | 432.69 |
| 2011 | 296.46 | 182.17 | 478.63 |
| 2012 | 272.54 | 190.96 | 463.50 |
| 2013 | 255.05 | 165.19 | 420.24 |
| 2014 | 294.86 | 181.85 | 476.71 |

**Source**: Conagua (2015n).

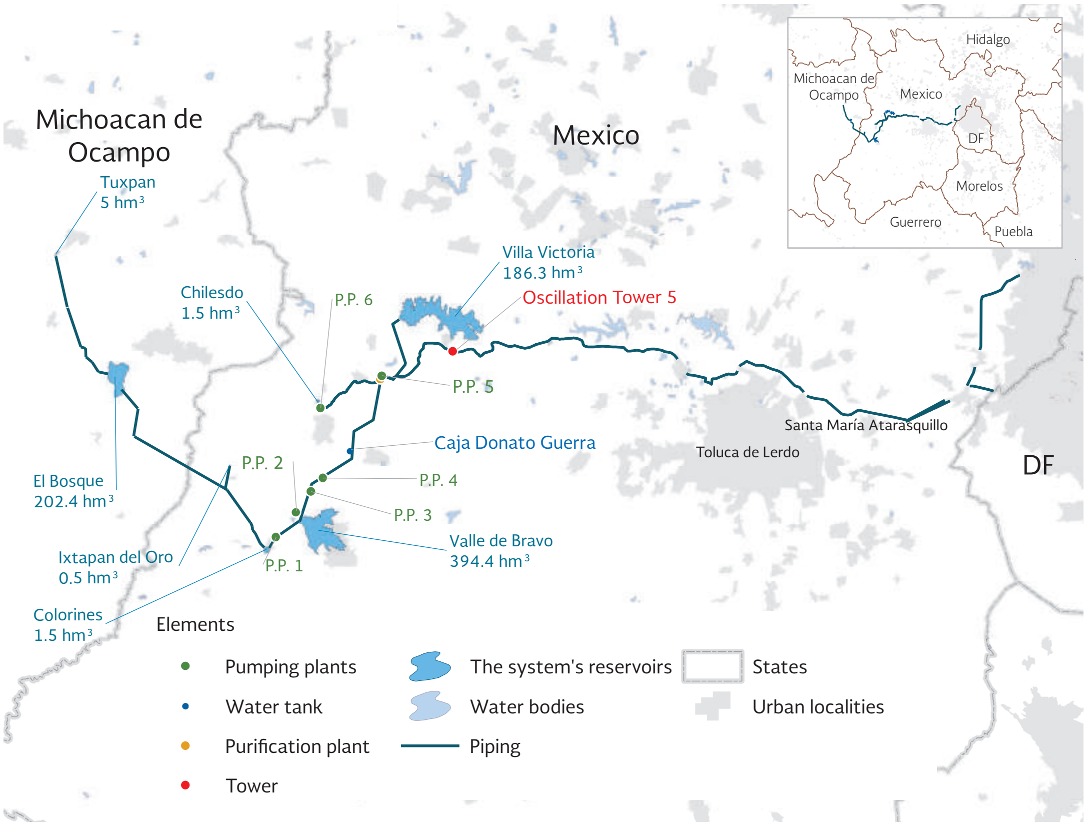
**Graph 4.8** Evolution in storage in the reservoirs of the Cutzamala System (hm³)



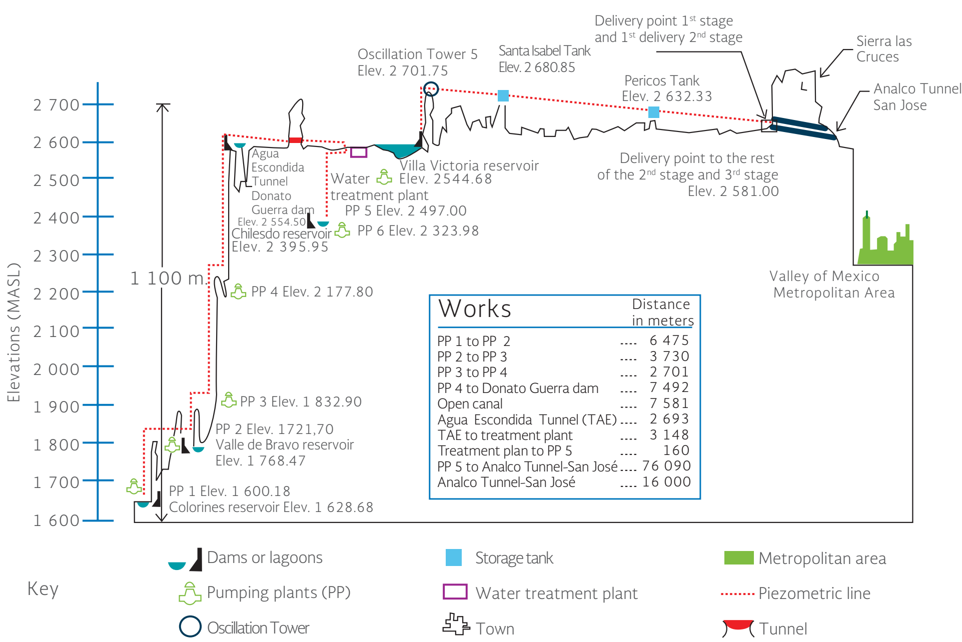

**Source**: Produced based on Conagua (2015n).

**FIGURE 4.1** Cutzamala System

## Plant




## Cross-section




**Source:** Produced based on CONAGUA (2015n), INEGI (2013c), INEGI (2013d).

## Purification plants

[Reporteador: Plantas Drinking water]

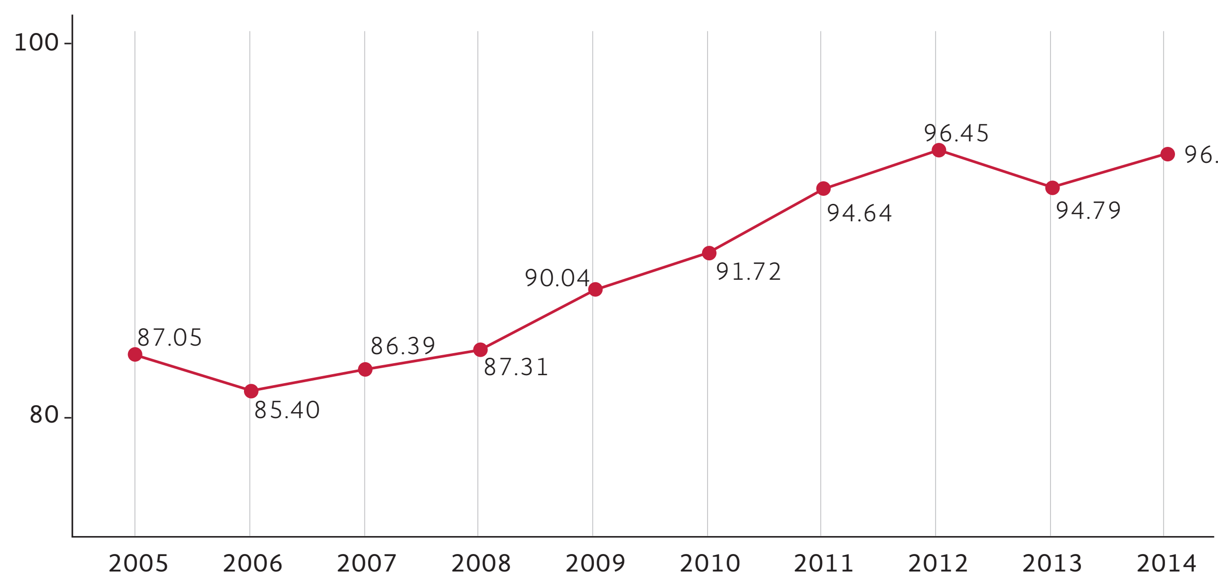
Municipal purification plants condition the water quality in surface and/or groundwater sources for public urban use. In 2014, 96.3 m³/s were treated in the 779 plants in operation in Mexico. The evolution in the flow treated annually is illustrated in graph 4.9.

In 2014 **96.3 m³/s** were treated in the **779** plants in operation in Mexico

The distribution of purification plants is listed in table 4.10 by HAR, and at the state level in [Adicional: Table 4.I]. It should be mentioned that the Los Berros treatment plant is included, found in the hydrological-administrative region IV Balsas. This plant is in the locality of the same name in the municipality of Villa de Allende, State of Mexico, and is part of the Cutzamala System. It is operated by the Waters of the Valley of Mexico River Basin Organization.

Table 4.11 illustrates the main treatment processes applied in those plants.

**Graph 4.9** Municipal flow treated (m³/s)




**Source**: Conagua (2015e).

**TABLE 4.10** Purification plants in operation, 2014

| Number of HAR | Number of plants in operation | Installed capacity (m³/s) | Flow treated (m³/s) |
|---|---|---|---|
| I | 44 | 12.37 | 7.17 |
| II | 24 | 5.58 | 2.29 |
| III | 156 | 9.47 | 8.44 |
| IV | 23 | 22.89 | 17.25 |
| V | 9 | 3.23 | 2.61 |
| VI | 63 | 27.17 | 14.28 |
| VII | 123 | 0.71 | 0.53 |
| VIII | 164 | 20.24 | 15.40 |
| IX | 47 | 8.19 | 7.40 |
| X | 13 | 7.09 | 4.59 |
| XI | 46 | 14.62 | 11.05 |
| XII | 1 | 0.03 | 0.02 |
| XIII | 66 | 6.47 | 5.25 |
| **Total** | **779** | **138.05** | **96.27** |

**Source**: CONAGUA (2015e).

**TABLE 4.11** Main purification processes applied, 2014

| Main process | Purpose | Plants | | Flow treated | |
|---|---|---|---|---|---|
| | | Number | % | m³/s | % |
| Softening | Elimination of hardness | 18 | 2.3 | 0.47 | 0.49 |
| Adsorption | Elimination of organic traces | 3 | 0.4 | 0.06 | 0.07 |
| Conventional clarification | Elimination of suspended solids | 213 | 27.3 | 68.81 | 71.47 |
| Patented clarification | Elimination of suspended solids | 157 | 20.2 | 5.09 | 5.28 |
| Direct filtration | Elimination of suspended solids | 76 | 9.8 | 15.34 | 15.94 |
| Slow filtering | Elimination of suspended solids | 10 | 1.3 | 0.06 | 0.06 |
| Carbon activated filters | Elimination of suspended solids | 35 | 4.5 | 0.03 | 0.03 |
| Reverse osmosis | Elimination of dissolved solids | 240 | 30.8 | 1.81 | 1.88 |
| Removal of iron and manganese | | 11 | 1.4 | 4.20 | 4.36 |
| Others | | 16 | 2.1 | 0.41 | 0.42 |
| | **Total** | **779** | **100.0** | **96.27** | **100.00** |

**Source**: CONAGUA (2015e).

# 4.5 Water treatment and reuse

## Wastewater discharge

[Reporteador: Descarga de Wastewater]

Wastewater discharges are classified as either municipal or industrial. Municipal ones are those which are managed in the urban and rural sanitation systems, whereas the latter are those that are discharged directly to national receiving water bodies, as is the case for self-supplying industry.

The sequence of wastewater generation, its collection in sewerage systems and treatment/disposal is shown in table 4.12. The table employs the abbreviation $BOD_5$, which corresponds to the parameter of five-day Biochemical Oxygen Demand.

In **2014**
**111.3 $m^3/s$**
of wastewater were treated in **2 337** municipal plants

**TABLE 4.12** Municipal and non-municipal wastewater discharges, 2014

| Urban centers (municipal discharges) | | |
|---|---|---|
| **Volume** | | |
| Municipal wastewater | 7.21 | thousand $hm^3$/year (228.7 $m^3$/s) |
| Collected in sewerage systems | 6.65 | thousand $hm^3$/year (211.0 $m^3$/s) |
| Treated | 3.51 | thousand $hm^3$/year (111.3 $m^3$/s) |
| **Polluting load** | | |
| Generated | 1.95 | million tons of $BOD_5$ per year |
| Collected in sewerage systems | 1.80 | million tons of $BOD_5$ per year |
| Removed in treatment systems | 0.77 | million tons of $BOD_5$ per year |
| **Non-municipal uses, including industry** | | |
| **Volume** | | |
| Non-municipal wastewater | 6.67 | thousand $hm^3$/year (211.4 $m^3$/s) |
| Treated | 2.07 | thousand $hm^3$/ year (65.6 $m^3$/s) |
| **Polluting load** | | |
| Generated | 9.99 | million tons of $BOD_5$ per year |
| Removed in treatment systems | 1.39 | million tons of $BOD_5$ per year |

**Source**: CONAGUA (2015e), CONAGUA (2015a).

## Municipal wastewater treatment plants

[Reporteador: Plantas de tratamiento]

In 2014, the 2 337 plants in operation in Mexico treated 111.3 m³/s, or 52.8% of the 211.0 m³/s collected in sewer systems. The evolution in the flow treated per year is shown in graph 4.10.

The wastewater treatment plants in operation by hydrological-administrative region are shown in table 4.13, as well as at the state level in [Adicional: T4.J].

The distribution of treatment plants is shown in map 4.3, and their main treatment processes are illustrated in graph 4.11.

**Table 4.13** Municipal wastewater treatment plants in operation, 2014

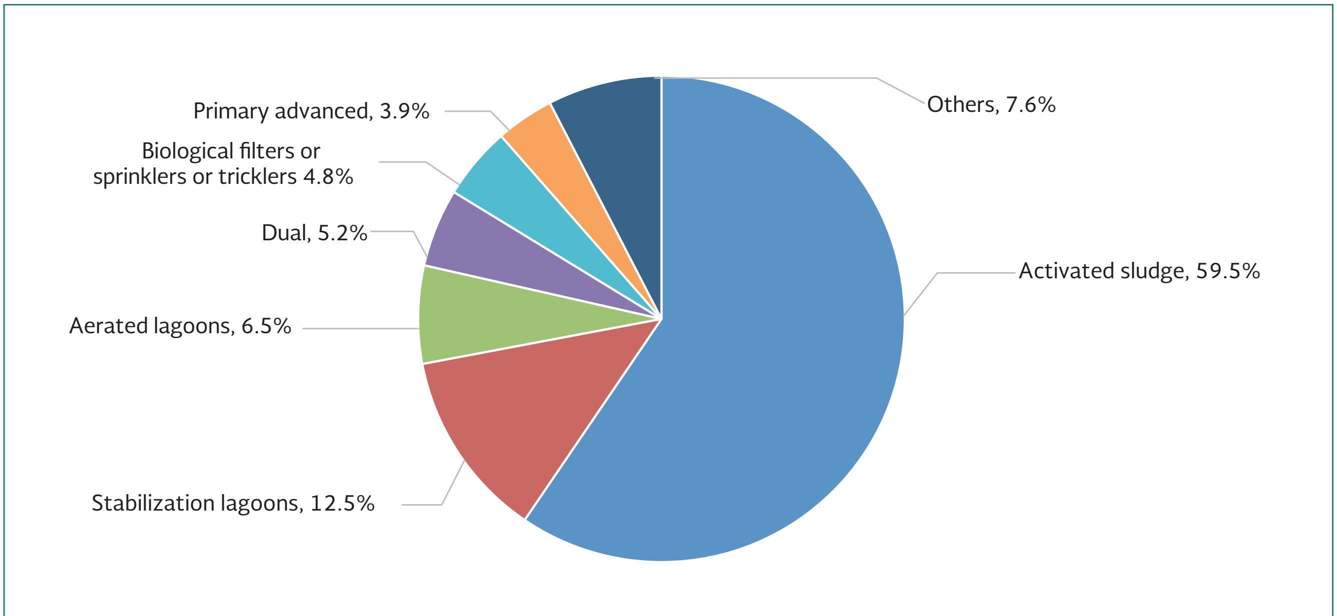
| Number of HAR | Number of plants in operation | Installed capacity (m³/s) | Flow treated (m³/s) |
|---|---|---|---|
| I | 66 | 9.86 | 6.87 |
| II | 101 | 4.94 | 3.44 |
| III | 362 | 10.26 | 7.88 |
| IV | 199 | 9.89 | 7.54 |
| V | 94 | 4.92 | 4.01 |
| VI | 225 | 34.15 | 24.04 |
| VII | 151 | 6.80 | 5.36 |
| VIII | 582 | 39.84 | 30.52 |
| IX | 86 | 5.53 | 4.16 |
| X | 137 | 6.80 | 5.30 |
| XI | 114 | 4.42 | 2.52 |
| XII | 81 | 2.95 | 2.03 |
| XIII | 139 | 11.54 | 7.58 |
| **Total** | **2 337** | **151.88** | **111.25** |

**Source**: Conagua (2015e).

**Graph 4.10** Flow of municipal wastewater treated (m³/s)

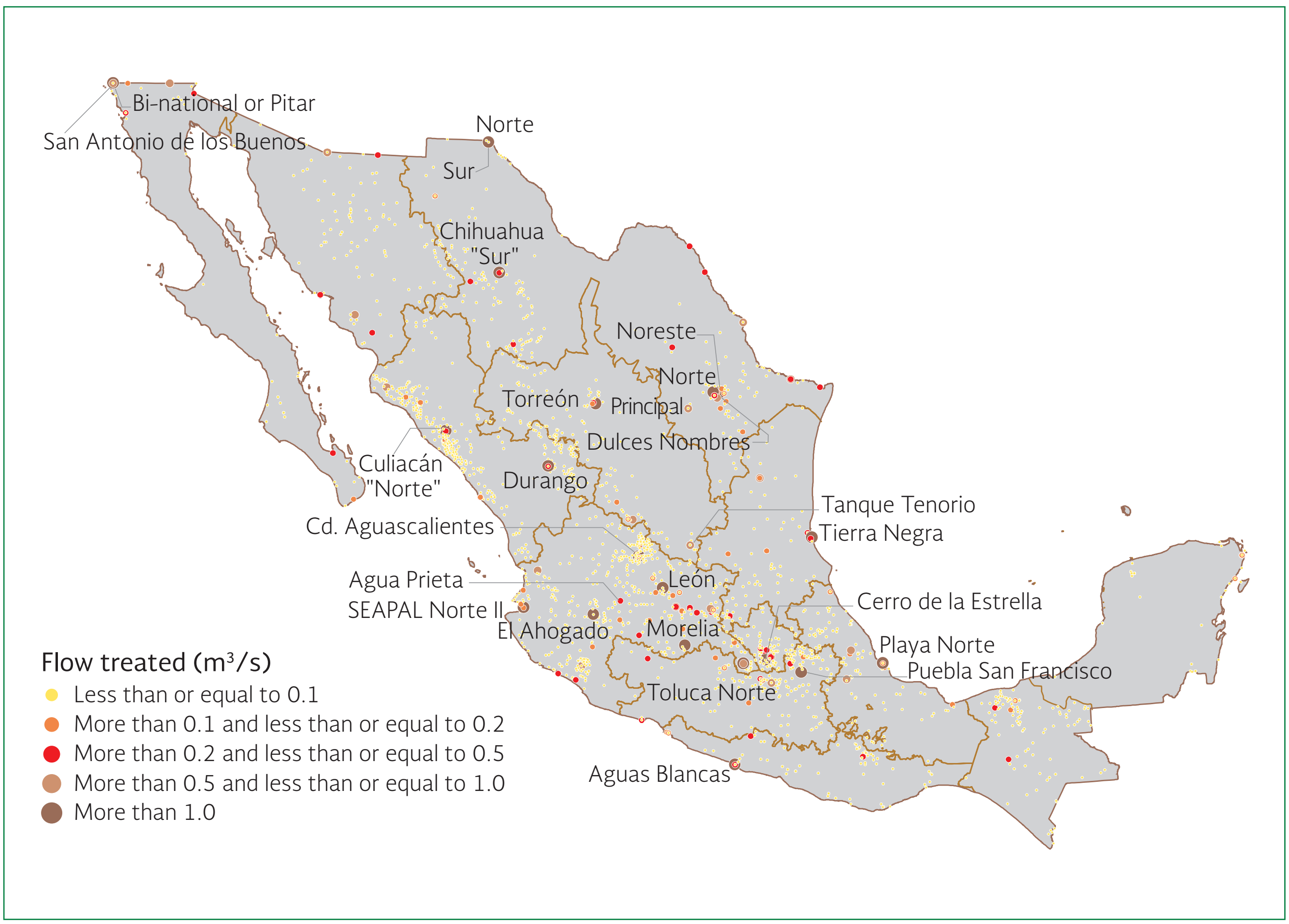

**Source**: Conagua (2015e).

**Graph 4.11** Main municipal wastewater treatment processes, by flow treated 2014




**Source**: CONAGUA (2015e).

**Map 4.3** Municipal wastewater treatment plants, 2014




**Source**: CONAGUA (2015e).

## Industrial wastewater treatment plants

[Reporteador: Plantas de tratamiento]

In 2014, industry treated 65.6 m³/s of wastewater, in 2 639 plants in operation nationwide.

In table 4.14 the main processes into which industrial treatment is broken down are shown; the evolution in the 2005-2014 period is shown in graph 4.12, whereas table 4.15 illustrates the distribution by states.

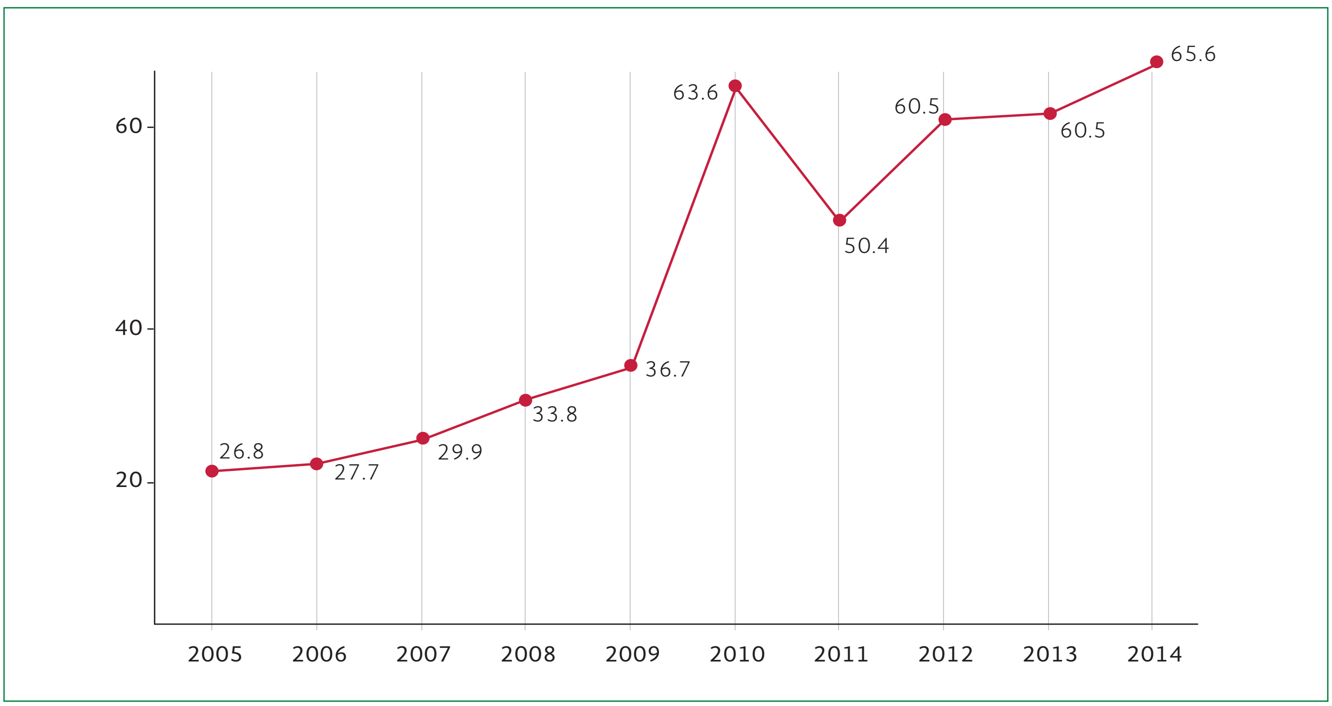
In 2014
**65.6 m³/s**
of wastewater were treated in 2 639
**industrial plants**

**TABLE 4.14** Types of industrial wastewater treatment, 2014

| Type of treatment | Purpose | Number of plants | Operating flow (m³/s) | Percentage |
|---|---|---|---|---|
| Primary | To adjust the pH and remove organic and/or inorganic materials in suspension, with a size equal to or greater than 0.1 mm. | 826 | 26.55 | 40.5 |
| Secondary | To remove colloidal and dissolved organic materials. | 1 569 | 31.63 | 48.2 |
| Tertiary | To remove dissolved materials, including gases, natural and synthetic organic substances, ions, bacteria and viruses. | 83 | 1.18 | 1.8 |
| Unspecified | | 161 | 6.20 | 9.5 |
| | **Total** | **2 639** | **65.56** | **100.0** |

**Source**: CONAGUA (2015a).

**GRAPH 4.12** Flow of industrial wastewater treated (m³/s)




**Source**: Produced based on CONAGUA (2015e).

## **Table 4.15** Industrial wastewater treatment plants in operation, 2014

| State | Number of plants in operation | Installed capacity ($m^3/s$) | Flow treated ($m^3/s$) |
|---|---|---|---|
| Aguascalientes | 47 | 0.34 | 0.14 |
| Baja California | 62 | 0.50 | 0.49 |
| Baja California Sur | 26 | 4.96 | 4.96 |
| Campeche | 129 | 1.93 | 1.92 |
| Coahuila de Zaragoza | 59 | 0.76 | 0.52 |
| Colima | 7 | 0.44 | 0.31 |
| Chiapas | 91 | 8.36 | 6.42 |
| Chihuahua | 15 | 0.65 | 0.28 |
| Federal District (Mexico City) | 7 | 0.01 | 0.01 |
| Durango | 43 | 1.08 | 0.62 |
| Guanajuato | 89 | 0.70 | 0.56 |
| Guerrero | 7 | 0.03 | 0.02 |
| Hidalgo | 46 | 1.84 | 1.38 |
| Jalisco | 71 | 1.54 | 1.54 |
| Mexico | 226 | 2.79 | 1.94 |
| Michoacan de Ocampo | 83 | 8.33 | 7.15 |
| Morelos | 97 | 2.13 | 2.09 |
| Nayarit | 6 | 0.16 | 0.16 |
| Nuevo Leon | 181 | 4.05 | 2.92 |
| Oaxaca | 18 | 2.77 | 2.45 |
| Puebla | 206 | 0.82 | 0.59 |
| Queretaro | 141 | 1.25 | 0.65 |
| Quintana Roo | 4 | 0.06 | 0.06 |
| San Luis Potosi | 57 | 0.79 | 0.53 |
| Sinaloa | 109 | 5.88 | 3.37 |
| Sonora | 235 | 6.46 | 6.26 |
| Tabasco | 117 | 0.85 | 0.86 |
| Tamaulipas | 115 | 8.36 | 7.72 |
| Tlaxcala | 82 | 0.28 | 0.25 |
| Veracruz de Ignacio de la Llave | 159 | 12.93 | 9.05 |
| Yucatan | 88 | 0.30 | 0.29 |
| Zacatecas | 16 | 0.16 | 0.05 |
| **Total** | **2 639** | **81.51** | **65.56** |

**Source**: Conagua (2015a).

## **Box 4.2** Water reuse

The Conagua estimates that in 2014, 21.8 $m^3/s$ of treated wastewater were directly reused (before being discharged), whereas 69.4 $m^3/s$ of treated wastewater were reused indirectly (after being discharged).

Exchanging treated wastewater, in which it replaces first-use water, is estimated at 8.9 $m^3/s$.

Reuse has several advantages: in cost, it reduces pressures on first-use water bodies and meets the demand for water that does not require drinking water quality.

**Source**: Conagua (2015e).

# 4.6 Emergency attention and flood protection

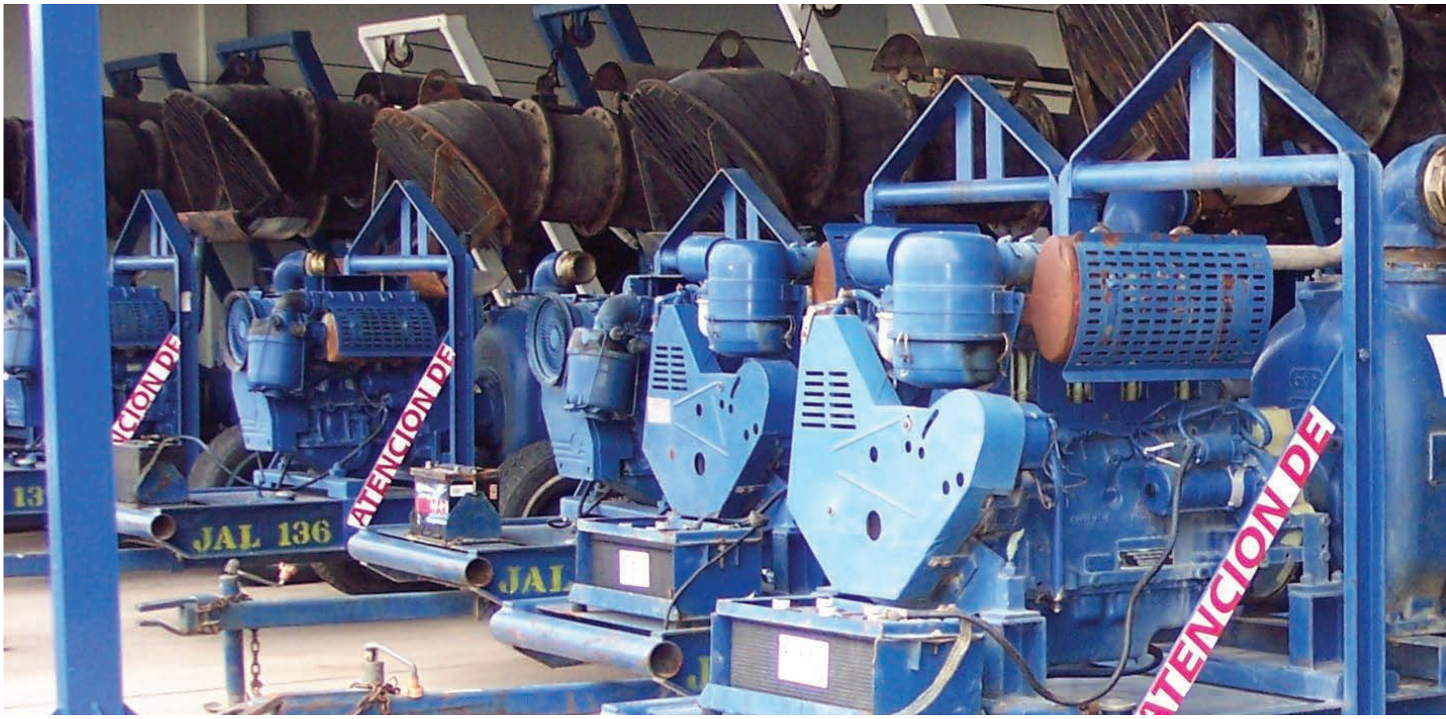
[Reporteador: Atención a emergencias]

As part of the Infrastructure Protection and Emergency Attention program (IPEA), the Conagua has set up 20 Regional Emergency Attention Centers (REACs) in various areas of the country, with the aim of supporting states and municipalities in supplying drinking water and sanitation in situations of risk. Map 4.4 shows the location of these centers.

Among the equipment at the disposal of the REACs are mobile treatment plants, pumping equipment, generators for independent electricity generation, water trucks and transportation equipment for the machinery. This emergency attention is carried out by the Conagua in coordination with the states, municipalities and federal agencies.

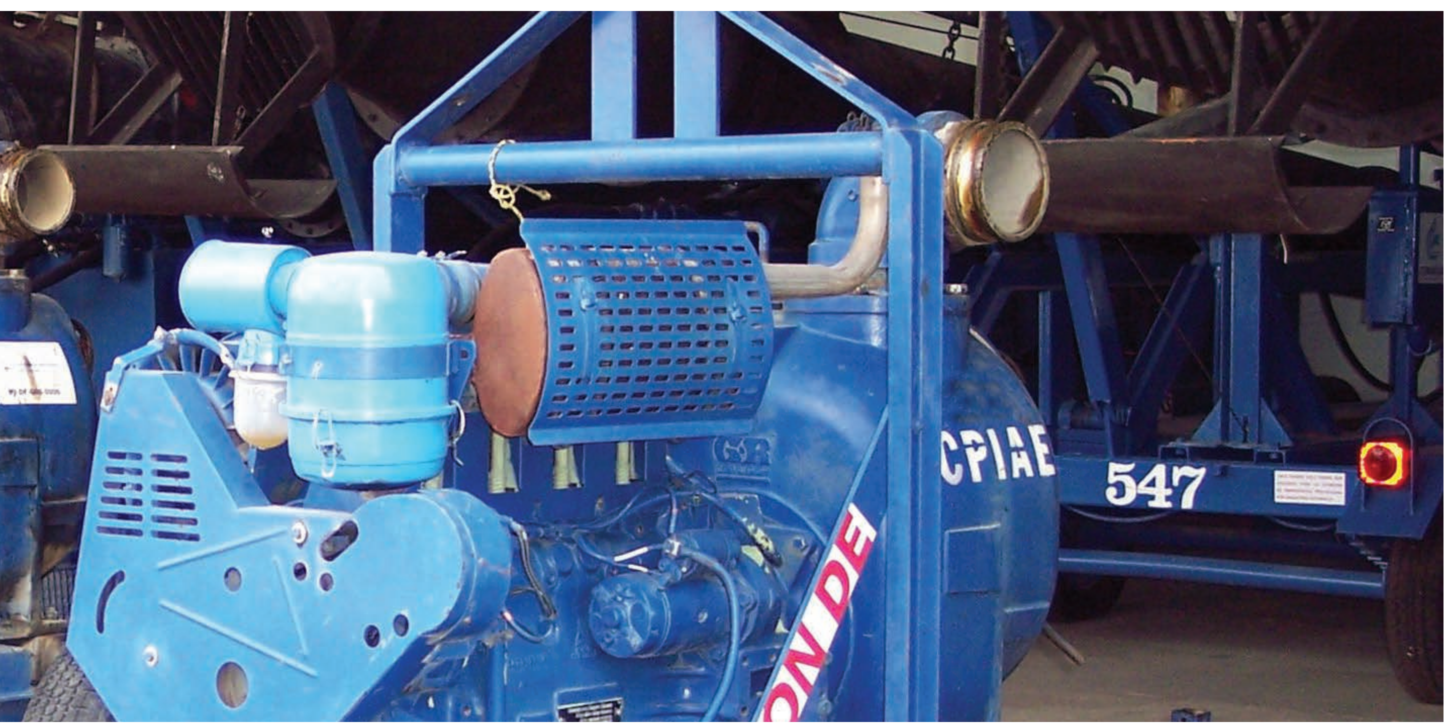
As regards the issue of the impacts of extreme hydro-meteorological phenomena, the most obvious manifestation of which is floods, emergency attention actions range from early warning on risks, to the development of prevention plans, the construction and maintenance of protection infrastructure and inter-institutional coordination.

The Conagua has installed **20** regional emergency attention centers



**Map 4.4** Regional Emergency Attention Centers, 2014


**Source**: Produced based on Conagua (2015d).



# Chapter 5

## Water management tools

# Water management tools

## Legal framework

**Availability to extract an additional volume:**

**watersheds**

**627** out of 731

**aquifers**

**458** out of 653

**Legal instruments**

| | |
|---|---|
| **145** | groundwater prohibition zones |
| **7** | aquifer regulations and regulated zones |
| **3** | reserve declarations |
| **349** | surface water prohibition zones |
| **333** | aquifers with suspension of free withdrawal |

**Deeds in the REPDA**

Surface water:
**120 822**

Groundwater:
**271 238**

Discharge permits:
**16 546**

Federal zone and material extraction permits
**111 219**


## Participation mechanisms

**26** river basin councils

### Auxiliary bodies

**35** commissions (for watersheds)

**47** committees (for micro-watersheds)

**87** technical committees (for aquifers)

**39** clean beach committees

2014

## Water economy and finances

CONAGUA'S **income** — Total raised **15.87** billion pesos — Volume employed **142 542 hm$^3$**

**greater than**

**The budget** for water government and governance — **12.42** billion pesos

**Investments** in drinking water, sewerage and sanitation — **34.21** billion pesos

### Tariffs

domestic m$^3$

**Merida:** **$ 3.90**

**Aguascalientes:** **$ 20.93**

# 5.1 Water-related institutions in Mexico

The National Water Commission of Mexico (Conagua), an administrative, regulatory, technical, consultative and decentralized agency of the Ministry of the Environment and Natural Resources (Semarnat), has the following mission and vision:

## Mission

*To manage and preserve the nation's water resources and its inherent public goods in order to achieve a sustainable use of these resources, with the co-responsibility of the tiers of government and society-at-large.*

## Vision

*To be an institution of excellence in the preservation and management of the nation's water resources and water security for the population.*

In 1989, the year in which the Conagua was created, it had 38 188 employees, a number which in recent years has been reduced. Thus in December 2014, the Conagua had 13 661 employees, of which 2 550 were assigned to its central offices and the remainder to the river basin organizations (RBOs) and local offices (LOs). This trend can be observed in graph 5.1.

In order to carry out the functions assigned to it, the Conagua works in conjunction with various federal, state and municipal bodies, water user associations and companies; institutions from the private sector and civil society as well as international organizations. Figure 5.1 shows the organization chart of the Conagua, whereas in figure 5.2 it is possible to observe the main institutions with which the Conagua coordinates for the attainment of the goals of national water planning.

According to article 115 of the Mexican Constitution, municipalities are responsible for providing drinking water, sewerage and sanitation services, subject to the compliance with both federal and state laws. The latest census that offered a complete registry nationwide found that the number of employees involved in the provision of drinking water, sewerage and sanitation services was 110 038 (Inegi 2009).

For the provision of drinking water services (2009) there were

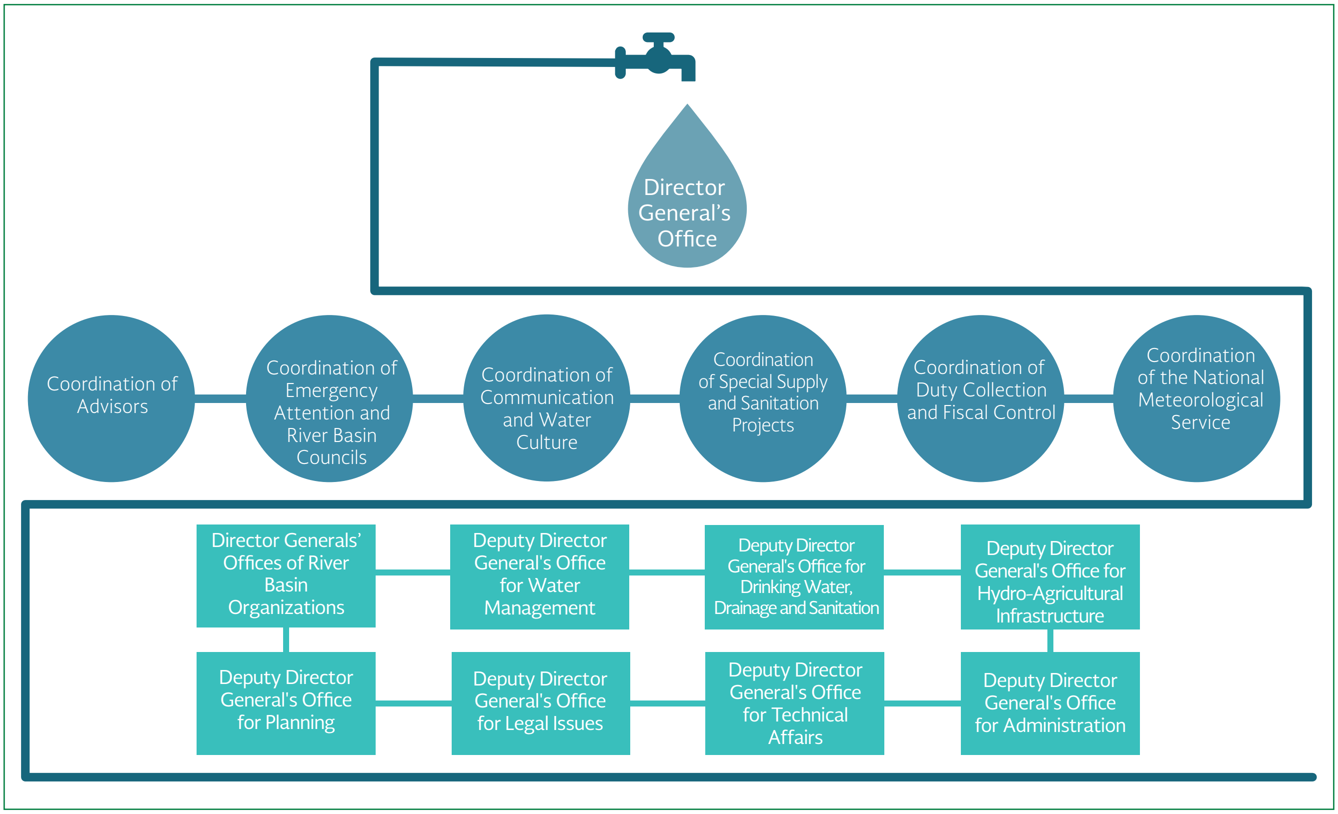
**110 038**

employees

**Graph 5.1** Conagua staff 2005-2014

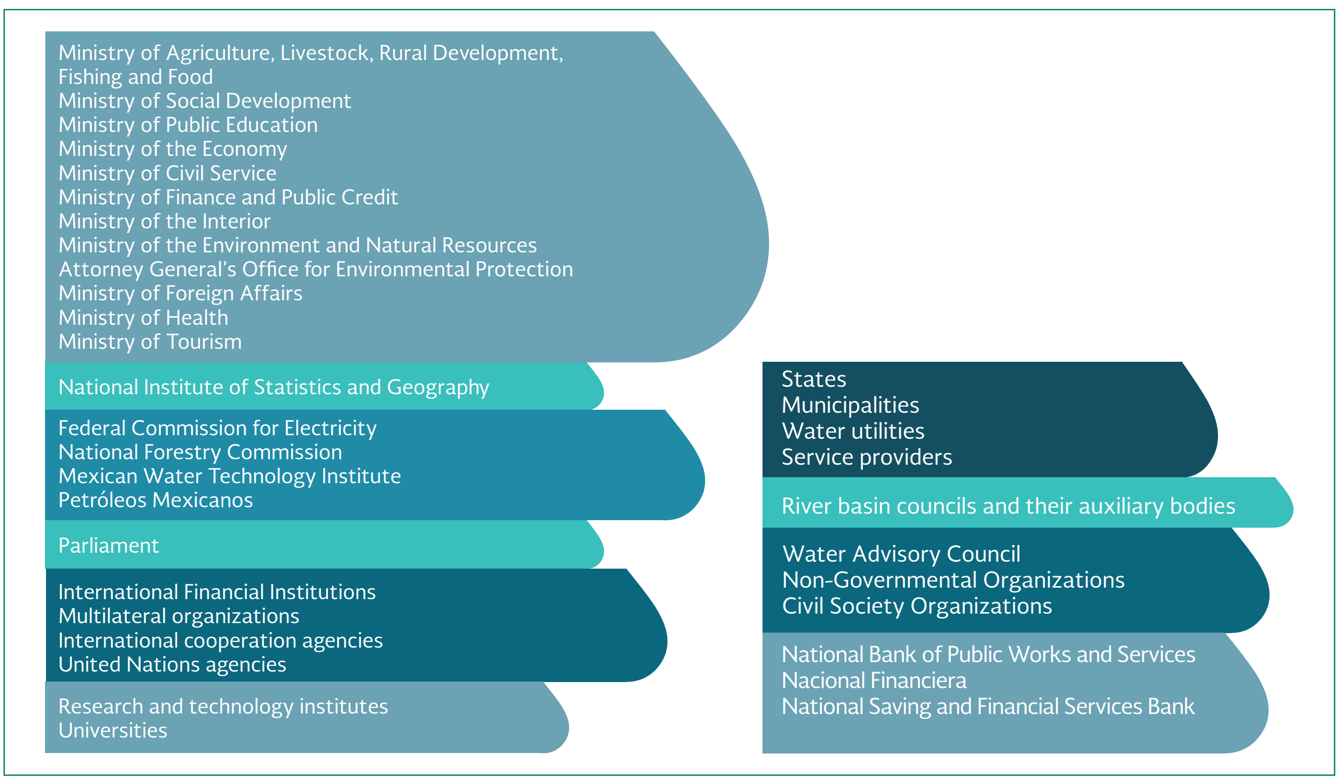

**Source**: Conagua (2015o).

**Figure 5.1** Organization chart of the Conagua, 2014




**Source**: Produced based on IFAI (2015), National Water Law

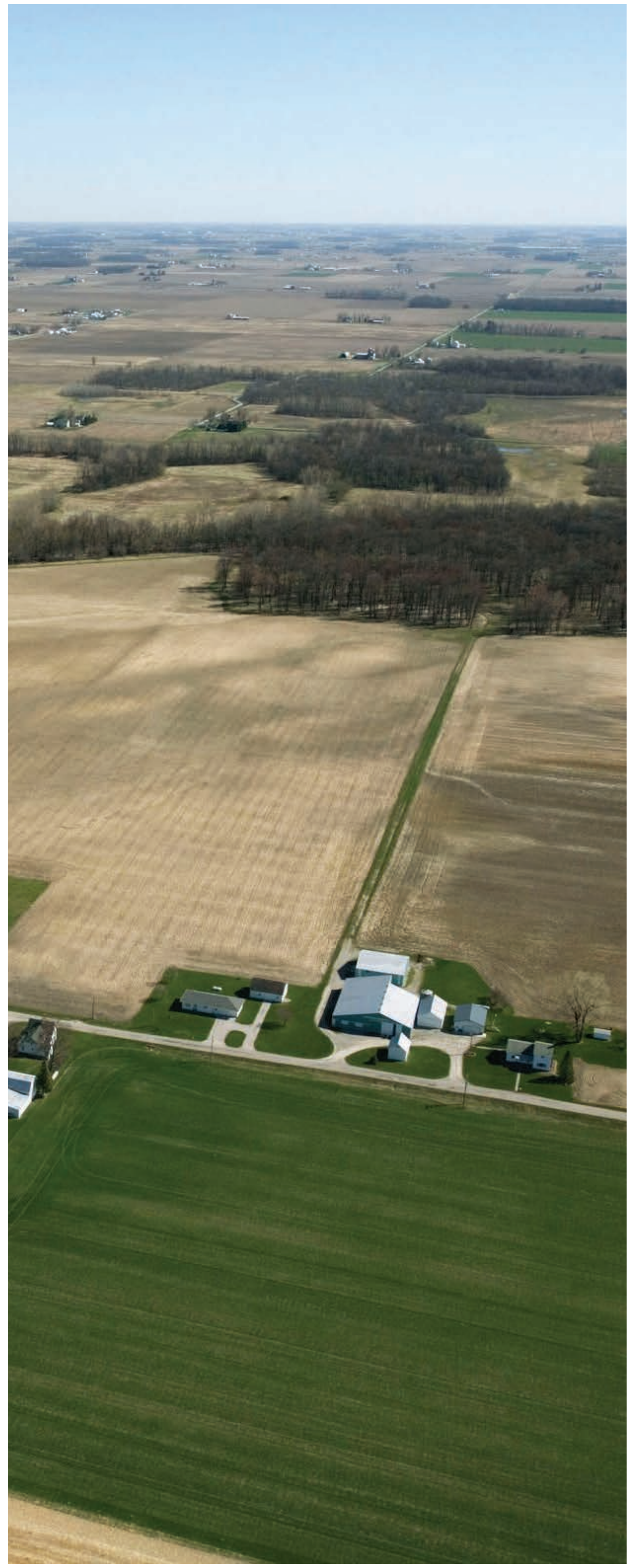
**Figure 5.2** Main institutions, entities and agencies with which the Conagua coordinates, 2014




**Source**: Produced based on Conagua (2005).

# 5.2 Legal framework for the use of water in Mexico

The National Water Law (NWL) establishes that the use of the nation's water resources will be carried out through the assigning of concession or allocation deeds by the Federal Executive Branch, through the Conagua, by means of the RBOs, or directly by the former when within its responsibilities, according to the rules and conditions laid down within the NWL and its By-Laws. Similarly, for wastewater discharges, it is necessary to have a discharge permit issued by the same institution.



## Deeds registered in the Public Registry of Water Duties (Repda)

[Reporteador: Usos (Títulos inscritos), Usos del agua]

Since the NWL was passed (1992), concession or allocation deeds and discharge permits have been registered in the Repda.

Up to December 2014, there were 481 031 concession deeds for the use of the nation's water resources registered in the Repda, which corresponded to a volume of 84.93 billion cubic meters allocated for offstream uses and 178 622 hm³ for instream uses. It should be mentioned that from this year there is a a new classification for offstream uses: that of ecological conservation.

The distribution of deeds by use is shown in table 5.1, and in table 5.2 they are grouped by hydrological-administrative region (HAR), considering the discharge permits, federal zone permits and material extraction. By number, regions VI Rio Bravo, VIII Lerma-Santiago-Pacific and X Central Gulf concentrate 40% of the total number of concession and/or allocation deeds.

It should be noted that one concession deed may cover one or more uses or permits. The term "grouped use" is employed (see chapter 3), wherein the grouped use for agriculture includes the agricultural, livestock, aquaculture, multiple and "others" headings of the Repda classification; public supply includes public urban and domestic, self-supplying industry considers industrial, agro-industrial, services and trade. There may be slight variations in the figures owing to the dates in which the Repda was consulted.

**Table 5.1** Concession or allocation deeds registered in the Repda, 2014

| Grouped uses | Deeds registered in the Repda | |
|---|---|---|
| | Number | Percentage |
| Agriculture | 307 374 | 63.90 |
| Public supply | 28 998 | 6.03 |
| Self-supplying industry | 144 461 | 30.03 |
| Electricity excluding hydropower | 55 | 0.01 |
| **Subtotal offstream uses** | **480 888** | **99.97** |
| Ecological conservation (instream use) | 1 | <0.01 |
| Hydropower (instream use) | 142 | 0.03 |
| **Total** | **481 031** | **100.00** |

**Source**: Conagua (2015c).

**Table 5.2** Deeds by hydrological-administrative region in the Repda, 2014

| Number of HAR | Concessions and/or allocations | | | | |
|---|---|---|---|---|---|
| | Surface water | Groundwater | Discharge permits | Federal zone permits | Material extraction |
| I | 2 318 | 9 256 | 600 | 1 608 | 421 |
| II | 4 107 | 18 246 | 645 | 2 907 | 118 |
| III | 12 164 | 13 097 | 650 | 7 245 | 455 |
| IV | 14 829 | 13 422 | 1 528 | 8 033 | 401 |
| V | 10 128 | 17 415 | 586 | 10 268 | 202 |
| VI | 6 033 | 37 222 | 702 | 5 977 | 61 |
| VII | 3 693 | 27 356 | 933 | 3 555 | 100 |
| VIII | 18 994 | 58 734 | 3 007 | 21 874 | 737 |
| IX | 9 269 | 14 483 | 856 | 13 261 | 172 |
| X | 12 902 | 19 175 | 1 747 | 18 722 | 670 |
| XI | 24 939 | 8 902 | 944 | 12 061 | 403 |
| XII | 257 | 31 545 | 3 498 | 86 | 3 |
| XIII | 1 189 | 2 385 | 850 | 1 879 | 0 |
| **Total** | **120 822** | **271 238** | **16 546** | **107 476** | **3 743** |

**Source**: Conagua (2015c).

## Legal instruments

[Reporteador: Ordenamientos]

Mexico's Political Constitution authorizes the Federal Executive Branch to establish regulatory means, if it is in public interest and utility, in order to maintain control over the extraction of the nation's groundwater resources through the issuing of prohibitions, regulations and reserves.

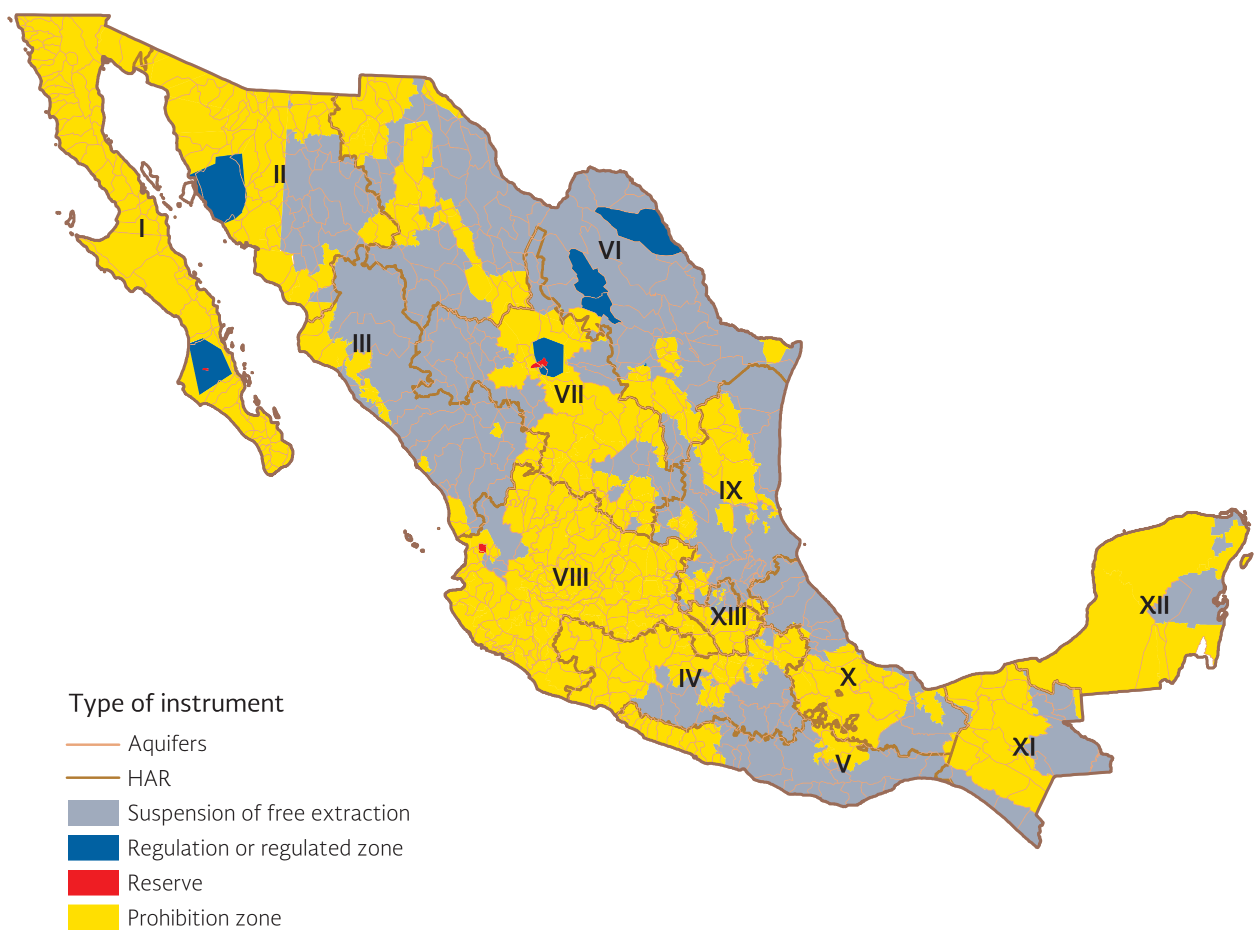
The different current legal control instruments have been issued since 1948. The NWL establishes that **prohibition zones** are necessary in those aquifers in which there is no mean annual availability of groundwater, as a result of which it is not possible to authorize concessions or allocations of water in addition to those legally authorized, due to the deterioration of water in quantity or quality, which affects hydrological sustainability.

**Regulations** are for those aquifers in which there is still mean annual availability of groundwater, which may be granted as a concession or allocation, for any use, within the limits of the available volume. When this type of legal instrument is applied to a portion of an aquifer, it is termed a **regulated zone.**

**Reserve zones** are specific areas of aquifers in which limits are established on the use of a part or all of the available water, with the aim of providing a service or setting up a restoration or conservation program. The Federal Executive Branch may declare the total or partial reserve of water resources for the following purposes: domestic and public-urban use, power generation for public service, and guaranteeing minimal flows for ecological protection, including the conservation of vital ecosystems.

In 2014 there were
**145**
groundwater prohibitions

**Map 5.1** Groundwater instruments, 2014




**Source:** Produced based on Conagua (2015a).

Up to December 31, 2014, 145 groundwater prohibition decrees, four aquifer regulations, three decrees of regulated zones and three declarations of reserve zones for public urban use had been declared, which together cover approximately 55% of the national territory (see map 5.1). In them it is established that to use groundwater within the territories outlined within them, it is necessary to request the corresponding concession or allocation. The CONAGUA, considering the results of the studies it carries out, may authorize or reject the concession or allocation.

For the remaining 45% of the country, in 2013 general agreements were published for a total of 333 aquifers, previously not subject to legal restrictions, and in which the digging or the construction of infrastructure to extract water from the subsoil is no longer permitted, nor the increase in the previously authorized volume (62 aquifers) or a concession or allocation is required to extract water from the subsoil as well as authorization from the CONAGUA to increase the volume (271 aquifers).

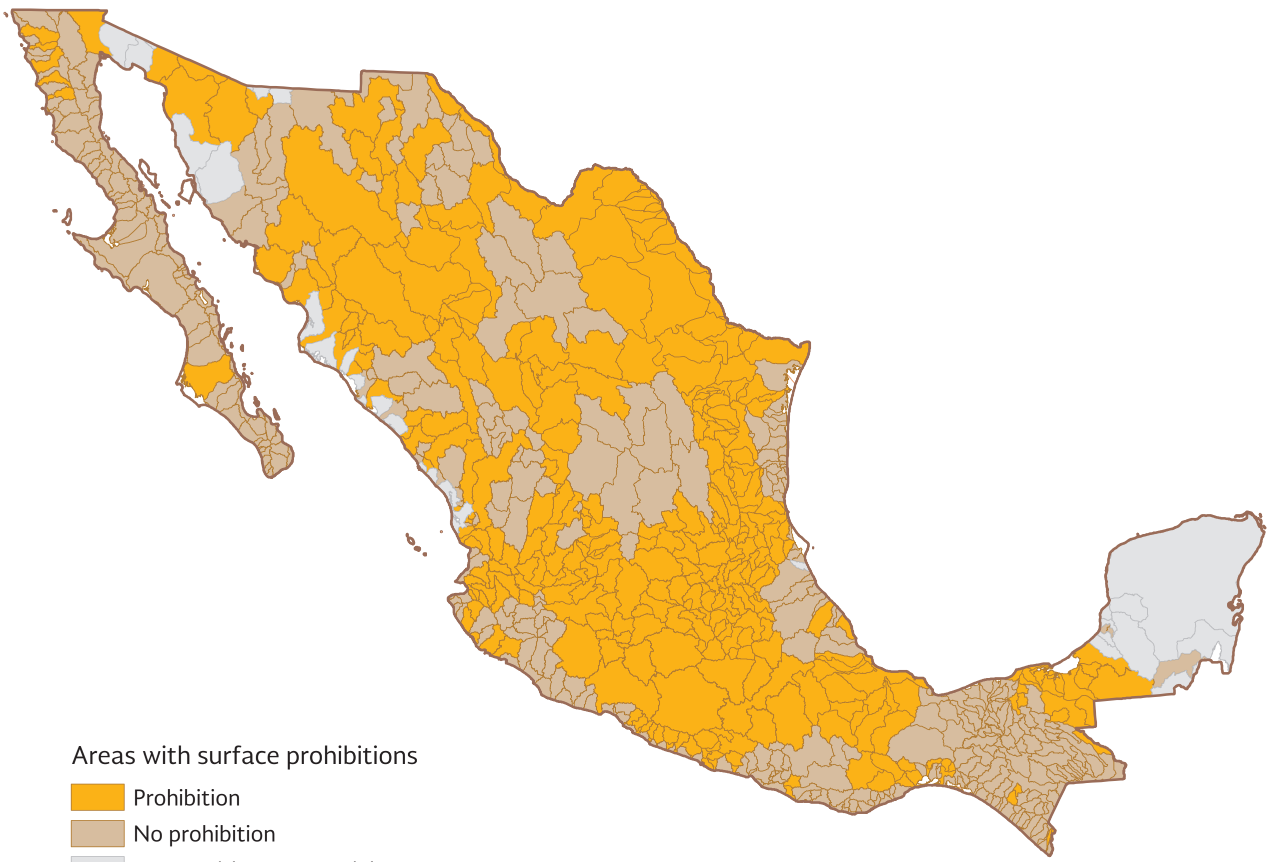
Surface prohibition zones are those specific areas of regions of watersheds in which additional uses of water to those that are legally established are not authorized, and the latter are controlled through specific regulations, by virtue of the deterioration in the quantity or quality of water, due to the impact on hydrological sustainability or the damage to surface water bodies. The CONAGUA consults with users and civil society organizations, within the scope of the river basin councils, and resolves the limitations resulting from the existence, declaration and implementation of prohibition zones. The surface prohibition zones are shown in map 5.2.

In 2014 there are

**349**

surface water prohibitions

**Map 5.2** Areas with surface water prohibition, 2014




**Source**: Produced based on Conagua (2015a).

# Publication of mean annual water availabilities

[Reporteador: Cuencas-disponibilidad]

The NWL establishes that in order to grant concession or allocation deeds, the mean annual availability of water in the watershed or aquifer in which the use is to be made should be taken into account. When it is determined that an additional volume to those already allocated may be extracted from an aquifer or watershed without compromising the ecosystem, this condition is termed “availability”. The Conagua is bound to publish these availabilities, for which the standard NOM-011-CONAGUA-2000 was created, “Conservation of Water Resources which establishes the specifications and the method to determine the mean annual availability of the nation’s water resources”.

Up to December 31, 2014, the availabilities of the 653 hydrogeological units or aquifers into which the country has been divided had been published in the DOF, as well as that of the 731 watersheds into which Mexico is subdivided.

Maps 5.3 and 5.4 show the location of Mexico’s watersheds and aquifers, the availability of which had been published in the DOF up to December 31, 2014.

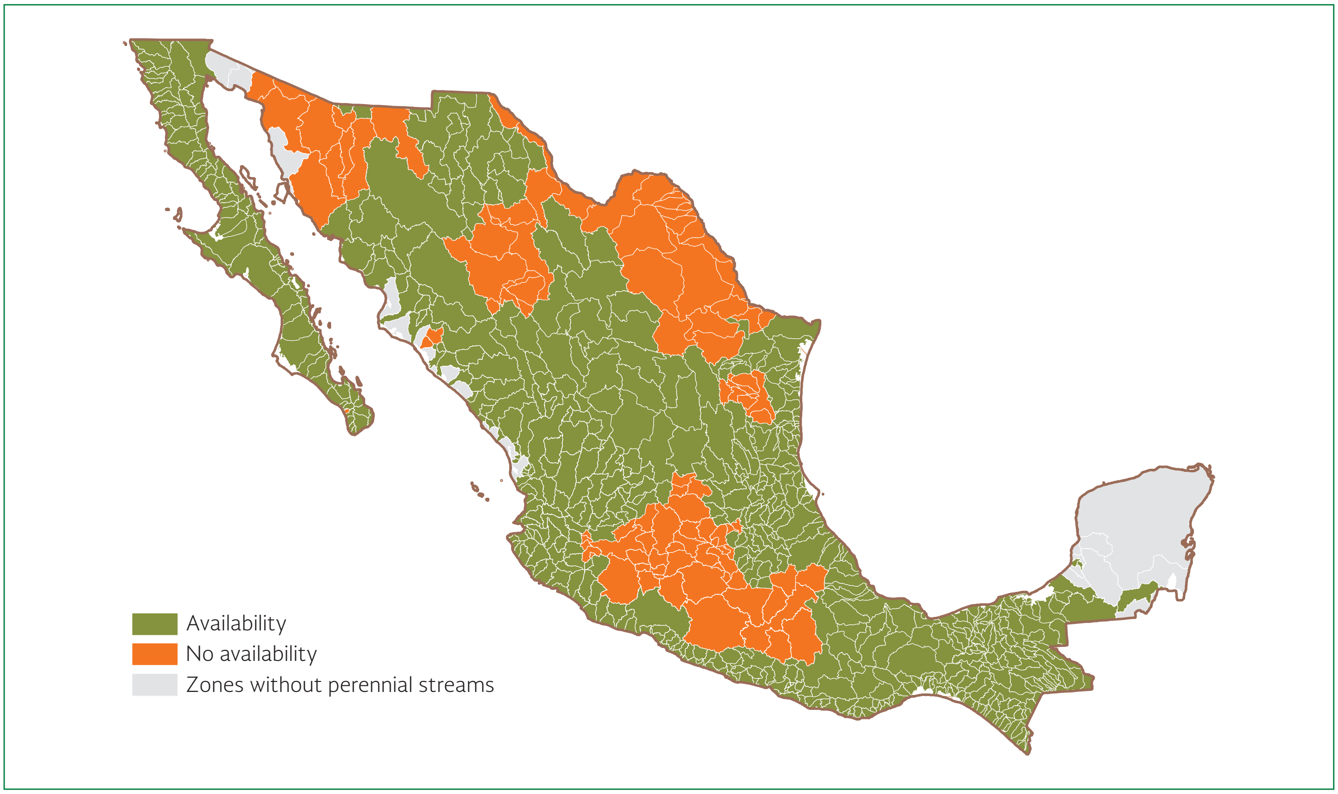
# Classification declarations for Mexico’s water bodies

[Reporteador: Acuíferos]

The NWL establishes that in order to grant wastewater discharge permits, the classification declarations of the national water bodies should be consulted. The Conagua has the responsibility of drawing up and publishing these declarations in the DOF.

According to article 87 of the NWL, **classification declarations** contain the limits of the water bodies studied in which the pollution assimilation and dilution capacity is determined, referring to their capacity to self-purify; as well as the quality parameters that wastewater should comply with and the maximum discharge limits of these parameters in the classified areas. Furthermore, they include quality targets in the receiving water bodies as regards the pollutants, as well as the timelines to achieve those targets.

