Statistics on Water in Mexico

2017 EDITION

National Water Commission

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Statistics on Water in Mexico, 2017 edition

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Urn of the deity Pitao Cocijo,
Classic, Monte Albán III A (200-500 A.D.)

Among the most important deities of the Zapotecs is Pitao Cocijo, whose name means "lightning"; god of rain, storms, hail, fog, dew, and terrestrial water sources. It is distinguished for having a broad nose that evokes the stylized jaws of a snake, a forked tongue, blinkers evoking hills and for carrying in its headdress the glyph C, which is associated with the rain. It generally holds in its hands a vessel from which corn leaves emerge.

Dr. Martha Carmona Macías
Curator-researcher

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Landscape at the Cuemanco Canal in Xochimilco.

Preface

The National Water Commission, through the Interinstitutional Coordination Department, which is part of the Deputy Director General's Office for Planning, manages and operates the National Water Information System (SINA).

With the idea of sharing the data contained in the SINA, CONAGUA presents the publication *Statistics on Water in Mexico*—which offers information on the quantity, quality, uses and conservation of water—as an effort to give a comprehensive overview of the water sector in our country.

In its 2017 edition, *Statistics on Water in Mexico* includes environmental, economic and social issues, categorized in eight chapters:

Chapter 1, Geographical and socioeconomic context of Mexico. Includes geographical aspects, population centers, economic indicators, sociodemographic conditions, water analyses by hydrological-administrative region (RHA), regional contrast between development and renewable water resources (RWR) and a summary of data by state.

Chapter 2, State of water resources. Presents an analysis of the state of the watersheds and aquifers of the country, as well as of renewable water resources, precipitation, hydrometeorological events, surface water, groundwater and water quality.

Chapter 3, Uses of water. A review of the registry of volumes allocated or assigned to the users of water in Mexico, their classification and distribution in the national territory.

Chapter 4, Water infrastructure. This chapter shows the infrastructure of our country for drinking water and sanitation, hydro-agriculture, water treatment and reuse, as well as for emergency response and flood protection.

Chapter 5, Water management tools. It refers to water-related institutions in Mexico, the legal framework for the use of water in Mexico, the regulations, economy, finances, duties, budget and revenue related to water, as well as social participation mechanisms.

Chapter 6, Water, health and the environment. It links the health of the population to exposure to waterborne pathogens. It also discusses the links between water and biodiversity and water and vegetation, as well as wetlands.

Chapter 7, FutureScenarios. It offers a projection of water resources and their future scenarios from a sustainable use policy, current trends and 2013–2018 planning.

Chapter 8, Water in the world. It allows to visualize a universe of the sector and several overviews, from economic to social, and comparisons with the situation of the sector in Mexico.

References for reading this work

Statistics on Water in Mexico, in its 2017 edition, presents data such as maps, tables and graphs, generally from the last ten years of information. For the reader interested in consulting the information in detail, the source data of tables and graphs preserve the entire period of annual statistics available.

Throughout the text you can identify them by their first letter, the chapter number and a consecutive number: Table 7.1, Graph 4.9. You will also find maps and figures that can be identified in the same way: Map 4.2, Figure 2.3.

In the electronic version (available for download and consultation at http://sina.conagua.gob.mx/sina/) it is possible to have access to these source data and find information on the topics of each chapter in the SINA with the indication [Tablero: <Name of the subject>], as well as in the tables, graphs and complementary maps.

The basis of the federal administration for water issues are the 13 hydrological-administrative regions (HARs), so its territorial division is presented in most of the maps of this document. Their characteristics are listed on the map located on page 228.

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

With the aim of guiding the reader, there are notes identified with numbers (1) at the bottom of the page, as well as footnotes on tables, graphs or maps. Annex F includes a few short notes ont the methodologies for relevant topics and in Annex G there is an index of tables, figures, graphs and maps.

Sources are identified by references within the text; for example, INEGI (2015a), and there is a complete bibliography in Annex H.

Petrified waterfalls in Hierve el Agua, Oaxaca.

Chapter 1

Geographical and socioeconomic context

Panoramic view of Mexico City's main square, known as the Zócalo.