**Map 5.3** Watersheds with availability published in the DOF, 2014




**Source**: Produced based on Conagua (2015a).

**Map 5.4** Aquifers with availability published in the DOF, 2014


**Source**: Produced based on Conagua (2015a).

# 5.3 Water economy and finances

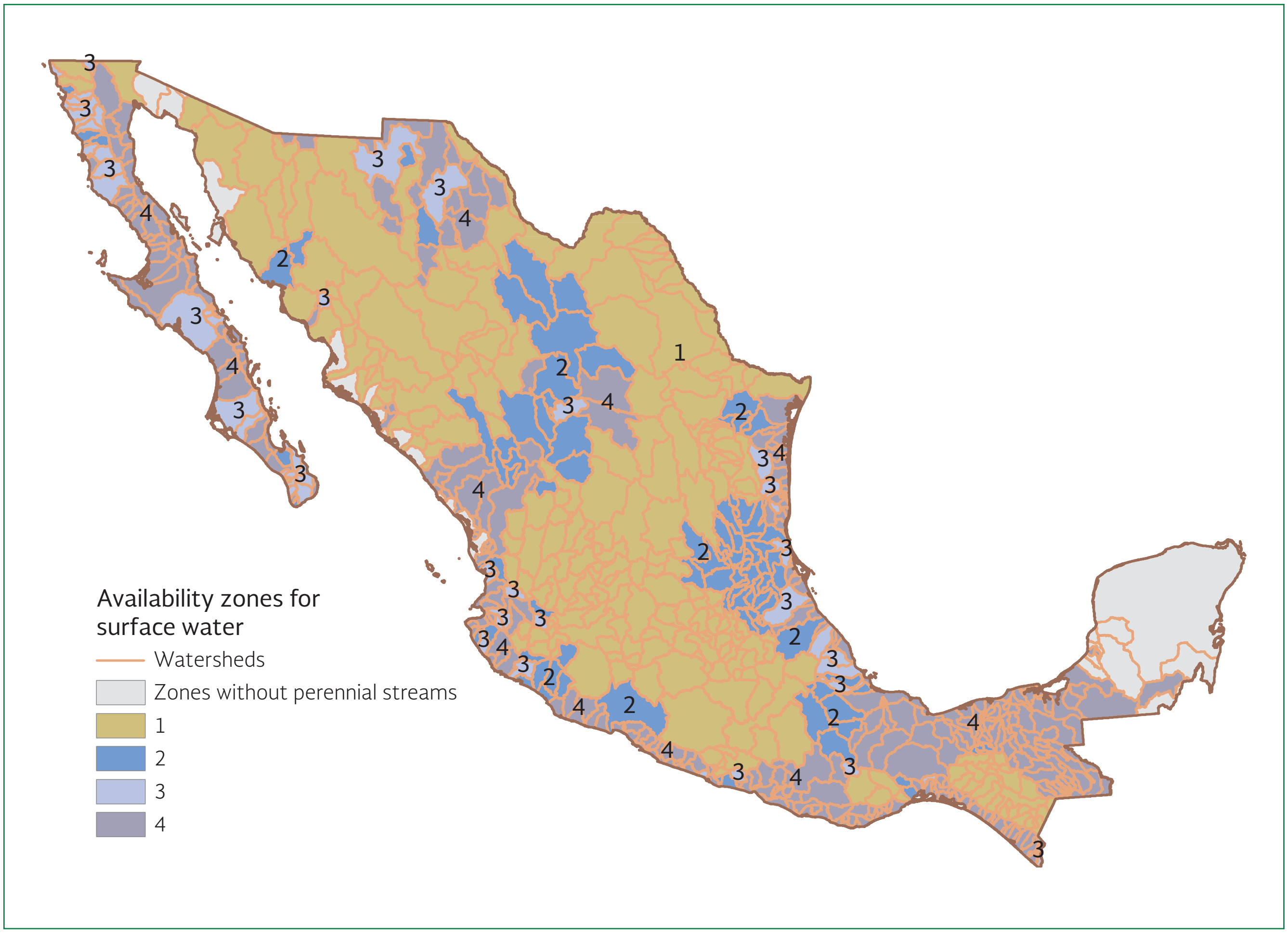
## Duties for the use of the nation's water resources

Both companies and individuals that use Mexico's water resources are bound to pay the corresponding duties, with or without the benefit of concession or allocation deeds, authorizations or permits assigned by the Federal Government. The same also applies to those who discharge wastewater into rivers, catchments, reservoirs, seawater or water currents, be it permanently, intermittently or on a one-off basis, as well as into the soil or into grounds which are public property or which could pollute the subsoil or aquifers. In the same case are those who use public goods which belong to the federation in ports, terminals and port installations, the federal sea zone, dikes, channels, reservoirs, areas with currents and tanks, which are the property of the nation.

Up to 2013, the Mexican Republic was divided into 9 availability zones for the charging of duties for the use of water. Each municipality was assigned to an availability zone.

In Mexico, since
**2014**
there have been 4 availability zones for the purpose of charging

**Map 5.5** Availability zones for surface water, 2014




**Source**: Produced based on Conagua (2015g).

**Table 5.3** Duties for the use of the nation's surface water resources according to availability zone, 2014 (cents of Mexican pesos per cubic meter)

| Use | Zone | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| General regime | 1 381.62 | 636.06 | 208.55 | 159.48 |
| Drinking water, consumption of more than 300 l/inhabitant/day (on the excess) | 82 124.00 | 39 388.00 | 19 670.00 | 9 792.00 |
| Drinking water, consumption equal to or less than 300 l/inhabitant/day | 41 062.00 | 19 694.00 | 9 835.00 | 4 896.00 |
| Agriculture and livestock, without exceeding the concession | 0.00 | 0.00 | 0.00 | 0.00 |
| Agriculture and livestock, for every m³ that exceeds the concession | 15.04 | 15.04 | 15.04 | 15.04 |
| Spas and recreation centers | 1 017.43 | 567.82 | 264.85 | 109.24 |
| Hydropower generation | 474.69 | 474.69 | 474.69 | 474.69 |
| Aquaculture | 341.35 | 170.31 | 78.21 | 36.27 |

**Source**: Conagua (2015g).

In the decree that reformed the Federal Duties Law (FDL) on December 11, 2013, article 231 was modified, in which an algorithm was specified for the calculation of the availability zone in terms of surface and groundwater. In this way, since 2014, four availability zones have been specified for each scope, watersheds (surface water) and aquifers (groundwater). Since 2014 the Conagua has published no later than the third month of every financial year the availability zone that corresponds to each of the country's watersheds and aquifers.

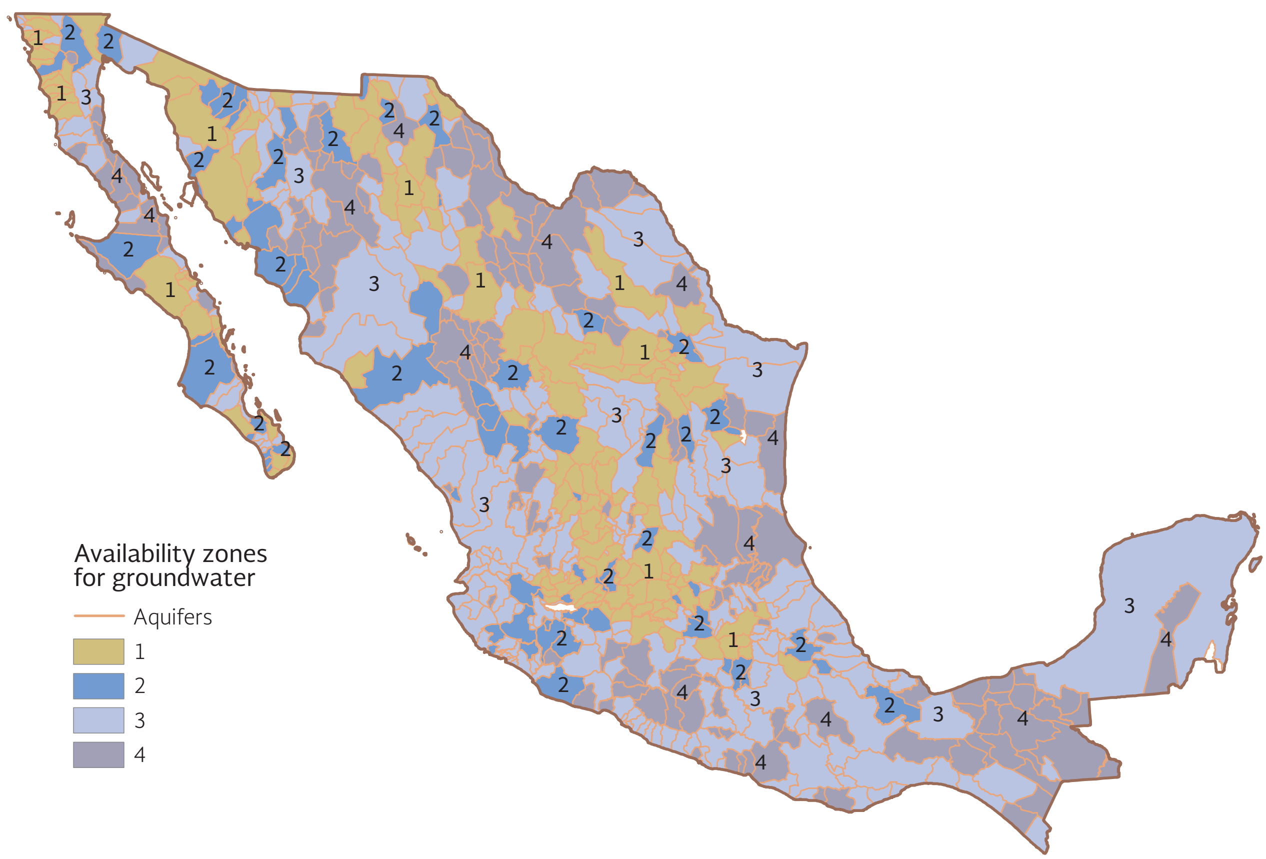
In general the cost per cubic meter is higher in the zones of lesser availability, as can be observed in table 5.3 for surface water and table 5.4 for groundwater. In both tables, "general regime" refers to any use other than those mentioned. The values are taken from the publication in the DOF (11/12/2013) of the reforms to the Federal Duties Law, with quantities updated in Annex 19 of the tax law for 2014 and its annex 19, on December 30, 2013. It should be mentioned that no payment is made for the extraction of seawater, nor for brackish water with concentrations of more than 2 500 mg/l of total dissolved solids (certified by the Conagua).

The availability zones are shown in maps 5.5 for surface water and 5.6 for groundwater.

For the purpose of charging duties for wastewater discharges, receiving bodies (rivers, lakes and lagoons, among others) are classified into three types: A, B or C, according to the effects caused by the pollution. The C-type receiving bodies are those in which the pollution has the strongest effects. The list of the receiving bodies that belong to each category can be found in the FDL.

The rates for wastewater discharges are related to the volume of the discharge and the load of the pollutants. To make this calculation the discharge that is characteristic of the activity that generated the discharge and the type of receiving body are taken into account. The methodology may be consulted in Article 278-B of the FDL.

**Map 5.6** Availability zones for groundwater, 2014




**Source**: Produced based on Conagua (2015g).

**Table 5.4** Duties for the use of the nation's groundwater resources according to availability zone, 2014 (cents of Mexican pesos per cubic meter)

| Use | Zone | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| General regime | 1 861.69 | 720.62 | 250.91 | 182.39 |
| Drinking water, consumption of more than 300 l/inhabitant/day (on excess) | 85 726.00 | 39 528.00 | 22 284.00 | 10 388.00 |
| Drinking water, consumption equal to or less than 300 l/inhabitant/day | 42 863.00 | 19 764.00 | 11 142.00 | 5 194.00 |
| Agriculture and livestock, without exceeding the concession | 0.00 | 0.00 | 0.00 | 0.00 |
| Agriculture and livestock, for every $m^3$ that exceeds the concession | 15.04 | 15.04 | 15.04 | 15.04 |
| Spas and recreation centers | 1 205.25 | 593.77 | 291.24 | 130.05 |
| Hydropower generation | 474.69 | 474.69 | 474.69 | 474.69 |
| Aquaculture | 374.82 | 173.63 | 86.24 | 39.54 |

**Source**: Conagua (2015g).

## The Conagua's income collection

[Reporteador: Recaudación de la CONAGUA, Volúmenes declarados]

As a fiscal authority, the CONAGUA intervenes in the charging of duties for the use of Mexico's water resources and its inherent public goods. In tables 5.5 and 5.6, its collection through the charging of duties may be visualized, which includes the concepts of the use of the nation's water resources; the use of receiving bodies; material extraction; bulk water supply to urban and industrial centers; irrigation services; use of federal zones; and various, such as transaction services, VAT and fines, among others. It should be mentioned that in 2013, the concept of "Programa Ponte al Corriente" (Get Up-to-date Program) was in force. Based on the implementation of the reforms to the Federal Duties Law, from January 1, 2014, a new concept of payment was included, referring to the inter-basin transfer of the nation's water.

The conversions to constant 2014 prices employed in the following section were carried out based on the average National Consumer Price Index for each year.

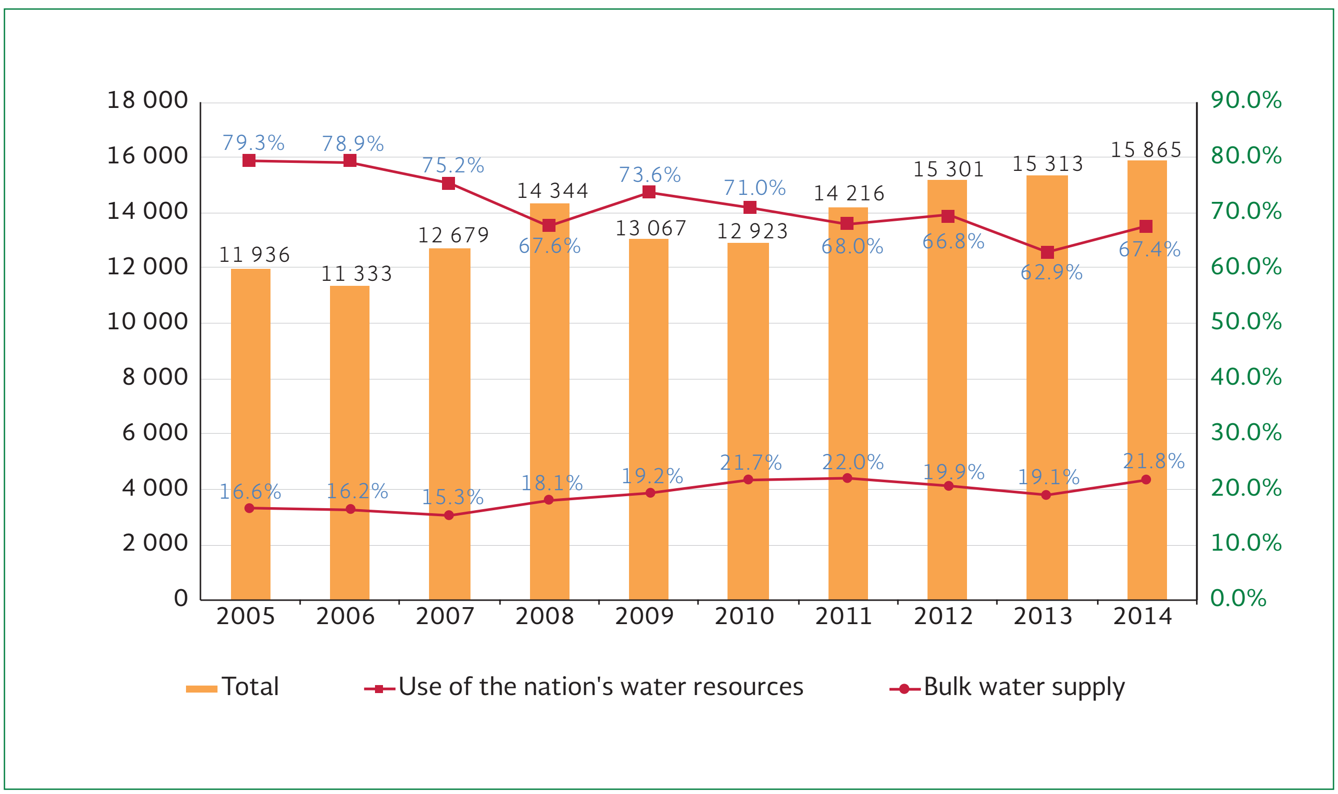
During 2014, **15.86** billion pesos were collected

**TABLE 5.5** The CONAGUA's collection through the charging of duties and concepts, 2007-2014 (millions of pesos at constant 2014 prices)

| Concept | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|
| Use of the nation's water resources | 9 535.2 | 9 690.9 | 9 612.0 | 9 169.9 | 9 667.0 | 10 228.2 | 9 632.0 | 10 699.0 |
| Bulk water supply to urban and industrial centers | 1 939.0 | 2 601.4 | 2 512.0 | 2 810.0 | 3 125.2 | 3 043.1 | 2 922.4 | 3 450.9 |
| Irrigation services | 254.6 | 248.0 | 273.2 | 255.7 | 308.4 | 225.3 | 201.6 | 220.5 |
| Material extraction | 48.6 | 54.3 | 55.3 | 57.1 | 33.9 | 40.1 | 22.6 | 23.8 |
| Use of receiving bodies | 76.7 | 74.1 | 217.2 | 258.1 | 301.0 | 323.5 | 406.0 | 649.8 |
| Use of federal zones | 46.0 | 40.0 | 46.2 | 42.8 | 44.1 | 49.9 | 43.8 | 52.3 |
| Various (transaction services, VAT and fines, among others) | 125.7 | 422.1 | 259.0 | 240.2 | 244.0 | 762.7 | 446.7 | 550.5 |
| Collection through fiscal credits | 653.6 | 1 213.5 | 91.7 | 89.7 | 492.0 | 628.5 | 495.3 | 208.0 |
| Collection through "Programa Ponte al Corriente" | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1 142.9 | 0.0 |
| Inter-basin transfer of the nation's water | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.1 |
| **Total** | **12 679.4** | **14 344.3** | **13 066.6** | **12 923.3** | **14 215.5** | **15 301.4** | **15 313.3** | **15 865.0** |

**Source**: CONAGUA (2015g).

**GRAPH 5.2** Evolution in the CONAGUA's collection, showing the two main components by amount, 2005-2014 (millions of pesos at constant 2014 prices)




**Source**: Produced based on CONAGUA (2015g).

Periodically, the Ministry of Finance and Public Credit (SHCP in Spanish) authorizes the Conagua to apply charges for services, for example: bulk water supply from the Cutzamala System to the Metropolitan Area of the Valley of Mexico or to irrigation district (ID) modules.

The Conagua's collection followed a growing trend through the 2005-2014 period, at constant 2014 prices. As can be observed in graph 5.2, the composition of this collection changed slightly during that period. In percentage terms, the concept of extraction and use of the nation's water resources decreased, going from 79.3% per year in 2004 to 67.4% in 2014.

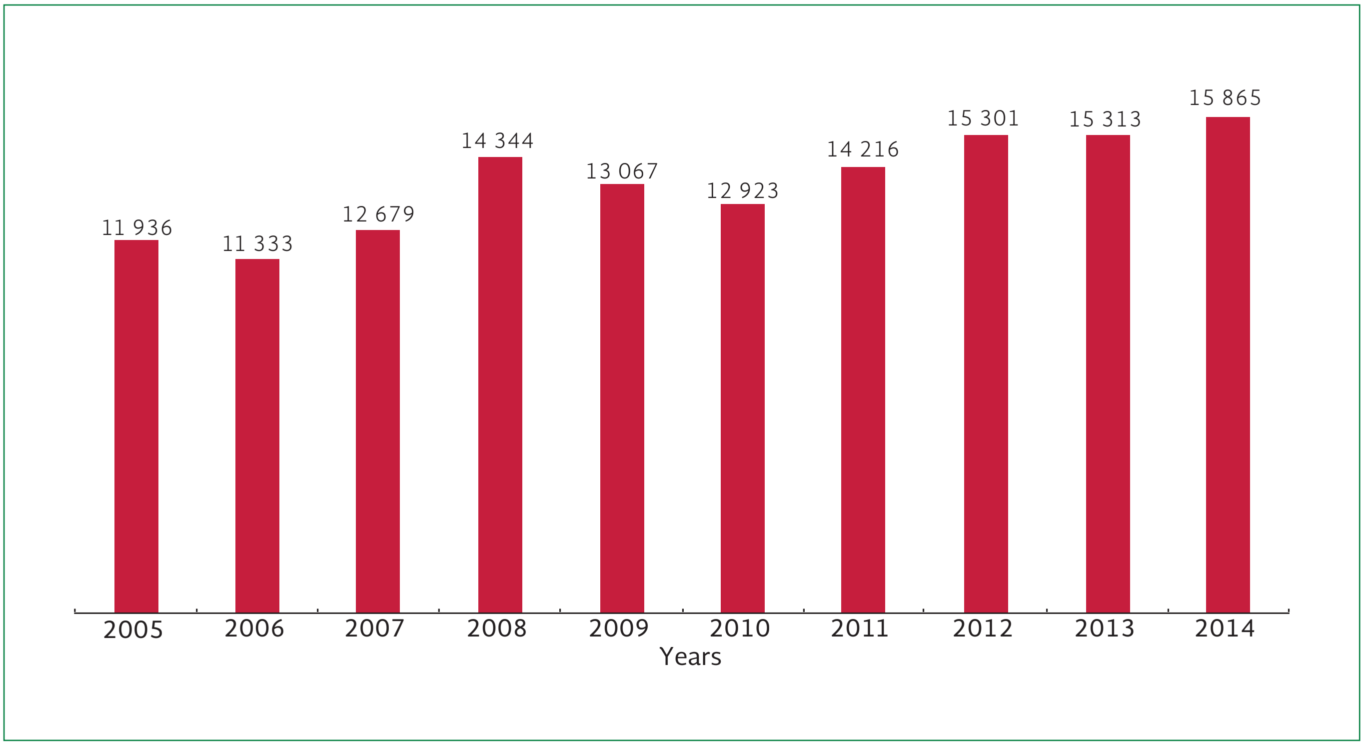
Since the creation of the Conagua in 1989, the collection through the charging of duties has increased every year. In the period from 2005 to 2014, it increased from 11.9 to 15.9 billion pesos, at constant 2014 prices, as can be appreciated in graph 5.3.

By hydrological-administrative region, the collection for 2014 is presented in table 5.6. Particularly worth highlighting is that the regions VIII Lerma-Santiago-Pacific, XIII Waters of the Valley of Mexico and VI Rio Bravo contribute 66% of the collection. In that table the concept of "Various" refers to transaction services, regularizations and fines, among others.

From **2005** to **2014** the Conagua's collection increased by

**32.9%**

**Graph 5.3** Collection for the charging of duties, 2005-2014 (millions of pesos at constant 2014 prices)




**Source**: Produced based on Conagua (2015g).

**Table 5.6** Collection by hydrological-administrative region, 2014 (millions of pesos)

| Number of HAR | Concepts | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Use of the nation's water resources | Bulk water supply to urban and industrial centers | Irrigation services | Material extraction | Wastewater discharges | Use of federal zones | Income from federal credits | Various | Inter-basin transfers of the nation's water resources | Total |
| I | 166.84 | 0.07 | 58.29 | 2.49 | 43.08 | 7.29 | 3.79 | 7.07 | 0.00 | 288.92 |
| II | 864.33 | 0.00 | 19.31 | 0.55 | 11.34 | 0.43 | 13.01 | 83.38 | 0.00 | 992.35 |
| III | 192.88 | 2.15 | 54.16 | 9.47 | 4.03 | 3.27 | 3.60 | 4.84 | 0.01 | 274.41 |
| IV | 662.46 | 11.68 | 7.12 | 0.65 | 49.23 | 1.87 | 10.33 | 44.32 | 0.01 | 787.68 |
| V | 252.62 | 0.00 | 0.71 | 1.07 | 1.43 | 0.54 | 3.43 | 1.76 | 0.00 | 261.56 |
| VI | 1 578.63 | 0.00 | 22.69 | 0.82 | 19.93 | 4.81 | 21.92 | 22.95 | 0.00 | 1 671.75 |
| VII | 847.64 | 0.00 | 12.72 | 0.46 | 13.04 | 1.96 | 14.05 | 181.91 | 0.00 | 1 071.78 |
| VIII | 2 487.01 | 93.98 | 23.38 | 1.89 | 148.55 | 15.79 | 37.38 | 42.69 | 0.02 | 2 850.68 |
| IX | 619.92 | 0.00 | 11.81 | 0.54 | 22.17 | 4.85 | 8.93 | 12.45 | 0.00 | 680.66 |
| X | 622.36 | 0.00 | 4.67 | 1.07 | 38.29 | 0.58 | 10.12 | 84.49 | 10.07 | 771.65 |
| XI | 518.07 | 0.00 | 0.66 | 4.84 | 37.35 | 1.07 | 7.57 | 7.35 | 0.00 | 576.90 |
| XII | 105.27 | 0.00 | 0.39 | 0.00 | 21.58 | 0.03 | 1.81 | 9.15 | 0.00 | 138.23 |
| XIII | 1 780.97 | 3 343.03 | 4.62 | 0.00 | 239.77 | 9.86 | 72.10 | 48.10 | 0.00 | 5 498.45 |
| **Total** | **10 699.01** | **3 450.91** | **220.51** | **23.85** | **649.77** | **52.35** | **208.05** | **550.46** | **10.11** | **15 865.01** |

**Source**: Conagua (2015g).

Table 5.7 shows the evolution in the 2005-2014 period in collection corresponding to each of the uses indicated in Article 223 of the FDL as regards water. Similarly, table 5.9 shows the values for 2014 by HAR.

The volumes reported by users in their declarations for the payment of duties are shown in table 5.8 for the 2005-2014 period, classified by uses, as well as in table 5.10 by hydrological-administrative region for 2014.

**Table 5.7** Collection for the use of the nation's water resources, 2005-2014 (millions of pesos at constant 2014 prices)

| Use | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|
| General regime | 6 497.0 | 6 177.4 | 6 632.9 | 6 634.7 | 6 517.7 | 6 124.0 | 6 496.6 | 7 139.8 | 7 110.6 | 7 900.9 |
| Public urban | 2 416.0 | 2 130.8 | 2 292.2 | 2 351.4 | 2 437.0 | 2 413.0 | 2 434.3 | 2 364.2 | 2 013.3 | 1 999.6 |
| Hydropower | 520.6 | 608.0 | 583.2 | 669.0 | 618.9 | 603.6 | 712.7 | 705.6 | 505.5 | 796.7 |
| Spas and recreational centers | 27.4 | 27.2 | 26.2 | 35.0 | 37.7 | 28.6 | 22.8 | 18.0 | 2.1 | 1.1 |
| Aquaculture | 0.7 | 0.5 | 0.7 | 0.9 | 0.7 | 0.6 | 0.7 | 0.6 | 0.4 | 0.7 |
| **Total** | **9 461.7** | **8 943.9** | **9 535.2** | **9 690.9** | **9 612.0** | **9 169.9** | **9 667.0** | **10 228.2** | **9 632.0** | **10 699.0** |

**Source**: Conagua (2015g).

**Table 5.8** Volumes declared for the payment of duties, 2005-2014 ($hm^3$)

| Use | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|
| General regime | 1 265 | 1 306 | 1 764 | 1 796 | 1 939 | 1 675 | 1 373 | 1 132 | 1 180 | 1 082 |
| Public urban | 7 083 | 8 240 | 7 584 | 7 639 | 5 609 | 5 617 | 6 967 | 6 185 | 10 262 | 8 010 |
| Hydropower | 115 386 | 140 295 | 122 832 | 150 669 | 136 085 | 134 783 | 164 773 | 155 717 | 112 816 | 133 018 |
| Spas and recreational centers | 94 | 115 | 84 | 86 | 64 | 56 | 109 | 78 | 85 | 94 |
| Aquaculture | 397 | 159 | 308 | 309 | 344 | 222 | 218 | 256 | 258 | 337 |
| **Total** | **124 225** | **150 115** | **132 571** | **160 499** | **144 041** | **142 353** | **173 440** | **163 368** | **124 602** | **142 542** |

**Source**: Conagua (2015g).

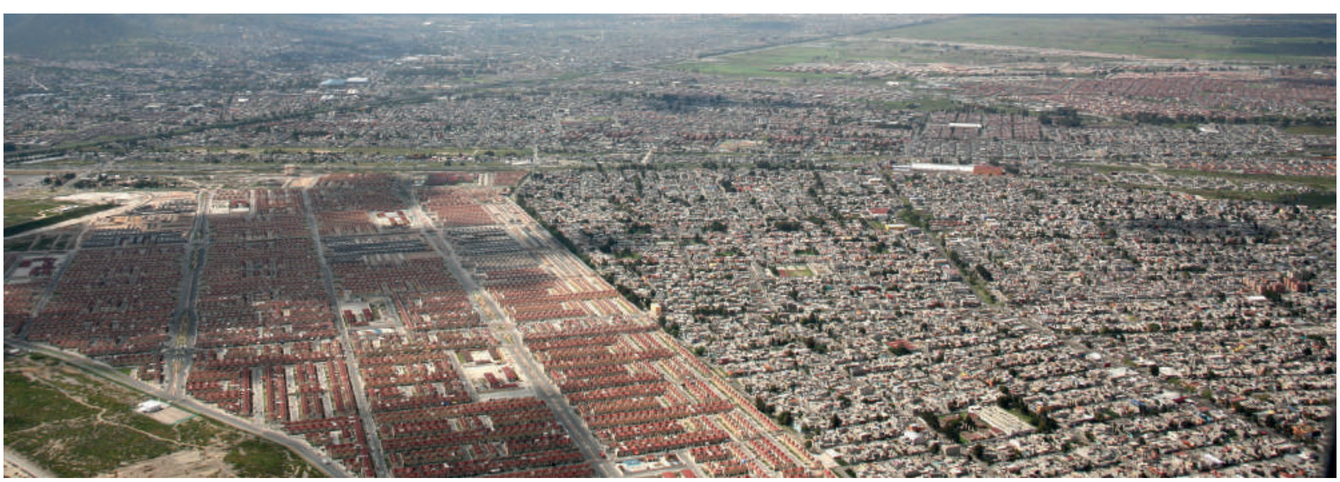


**Table 5.9** Collection for the use of the nation's water resources, by hydrological-administrative region, 2014 (millions of pesos)

| Number of HAR | General regime | Public urban | Hydropower | Spas and recreational centers | Aquaculture | Total |
|---|---|---|---|---|---|---|
| I | 83.3 | 83.5 | 0.0 | 0.0 | 0.0 | 166.8 |
| II | 813.3 | 35.3 | 15.7 | 0.0 | 0.0 | 864.3 |
| III | 86.1 | 59.0 | 47.8 | 0.0 | 0.0 | 192.9 |
| IV | 399.3 | 92.7 | 169.9 | 0.2 | 0.3 | 662.5 |
| V | 228.5 | 24.0 | 0.1 | 0.0 | 0.0 | 252.6 |
| VI | 1 211.5 | 356.5 | 10.5 | 0.0 | 0.0 | 1 578.6 |
| VII | 777.5 | 70.2 | 0.0 | 0.0 | 0.0 | 847.6 |
| VIII | 2 015.4 | 391.0 | 80.0 | 0.5 | 0.2 | 2 487.0 |
| IX | 561.1 | 50.4 | 8.3 | 0.1 | 0.0 | 619.9 |
| X | 519.3 | 30.6 | 72.4 | 0.0 | 0.0 | 622.4 |
| XI | 110.4 | 15.7 | 392.0 | 0.0 | 0.0 | 518.1 |
| XII | 74.9 | 30.3 | 0.0 | 0.1 | 0.0 | 105.3 |
| XIII | 1 020.4 | 760.3 | 0.0 | 0.2 | 0.0 | 1 781.0 |
| **Total** | **7 900.9** | **1 999.6** | **796.7** | **1.1** | **0.7** | **10 699.0** |

**Source**: Conagua (2015g).

**Table 5.10** Volumes declared for the payment of duties for the use of the nation's water resources, by hydrological-administrative region, 2014 (hm$^3$)

| Number of HAR | Use | | | | | |
|---|---|---|---|---|---|---|
| | General regime | Public urban | Hydropower | Spas and recreational centers | Aquaculture | Total |
| I | 8.8 | 213.0 | 0.0 | 0.4 | 0.6 | 222.8 |
| II | 68.4 | 108.9 | 2 456.3 | 0.1 | 5.4 | 2 639.1 |
| III | 12.2 | 219.0 | 7 475.4 | 1.7 | 66.6 | 7 775.0 |
| IV | 98.7 | 421.4 | 29 688.3 | 21.0 | 116.4 | 30 345.9 |
| V | 21.6 | 89.5 | 26.3 | 0.0 | 0.0 | 137.4 |
| VI | 112.1 | 930.4 | 2 125.5 | 0.8 | 0.2 | 3 169.0 |
| VII | 97.9 | 147.8 | 0.0 | 0.6 | 0.3 | 246.6 |
| VIII | 151.4 | 1 544.9 | 10 693.3 | 38.0 | 33.4 | 12 461.0 |
| IX | 89.7 | 188.5 | 1 225.7 | 4.4 | 32.2 | 1 540.6 |
| X | 215.8 | 1 696.7 | 12 319.4 | 9.6 | 55.7 | 14 297.1 |
| XI | 58.5 | 154.7 | 67 007.6 | 0.1 | 14.5 | 67 235.5 |
| XII | 25.0 | 110.1 | 0.0 | 11.4 | 0.3 | 146.7 |
| XIII | 122.2 | 2 185.1 | 0.5 | 5.6 | 11.7 | 2 325.1 |
| **Total** | **1 082.3** | **8 010.0** | **133 018.3** | **93.7** | **337.3** | **142 541.8** |

**Source**: Conagua (2015g).

## The Conagua's budget

[Reporteador: Presupuesto ejercido]

The budget authorized for the Conagua for any given fiscal year is defined at the end of the previous year. Throughout the fiscal year budgetary adjustments take place, as a result of which the end-of-year budget, the evolution of which is shown in graph 5.4, may vary from the originally authorized budget.

## Water pays for water

One of the principles that supports national water policy, in accordance with the dispositions in the NWL (Article 14 Bis 5), is the so-called "water pays for water". That principle disposes that "water management should generate the necessary economic and financial resources to carry out its inherent tasks".

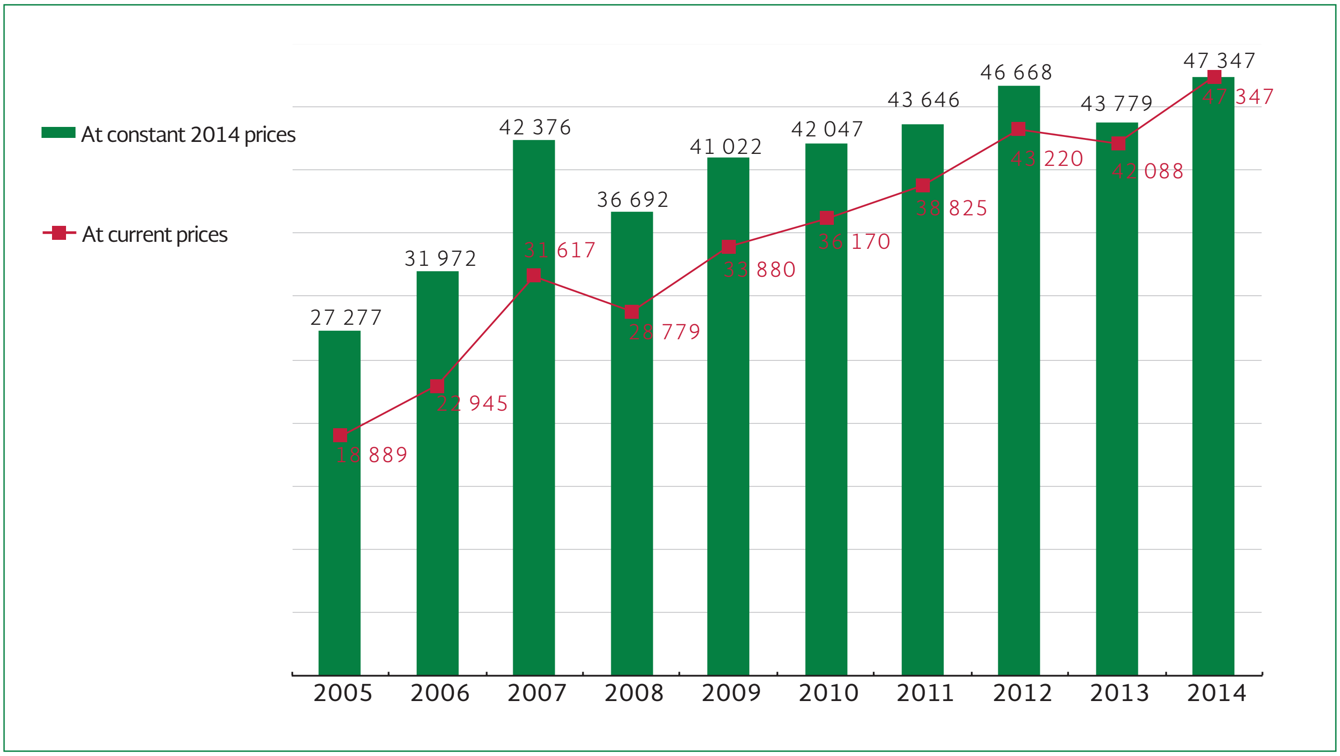
In this context, and with the intention of evaluating its compliance, a series of budgetary programs have been defined, linked with water government and governance functions [Adicional: Table 5.A], which are part of the budget assigned by the Conagua each year, to be contrasted with the amount of the collection of contributions and use of the nation's water resources and its inherent public goods. In this way the amount of the budgetary programs linked with water government and governance is divided by the collection. When the result of the indicator is lower than the unit, it is considered that the collection provides sufficient resources to finance the water government and governance activities, as shown in graph 5.5.

In 2014 the Conagua exercised

**47.35**

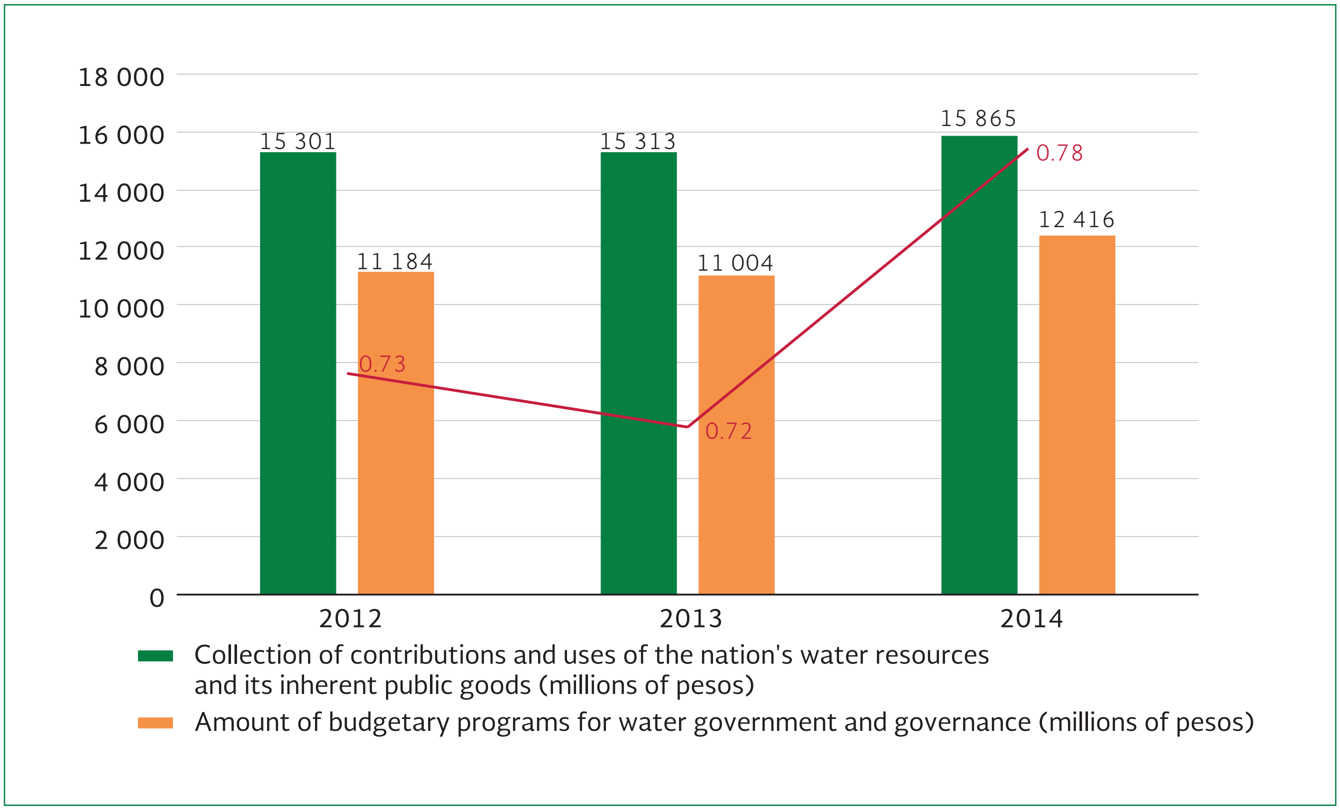
billion pesos

**Graph 5.4** Evolution in the Conagua's end-of-year budget (millions of pesos)




**Source**: Conagua (2015o).

**Graph 5.5** Indicator "Water pays for water" (at constant 2014 prices)




**Source**: Produced based on Conagua (2015o), Conagua (2015g).

[Reporteador: Presupuesto invertido]

The evolution in the investment in the drinking water, drainage and sanitation subsector is shown in table 5.11, considering the programs operated through the Conagua, Sedesol, Cdi, Banobras, state bodies, the private sector and credits. For table 5.11 the concept of "Others" considers studies, projects and supervision.

It should be mentioned that this investment has diverse origins. As can be observed in table 5.12, 60.0% of the investment was of federal origin, whereas states contributed 16.4%, municipalities 9.5% and other sources, including state commissions, housing developers, credits, contributions of the private sector and others, the remaining 14.1%. For table 5.12, in the "Prome" and "Prossapys" concepts, the state investment includes municipal resources; the Valley of Mexico concept refers to the federal resources from the 1928 Trust Fund, derived from the payment of duties for the concept of bulk water supply; and the "Other projects" concept includes infrastructure projects such as El Zapotillo, El Realito and Bicentenario.

**60%**
of the investment in the drinking water sub-sector was of federal origin

**Table 5.11** Investments by area applied to the drinking water, sewerage and sanitation subsector, 2002-2014 (millions of pesos at constant 2014 prices)

| Year | Drinking water | Sewerage | Sanitation | Improving efficiency | Others | Total |
|---|---|---|---|---|---|---|
| 2002 | 5 863 | 6 642 | 2 517 | 1 967 | 134 | **17 124** |
| 2003 | 8 144 | 7 754 | 1 901 | 1 470 | 276 | **19 546** |
| 2004 | 8 038 | 8 172 | 2 311 | 1 628 | 106 | **20 256** |
| 2005 | 12 118 | 11 896 | 4 717 | 2 300 | 170 | **31 202** |
| 2006 | 7 587 | 8 114 | 2 538 | 3 334 | 343 | **21 917** |
| 2007 | 12 525 | 9 946 | 2 326 | 3 283 | 759 | **28 839** |
| 2008 | 13 383 | 11 929 | 2 948 | 3 889 | 1 407 | **33 556** |
| 2009 | 12 061 | 13 135 | 2 758 | 6 572 | 2 098 | **36 623** |
| 2010 | 10 647 | 14 384 | 3 319 | 5 654 | 2 616 | **36 619** |
| 2011 | 10 167 | 15 695 | 8 664 | 5 157 | 2 445 | **42 128** |
| 2012 | 11 749 | 7 992 | 17 183 | 4 079 | 2 731 | **43 733** |
| 2013 | 11 051 | 13 299 | 7 719 | 4 792 | 1 743 | **38 605** |
| 2014 | 10 356 | 10 018 | 5 576 | 6 335 | 1 920 | **34 206** |

**Source**: Conagua (2015e).

**Table 5.12** Investments reported by program and agency by the sector of origin of the resources, 2014 (millions of pesos)

| Concept | Federal | State | Municipal | Credit/Private/Others | Total |
|---|---|---|---|---|---|
| **Conagua investments** | **16 734.32** | **5 040.82** | **2 306.14** | **1 086.78** | **25 168.06** |
| Agua Limpia | 69.51 | 53.48 | 0.00 | 0.00 | 122.99 |
| Apazu | 5 066.35 | 2 416.62 | 857.18 | 528.41 | 8 868.56 |
| Prodder | 1 310.32 | 0.00 | 1 310.32 | 0.00 | 2 620.65 |
| Promagua | 974.36 | 806.49 | 0.00 | 504.48 | 2 285.33 |
| Prome | 523.11 | 383.97 | 0.00 | 0.00 | 907.07 |
| Prossapys | 3 062.91 | 725.11 | 0.00 | 0.00 | 3 788.01 |
| Protar | 1 169.97 | 492.08 | 102.80 | 53.88 | 1 818.74 |
| Valley of Mexico | 3 709.14 | 0.00 | 0.00 | 0.00 | 3 709.14 |
| Other projects | 848.64 | 163.09 | 35.84 | 0.00 | 1 047.56 |
| **Other bodies** | **3 778.08** | **579.51** | **942.27** | **3 738.27** | **9 038.13** |
| Cdi | 2 627.47 | 322.94 | 263.81 | 0.00 | 3 214.21 |
| Conavi | 0.00 | 0.00 | 0.00 | 3 684.26 | 3 684.26 |
| Sedesol | 1 150.61 | 256.57 | 678.46 | 54.01 | 2 139.65 |
| **Total** | **20 512.40** | **5 620.33** | **3 248.41** | **4 825.05** | **34 206.19** |

**Source**: Conagua (2015e).

# Drinking water and sanitation tariffs

[Reporteador: Tarifas]

Drinking water tariffs are established independently for each municipality, depending on the provisions of the corresponding state's legislation. In some states, the tariffs are approved by the local state congress, whereas in others they are approved by the governing body or Board of Directors of the municipality's or locality's drinking water utility or the state water commission [Adicional: Table 5.B].

In principle, tariffs have the objective of recovering the costs incurred by the service provider. There is a Mexican standard on the evaluation of tariffs (NMX-AA-147-SCFI-2008), published in April 2009, which includes a definition of these costs.

The tariff level, or the payment due, is expressed in a **tariff structure**, more often than not differentiated by the type of users (domestic, commercial and industrial, among others). On occasions the tariff structure contains some mechanism of redistribution of costs through crossed subsidies, in which users in poorer socio-economic conditions are assigned lower tariffs than those considered as being in better conditions.

Tariff structures for **metered services** (when the charge is calculated based on the volume consumed) are generally in increasing blocks, meaning that the price per cubic meter is higher for a greater consumption of water. It should be mentioned that there is a great variety of mechanisms, including the fixed price, meaning when the user pays a certain amount independently of the water that has been used.

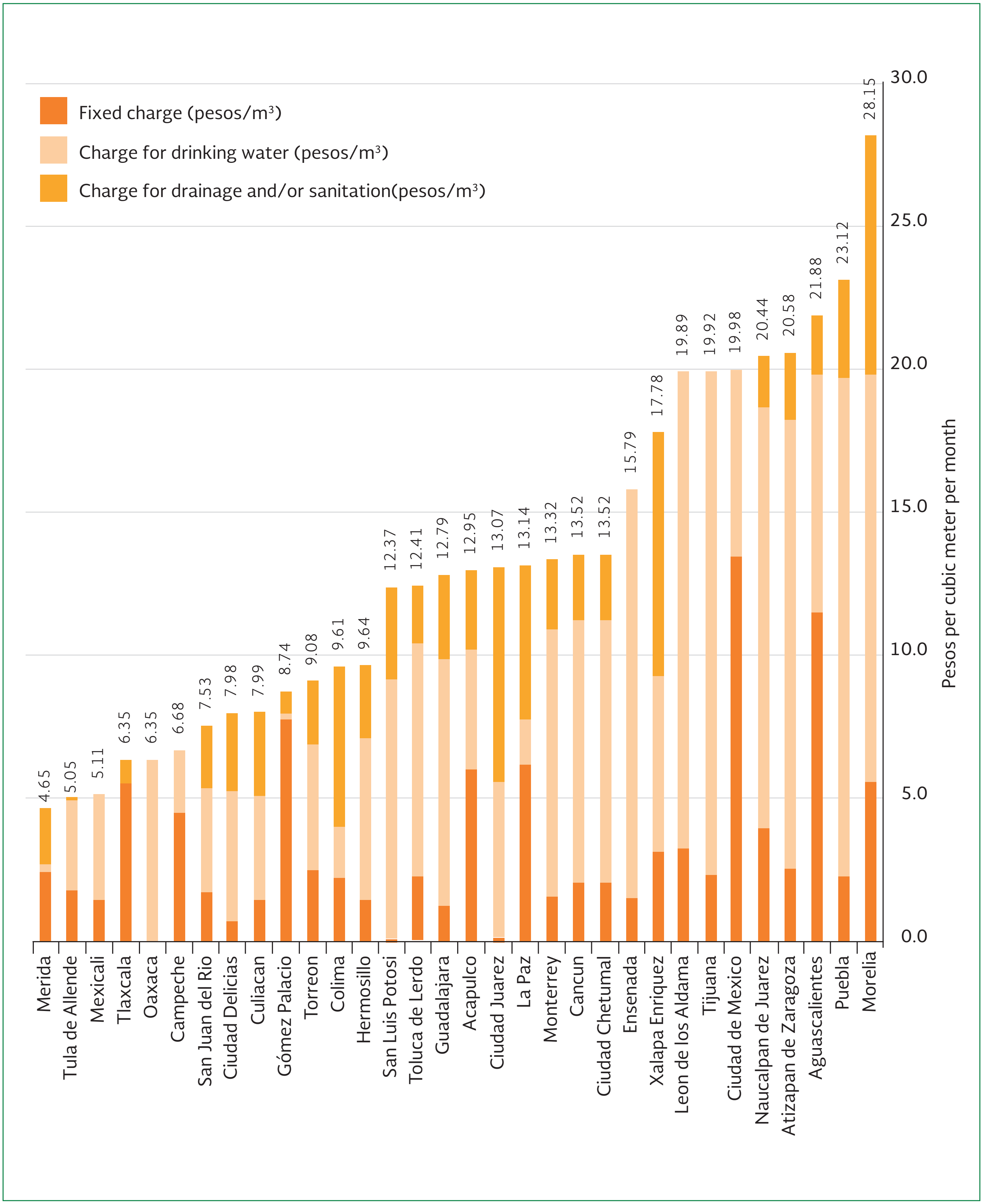
Water tariffs generally include:

- Fixed costs, independent from the volume used,
- Variable charges for the water supplied, according to the volume used,
- Variable charges for the concept of sewerage and wastewater treatment, generally applied as a percentage of the costs for water supply.

Graph 5.6 indicates, for some cities in Mexico, the drinking water, sewerage and/or sanitation tariffs for a consumption of 30 $m^3$/month for domestic use, as well as the highest tariff applicable.

Graph 5.7 indicates, for some localities in Mexico, the tariffs for domestic, industrial and commercial use, assuming a consumption of 30 $m^3$/month, as well as the highest tariff applicable.

**GRAPH 5.6** Domestic drinking water, sewerage and/or sanitation tariffs in selected cities, 2014




**Source**: CONAGUA (2015e).

It should be mentioned that with the level of the tariff established, the service provider carries out the billing to users as a necessary step to charge for the service. The payment of these bills by users represents the income collected by the service provider. There are payments that are carried out in the same billing period, whereas others are late payments, fines or surcharges.

## External funding and international cooperation

The resources destined for the sector include those that come from international financial institutions, which additionally benefit from some innovative aspects of international experience.

In external credit, during 2014 the Conagua exercised three projects with a disbursement that year of 69.1 million dollars, on the issues of:

- Improving efficiencies of water utilities (Prome), financed by the IBRD.
- Modernization of the National Meteorological Service (MoMet), financed by the IBRD.
- Rural drinking water and sanitation (Prossapys IV), financed by the IADB.

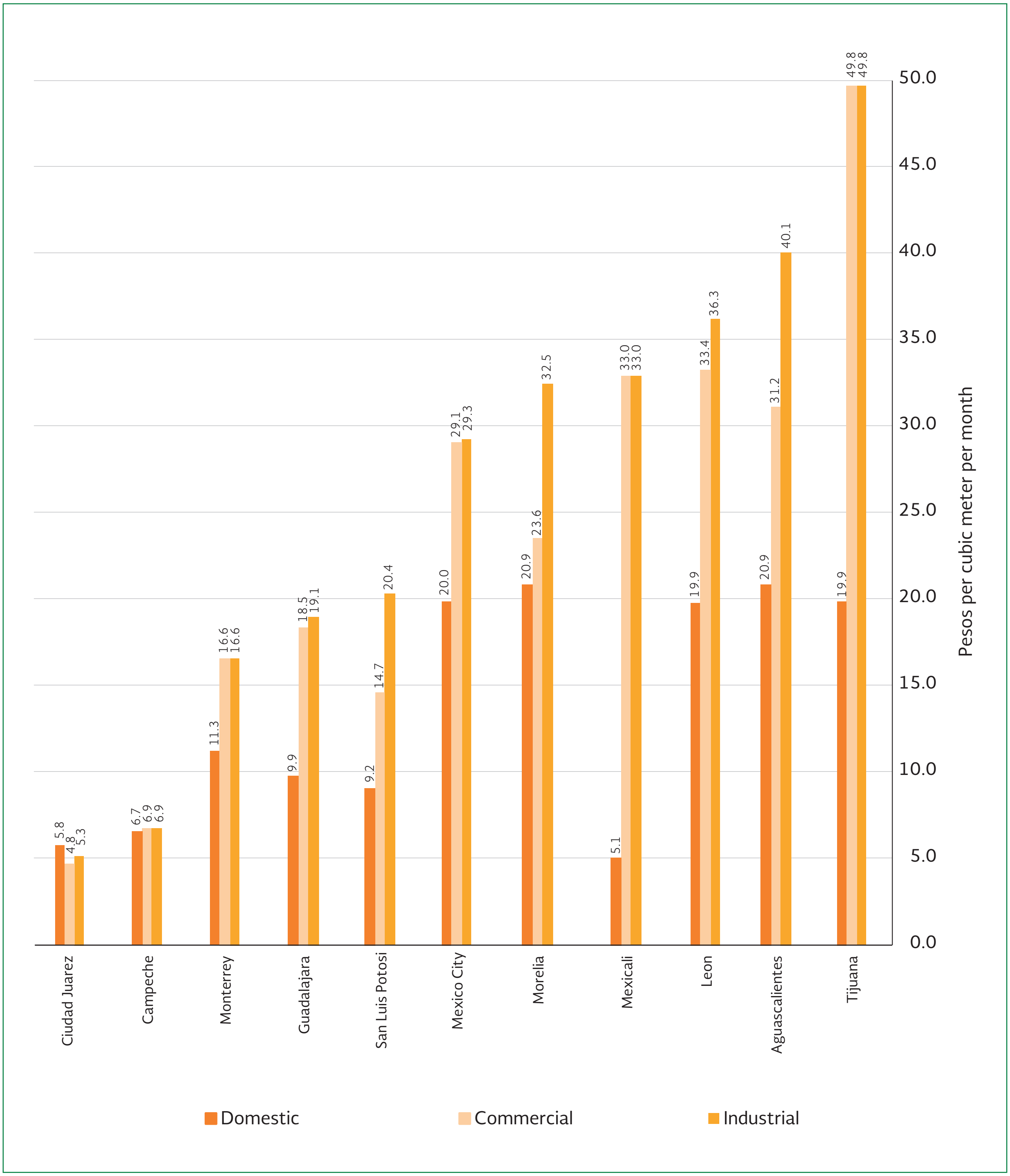
In 2014 another project with external credit was formalized, on the issue of public policy for drinking water and sanitation with the French Development Agency and the German Development Bank.

Technical cooperations with international financial institutions were on issues of the efficient use of energy, for which two studies were developed; water reserves and the promotion of private sector participation, issues that concluded in 2014. Two cooperations were managed during the year: on integrated watershed management for the Cutzamala System (WB) and technical cooperation and capacity development with the Korean Institute of Industry and Environmental Technology (South Korea).

In 2014 the Conagua had bilateral actions with 20 countries and multilaterals with 17 international organizations. There were several training actions within the framework of international cooperation.

In **2014,**
**69.1**
million dollars of external credit were disbursed

**Graph 5.7** Comparison of tariffs for domestic, industrial and commercial use in selected cities, 2014




**Source**: Conagua (2015e).

# 5.4 Participation mechanisms

[Reporteador: Instrumentos de gestión]

## River basin councils and auxiliary bodies

The NWL establishes that river basin councils are multi-stakeholder collegiate bodies, which are coordination and consensus-reaching bodies providing support, consultation and advice, between the Conagua, including the corresponding river basin organization, the agencies and entities of the federal, state or municipal governments and representatives of water users and civil society organizations, in the respective watershed or hydrological region.

As of December 31, 2014, there were 26 river basin councils [Adicional: Map 5.A].

In the process of consolidating the river basin councils, it was necessary to attend very specific issues in more localized geographic zones, as a result of which auxiliary bodies known as river basin commissions were created to attend sub-catchments; river basin committees for micro-catchments; technical groundwater committees (Cotas) and clean beach committees in the country's coastal zones.

The clean beach committees are worth special mention. They have the purpose of promoting the cleaning up of beaches, watersheds and the aquifers associated with them, as well as preventing and rectifying the pollution of Mexico's beaches, respecting the native ecology and raising the quality and the standard of living of the local population, tourism and the competitiveness of the beaches.

As regards the auxiliary bodies, up to 2014 there was a total of 208 auxiliary bodies of the river basin councils, with 35 commissions, 47 committees, 87 Cotas and 39 clean beach committees [Adicional: Table 5.C].

**Box 5.1** Actions of river basin councils and their auxiliary bodies

**Blue flag.** Since 2013 some beaches under the clean beach committees have obtained the annual Blue Flag certification, which rewards coastal destinations which excel in environmental management, security and hygiene installations, education and environmental information activities and water quality. In 2014 there were 11 beaches in 6 tourist destinations: Los Cabos (Baja California Sur), Bahia de Banderas (Nayarit), Zihuatanejo (Guerrero), Santa Maria Huatulco (Oaxaca), Puerto Vallarta (Jalisco) and Benitez Juarez (Quintana Roo).

**Rectification of the Mayo river.** Through the promotion of the Mayo river basin council, efforts of federal and state authorities, the private sector and agricultural users were combined to clean the river bed, build and reinforce water retention berms, and eliminate fencing and trash, which allowed the 2014 hurricane season to occur without incidents.

**Rainwater harvesting to recover the Caborca aquifer.** The Alto Noroeste river basin council managed with the Conafor a triennial project (2013-2015) on "Environmental compensation from the loss of soil use in forest grounds" for 208 hectares in the region known as the "Charco de las Calenturas" to recover the forest ecosystem and recharge the aquifer, through soil restoration activities, reforestation and water retention works.

**Source**: Produced based on Conagua (2015a), Conagua (2015b).

# 5.5 Water-related standards

## Official Mexican Standards

Due to the crosscutting nature of the water sector, there are several standards related to water issues. The following table shows some of the relevant standards. It is worth highlighting that, according to the Federal Law on Metrology and Standardization, the Official Mexican Standards (NOMs in Spanish) are technical regulations to be obligatorily observed, whereas the Mexican Norms (NMX) are voluntarily applied.

Of special interest is NOM-001-SEMARNAT-1996, given that it establishes compliance deadlines for its requirements regarding maximum permissible limits in wastewater discharges into the nation's water and public goods (see table 5.14).

NOM-011-CONAGUA-2000 is another standard to be highlighted, since it is the basis upon which the calculation of availability of water in catchments and aquifers is carried out, and it thus makes it possible to comply with one of the Conagua's legal obligations.

On the other hand, the Conagua has issued standards that establish the dispositions, specifications and testing methods that guarantee that the products and services associated with the water sector comply efficiently with preserving water in quality and quantity.

Additionally, NOM-127-SSA1-1994 establishes the guidelines to guarantee water supply for human use and consumption with appropriate quality. This standard establishes permissible limits of bacteriological characteristics (fecal coliforms and total coliforms); physical and sensory characteristics (color, smell, taste and cloudiness); chemical characteristics (which include 34 parameters, such as aluminum, arsenic, barium, etc.), as well as treatment methods which should be applied according to the pollutants encountered.

**Table 5.13** Mexican standards related with the water sector, 2014

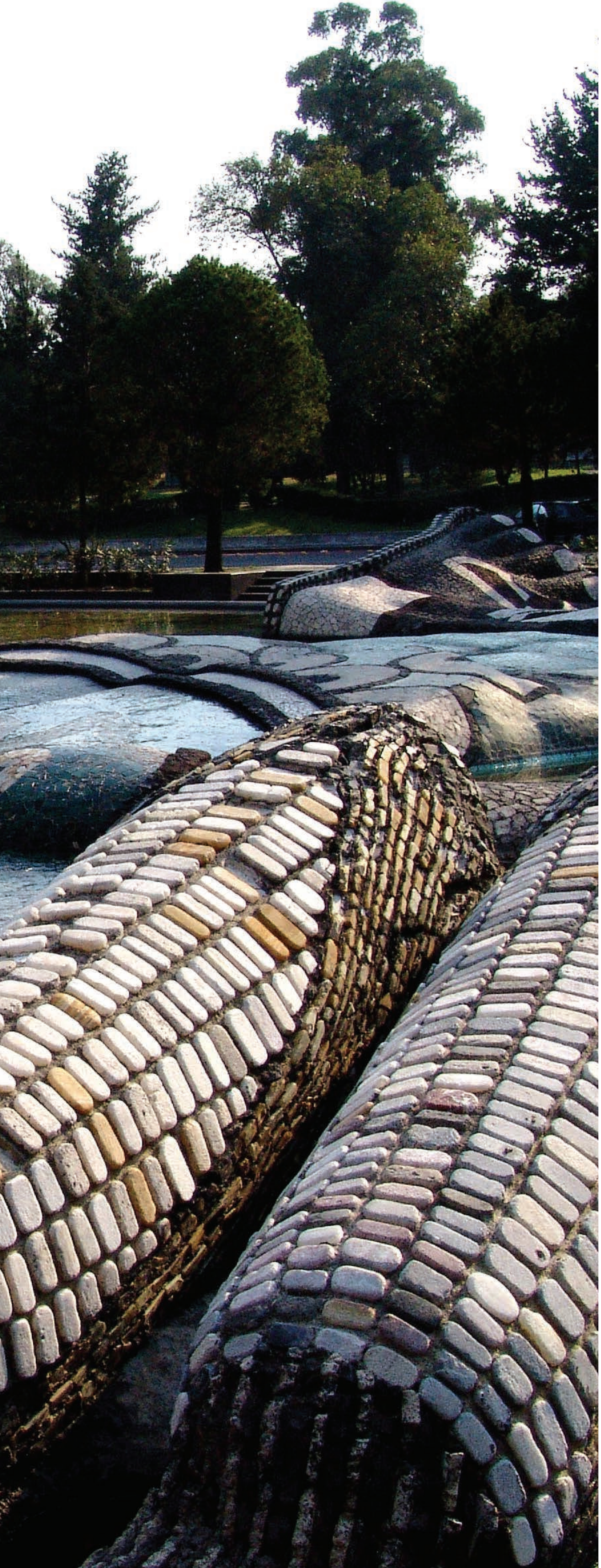
| Nº | Group: SEMARNAT |
|---|---|
| 1 | NOM-001-SEMARNAT-1996 - Maximum permissible limits of pollutants in wastewater discharges in the nation's water resources and goods |
| 2 | NOM-002-SEMARNAT-1996 - Maximum permissible limits of pollutants in wastewater discharges to urban and municipal sewerage systems |
| 3 | NOM-003-SEMARNAT-1997 - Maximum permissible limits of pollutants for treated wastewater that is reused in services to the public. |
| 4 | NOM-022-SEMARNAT-2003 - Preservation, conservation, sustainable use and restoration of coastal wetlands in areas of mangrove swamps. |
| 5 | NOM-060-SEMARNAT-1994 - Specifications to mitigate the adverse effects caused on soil and water bodies by forest activities. |
| **Nº** | **Group: CONAGUA** |
| 1 | NOM-001-CONAGUA-2011 – Drinking water systems, domestic intakes and sanitary sewerage- Airtightness-Specifications and testing methods. |
| 2 | NOM-003-CONAGUA-1996 - Requirements for the construction of wells for the prevention of aquifer pollution. |
| 3 | NOM-004-CONAGUA-1996 - Requirements for the protection of aquifers during maintenance and rehabilitation of water wells, and the closing of wells in general. |
| 4 | NOM-006-CONAGUA-1997 - Specifications and testing methods for pre-manufactured septic tanks. |
| 5 | NOM-008-CONAGUA-1998 - Specifications and testing methods for showers. |
| 6 | NOM-009-CONAGUA-2001 - Specifications and testing methods for lavatories. |
| 7 | NOM-010-CONAGUA-2000 - Specifications and testing methods for valves for lavatories. |
| 8 | NOM-011-CONAGUA-2000 - Conservation of water resources. Specifications and the method to determine the mean annual availability of the nation's water resources. |
| 9 | NOM-014-CONAGUA-2003 - Requirements for artificial aquifer recharge with treated wastewater. |
| 10 | NOM-015-CONAGUA-2007 - Characteristics and specifications of works and of water for its artificial infiltration into aquifers. |
| **Nº** | **Group: Salud** |
| 1 | NOM-117-SSA1-1994 - Testing method for the determination of cadmium, arsenic, lead, tin, copper, iron, zinc and mercury in food, drinking water and treated water by atomic absorption spectrometry. |
| 2 | NOM-127-SSA1-1994 - Environmental health. Water for human use and consumption. Permissible limits of quality and treatment to which water should be submitted for its purification. |
| 3 | NOM-179-SSA1-1998 - Monitoring and evaluation of the control of drinking water quality in networks. |
| 4 | NOM-201-SSA1-2002 - Products and services. Water and ice for human consumption, packaging and bulk. Sanitary specifications. |
| 5 | NOM-230-SSA1-2002 - Health requirements for water management in drinking water networks. |
| 6 | NOM-244-SSA-2008. Equipment and germicidal substances for domestic water treatment. Sanitary requirements. |
| **Nº** | **Group: Mexican Standards** |
| 1 | NMX-AA-120-SCFI-2006 - Requirements and specifications for the sustainability of beach quality. |
| 2 | NMX-AA-147-SCFI-2008 - Methodology for the evaluation of drinking water, sewerage and sanitation tariffs. |
| 3 | NMX-AA-148-SCFI-2008 - Methodology to evaluate the quality of drinking water, sewerage and sanitation services. Guidelines for the evaluation and improvement of services to users |
| 4 | NMX-AA-149/1-SCFI-2008 - Methodology to evaluate the efficiency of drinking water, drainage and sanitation service providers. Guidelines for wastewater service provision and evaluation. |
| 5 | NMX-AA-149/2-SCFI-2008 - Methodology to evaluate the efficiency of drinking water, drainage and sanitation service providers. Guidelines for drinking water service provision and evaluation. |

**Source**: Produced based on Economía (2015b), Semarnat (2015b).

**Table 5.14** Compliance dates of NOM-001-SEMARNAT-1996

| Municipal discharges | | |
|---|---|---|
| **Modified compliance dates from:** | **Population range (according to 1990 Census)** | **Number of localities (according to 1990 Census)** |
| January 1, 2000 | More than 50 000 inhabitants | 139 |
| January 1, 2005 | From 20 001 to 50 000 inhabitants | 181 |
| January 2, 2010 | From 2 501 to 20 000 inhabitants | 2 266 |
| **Non-municipal discharges** | | |
| **Modified compliance dates from:** | **Biochemical Oxygen Demand ($BOD_5$)(t/day)** | **Total Suspended Solids (t/day)** |
| January 1, 2000 | More than 3.0 | More than 3.0 |
| January 1, 2005 | From 1.2 to 3.0 | From 1.2 to 3.0 |
| January 2, 2010 | From 1.2 to 3.0 | Less than 1.2 |

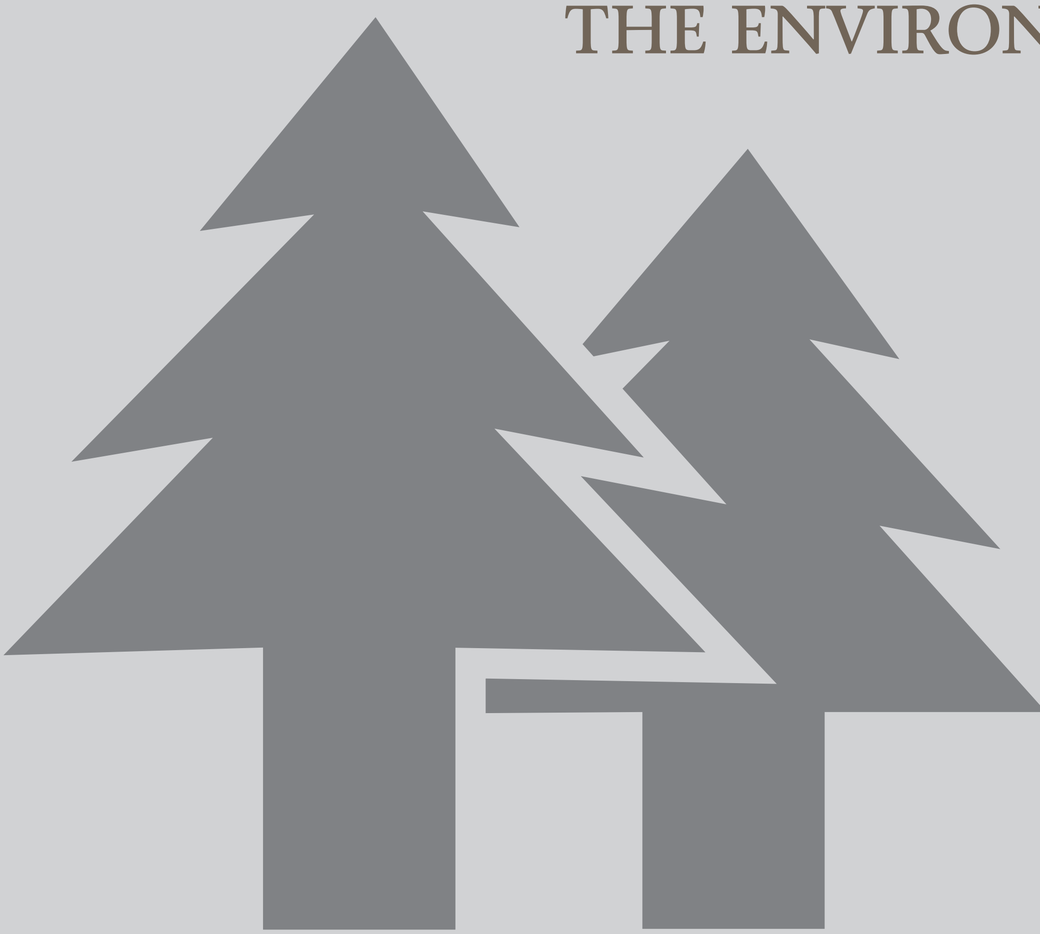
**Source**: Conagua (2015b).



# Chapter 6

## Water, health and the environment

# Water, health and the environment



## Environmental protection

**Environmental hydrological services:** support of the National Forestry Program is provided for properties in

Overdrafted aquifers

Watersheds with low availability

Natural protected areas under federal jurisdiction 2014: **177**

**25.6** million hectares

Natural protected areas voluntarily allocated: **369**

**404 517** hectares

## Water and health

Mortality rate from diarrheal diseases in children under the age of five (for every **100 000** inhabitants)

| 1990 | 2014 |
|---|---|
| **122.7** | **9.1** |

Drinking water coverage

1990 **78.4%**

2014 **92.4%**

Sanitation coverage

1990 **61.5%**

2014 **91.0%**

## Use of soil and vegetation

**Vegetation cover**

Protects the soil

Intercepts rain

**Soil**

Its degradation reduces the capacity to provide goods and services

Subject to water and wind erosion

## Wetlands

Ecosystems with rich biodiversity and which provide environmental services

| National Inventory of **Wetlands** | Designation as **RAMSAR** sites |
|---|---|
| **6 331** | **142** |
| **10** million hectares | **8.6** million hectares |

## 6.1 Health

[Reporteador: Agua y salud]

The provision of drinking water and sanitation is a significant factor in public health, by avoiding exposure to pathogenic agents. Appropriate access to these services is fundamental for the reduction of mortality and morbidity among the population under the age of five; the decrease in water-borne diseases (viral hepatitis, typhoid fever, cholera, dysentery and other causes of diarrhea), as well as illnesses resulting from exposure to pathogenic chemical components (arsenic, nitrates or fluoride).

In the case of diarrheal diseases, child mortality in Mexico has been reduced as a result of several public health-related actions and interventions [Adicional: Graph 6.A], including the distribution of oral serum from 1984 onwards, vaccination campaigns since 1986, the Clean Water Program in 1991, and the increase in drinking water, sewerage and sanitation coverage (Sepúlveda et al. 2007).

In addition to these factors, those related to hygiene, education, access to health services and improvements in socio-economic and environmental conditions should be mentioned.

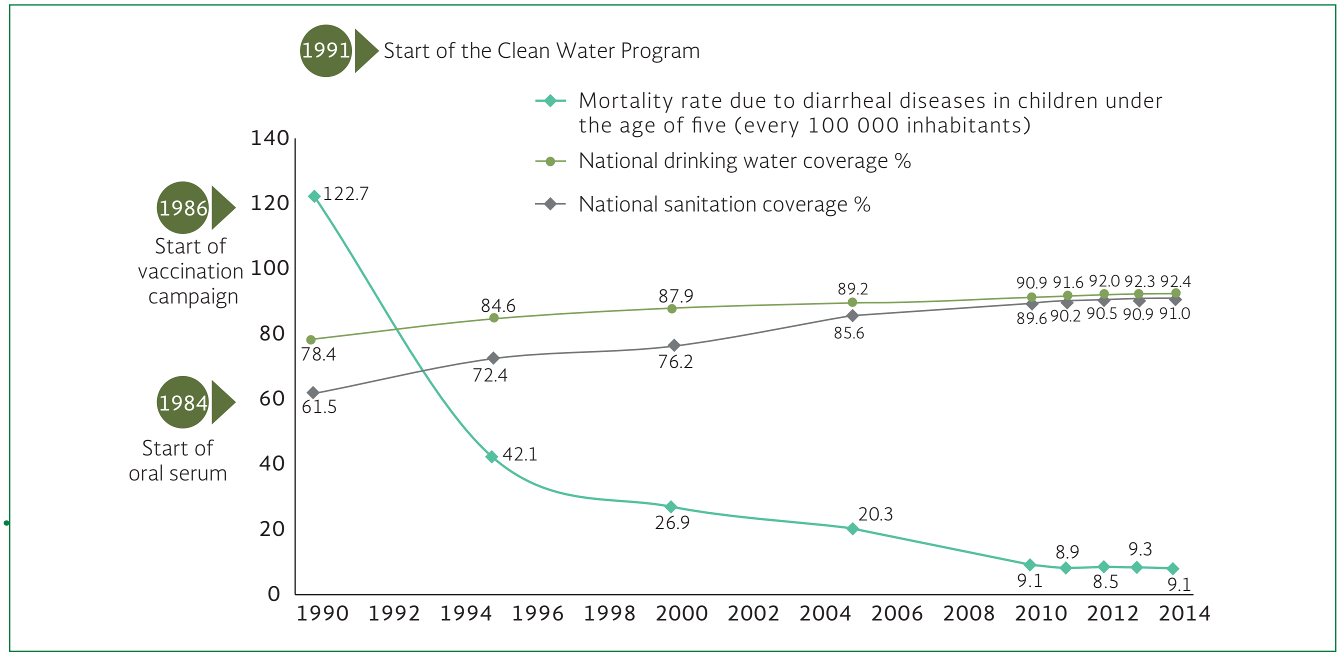
It is interesting to compare the increasing trend in drinking water and sanitation coverage against the reduction in the mortality rate through diarrheal diseases in children under the age of five, which can be observed in graph 6.1.

**1991**
start of the Clean Water Program

In Mexico, drinking water service providers also carry out the disinfection of water through chlorination (which is necessary in order to destroy pathogenic agents or microscopic parasites). The service provider is generally speaking the municipality, or in exceptional cases the state.

The effectiveness of the water disinfection process in formal supply systems is evaluated through the determination of free chlorine residual, the presence of which in the domestic outlet signals the efficiency of the disinfection process.

**Graph 6.1** Coverage of drinking water and sanitation and the mortality rate through diarrheal diseases in children under the age of five, 1990-2014




**Source**: Produced based on Conagua (2015e), Salud (2015).

# 6.2 Vegetation

[Reporteador: Uso del suelo y vegetación]

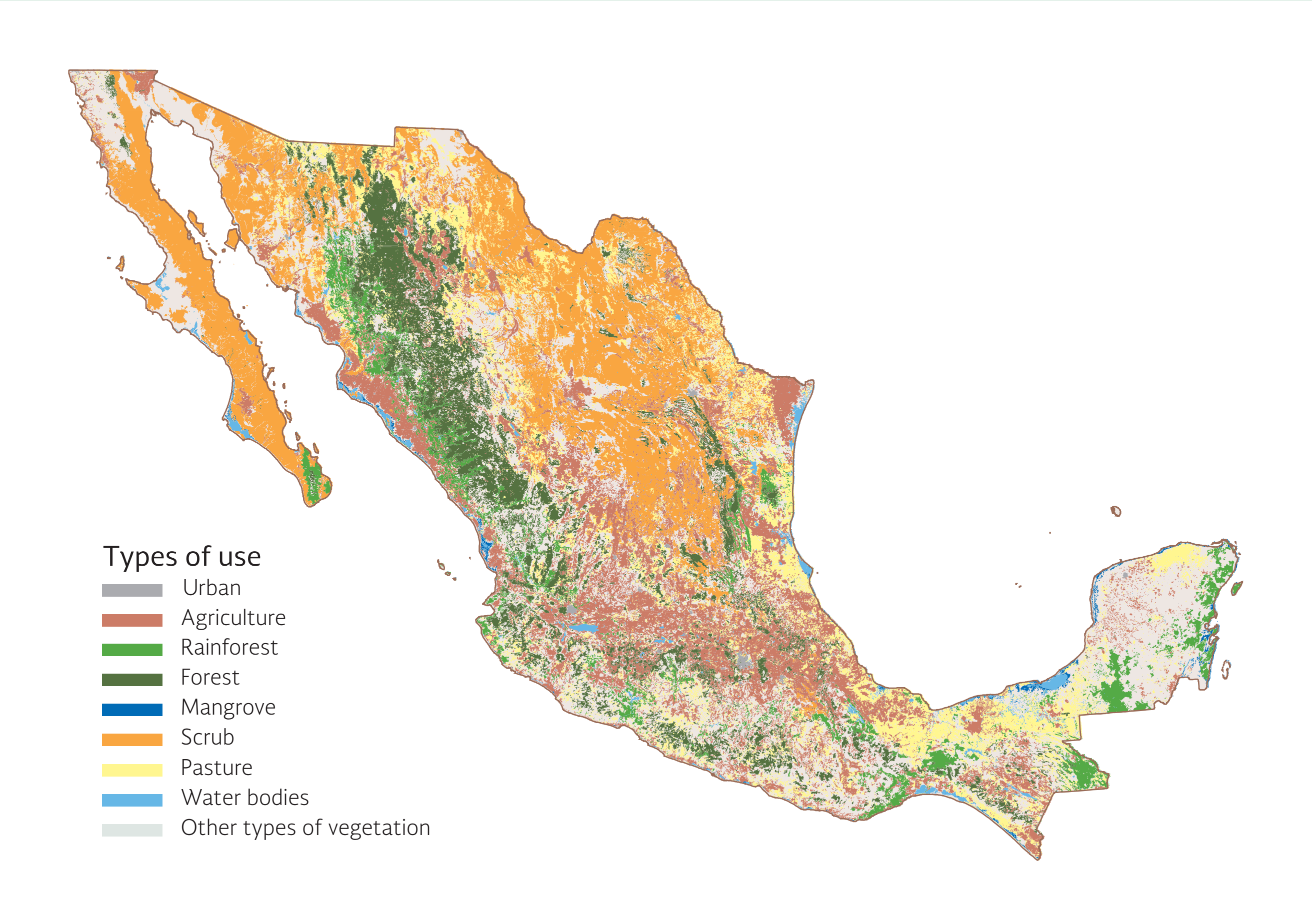
According to data from the "Charter of Soil and Vegetation Use" (INEGI 2014k), Mexico is classified into twelve vegetation groups compatible with the Rzedowski classification system. It should be mentioned that over time INEGI has generated updates to this charter, the result of which is series I (updated in the 1980-90 period), II (1993), III (2002), IV (2007) and V (2011-2012) (map 6.1).

Series V was generated during the 2011–2012 period, based on the information presented in series IV of Soil and Vegetation Use and updated with Landsat satellite images from 2011.

It is possible to compare the evolution from series I to V, as can be observed in graph 6.2. Vegetation is referred to as **primary** when it develops naturally according to the site's environmental factors, and has not been significantly modified by human activity. **Secondary** refers to a successional state of vegetation, when there is an indication that the original vegetation has been eliminated or strongly disturbed. **Induced** vegetation is that which develops when the original vegetation has been eliminated, or in abandoned agricultural areas. As can be observed, the graph reflects the progressive increase in induced and secondary vegetation, linked to the corresponding decrease in primary vegetation. The years correspond to the period in which the information used in each series was captured.

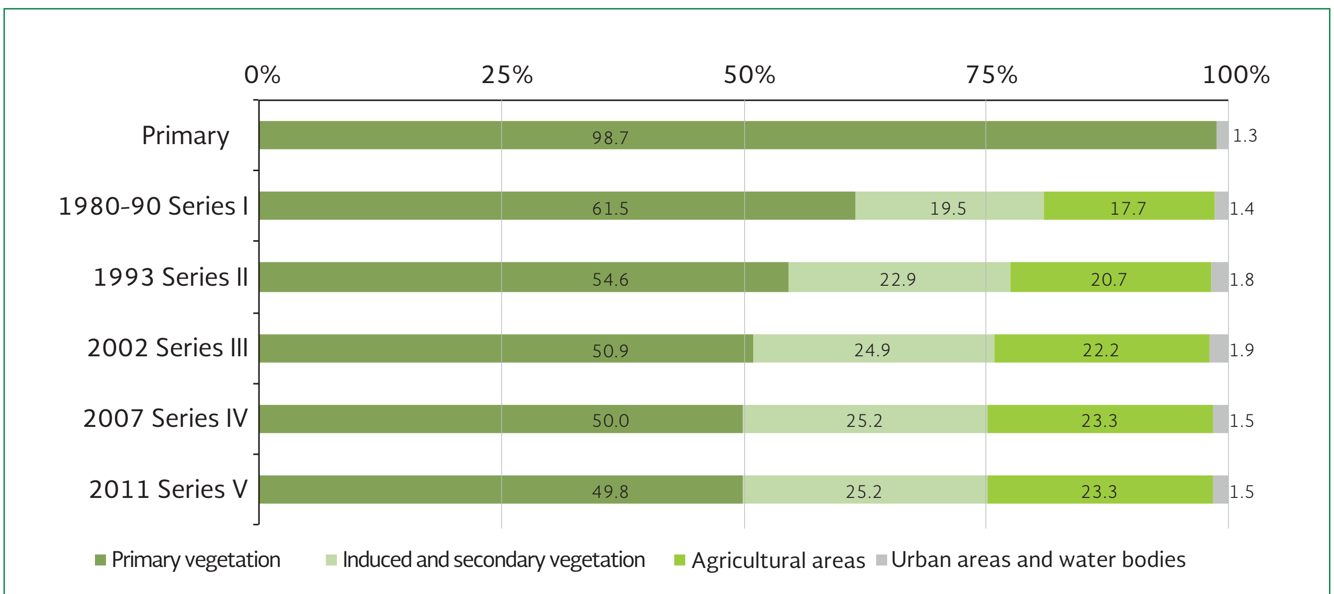
Primary vegetation according to series V covers **49.8%** of the national surface

## **Map 6.1** Main uses of soil and vegetation, series V Inegi (2011-2012)




**Source**: Produced based on Inegi (2015k).

## **Graph 6.2** Evolution in the use of soil and vegetation based on the Inegi charters (percentage of national territory)




**Source**: Produced based on Inegi (2015m).

Soil **degradation** reduces its capacity to provide goods and services for the ecosystem and the latter's beneficiaries. It is physically expressed through the loss of productivity, the availability of water, water logging or landslides. Chemical degradation increases the levels of pollution, salinization, alkalinization as well as eutrophication, which reduce the fertility and the content of organic matter in the soil.

Since vegetation cover acts as a protective layer, when it is lost, the soil is more vulnerable to water-based and wind **erosion**. The effects of erosion and degradation, estimated in 2002 and updated to 2008 (the latest year available), are shown in table 6.1.

The change in soil uses is highlighted by the increase in secondary and induced vegetation in urban and agricultural areas. The process of erosion gradually reduces the capacity of riverbeds and water bodies, leading to flood impacts during intense or sustained rainfall. Another vector of change in vegetation is forest fires. In graph 6.3 the hectares affected by this phenomenon every year in Mexico are shown.

It is estimated that in the 1990-2000 period, almost 354 000 hectares of forests changed to another soil use. For the 2000-2005 period, the rate of change slowed down to 235 000 hectares per year, and for the latest period reported on, from 2005 to 2010, it dropped to 155 000 hectares per year (FAO 2010).

Between **1990** and **2000**, it is estimated that

**354 000**

hectares of forests in Mexico changed to another soil use

**Table 6.1** Soil degradation: surface area affected by processes, types and levels of degradation (percentage of the national territory)

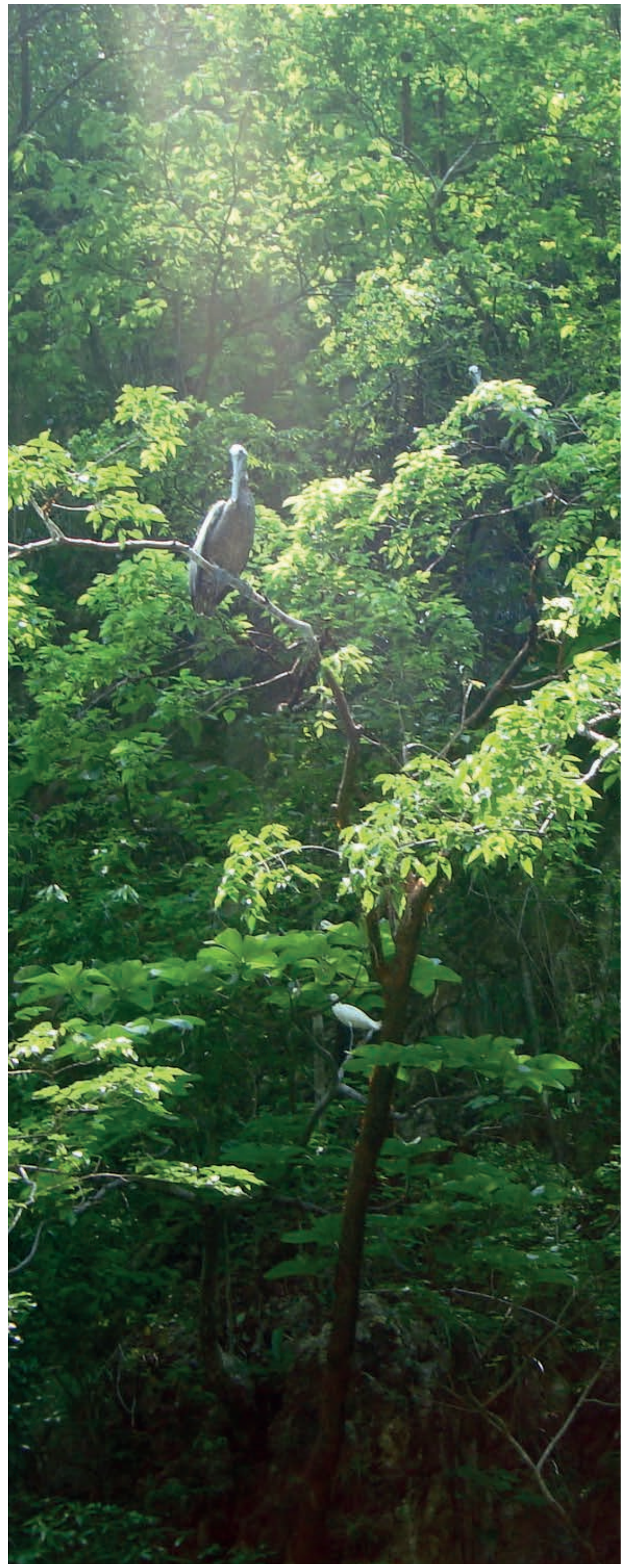
| Process of degradation | Light | Moderate | Severe | Extreme | Total |
|---|---|---|---|---|---|
| Physical degradation | 3.43 | 1.19 | 0.30 | 0.61 | 5.53 |
| Chemical degradation | 9.55 | 7.51 | 0.28 | 0.03 | 17.38 |
| Wind erosion | 2.73 | 6.17 | 0.35 | 0.01 | 9.25 |
| Water-based erosion | 6.54 | 4.61 | 0.43 | 0.02 | 11.60 |

**Source**: Semarnat (2014).

**Graph 6.3** Surface area affected by fires in Mexico (hectares)


**Source**: Semarnat (2015a)

## 6.3 Biodiversity



Nature provides water-related environmental services, by affecting soil and vegetation cover in water resources retention, which determines the accumulation of surface flows and aquifer recharge. Consequently, the conservation of soil and vegetation cover helps to maintain the integrity and balance of the natural elements that are part of the water cycle.

In this sense Protected Areas (PAs) are relevant, as terrestrial or aquatic portions that are representative of different ecosystems, which have not suffered anthropogenic alteration, and which produce ecological benefits which are increasingly recognized and valued, hence them being subject to special regimes of protection, conservation, restoration and development (Conanp 2015a). In core areas of PAs it is possible to limit or prohibit activities that alter ecosystems, as well as there being a prohibition on interrupting, filling, drying out or deviating hydrological flows. One of the management categories of PAs, natural resource protection areas, focuses on the preservation and protection of watersheds, as well as protection areas for national water bodies (General Laws on Ecological Balance and Environmental Protection).

In Mexico, the PAs that are under federal jurisdiction are administered by the National Commission for Protected Areas (Conanp), and are described in table 6.2. Additionally, the Conanp supports 369 areas voluntarily allocated for conservation, covering 404 517 hectares.

Environmental hydrological services are the objective of the National Forestry Program (*Operating Rules of the National Forestry Program 2014*). Every year the National Forestry Commission (Conafor) determines the eligible zones. Among the criteria taken into account are whether the polygons proposed to receive resources under this program are located within overdrafted aquifers or in watersheds with an average availability of surface water, according to the Conagua's classification.

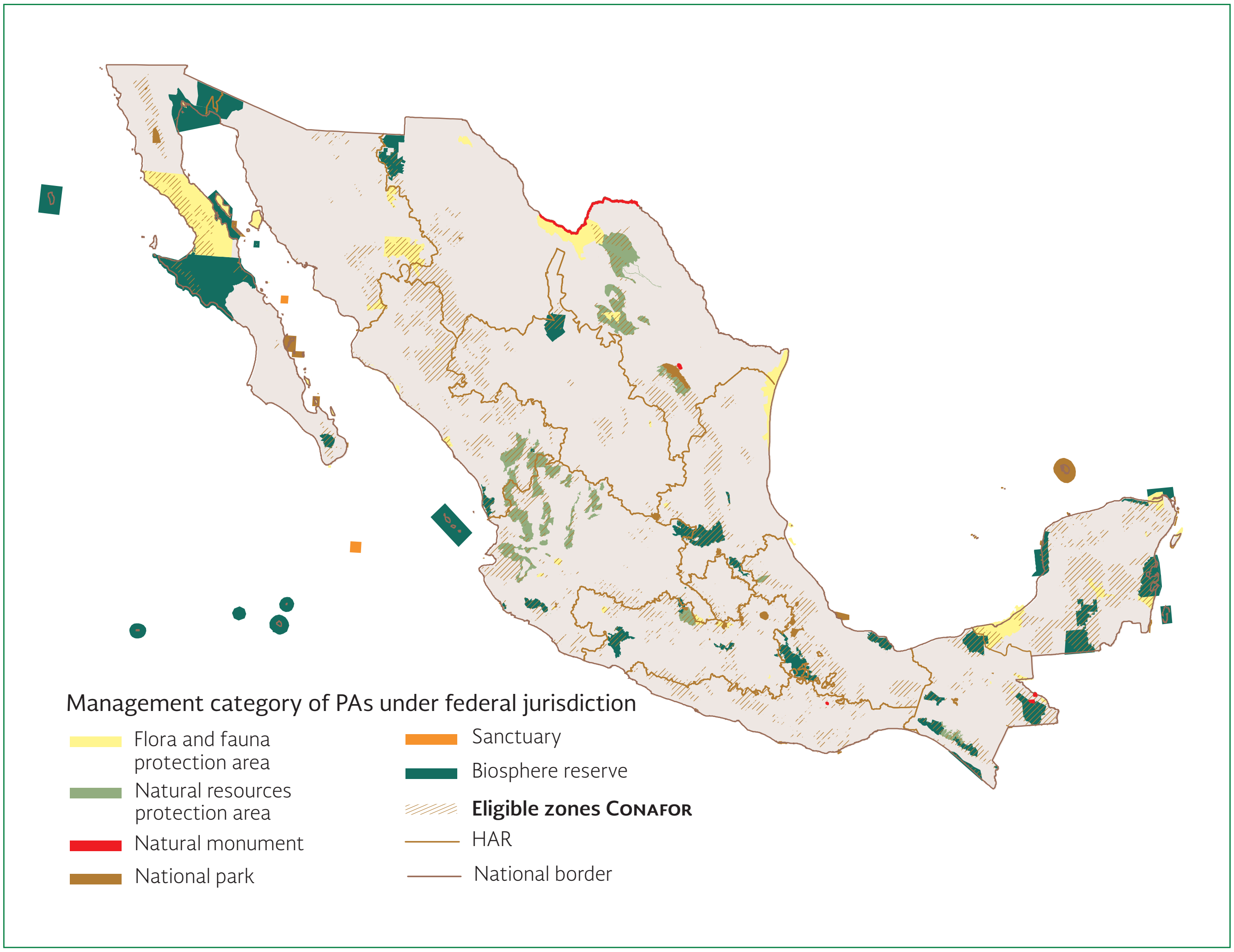
Map 6.2 shows the PAs under federal jurisdiction, as well as the eligible zones determined by the Conafor for 2014.

## Table 6.2 Protected areas under federal jurisdiction, 2014

| Category | Description | Quantity | Area (ha) |
|---|---|---|---|
| Biosphere reserves | Non-altered ecosystems or which need to be preserved or restored, with species that are representative of the national biodiversity. | 41 | 12 751 149 |
| National parks | Ecosystems with scenic beauty, scientific, educational, recreational or historic value, related to species or suitable for the development of tourism. | 66 | 1 411 319 |
| Natural monuments | Areas with unique or exceptional natural elements with esthetic, scientific or historic value. Does not require the variety of ecosystems or area of other categories. | 5 | 16 269 |
| Natural resources protection areas | Areas allocated for the preservation and protection of soil, watersheds, water and resources in forest grounds (and which are not included in other categories). | 8 | 4 503 345 |
| Flora and fauna protection areas | Places with habitat on whose balance and preservation the existence, transformation and development of forest species depends | 39 | 6 795 963 |
| Sanctuaries | Areas with considerable wealth of flora and fauna or species, sub-species or habitat with restricted distribution. | 18 | 150 193 |
| **Total** | | **177** | **25 628 239** |

**Source**: Conanp (2015a).

## Map 6.2 Conservation of nature and its services, 2014




**Source:** Conanp (2015b), Conafor (2014).

## 6.4 Wetlands

[Reporteador: Sitios Ramsar]

The conservation and sustainable management of wetlands can ensure the rich biodiversity and environmental services that they provide, such as: water storage, the conservation of aquifers, water purification through the retention of nutrients, sediments and pollutants, storm protection and flood mitigation, the stabilization of coasts and erosion control.

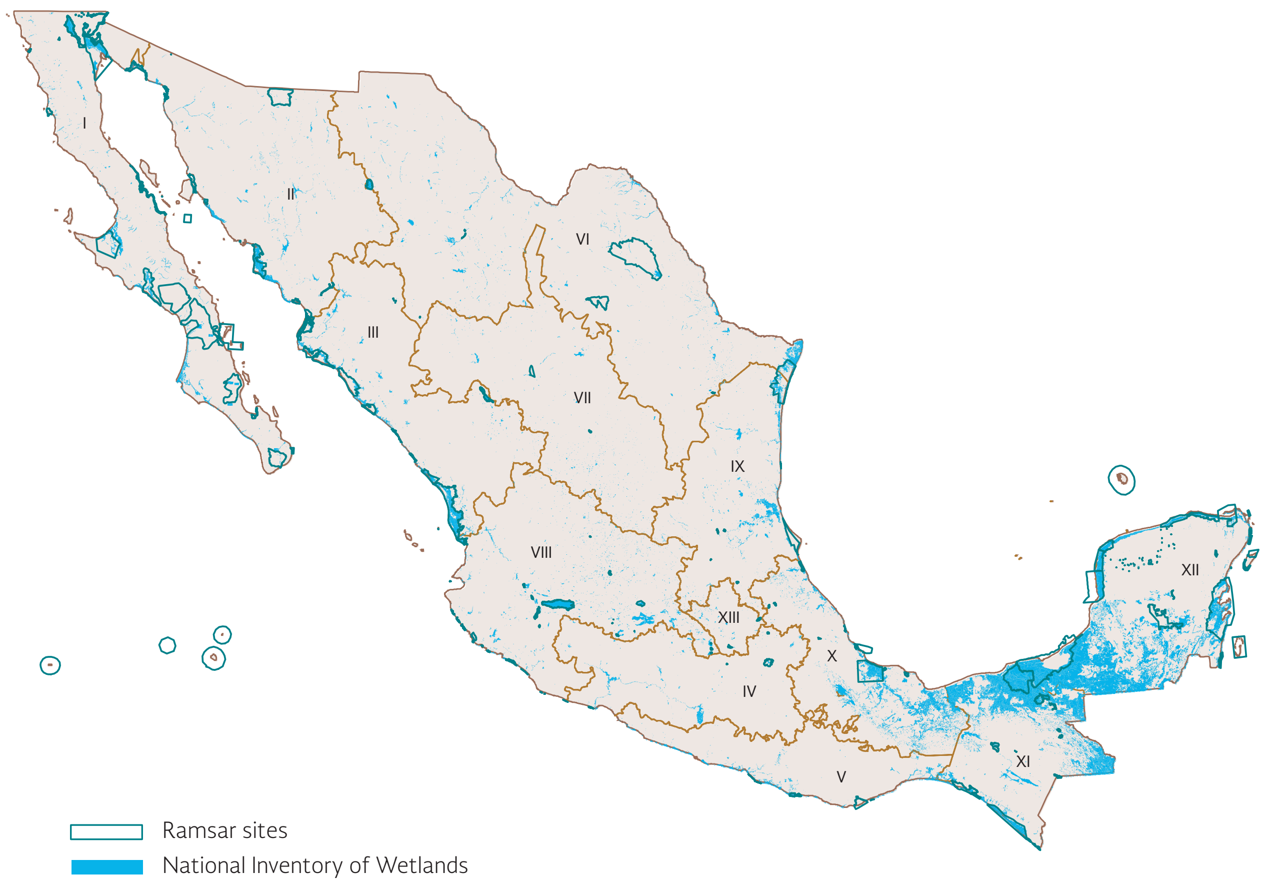
These ecosystems have undergone transformation processes with various purposes. The lack of knowledge on wetlands and their inappropriate management constitute some of the problems that adversely affect their conservation. As stipulated in the National Water Law, it is the Conagua's responsibility to carry out and update the National Inventory of Wetlands (NIW), as well as to define their contours, classify them and propose standards for their protection, restoration and use. In 2012, the study "Wetlands of the Mexican Republic" was produced, including the "National Map of Wetlands, scale 1:250 000".

Internationally, an intergovernmental convention was signed in the city of Ramsar, Iran (1971), known as the Ramsar Convention. This convention "...provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources" (Ramsar 2015).

At the time of going to press, 142 Mexican wetlands had been registered in the Ramsar Convention, taking the total surface area of the country registered to 8.6 million hectares (Conanp 2015c). Map 6.3 shows the wetlands that have been registered in the Ramsar Convention, as well as the NIW wetlands.

**Mexico** has
**142**
wetlands
registered in the
**Ramsar Convention**

**Map 6.3** Wetlands and Ramsar sites in Mexico



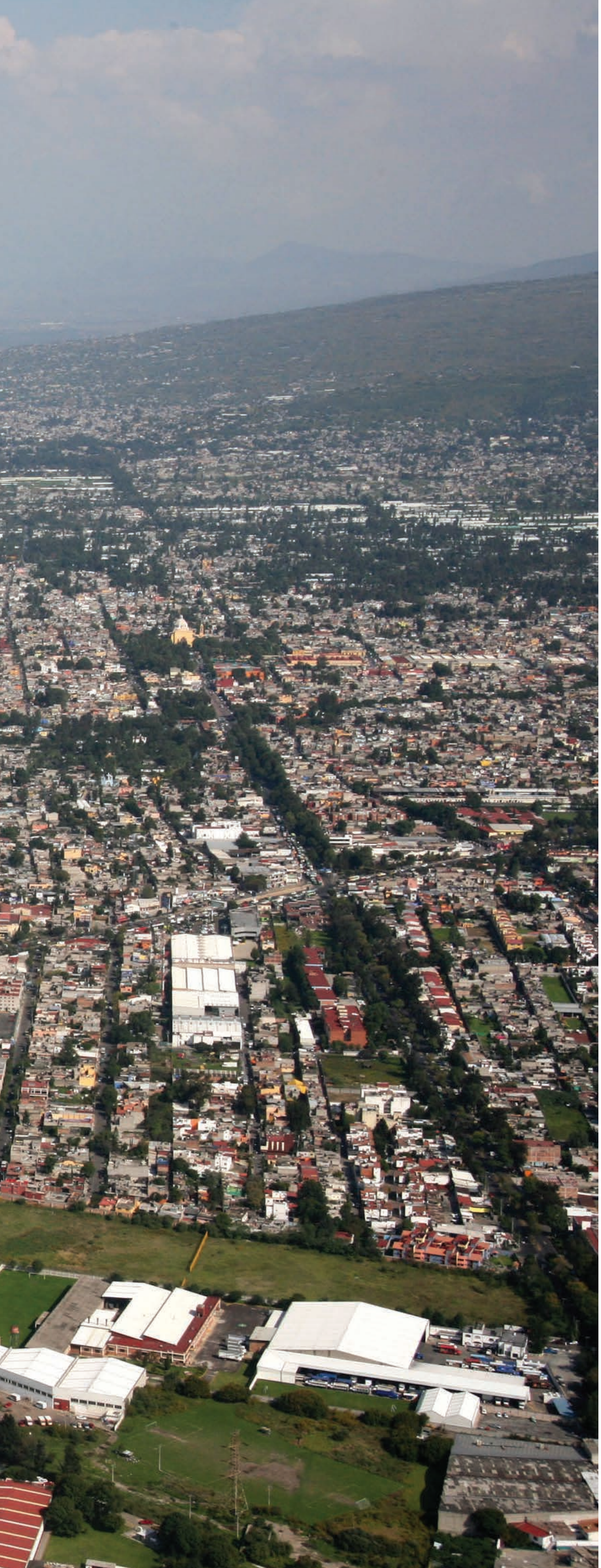

**Source**: Produced based on Conagua and UNAM (2012), Conanp (2015c).

**Box 6.1** The environment in Mexico's economic and ecological accounts

In the national integration of the System of Environmental-Economic Accounting (SEEA), Mexico's economic and ecological accounts include, as well as water-related items (see box 3.1), the following environmental issues: depletion of hydrocarbons, of timber-yielding forest resources and soil degradation, emissions into the atmosphere and solid waste.

They also include the estimation of the environmental protection expenditure (EPE) of the public sector. EPE allows the expenditure carried out on activities aiming to prevent, reduce or eliminate pollution to be quantified; as well as any other form of environmental degradation generated by decisions on production, distribution or consumption activities.

**Source:** Inegi (2014b), Inegi (2015o).



# Chapter 7

## Future scenarios

# Future scenarios


## Trends

Concentration in urban localities **2030:**

**73.7**

million Mexicans in

**38**

population centers

Population increase

**2014–2030:**

**17.76**

million people

Rural

**4.34**

million

Urban

**13.42**

million

Affects the per capita renewable water resources

| 2014 | 2030 |
|---|---|
| **3 736** | **3 253** |
| $m^3$/inhabitant/year | $m^3$/inhabitant/year |

## Sustainable water policy

**20th** century focus on supply

**End of the 20th** century focus on demand and decentralization

**21st** century focus on water sustainability

## National Water Program

Derived from the **2013-2018** National Development Plan

Articulates public policies around the water sector

**6** objetives

1. Strengthen integrated and sustainable water management
2. Increase water security to face droughts and floods
3. Strengthen water supply and access to drinking water, sanitation and sewerage services
4. Increase the technical, scientific and technological capacities in the sector
5. Sustainably ensure water for agricultural irrigation,energy, industry, tourism and other economic and financial activities
6. Consolidate Mexico's participation in the international context on water

# 7.1 Sustainable water policy

In the history of Mexico's water policy, three clear phases can be discerned:

**First stage:** At the beginning of the 20th century, the focus was placed on the **supply** side, which explains why a large number of storage reservoirs, irrigation districts, aqueducts and water supply systems were built.

**Second stage:** From the 1980s-1990s onwards, water policy became more **demand**-oriented and based on the principle of decentralization. The responsibility for providing drinking water, sewerage and sanitation services was transferred to the municipalities, and the Conagua was created as an institution that concentrated the tasks of managing the nation's water resources. Among the actions which aimed to meet this objective was the creation of the Public Registry of Water Duties (Repda), as a mechanism to provide order to the use of water resources.

**Third stage:** At the dawn of the 21st century, a new phase is coming to the fore, that of water **sustainability**, in which wastewater treatment is being significantly increased, the reuse of water is being promoted and the emphasis is being placed on the management of the nation's water resources through the verification of extractions, regulations around aquifers and watersheds and the updating of the methodology for the payment of duties for the use of the nation's water resources.

## 7.2 Trends

[Reporteador: Población, Grado de presión, Agua renovable]

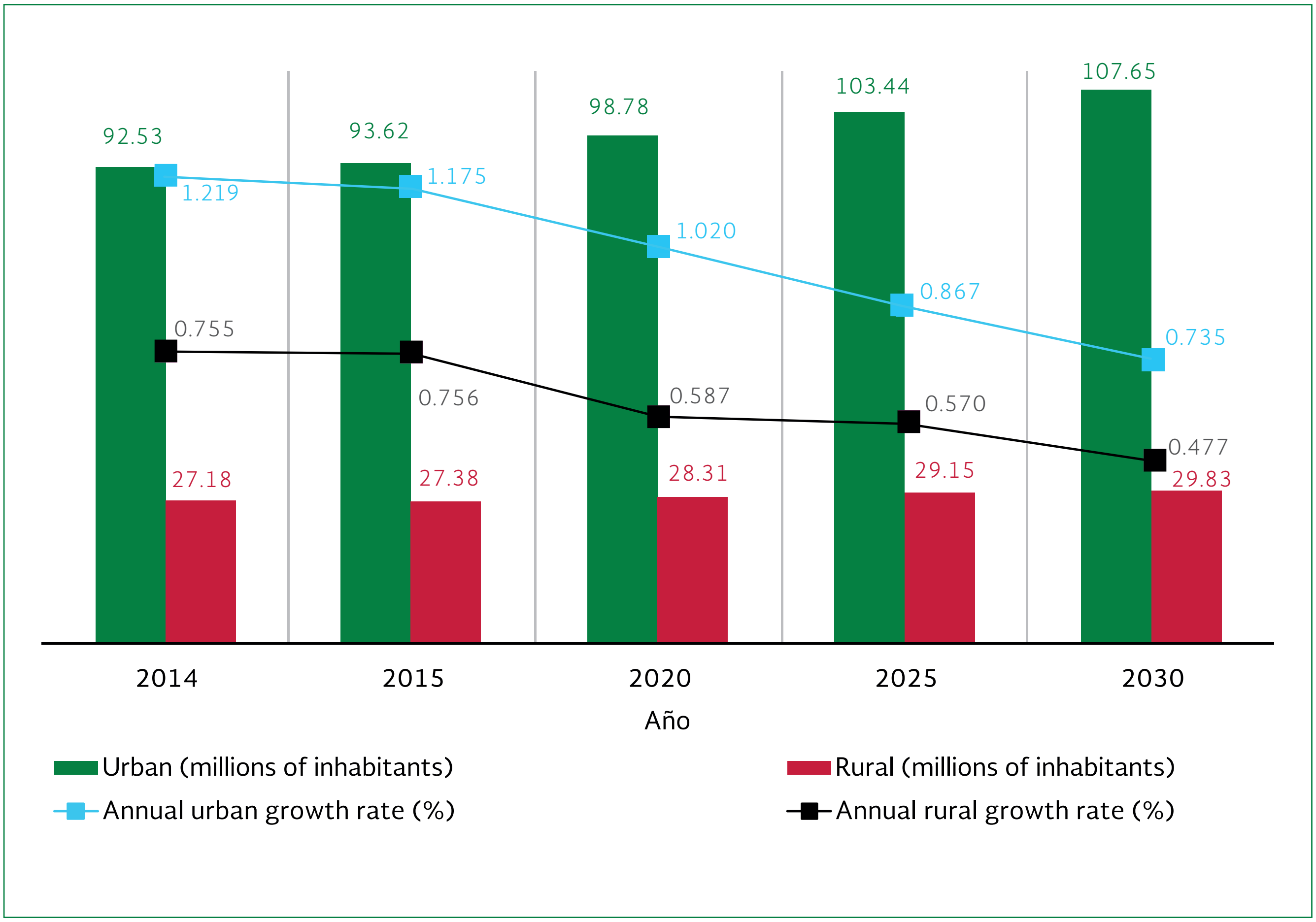
One very important aspect to be considered in Mexico's future scenarios is the population growth and its concentration in urban areas.

According to estimates from the Conapo, between 2014 and 2030, the population of Mexico will increase by 17.8 million people, although the growth rate will tend to decrease. Furthermore, by 2030 approximately 78.3% of the total population will be based in urban localities, as can be observed in graph 7.1. The data in the graph is at the mid-year point. The rural population is considered as that which lives in localities of less than 2 500 inhabitants, whereas the urban population refers to that of 2 500 inhabitants or more.

By 2030 approximately **78.3%** of the total population will be based in urban localities

It is calculated that for the 2014-2030 period, more than half of the population growth will occur in the hydrological-administrative regions (HARs) IV Balsas, VI Río Bravo, VIII Lerma-Santiago-Pacific and XIII Waters of the Valley of Mexico. On the other hand, the four HARs with the lowest growth (II Northwest, III Northern Pacific, V Southern Pacific and VII Central Basins of the North) will represent only 12% of the growth during that period, as shown in table 7.1. Rurally, the proportion of the regional population growth is greater than the national proportion for the HARs V Southern Pacific, XI Southern Border, X Central Gulf, IV Balsas, IX Northern Gulf and VIII Lerma-Santiago-Pacific, whereas in the remaining HARs the proportion of urban growth is above the national rate.

**GRAPH 7.1** Projection for the growth of the urban and rural population in Mexico




**Source**: Produced based on CONAPO (2015).

**TABLE 7.1** Population in 2014 and 2030 (thousands of inhabitants)

| HAR number | Rural population | | | Urban population | | | Total population | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2030 | Increase 2014-2030 | 2014 | 2030 | Increase 2014-2030 | 2014 | 2030 | Increase 2014-2030 |
| I | 380 | 537 | 158 | 3 989 | 4 975 | 986 | 4 369 | 5 513 | 1 144 |
| II | 452 | 524 | 72 | 2 351 | 2 833 | 481 | 2 803 | 3 357 | 554 |
| III | 1 380 | 1 395 | 16 | 3 088 | 3 662 | 574 | 4 467 | 5 057 | 590 |
| IV | 3 427 | 3 844 | 417 | 8 260 | 9 471 | 1 211 | 11 687 | 13 315 | 1 628 |
| V | 1 995 | 2 143 | 148 | 3 029 | 3 257 | 228 | 5 024 | 5 400 | 376 |
| VI | 838 | 925 | 87 | 11 314 | 13 443 | 2 129 | 12 152 | 14 368 | 2 216 |
| VII | 1 133 | 1 202 | 69 | 3 382 | 3 922 | 540 | 4 515 | 5 125 | 610 |
| VIII | 5 181 | 5 839 | 658 | 18 708 | 21 860 | 3 152 | 23 888 | 27 699 | 3 811 |
| IX | 2 406 | 2 488 | 81 | 2 827 | 3 475 | 648 | 5 233 | 5 963 | 729 |
| X | 4 424 | 4 727 | 303 | 6 058 | 6 880 | 822 | 10 482 | 11 607 | 1 125 |
| XI | 3 633 | 4 001 | 368 | 3 939 | 4 843 | 904 | 7 572 | 8 844 | 1 272 |
| XII | 723 | 830 | 107 | 3 792 | 5 004 | 1 212 | 4 516 | 5 834 | 1 319 |
| XIII | 1 206 | 1 378 | 172 | 21 799 | 24 023 | 2 224 | 23 005 | 25 401 | 2 396 |
| **Total** | **27 178** | **29 834** | **2 656** | **92 535** | **107 647** | **15 112** | **119 713** | **137 481** | **17 768** |

**Source**: Produced based on CONAPO (2015).

It should be noted that some of the HARs in which the highest population growth is expected are at the same time those where there is already a degree of water stress that is higher than the national average, as can be appreciated in graph 7.2. By contrast, in some HARs with a lower degree of water stress (V Southern Pacific and X Central Gulf) a lower population growth is expected.

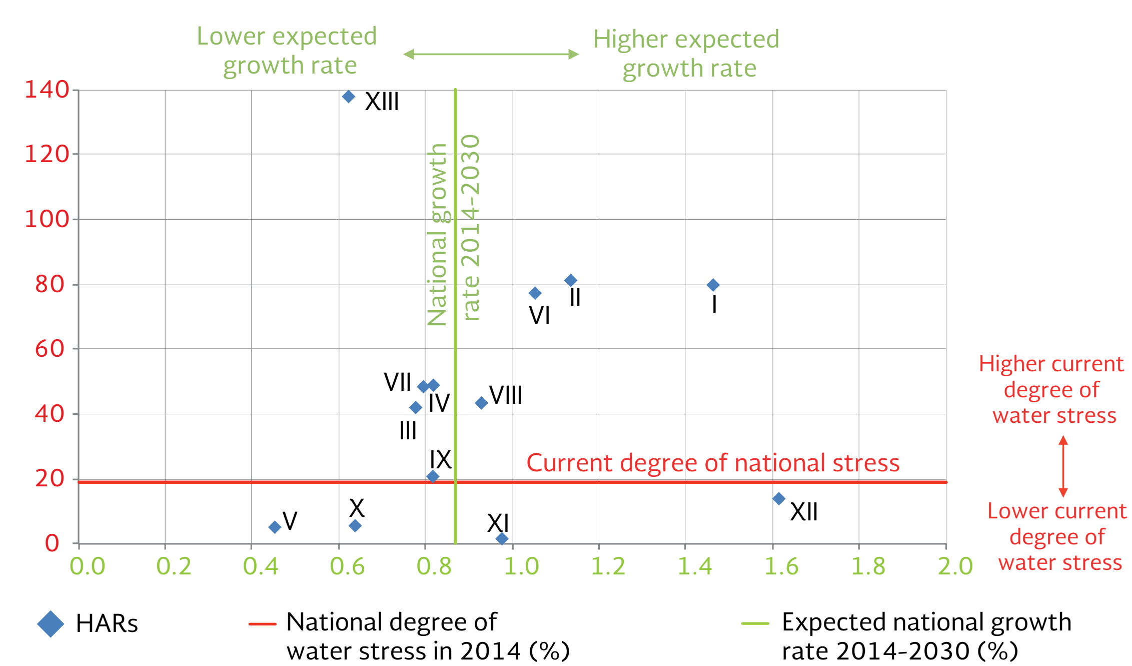
In 2030, it is expected that 53.6% of the population of Mexico, or 73.7 million inhabitants, will be living in 38 population centers (35 metropolitan areas and three non-suburban municipalities) with more than 500 000 inhabitants (map 7.1).

The increasing population will bring about a reduction in the per capita renewable water resources nationwide. The decrease foreseen is shown in graph 7.3, from 3 736 m³/inhabitant/year in 2014 to 3 253 in 2030. It is worth mentioning that in this chapter the value of renewable water resources for 2014 (447 260 hm³) remains constant throughout the 2014-2030 period.

By 2030, it is estimated that in some of the country's HARs, the per capita renewable water resources will reach levels close to or even lower than 1 000 m³/inhabitant/year, a condition classified as scarcity.

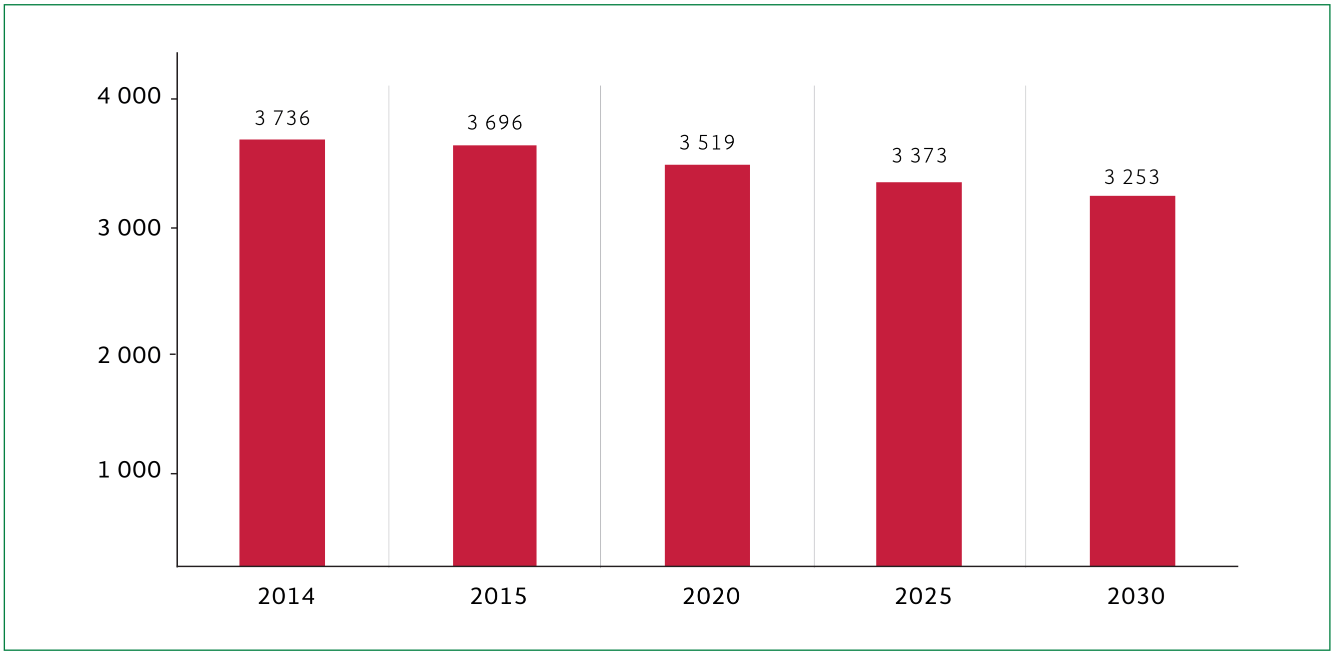
In 2030 it is expected that **73.7** million inhabitants will be living in **38** population centers

**Graph 7.2** Current degree of water stress and growth rate, 2014-2030



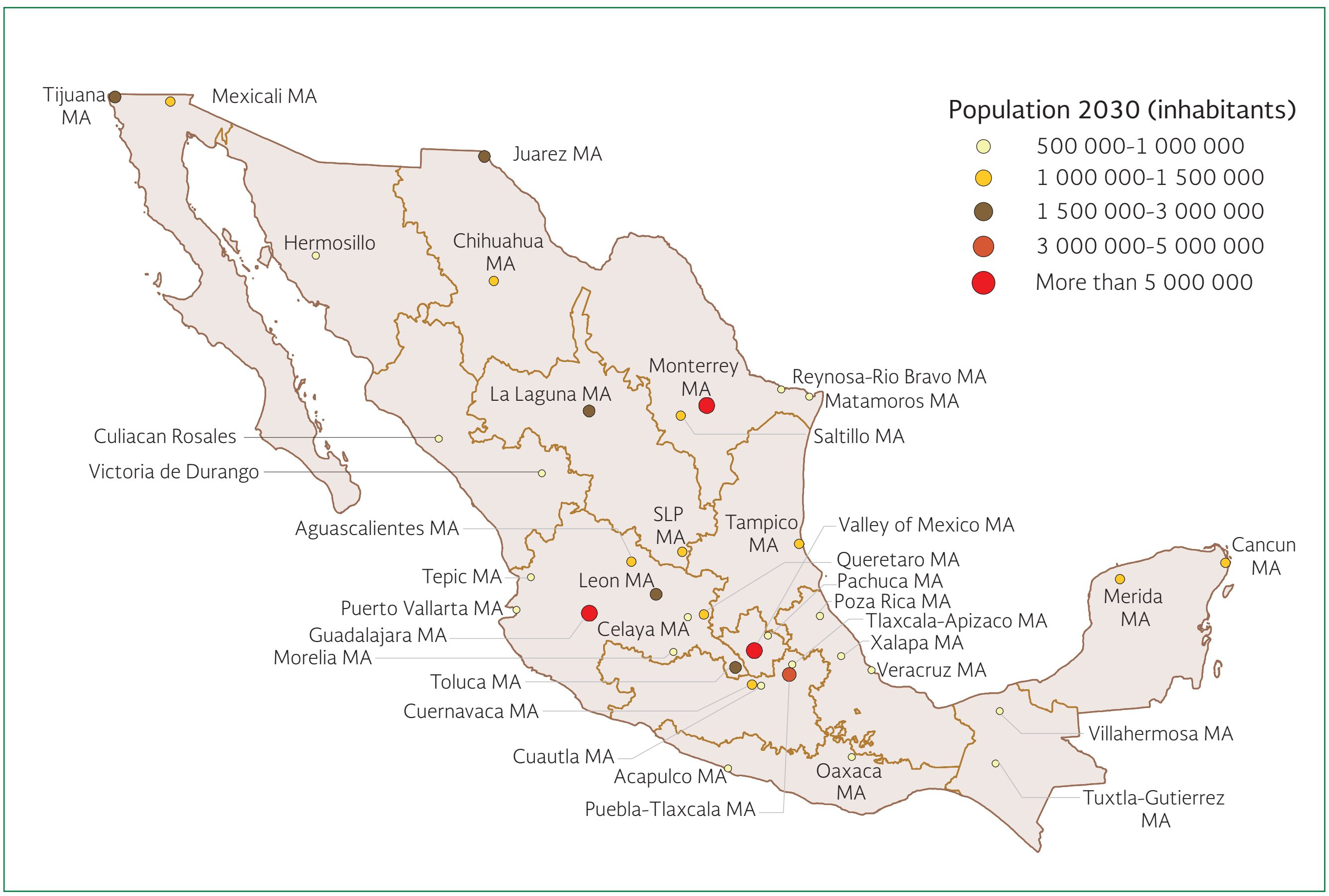

**Source**: Produced based on Conagua (2015c).

**Graph 7.3** Projections of per capita renewable water resources in Mexico, selected years, 2014-2030 (m³/inhabitant/year)




**Source**: Produced based on Conagua (2015a), Conapo (2015).

**Map 7.1** Main population centers




**Source**: Produced based on Conapo (2015), Sedesol et al. (2012).

Table 7.2 and figure 7.1 show the evolution in renewable water resources between 2014 and 2030. As can be observed, the HARs I Baja California Peninsula, VI Rio Bravo and XIII Waters of the Valley of Mexico will present low levels of per capita renewable water resources in 2030.

Special attention should be paid to groundwater, the overdrafting of which leads to the reduction of phreatic levels, land subsidence and wells having to to be dug ever deeper. The majority of the rural population, especially in arid areas, depends almost exclusively on groundwater.

With the aim of facing the decrease in the availability of water in the coming years, it will be necessary to carry out actions to reduce the demand, by increasing the efficiency in the use of water for irrigation and in water distribution systems in cities. Furthermore, the volumes of wastewater that are treated and reused should increase significantly, so as to increase the availability and quality of water for the uses for which it is destined.

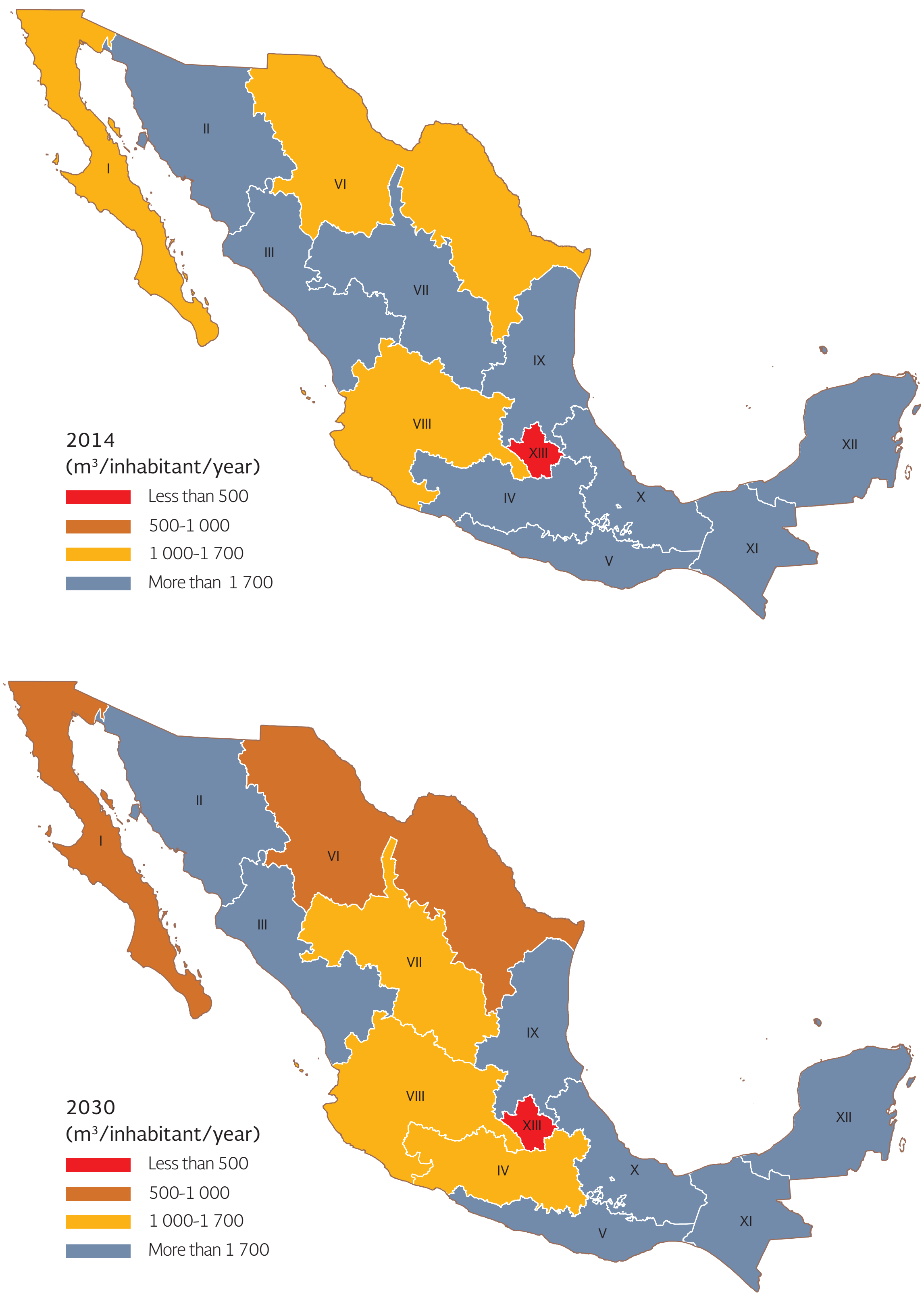
In addition, in order to continue guaranteeing social development, it will be necessary to significantly increase drinking water, drainage and sanitation coverage in rural settings.

**Table 7.2** Per capita renewable water resources, 2014 and 2030

| HAR number | Renewable water resources 2014 ($hm^3$/year) | Per capita renewable water resources 2014 ($m^3$/inhabitant/year) | Per capita renewable water resources 2030 ($m^3$/inhabitant/year) |
|---|---|---|---|
| I | 4 958 | 1 135 | 899 |
| II | 8 273 | 2 951 | 2 465 |
| III | 25 596 | 5 730 | 5 062 |
| IV | 22 156 | 1 896 | 1 664 |
| V | 30 565 | 6 084 | 5 660 |
| VI | 12 316 | 1 014 | 857 |
| VII | 7 849 | 1 738 | 1 532 |
| VIII | 35 093 | 1 469 | 1 267 |
| IX | 28 085 | 5 366 | 4 710 |
| X | 95 129 | 9 075 | 8 196 |
| XI | 144 459 | 19 078 | 16 334 |
| XII | 29 324 | 6 494 | 5 026 |
| XIII | 3 458 | 150 | 136 |
| **Total** | **447 260** | **3 736** | **3 253** |

**Source:** Produced based on Conagua (2015a), Conapo (2015).

**FIGURE 7.1** Per capita renewable water resources




**Source**: Produced based on CONAGUA (2015a), CONAPO (2015).

# 7.3 National water planning 2013-2018

The Political Constitution of the United Mexican States establishes the planning of national development as the basis for the articulation of public policies in the government of the republic, as well as the direct source of participatory democracy through consultation with society-at-large. The 2013-2018 National Development Plan (NDP) establishes the national targets and guiding objectives of public policies.

Within the scheme of the National System of Democratic Planning, the 2014-2018 National Water Program (NWP)[1] is derived from and aligned with the NDP. The NWP articulates the government of the republic's public policies around the water sector and is part of the water-related planning formalized in the National Water Law. Water-related planning is mandatory for integrated water resources management, the conservation of natural resources, vital ecosystems and the environment.

The NWP was developed with the collaboration of and contributions from institutions and agencies, experts as well as a public consultation process carried out in regional fora with the participation of users, academics, civil society organizations, communicators, legislators and scholars.

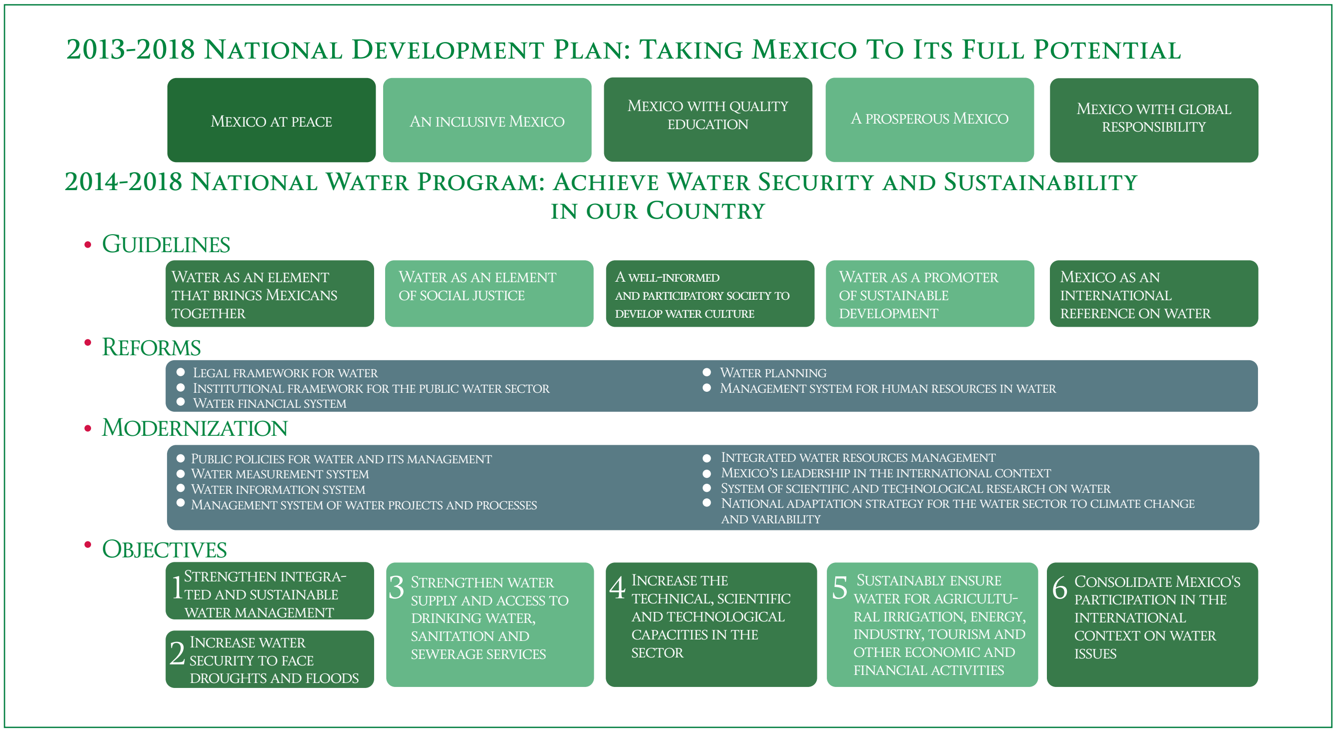
Figure 7.2 shows the alignment of the national targets of the NDP with the NWP by means of the latter's five overarching guidelines, articulated through the reforms and modernizations proposed for the water sector in the NWP's six objectives.

It is worth mentioning the eight indicators proposed for the follow up and evaluation of the NWP's impacts, which are shown in table 7.3.

**8** indicators were proposed for the follow up of the **NWP**

1 Due to its publication date, it is referred to as 2014-2018.

## **Figure 7.2** Alignment of the NDP with the NWP




## **Table 7.3** Indicators for the follow up and evaluation of the NWP's impacts

| Objectives | Indicator |
|---|---|
| 1. Strengthen integrated and sustainable water management. | 1. Global Water Sustainability Index |
| 2. Increase water security to face droughts and floods | 2. Water reserve decrees formulated for environmental use. |
| | 3. Population and productive surface area protected against floods. |
| | 4. Drought management programs produced and approved by River Basin Councils. |
| 3. Strengthen water supply and access to drinking water, sewerage and sanitation services. | 5. Global Index of Access to Basic Water Services. |
| 4. Increase the technical, scientific and technological capacities of the sector. | 6. Influence of the technological development of the water sector in decision making. |
| 5. Sustainably ensure water for irrigated agriculture, energy, industry, tourism and other economic and financial activities. | 7. Productivity of water in irrigation districts (kg/m$^3$) |
| 6. Consolidate Mexico's participation in the international context on water issues. | 8. International cooperation projects duly attended to. |

**Source**: Conagua (2014b), Conagua (2015b).

# Chapter 8

Water in the World

# Water in the world

## Water and health

Reduction in annual child mortality through diarrheal diseases:

**1.5** million (1990) ······ **600 000** (2012)

## Water cycle

**Mexico:**
Per capita renewable water resources

**3736** m³/inhabitant/year | **92nd** place worldwide

**Water in the world:**

**1.39** quadrillion hm³

Saltwater **97.5%**

Freshwater **2.5%**

## Climate change

Non-uniform changes between countries and regions

Intensification of the world water cycle

Collaboration is necessary to mitigate risks

## Socio-economic and demographic data

Mexico:

Population 2014
**119.7** million inhabitants
11th place worldwide by size

Per capita GDP 2014
**10 714.83** dollars
66th place worldwide

Per capita GDP 2014
**1.28** trillion dollars
15th place worldwide

## Uses of water and infrastructure

Water footprint of **consumption:** Water employed for the goods and services consumed in a country

| m³/inhabitant/year | |
|---|---|
| Mexico | United States |
| 1978 | 2842 |

| Industrial use | Agricultural use |
|---|---|
| 19% | 70% |

**Virtual water:** Quantity of water employed in processing a product

| Liters for 1 kg of: | |
|---|---|
| Corn | Beef |
| 1222 | 15415 |

## Millennium Development Goals (1990-2015)

**Drinking water:** Halving by 2015 the population without safe access in 1990

Worldwide: Met ✓ Mexico: Met ✓

**Sanitation:** Halving by 2015 the population without safe access in 1990

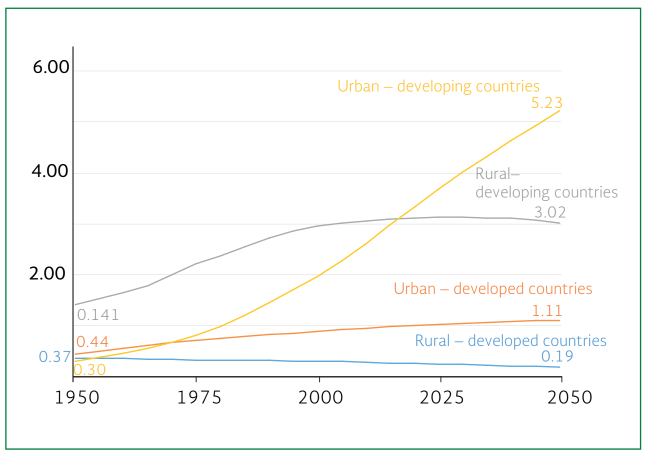
Worldwide: Not met ✗ Mexico: Met ✓

## 8.1 Socio-economic and demographic aspects

[Reporteador: Indicadores económicos, Población]

The United Nations periodically refines estimations of the world population. In the latest exercise (UN-DESA 2014), it is estimated that in 1950 the world population was 2.53 billion people, whereas for 2015, it will have increased to 7.33 billion. Over the last 60 years, this growth has been mainly concentrated in **developing regions**, a trend that will continue until 2050, as can be observed in graph 8.1 [Adicional: Table 8.A]. It is estimated that for 2050 the world population will be 9.55 billion.

**Graph 8.1** World population, according to region and development (billions of inhabitants)




**Source:** Produced based on UN-DESA (2014).

The growing concentration of the population in **urban** areas should be highlighted, as shown in graph 8.1. Conversely, the rural population shows a stable or decreasing trend in both developed and developing countries. The pressure of cities on the environment is significant: as readily-available water resources are exhausted, cities will have to transport water from greater distances or extract it from greater depths, or depend on advanced technologies to desalinize or reuse water (WWAP 2015).

In table 8.1, the countries with the world's highest population are shown, among which Mexico is in eleventh place worldwide. In each table of this chapter, in addition to the countries in the first places for each concept (for example population and irrigation surface, among others), five countries appear as references (Brazil, United States of America, France, South Africa and Turkey), as well as Mexico, in order to facilitate comparisons. The population for Mexico corresponds to the definition of Conapo (2015).

In table 8.2 information is presented on the countries with the largest per capita Gross Domestic Product (GDP). Some values are estimated.

Mexico is ranked 66th worldwide in terms of its per capita GDP. In terms of the total GDP, the country is ranked 15th worldwide.

**Mexico** is the country with the **15th** highest GDP in the world

**Table 8.1** Countries with the highest population, 2014

| Nº | Country | Population (millions of inhabitants) | Population density (inhabitants/km$^2$) |
|---|---|---|---|
| 1 | China | 1 416.67 | 147.6 |
| 2 | India | 1 252.14 | 380.9 |
| 3 | United States of America | 320.05 | 32.6 |
| 4 | Indonesia | 249.87 | 130.8 |
| 5 | Brazil | 200.36 | 23.5 |
| 6 | Pakistan | 182.14 | 228.8 |
| 7 | Nigeria | 173.62 | 187.9 |
| 8 | Bangladesh | 156.60 | 1 054.8 |
| 9 | Russian Federation | 142.83 | 8.4 |
| 10 | Japan | 127.14 | 336.4 |
| **11** | **Mexico** | **119.71** | **61.1** |
| 12 | Philippines | 98.39 | 328.0 |
| 13 | Ethiopia | 94.10 | 85.2 |
| 14 | Vietnam | 91.68 | 277.0 |
| 15 | Germany | 82.73 | 231.6 |
| 16 | Egypt | 82.06 | 81.9 |
| 17 | Iran (Islamic Republic) | 77.45 | 44.4 |
| 18 | Turkey | 74.93 | 95.6 |
| 19 | Democratic Republic of Congo | 67.51 | 28.8 |
| 20 | Thailand | 67.01 | 130.6 |
| 21 | France | 64.29 | 117.1 |
| 22 | United Kingdom | 63.38 | 260.2 |
| 23 | Italy | 60.99 | 202.4 |
| 24 | Myanmar | 53.26 | 78.7 |
| 25 | South Africa | 52.78 | 43.3 |

**Source:** Produced based on FAO (2015), Conapo (2015), Inegi (2015a).

**Table 8.2** Countries with the highest total and per capita GDP, 2014

| Total GDP | | | Per capita GDP | | |
|---|---|---|---|---|---|
| Nº | Country | GDP (billions of US dollars) | Nº | Country | Per capita GDP (US dollars) |
| 1 | United States of America | 17 418.93 | 1 | Luxembourg | 111 716.27 |
| 2 | China | 10 380.38 | 2 | Norway | 97 013.26 |
| 3 | Japan | 4 616.34 | 3 | Qatar | 93 965.18 |
| 4 | Germany | 3 859.55 | 4 | Switzerland | 87 475.46 |
| 5 | United Kingdom | 2 945.15 | 5 | Australia | 61 219.16 |
| 6 | France | 2 846.89 | 6 | Denmark | 60 563.62 |
| 7 | Brazil | 2 353.03 | 7 | Sweden | 58 491.47 |
| 8 | Italy | 2 147.95 | 8 | San Marino | 56 820.02 |
| 9 | India | 2 049.50 | 9 | Singapore | 56 319.34 |
| 10 | Russian Federation | 1 857.46 | 10 | United States of America | 54 596.65 |
| 11 | Canada | 1 788.72 | 11 | Ireland | 53 461.97 |
| 12 | Australia | 1 444.19 | 12 | Netherlands | 51 372.96 |
| 13 | South Korea | 1 416.95 | 13 | Austria | 51 306.67 |
| 14 | Spain | 1 406.86 | 14 | Iceland | 51 261.88 |
| **15** | **Mexico** | **1 282.73** | 15 | Canada | 50 397.86 |
| 16 | Indonesia | 888.65 | 16 | Finland | 49 496.72 |
| 17 | Netherlands | 866.35 | 17 | Belgium | 47 721.59 |
| 18 | Turkey | 806.11 | 18 | Germany | 47 589.97 |
| 19 | Saudi Arabia | 752.46 | 19 | United Kingdom | 45 653.41 |
| 20 | Switzerland | 712.05 | 20 | France | 44 538.15 |
| 21 | Nigeria | 573.65 | 61 | Brazil | 11 604.47 |
| 22 | Sweden | 570.14 | **66** | **Mexico** | **10 714.83** |
| 23 | Poland | 546.64 | 68 | Turkey | 10 482.14 |
| 33 | South Africa | 350.08 | 87 | South Africa | 6 482.75 |

**Source:** IMF (2015).

# 8.2 Components of the water cycle

[Reporteador: Distribución global del agua en el mundo]

The mean annual availability of water in the world is approximately 1.39 quadrillion $hm^3$, of which 97.5% is saltwater and only 2.5%, or 35 trillion $hm^3$, is freshwater. Of that amount, almost 70% is unavailable for human consumption since it is locked up in glaciers, snowpack and ice (figure 8.1).

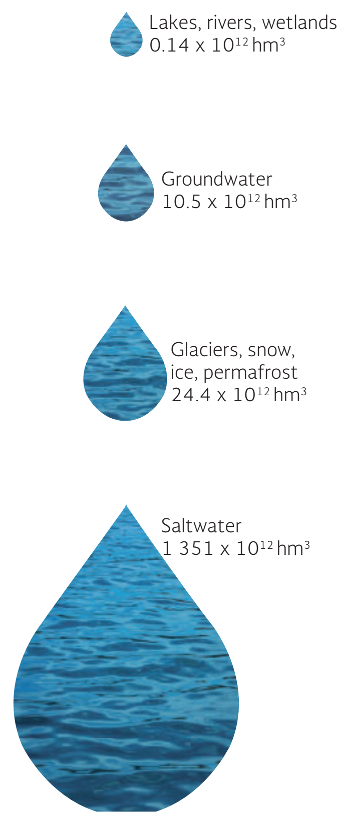
Of the water that is technically available for human consumption, only a small percentage is found in lakes, rivers, soil humidity and relatively shallow groundwater deposits, the replenishment of which is the result of infiltration. Much of this theoretically usable water is far from populated areas, making it difficult or expensive to effectively use. It is estimated that only 0.77% is freshwater accessible to human beings.

## Precipitation

Precipitation constitutes an important part of the water cycle, since it produces the planet's **renewable** water resources. However, precipitation varies from region to region and seasonally.

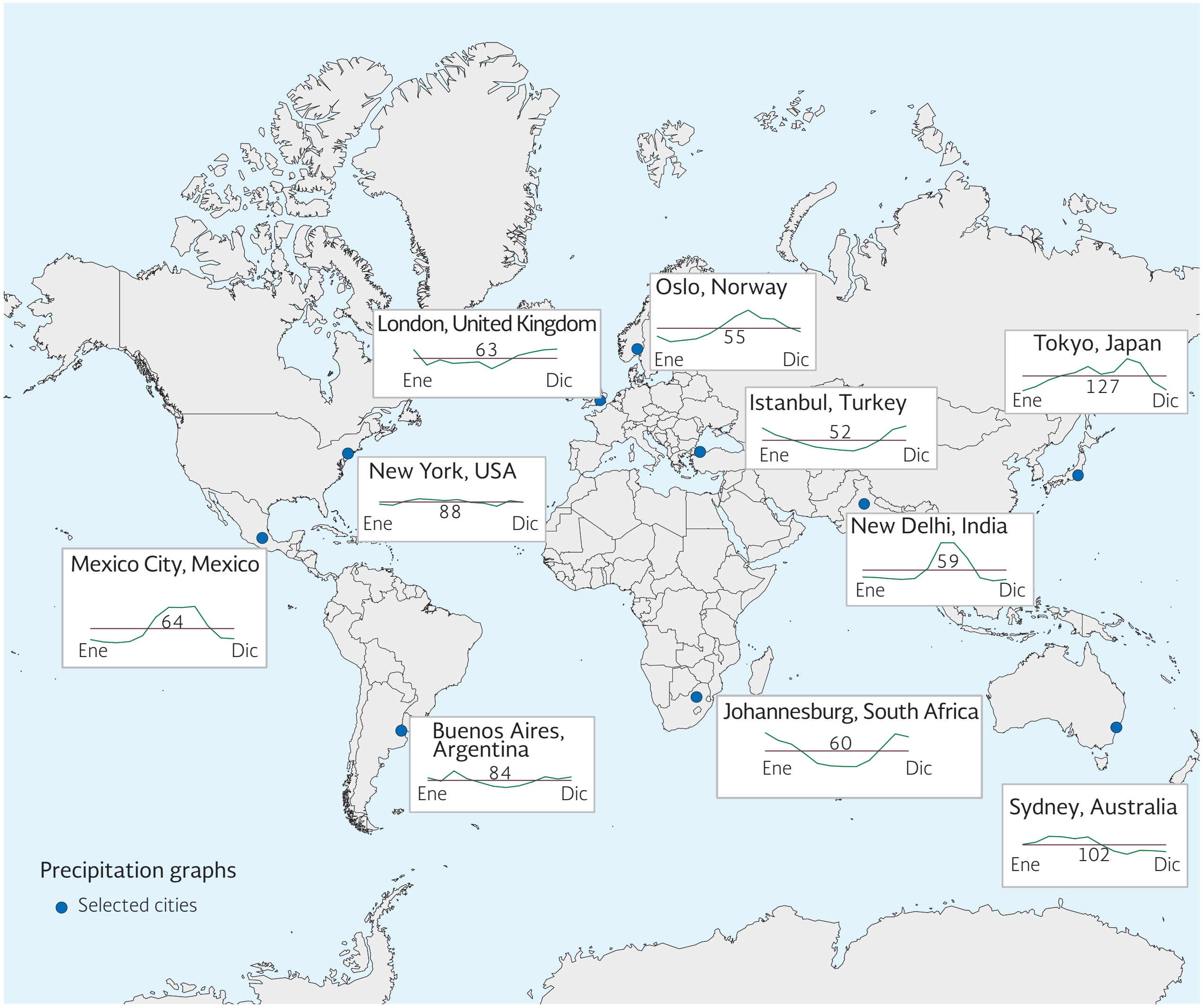
In figure 8.2 the different patterns of annual rainfall (green color) in selected cities around the world can be observed, as well as their monthly averages. In general, cities at higher latitudes are characterized by having a uniform precipitation throughout the world, whereas cities closer to the Equator have an accentuated precipitation in the summer.

**FIGURE 8.1** Distribution of water in the world




**Source:** Produced based on Clarke and King (2004).

**FIGURE 8.2** Precipitation variability (mm)




**Source**: Produced based on World Climate (2011).

## Renewable water resources

[Reporteador: Agua renovable]

A country's per capita renewable water resources may be calculated by dividing its renewable resources by the number of inhabitants. According to this criterion, Mexico is in 92nd place worldwide out of 200 countries on which data is available, as shown in table 8.3. In this table the value for Mexico is from 2014, and from other countries the value is the latest one available.

Of **200** countries, **Mexico** is in

**92nd**

place worldwide in terms of **per capita** renewable water resources

## Climate change

In the Intergovernmental Panel on Climate Change's 5th Report (IPCC 2013), the evidence on climate change is consolidated. Human influence has been detected on both the climate system –evidenced by the growing concentrations of greenhouse gases– and on the warming of the atmosphere and the ocean, as well as on changes in the global water cycle, on the reductions in snow and ice, on the increase in sea level, and on changes in some climate extremes.

It is estimated that changes in the global water cycle, due to climate change, **will not be uniform.** The contrast in precipitation will increase between dry and humid regions, and between wet and dry seasons, although it is possible that there may be regional exceptions. This will result in risks related to the quantity and quality of water available for society.

It is considered that the impacts of recent extreme hydro-meteorological events, including heatwaves, droughts, floods, cyclones and fires reveal the significant vulnerability and risk exposure of certain ecosystems and many human systems to climate variability.

In terms of freshwater, it is foreseen that during the 21st century the renewable surface and groundwater resources will be reduced in the majority of sub-tropical dry regions, which will increase the competition between users. The effects of climate change **will be accentuated** in areas with rapid processes of urbanization, without disregarding the impacts in rural areas on the availability of water and changes in temperature, which could result in a shift in crop zones and the consequent impact both on rural population and on food security in general.

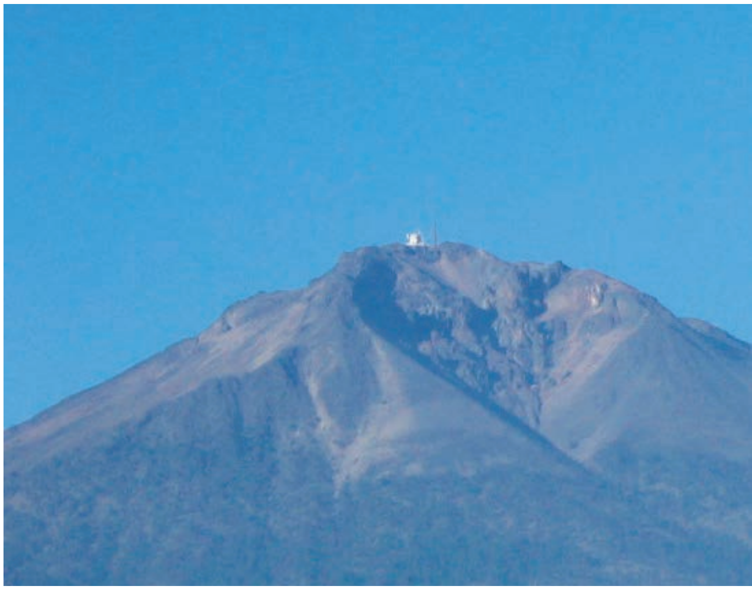
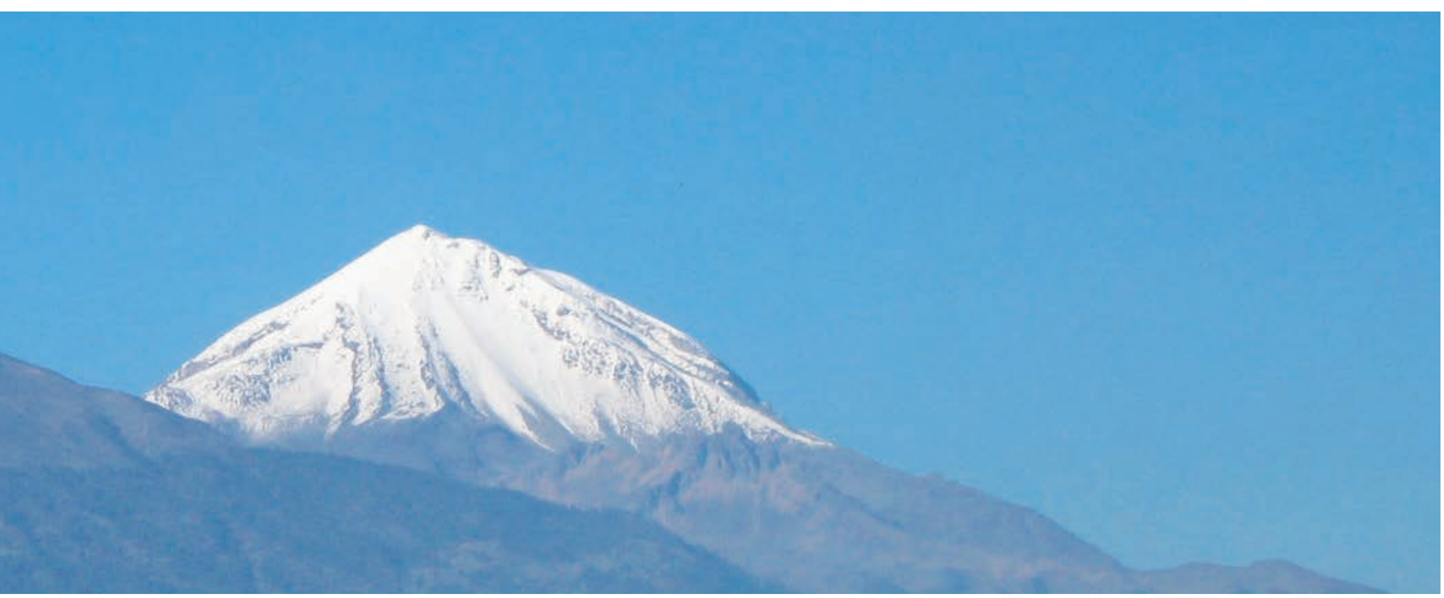


**Table 8.3** Countries with the highest per capita renewable water resources

| Nº | Country | Population (thousands of inhabitants) | Renewable water resources (billions of $m^3$) | Per capita renewable water resources ($m^3$/inhabitant/year) |
|---|---|---|---|---|
| 1 | Iceland | 330 | 170 | 515 152 |
| 2 | Guyana | 800 | 271 | 338 750 |
| 3 | Congo | 4 448 | 832 | 187 050 |
| 4 | Surinam | 539 | 99 | 183 673 |
| 5 | Papua New Guinea | 7 321 | 801 | 109 411 |
| 6 | Bhutan | 754 | 78 | 103 448 |
| 7 | Gabon | 1 672 | 166 | 99 282 |
| 8 | Canada | 35 182 | 2 902 | 82 485 |
| 9 | Salomon Islands | 561 | 45 | 79 679 |
| 10 | Norway | 5 043 | 393 | 77 930 |
| 11 | New Zealand | 4 506 | 327 | 72 570 |
| 12 | Belize | 332 | 22 | 65 452 |
| 13 | Peru | 30 376 | 1 894 | 62 352 |
| 14 | Paraguay | 6 802 | 388 | 57 013 |
| 15 | Liberia | 4 294 | 232 | 54 029 |
| 16 | Plurinational State of Bolivia | 10 671 | 574 | 53 791 |
| 17 | Chile | 17 620 | 923 | 52 389 |
| 18 | Uruguay | 3 407 | 172 | 50 543 |
| 19 | Lao People's Democratic Republic | 6 770 | 334 | 49 261 |
| 20 | Colombia | 48 321 | 2 360 | 48 840 |
| 22 | Brazil | 200 362 | 8 647 | 43 157 |
| 60 | United States of America | 320 051 | 3 069 | 9 589 |
| **92** | **Mexico** | **119 713** | **447** | **3 736** |
| 99 | France | 64 291 | 211 | 3 282 |
| 107 | Turkey | 74 933 | 212 | 2 824 |
| 152 | South Africa | 52 776 | 51 | 973 |

**Source:** Produced based on FAO (2015), Conapo (2015), Conagua (2015a).



Mitigation, understood as an anthropogenic intervention to reduce the sources or improve greenhouse gas sinks, and adaptation, defined as the process of adjusting human or natural systems as a response to projected or real climate stimuli and their effects, will only be possible through joint collaborative efforts, which in turn involve issues of equity, justice and impartiality between stakeholders in a context of decision making through value judgments, ethical considerations and perceptions of risks and opportunities for individuals and organizations.

Losses in 2013 are estimated at

**109.56**

billion dollars

## Extreme hydro-meteorological phenomena

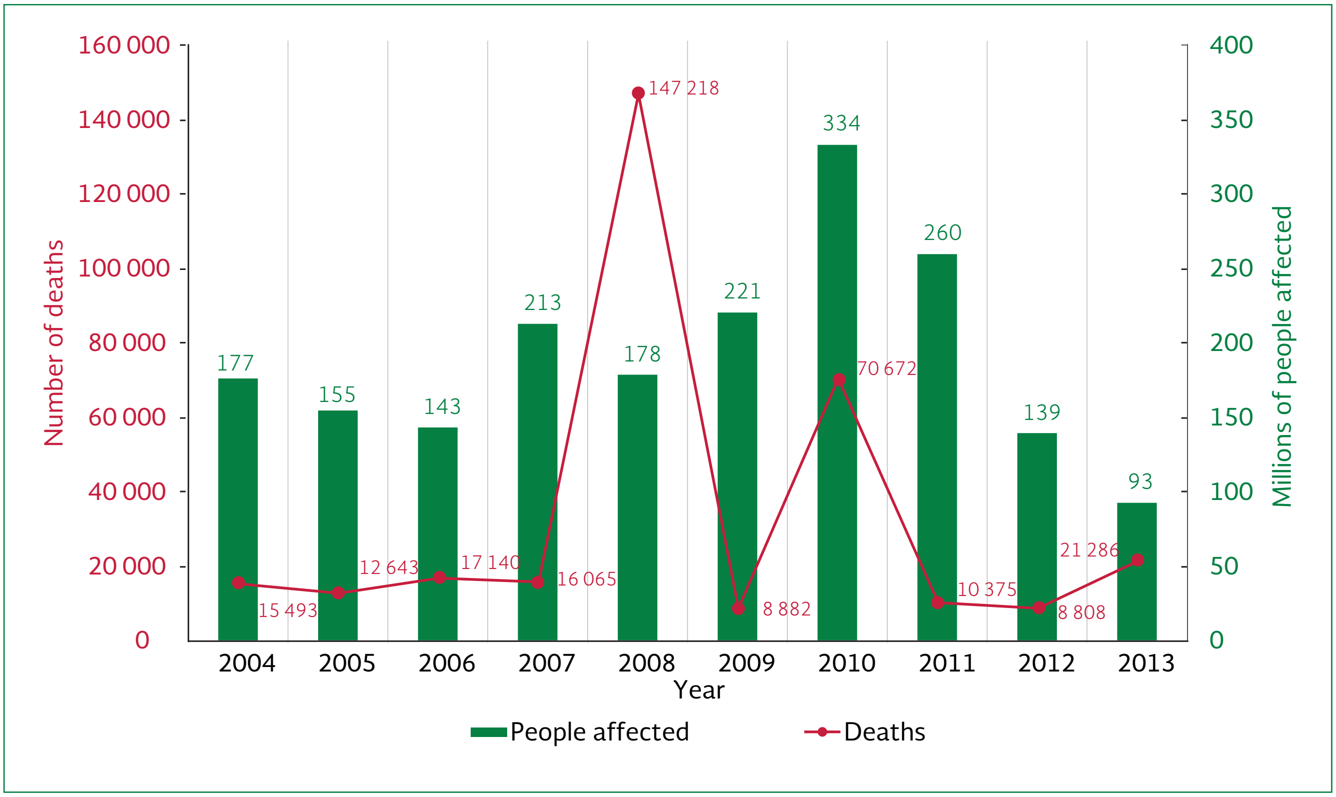
Extreme hydro-meteorological phenomena, such as droughts, floods and hurricanes, are natural events that frequently result in disasters with human and material losses. In the analysis of disasters, it can be seen that the damages estimated as a percentage of GDP are significantly higher in developing countries, which may be further accentuated if the global trend towards the concentration of population in urban localities continues.

Droughts, the lack of food security, extreme temperatures, floods, forest fires, insect infestations, water-related landslides and windstorms are all considered disasters of climate and hydro-meteorological origin (IFRC 2014). This type of events represents a significant proportion of the estimated damage caused by disasters, which in 2013 (the latest year available at the source) represented 109.56 billion dollars [Additional: Graph 8.A], or 92% of the total damage caused by all types of disasters.

The number of people affected by climate and hydro-meteorological disasters in the period between 2004 and 2013 is shown in graph 8.2, which reveals the annual variability in the occurrence of major disasters due to hydro-meteorological phenomena.

It should be noted that disasters are expected to increase, both in number and as regards their consequences, as a result of climate change. The risk of disasters will be the result of the coming together of climate and weather events, vulnerability and exposure of social groups, environmental services and resources, infrastructure and economic, social and cultural assets (IPCC 2012).

**Graph 8.2** People affected by climate-related and hydro-meteorological disasters




**Source:** Produced based on IFRC (2014).

# 8.3 Uses of water and infrastructure

[Reporteador: Usos del agua]

While the world population tripled in the 20th century, water extractions multiplied six-fold, thus increasing the degree of water stress. In the future, in the context of population growth and climate change, it is expected that this pressure will increase.

In table 8.4, the countries with the highest water extractions are shown, in which it can be observed that Mexico is ranked in seventh place. The classification of uses in this table considers agriculture, industry –including cooling of power stations– and public supply. The values for each country vary since they are the latest available at the source; for Mexico they are updated to 2014.

The main use of water resources worldwide, according to estimations from the FAO (2011), is agriculture, with 70% of the total extraction.

Worldwide,
**19%**
of extracted water
is used in **industry**

## Industrial use

[Reporteador: Usos del agua]

Industry is one of the main motors of growth and economic development. Around 19% of water extracted worldwide is employed in industry (FAO 2011). Of this volume, more than half is used in thermoelectric stations in cooling processes. Among the greatest consumers of water under this heading are oil stations, and the metal, paper, wood, food processing and manufacturing industries.

It is estimated that the global demand for water for the manufacturing industry will increase by 400% between 2000 and 2050, mainly in emerging economies (WWAP 2015).

## Use for agriculture

[Reporteador: Distritos de riego]

Irrigation is fundamental for the world's food requirements. Only 19% of the area on which crops are grown has irrigation infrastructure, but that area produces more than 40% of the world's crops (FAO 2011). In recent years agriculture has used greater quantities of agrochemical products, resulting in pollution of soil and aquifers.

**Table 8.4** Countries with the highest extraction of water and percentage of use in agriculture, industry and public supply

| Nº | Country | Total extraction of water (billions of m³/year) | % Use for agriculture | % Use for industry | % Use for public supply |
|---|---|---|---|---|---|
| 1 | India | 761.00 | 90.4 | 2.2 | 7.4 |
| 2 | China | 554.10 | 64.6 | 23.2 | 12.2 |
| 3 | United States of America | 478.40 | 40.2 | 46.1 | 13.7 |
| 4 | Pakistan | 183.50 | 94.0 | 0.8 | 5.3 |
| 5 | Indonesia | 113.30 | 81.9 | 6.5 | 11.6 |
| 6 | Iran (Islamic Republic) | 93.30 | 92.2 | 1.2 | 6.6 |
| **7** | **Mexico** | **84.93** | **76.7** | **9.1** | **14.2** |
| 8 | Vietnam | 82.03 | 94.8 | 3.7 | 1.5 |
| 9 | Philippines | 81.56 | 82.2 | 10.1 | 7.6 |
| 10 | Japan | 81.45 | 66.8 | 14.3 | 18.9 |
| 11 | Brazil | 74.83 | 60.0 | 17.0 | 23.0 |
| 12 | Egypt | 68.30 | 86.4 | 5.9 | 7.8 |
| 13 | Russian Federation | 66.20 | 19.9 | 59.8 | 20.2 |
| 14 | Iraq | 66.00 | 78.8 | 14.7 | 6.5 |
| 15 | Thailand | 57.31 | 90.4 | 4.8 | 4.8 |
| 16 | Uzbekistan | 56.00 | 90.0 | 2.7 | 7.3 |
| 17 | Italy | 53.75 | 44.1 | 35.9 | 16.9 |
| 18 | Turkey | 40.10 | 73.8 | 10.7 | 15.5 |
| 19 | Canada | 38.80 | 12.2 | 80.2 | 14.2 |
| 20 | Argentina | 37.78 | 73.9 | 10.6 | 15.5 |
| 21 | Bangladesh | 35.87 | 87.8 | 2.1 | 10.0 |
| 22 | Chile | 35.43 | 83.0 | 13.4 | 3.6 |
| 25 | France | 33.11 | 9.5 | 73.9 | 16.6 |
| 41 | South Africa | 12.50 | 62.7 | 6.0 | 31.2 |

**Source**: FAO (2015), Conagua (2015c).

The **perspective** is that by 2050, agriculture will need to increase its production by 60% globally, and 100% in developing countries, which will be difficult to achieve with the current growth trends in use and inefficiency (WWAP 2015).

Mexico is ranked seventh worldwide in terms of the surface area with irrigation infrastructure, the first places being occupied by India, China and the United States of America, as shown in table 8.5. This table shows the latest values available at the source.

## Energy generation

[Reporteador: Generación de energía]

Electricity performs a key function in poverty alleviation, the promotion of economic activities and the improvement of the quality of life, health and education opportunities, especially for women and children.

The International Energy Agency (IEA) considers that energy generation practically doubled in the period from 1973 to 2012 (the latest year available at the source), going from 6.12 to 13.37 billion metric tons of oil equivalent (IEA 2014a).

Water has a significant link with energy, since on the one hand energy is used in water supply and treatment, and on the other water is employed in virtually every phase of energy generation (IEA 2014b).

It is estimated that electricity represents between 5 and 30% of the total cost of operation of water and sanitation services, and in some cases like India and Bangladesh, that figure may reach 40% (WWAP 2015).

In fuel production it is used to extract fossil fuel, to grow biofuel and in processing and refining. It is used in the generation of steam and cooling in thermal plants (fossil fuels, bioenergy, geothermal, nuclear and some types of solar stations), which represent more than 90% of the world energy generation. 2.4% of the world's energy is generated through the water contained in dams through hydropower stations. In this sense, energy generation is a use of water that has potential impacts on the quantity and quality of water available (IEA 2012).

**Mexico** has
**25.81**
million hectares
under cultivation

**TABLE 8.5** Countries with the largest irrigation infrastructure

| Nº | Country | Area with full control irrigation infrastructure (thousands of has) | Area cultivated (thousands of has) | Irrigation infrastructure compared to the area cultivated (%) |
|---|---|---|---|---|
| 1 | India | 66 334 | 169 000 | 39.3 |
| 2 | China | 62 938 | 122 527 | 51.4 |
| 3 | United States of America | 26 644 | 157 708 | 16.2 |
| 4 | Pakistan | 19 270 | 22 040 | 90.7 |
| 5 | Iran (Islamic Republic) | 8 700 | 19 654 | 44.3 |
| 6 | Indonesia | 6 722 | 45 500 | 16.0 |
| **7** | **Mexico** | **6 460** | **25 808** | **25.0** |
| 8 | Thailand | 6 415 | 21 060 | 33.8 |
| 9 | Brazil | 5 400 | 79 605 | 6.8 |
| 10 | Turkey | 5 340 | 23 790 | 22.5 |
| 11 | Bangladesh | 5 050 | 8 525 | 59.2 |
| 12 | Vietnam | 4 585 | 10 200 | 48.7 |
| 13 | Uzbekistan | 4 198 | 4 690 | 89.5 |
| 14 | Italy | 3 951 | 9 560 | 40.7 |
| 15 | Iraq | 3 525 | 3 657 | 63.5 |
| 16 | Spain | 3 470 | 16 960 | 20.5 |
| 17 | Egypt | 3 422 | 3 612 | 99.9 |
| 18 | Afghanistan | 3 208 | 7 910 | 41.4 |
| 19 | France | 2 642 | 19 293 | 13.7 |
| 20 | Peru | 2 580 | 5 529 | 46.7 |
| 21 | Australia | 2 546 | 47 493 | 5.7 |
| 22 | Japan | 2 500 | 4 549 | 55.0 |
| 23 | Russian Federation | 2 375 | 121 350 | 1.9 |
| 30 | South Africa | 1 670 | 12 413 | 13.5 |

**Source:** FAO (2015).

The composition of the total energy supply in 2012 can be observed in graph 8.3.

Energy generation should be considered from the perspective of greenhouse gas emissions, which contribute to climate change. Hydropower is considered as a source of renewable energy, together with geothermal, solar and wind energy.

## Storage reservoirs in the world

[Reporteador: Principales presas]

The water storage capacity for various uses and for flood control is directly proportional to the degree of hydraulic development of any given country. An indicator that allows this degree to be appreciated is the per capita storage capacity. It should be mentioned that according to the FAO, Mexico is in 35th place worldwide in terms of the per capita storage capacity, as shown in graph 8.4. This graph shows the latest data available for each country.

## Water footprint

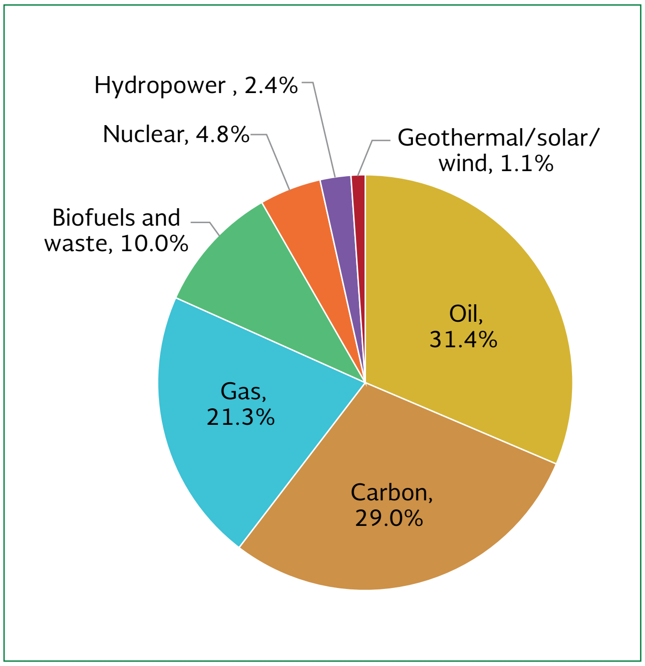
[Reporteador: Agua virtual / Huella hídrica]

One means of measuring the impact of human activities on water resources is the so-called water footprint. This concept, created in 2002 by Hoekstra (WFN 2015a), has evolved to become a mechanism that allows an understanding of how the population's consumption habits and production affects the environment. Water footprints can be calculated by person, process, product, business, watershed or country. In this way it is possible to understand the risks related to supply, the dependence on water, and the water used in products and services.

The national water footprint has two perspectives. The water footprint of production is the volume of local water resources employed to produce goods and services in a country. From the perspective of consumption, it is calculated for all goods and services consumed by the population of a country, and generally occurs both inside and outside a country, according to whether the products are local or imported.

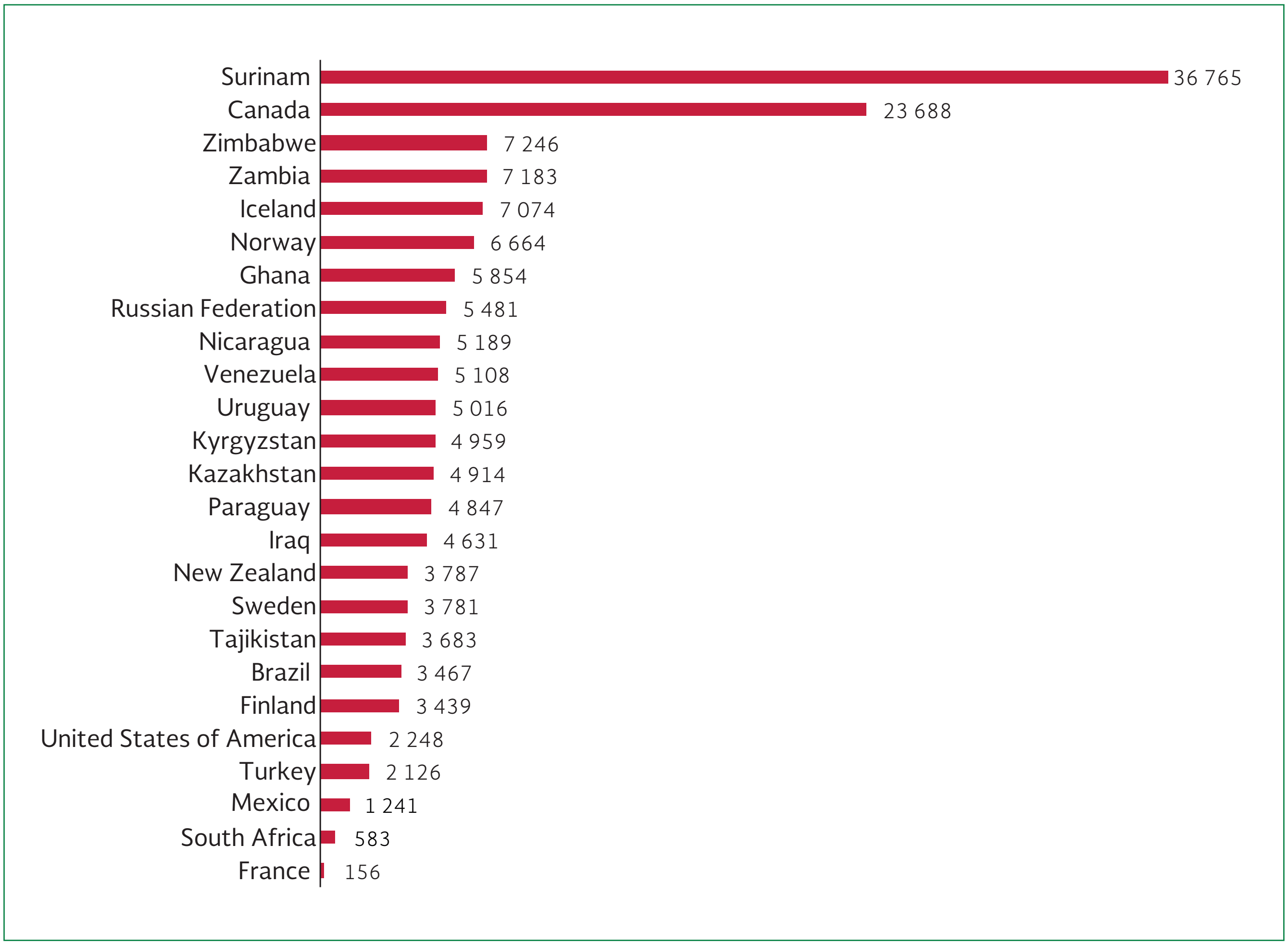
The average worldwide water footprint, associated to consumption and estimated for the 1996-2005 period, is 1 385 m³ per person per year [Adicional: Table 8.B]. The annual value for the United States is 2 842 m³, for China it is 1 071 m³ and for Mexico it is 1 978 m³ (Mekonnen and Hoekstra 2011).

**Graph 8.3** Sources of energy supply, 2012




**Source**: IEA (2014a).

**Graph 8.4** Per capita storage capacity ($m^3$/inhabitant)




**Source**: FAO (2015).

In these calculations, both the water extracted from aquifers, lakes, rivers and streams (referred to as blue water), and the rainwater that feeds rainfed crops (green water) are included. Another concept employed in the calculation of the water footprint is grey water, which is the volume of water required to assimilate the contaminant load, based on existing water quality standards.

## Virtual water

[Reporteador: Agua virtual / Huella hídrica]

A concept that is closely related to the water footprint is that of virtual water content. The virtual water content of a product is the volume of water employed in its productive process.

Commercial trade between countries entails an implicit flow of virtual water, corresponding to the water that is employed in the generation of the products or services imported or exported. The total volume of virtual water exchanged between the countries of the world is 2.32 trillion $m^3$ per year, of which approximately 76% corresponds to agricultural products, and the remainder to industrial products and livestock (Mekonnen and Hoekstra 2011).

**15 415**
liters of water are required to produce one kilogram of beef

Growing one kilogram of corn requires on average 1 222 liters of water (1 860 in Mexico), whereas one kilogram of white rice employs 1 673 liters (Mekonnen and Hoekstra 2010a). On the other hand, the production of one kilogram of beef requires 15 415 liters (Mekonnen and Hoekstra 2010b), which includes the water drunk by the animal throughout its lifetime and the water required to grow the grain that served as its food. The values are different in each country, depending on the climate conditions and the efficiency in the use of water [Adicional: table 8.C].

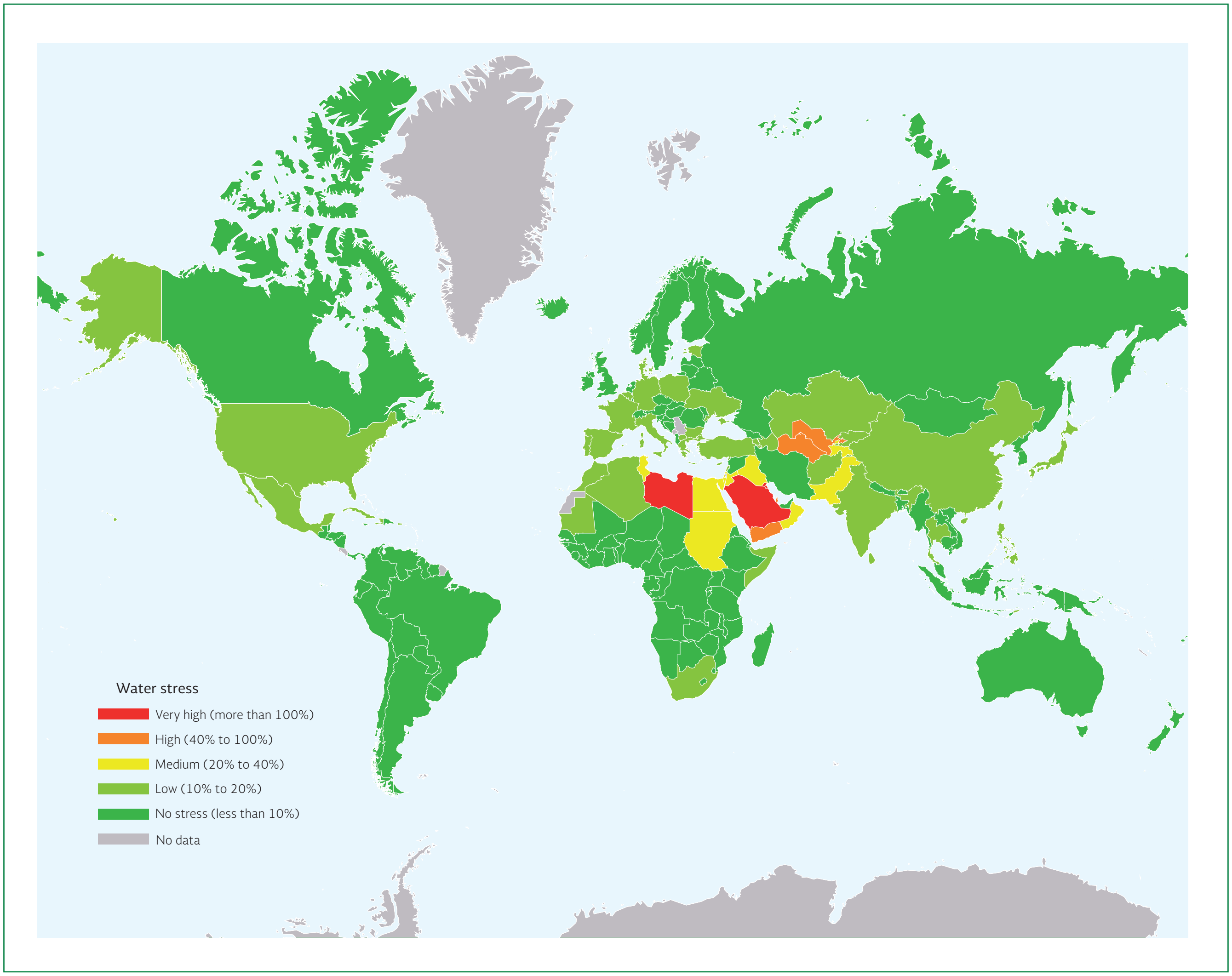
Importing virtual water may be an option to reduce the problems of water scarcity in some countries. Countries that export virtual water should evaluate the impact of this activity on the availability of their water resources and the possible distortions derived from subsidies applied to agricultural production.

## Water stress

[Reporteador: Grado de presión]

The degree of water stress is calculated by dividing the extraction by the renewable water resources. Due to their low availability, the Middle East countries suffer from very high water stress, as can be observed in map 8.1 [Adicional: Table 8.D], whereas Mexico is in 48th place according to this indicator. This map represents the latest data available for each country.

**Map 8.1** Degree of water stress




**Source:** Produced based on FAO (2015).

# Drinking water, sanitation and wastewater treatment

[Reporteador: Cobertura universal]

In 2000, the United Nations (UN) established the Millennium Development Goals (MDGs), with the aim of reducing extreme poverty by 2015. Goal number seven, "Ensuring environmental sustainability", includes target 7.C, related to drinking water and sanitation, which establishes the aim of reducing by half the proportion of people without sustainable access to safe drinking water[1] and improved sanitation services,[2] between the reference year (1990) and 2015.

The 2015 report of the Joint Monitoring Programme (WHO-UNICEF 2015) evaluates the achievement of the MDGs. For drinking water, globally, the goal was met in the year 2010. It is considered that in 2015, 91% of the world population used improved drinking water sources, which can be broken down as 96% of the world's urban population and 84% of the rural population. In the 1990-2015 period, 2.6 billion people obtained access to those sources.

Mexico also met the target. Up to 2015, 96% of the population of Mexico (96% urban and 92% rural) had access to improved drinking water sources.

However, some regions of the world did not meet the target: the Caucasus-Central Asia, Northern Africa, Oceania and Sub-Saharan Africa. By 2015, 663 million people still lacked access to improved drinking water sources.

In contrast to the drinking water target, globally the sanitation target was not met, with 700 million people lacking at the time of going to press. 68% of the world population currently uses improved sanitation services, composed of 82% of the urban population and 51% rurally. In the 1990-2015 period, 2.1 billion people obtained access to those services.

Mexico also met the sanitation target. Up to 2015, 85% of the population of Mexico (88% urban and 74% rural) had access to improved sanitation services.

**85%**

of the population of Mexico has access to improved sanitation services

1 Those that are protected against outside pollution, especially fecal matter

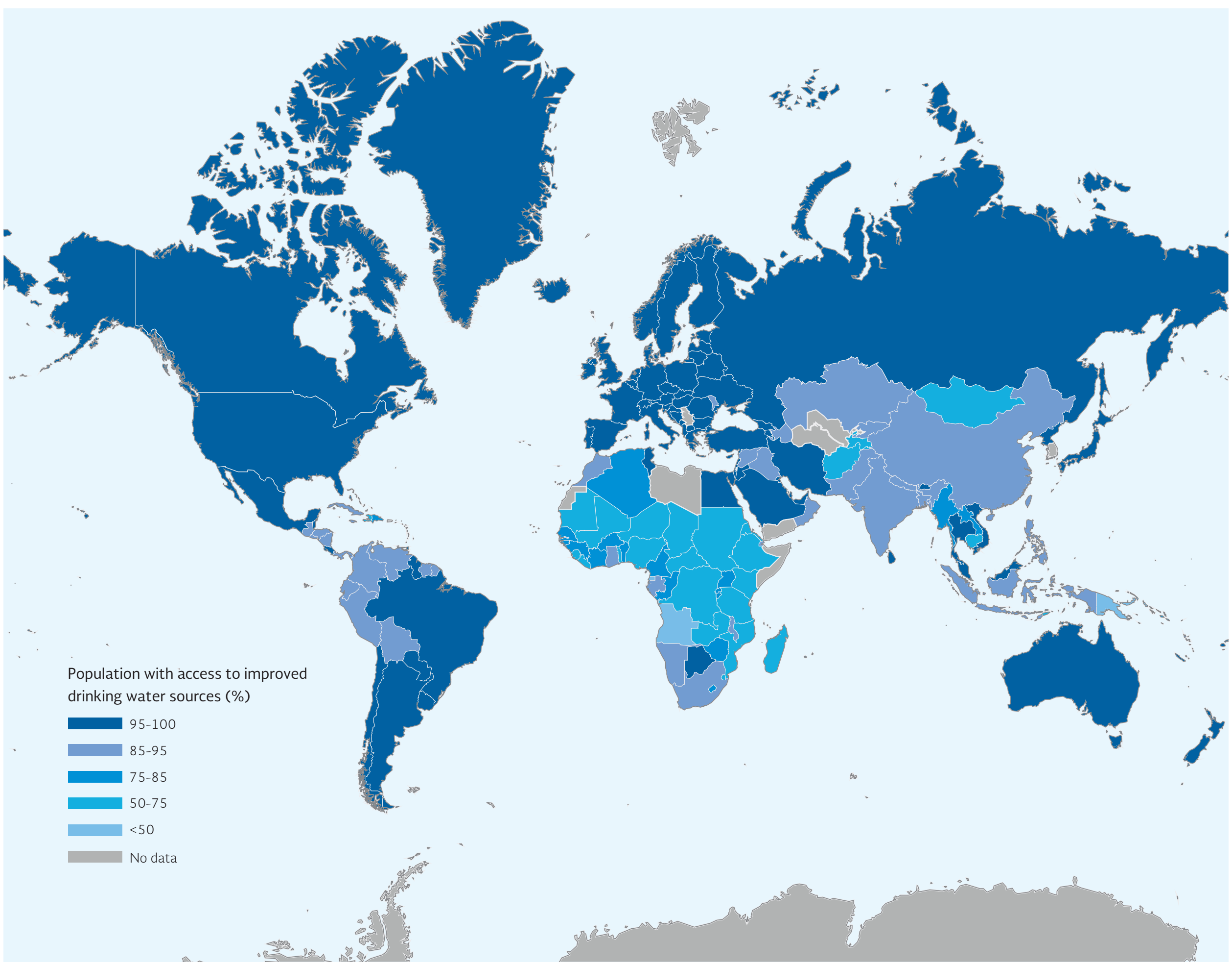
2 Those that hygienically ensure that there is no contact between people and fecal matter.

**Table 8.6** Number of countries and status of achievement of the MDG targets related to drinking water and sanitation, 2015

| Status | Drinking water | Sanitation |
|---|---|---|
| Met | 146 | 84 |
| On track to be met | 22 | 32 |
| Insufficient progress | 6 | 17 |
| Not on track to be met | 50 | 91 |

**Source**: WHO-UNICEF (2015).

**Map 8.2** Access to improved drinking water sources




**Source**: Produced based on WHO-UNICEF (2015).

Up to 2015, 2.4 billion people, mainly in Asia, Sub-Saharan Africa, Latin America and the Caribbean, still did not have access to improved sanitation services. It is currently estimated that 946 million people defecate in the open air.

The national summary can be seen in table 8.6.

Since the period designated for the MDGs has now finalized, the international community is currently developing targets and indicators for the following years, termed Sustainable Development Goals (SDGs). It is considered that the SDGs should be built based on the experience of the MDGs and should finish pending items. For the year 2030 the following targets are foreseen:

- reaching universal access to drinking water and hygiene in homes, schools and health facilities,
- reducing by half the proportion of the population without safe access within their homes to drinking water and sanitation
- Eliminating open-air defecation,
- reaching universal access to sanitation and hygiene in homes, schools and health facilities, and
- Progressively eliminating inequalities in access.

The situation worldwide is presented in maps 8.2 and 8.3.

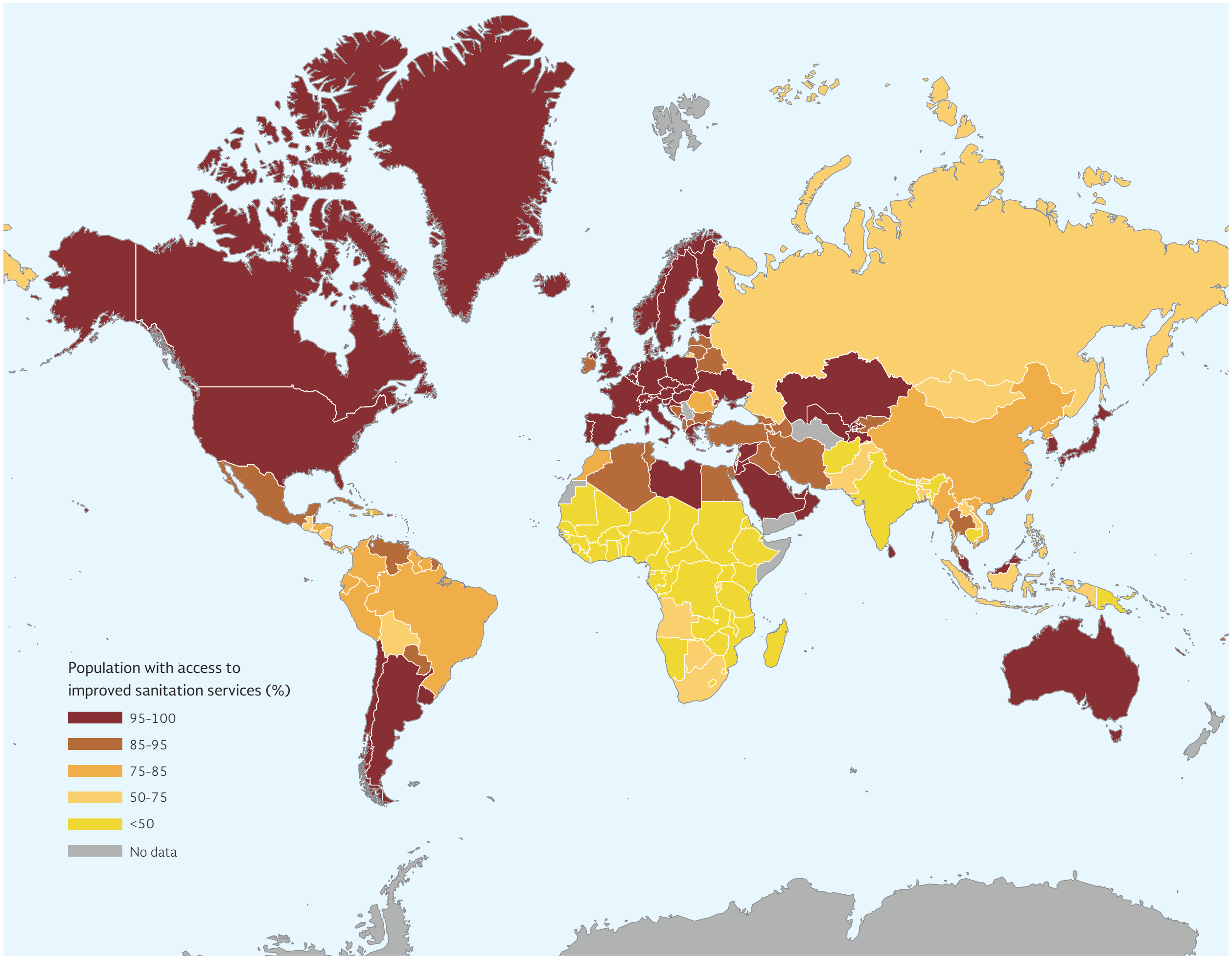
In 2015, worldwide,
**2.40**
billion people still did not have access to sanitation services

## Drinking water and sanitation tariffs

[Reporteador: Tarifas]

It may be considered that drinking water, sewerage and sanitation services are financed through Tariffs, Transfers and Taxes (known collectively as the 3Ts). There is no uniformly applied definition of the costs derived from service provision, entailing that the relationship between tariffs and costs is also variable. In some regions the aim is for the tariffs to recover the total cost of the service. In others the tariffs recover variable percentages of the cost.

**Map 8.3** Access to improved sanitation services




**Source**: Produced based on WHO-UNICEF (2015).

In graph 8.5 the drinking water and sanitation tariffs, as well as the taxes associated with this service, are indicated for selected world cities, for a domestic consumption of 15 $m^3$ per month. The graph shows the values in pesos, with an exchange rate of 1 dollar = 13.00 pesos, as of July 1, 2014.

Worldwide in **2012** there were just over **600 000** child deaths due to **diarrheal diseases**

## Water and health

[Reporteador: Agua y salud]

Drinking water in appropriate quantity and quality, in combination with appropriate sanitation and hygiene, have effects on the population's health and quality of living, on poverty alleviation and hunger, the reduction in child mortality, the improvement of maternal health, the fight against infectious diseases and environmental sustainability.

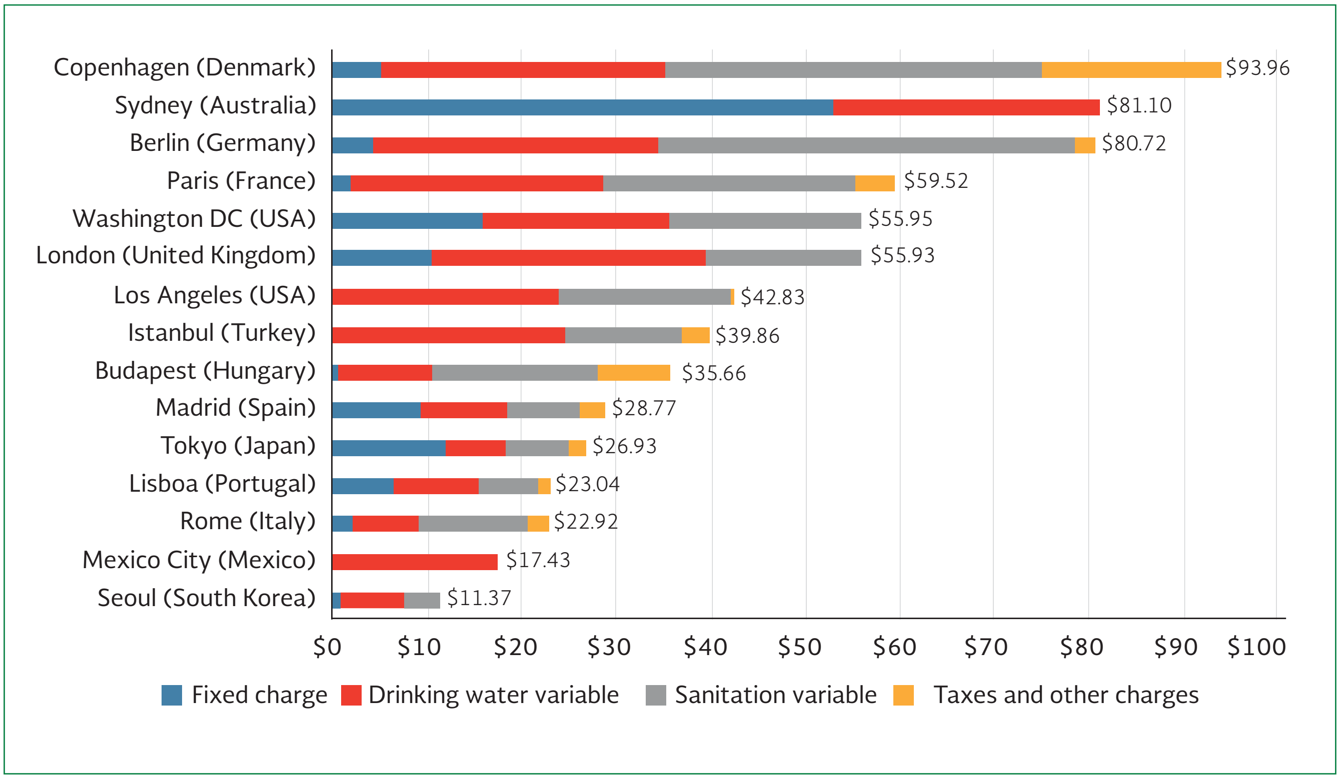
Estimations from the World Health Organization (WHO) indicate that the incidence of child mortality from diarrheal diseases dropped from 1.5 million deaths per year in 1990 to just over 600 000 in 2012 (WHO, 2014), which can be related to the progress registered as part of the MDGs.

Cholera, typhoid fever and dysentery are among diarrheal diseases; all of them associated with the fecal-oral means of transmission. The majority of deaths resulting from these diseases could be avoided through better access to drinking water, sewerage and sanitation services, since it is estimated that 88% of the cases of diarrhea are caused by polluted water, inadequate sanitation and poor hygiene habits (Corcoran et al. 2010). For 2012 it was estimated that 685 000 deaths were attributable to inadequate water and sanitation, a figure that rises to 842 000 when taking into account the combined effect of inadequate hand washing (Prüss-Üstün et al. 2014).

These figures are constantly refined, since the growing availability of data allows the key factors to be identified and analyzed, such as rehydration campaigns, the effects of hand washing, the incomplete coverage of services within the locality and improved sanitation schemes which do not involve treatment, all of which could continue exposing the population to sanitary risks.

It has been estimated that the lack of access to drinking water and adequate sanitation results in a cost of between 1 and 7% of each country's annual GDP (WSP 2012). A study by the WHO calculates that the return on investment for sanitation is around 5.5 for each dollar invested, whereas for drinking water it is 2.0 dollars for every dollar invested (WHO 2012a).

**Graph 8.5** Domestic tariffs (pesos/m³ for a consumption of 15 m³/month)




**Source**: Produced based on GWI (2015).

# Annexes

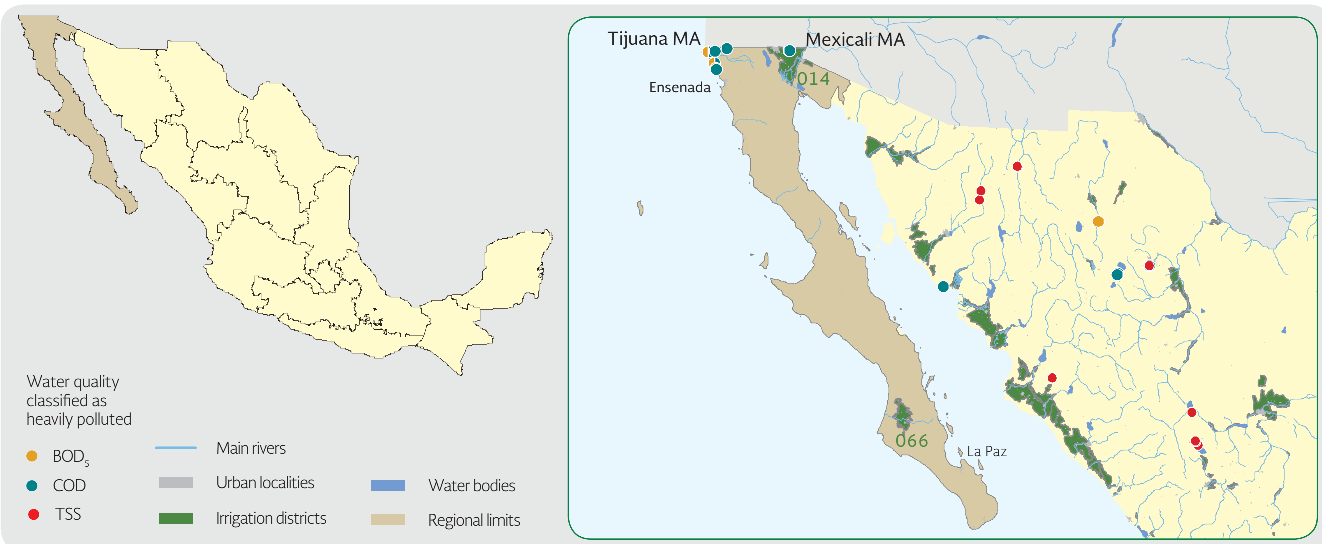
# HYDROLOGICAL-ADMINISTRATIVE REGIONS AND STATES


| Key | Hydrological-administrative region |
|---|---|
| I | Baja California Peninsula |
| II | Northwest |
| III | Northern Pacific |
| IV | Balsas |
| V | Southern Pacific |
| VI | Rio Bravo |
| VII | Central Basins of the North |
| VIII | Lerma-Santiago-Pacifico |
| IX | Northern Gulf |
| X | Central Gulf |
| XI | Southern Border |
| XII | Yucatan Peninsula |
| XIII | Waters of the Valley of Mexico |

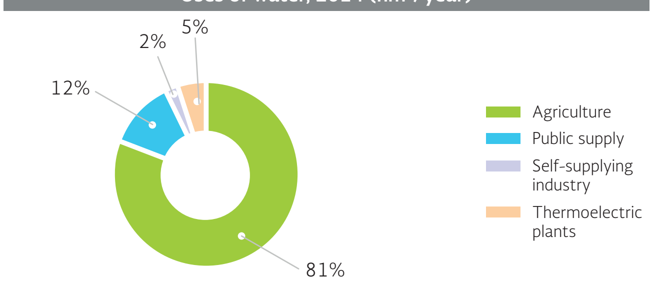
| Key | State | Key | State |
|---|---|---|---|
| 01 | Aguascalientes | 17 | Morelos |
| 02 | Baja California | 18 | Nayarit |
| 03 | Baja California Sur | 19 | Nuevo Leon |
| 04 | Campeche | 20 | Oaxaca |
| 05 | Coahuila de Zaragoza | 21 | Puebla |
| 06 | Colima | 22 | Queretaro |
| 07 | Chiapas | 23 | Quintana Roo |
| 08 | Chihuahua | 24 | San Luis Potosi |
| 09 | Distrito Federal | 25 | Sinaloa |
| 10 | Durango | 26 | Sonora |
| 11 | Guanajuato | 27 | Tabasco |
| 12 | Guerrero | 28 | Tamaulipas |
| 13 | Hidalgo | 29 | Tlaxcala |
| 14 | Jalisco | 30 | Veracruz de Ignacio de la Llave |
| 15 | Mexico | 31 | Yucatan |
| 16 | Michoacan de Ocampo | 32 | Zacatecas |

# Annex A. Relevant data by hydrological-administrative region

| Hydrological-administrative region: I. Baja California Peninsula<br>River basin organization with its headquarters in: Mexicali, Baja California | | | |
|---|---|---|---|
| **Contextual data** | | **Renewable water resources, 2014** | |
| Number of municipalities | 11 | Normal annual precipitation 1981-2010 | 168 mm |
| Total population, 2014 | 4 368 750 inhabitants | Mean surface runoff | 3 300 $hm^3$/year |
| Urban | 3 988 797inhabitants | Number of aquifers | 88 |
| Rural | 379 954 inhabitants | Mean aquifer recharge | 1 658 $hm^3$/year |
| Total population, 2030 | 5 512 727 inhabitants | Per capita renewable water resources, 2014 | 1 135 $m^3$/inhabitant/year |
| Irrigation districts | 2 | Per capita renewable water resources, 2030 | 899 $m^3$/inhabitant/year |
| Surface area | 245 678 hectares | Degree of water stress, 2014 | 80% (High) |




## Uses of water, 2014 ($hm^3$/year)

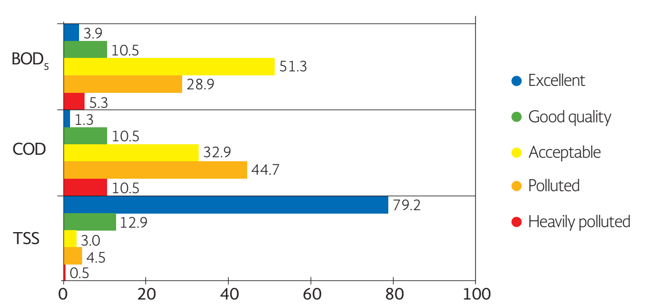



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 3 194 | 1 759 | 1 436 |
| Public supply | 462 | 123 | 339 |
| Self-supplying industry | 97 | 72 | 25 |
| Thermoelectric plants | 196 | 0 | 196 |
| **Total** | **3 949** | **1 954** | **1 995** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 126 | | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 76 |
| COD | 76 |
| TSS | 202 |

## Distribution of sites by indicator and classification (%)

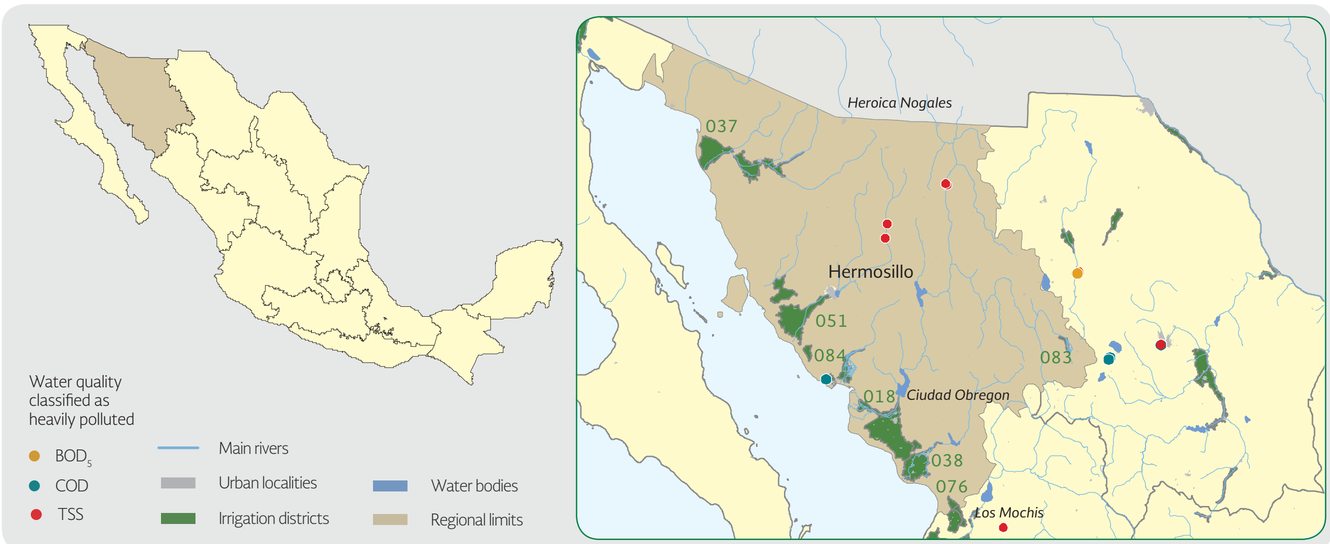



| Municipal plants, 2014 | | |
|---|---|---|
| | Drinking water | Wastewater |
| Number in operation | 44 | 66 |
| Installed capacity ($m^3$/s) | 12.37 | 9.86 |
| Flow processed ($m^3$/s) | 7.17 | 6.87 |

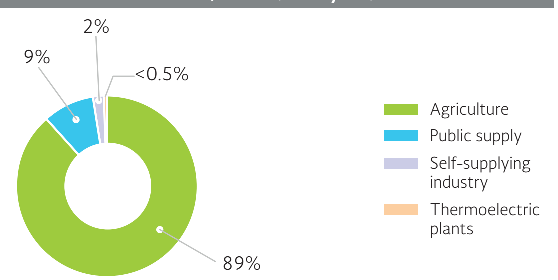
| Coverage, 2010 (%) | | |
|---|---|---|
| | Drinking water | Sanitation |
| Regional | 95.46 | 93.08 |
| Urban | 97.20 | 95.43 |
| Rural | 76.59 | 67.68 |

**Note:** The projection considers the population at the mid-point of the indicated year.

| Hydrological-administrative region: II. Northwest<br>River basin organization with its headquarters in: Hermosillo, Sonora | | | |
|---|---|---|---|
| **Contextual data** | | **Renewable water resources, 2014** | |
| Number of municipalities | 78 | Normal annual precipitation 1981-2010 | 428 mm |
| Total population, 2014 | 2 803 163 inhabitants | Mean surface runoff | 5 066 hm³/year |
| Urban | 2 351 378 inhabitants | Number of aquifers | 62 |
| Rural | 451 785 inhabitants | Mean aquifer recharge | 3 207 hm³/year |
| Total population, 2030 | 3 356 804 inhabitants | Per capita renewable water resources, 2014 | 2 951 m³/inhabitant/year |
| Irrigation districts | 7 | Per capita renewable water resources, 2030 | 2 465 m³/inhabitant/year |
| Surface area | 466 272 hectares | Degree of water stress, 2014 | 81% (High) |




## Uses of water, 2014 (hm³/year)

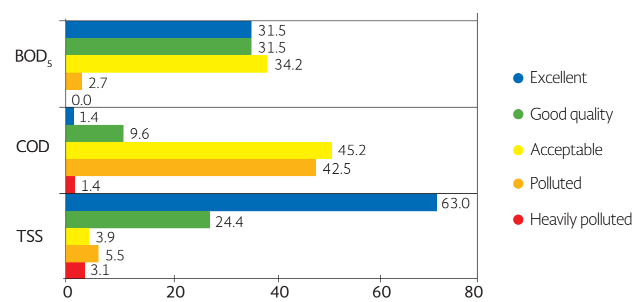



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 5 992 | 3 789 | 2 203 |
| Public supply | 581 | 289 | 292 |
| Self-supplying industry | 125 | 4 | 121 |
| Thermoelectric plants | 16 | 7 | 9 |
| **Total** | **6 715** | **4 090** | **2 625** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 5 214 | | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 73 |
| COD | 73 |
| TSS | 127 |

## Distribution of sites by indicator and classification (%)




## Municipal plants, 2014

| | Drinking water | Wastewater |
|---|---|---|
| Number in operation | 24 | 101 |
| Installed capacity (m³/s) | 5.58 | 4.94 |
| Flow processed (m³/s) | 2.29 | 3.44 |

## Coverage, 2010 (%)

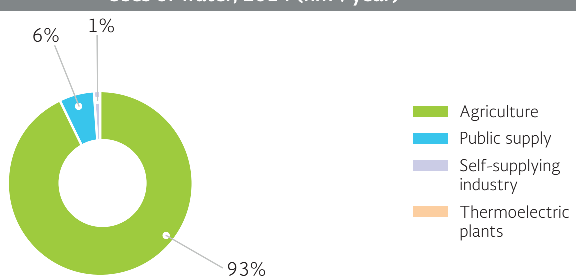
| | Drinking water | Sanitation |
|---|---|---|
| Regional | 96.28 | 88.08 |
| Urban | 97.31 | 94.68 |
| Rural | 90.95 | 53.97 |

**Note:** The projection considers the population at the mid-point of the indicated year.

## Hydrological-administrative region: III. Northern Pacific
## River basin organization with its headquarters in: Culiacan, Sinaloa

| Contextual data | | Renewable water resources, 2014 | |
|---|---|---|---|
| Number of municipalities | 51 | Normal annual precipitation 1981-2010 | 765 mm |
| Total population, 2014 | 4 467 253 inhabitants | Mean surface runoff | 22 519 $hm^3$/year |
| Urban | 3 087 605 inhabitants | Number of aquifers | 24 |
| Rural | 1 379 649 inhabitants | Mean aquifer recharge | 3 076 $hm^3$/year |
| Total population, 2030 | 5 056 867 inhabitants | Per capita renewable water resources, 2014 | 5 730 $m^3$/inhabitant/year |
| Irrigation districts | 9 | Per capita renewable water resources, 2030 | 5 062 $m^3$/inhabitant/year |
| Surface area | 806 643 hectares | Degree of water stress, 2014 | 42% (Medium) |


### Uses of water, 2014 ($hm^3$/year)

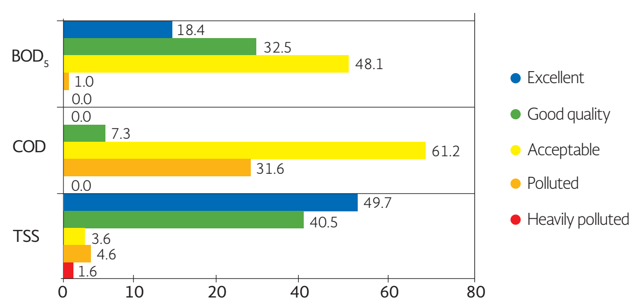



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 10 029 | 8 916 | 1 113 |
| Public supply | 643 | 306 | 337 |
| Self-supplying industry | 59 | 38 | 22 |
| Thermoelectric plants | 0 | 0 | 0 |
| **Total** | **10 731** | **9 260** | **1 472** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 11 010 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 206 |
| COD | 206 |
| TSS | 306 |

### Distribution of sites by indicator and classification (%)




### Municipal plants, 2014

| | Drinking water | Wastewater |
|---|---|---|
| Number in operation | 156 | 362 |
| Installed capacity ($m^3$/s) | 9.47 | 10.26 |
| Flow processed ($m^3$/s) | 8.44 | 7.88 |

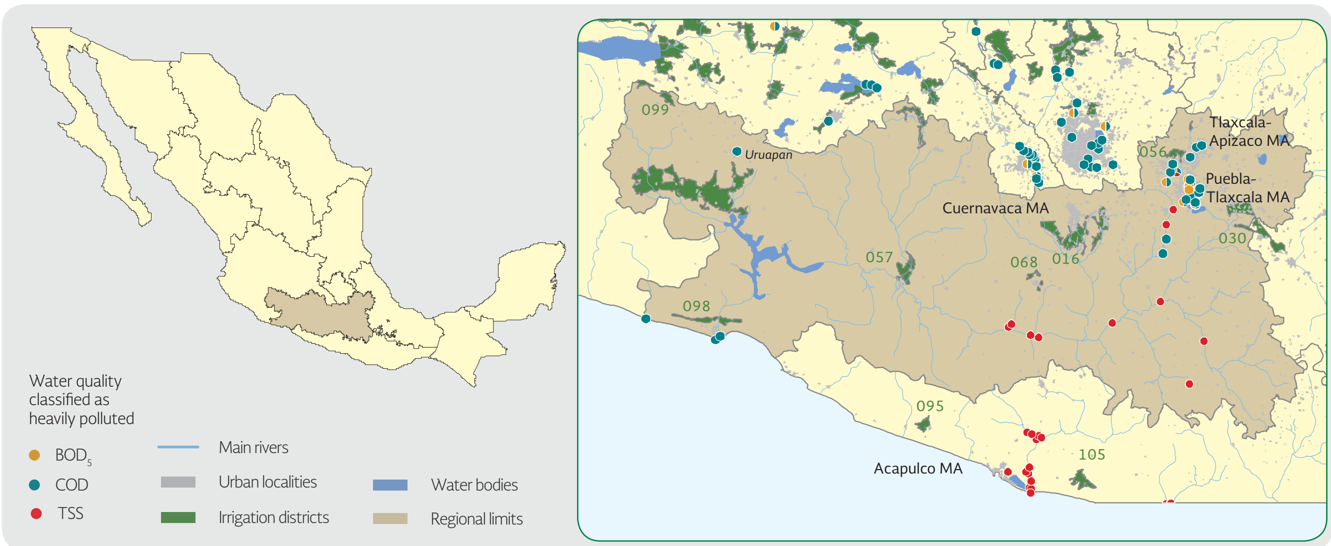
### Coverage, 2010 (%)

| | Drinking water | Sanitation |
|---|---|---|
| Regional | 91.29 | 87.45 |
| Urban | 98.03 | 96.60 |
| Rural | 76.98 | 68.01 |

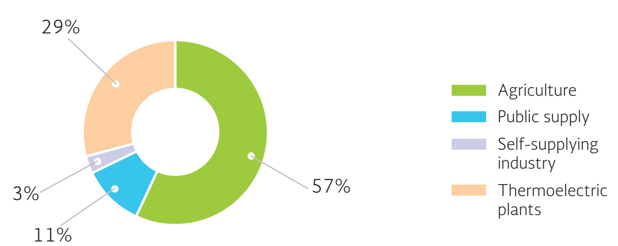
**Note:** The projection considers the population at the mid-point of the indicated year.

## Hydrological-administrative region: IV. Balsas
## River basin organization with its headquarters in: Cuernavaca, Morelos

| Contextual data | | Renewable water resources, 2014 | |
|---|---|---|---|
| Number of municipalities | 420 | Normal annual precipitation 1981-2010 | 962 mm |
| Total population, 2014 | 11 686 789 inhabitants | Mean surface runoff | 16 805 hm³/year |
| Urban | 8 260 213 inhabitants | Number of aquifers | 45 |
| Rural | 3 426 576 inhabitants | Mean aquifer recharge | 5 351 hm³/year |
| Total population, 2030 | 13 315 109 inhabitants | Per capita renewable water resources, 2014 | 1 896 m³/inhabitant/year |
| Irrigation districts | 9 | Per capita renewable water resources, 2030 | 1 664 m³/inhabitant/year |
| Surface area | 199 396 hectares | Degree of water stress, 2014 | 49% (High) |




### Uses of water, 2014 (hm³/year)

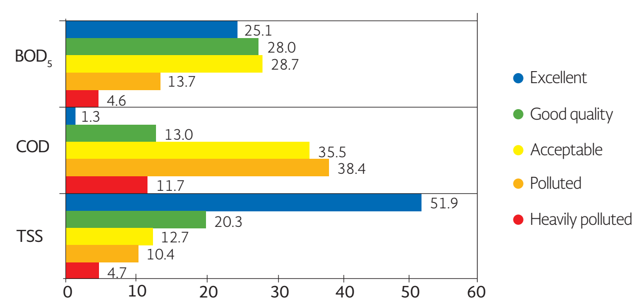



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 6 113 | 5 009 | 1 104 |
| Public supply | 1 218 | 604 | 614 |
| Self-supplying industry | 305 | 216 | 89 |
| Thermoelectric plants | 3 148 | 3 122 | 26 |
| **Total** | **10 784** | **8 951** | **1 833** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 34 352 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 307 |
| COD | 307 |
| TSS | 316 |

### Distribution of sites by indicator and classification (%)




### Municipal plants, 2014

| | Drinking water | Wastewater |
|---|---|---|
| Number in operation | 23 | 199 |
| Installed capacity (m³/s) | 22.89 | 9.89 |
| Flow processed (m³/s) | 17.25 | 7.54 |

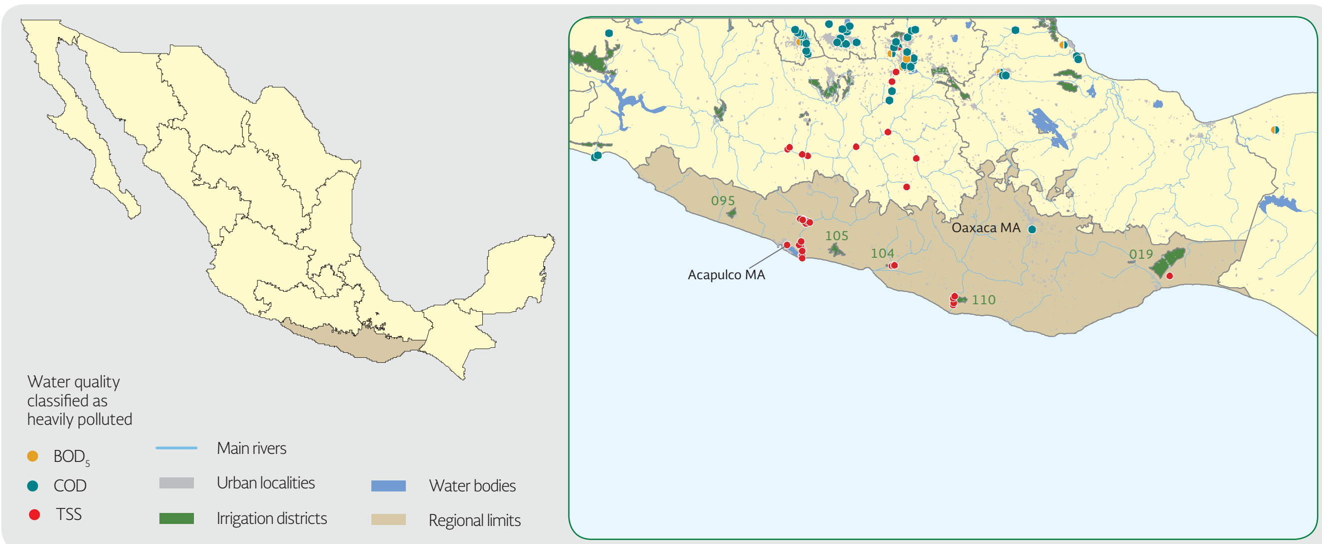
### Coverage, 2010 (%)

| | Drinking water | Sanitation |
|---|---|---|
| Regional | 85.76 | 86.87 |
| Urban | 91.74 | 94.47 |
| Rural | 71.80 | 69.13 |

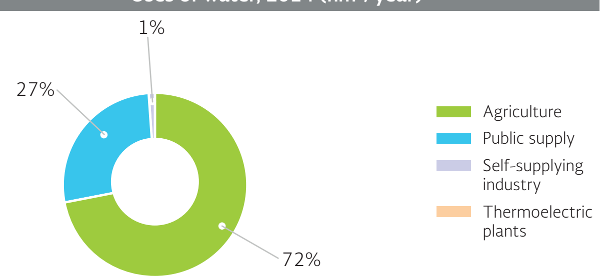
**Note:** The projection considers the population at the mid-point of the indicated year.

## Hydrological-administrative region: V. Southern Pacific
## River basin organization with its headquarters in: Oaxaca, Oaxaca

| Contextual data | | Renewable water resources, 2014 | |
|---|---|---|---|
| Number of municipalities | 378 | Normal annual precipitation 1981-2010 | 855 mm |
| Total population, 2014 | 5 024 088 inhabitants | Mean surface runoff | 28 629 $hm^3$/year |
| Urban | 3 028 638 inhabitants | Number of aquifers | 36 |
| Rural | 1 995 450 inhabitants | Mean aquifer recharge | 1 936 $hm^3$/year |
| Total population, 2030 | 5 399 687 inhabitants | Per capita renewable water resources, 2014 | 6 084 $m^3$/inhabitant/year |
| Irrigation districts | 5 | Per capita renewable water resources, 2030 | 5 660 $m^3$/inhabitant/year |
| Surface area | 71 927 hectares | Degree of water stress, 2014 | 5% (No stress) |




### Uses of water, 2014 ($hm^3$/year)

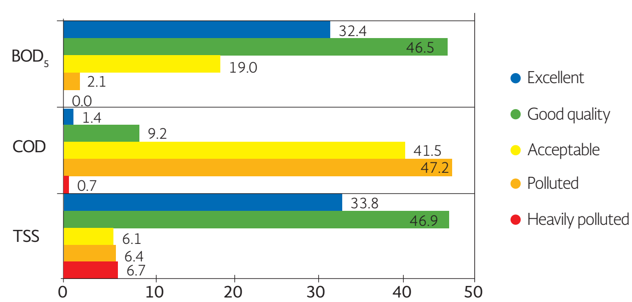



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 105 | 855 | 250 |
| Public supply | 412 | 183 | 229 |
| Self-supplying industry | 23 | 1 | 22 |
| Thermoelectric plants | 0 | 0 | 0 |
| **Total** | **1 539** | **1 039** | **501** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 11 151 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 142 |
| COD | 142 |
| TSS | 358 |

### Distribution of sites by indicator and classification (%)




### Municipal plants, 2014

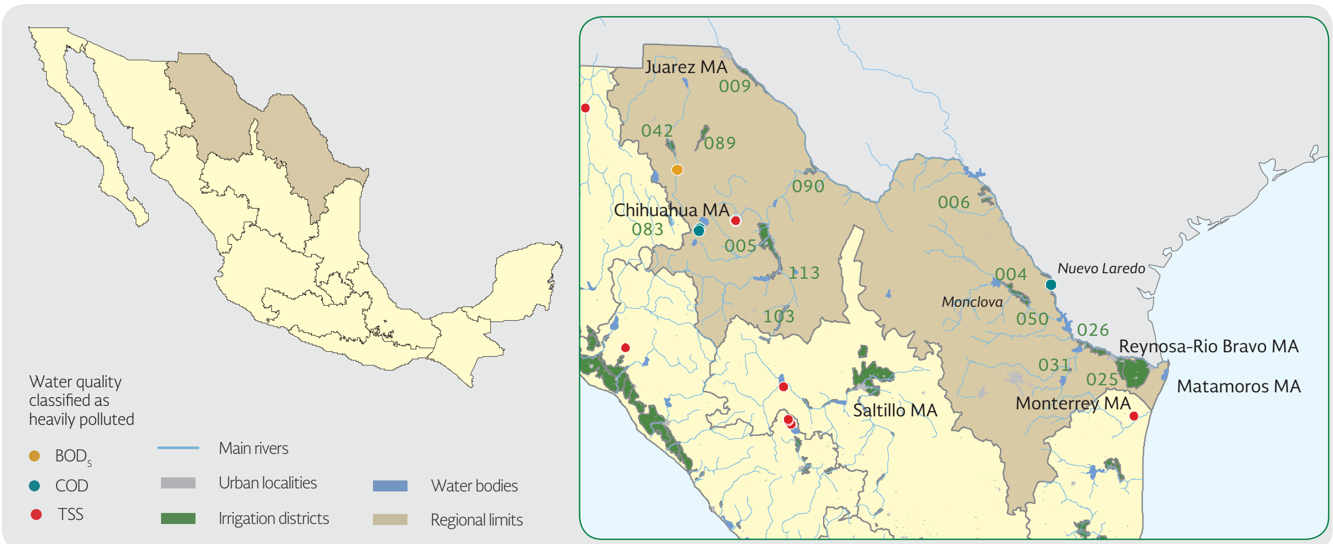
| | Drinking water | Wastewater |
|---|---|---|
| Number in operation | 9 | 94 |
| Installed capacity ($m^3$/s) | 3.23 | 4.92 |
| Flow processed ($m^3$/s) | 2.61 | 4.01 |

### Coverage, 2010 (%)

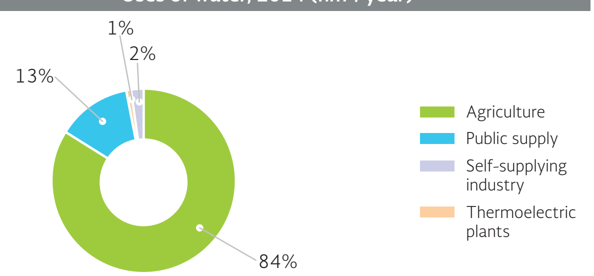
| | Drinking water | Sanitation |
|---|---|---|
| Regional | 75.60 | 72.55 |
| Urban | 83.82 | 89.49 |
| Rural | 63.66 | 47.94 |

**Note:** The projection considers the population at the mid-point of the indicated year.

| Hydrological-administrative region: VI. Rio Bravo<br>River basin organization with its headquarters in: Monterrey, Nuevo Leon | | | |
|---|---|---|---|
| Contextual data | | Renewable water resources, 2014 | |
| Number of municipalities | 144 | Normal annual precipitation 1981-2010 | 1 139 mm |
| Total population, 2014 | 12 151 555 inhabitants | Mean surface runoff | 6 416 hm³/year |
| Urban | 11 313 583 inhabitants | Number of aquifers | 102 |
| Rural | 837 972 inhabitants | Mean aquifer recharge | 5 900 hm³/year |
| Total population, 2030 | 14 368 012 inhabitants | Per capita renewable water resources, 2014 | 1 014 m³/inhabitant/year |
| Irrigation districts | 13 | Per capita renewable water resources, 2030 | 857 m³/inhabitant/year |
| Surface area | 469 451 hectares | Degree of water stress, 2014 | 77% (High) |




## Uses of water, 2014 (hm³/year)

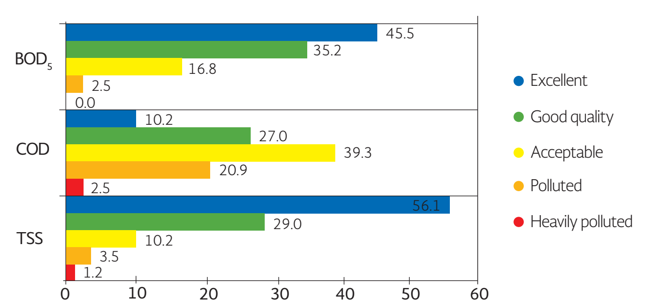



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 7 939 | 4 323 | 3 616 |
| Public supply | 1 248 | 549 | 699 |
| Self-supplying industry | 215 | 14 | 202 |
| Thermoelectric plants | 111 | 53 | 58 |
| **Total** | **9 513** | **4 938** | **4 575** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 5 400 | | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 244 |
| COD | 244 |
| TSS | 255 |

## Distribution of sites by indicator and classification (%)




## Municipal plants, 2014

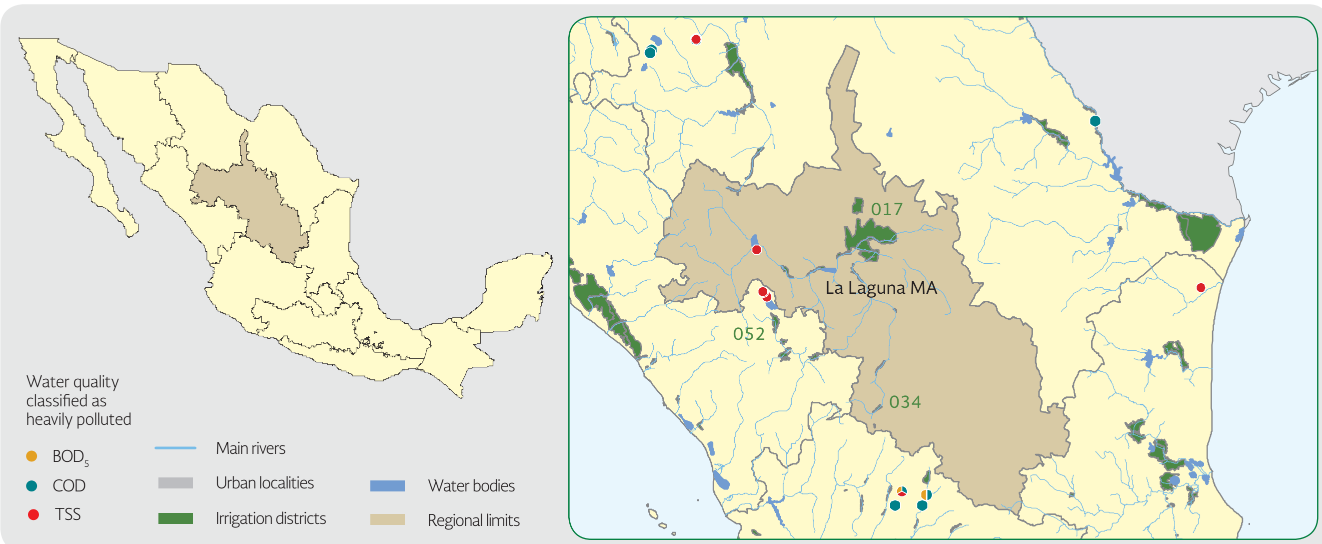
| | Drinking water | Wastewater |
|---|---|---|
| Number in operation | 65 | 225 |
| Installed capacity (m³/s) | 27.17 | 34.15 |
| Flow processed (m³/s) | 14.28 | 24.04 |

## Coverage, 2010 (%)

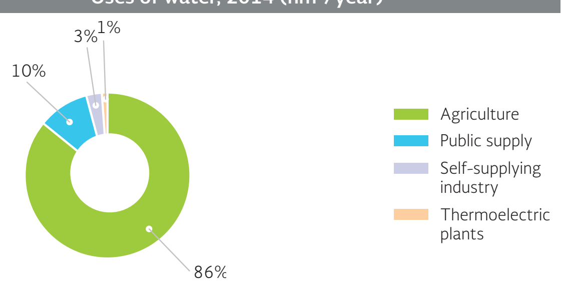
| | Drinking water | Sanitation |
|---|---|---|
| Regional | 97.00 | 95.42 |
| Urban | 98.16 | 97.23 |
| Rural | 80.94 | 70.57 |

**Note:** The projection considers the population at the mid-point of the indicated year.

| Hydrological-administrative region: VII. Central Basins of the North<br>River basin organization with its headquarters in: Torreon, Coahuila de Zaragoza | | | |
|---|---|---|---|
| **Contextual data** | | **Renewable water resources, 2014** | |
| Number of municipalities | 78 | Normal annual precipitation 1981-2010 | 372 mm |
| Total population, 2014 | 4 515 109 inhabitants | Mean surface runoff | 5 529 hm³/year |
| Urban | 3 382 090 inhabitants | Number of aquifers | 65 |
| Rural | 1 133 019 inhabitants | Mean aquifer recharge | 2 320 hm³/year |
| Total population, 2030 | 5 124 677 inhabitants | Per capita renewable water resources, 2014 | 1 738 m³/inhabitant/year |
| Irrigation districts | 1 | Per capita renewable water resources, 2030 | 1 532 m³/inhabitant/year |
| Surface area | 71 964 hectares | Degree of water stress, 2014 | 48% (High) |




## Uses of water, 2014 (hm³/year)

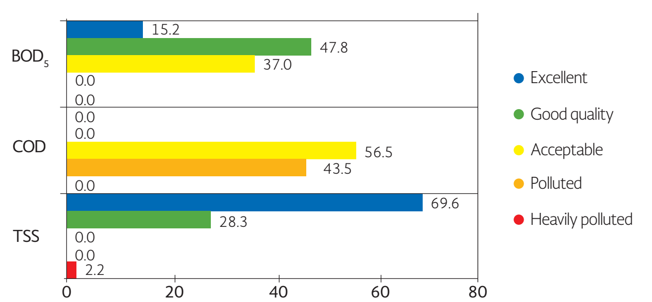



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 3 292 | 1 289 | 2 003 |
| Public supply | 381 | 12 | 369 |
| Self-supplying industry | 99 | 1 | 98 |
| Thermoelectric plants | 28 | 0 | 28 |
| **Total** | **3 801** | **1 302** | **2 499** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 0 | | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 46 |
| COD | 46 |
| TSS | 46 |

## Distribution of sites by indicator and classification (%)

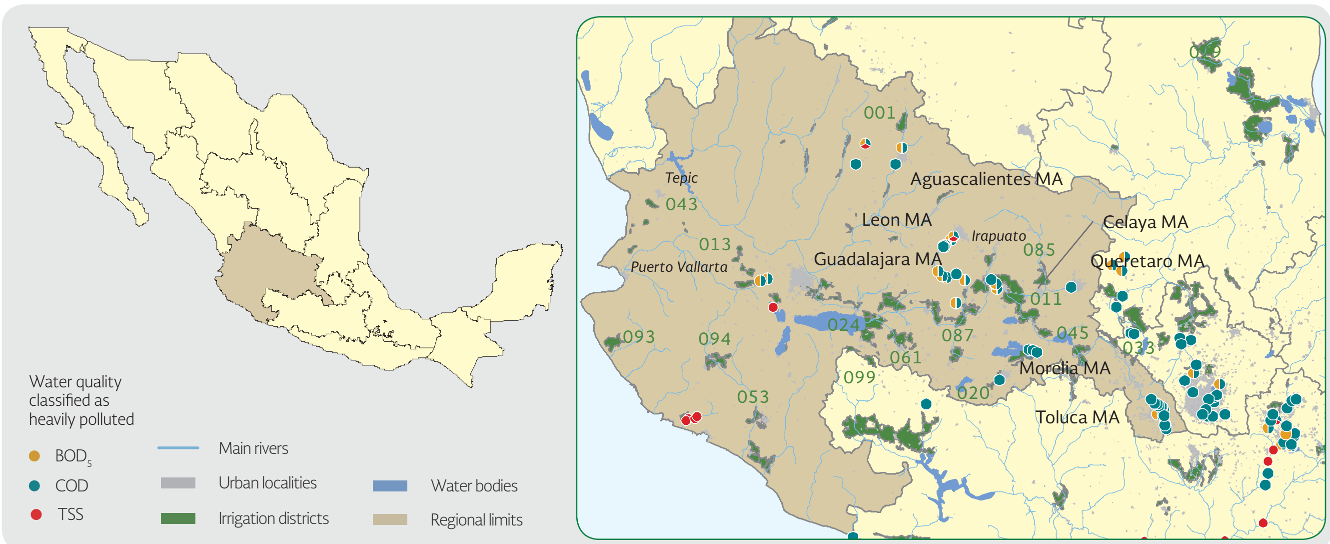



| Municipal plants, 2014 | Drinking water | Wastewater |
|---|---|---|
| Number in operation | 121 | 151 |
| Installed capacity (m³/s) | 0.71 | 6.80 |
| Flow processed (m³/s) | 0.53 | 5.36 |

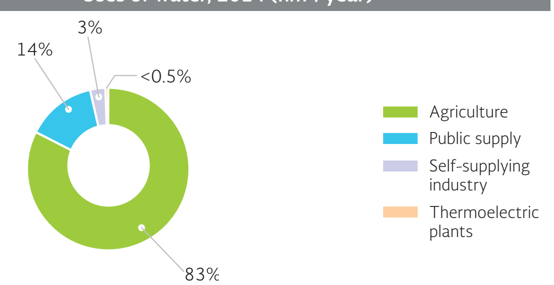
| Coverage, 2010 (%) | Drinking water | Sanitation |
|---|---|---|
| Regional | 95.04 | 90.72 |
| Urban | 98.84 | 97.30 |
| Rural | 84.20 | 71.96 |

**Note:** The projection considers the population at the mid-point of the indicated year.

| Hydrological-administrative region: VIII. Lerma-Santiago-Pacific<br>River basin organization with its headquarters in: Guadalajara, Jalisco | | | |
|---|---|---|---|
| **Contextual data** | | **Renewable water resources, 2014** | |
| Number of municipalities | 332 | Normal annual precipitation 1981-2010 | 398 mm |
| Total population, 2014 | 23 888 024 inhabitants | Mean surface runoff | 25 423 hm³/year |
| Urban | 18 707 502 inhabitants | Number of aquifers | 128 |
| Rural | 5 180 522 inhabitants | Mean aquifer recharge | 9 670 hm³/year |
| Total population, 2030 | 27 698 619 inhabitants | Per capita renewable water resources, 2014 | 1 469 m³/inhabitant/year |
| Irrigation districts | 14 | Per capita renewable water resources, 2030 | 1 267 m³/inhabitant/year |
| Surface area | 501 196 hectares | Degree of water stress, 2014 | 44% (High) |




## Uses of water, 2014 (hm³/year)

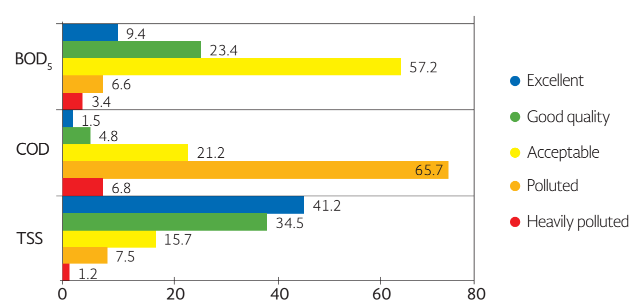



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 12 600 | 6 675 | 5 925 |
| Public supply | 2 139 | 689 | 1 450 |
| Self-supplying industry | 510 | 65 | 445 |
| Thermoelectric plants | 43 | 0 | 43 |
| **Total** | **15 292** | **7 429** | **7 863** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 22 943 | | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 650 |
| COD | 650 |
| TSS | 746 |

### Distribution of sites by indicator and classification (%)




## Municipal plants, 2014

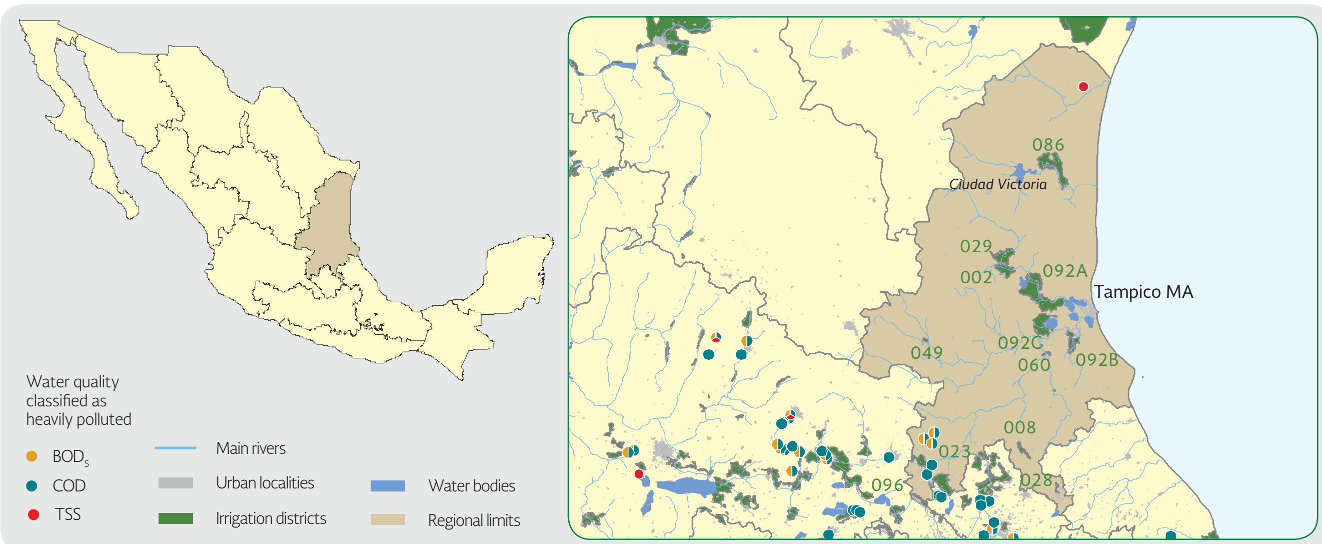
| | Drinking water | Wastewater |
|---|---|---|
| Number in operation | 164 | 582 |
| Installed capacity (m³/s) | 20.24 | 39.84 |
| Flow processed (m³/s) | 15.40 | 30.52 |

## Coverage, 2010 (%)

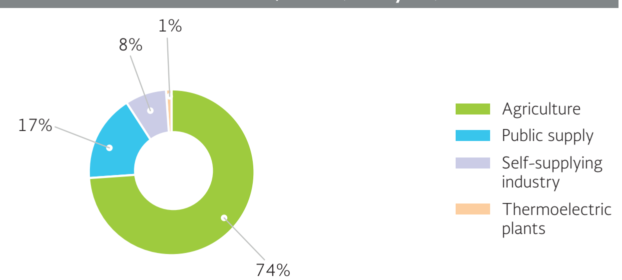
| | Drinking water | Sanitation |
|---|---|---|
| Regional | 94.86 | 93.05 |
| Urban | 96.92 | 97.40 |
| Rural | 87.76 | 78.01 |

**Note:** The projection considers the population at the mid-point of the indicated year.

| Hydrological-administrative region: IX. Northern Gulf<br>River basin organization with its headquarters in: Ciudad Victoria, Tamaulipas | | | |
|---|---|---|---|
| **Contextual data** | | **Renewable water resources, 2014** | |
| Number of municipalities | 148 | Normal annual precipitation 1981-2010 | 808 mm |
| Total population, 2014 | 5 233 402 inhabitants | Mean surface runoff | 24 016 hm³/year |
| Urban | 2 827 164 inhabitants | Number of aquifers | 40 |
| Rural | 2 406 238 inhabitants | Mean aquifer recharge | 4 069 hm³/year |
| Total population, 2030 | 5 962 759 inhabitants | Per capita renewable water resources, 2014 | 5 366 m³/inhabitant/year |
| Irrigation districts | 13 | Per capita renewable water resources, 2030 | 4 710 m³/inhabitant/year |
| Surface area | 257 993 hectares | Degree of water stress, 2014 | 21% (Medium) |




## Uses of water, 2014 (hm³/year)

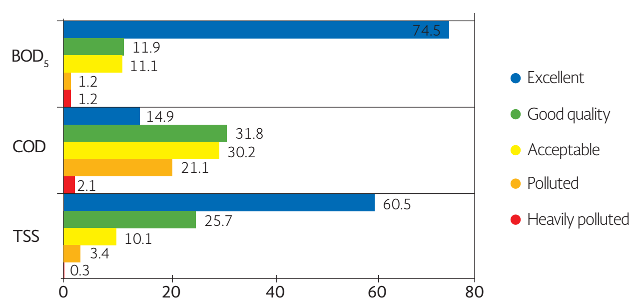



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 4 344 | 3 455 | 889 |
| Public supply | 1 018 | 858 | 159 |
| Self-supplying industry | 470 | 430 | 40 |
| Thermoelectric plants | 67 | 61 | 6 |
| **Total** | **5 899** | **4 805** | **1 094** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 1 959 | | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 243 |
| COD | 242 |
| TSS | 296 |

## Distribution of sites by indicator and classification (%)




## Municipal plants, 2014

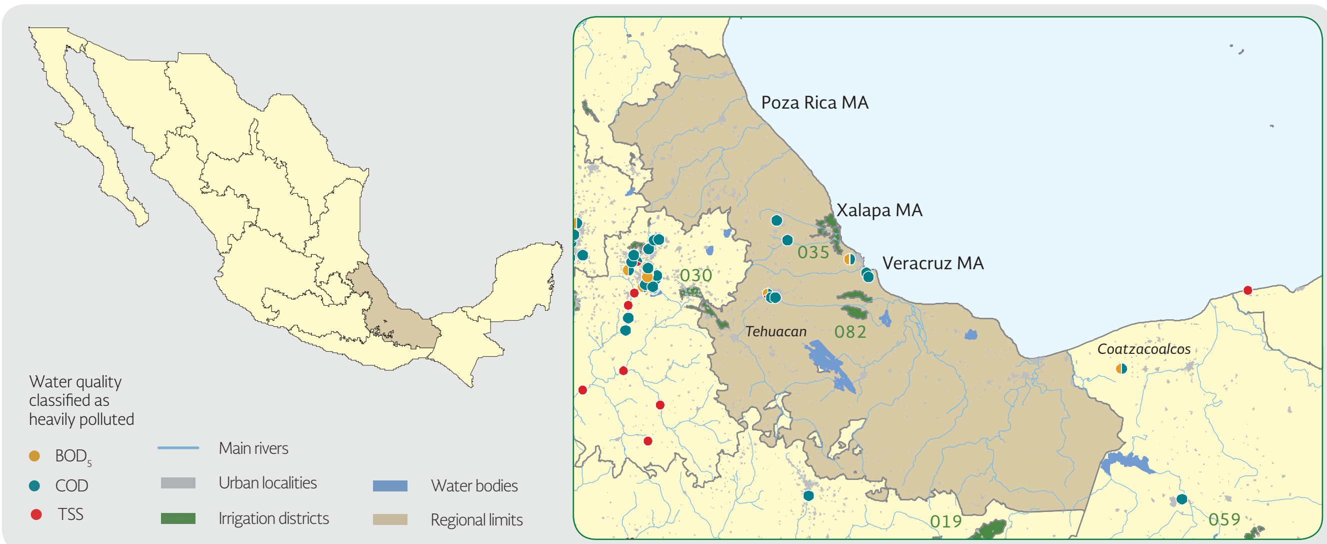
| | Drinking water | Wastewater |
|---|---|---|
| Number in operation | 47 | 86 |
| Installed capacity (m³/s) | 8.19 | 5.53 |
| Flow processed (m³/s) | 7.40 | 4.16 |

## Coverage, 2010 (%)

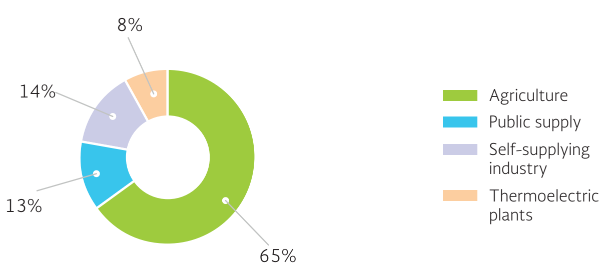
| | Drinking water | Sanitation |
|---|---|---|
| Regional | 84.94 | 72.98 |
| Urban | 96.71 | 92.13 |
| Rural | 71.83 | 51.66 |

Note: The projection considers the population at the mid-point of the indicated year.

| Hydrological-administrative region: X. Central Gulf<br>River basin organization with its headquarters in: Xalapa, Veracruz | | | |
|---|---|---|---|
| **Contextual data** | | **Renewable water resources, 2014** | |
| Number of municipalities | 432 | Normal annual precipitation 1981-2010 | 1 626 mm |
| Total population, 2014 | 10 482 417 inhabitants | Mean surface runoff | 90 424 hm³/year |
| Urban | 6 058 319 inhabitants | Number of aquifers | 22 |
| Rural | 4 424 099 inhabitants | Mean aquifer recharge | 4 705 hm³/year |
| Total population, 2030 | 11 606 944 inhabitants | Per capita renewable water resources, 2014 | 9 075 m³/inhabitant/year |
| Irrigation districts | 2 | Per capita renewable water resources, 2030 | 8 196 m³/inhabitant/year |
| Surface area | 41 416 hectares | Degree of water stress, 2014 | 6% (No stress) |




## Uses of water, 2014 (hm³/year)

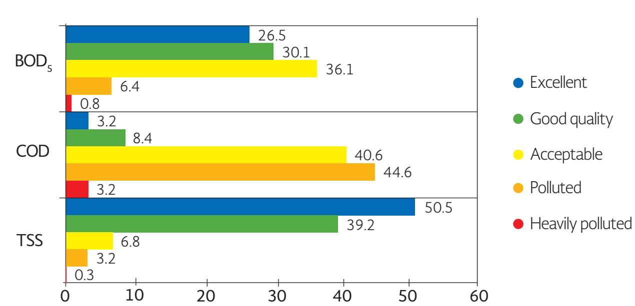



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 3 530 | 2 578 | 952 |
| Public supply | 723 | 443 | 280 |
| Self-supplying industry | 782 | 640 | 141 |
| Thermoelectric plants | 414 | 406 | 8 |
| **Total** | **5 449** | **4 068** | **1 381** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 24 526 | | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 249 |
| COD | 249 |
| TSS | 309 |

## Distribution of sites by indicator and classification (%)

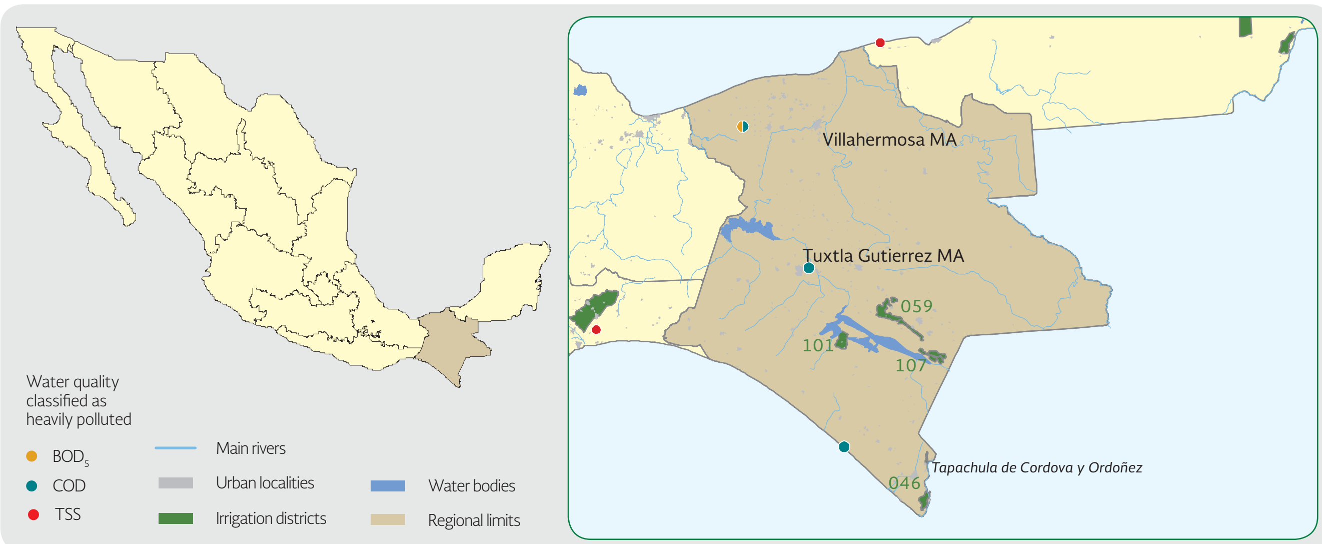



| Municipal plants, 2014 | Drinking water | Wastewater |
|---|---|---|
| Number in operation | 13 | 137 |
| Installed capacity (m³/s) | 7.09 | 6.80 |
| Flow processed (m³/s) | 4.59 | 5.30 |

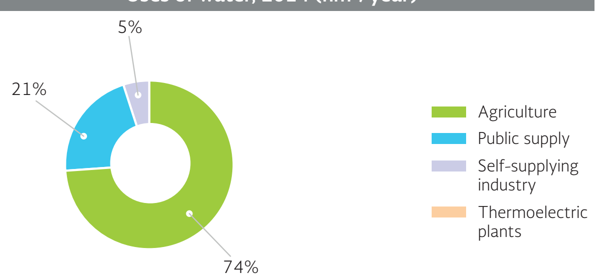
| Coverage, 2010 (%) | Drinking water | Sanitation |
|---|---|---|
| Regional | 81.24 | 81.60 |
| Urban | 91.18 | 94.69 |
| Rural | 68.18 | 64.40 |

**Note:** The projection considers the population at the mid-point of the indicated year.

| Hydrological-administrative region: XI. Southern Border<br>River basin organization with its headquarters in: Tuxtla Gutierrez, Chiapas | | | |
|---|---|---|---|
| Contextual data | | Renewable water resources, 2014 | |
| Number of municipalities | 137 | Normal annual precipitation 1981-2010 | 1 842 mm |
| Total population, 2014 | 7 571 983 inhabitants | Mean surface runoff | 121 742 hm³/year |
| Urban | 3 938 578 inhabitants | Number of aquifers | 23 |
| Rural | 3 633 404 inhabitants | Mean aquifer recharge | 22 718 hm³/year |
| Total population, 2030 | 8 844 011 inhabitants | Per capita renewable water resources, 2014 | 19 078 m³/inhabitant/year |
| Irrigation districts | 4 | Per capita renewable water resources, 2030 | 16 334 m³/inhabitant/year |
| Surface area | 36 180 hectares | Degree of water stress, 2014 | 2% (No stress) |




## Uses of water, 2014 (hm³/year)

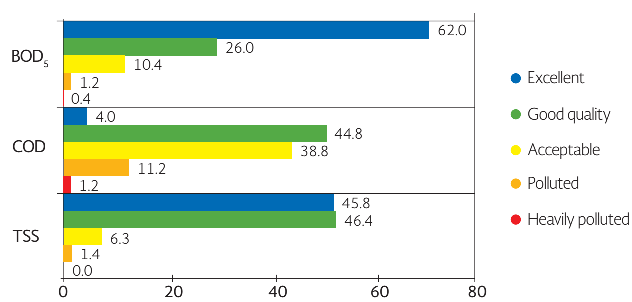



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 740 | 1 222 | 518 |
| Public supply | 484 | 354 | 129 |
| Self-supplying industry | 114 | 53 | 61 |
| Thermoelectric plants | 0 | 0 | 0 |
| **Total** | **2 337** | **1 630** | **708** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 61 721 | | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 250 |
| COD | 250 |
| TSS | 347 |

## Distribution of sites by indicator and classification (%)

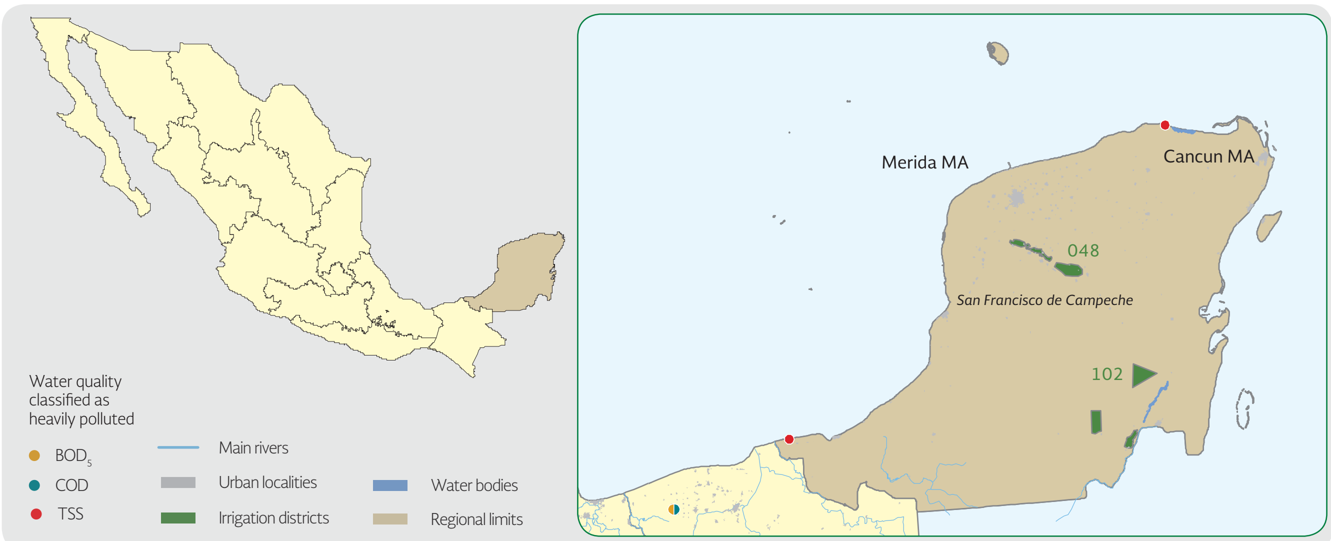



| Municipal plants, 2014 | Drinking water | Wastewater |
|---|---|---|
| Number in operation | 45 | 114 |
| Installed capacity (m³/s) | 14.62 | 4.42 |
| Flow processed (m³/s) | 11.05 | 2.52 |

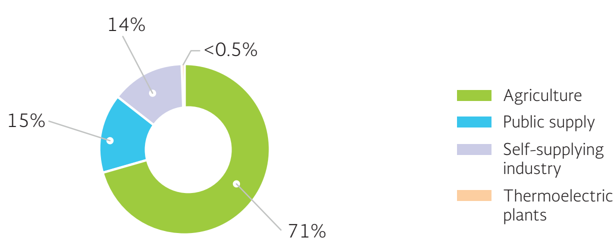
| Coverage, 2010 (%) | Drinking water | Sanitation |
|---|---|---|
| Regional | 78.51 | 85.61 |
| Urban | 88.72 | 96.60 |
| Rural | 67.63 | 73.90 |

**Note:** The projection considers the population at the mid-point of the indicated year.

| Hydrological-administrative region: XII. Yucatan Peninsula<br>River basin organization with its headquarters in: Merida, Yucatan | | | |
|---|---|---|---|
| Contextual data | | Renewable water resources, 2014 | |
| Number of municipalities | 127 | Normal annual precipitation 1981-2010 | 1 207 mm |
| Total population, 2014 | 4 515 526 inhabitants | Mean surface runoff | 4 008 $hm^3$/year |
| Urban | 3 792 230 inhabitants | Number of aquifers | 4 |
| Rural | 723 296 inhabitants | Mean aquifer recharge | 25 316 $hm^3$/year |
| Total population, 2030 | 5 834 470 inhabitants | Per capita renewable water resources, 2014 | 6 494 $m^3$/inhabitant/year |
| Irrigation districts | 2 | Per capita renewable water resources, 2030 | 5 026 $m^3$/inhabitant/year |
| Surface area | 18 490 hectares | Degree of water stress, 2014 | 14% (Low) |




## Uses of water, 2014 ($hm^3$/year)

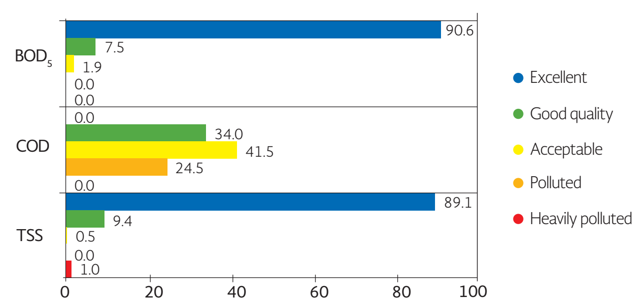



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 2 925 | 140 | 2 785 |
| Public supply | 611 | <0.5 | 610 |
| Self-supplying industry | 601 | 0 | 601 |
| Thermoelectric plants | 13 | 0 | 13 |
| **Total** | **4 149** | **141** | **4 009** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 0 | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 53 |
| COD | 53 |
| TSS | 202 |

## Distribution of sites by indicator and classification (%)



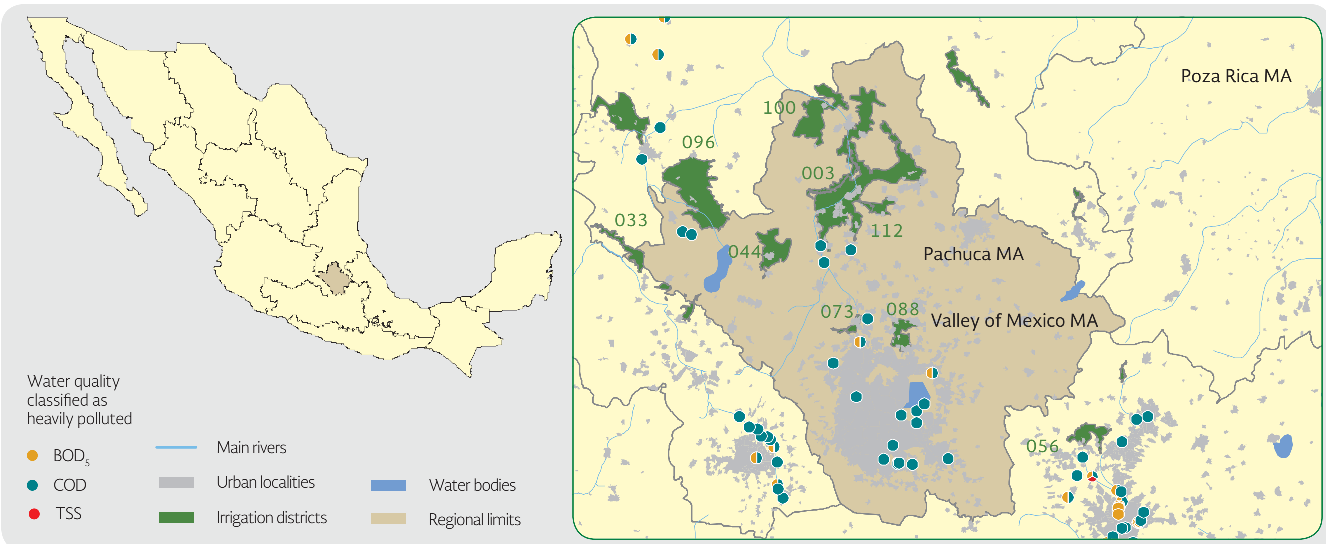

| Municipal plants, 2014 | | |
|---|---|---|
| | Drinking water | Wastewater |
| Number in operation | 2 | 81 |
| Installed capacity ($m^3$/s) | 0.03 | 2.95 |
| Flow processed ($m^3$/s) | 0.02 | 2.03 |

| Coverage, 2010 (%) | | |
|---|---|---|
| | Drinking water | Sanitation |
| Regional | 94.22 | 84.48 |
| Urban | 94.89 | 89.24 |
| Rural | 90.87 | 60.67 |

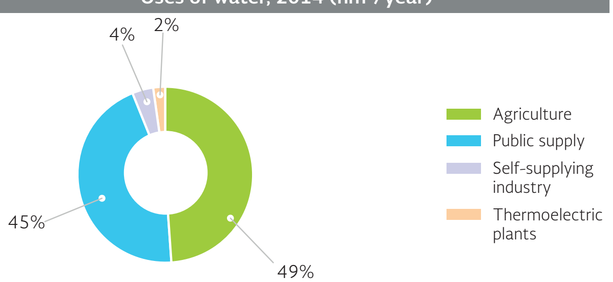
**Note:** The projection considers the population at the mid-point of the indicated year.

## Hydrological-administrative region: XIII. Waters of the Valley of Mexico
## River basin organization with its headquarters in: Mexico City, Federal District

| Contextual data | | Renewable water resources, 2014 | |
|---|---|---|---|
| Number of municipalities | 121 | Normal annual precipitation 1981-2010 | 649 mm |
| Total population, 2014 | 23 005 142 inhabitants | Mean surface runoff | 1 112 hm³/year |
| Urban | 21 798 902 inhabitants | Number of aquifers | 14 |
| Rural | 1 206 240 inhabitants | Mean aquifer recharge | 2 346 hm³/year |
| Total population, 2030 | 25 400 649 inhabitants | Per capita renewable water resources, 2014 | 150 m³/inhabitant/year |
| Irrigation districts | 5 | Per capita renewable water resources, 2030 | 136 m³/inhabitant/year |
| Surface area | 97 950 hectares | Degree of water stress, 2014 | 138% (Very high) |




### Uses of water, 2014 (hm³/year)

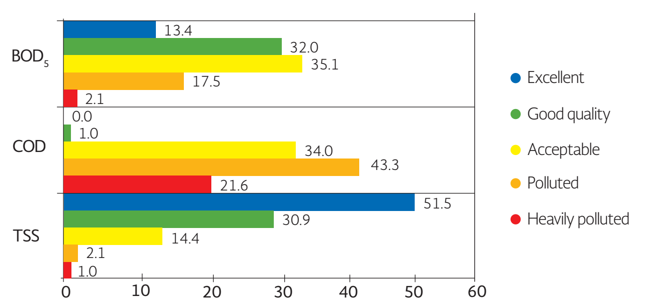



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 2 352 | 1 990 | 362 |
| Public supply | 2 134 | 351 | 1 783 |
| Self-supplying industry | 172 | 31 | 141 |
| Thermoelectric plants | 113 | 46 | 68 |
| **Total** | **4 771** | **2 418** | **2 354** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 221 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 97 |
| COD | 97 |
| TSS | 97 |

### Distribution of sites by indicator and classification (%)




| Municipal plants, 2014 | Drinking water | Wastewater |
|---|---|---|
| Number in operation | 66 | 139 |
| Installed capacity (m³/s) | 6.47 | 11.54 |
| Flow processed (m³/s) | 5.25 | 7.58 |

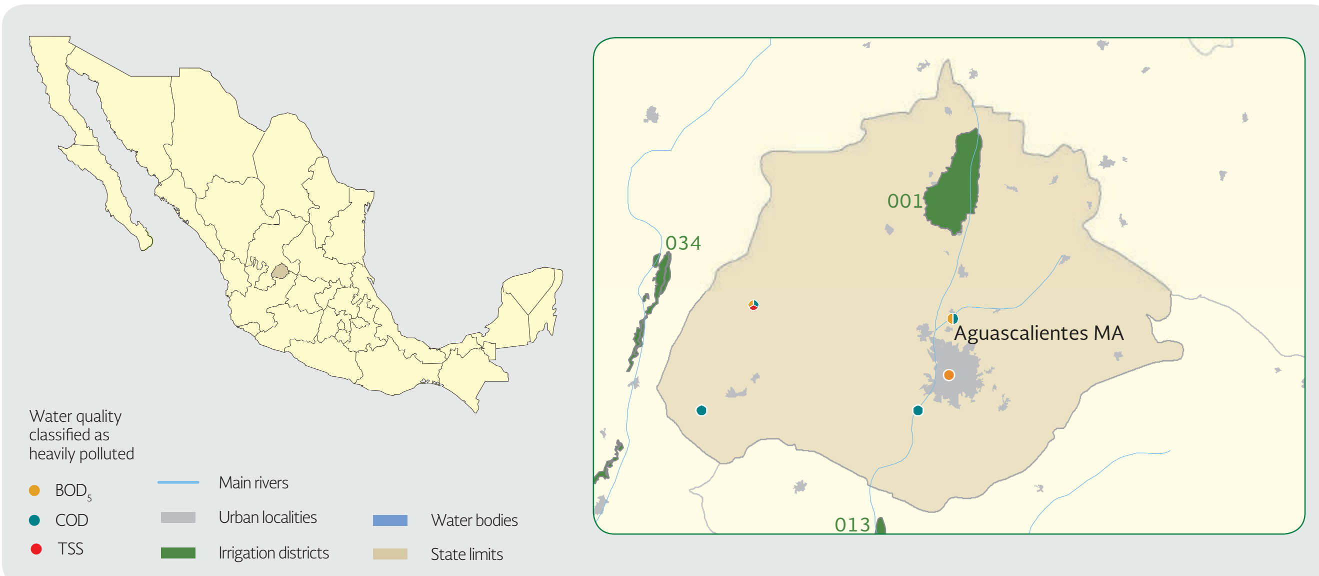
| Coverage, 2010 (%) | Drinking water | Sanitation |
|---|---|---|
| Regional | 96.79 | 97.82 |
| Urban | 97.36 | 98.68 |
| Rural | 86.75 | 82.68 |

**Note:** The projection considers the population at the mid-point of the indicated year.

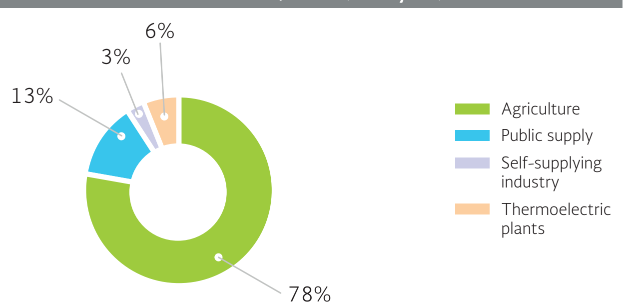
# Annex B. Relevant data by state

## 1. Aguascalientes

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 11 | | **Municipal** | **Industrial** |
| Total population, 2014 | 1 270 174 inhabitants | Number in operation | 134 | 47 |
| Urban | 1 030 342 inhabitants | Installed capacity ($m^3/s$) | 4.73 | 0.34 |
| Rural | 239 832 inhabitants | Flow processed ($m^3/s$) | 3.28 | 0.14 |
| Total population, 2030 | 1 507 807 inhabitants | | | |
| Normal precipitation 1981-2010 | 515 mm | | | |




### Uses of water, 2014 (hm³/year)

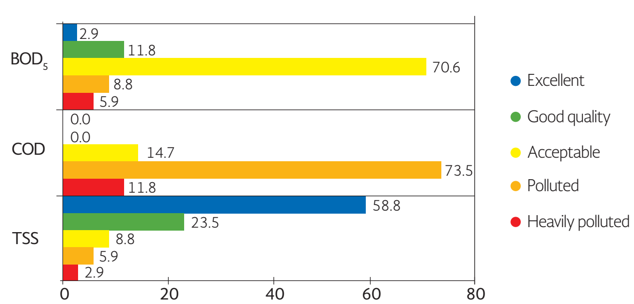



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 480 | 176 | 304 |
| Public supply | 127 | 0 | 127 |
| Self-supplying industry | 15 | 2 | 13 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **622** | **178** | **444** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 0 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 34 |
| COD | 34 |
| TSS | 34 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

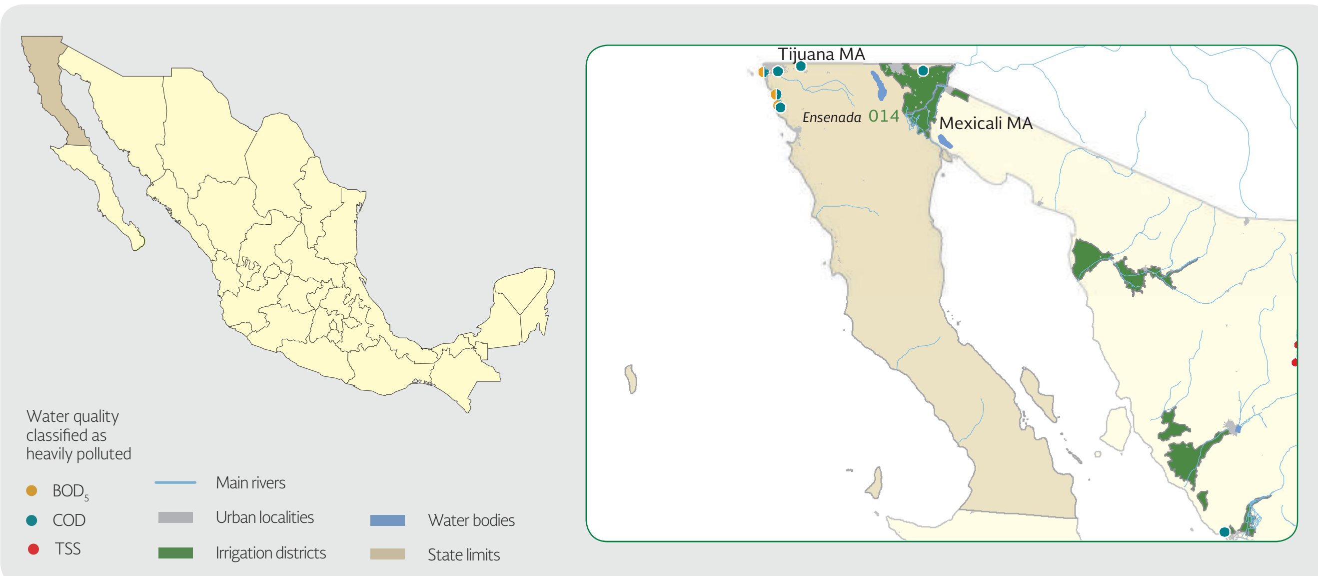
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 98.84 | 98.09 |
| Urban | 99.68 | 99.37 |
| Rural | 95.28 | 92.65 |

### Municipal purification plants, 2014

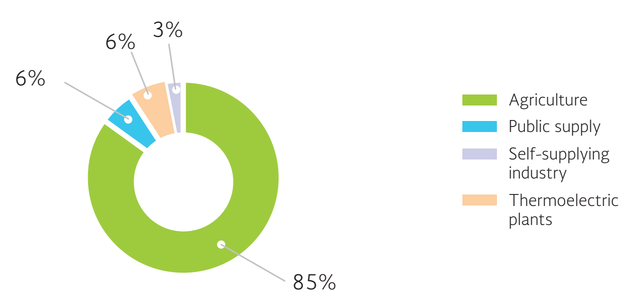
| | |
|---|---|
| Number in operation | 3 |
| Installed capacity ($m^3/s$) | 0.044 |
| Flow processed ($m^3/s$) | 0.026 |

## 2.Baja California

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 5 | | Municipal | Industrial |
| Total population, 2014 | 3 432 944 inhabitants | Number in operation | 38 | 62 |
| Urban | 3 160 700 inhabitants | Installed capacity ($m^3/s$) | 7.60 | 0.50 |
| Rural | 272 244 inhabitants | Flow processed ($m^3/s$) | 5.32 | 0.49 |
| Total population, 2030 | 4 169 240 inhabitants | | | |
| Normal precipitation 1981-2010 | 173 mm | | | |




### Uses of water, 2014 ($hm^3$/year)



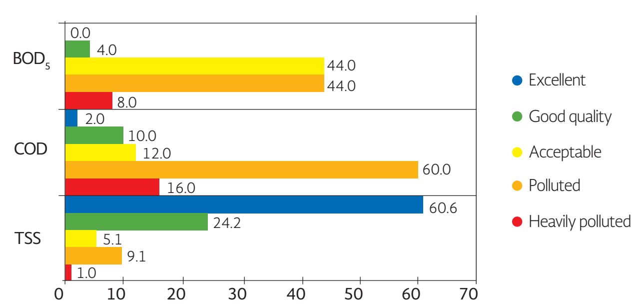

| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 2 586 | 1 522 | 1 064 |
| Public supply | 188 | 120 | 68 |
| Self-supplying industry | 83 | 69 | 13 |
| Thermoelectrics | 192 | 0 | 192 |
| **Total** | **3 048** | **1 711** | **1 337** |

| Instream uses | |
|---|---|
| Hydropower (volume allocated) | 126 |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 50 |
| COD | 50 |
| TSS | 99 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

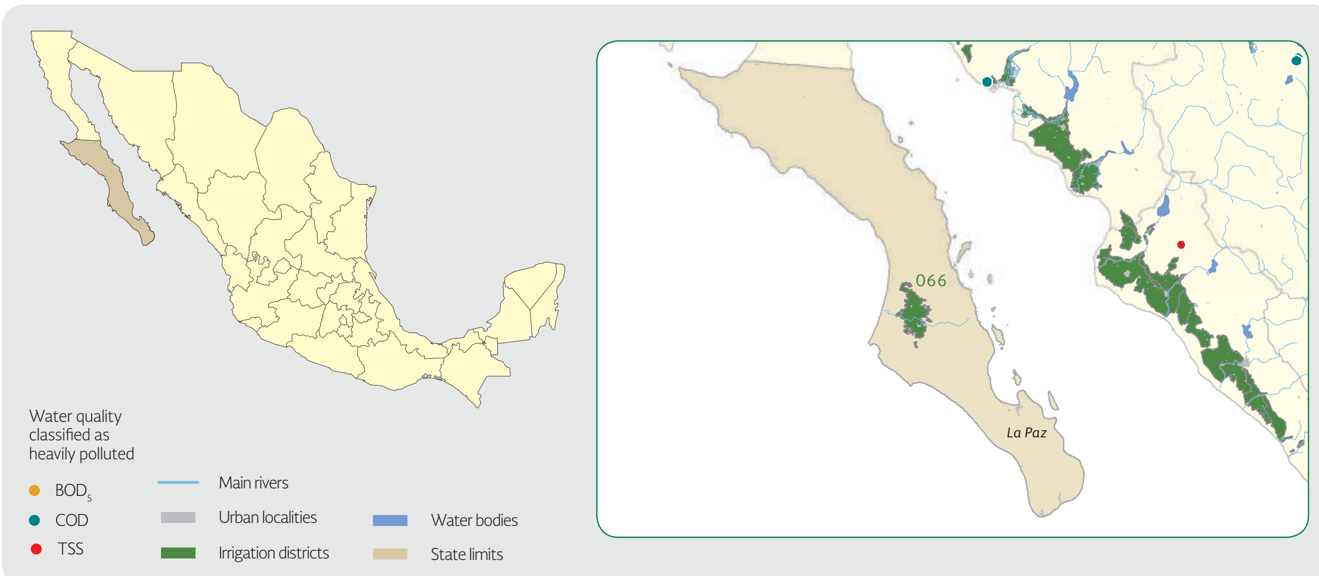
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 95.87 | 93.08 |
| Urban | 97.62 | 95.34 |
| Rural | 74.50 | 65.65 |

### Municipal purification plants, 2014

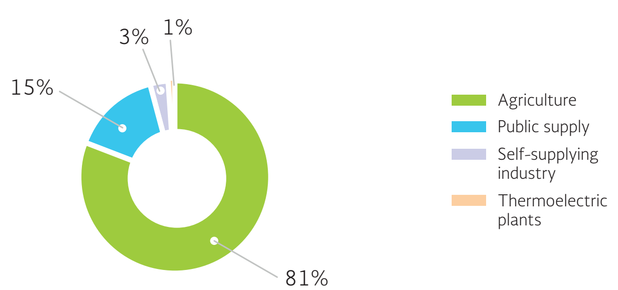
| | |
|---|---|
| Number in operation | 31 |
| Installed capacity ($m^3/s$) | 12.156 |
| Flow processed ($m^3/s$) | 6.980 |

## 3. Baja California Sur

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 5 | | **Municipal** | **Industrial** |
| Total population, 2014 | 741 037 inhabitants | Number in operation | 27 | 26 |
| Urban | 644 768 inhabitants | Installed capacity ($m^3/s$) | 1.66 | 4.96 |
| Rural | 96 269 inhabitants | Flow processed ($m^3/s$) | 1.25 | 4.96 |
| Total population, 2030 | 1 106 468 inhabitants | | | |
| Normal precipitation 1981-2010 | 222 mm | | | |




### Uses of water, 2014 ($hm^3$/year)

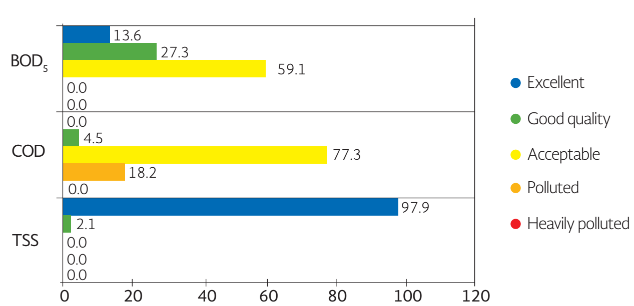



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 334 | 29 | 306 |
| Public supply | 63 | 3 | 60 |
| Self-supplying industry | 14 | 3 | 11 |
| Thermoelectrics | 4 | 0 | 4 |
| **Total** | **415** | **35** | **381** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 0 | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 22 |
| COD | 22 |
| TSS | 97 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

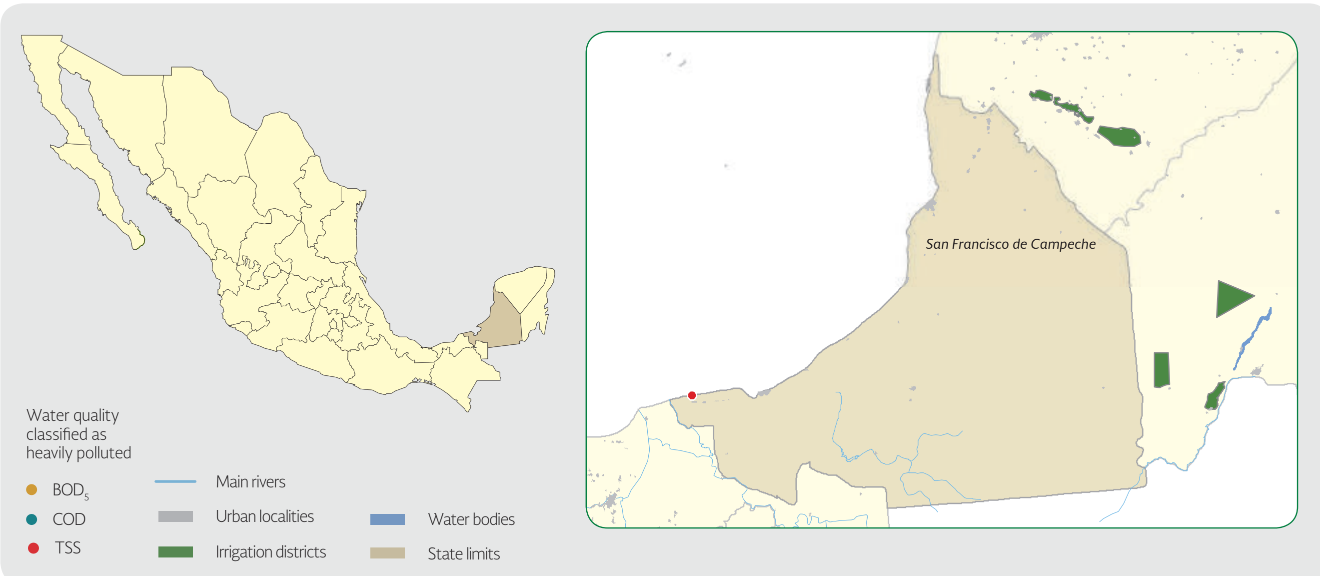
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 92.56 | 96.68 |
| Urban | 94.40 | 96.56 |
| Rural | 80.65 | 75.10 |

### Municipal purification plants, 2014

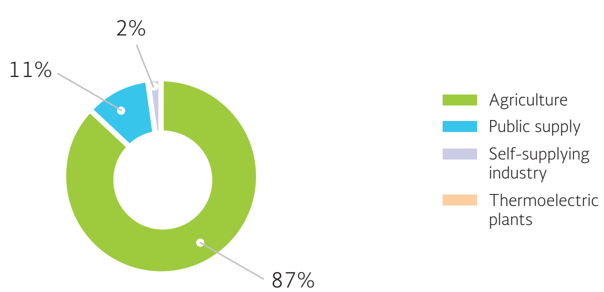
| | |
|---|---|
| Number in operation | 13 |
| Installed capacity ($m^3/s$) | 0.209 |
| Flow processed ($m^3/s$) | 0.189 |

## 4. Campeche

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 11 | | **Municipal** | **Industrial** |
| Total population, 2014 | 894 136 inhabitants | Number in operation | 20 | 129 |
| Urban | 665 594 inhabitants | Installed capacity (m³/s) | 0.16 | 1.93 |
| Rural | 228 543 inhabitants | Flow processed (m³/s) | 0.13 | 1.92 |
| Total population, 2030 | 1 098 636 inhabitants | | | |
| Normal precipitation 1981-2010 | 1 252 mm | | | |




### Uses of water, 2014 (hm³/year)

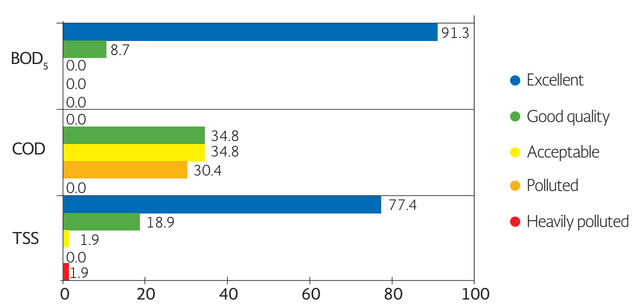



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 112 | 139 | 972 |
| Public supply | 144 | 0 | 144 |
| Self-supplying industry | 25 | 0 | 24 |
| Thermoelectrics | 4 | 0 | 4 |
| **Total** | **1 284** | **140** | **1 144** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 0 | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 23 |
| COD | 23 |
| TSS | 53 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

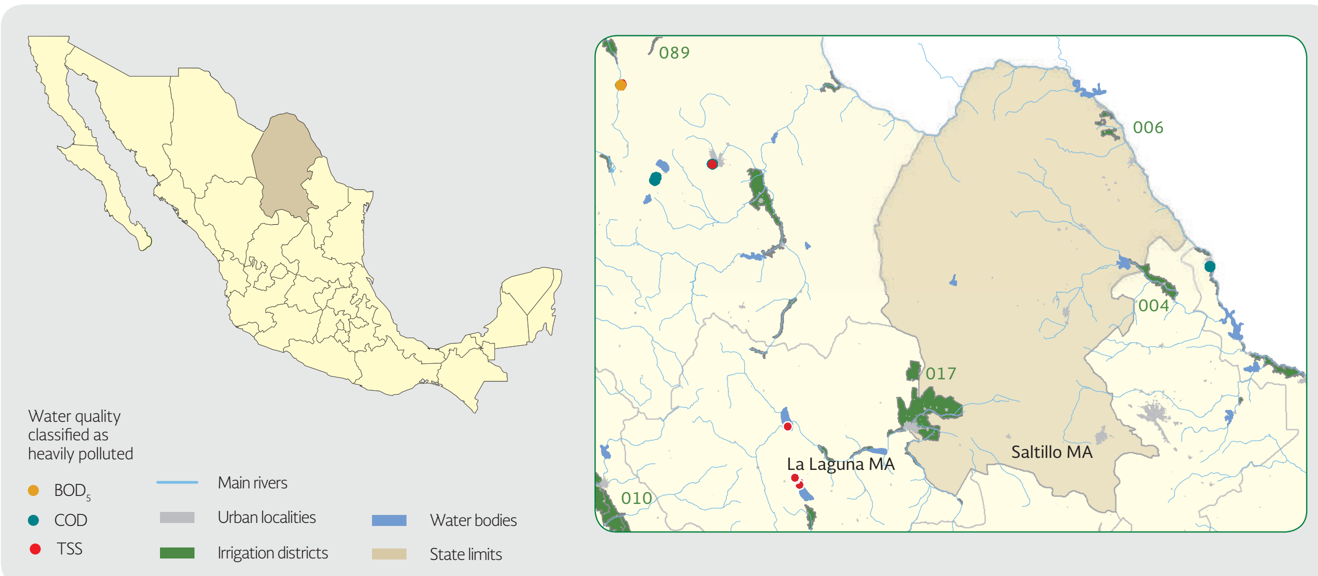
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 89.99 | 84.92 |
| Urban | 92.39 | 92.34 |
| Rural | 82.95 | 63.17 |

### Municipal purification plants, 2014

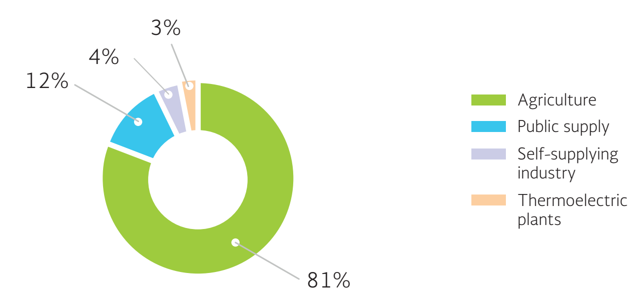
| | |
|---|---|
| Number in operation | 2 |
| Installed capacity (m³/s) | 0.025 |
| Flow processed (m³/s) | 0.023 |

## 5. Coahuila de Zaragoza

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 38 | | **Municipal** | **Industrial** |
| Total population, 2014 | 2 925 594 inhabitants | Number in operation | 21 | 59 |
| Urban | 2 639 717 inhabitants | Installed capacity ($m^3/s$) | 4.98 | 0.76 |
| Rural | 285 876 inhabitants | Flow processed ($m^3/s$) | 3.88 | 0.52 |
| Total population, 2030 | 3 427 879 inhabitants | | | |
| Normal precipitation 1981-2010 | 332 mm | | | |




### Uses of water, 2014 ($hm^3/year$)

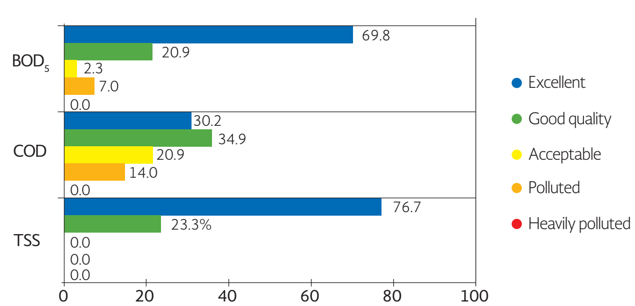



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 648 | 848 | 800 |
| Public supply | 240 | 18 | 222 |
| Self-supplying industry | 75 | 1 | 74 |
| Thermoelectrics | 75 | 47 | 27 |
| **Total** | **2 038** | **915** | **1 123** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 1 465 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 43 |
| COD | 43 |
| TSS | 43 |

### Distribution of sites by indicator and classification (%)

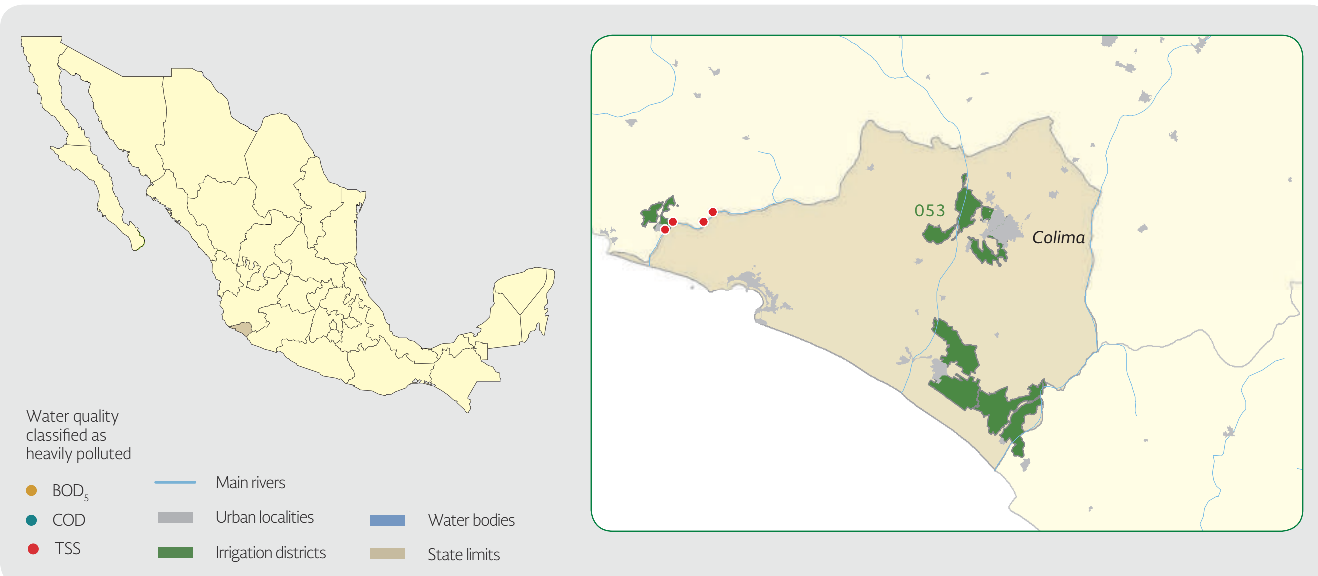



| Coverage, 2010 (%) | Drinking water | Sanitation |
|---|---|---|
| State-wide | 98.32 | 95.41 |
| Urban | 99.20 | 97.54 |
| Rural | 90.44 | 76.46 |

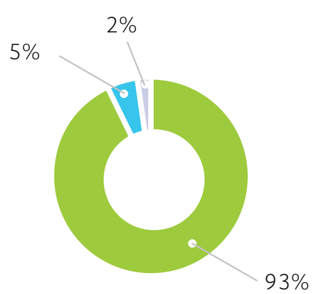
| Municipal purification plants, 2014 | |
|---|---|
| Number in operation | 24 |
| Installed capacity ($m^3/s$) | 2.133 |
| Flow processed ($m^3/s$) | 1.708 |

## 6. Colima

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 10 | | Municipal | Industrial |
| Total population, 2014 | 710 982 inhabitants | Number in operation | 60 | 7 |
| Urban | 639 229 inhabitants | Installed capacity (m³/s) | 2.29 | 0.44 |
| Rural | 71 753 inhabitants | Flow processed (m³/s) | 1.61 | 0.31 |
| Total population, 2030 | 891 050 inhabitants | | | |
| Normal precipitation 1981-2010 | 896 mm | | | |




### Uses of water, 2014 (hm³/year)

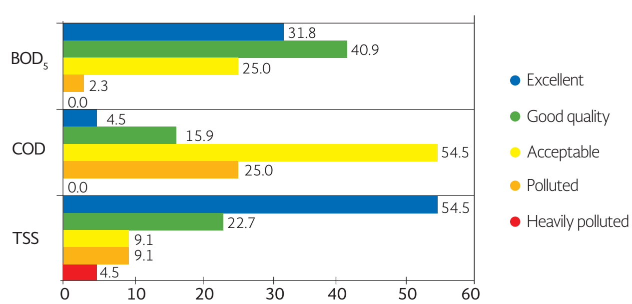



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 661 | 1 359 | 302 |
| Public supply | 97 | 39 | 58 |
| Self-supplying industry | 27 | 4 | 23 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **1 785** | **1 401** | **383** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 0 | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 44 |
| COD | 44 |
| TSS | 66 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

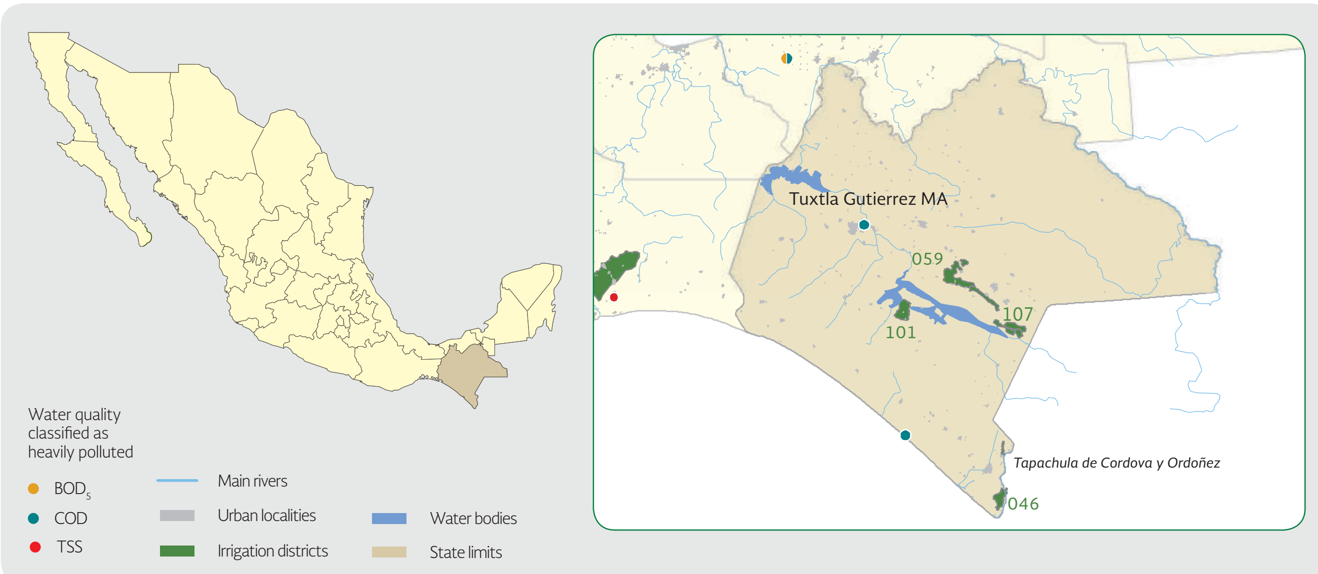
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 98.57 | 98.69 |
| Urban | 99.48 | 99.19 |
| Rural | 91.35 | 94.68 |

### Municipal purification plants, 2014

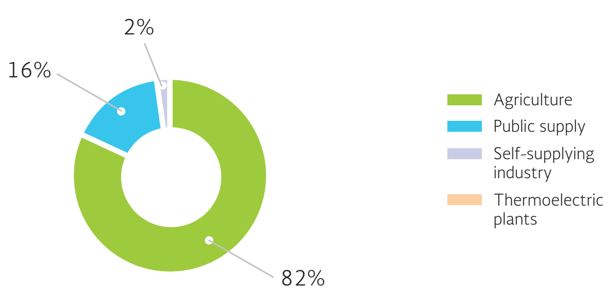
| | |
|---|---|
| Number in operation | 58 |
| Installed capacity (m³/s) | 0.014 |
| Flow processed (m³/s) | 0.005 |

## 7. Chiapas

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 118 | | **Municipal** | **Industrial** |
| Total population, 2014 | 5 186 572 inhabitants | Number in operation | 33 | 91 |
| Urban | 2 552 810 inhabitants | Installed capacity (m³/s) | 1.60 | 8.36 |
| Rural | 2 633 762 inhabitants | Flow processed (m³/s) | 0.75 | 6.42 |
| Total population, 2030 | 6 129 218 inhabitants | | | |
| Normal precipitation 1981-2010 | 1 923 mm | | | |




### Uses of water, 2014 (hm³/year)

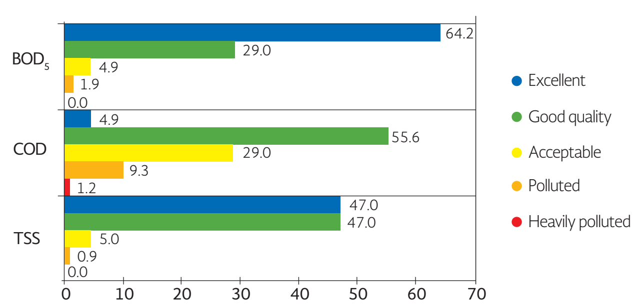



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 506 | 1 114 | 392 |
| Public supply | 300 | 247 | 52 |
| Self-supplying industry | 38 | 2 | 36 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **1 844** | **1 363** | **480** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 61 721 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 162 |
| COD | 162 |
| TSS | 219 |

### Distribution of sites by indicator and classification (%)

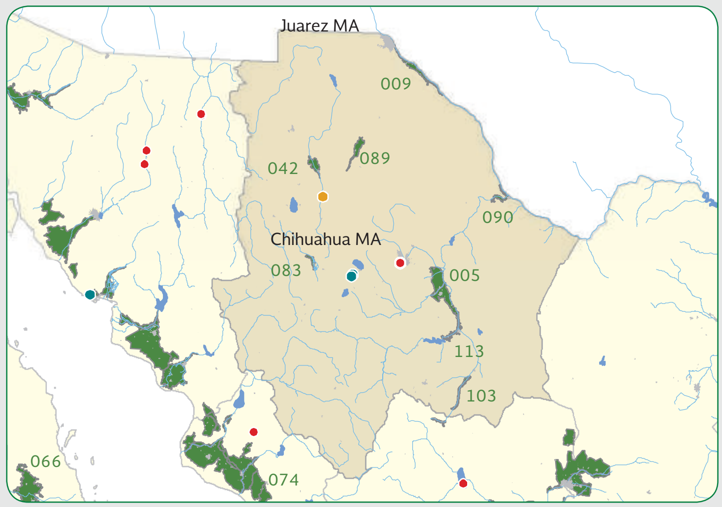



| Coverage, 2010 (%) | | |
|---|---|---|
| | Drinking water | Sanitation |
| State-wide | 77.29 | 81.00 |
| Urban | 87.47 | 95.75 |
| Rural | 67.35 | 66.84 |

| Municipal purification plants, 2014 | |
|---|---|
| Number in operation | 6 |
| Installed capacity (m³/s) | 4.662 |
| Flow processed (m³/s) | 2.588 |

## 8. Chihuahua

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 67 | | Municipal | Industrial |
| Total population, 2014 | 3 673 342 inhabitants | Number in operation | 168 | 15 |
| Urban | 3 123 474 inhabitants | Installed capacity ($m^3/s$) | 10.17 | 0.65 |
| Rural | 549 868 inhabitants | Flow processed ($m^3/s$) | 6.97 | 0.28 |
| Total population, 2030 | 4 177 815 inhabitants | | | |
| Normal precipitation 1981-2010 | 377 mm | | | |

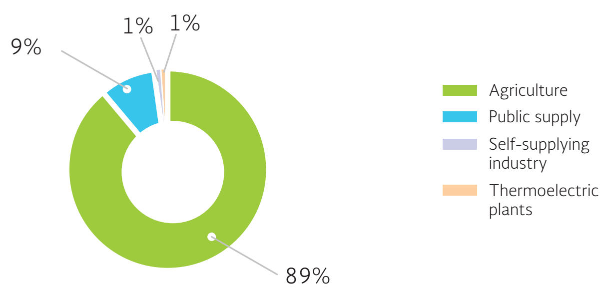



Water quality classified as heavily polluted

- $BOD_5$
- COD
- TSS

Main rivers
Urban localities
Irrigation districts
Water bodies
State limits

### Uses of water, 2014 ($hm^3$/year)

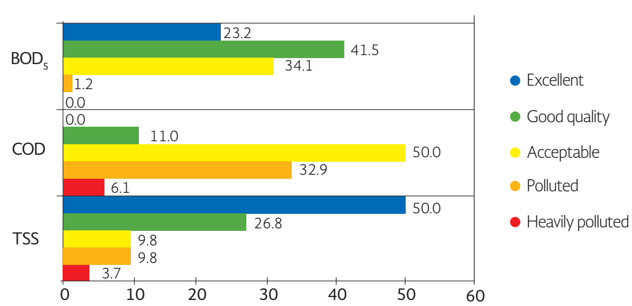



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 4 578 | 1 938 | 2 641 |
| Public supply | 490 | 51 | 439 |
| Self-supplying industry | 54 | 6 | 48 |
| Thermoelectrics | 28 | 0 | 28 |
| **Total** | **5 150** | **1 995** | **3 155** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 2 311 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 82 |
| COD | 82 |
| TSS | 82 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

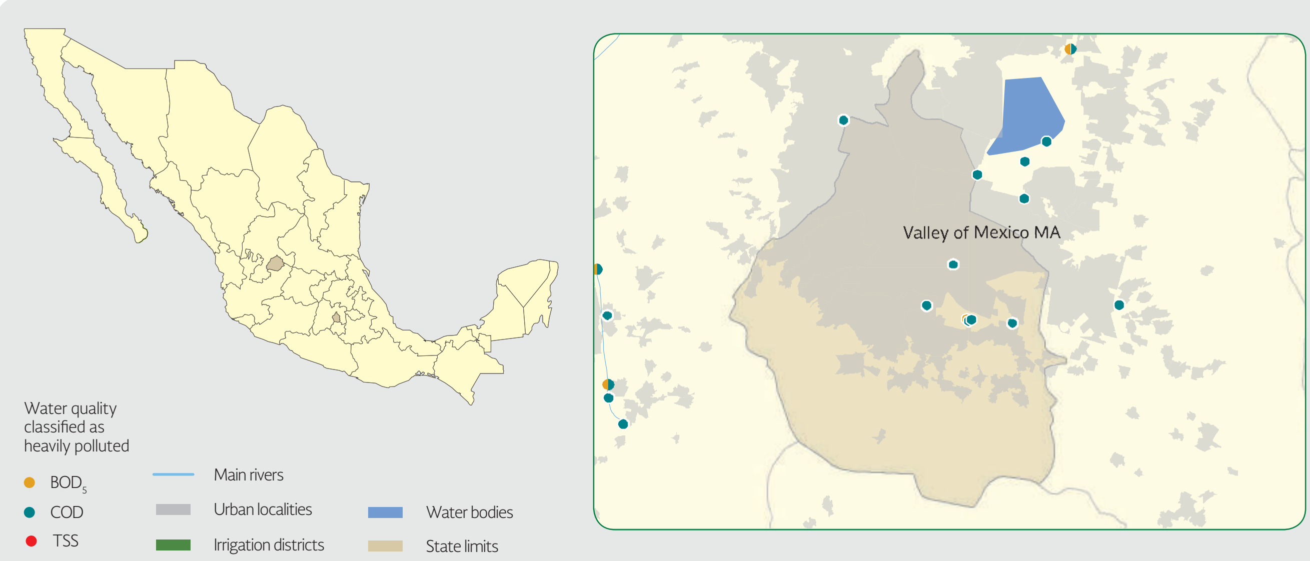
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 94.57 | 92.09 |
| Urban | 98.29 | 97.66 |
| Rural | 74.22 | 61.62 |

### Municipal purification plants, 2014

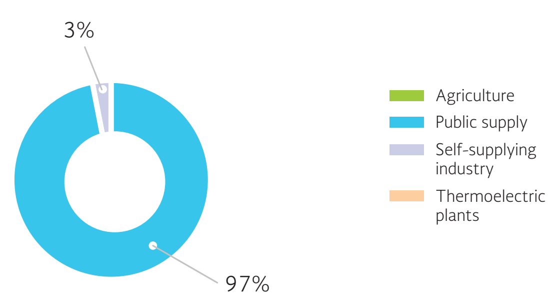
| | |
|---|---|
| Number in operation | 4 |
| Installed capacity ($m^3/s$) | 0.650 |
| Flow processed ($m^3/s$) | 0.380 |

## 9. Federal District (Mexico City)

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 16 | | **Municipal** | **Industrial** |
| Total population, 2014 | 8 874 724 inhabitants | Number in operation | 29 | 7 |
| Urban | 8 825 767 inhabitants | Installed capacity (m³/s) | 5.62 | 0.01 |
| Rural | 48 957 inhabitants | Flow processed (m³/s) | 3.42 | <0.01 |
| Total population, 2030 | 8 439 786 inhabitants | | | |
| Normal precipitation 1981-2010 | 869 mm | | | |




### Uses of water, 2014 (hm³/year)

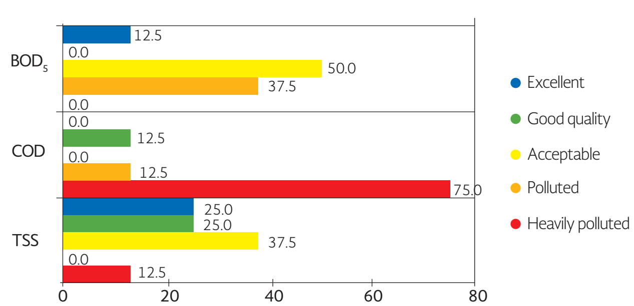



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 | 1 | 1 |
| Public supply | 1 090 | 309 | 781 |
| Self-supplying industry | 32 | 0 | 32 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **1 123** | **310** | **813** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 0 | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 8 |
| COD | 8 |
| TSS | 8 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 97.67 | 99.07 |
| Urban | 97.92 | 99.10 |
| Rural | 44.89 | 92.69 |

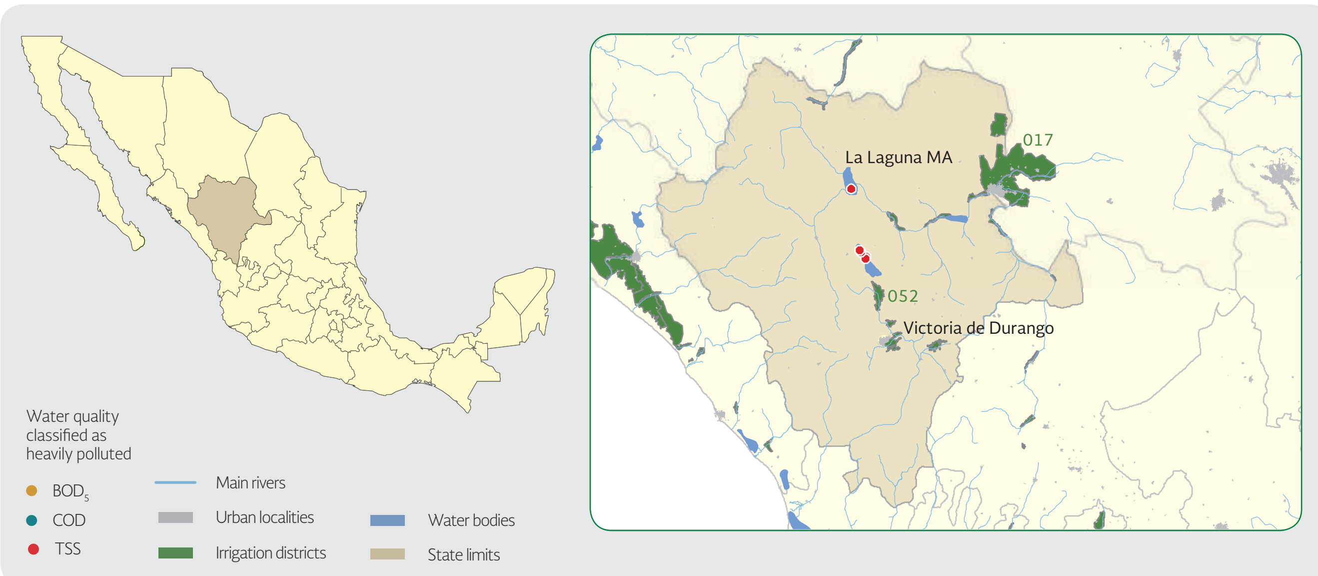
### Municipal purification plants, 2014

| | |
|---|---|
| Number in operation | 43 |
| Installed capacity (m³/s) | 4.791 |
| Flow processed (m³/s) | 3.806 |

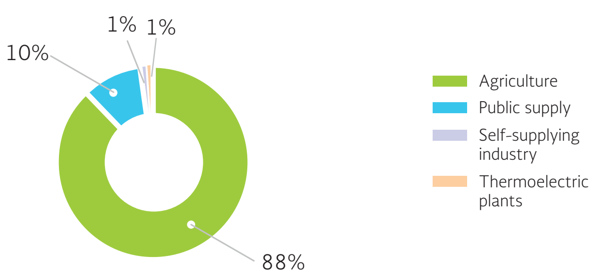
## 10. Durango

| Contextual data | |
|---|---|
| Number of municipalities | 39 |
| Total population, 2014 | 1 746 805 inhabitants |
| Urban | 1 215 107 inhabitants |
| Rural | 531 698 inhabitants |
| Total population, 2030 | 1 983 389 inhabitants |
| Normal precipitation 1981-2010 | 506 mm |

| Wastewater treatment plants, 2014 | Municipal | Industrial |
|---|---|---|
| Number in operation | 178 | 43 |
| Installed capacity (m³/s) | 4.51 | 1.08 |
| Flow processed (m³/s) | 3.41 | 0.62 |




### Uses of water, 2014 (hm³/year)

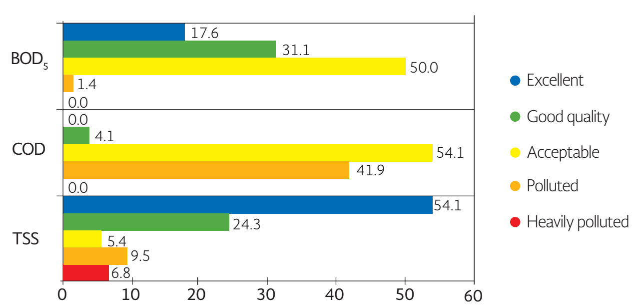



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 363 | 743 | 619 |
| Public supply | 154 | 12 | 141 |
| Self-supplying industry | 17 | 2 | 16 |
| Thermoelectrics | 12 | 0 | 12 |
| **Total** | **1 545** | **757** | **788** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 29 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 74 |
| COD | 74 |
| TSS | 74 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

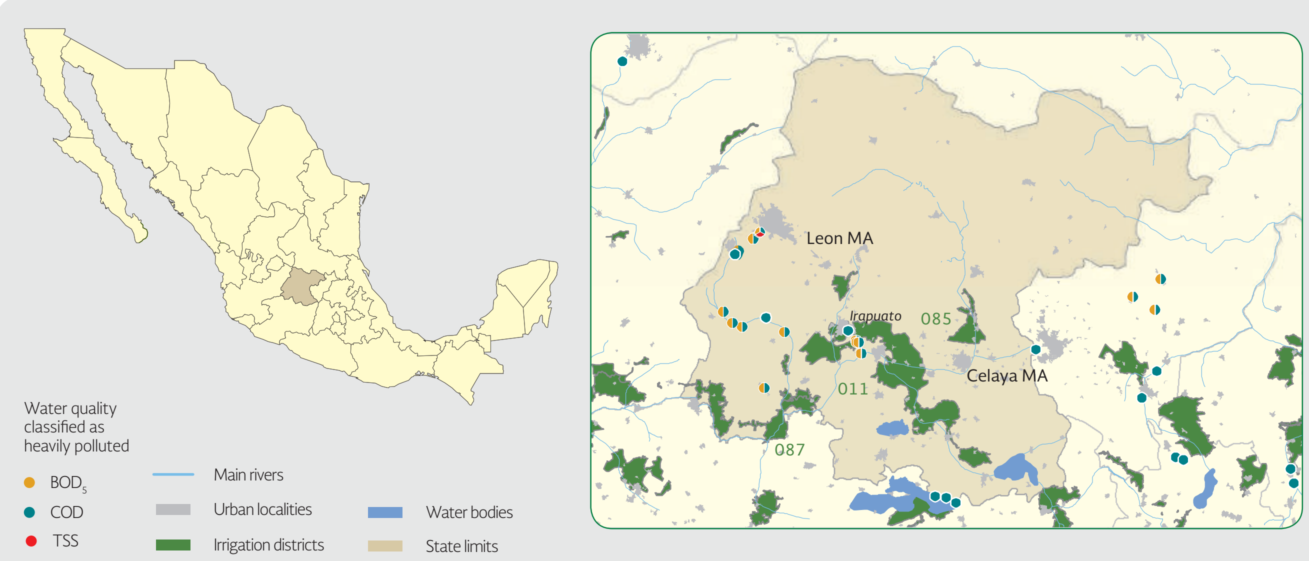
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 93.87 | 87.61 |
| Urban | 99.31 | 96.73 |
| Rural | 82.12 | 67.91 |

### Municipal purification plants, 2014

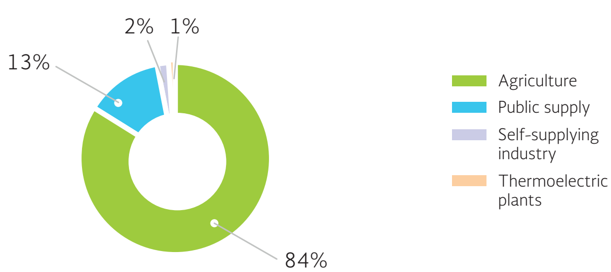
| | |
|---|---|
| Number in operation | 58 |
| Installed capacity (m³/s) | 0.130 |
| Flow processed (m³/s) | 0.125 |

## 11. Guanajuato

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 46 | | **Municipal** | **Industrial** |
| Total population, 2014 | 5 769 524 inhabitants | Number in operation | 72 | 89 |
| Urban | 4 054 721 inhabitants | Installed capacity (m³/s) | 7.29 | 0.70 |
| Rural | 1 714 804 inhabitants | Flow processed (m³/s) | 5.24 | 0.56 |
| Total population, 2030 | 6 361 401 inhabitants | | | |
| Normal precipitation 1981-2010 | 605 mm | | | |




### Uses of water, 2014 (hm³/year)

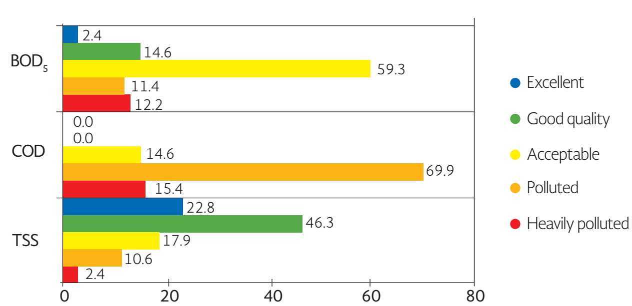



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 3 444 | 1 337 | 2 107 |
| Public supply | 547 | 94 | 453 |
| Self-supplying industry | 72 | 0 | 72 |
| Thermoelectrics | 21 | 0 | 21 |
| **Total** | **4 083** | **1 431** | **2 652** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 800 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 123 |
| COD | 123 |
| TSS | 123 |

### Distribution of sites by indicator and classification (%)

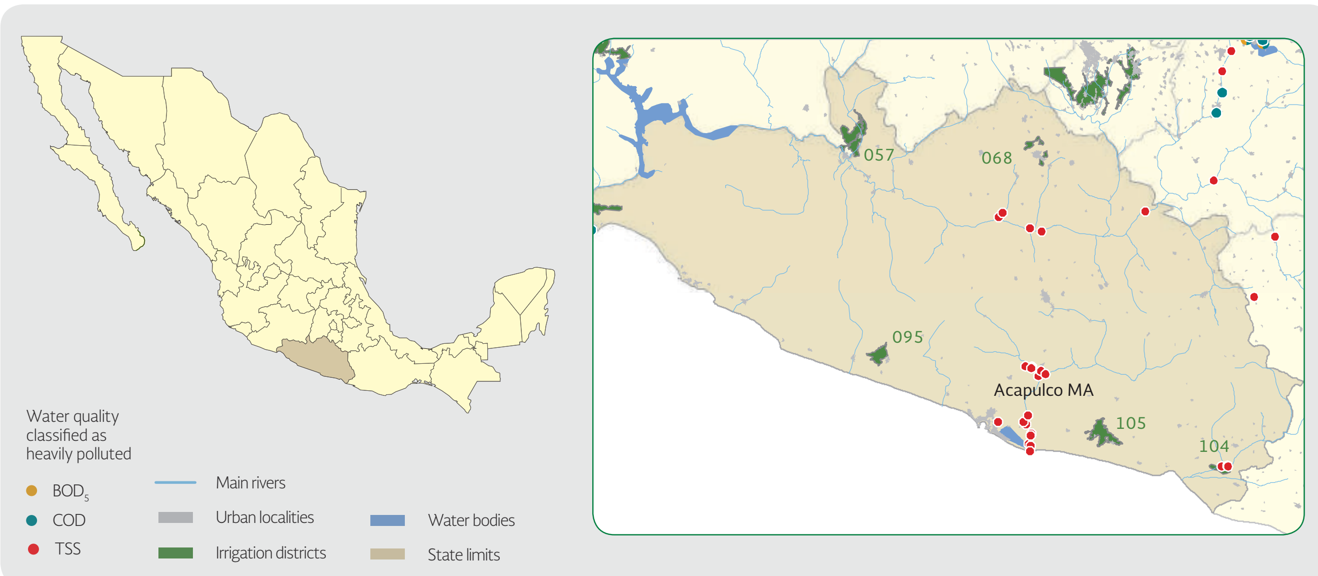



| Coverage, 2010 (%) | | |
|---|---|---|
| | Drinking water | Sanitation |
| State-wide | 94.36 | 90.32 |
| Urban | 96.95 | 97.57 |
| Rural | 88.37 | 73.57 |

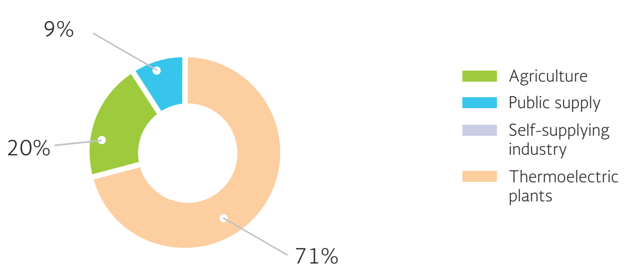
| Municipal purification plants, 2014 | |
|---|---|
| Number in operation | 30 |
| Installed capacity (m³/s) | 0.680 |
| Flow processed (m³/s) | 0.493 |

## 12. Guerrero

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 81 | | **Municipal** | **Industrial** |
| Total population, 2014 | 3 546 710 inhabitants | Number in operation | 60 | 7 |
| Urban | 2 096 023 inhabitants | Installed capacity (m³/s) | 4.21 | 0.03 |
| Rural | 1 450 686 inhabitants | Flow processed (m³/s) | 3.51 | 0.02 |
| Total population, 2030 | 3 772 110 inhabitants | | | |
| Normal precipitation 1981-2010 | 1 160 mm | | | |




### Uses of water, 2014 (hm³/year)



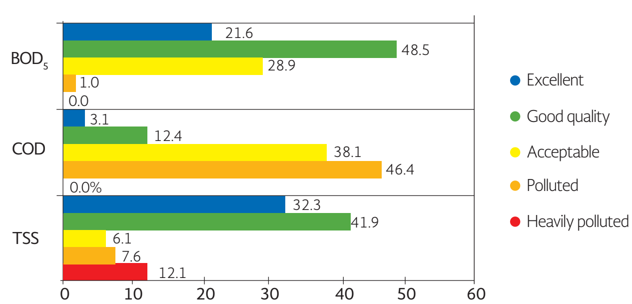

| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 893 | 780 | 113 |
| Public supply | 383 | 212 | 170 |
| Self-supplying industry | 25 | 0 | 24 |
| Thermoelectrics | 3 122 | 3 122 | 0 |
| **Total** | **4 422** | **4 115** | **308** |

| Instream uses | |
|---|---|
| Hydropower (volume allocated) | 15 799 |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 97 |
| COD | 97 |
| TSS | 198 |

### Distribution of sites by indicator and classification (%)



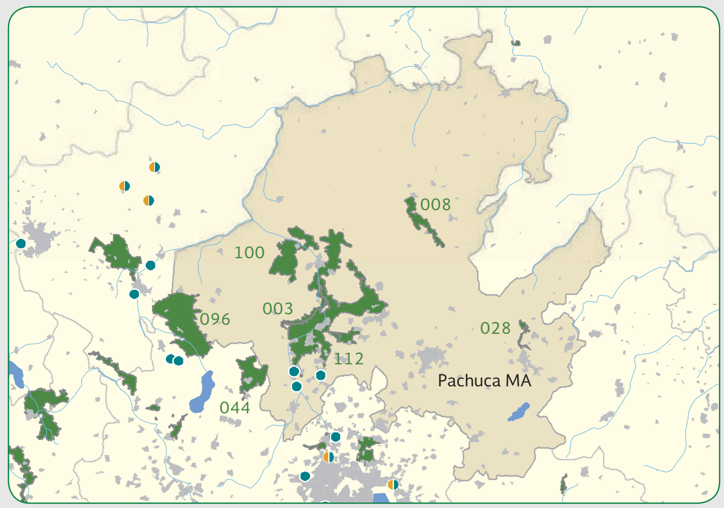

### Coverage, 2010 (%)

| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 69.83 | 74.05 |
| Urban | 81.14 | 90.52 |
| Rural | 54.19 | 51.27 |

### Municipal purification plants, 2014

| | |
|---|---|
| Number in operation | 13 |
| Installed capacity (m³/s) | 3.548 |
| Flow processed (m³/s) | 3.186 |

| 13. Hidalgo | | | | |
|---|---|---|---|---|
| Contextual data | | Wastewater treatment plants, 2014 | | |
| Number of municipalities | 84 | | **Municipal** | **Industrial** |
| Total population, 2014 | 2 842 784 inhabitants | Number in operation | 24 | 46 |
| Urban | 1 540 265 inhabitants | Installed capacity (m³/s) | 0.51 | 1.84 |
| Rural | 1 302 518 inhabitants | Flow processed (m³/s) | 0.30 | 1.38 |
| Total population, 2030 | 3 329 765 inhabitants | | | |
| Normal precipitation 1981-2010 | 725 mm | | | |

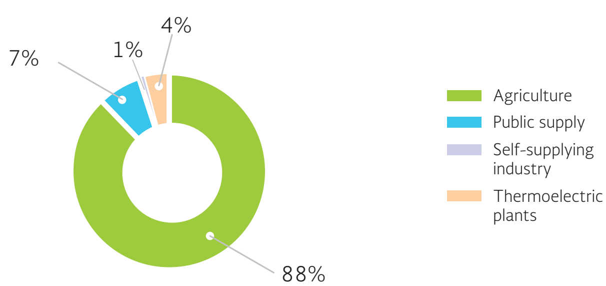



Water quality classified as heavily polluted

- BOD$_5$
- COD
- TSS

- Main rivers
- Urban localities
- Irrigation districts
- Water bodies
- State limits

## Uses of water, 2014 (hm³/year)

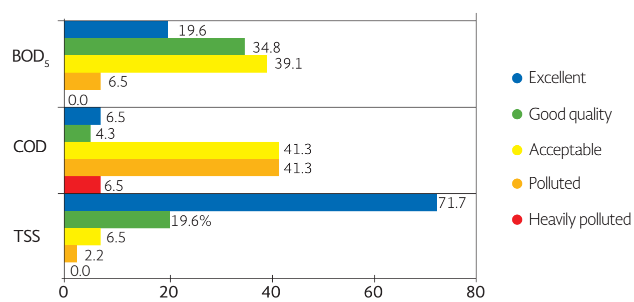



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 2 099 | 1 902 | 197 |
| Public supply | 176 | 47 | 129 |
| Self-supplying industry | 33 | 14 | 19 |
| Thermoelectrics | 83 | 22 | 61 |
| **Total** | **2 391** | **1 985** | **406** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 1 215 | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| BOD$_5$ | 46 |
| COD | 46 |
| TSS | 46 |

## Distribution of sites by indicator and classification (%)

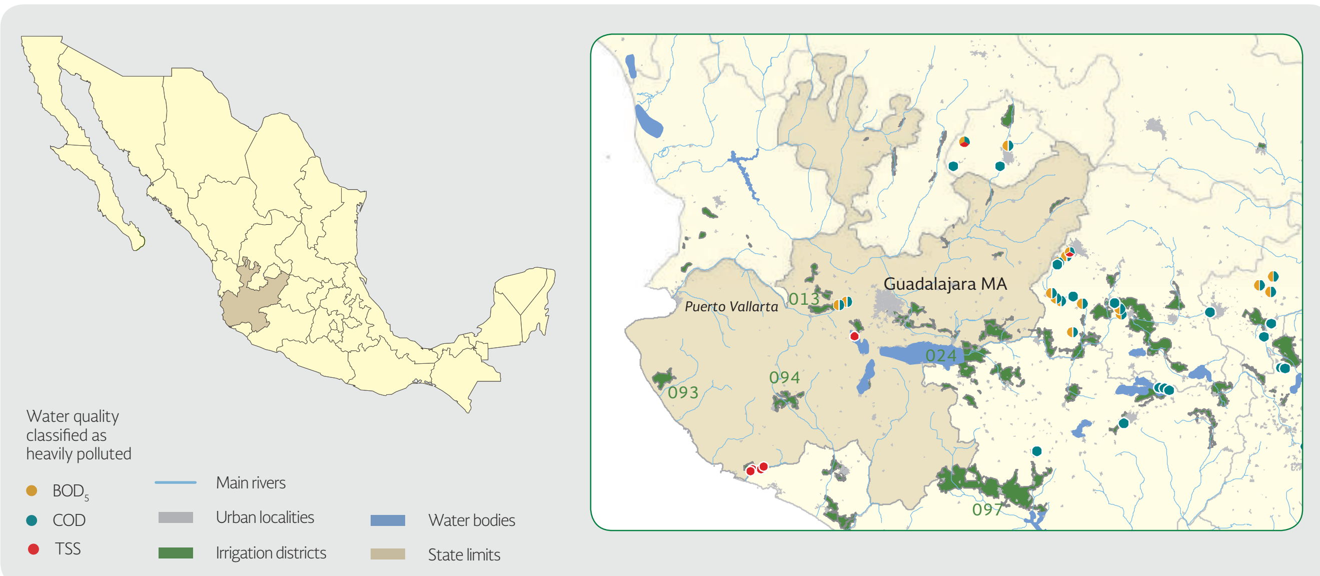



| Coverage, 2010 (%) | | |
|---|---|---|
| | Drinking water | Sanitation |
| State-wide | 90.66 | 85.01 |
| Urban | 96.89 | 96.72 |
| Rural | 83.91 | 72.33 |

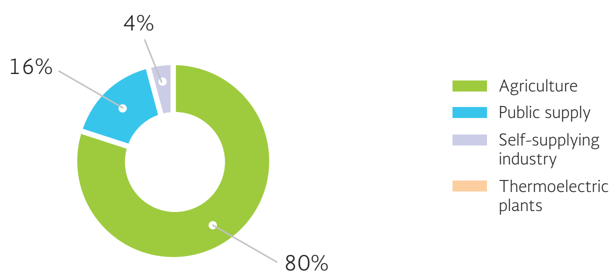
| Municipal purification plants, 2014 | |
|---|---|
| Number in operation | 23 |
| Installed capacity (m³/s) | 0.362 |
| Flow processed (m³/s) | 0.356 |

## 14. Jalisco

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 125 | | **Municipal** | **Industrial** |
| Total population, 2014 | 7 838 010 inhabitants | Number in operation | 149 | 71 |
| Urban | 6 822 923 inhabitants | Installed capacity (m³/s) | 15.39 | 1.54 |
| Rural | 1 015 087 inhabitants | Flow processed (m³/s) | 12.09 | 1.54 |
| Total population, 2030 | 9 102 259 inhabitants | | | |
| Normal precipitation 1981-2010 | 844 mm | | | |




### Uses of water, 2014 (hm³/year)

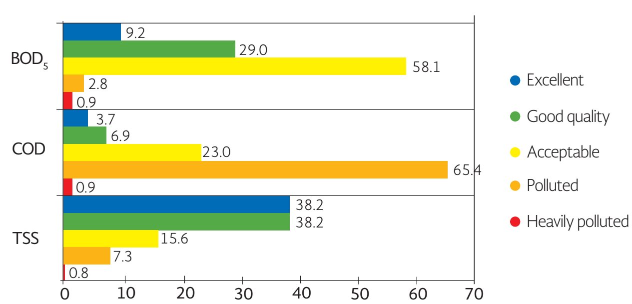



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 3 711 | 1 730 | 1 981 |
| Public supply | 764 | 403 | 362 |
| Self-supplying industry | 198 | 8 | 190 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **4 673** | **2 140** | **2 532** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 8 943 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 217 |
| COD | 217 |
| TSS | 262 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

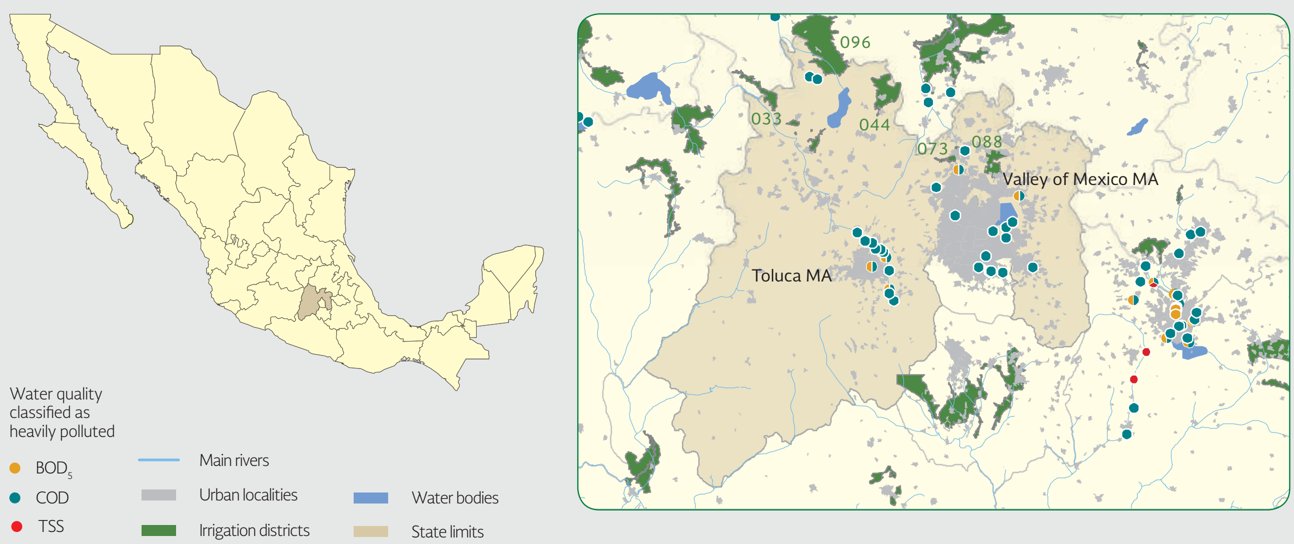
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 95.77 | 97.38 |
| Urban | 97.40 | 98.94 |
| Rural | 85.33 | 87.39 |

### Municipal purification plants, 2014

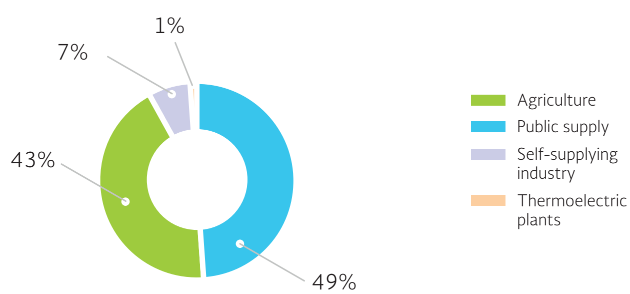
| | |
|---|---|
| Number in operation | 43 |
| Installed capacity (m³/s) | 16.362 |
| Flow processed (m³/s) | 12.362 |

## 15. Mexico

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 125 | | **Municipal** | **Industrial** |
| Total population, 2014 | 16 618 929 inhabitants | Number in operation | 148 | 226 |
| Urban | 14 586 367 inhabitants | Installed capacity (m³/s) | 9.08 | 2.79 |
| Rural | 2 032 562 inhabitants | Flow processed (m³/s) | 6.87 | 1.94 |
| Total population, 2030 | 20 167 433 inhabitants | | | |
| Normal precipitation 1981-2010 | 900 mm | | | |




### Uses of water, 2014 (hm³/year)

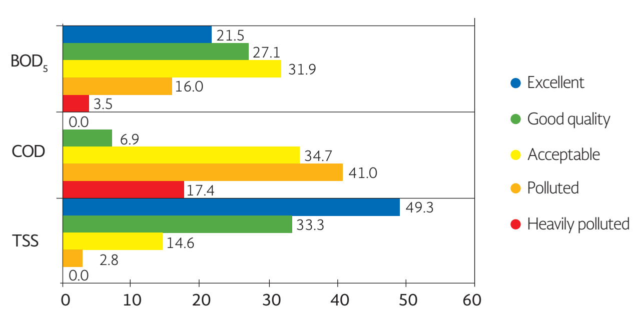



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 157 | 807 | 350 |
| Public supply | 1 343 | 318 | 1 024 |
| Self-supplying industry | 179 | 38 | 141 |
| Thermoelectrics | 31 | 24 | 7 |
| **Total** | **2 709** | **1 186** | **1 523** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 2 064 | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 144 |
| COD | 144 |
| TSS | 144 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

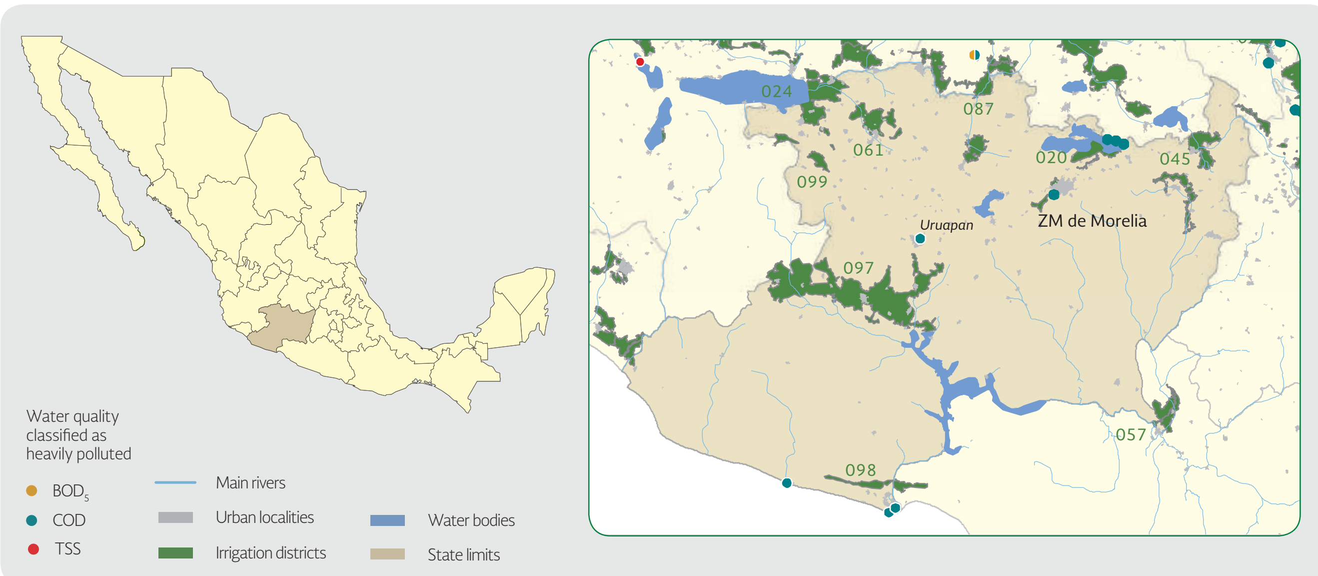
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 93.97 | 93.61 |
| Urban | 96.16 | 97.21 |
| Rural | 79.51 | 69.77 |

### Municipal purification plants, 2014

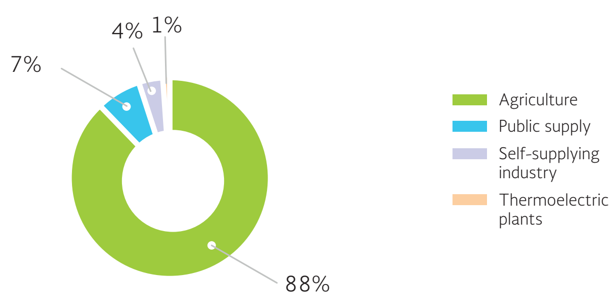
| | |
|---|---|
| Number in operation | 11 |
| Installed capacity (m³/s) | 22.164 |
| Flow processed (m³/s) | 16.739 |

## 16. Michoacan de Ocampo

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 113 | | Municipal | Industrial |
| Total population, 2014 | 4 563 849 inhabitants | Number in operation | 38 | 83 |
| Urban | 3 129 464 inhabitants | Installed capacity (m³/s) | 4.05 | 8.33 |
| Rural | 1 434 386 inhabitants | Flow processed (m³/s) | 3.27 | 7.15 |
| Total population, 2030 | 4 960 773 inhabitants | | | |
| Normal precipitation 1981-2010 | 848 mm | | | |




### Uses of water, 2014 (hm³/year)

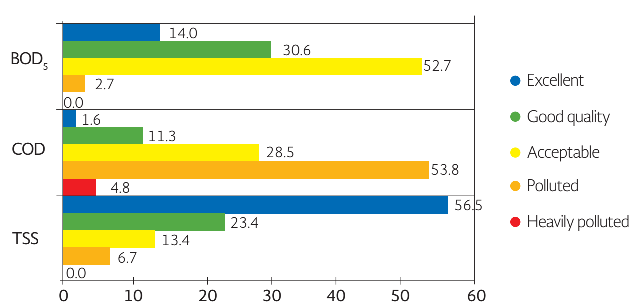



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 4 776 | 3 715 | 1 061 |
| Public supply | 372 | 209 | 163 |
| Self-supplying industry | 223 | 186 | 37 |
| Thermoelectrics | 48 | 0 | 48 |
| **Total** | **5 419** | **4 110** | **1 309** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 26 361 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 186 |
| COD | 186 |
| TSS | 209 |

### Distribution of sites by indicator and classification (%)



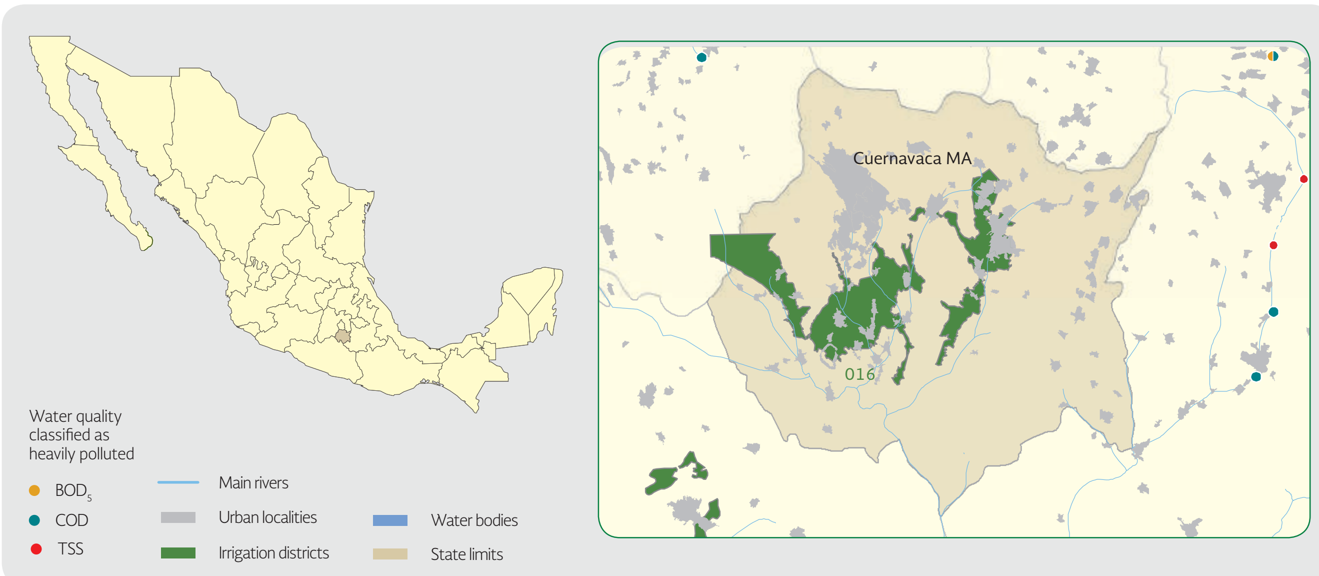

### Coverage, 2010 (%)

| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 91.61 | 87.98 |
| Urban | 95.35 | 94.18 |
| Rural | 83.48 | 74.53 |

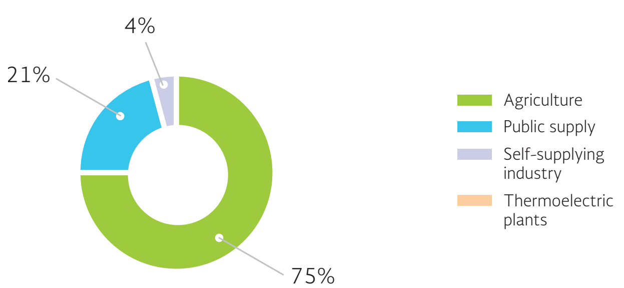
### Municipal purification plants, 2014

| | |
|---|---|
| Number in operation | 5 |
| Installed capacity (m³/s) | 3.025 |
| Flow processed (m³/s) | 2.495 |

| 17. Morelos | | | | |
|---|---|---|---|---|
| Contextual data | | Wastewater treatment plants, 2014 | | |
| Number of municipalities | 33 | | **Municipal** | **Industrial** |
| Total population, 2014 | 1 897 393 inhabitants | Number in operation | 48 | 97 |
| Urban | 1 577 889 inhabitants | Installed capacity ($m^3/s$) | 2.83 | 2.13 |
| Rural | 319 503 inhabitants | Flow processed ($m^3/s$) | 1.53 | 2.09 |
| Total population, 2030 | 2 222 863 inhabitants | | | |
| Normal precipitation 1981-2010 | 1 000 mm | | | |




## Uses of water, 2014 ($hm^3$/year)

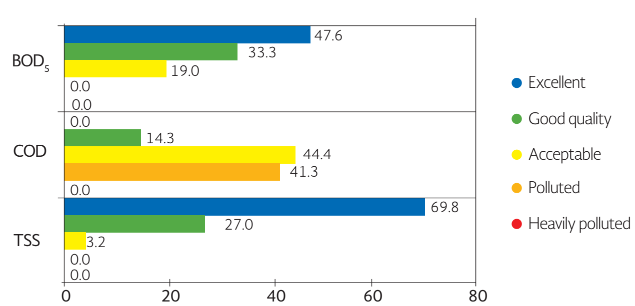



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 986 | 878 | 108 |
| Public supply | 278 | 36 | 242 |
| Self-supplying industry | 48 | 25 | 23 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **1 312** | **938** | **374** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 0 | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 63 |
| COD | 63 |
| TSS | 63 |

## Distribution of sites by indicator and classification (%)

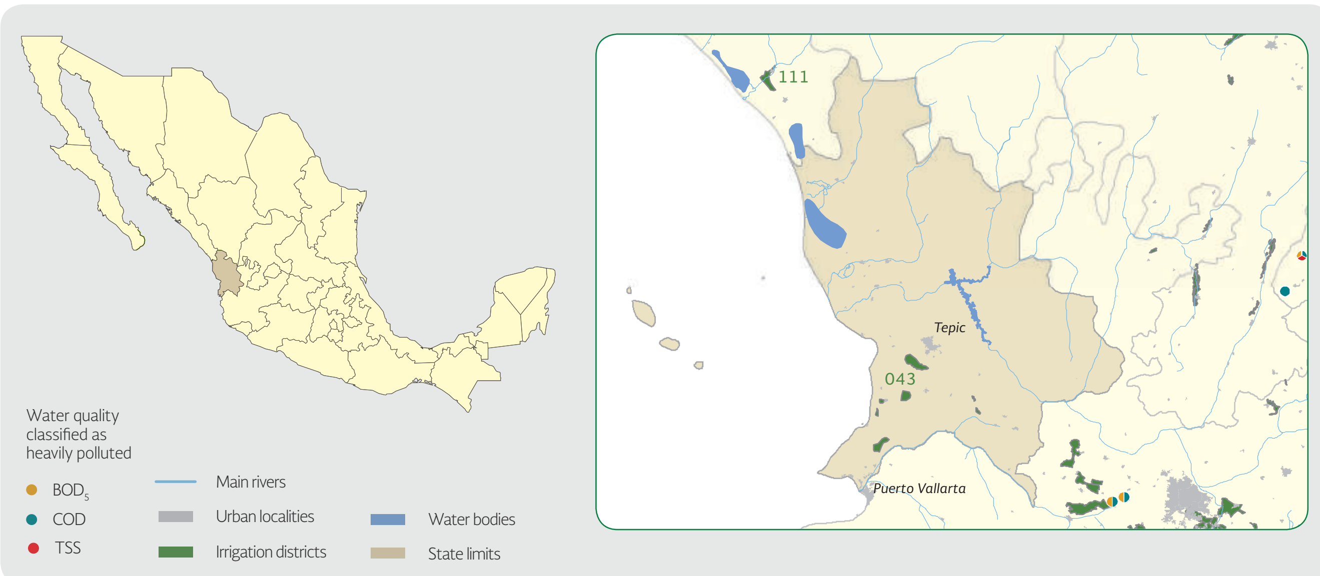



| Coverage, 2010 (%) | | |
|---|---|---|
| | Drinking water | Sanitation |
| State-wide | 91.45 | 94.98 |
| Urban | 95.35 | 97.00 |
| Rural | 71.04 | 84.43 |

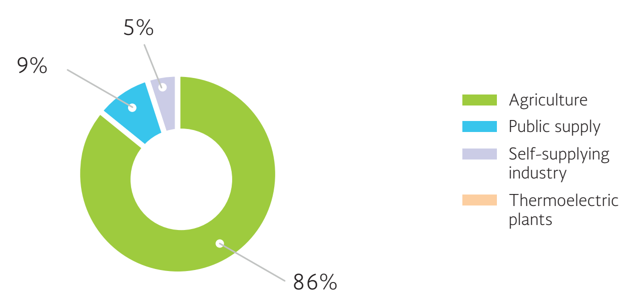
| Municipal purification plants, 2014 | |
|---|---|
| Number in operation | 3 |
| Installed capacity ($m^3/s$) | 0.006 |
| Flow processed ($m^3/s$) | 0.003 |

## 18. Nayarit

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 20 | | **Municipal** | **Industrial** |
| Total population, 2014 | 1 201 202 inhabitants | Number in operation | 68 | 6 |
| Urban | 838 371 inhabitants | Installed capacity (m³/s) | 2.79 | 0.16 |
| Rural | 362 830 inhabitants | Flow processed (m³/s) | 2.25 | 0.16 |
| Total population, 2030 | 1 544 709 inhabitants | | | |
| Normal precipitation 1981-2010 | 1 227 mm | | | |




### Uses of water, 2014 (hm³/year)

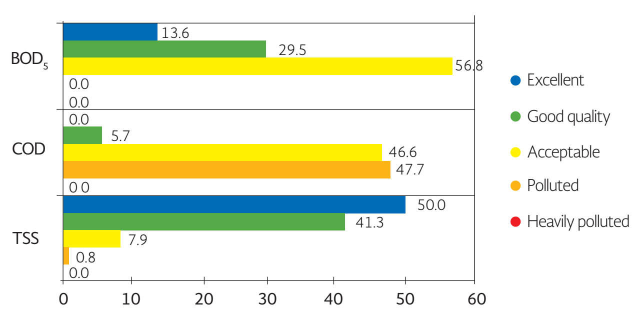



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 094 | 977 | 117 |
| Public supply | 115 | 20 | 94 |
| Self-supplying industry | 61 | 22 | 39 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **1 270** | **1 019** | **251** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 13 341 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 88 |
| COD | 88 |
| TSS | 126 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

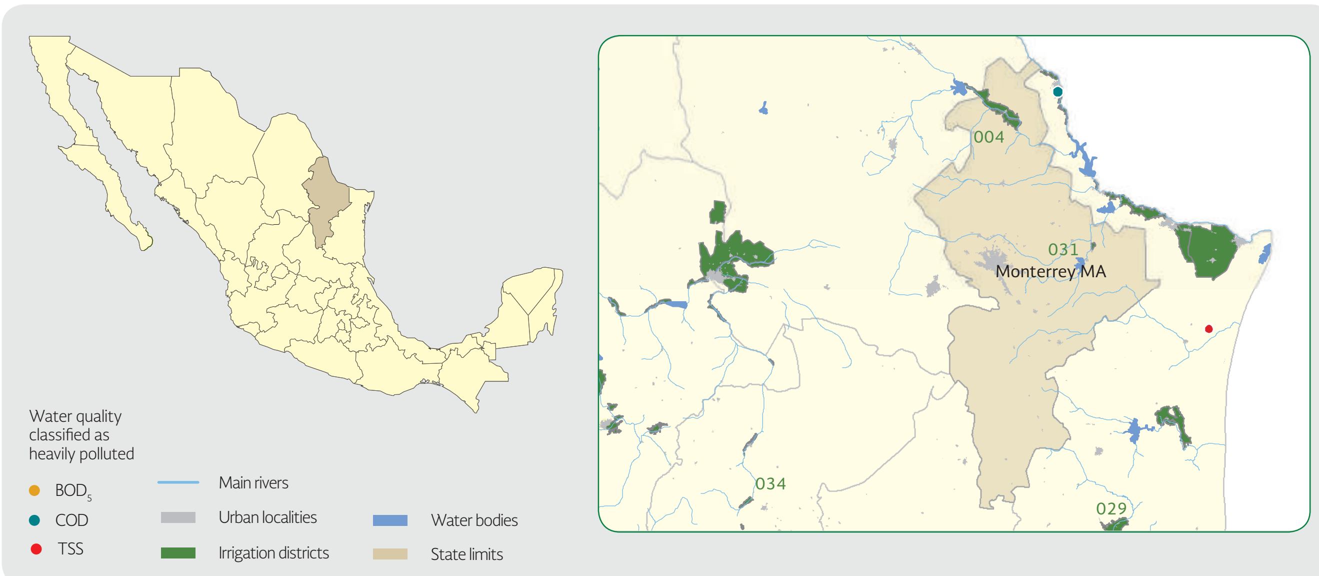
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 92.38 | 93.07 |
| Urban | 96.67 | 98.42 |
| Rural | 82.85 | 81.18 |

### Municipal purification plants, 2014

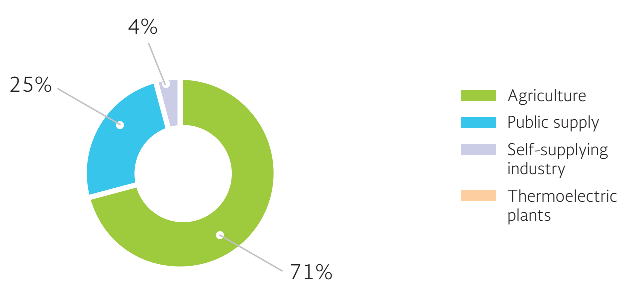
| | |
|---|---|
| Number in operation | 0 |
| Installed capacity (m³/s) | 0 |
| Flow processed (m³/s) | 0 |

## 19. Nuevo Leon

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 51 | | **Municipal** | **Industrial** |
| Total population, 2014 | 5 013 589 inhabitants | Number in operation | 61 | 181 |
| Urban | 4 742 822 inhabitants | Installed capacity (m³/s) | 17.62 | 4.05 |
| Rural | 270 767 inhabitants | Flow processed (m³/s) | 12.48 | 2.92 |
| Total population, 2030 | 6 097 769 inhabitants | | | |
| Normal precipitation 1981-2010 | 542 mm | | | |




### Uses of water, 2014 (hm³/year)

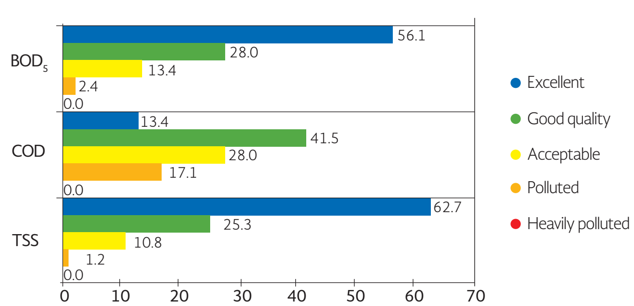



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 474 | 828 | 646 |
| Public supply | 512 | 356 | 156 |
| Self-supplying industry | 83 | 0 | 83 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **2 069** | **1 184** | **885** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 0 | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 82 |
| COD | 82 |
| TSS | 83 |

### Distribution of sites by indicator and classification (%)

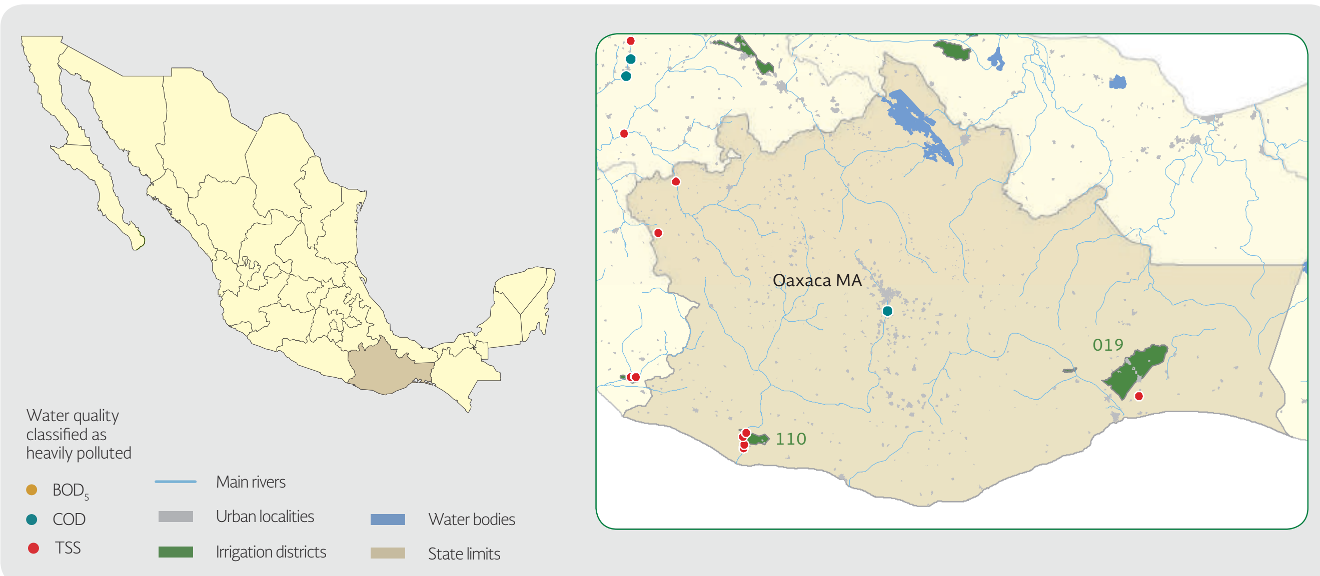



| Coverage, 2010 (%) | | |
|---|---|---|
| | Drinking water | Sanitation |
| State-wide | 96.56 | 96.04 |
| Urban | 97.84 | 97.77 |
| Rural | 73.75 | 63.56 |

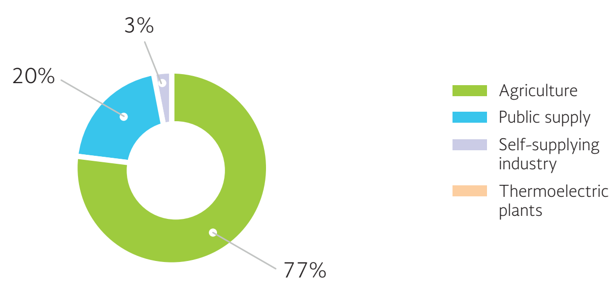
| Municipal purification plants, 2014 | |
|---|---|
| Number in operation | 13 |
| Installed capacity (m³/s) | 14.748 |
| Flow processed (m³/s) | 5.212 |

# 20. Oaxaca

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 570 | | Municipal | Industrial |
| Total population, 2014 | 3 986 206 inhabitants | Number in operation | 69 | 18 |
| Urban | 1 912 696 inhabitants | Installed capacity ($m^3/s$) | 1.52 | 2.77 |
| Rural | 2 073 510 inhabitants | Flow processed ($m^3/s$) | 1.00 | 2.45 |
| Total population, 2030 | 4 293 423 inhabitants | | | |
| Normal precipitation 1981-2010 | 977 mm | | | |




## Uses of water, 2014 ($hm^3$/year)

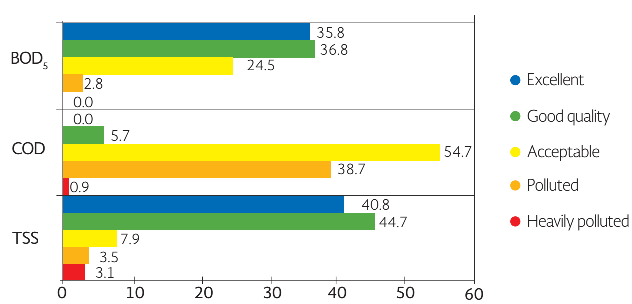



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 005 | 763 | 242 |
| Public supply | 262 | 136 | 126 |
| Self-supplying industry | 34 | 8 | 26 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **1 302** | **907** | **394** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 16 869 | | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 106 |
| COD | 106 |
| TSS | 228 |

## Distribution of sites by indicator and classification (%)




## Coverage, 2010 (%)

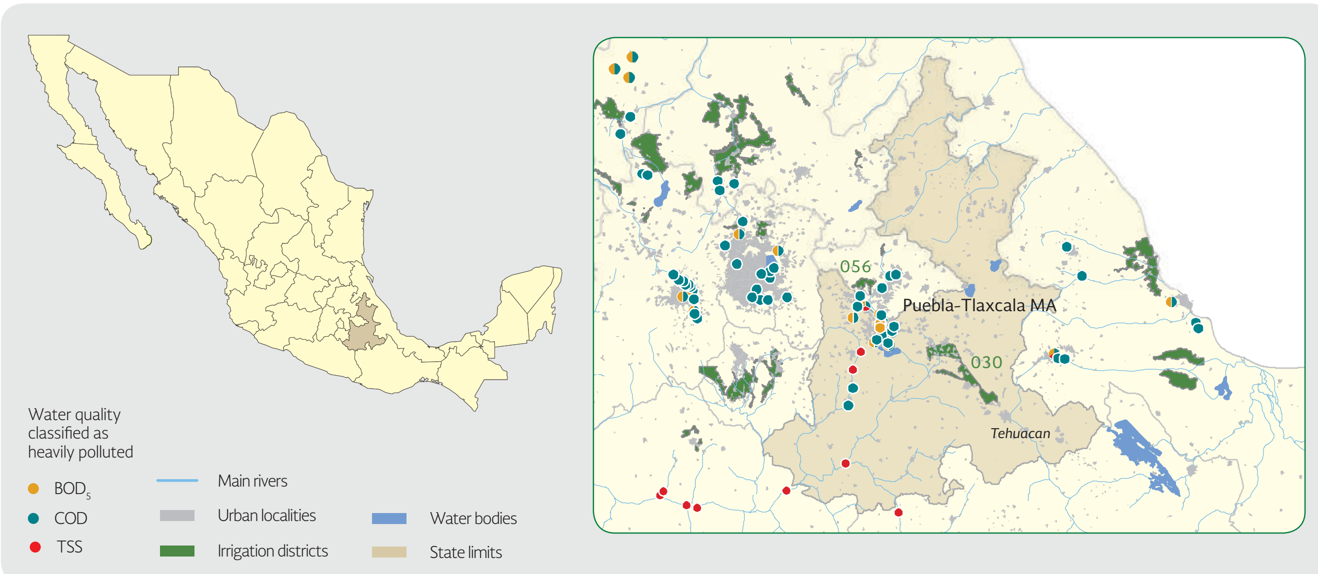
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 76.07 | 69.20 |
| Urban | 85.51 | 88.62 |
| Rural | 67.66 | 51.89 |

## Municipal purification plants, 2014

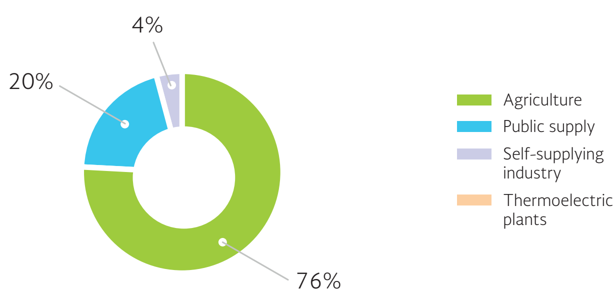
| | |
|---|---|
| Number in operation | 6 |
| Installed capacity ($m^3/s$) | 1.291 |
| Flow processed ($m^3/s$) | 0.771 |

## 21. Puebla

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 217 | | Municipal | Industrial |
| Total population, 2014 | 6 131 498 inhabitants | Number in operation | 71 | 206 |
| Urban | 4 448 251 inhabitants | Installed capacity (m³/s) | 3.34 | 0.82 |
| Rural | 1 683 247 inhabitants | Flow processed (m³/s) | 3.59 | 0.59 |
| Total population, 2030 | 6 942 481 inhabitants | | | |
| Normal precipitation 1981-2010 | 947 mm | | | |




### Uses of water, 2014 (hm³/year)

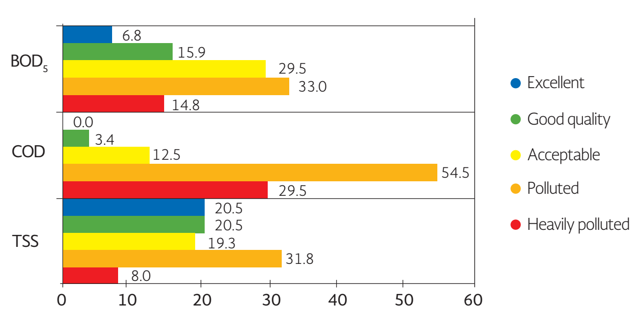



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 611 | 998 | 613 |
| Public supply | 428 | 178 | 250 |
| Self-supplying industry | 73 | 31 | 42 |
| Thermoelectrics | 6 | 0 | 6 |
| **Total** | **2 118** | **1 206** | **912** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 4 610 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 88 |
| COD | 88 |
| TSS | 88 |

### Distribution of sites by indicator and classification (%)




| Coverage, 2010 (%) | Drinking water | Sanitation |
|---|---|---|
| State-wide | 87.23 | 86.34 |
| Urban | 90.54 | 93.70 |
| Rural | 78.90 | 67.83 |

| Municipal purification plants, 2014 | |
|---|---|
| Number in operation | 5 |
| Installed capacity (m³/s) | 0.815 |
| Flow processed (m³/s) | 0.515 |

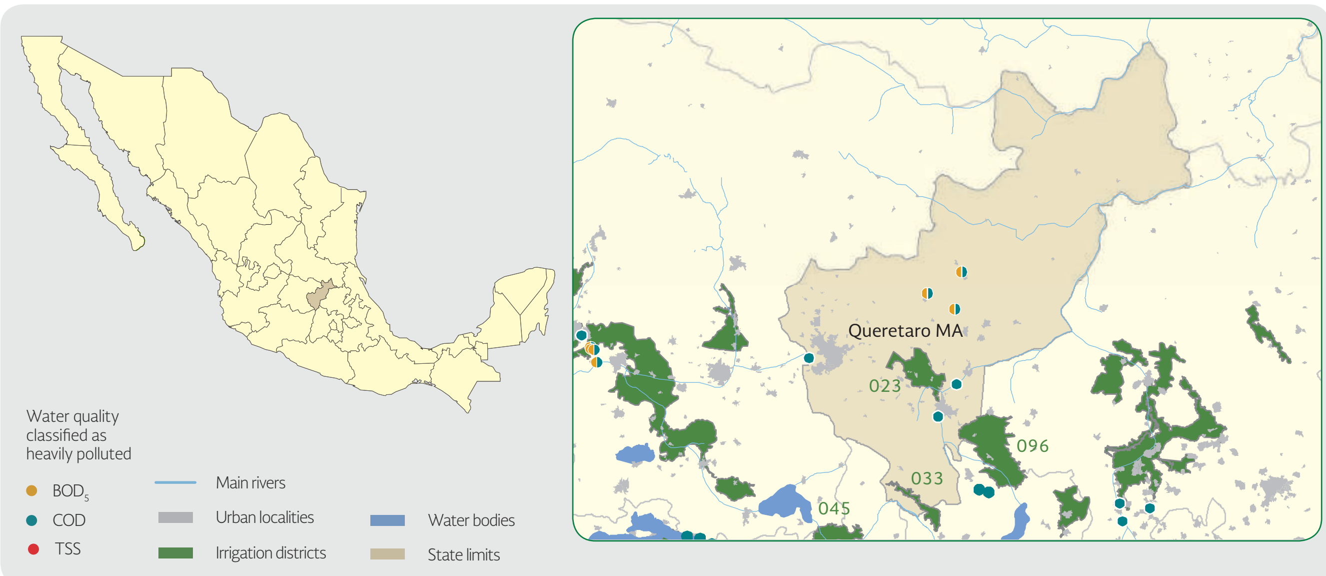
## 22. Queretaro

### Contextual data

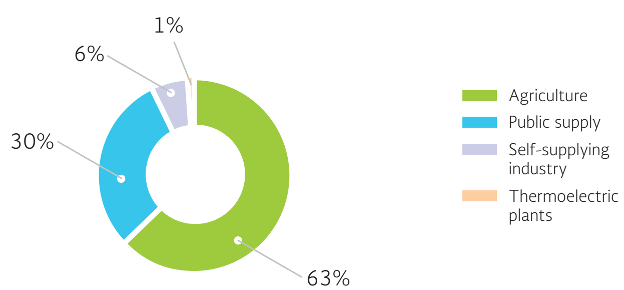
| | |
|---|---|
| Number of municipalities | 18 |
| Total population, 2014 | 1 974 436 inhabitants |
| Urban | 1 401 364 inhabitants |
| Rural | 573 072 inhabitants |
| Total population, 2030 | 2 403 016 inhabitants |
| Normal precipitation 1981-2010 | 609 mm |

### Wastewater treatment plants, 2014

| | Municipal | Industrial |
|---|---|---|
| Number in operation | 46 | 141 |
| Installed capacity (m³/s) | 2.43 | 1.25 |
| Flow processed (m³/s) | 1.66 | 0.65 |




### Uses of water, 2014 (hm³/year)



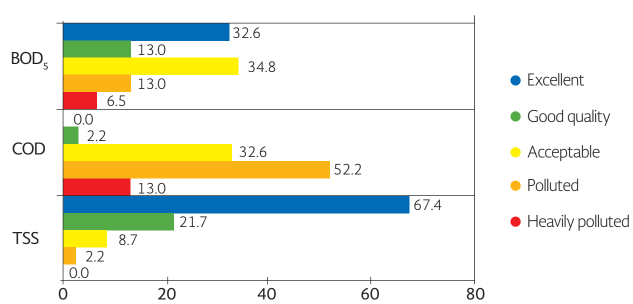

| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 637 | 171 | 466 |
| Public supply | 305 | 151 | 153 |
| Self-supplying industry | 60 | 1 | 59 |
| Thermoelectrics | 6 | 0 | 6 |
| **Total** | **1 007** | **324** | **684** |

| Instream uses | |
|---|---|
| Hydropower (volume allocated) | 18 |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 46 |
| COD | 46 |
| TSS | 46 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

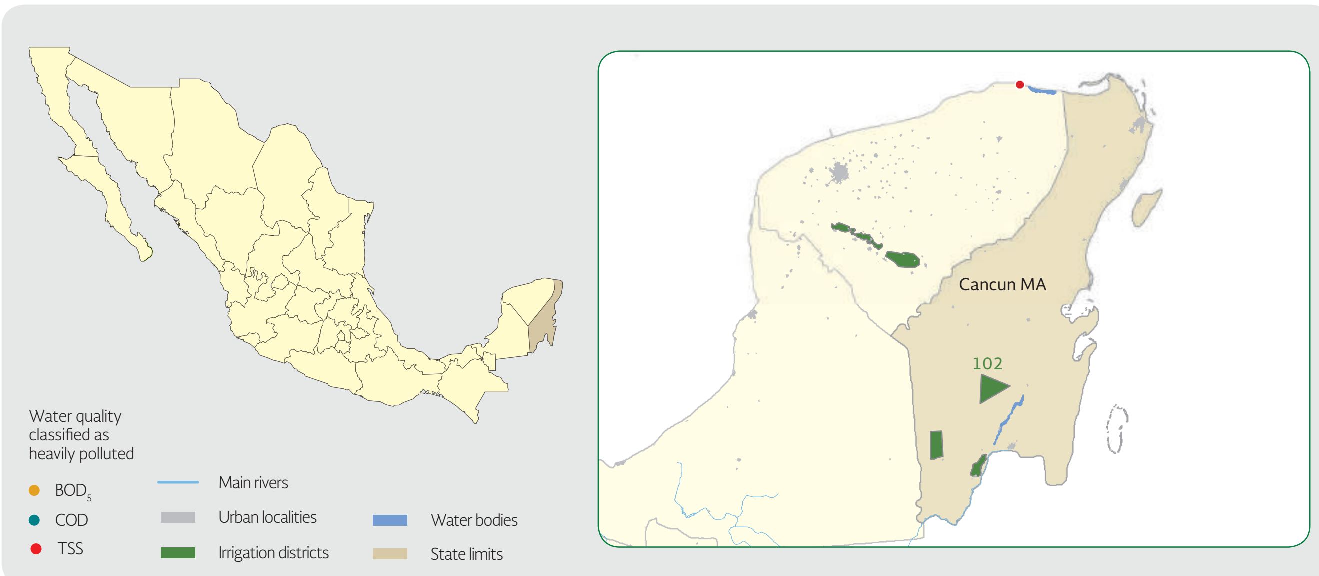
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 94.72 | 90.42 |
| Urban | 98.23 | 97.07 |
| Rural | 86.38 | 74.64 |

### Municipal purification plants, 2014

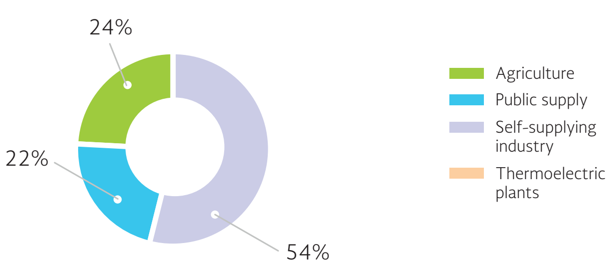
| | |
|---|---|
| Number in operation | 5 |
| Installed capacity (m³/s) | 1.602 |
| Flow processed (m³/s) | 1.592 |

## 23. Quintana Roo

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 10 | | **Municipal** | **Industrial** |
| Total population, 2014 | 1 529 877 inhabitants | Number in operation | 35 | 4 |
| Urban | 1 349 311 inhabitants | Installed capacity (m³/s) | 2.38 | 0.06 |
| Rural | 180 566 inhabitants | Flow processed (m³/s) | 1.73 | 0.05 |
| Total population, 2030 | 2 232 702 inhabitants | | | |
| Normal precipitation 1981-2010 | 1 267 mm | | | |




### Uses of water, 2014 (hm³/year)

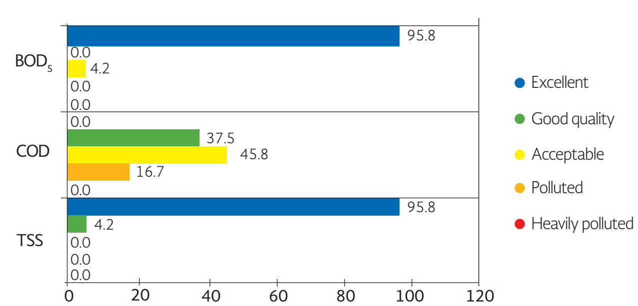



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 240 | 1 | 239 |
| Public supply | 212 | 0 | 212 |
| Self-supplying industry | 532 | 0 | 532 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **984** | **1** | **983** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 0 | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 24 |
| COD | 24 |
| TSS | 120 |

### Distribution of sites by indicator and classification (%)

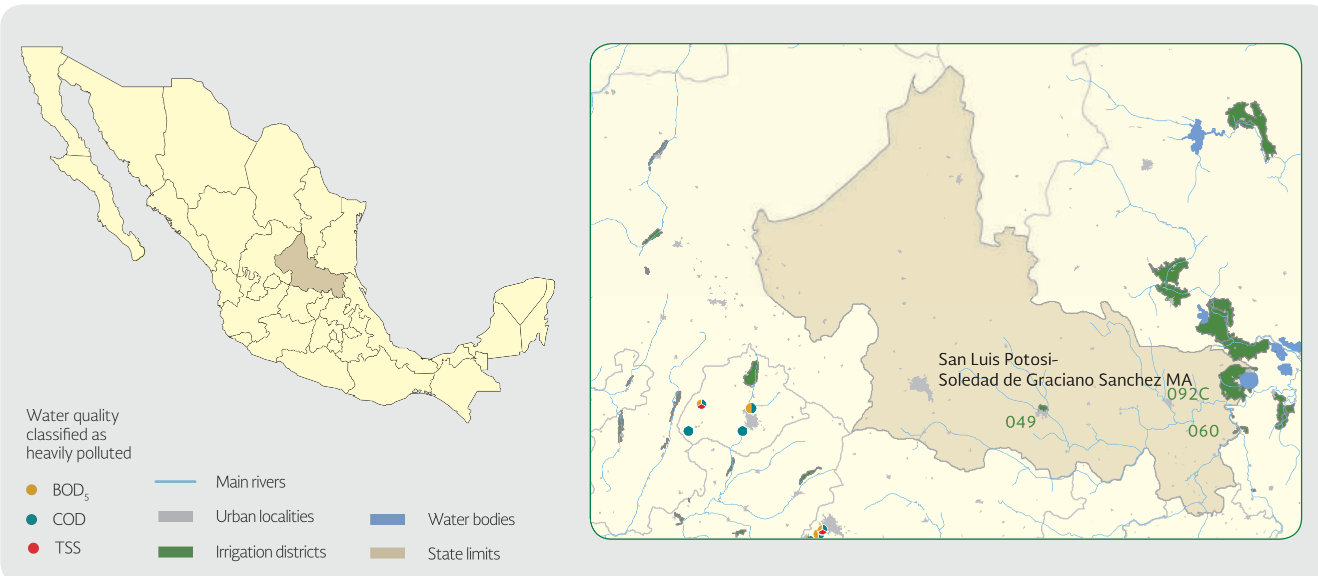



| Coverage, 2010 (%) | | |
|---|---|---|
| | Drinking water | Sanitation |
| State-wide | 92.38 | 92.72 |
| Urban | 92.42 | 92.12 |
| Rural | 96.19 | 67.19 |

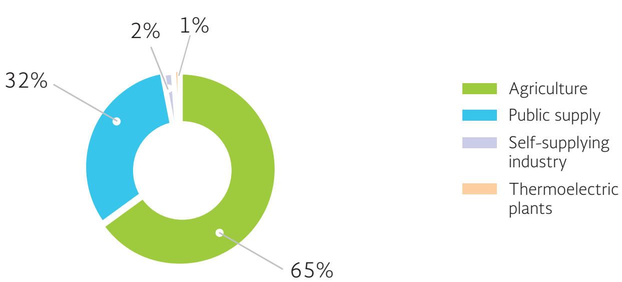
| Municipal purification plants, 2014 | |
|---|---|
| Number in operation | 0 |
| Installed capacity (m³/s) | 0 |
| Flow processed (m³/s) | 0 |

## 24. San Luis Potosi

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 58 | | **Municipal** | **Industrial** |
| Total population, 2014 | 2 728 208 inhabitants | Number in operation | 38 | 57 |
| Urban | 1 767 644 inhabitants | Installed capacity ($m^3/s$) | 2.51 | 0.79 |
| Rural | 960 564 inhabitants | Flow processed ($m^3/s$) | 2.12 | 0.53 |
| Total population, 2030 | 3 055 130 inhabitants | | | |
| Normal precipitation 1981-2010 | 853 mm | | | |




## Uses of water, 2014 ($hm^3$/year)



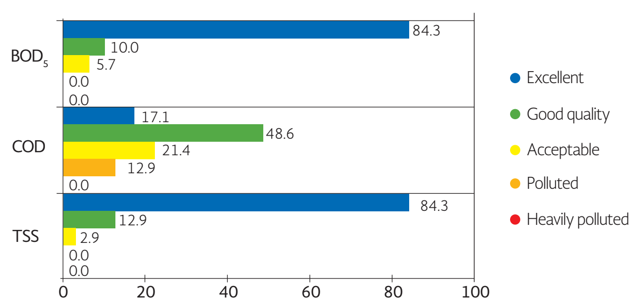

| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 320 | 762 | 559 |
| Public supply | 653 | 504 | 149 |
| Self-supplying industry | 34 | 12 | 22 |
| Thermoelectrics | 31 | 14 | 17 |
| **Total** | **2 039** | **1 292** | **747** |

| Instream uses | |
|---|---|
| Hydropower (volume allocated) | 390 |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 70 |
| COD | 70 |
| TSS | 70 |

## Distribution of sites by indicator and classification (%)




## Coverage, 2010 (%)

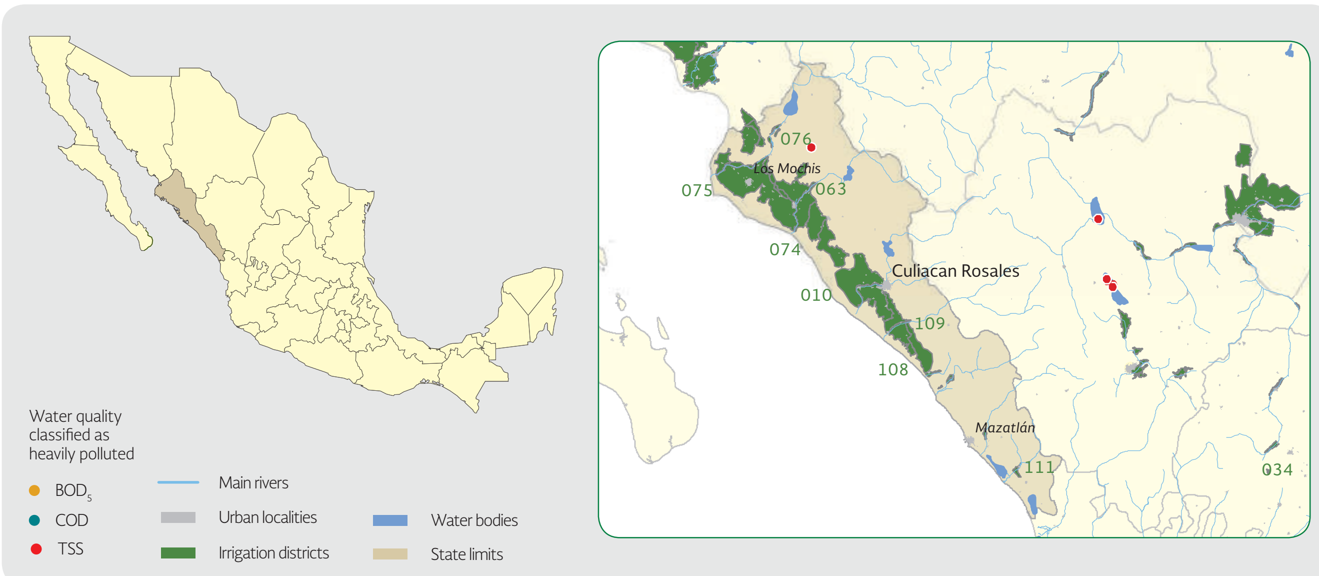
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 85.52 | 79.65 |
| Urban | 97.47 | 95.33 |
| Rural | 64.70 | 52.33 |

## Municipal purification plants, 2014

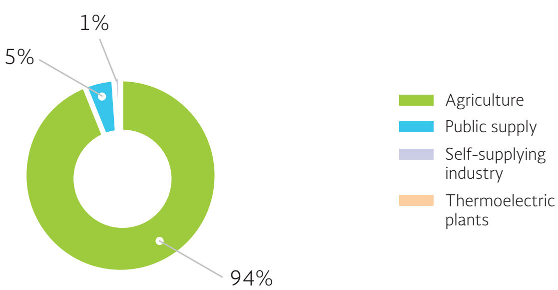
| | |
|---|---|
| Number in operation | 14 |
| Installed capacity ($m^3/s$) | 1.315 |
| Flow processed ($m^3/s$) | 0.957 |

## 25. Sinaloa

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 18 | | **Municipal** | **Industrial** |
| Total population, 2014 | 2 958 691 inhabitants | Number in operation | 243 | 109 |
| Urban | 2 189 509 inhabitants | Installed capacity ($m^3/s$) | 6.43 | 5.88 |
| Rural | 769 181 inhabitants | Flow processed ($m^3/s$) | 5.11 | 3.37 |
| Total population, 2030 | 3 302 931 inhabitants | | | |
| Normal precipitation 1981-2010 | 728 mm | | | |




### Uses of water, 2014 ($hm^3$/year)

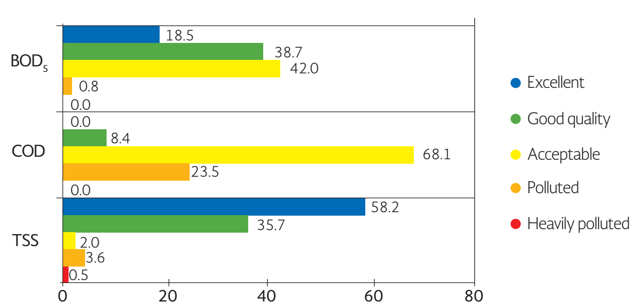



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 8 974 | 8 153 | 821 |
| Public supply | 509 | 280 | 229 |
| Self-supplying industry | 43 | 34 | 8 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **9 526** | **8 468** | **1 058** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 10 982 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 119 |
| COD | 119 |
| TSS | 196 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

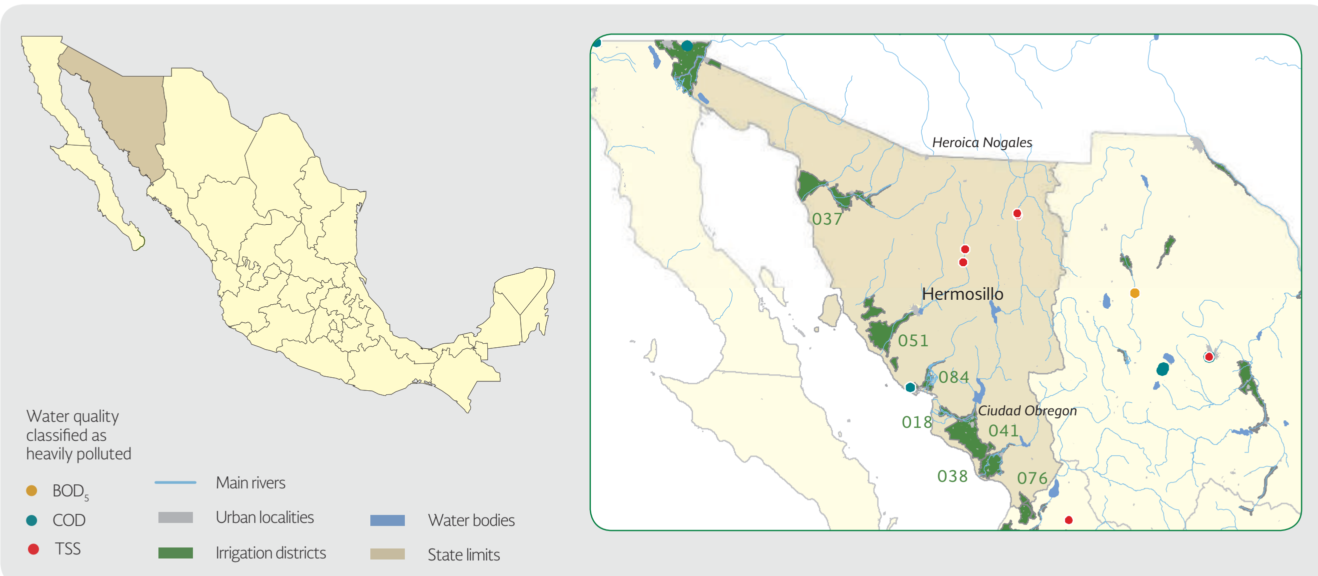
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 94.73 | 91.08 |
| Urban | 98.43 | 96.57 |
| Rural | 84.85 | 76.41 |

### Municipal purification plants, 2014

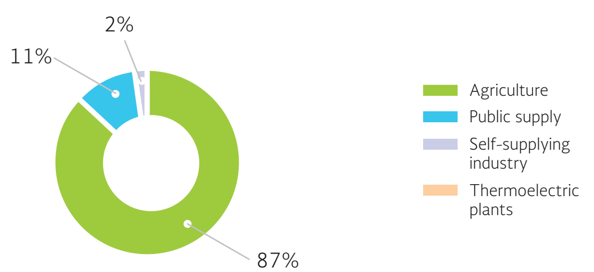
| | |
|---|---|
| Number in operation | 143 |
| Installed capacity ($m^3/s$) | 9.364 |
| Flow processed ($m^3/s$) | 8.332 |

## 26. Sonora

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 72 | | **Municipal** | **Industrial** |
| Total population, 2014 | 2 892 464 inhabitants | Number in operation | 82 | 235 |
| Urban | 2 493 649 inhabitants | Installed capacity (m³/s) | 5.41 | 6.46 |
| Rural | 398 815 inhabitants | Flow processed (m³/s) | 3.65 | 6.25 |
| Total population, 2030 | 3 476 930 inhabitants | | | |
| Normal precipitation 1981-2010 | 465 mm | | | |




### Uses of water, 2014 (hm³/year)

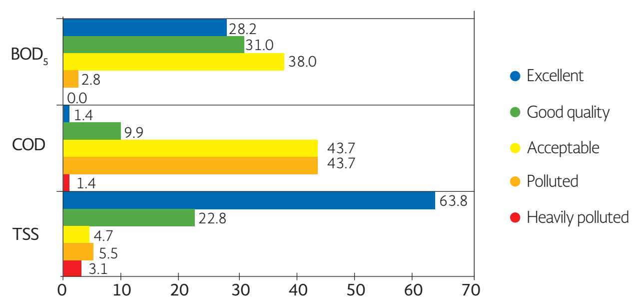



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 6 100 | 3 957 | 2 143 |
| Public supply | 770 | 277 | 492 |
| Self-supplying industry | 124 | 4 | 120 |
| Thermoelectrics | 16 | 7 | 9 |
| **Total** | **7 010** | **4 245** | **2 765** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 5 214 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 71 |
| COD | 71 |
| TSS | 127 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

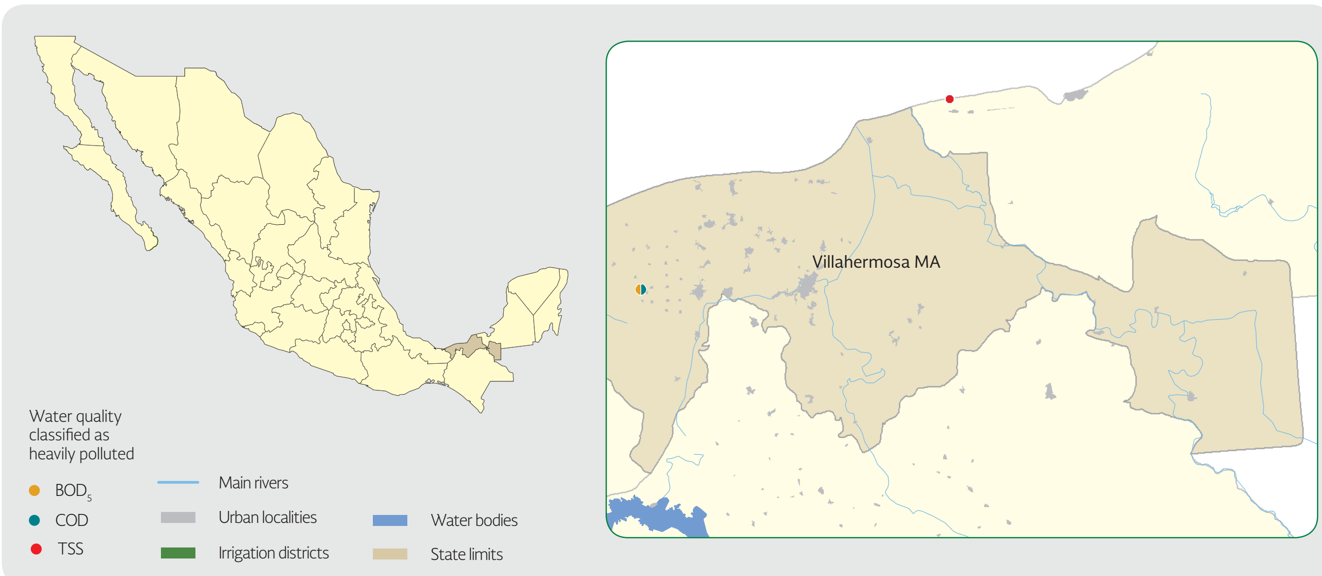
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 96.62 | 89.22 |
| Urban | 97.40 | 94.85 |
| Rural | 91.72 | 54.17 |

### Municipal purification plants, 2014

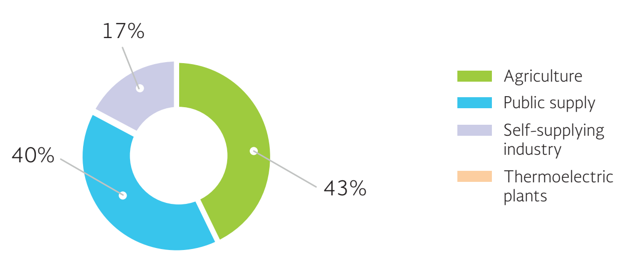
| | |
|---|---|
| Number in operation | 24 |
| Installed capacity (m³/s) | 5.577 |
| Flow processed (m³/s) | 2.293 |

## 27. Tabasco

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 17 | | **Municipal** | **Industrial** |
| Total population, 2014 | 2 359 444 inhabitants | Number in operation | 80 | 117 |
| Urban | 1 366 950 inhabitants | Installed capacity (m³/s) | 2.82 | 0.85 |
| Rural | 992 493 inhabitants | Flow processed (m³/s) | 1.77 | 0.86 |
| Total population, 2030 | 2 687 426 inhabitants | | | |
| Normal precipitation 1981-2010 | 2 185 mm | | | |




### Uses of water, 2014 (hm³/year)

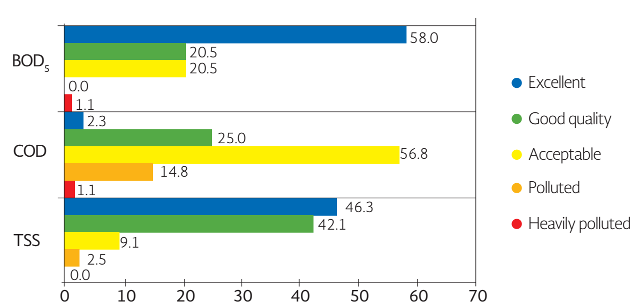



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 198 | 81 | 116 |
| Public supply | 183 | 107 | 76 |
| Self-supplying industry | 76 | 51 | 25 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **456** | **239** | **217** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 0 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 88 |
| COD | 88 |
| TSS | 121 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

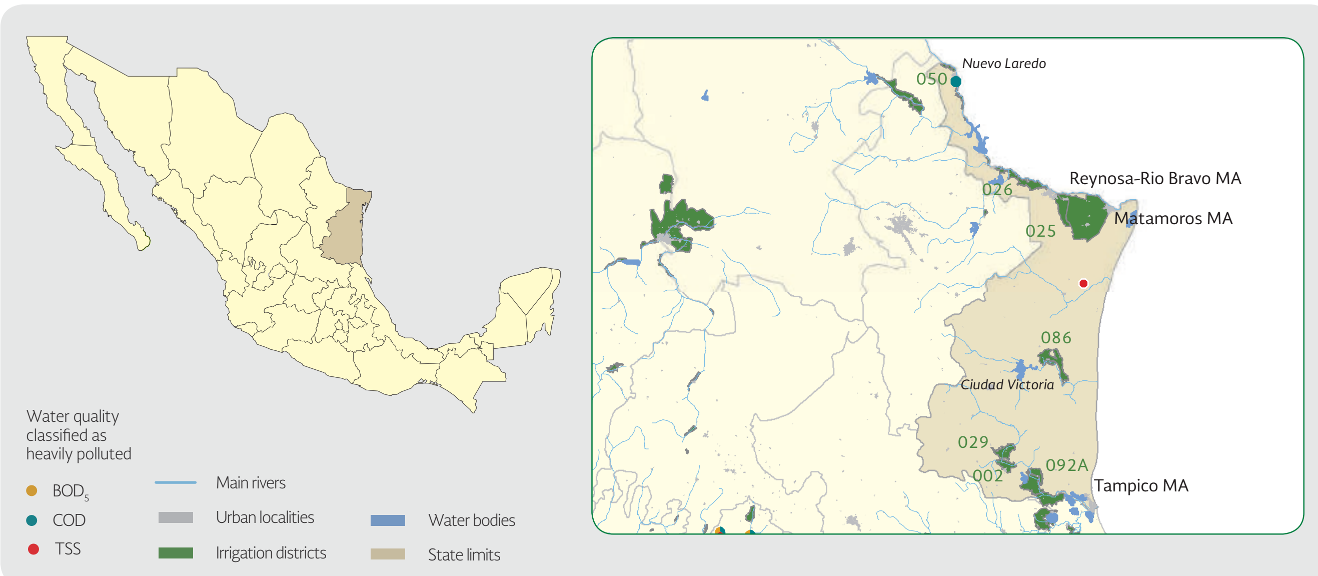
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 81.18 | 95.41 |
| Urban | 91.24 | 98.18 |
| Rural | 67.87 | 91.74 |

### Municipal purification plants, 2014

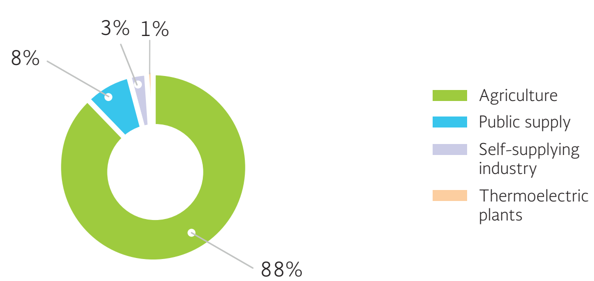
| | |
|---|---|
| Number in operation | 39 |
| Installed capacity (m³/s) | 9.960 |
| Flow processed (m³/s) | 8.465 |

## 28. Tamaulipas

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 43 | | Municipal | Industrial |
| Total population, 2014 | 3 502 721 inhabitants | Number in operation | 44 | 115 |
| Urban | 3 065 769 inhabitants | Installed capacity (m³/s) | 7.80 | 8.36 |
| Rural | 436 951 inhabitants | Flow processed (m³/s) | 5.50 | 7.72 |
| Total population, 2030 | 4 069 115 inhabitants | | | |
| Normal precipitation 1981-2010 | 783 mm | | | |




## Uses of water, 2014 (hm³/year)

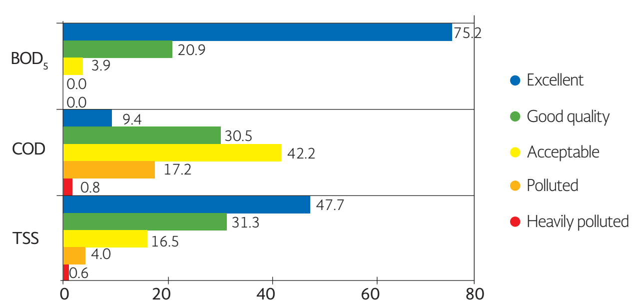



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 3 671 | 3 279 | 391 |
| Public supply | 335 | 292 | 42 |
| Self-supplying industry | 116 | 104 | 13 |
| Thermoelectrics | 55 | 52 | 3 |
| **Total** | **4 177** | **3 728** | **449** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 2 181 | | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 129 |
| COD | 128 |
| TSS | 176 |

## Distribution of sites by indicator and classification (%)




## Coverage, 2010 (%)

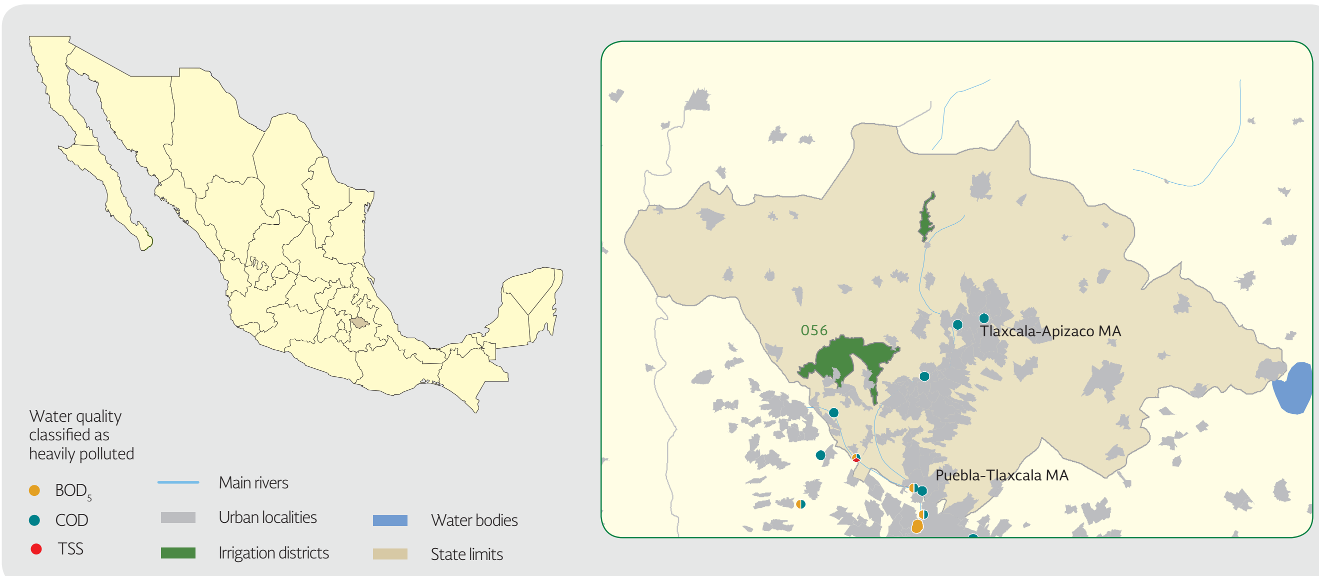
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 95.92 | 86.91 |
| Urban | 97.95 | 93.73 |
| Rural | 81.55 | 38.61 |

## Municipal purification plants, 2014

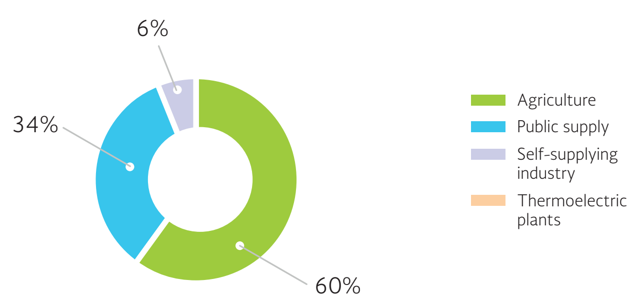
| | |
|---|---|
| Number in operation | 53 |
| Installed capacity (m³/s) | 15.088 |
| Flow processed (m³/s) | 11.892 |

## 29. Tlaxcala

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 60 | | **Municipal** | **Industrial** |
| Total population, 2014 | 1 260 628 inhabitants | Number in operation | 56 | 82 |
| Urban | 1 012 640 inhabitants | Installed capacity (m³/s) | 1.12 | 0.28 |
| Rural | 247 989 inhabitants | Flow processed (m³/s) | 0.61 | 0.25 |
| Total population, 2030 | 1 516 712 inhabitants | | | |
| Normal precipitation 1981-2010 | 704 mm | | | |




### Uses of water, 2014 (hm³/year)

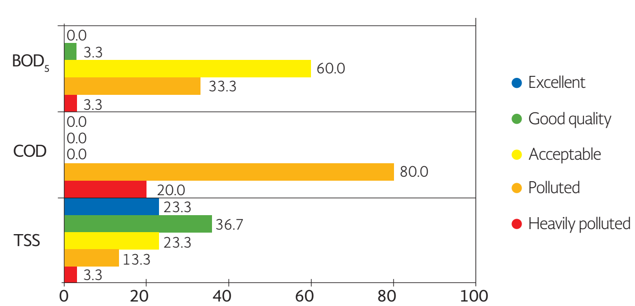



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 161 | 59 | 102 |
| Public supply | 90 | 8 | 82 |
| Self-supplying industry | 17 | 0 | 17 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **268** | **67** | **201** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 0 | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 30 |
| COD | 30 |
| TSS | 30 |

### Distribution of sites by indicator and classification (%)

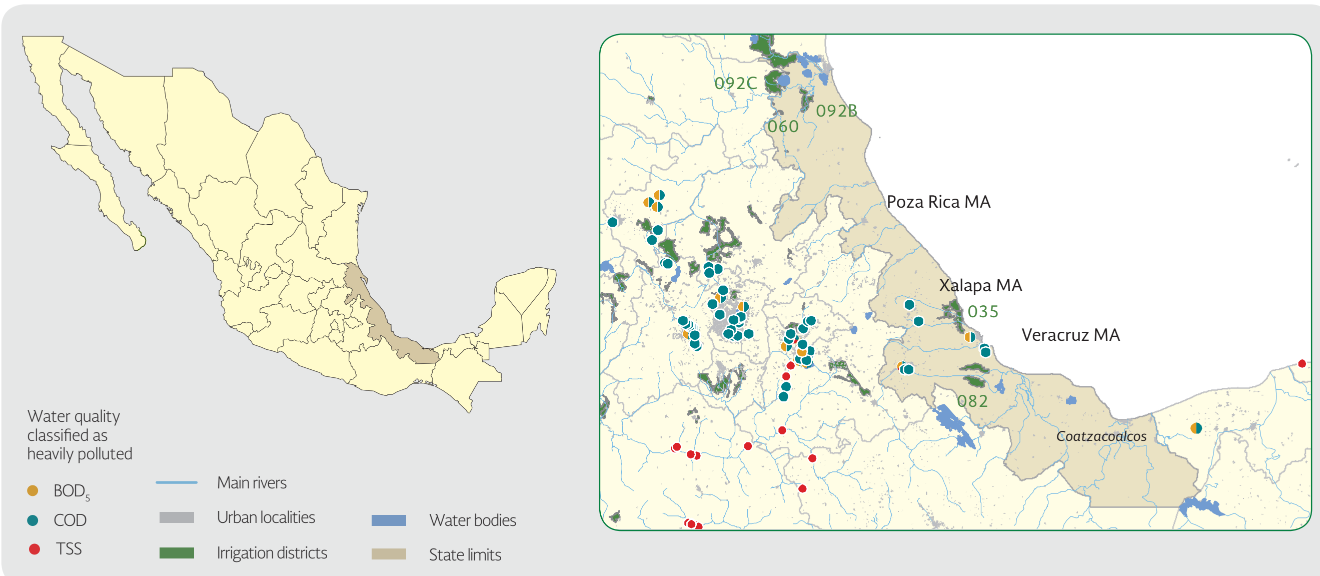



| Coverage, 2010 (%) | | |
|---|---|---|
| | Drinking water | Sanitation |
| State-wide | 98.24 | 94.52 |
| Urban | 98.57 | 95.90 |
| Rural | 96.92 | 89.07 |

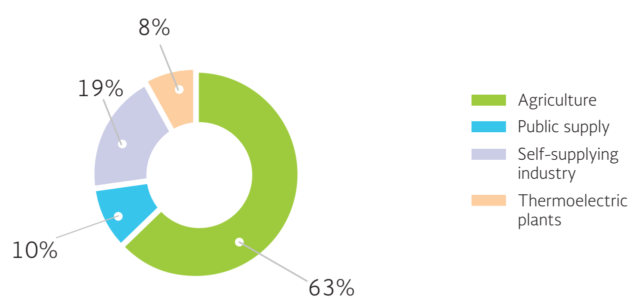
| Municipal purification plants, 2014 | |
|---|---|
| Number in operation | 0 |
| Installed capacity (m³/s) | 0 |
| Flow processed (m³/s) | 0 |

## 30. Veracruz de Ignacio de la Llave

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 212 | | Municipal | Industrial |
| Total population, 2014 | 7 985 893 inhabitants | Number in operation | 101 | 159 |
| Urban | 4 921 928 inhabitants | Installed capacity (m³/s) | 6.72 | 12.93 |
| Rural | 3 963 965 inhabitants | Flow processed (m³/s) | 5.18 | 9.05 |
| Total population, 2030 | 8 781 620 inhabitants | | | |
| Normal precipitation 1981-2010 | 1 544 mm | | | |




### Uses of water, 2014 (hm³/year)

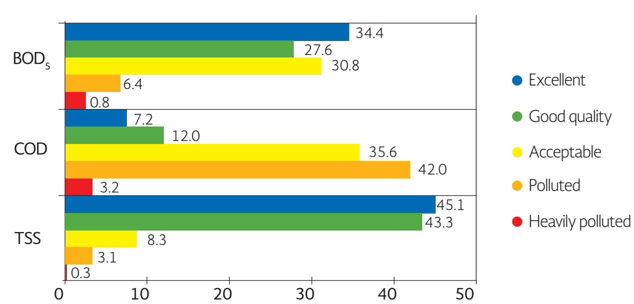



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 3 382 | 2 615 | 766 |
| Public supply | 546 | 320 | 226 |
| Self-supplying industry | 1 054 | 939 | 114 |
| Thermoelectrics | 408 | 406 | 1 |
| **Total** | **5 389** | **4 281** | **1 108** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | 4 185 | | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 250 |
| COD | 250 |
| TSS | 326 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

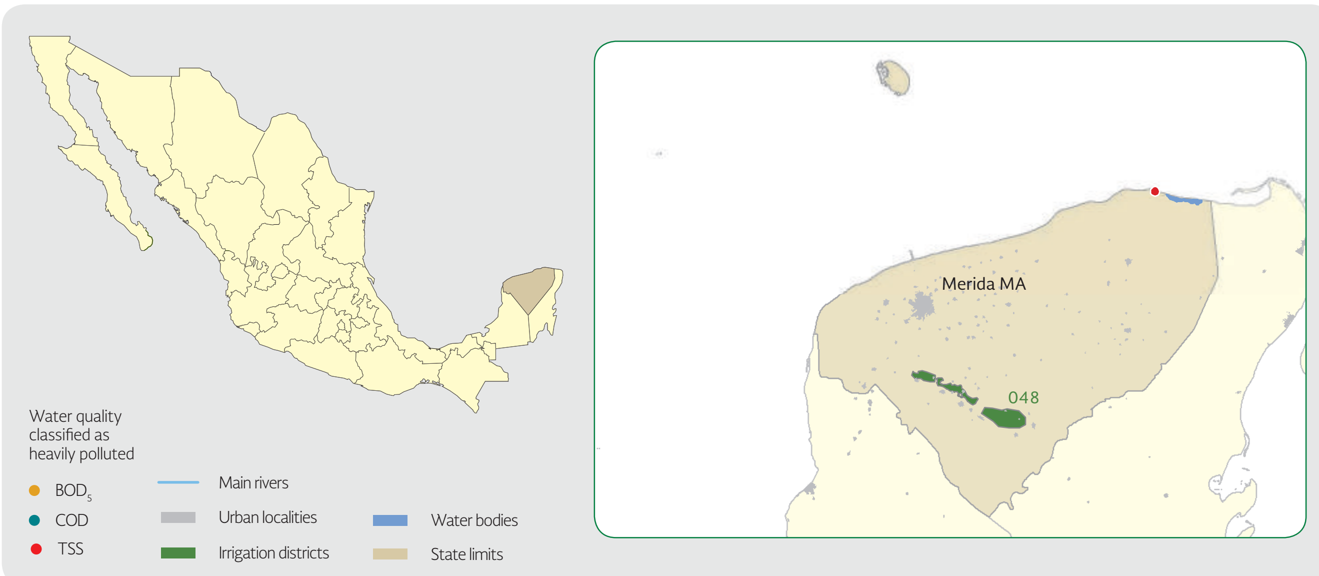
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 80.26 | 82.56 |
| Urban | 90.93 | 95.54 |
| Rural | 63.78 | 62.53 |

### Municipal purification plants, 2014

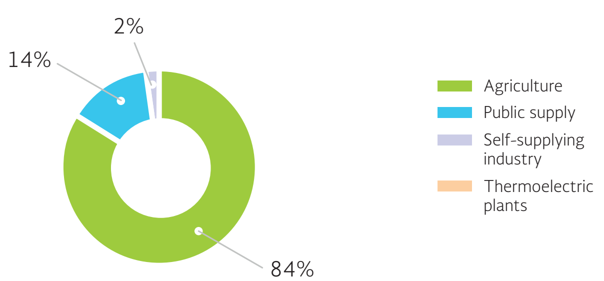
| | |
|---|---|
| Number in operation | 15 |
| Installed capacity (m³/s) | 7.162 |
| Flow processed (m³/s) | 4.644 |

## 31. Yucatan

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 106 | | Municipal | Industrial |
| Total population, 2014 | 2 091 513 inhabitants | Number in operation | 26 | 88 |
| Urban | 1 777 325 inhabitants | Installed capacity (m³/s) | 0.42 | 0.30 |
| Rural | 314 188 inhabitants | Flow processed (m³/s) | 0.17 | 0.28 |
| Total population, 2030 | 2 503 132 inhabitants | | | |
| Normal precipitation 1981-2010 | 1 056 mm | | | |




## Uses of water, 2014 (hm³/year)

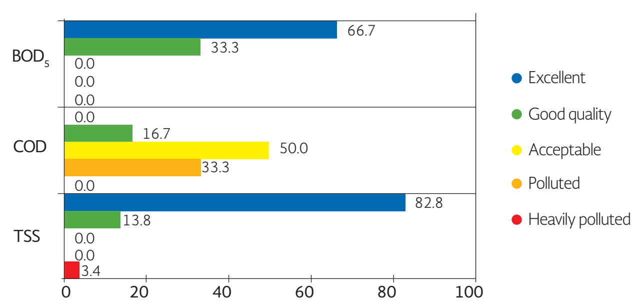



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 574 | 0 | 1 574 |
| Public supply | 254 | 0 | 254 |
| Self-supplying industry | 45 | 0 | 45 |
| Thermoelectrics | 9 | 0 | 9 |
| **Total** | **1 881** | **0** | **1 881** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 0 | |

## Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 6 |
| COD | 6 |
| TSS | 29 |

## Distribution of sites by indicator and classification (%)




## Coverage, 2010 (%)

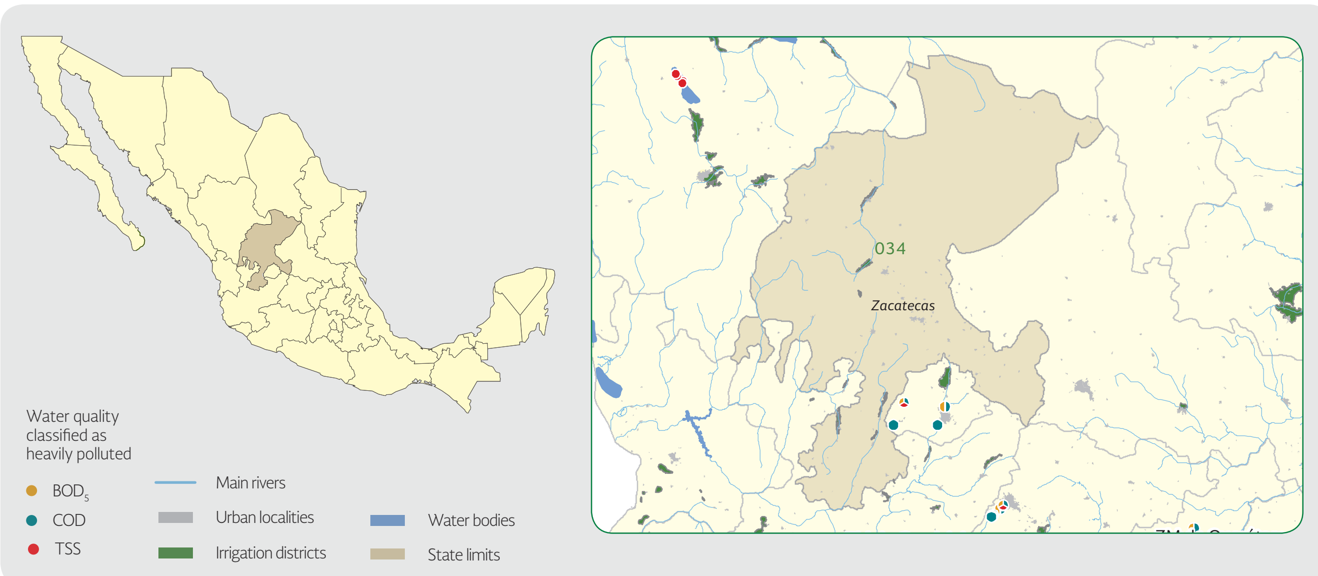
| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 97.24 | 78.77 |
| Urban | 97.57 | 83.18 |
| Rural | 95.51 | 55.75 |

## Municipal purification plants, 2014

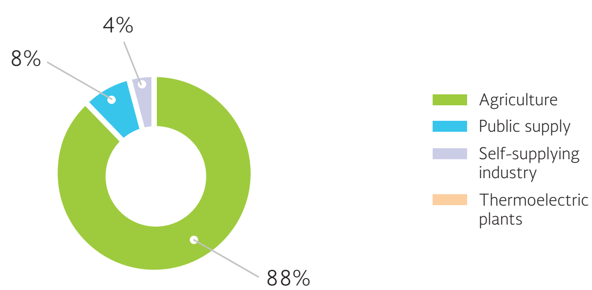
| | |
|---|---|
| Number in operation | 0 |
| Installed capacity (m³/s) | 0 |
| Flow processed (m³/s) | 0 |

## 32. Zacatecas

| Contextual data | | Wastewater treatment plants, 2014 | | |
|---|---|---|---|---|
| Number of municipalities | 58 | | **Municipal** | **Industrial** |
| Total population, 2014 | 1 563 324 inhabitants | Number in operation | 70 | 16 |
| Urban | 941 609 inhabitants | Installed capacity (m³/s) | 1.92 | 0.16 |
| Rural | 621 715 inhabitants | Flow processed (m³/s) | 1.64 | 0.05 |
| Total population, 2030 | 1 726 347 inhabitants | | | |
| Normal precipitation 1981-2010 | 496 mm | | | |




### Uses of water, 2014 (hm³/year)

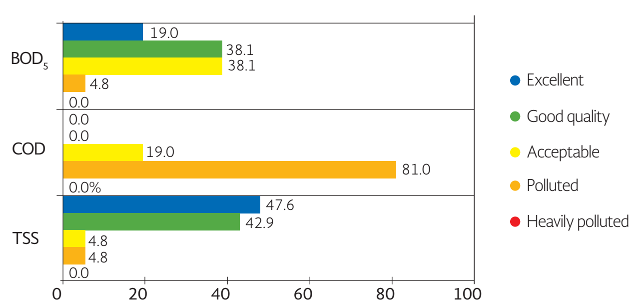



| Offstream uses | Total | Surface water | Groundwater |
|---|---|---|---|
| Agriculture | 1 381 | 340 | 1 042 |
| Public supply | 124 | 11 | 113 |
| Self-supplying industry | 65 | 1 | 64 |
| Thermoelectrics | 0 | 0 | 0 |
| **Total** | **1 570** | **351** | **1 219** |
| **Instream uses** | | | |
| Hydropower (volume allocated) | | 0 | |

### Surface water quality, 2014

| Number of monitoring sites according to water quality indicator | |
|---|---|
| $BOD_5$ | 21 |
| COD | 21 |
| TSS | 21 |

### Distribution of sites by indicator and classification (%)




### Coverage, 2010 (%)

| | Drinking water | Sanitation |
|---|---|---|
| State-wide | 94.31 | 89.07 |
| Urban | 98.38 | 97.60 |
| Rural | 88.42 | 76.69 |

### Municipal purification plants, 2014

| | |
|---|---|
| Number in operation | 92 |
| Installed capacity (m³/s) | 0.163 |
| Flow processed (m³/s) | 0.139 |

# Annex C. Characteristics of the hydrological regions, 2014

| Code | Hydrological region | Mainland extension (km²) | Normal annual precipitation 1981-2010 (mm) | Mean natural internal surface runoff (hm³/year) | Inflows (+) or outflows (-) from/ to other countries (hm³/year) | Total mean natural surface runoff (hm³/year) | Number of watersheds |
|---|---|---|---|---|---|---|---|
| 1 | Baja California Northwest | 28 492 | 209 | 337 | | 337 | 16 |
| 2 | Baja California Central-West | 44 314 | 116 | 251 | | 251 | 16 |
| 3 | Baja California Southwest | 29 722 | 200 | 362 | | 362 | 15 |
| 4 | Baja California Northeast | 14 418 | 151 | 122 | | 122 | 8 |
| 5 | Baja California Central-East | 13 626 | 132 | 101 | | 101 | 15 |
| 6 | Baja California South-East | 11 558 | 291 | 200 | | 200 | 14 |
| 7 | Colorado River | 6 911 | 98 | 78 | 1 850 | 1 928 | 4 |
| 8 | Sonora North | 61 429 | 297 | 132 | | 132 | 5 |
| 9 | Sonora South | 139 370 | 483 | 4 934 | | 4 934 | 16 |
| 10 | Sinaloa | 103 483 | 747 | 14 319 | | 14 319 | 23 |
| 11 | Presidio-San Pedro | 51 717 | 819 | 8 201 | | 8 201 | 23 |
| 12 | Lerma-Santiago | 132 916 | 717 | 13 180 | | 13 180 | 58 |
| 13 | Huicicila River | 5 225 | 1 400 | 1 279 | | 1 279 | 6 |
| 14 | Ameca River | 12 255 | 1 063 | 2 205 | | 2 205 | 9 |
| 15 | Jalisco Coast | 12 967 | 1 144 | 3 606 | | 3 606 | 11 |
| 16 | Armeria-Coahuayana | 17 628 | 866 | 3 537 | | 3 537 | 10 |
| 17 | Michoacan Coast | 9 205 | 944 | 1 617 | | 1 617 | 6 |
| 18 | Balsas | 118 268 | 947 | 16 805 | | 16 805 | 15 |
| 19 | Greater Guerrero Coast | 12 132 | 1 215 | 5 113 | | 5 113 | 28 |
| 20 | Lower Guerrero Coast | 39 936 | 1 282 | 18 170 | | 18 170 | 32 |
| 21 | Oaxaca Coast | 10 514 | 951 | 2 892 | | 2 892 | 19 |
| 22 | Tehuantepec | 16 363 | 884 | 2 453 | | 2 453 | 15 |
| 23 | Chiapas Coast | 12 293 | 2 220 | 12 617 | 1 586 | 14 203 | 25 |
| 24 | Bravo-Conchos | 229 740 | 399 | 5 588 | - 432 | 5 156 | 37 |
| 25 | San Fernando-Soto la Marina | 54 961 | 703 | 4 864 | | 4 864 | 45 |
| 26 | Panuco | 96 989 | 855 | 19 673 | | 19 673 | 77 |
| 27 | North of Veracruz (Tuxpan-Nautla) | 26 592 | 1 422 | 14 155 | | 14 155 | 12 |
| 28 | Papaloapan | 57 355 | 1 440 | 48 181 | | 48 181 | 18 |
| 29 | Coatzacoalcos | 30 217 | 2 211 | 34 700 | | 34 700 | 15 |
| 30 | Grijalva-Usumacinta | 102 465 | 1 703 | 59 297 | 44 080 | 103 378 | 83 |
| 31 | Yucatan West | 25 443 | 1 175 | 707 | | 707 | 2 |
| 32 | Yucatan North | 58 135 | 1 143 | 0 | | 0 | 0 |
| 33 | Yucatan East | 38 308 | 1 210 | 576 | 864 | 1 441 | 1 |
| 34 | Closed Catchments of the North | 90 829 | 298 | 1 261 | | 1 261 | 22 |
| 35 | Mapimi | 62 639 | 292 | 568 | | 568 | 6 |
| 36 | Nazas-Aguanaval | 93 032 | 393 | 2 085 | | 2 085 | 16 |
| 37 | El Salado | 87 801 | 393 | 2 876 | | 2 876 | 8 |
| | **Total** | **1 959 248** | **740** | **307 041** | **47 949** | **354 990** | **731** |

**Source**: CONAGUA (2015a).

# Annex D. Glossary

**Alkalinization**. Also known as salinization. It represents an increase of the salt content in the surface soil that causes, among other impacts, a decrease in crop yield. Its possible causes include saltwater intrusion and the use of irrigation systems that use water with a high sodium concentration. Salinization or alkalinization mainly occurs in arid regions, in closed catchments and in coastal areas that have naturally saline soils.[v]

**Allocation.** A deed granted by the Federal Executive Branch to municipalities, states or the Federal District in order to use the nation's water resources, destined for public-urban or domestic water services, in which case it is termed in Spanish an "asignación", or for the use of the nation's water resources and public inherent assets to individuals or companies, be they private or public, in which case they are termed a "concesión".[a]

**Aquifer.** A geological formation or group of hydrologically interconnected geological formations, through which subsoil water flows or is stored that may be extracted for different uses, and whose lateral and vertical limits are conventionally defined for the purpose of the evaluation, management and administration of the nation's subsoil water.[a]

**Artificial recharge.** A set of hydrogeological techniques applied to introduce water to an aquifer, through purpose-built infrastructure.[q]

**Availability zone.** For the purpose of the payment of water duties, the municipalities in the Mexican Republic have been classified into nine availability zones. This classification is contained in the Federal Duties Law.

**Blue water.** The quantity of water withdrawn from the country's rivers, lakes, streams and aquifers for various uses, both offstream and instream.

**Brackish water.** Water with a concentration of total dissolved solids equal to or greater than 2 000 and less than 10 000 mg/l.[aa]

**Channel of a current.** A natural or artificial channel that has the necessary capacity for the waters of the maximum ordinary flow to run through it without overflowing. When currents are subject to overflowing, the natural channel is considered a riverbed, while no channeling infrastructure is built. At the origins of any current, is it considered a channel strictly speaking, when the runoff is concentrated towards a topographic depression and it forms an erosion gully or channel, as a result of the action of water flowing over the ground.[a]

**Climate contingency.** In terms of declarations related to extreme hydro-meteorological phenomena, this recognizes the risk of impacts on the productive capacity of economic activities.

**Climate station.** A given area or zone of open-air ground, with the particular climate conditions of the area, meant for measuring climate parameters. Equipped with instruments and sensors exposed to the open air, for the measurement of precipitation, temperature, evaporation and the direction and speed of the wind.

**Connate water.** Connate or formation water is saltwater that is found inside rock, associated with the presence of hydrocarbons. It contains dissolved salts, such as calcium and sodium chlorides, sodium carbonates, potassium chlorides, calcium or barium sulfates, among others; it may even include some metals. The concentration of these components may lead to negative impacts on the environment when they are not appropriately managed and disposed of.[r]

**Cyclone.** Atmospheric instability associated with an area of low pressure, which causes convergent surface winds which flow anti-clockwise in the northern hemisphere. It originates over tropical or subtropical waters and is classified according to the wind intensity as a tropical depression, tropical storm or a hurricane.[m]

**Dam**. Infrastructure that serves to capture, store and control the water of a natural catchment and which includes a contention wall and an overflow spillway.[c]

**Degree of water stress.** A percentage indicator of the stress placed on water resources, calculated by the quotient between the total volume of water allocated and the natural mean availability of water.

**Demand.** For the drinking water, sewerage and sanitation subsector, the demand is the total volume of water required in order for a population to meet all types of consumption (domestic, commercial, industrial and public), including losses in the system.[e]

**Demographic conciliation.** Indirect method to establish the volume and structure of the population, in order to carry out new population projections. It is carried out by reconstructing the demographic dynamic of the recent past.[w]

**Disaster.** In terms of extreme hydro-meteorological phenomena, the disaster declaration allows resources from the state and society to be focused on the reconstruction of affected areas.

**Discharge permit.** A deed granted by the Federal Executive Branch through the Conagua or the corresponding river basin organization, in conformity with their respective areas of competence, for discharging wastewater into receiving bodies that are the property of the nation, for individuals or organizations, be they public or private.[a]

**Discharge.** The action of emptying, infiltrating, depositing or injecting wastewater into a receiving body.[a]

**Drainage.** Natural or artificial conducts that are an outlet or vent for water.

**Drinking water and sanitation system.** A series of infrastructure and actions that allow public drinking water and sanitation services to be provided, including sanitation, which contemplates the piping, treatment, removal and discharge of wastewater.[a]

**Drinking water coverage**. Percentage of the population living in private homes with running water within their house, on the lot, or from a public water tap or hydrant. This information is determined by means of censuses carried out by Inegi and estimates from the Conagua for intermediate years.

**Drinking water treatment plant.** Infrastructure designed to remove elements that are dangerous to human health from water, prior to its distribution for water supply to population centers.

**Drinking water.** Literally, water that can be drunk. The Mexican standard (NOM-127-SSA1-1994) defines water for human use and consumption as that which does not contain noxious pollutants, be they chemical or infections agents, and which does not have a negative effect on human beings.[d]

**Drought.** Atypical drought, according to the operating rules of the Natural Disaster Fund, refers to a prolonged period (a season, a year or several consecutive years), with a deficit of precipitation as compared to the mean statistical value from various years (generally 30 years or more). Drought is a normal and recurring property of the climate and it will be considered that a drought is atypical when the deficit of precipitation has a probability of occurrence equal to or less than 10% (meaning that the aforementioned deficit occurs in one or less of every ten years) and that furthermore that situation has not occurred five time or more over the last ten years.[m]

**Duty collection.** In terms of the water sector, the amount charged to taxpayers for the use of the nation's water resources, as well as wastewater discharges and for the use of inherent assets associated with water.

**Emergency.** In terms of declarations related to extreme hydro-meteorological phenomena, this recognizes the risk of impacts on the life and health of the population.

**Environmental services.** The benefits of social interest that are generated by or derived from watersheds and their components, such as climate regulation, conservation of hydrological cycles, erosion control, flood control, aquifer recharge, maintenance of runoff in quality and quantity, soil formation, carbon capture, purification of water bodies, as well as the conservation and protection of biodiversity; for the application of this concept in the National Water Law, water resources and their link with forest resources are considered first and foremost.[a]

**Eutrophication**. Also known as eutrofization. The excess of soil nutrients which adversely affects the development of vegetation and may be due to the excessive application of chemical fertilizers.[x]

**Evaporite rocks.** Evaporite rocks are the main chemical rocks, meaning that they are formed through direct chemical solidification of mineral components. They are often formed from seawater, although there are also continental evaporite rocks, formed in saltwater lakes, or in desert regions which are sporadically flooded. They thus originate as a result of the evaporation of waters containing abundant dissolved salts. When the saturation level of the corresponding salts is reached, as a result of evaporation, the precipitation of the mineral that forms this composite takes place. Successive precipitations often takes place: at an initial stage the least soluble salts fall as rain, and when the evaporation increases, the more soluble salts then fall.[s]

**Exploitation.** Application of water in activities aiming to extract chemical or organic elements dissolved in it, after which it is returned to its original source without significant consumption.[a]

**Extraction index.** The result of dividing the volume of groundwater extraction by the volume of mean total annual recharge.

**Federal zone.** Ten-meter strips adjacent to channels, currents or reservoirs which belong to the nation, measured horizontally from the normal pool elevation. The width of the bank or federal zone is five meters in channels with a width of less than five meters.[a]

**Flood.** An atypical flood, according to the operating rules of the Natural Disaster Fund, consists of the overflow of water beyond the normal limits of a channel or a stretch of water, or an accumulation of water as a result of an excess in areas that are not normally submerged.[m]

**Freshwater.** Water which has a concentration of total dissolved solids of under 1 000 mg/l.[aa]

**Green water.** The quantity of water that is part of the soil humidity and that is used for rainfed crops and vegetation in general.

**Gross Domestic Product (GDP).** The total value of goods and services produced in the territory of a country in a given period, free from duplication.[h]

**Groundwater extraction.** The volume of water that is extracted artificially from a hydrogeological unit for different uses.[b]

**Groundwater.** Water that is completely saturated into the pores or interstices of the subsoil.

**Grouped use for agriculture.** In this document, it includes agriculture, livestock and aquaculture uses, in conformity with the definitions in the National Water Law.

**Grouped use for public supply.** In this document, it is the volume of water employed for public-urban and domestic uses, in conformity with the definitions in the National Water Law.

**Grouped use for self-supplying industry.** In this document, it is the volume of water employed in industrial, agro-industry, services and trade uses, in conformity with the definitions in the National Water Law.

**Housing.** A place surrounded by walls and covered with a roof, with an independent entrance, in which people generally eat, prepare food, sleep and shelter from the environment.[k]

**Human system.** Any system in which human organizations play a predominant role. Often, but not always, the term is a synonym of 'society' or 'social system' (for example, agricultural system, political system, technological system or economic system).[y]

**Hurricane.** A tropical cyclone in which the maximum sustained wind reaches or surpasses 118 km/h. The corresponding cloudy area covers an extension between 500 and 900 km in diameter producing intense rainfall. The center of the hurricane, known as the "eye", normally reaches a diameter that varies between 20 and 40 km, however it may even reach 100 km. At that stage it is classified according to the Saffir-Simpson scale.[m]

**Hydrogeological units.** A combination of inter-connected geological layers, the lateral and vertical limits of which are conventionally defined for the purpose of the evaluation, management and administration of the nation's groundwater resources.[b]

**Hydrological region.** A territorial area shaped according to its morphological, orographical and hydrological features, in which the watershed is considered as the basic unit for water management, and the finality of which is to group and systematize information, analysis, diagnoses, programs and actions with regard to the occurrence of water in quantity and quality, as well as its use. Normally a hydrological region is made up of one or several watersheds. As a result, the limits of the hydrological region are generally speaking different from those of the political division of states, the Federal District and municipalities. One or several hydrological regions make up a Hydrological-Administrative Region.[a]

**Hydrological-administrative region (HAR).** A territorial area defined according to hydrological criteria, made up of one or several hydrological regions, in which the watershed is considered the basic unit for water resources management. The municipality, as in other legal instruments, represents the minimal unit of administrative management in the country.[a]

**Hydro-meteorological phenomenon.** An unsettling occurrence that is generated as a result of atmospheric agents such as: tropical cyclones, extreme rainfall, rain-related, coastal and lake flooding; snow, hail, dust and electricity storms; frost; droughts; heatwaves and ice fronts; and tornadoes.[ac]

**Hydropower dams.** Infrastructure that generates electricity through dynamos or alternators, in which the energy is obtained through turbines propelled by water.

**Incidental recharge.** A recharge that is the result of some sort of human activity and that does not have specific infrastructure for artificial recharge.[q]

**Inflow.** Volume of water that is received in a watershed or hydrogeological unit from other watersheds, towards which it does not naturally drain.[b]

**Inherent public assets.** The national assets listed in Article 113 of the Political Constitution of the United Mexican States: the beaches and federal zones, in the part that corresponds to the riverbeds according to the terms of the NWL; the grounds occupied by the reservoirs of lakes, lagoons, estuaries or natural deposits, the waters of which are the property of the nation; riverbeds that are of the nation's water resources; riverbanks or federal zones that are adjacent to riverbeds and the reservoirs or deposits which are the property of the nation, according to the terms of the NWL; the grounds of riverbeds and those of reservoirs of lakes, lagoons or estuaries that are the property of the nation, uncovered by natural causes or by artificial works; the islands that exist or that are formed in the reservoirs of lakes, lagoons, estuaries, dams and deposits or in the riverbeds that are the property of the nation, except those that are formed when a stream dissects grounds that are private or community property, and the water infrastructure works funded by the federal government, such as dams, dykes, reservoirs, canals, drains, water retention berms, trenches, aqueducts, irrigation districts or units and others built for the use of water, flood control and management of the nation's water resources, including the grounds they occupy and the protection areas, in the extension that is defined by the Conagua in each case.[a]

**Irrigation district.** A geographical area where irrigation services are provided by means of hydro-agricultural infrastructure works.

**Irrigation sheet.** The quantity of water, measured in longitudinal units, which is applied to a crop so that it may meet its physiological needs during the entire growth cycle, in addition to soil evaporation (offstream use = evapotranspiration + water in the fabric of the plant).

**Irrigation surface.** An area with irrigation infrastructure.

**Irrigation unit.** An agricultural area which has infrastructure and irrigation systems, different from an irrigation district and commonly of a more reduced area; it may be made up of user associations or other figures of organized farmers who are freely associated in order to provide irrigation services with autonomous management systems and operate water infrastructure works in order to capture, divert, conduct, regulate, distribute and remove the nation's water resources that are destined for agricultural irrigation.[a]

**Irrigation.** Application of water to crops through infrastructure, in comparison with crops that only receive precipitation, which are known as rainfed crops.

**Lake, lagoon or marsh bed.** The natural deposit of the nation's water resources outlined by the elevation of the maximum ordinary surge.[a]

**Lake**. A continental water body of considerable extension, surrounded by freshwater or saltwater.[c]

**Large dams.** Dams whose height above the bed is greater than 15 m or with a maximum capacity of more than 3 million $m^3$ at the surcharge pool elevation.[p]

**Lentic.** Water bodies whose liquid content moves basically within the depression they are located in, mainly with convective movements with a more or less limited replacement of water. A concept applied to stagnant water, such as swamps, ponds, lakes and wetlands, which are shallow water bodies.[x]

**Locality.** Any place occupied by one or more houses, which may or may not be inhabited; this place is recognized by either law or custom. According to their characteristics and for statistical purposes, they may be classified into urban and rural.

**Lotic.** Water bodies which move in a more or less defined direction, and in which the liquid is replaced by nimble flow. A term related to flowing water, such as a stream or river.[x]

**Marsh.** Swampy lowlands which are often filled with rainwater or from the overflow of a current, a nearby lagoon or the sea.[a]

**Marshy.** Belonging to or related to a lagoon or a swamp.[t]

**Mean annual availability of groundwater.** The mean annual volume of groundwater that may be allocated in order to be extracted from a hydrogeological unit or aquifer for different uses, in addition to the already allocated extraction and the natural discharge that has been committed, without jeopardizing the balance of the ecosystems.[a]

**Mean annual availability of surface water**. The value that results from the difference between the mean annual volume of runoff from a watershed to downstream areas, and the current mean annual volume committed downstream.[a]

**Mean annual precipitation.** Precipitation calculated for any period of at least ten years, which starts on January 1 of the first year and ends on December 31 of the final year.

**Mean aquifer recharge.** The mean annual volume of water that flows into an aquifer.

**Mean natural availability.** The total volume of renewable surface water and groundwater that occurs naturally in a region.

**Mean natural internal surface runoff.** In a given territory, this is the volume of precipitation minus the volume of evapotranspiration minus the mean aquifer recharge. It represents the surface runoff in channels and currents without considering volumes of inflows or outflows from the territory to neighboring territories.

**Mean natural surface runoff.** The part of mean historical precipitation that occurs in the form of flows into a watercourse.

**Meteorological station.** A given area or zone of open-air ground, used for the measurement of surface meteorological parameters. It is equipped with instruments to measure precipitation, temperature, wind speed and direction, relative humidity, atmospheric pressure and solar radiation.

**Mexican Standard (NMX).** A standard produced by a national standardization body, or the Ministry of the Economy, which foresees, for a common and repeated use, rules, specifications, attributes, testing methods, guidelines, characteristics or previsions applicable to a product, process, installation, system, activity, service or production or operating method, as well as those related to terminology, symbology, packaging, marking or labelling. Mexican standards are voluntarily applied, except for those cases where private parties state that their products, processes or services comply with the standards, notwithstanding the agencies requiring their observance of an Official Mexican Standard for any given purpose.[l]

**Mine tailing dam.** One of the systems for the final disposal of solid waste generated, for the benefit of minerals, which should comply with conditions of maximum security, in order to guarantee the protection of the population, economic and social activities, and in general, ecological balance.

**Municipality.** A basic political entity of territorial division and of the political and administrative organization of the states of the Republic.

**Natural recharge.** The recharge generated by direct infiltration from precipitation, from surface water runoff into channels or from water stored in water bodies.[q]

**Normal pool elevation (NPE).** For reservoirs, this is the equivalent of the elevation of the weir crest in the case of a freely-flowing structure; if it has floodgates, this refers to their highest level.

**Normal precipitation.** Precipitation measured for a uniform and relatively long period, which should have at least 30 years of data, which is considered a minimum representative climate period, and which starts on January 1 of a year ending in one, and ends on December 31 of a year ending in zero.

**Official Mexican Standard (NOM).** The obligatorily-observed technical regulation, issued by the competent authorities, which establishes rules, specifications, attributes, guidelines, characteristics or provisions applicable to a product, process, installation, system, activity, service or method of production or operation, as well as those related to terminology, symbology, packaging, marking or labelling and which refer to its compliance or application.[l]

**Offstream use.** The volume of water of a given quality that is consumed when implementing a specific activity, which is determined as the difference in the volume of a given quality that is extracted, minus the volume of an also given quality that is discharged, and which is indicated in the respective deed.[a]

**Outflow.** Volume of surface water that is transferred from one watershed or hydrogeological unit to another or others.[b]

**Overdrafted aquifer.** One in which the groundwater extraction is greater than the volume of the mean annual recharge, in such a way that the persistence of this condition over prolonged periods of time brings about some of the following environmental impacts: depletion or disappearance of springs, lakes or wetlands; reduction or disappearance of base river flow; indefinite depletion of the groundwater level; formation of cracks; differential ground settlement; saltwater intrusion in coastal aquifers; and migration of poor quality water. These impacts may bring about economic losses for users and society-at-large.

**Particular discharge conditions.** The series of physical, chemical and biological parameters, and of their maximum permitted levels in wastewater discharges, determined by the Conagua or by the corresponding river basin organization, according to their respective areas of competence, for each user, for a specific use or user group of a specific receiver body, with the purpose of conserving and controlling the water quality, in accordance with the 2004 National Water Law and the By-Laws derived from that Law.[a]

**Perennial crops**. Crops whose maturation cycle is more than one year long.

**Permits.** Granted by the Federal Executive Branch through the Conagua or the corresponding river basin organization, for the use of the nation's water resources, as well as for the construction of hydraulic works and other of a diverse nature related with water and national assets, as referred to in Article 113 of the 2004 National Water Law.[a]

**Phenology.** The study of the relationship of biological phenomena with the weather, particularly seasonal changes.[t]

**Physically irrigated surface.** Surface which receives at least some irrigation within a given time period.

**Pollution.** Incorporation of foreign agents in water, capable of modifying its physical and chemical composition and quality.[c]

**Population center.** A group of one or more municipalities in which the population is concentrated mainly in urban localities. Metropolitan areas are considered population centers.

**Precipitation.** Water that falls from the atmosphere in liquid or solid form, onto the earth's surface; it includes dew, drizzle, rain, hail, sleet and snow.[c]

**Private inhabited housing.** Of interest for the calculation of coverage based on different types of censuses (called respectively "Censos" and "Conteos" in Spanish), it is an independent house, apartment in a building or a house in a neighborhood which at the time of the census was occupied by people that make up one or more homes.[k]

**Productivity of water in irrigation districts.** The quantity of agricultural produce from all crops in irrigation districts to which irrigation has been applied, divided by the quantity of water applied to them. It is presented in kg/m$^3$.

**Prohibition zone.** Those specific areas of hydrological regions, watersheds or aquifers, in which no use of water is authorized in addition to those legally established, the latter being controlled through specific regulations, as a result of the deterioration in the quantity or quality of water, due to the impact on the sustainability of water resources, or the damage to surface and groundwater bodies.[a]

**Protection zone.** The strip of ground immediately surrounding dams, hydraulic structures and other infrastructure and related installations, when the aforementioned infrastructure is the property of the nation, of the extension that in each case is established by the Conagua or the corresponding river basin organization, in conformity with their respective competencies, for their protection and appropriate operation, conservation and surveillance.[a]

**Public Registry of Water Rights (Repda)**. A Registry that provides information and legal certainty to the users of the nation's water resources and inherent assets through the registration of concession or allocation deeds or discharge permits, as well as the modifications that are made to their characteristics.

**Receiving body.** The current or natural water deposit, dam, channel, salt-water zone or national asset into which wastewater is discharged, as well as the grounds into which this water is filtered or injected, when it may pollute the soil, subsoil or aquifers.[a]

**Reclamation.** An act issued by the Federal Executive Branch for the purpose of public utility or interest, through the corresponding declaration, to eliminate concessions or allocations for the use of the nation's water resources and their inherent public assets; or concessions to build, equip, operate, conserve, maintain, rehabilitate and extend federal water infrastructure and the provision of the related services.[a]

**Regulated zone.** Those specific areas of aquifers, watersheds, or hydrological regions, which due to their characteristics of deterioration, hydrological imbalance, risks or damage to water bodies or the environment, fragility of vital ecosystems, overdrafting, as well as for their reorganization and restoration, require a specific water management in order to guarantee hydrological sustainability.[a]

**Renewable water resources.** The total amount of water that can feasibly be used every year. Renewable water resources are calculated as the annual unaltered surface runoff, plus the mean annual aquifer recharge, plus inflows from other regions or countries, minus the outflows to other regions or countries.

**Reserve zone.** Those specific areas of aquifers, watersheds or hydrological regions, in which limits are established in the use of a proportion or all of the available water, with the aim of providing a public service, implementing a restoration, conservation or preservation program, or when the State resolves to use those water resources for public utility.[a]

**Reuse**. The use of wastewater with or without prior treatment.[a]

**River basin commission**. A collegiate body of mixed membership, not subordinate to the Conagua or the river basin organizations. An auxiliary body of the river basin council at the sub-basin level.[a]

**River basin council.** Collegiate bodies of mixed membership, which carry out coordination and consultation, support and advice, between the Conagua, including the corresponding river basin organization, the agencies and bodies at the federal, state and municipal levels, and the representatives of water users and civil society organizations, from the respective watershed or hydrological region. They have the vocation of formulating and implementing programs and actions to improve water management, the development of water infrastructure and the respective services and the preservation of the watershed's resources.[a]

**River basin organization.** A specialized technical, administrative and legal unit, autonomous in nature, which directly reports to the Head of the Conagua, the attributions of which are established in the National Water Law and its By-Laws, and whose specific resources and budget are determined by the Conagua. Prior to the 2004 reform, they were known as regional offices.[a]

**River.** A natural current of water, either permanent or intermittent, which flows into other currents, into a natural or artificial reservoir, or the sea.[a]

**Rural locality.** A locality with a population of less than 2 500 inhabitants, and which is not a municipal seat.

**Saltwater intrusion.** A phenomenon in which saltwater enters through the subsoil towards the inner land mass, causing groundwater salinization; this occurs when the extraction of water causes a drop in the groundwater level below sea level, altering the natural dynamic balance between seawater and freshwater.

**Saltwater**. Water with a concentration of total dissolved solids greater than 10 000 mg/l.[aa]

**Sanitation coverage.** Percentage of the population that lives in private housing, whose housing has an outlet connected to the public sewerage network, a septic tank, a river, lake or sea, or a ravine or crevice. Determined by means of the different types of census carried out by Inegi and estimations from the Conagua for intermediate years.

**Sanitation.** Collection and transportation of wastewater and the treatment of both wastewater and the sub-products generated in the course of these activities, in such a way that its disposal produces the smallest possible impact on the environment.[i]

**Sewerage.** System of pipes that conduct wastewater to the site of its final disposal.[e]

**Sink.** Any process, activity or mechanism which withdraws a greenhouse gas, an aerosol, or a precursor of greenhouse gas from the atmosphere.[y]

**Slightly brackish water.** Water with a concentration of total dissolved solids equal to or greater than 1 000 and less than 2 000 mg/l.[aa]

**Source.** Site from which water is taken for its supply.

**State.** The 31 states and the Federal District, which together make up the Federation.[f]

**Storage.** Volume or quantity of water that can be captured, in millions of cubic meters.[c]

**Stream gage.** A place in which volumes of water are measures and recorded by means of different instruments and/or apparatuses.[c]

**Stream.** Channel of a current of water with a limited flow occupied over periods of time.[c]

**Supply.** Water supply.

**Surcharge pool elevation (SPE).** The highest level that water should reach in a reservoir under any condition.

**Surface water extraction.** Volume of water that is artificially extracted from surface water channels and reservoirs for different uses.[b]

**Surface water.** Water which flows over or is stored on the surface of the earth's crust in the form of rivers, lakes or artificial reservoirs such as dams, berms or canals.[c]

**Sustainable development.** As regards water resources, this is the process that is measurable through criteria and indicators related to water, the economy, social and environmental aspects, which aims to improve the quality of life and the productivity of people, supported by the necessary measures for the preservation of hydrological balance and the use and protection of water resources, in such a way that the needs for future generations are not compromised.

**Tariff.** The unit price established by the competent authorities for the provision of public drinking water, sewerage and sanitation services.[j]

**Technical groundwater committee (Cotas).** Collegiate bodies of mixed membership and which are not subordinate to the Conagua or the river basin organizations. They carry out their activities on a given aquifer or group of aquifers.[a]

**Technified rainfed district.** Geographical area intended for agricultural activities without but which lacks irrigation infrastructure, and in which, through the use of certain techniques and infrastructure, the damage to production caused by periods of strong and prolonged rainfall is reduced –in which case they are also referred to as drainage districts– or in conditions of drought, when rain or agricultural soil humidity is used with greater efficiency; the technified rainfed district is made up of rainfed units.[a]

**The nation's water.** Water resources that are the property of the Nation, according to the terms of paragraph 5 of article 27 of the Political Constitution of the United Mexican States.[a]

**Thermoelectric plant.** Infrastructure that generates electricity through dynamos or alternators, in which the power is obtained from steam-propelled turbines.

**Ton of oil equivalent.** Accounting unit employed to measure the use of energy. The IEA defines it as the net calorific value of 10 Gcal (Giga calories).[z]

**Total capacity of a reservoir.** The volume of water that a reservoir can store at the Normal Pool Elevation (NPE).

**Total mean natural surface runoff.** The mean natural internal surface runoff of a territory, plus the volumes of inflows from neighboring territories, minus the volumes of outflows to neighboring territories. It represents the total surface runoff in channels and currents.

**Total recharge.** The volume of water that enters a hydrogeological unit, in a given time period.[q]

**Torrential rain.** Rainfall with an intensity of more than 60 mm/h.[ab]

**Urban locality.** A locality with a population equal to or more than 2 500 inhabitants, or which is a municipal seat, regardless of the number of inhabitants it had at the time of the most recent census.

**Use.** Application of water in activities that do not imply its total or partial consumption.[a]

**Virtual water**. The sum of the quantity of water employed in the productive process of a product.

**Vulnerability.** The degree of exposure or propensity of a component of the social or natural structure to suffer damage as a result of a threat or danger, of natural or anthropogenic origin, or the lack of resilience to recover subsequently. It corresponds to the physical, economic, political or social predisposition or susceptibility of a community to be affected or to suffer adverse effects as a result of the occurrence of a dangerous phenomenon. Vulnerabilities may be institutional, legal, political or territorial in nature.[ad]

**Wastewater treatment plant.** Infrastructure designed to receive wastewater and remove materials that might degrade water quality or place public health at risk when discharged into receiving bodies or channels.[g]

**Wastewater.** Water of varied composition coming from discharges from public urban, domestic, industrial, commercial, service, agricultural, livestock, from treatment plants and in general from any other use, as well as any combination of them.[a]

**Water footprint.** The sum of the quantity of water used by each person for his or her different activities and which is necessary to produce the goods and services that he or she consumes. It includes both blue and green water.

**Water infrastructure.** A combination of structures built with the objective of water management, whatever its origin may be, with the purpose of exploitation, removal, treatment or defense, such as dams, dykes, reservoirs, canals, drains, water retention berms, trenches, aqueducts, irrigation districts and units and others built for the use of water, flood control and the management of the nation's water resources.[aa]

**Water utility.** A body in charge of supplying drinking water and sanitation services in a given locality.[n]

**Watershed.** A territorial unit, differentiated from other units, normally outlined by a divide between waters through the polygonal line formed by the points of highest elevation of that unit, in which water appears in different forms, and is stored or flows to an exit point, which may be the sea or another inland receiving body, through a hydrographic network of channels which converge into one main one, or the territory in which waters form an autonomous unit or one that is differentiated from others, without flowing out into the sea. In that space that is outlined by a topographic diversity, water resources, soils, flora, fauna, other natural resources related with the latter and the environment co-exist. The watershed together with aquifers constitutes the management unit of water resources.[a]

**Wetlands**. Transition zones between aquatic and terrestrial systems that constitute temporary or permanent flood zones, subject or not to the influence of tides, such as swamps, marshes and mudflats, the limits of which are made up by the type of moisture-absorbing vegetation, either permanent or seasonal; areas in which the soil is predominantly water-based; and lake areas or areas of permanently humid soils due to natural aquifer discharge.[a]

**Note:** The glossary is a compilation from different sources, with the aim of illustrating the diverse concepts employed in this document. They thus do not constitute legally binding definitions.

**Source:**


- **a** National Water Law (*Ley de Aguas Nacionales*).
- **b** *NOM-011-CONAGUA-2000*.
- **c** Inegi (2000).
- **d** *NOM-127-SSA1-1994*.
- **e** Conagua (2003).
- **f** Political Constitution of the United Mexican States (*Constitución Política de los Estados Unidos Mexicanos*).
- **g** USGS (2015c).
- **h** CEFP (2012).
- **i** Trillo (1995).
- **j** *NMX-AA-147-SCFI-2008*.
- **k** Inegi (2011).
- **l** Federal Law on Metrology and Standardization (*Ley Federal sobre Metrología y Normalización*).
- **m** Specific operating guidelines of the Fonden (*Lineamientos de operación específicos del Fonden*).
- **n** *NOM-002-CNA-1995*.
- **p** Arreguín et al. (2009).
- **q** *NOM-014-CONAGUA-2003*.
- **r** *NOM-143-SEMARNAT-2003*.
- **s** Higueras and Oyarzún (2013).
- **t** RAE (2015).
- **u** Conagua (2012).
- **v** Semarnat (2008).
- **w** Conapo (2015).
- **x** Sánchez et al (2010).
- **y** IPCC (2007).
- **z** WB (1996).
- **aa** Conagua (2015a).
- **ab** AEMET (2015).
- **ac** General Law of Civil Defense (*Ley General de Protección Civil*).
- **ad** 014-2018 Program for national security (*Programa para la seguridad nacional 2014-2018*).

# Annex E. Abbreviations and acronyms

| | |
|---|---|
| **AECID** | Spanish International Cooperation Agency |
| **AFD** | French Development Agency |
| **Amexcid** | Mexican Agency for International Cooperation Development |
| **ANEAS** | National Association of Water and Sanitation Utilities |
| **Apazu** | Drinking water and sanitation in urban zones |
| **Banobras** | National Bank of Works and Services |
| **Bansefi** | Bank of National Saving and Financial Services |
| **Banxico** | Bank of Mexico |
| **$BOD_5$** | Five-day Biochemical Oxygen Demand |
| **Cdi** | National Commission for the Development of Indigenous Peoples |
| **CEAS** | State Water and Sanitation Commission |
| **Cenapred** | National Disaster Prevention Center |
| **CFE** | Federal Electricity Commission |
| **CIAT** | International Center for Tropical Agriculture |
| **COD** | Chemical Oxygen Demand |
| **Cofepris** | Federal Commission for Protection against Health Risks |
| **Conabio** | National Commission for Knowledge and Use of Biodiversity |
| **Conagua** | National Water Commission |
| **Conapo** | National Population Council |
| **Conavi** | National Housing Commission |
| **Coneval** | National Council for the Evaluation of the Social Development Policy |
| **Cotas** | Technical Groundwater Commission |
| **CPL** | Clean Beach Committee |
| **CRAE** | Regional Emergency Attention Center |
| **CRED** | Centre for Research on the Epidemiology of Disasters |
| **DESA** | Department of Economic and Social Affairs |
| **DF** | Federal District (Mexico City) |
| **DOF** | Official Government Gazette |
| **DPL** | Development Policy Loan |
| **EEPs** | External Energy Producers (also known as IPPs: Independent Power Producers) |
| **Enoe** | National Employement Survey |
| **ENSO** | El Niño Southern Oscillation |
| **ETM** | Enhanced Thematic Mapper |
| **EPC** | Environmental Protection Costs |
| **FAO** | Food and Agriculture Organization |
| **FCAS** | Spanish Water and Sanitation Cooperation Fund |
| **FDL** | Federal Duties Law |
| **Fonadin** | National Infrastructure Fund |
| **Fonden** | National Natural Disaster Fund |
| **GDP** | Gross Domestic Product |
| **GEF** | Global Environmental Facility |
| **GIS** | Geographic Information System |
| **GIZ** | German Federal Enterprise for International Cooperation |
| **GWI** | Global Water Intelligence |
| **HARs** | Hydrological-administrative regions |
| **IADB** | Inter-American Development Bank |
| **IAH** | International Association of Hydrogeologists |
| **IBRD** | International Bank for Reconstruction and Developmen |
| **IBWC** | International Boundary and Water Commission |
| **Icold** | International Commission on Large Dams |
| **ID** | Irrigation District |
| **IEA** | International Energy Agency |
| **INBO** | International Network of Basin Organizations |
| **INECC** | National Institute of Ecology and Climate Change |
| **Inegi** | National Institute of Statistics and Geography (formerly the National Institute of Statistics, Geography and Informatics) |
| **IP** | Private Initiative |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **ITAM** | Autonomous Technical Institute of Mexico |
| **IUs** | Irrigation units |
| **IWA** | International Water Association |
| **JBIC** | Japan Bank for International Cooperation |
| **KFW** | German Development Bank |
| **MA** | Metropolitan area |
| **MASL** | Meters above sea level |
| **MDGs** | Millennium Development Goals |
| **MLN** | Most likely number |
| **MT** | Master table |
| **Nadbank** | North American Development Bank |
| **NADM** | North American Drought Monitor |
| **NAICS** | North American Industry Classification System |
| **NASA** | National Aeronautics and Space Administration |
| **NDP** | National Development Plan |
| **NIW** | National Inventory of Wetlands |
| **NMX** | Mexican standard |
| **NOM** | Official Mexican standard |
| **NPE** | Normal Pool Elevation |
| **NWL** | National Water Law |
| **NWP** | National Water Program |
| **Patme** | Program for Technical Assistance for the Improvement of Efficiency in the Drinking Water and Sanitation Sector |
| **PIAE** | Protection for Infrastructure and Emergency Attention |
| **Premia** | Project to Strengthen Integrated Water Resources Management in Mexico |

| | |
|---|---|
| **Prodder** | Program for Reimbursing Duties |
| **Profepa** | Attorney General's Office for Environmental Protection |
| **Promagua** | Water Utility Modernization Project |
| **Prome** | Program for the improvement of efficiency in the drinking water and sanitation sector |
| **Pronacose** | National Program against Drought |
| **Prosanear** | Federal Program for Wastewater Treatment |
| **Prosiba** | Program of Integral Sanitation of the Acapulco Bay |
| **Prossapys** | Program for the Construction and Rehabilitation of Drinking Water and Sanitation Systems in Rural Areas |
| **Repda** | Public Registry of Water Duties |
| **Sagarpa** | Ministry of Agriculture, Livestock, Rural Development, Fishing and Food |
| **SDGs** | Sustainable Development Goals (evolution of the Millennium Development Goals) |
| **SEEA** | System for Environmental-Economic Accounting |
| **SCFI** | Ministry of Trade and Industrial Development (obsolete, employed in the names of NOMs) |
| **SECCI** | Sustainable Energy and Climate Change Initiative |
| **Sectur** | Ministry of Tourism |
| **SPE** | Surcharge Pool Elevation |
| **Sedesol** | Ministry of Social Development |
| **SEEAW** | System of Environmental-Economic Accounting for Water |
| **Segob** | Ministry of the Interior |
| **Semar** | Ministry of the Navy |
| **Semarnat** | Ministry of the Environment and Natural Resources |
| **SHCP** | Ministry of Finances and Public Credit |
| **SIAP** | Agro-Food and Fishing Information Service |
| **SINA** | National Water Information System (full name according to NWL: National information system on water quality, quantity, uses and conservation) |
| **SPOT** | Satellite for Earth Observation |
| **SRTM** | Shuttle Radar Topography Model |
| **SS** | Ministry of Health |
| **SSA** | Ministry of Healthiness and Assistence (obsolete, employed in the names of NOMs) |
| **STPS** | Ministry of Employment and Social Prevention |
| **TD** | Tropical depression |
| **TRD** | Technified rainfed district |
| **TS** | Tropical storm |
| **TSS** | Total Suspended Solids |
| **UN** | United Nations |
| **UNDP** | United Nations Development Programme |
| **UNESCO** | United Nations Education, Science and Culture Organization |
| **UNISDR** | United Nations - International Strategy for Disaster Reduction |
| **UNSD** | United Nations Statistics Division |
| **USGS** | United States Geological Survey |
| **WB** | World Bank |
| **WCIF** | Water Conservation Investment Fund (NADBANK) |
| **WHO** | World Health Organization |
| **WMO** | World Meteorological Organization |
| **WQI** | Water Quality Index |
| **WWF** | World Water Forum |
| **WWTP** | Wastewater treatment plant |
| **ZMVM** | Valley of Mexico metropolitan area |
| **Zofematac** | Federal Maritime Land Area and Coastal Areas |

# Annex F. Measurement units and notes

**Renewable water resources:** The calculation of renewable water resources is carried out through spatial analysis, intersecting the layers of municipalities, watersheds and aquifers in order to make up minimal spatial units (municipality-watershed-aquifer). Assuming an equal distribution throughout the area of the relevant and most up-to-date values, the renewable water resources for each minimal spatial unit are calculated. This calculation allows the value of renewable water resources to be represented through the aggregation of minimal units both in municipalities, watersheds and aquifers and in groups of municipalities: states and hydrological-administrative regions.

**Closing:** The closing date of the data is generally speaking December 31, 2014, except for specific cases, in which the information is derived from different censuses, such as socio-economic information at the municipal level, calculated up to 2010; when the latest information available is not at the closing date, such as the state GDP (see the note below); or when it has a significant deadline, such as the Millennium Development Goals, for which the global compliance is evaluated up to 2015.

**Population:** The population projection employed by Conapo (2015), at the mid-year point, is used for the 2010-2030 period. It should be mentioned that the 2010 Census on Population and Housing found a population of 112.3 million inhabitants at the time it was carried out. For the calculation of 2010-2030 population projections, the Conapo carried out a 1990-2010 demographic conciliation, which allowed it to establish that the population at mid-year 2010 was 114.3 million inhabitants. The Conapo's projections consider 137.48 million inhabitants by 2030.

**Precipitation:** The values reported by the National Meteorological Service are employed (total, regional and state-wide) for both the normal 1981-2010 precipitation and the 2014 annual precipitation.

**Gross Domestic Product (GDP):** For the present document the national GDP available was calculated for the year 2014. The calculation by state and by hydrological-administrative region is based on the GDP per state, the latest data on which available for this edition was for 2013.

**Rounding up or down:** Because of rounding up or down, the sums in the tables both in values and percentages do not necessarily add up to the totals.

**Bibliographic references:** The Harvard System or author-date system is used. In the text, when the reference document is quoted, a particle is included with the format "Author (date)", for example "Conagua (2003)". The list of bibliographical references is included in annex G. For the previous example, the corresponding entry in the annex is "Conagua. 2003. Manual de Drinking water, Sanitation y saneamiento - MAPAS.". Specific formats are used for printed documents, institutional authors and sources consulted online. In order to identify the works from one author from the same year, the years are differentiated by a progressive literal: "Conagua (2015a)", "Conagua (2015b)". Using this system results in space saving and allows the sources used to be rigorously quoted.

**System of units:** The units used in this document are expressed in conformity with NOM-008-SCFI-2002 "General System of Measurement Units" considering its modification on September 24, 2009, which establishes that the decimal point may be a comma or a period.

**Mainland area:** In Inegi's Information Bank, the "Mainland area" item (Inegi 2015p), there is information up to 2005 on the mainland area for each one of the 2 454 municipalities existing at that time, and consistent with the totals of mainland area present in Inegi's statistical almanac. Considering that the new municipalities are made up of fractions of existing municipalities, the Conagua, based on the analysis of the information in the geographical layer "Marco geoestadístico municipal" (Municipal geostatistical framework), 2005 and 2014 versions, assigned areas to each of the 2 457 municipalities existing in 2014, conserving the same totals. It is of interest to the Conagua to have the mainland areas and totals at the municipal level, since with that it is possible to calculate consistently the mainland and total area both of states and hydrological-administrative regions, which are the aggregation of municipalities.

**Baseline units, derived or conserved for their use from NOM-008-SCFI-2002**

| Symbol | Unit | Equivalents |
|---|---|---|
| cm | centimeter | 1 cm = 0.01 m |
| ha | hectare | 1 ha = 10 000 $m^2$ = 2.47 acres |
| $hm^3$ | cubic hectometer | 1 $hm^3$ = 1 000 000 $m^3$ |
| kg | kilogram | 1 kg = 1 000 g |
| km/h | kilometer per hour | 1 km/h = 0.2778 m/s |
| $km^2$ | square kilometer | 1 $km^2$ = 1 000 000 $m^2$ |
| $km^3$ | cubic kilometer | 1 $km^3$ = 1 000 000 000 $m^3$ |
| L, l | liter | 1 L = 0.2642 gal |
| L/s, l/s | liter per second | 1 L/s = 0.001 $m^3$/s |
| m | meter | 1 m = 3.281 ft |
| $m^3$ | cubic meter | 1 $m^3$ = 0.000810 AF |
| $m^3$/s | cubic meter per second | 1 $m^3$/s = 35.3 cfs |
| mm | millimeter | 1 mm = 0.001 m |
| mm | millimeter | 1 mm = 0.0394 in |
| t | ton | 1 t = 1 000 kg |
| W | watt | 1 W = 1 $m^2$ kg/$s^3$ |

| Units not included in NOM-008-SCFI-2002 | | |
|---|---|---|
| **Symbol** | **Unit** | **Equivalents** |
| AF | acre-foot | 1 AF = 1 233 $m^3$ |
| cfs | cubic feet per second | 1 cfs = 0.0283 $m^3/s$ |
| ft | foot | 1 foot = 0.3048 m |
| gal | gallon | 1 gal = 3.785 L |
| hab | inhabitants | Not applicable |
| in | inch | 1 in = 25.4 mm |
| MAF | million acre-feet | 1 MAF = 1.23 $km^3$ |
| MASL | meters above sea level | Not applicable |
| pesos | Mexican pesos | 1 Mexican peso = 0.07643 United States dollars |
| ppm | parts per million | 1 ppm = 0.001 g/L |
| USD | United States dollar | 1 United States dollar = 14.7414 Mexican pesos |
| * The FIX exchange rate as of December 31, 2014 was considered (Banxico 2015b). | | |

| Examples of measurements |
|---|
| 1 $m^3$ = 1 000 liters |
| 1 $hm^3$ = 1 000 000 $m^3$ |
| 1 $km^3$ = 1 000 $hm^3$ = 1 000 000 000 $m^3$ |
| 1 TWh = 1 000 GWh = 1 000 000 MWh |

| Prefixes to form multiples | | | | | |
|---|---|---|---|---|---|
| **Symbol** | **Name** | **Value** | **Symbol** | **Name** | **Value** |
| T | tera | $10^{12}$ | h | hecto | $10^{2}$ |
| G | giga | $10^{9}$ | c | centi | $10^{-2}$ |
| M | mega | $10^{6}$ | m | mili | $10^{-3}$ |
| k | kilo | $10^{3}$ | | | |

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# **Annex H.** Analytical index

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