Geographical and socioeconomic context

Geographical and demographic aspects

Surface area

1.964 million km²

9.4 million people in extreme poverty

Economy

Inflation:
3.36%

Per capita:
$159 663.83

Total GDP:
$19.523 trillion

Composition of the GDP

	1950	2016
Primary Agriculture and livestock	**19.2%**	**3.8%**
Secondary Industry	**26.5%**	**32.7%**
Tertiary services	**54.3%**	**63.4%**

Political division:
32
federative entities

2 458
municipalities and precincts

56.97%
of the population is concentrated in metropolitan areas

59
metropolitan areas in Mexico as of 2015

2016 projection:
122.27
million inhabitants in Mexico

2030 projection
137.5
million inhabitants in Mexico

Extreme poverty decreased
17.54%

equivalent to 2 million people

13
regions for water management

Hydrological-administrative regions

North
Less water availability
Greater population
Higher contribution to the GDP

South
Higher water availability
Lower population
Lower contribution to the GDP

1.1 Geographical and demographic aspects

[Tablero: Ubicación geográfica de México]

The territorial extension of the United Mexican States is 1.964 million km^2, 1.959 million of which correspond to the continental area and the rest to the island area, as can be observed in Table 1.1. Also to be considered is the Exclusive Economic Zone (EEZ), defined as a strip of up to 370 kilometers wide[1] measured from the coastal baseline[2], the extension of which is estimated at approximately three million square kilometers.

Mexico has a surface area of

1.964

million km²

There are different factors that 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 shown in Map 1.1.

As a second factor are the geographical accidents that characterize Mexico's landform, as illustrated in Figure 1.1. The geographical location and the geomorphology have a direct impact on the availability of water resources.

Table 1.1 Mexico's location and territorial extension

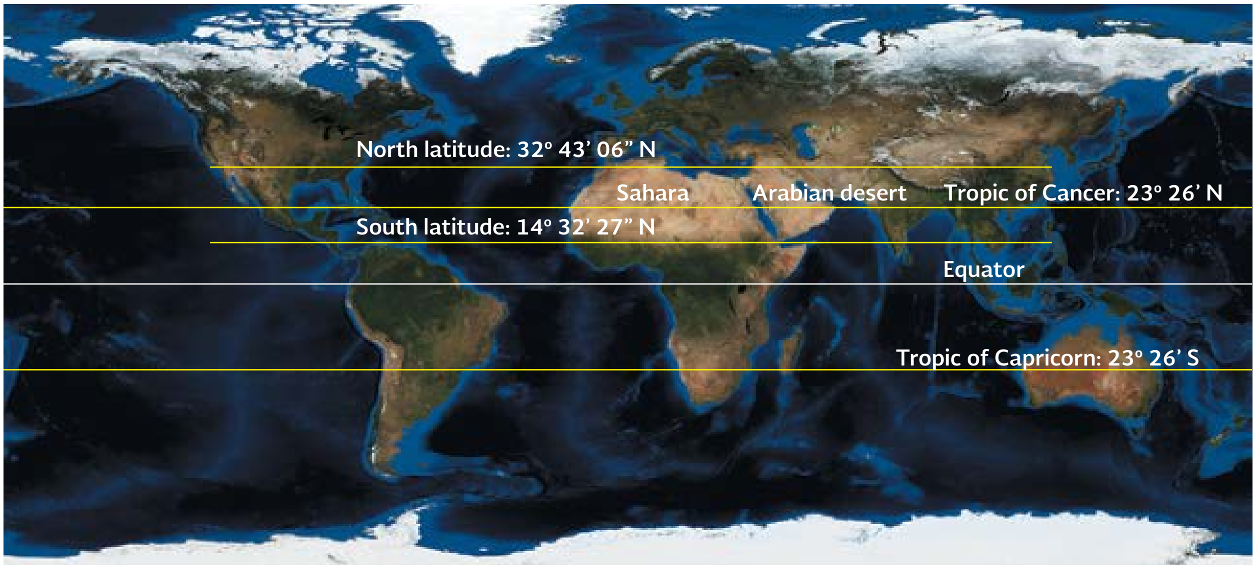
Territorial extension	
Territorial area	1 964 375 km²
Mainland	1 959 248 km²
Islands	5 127 km²
Coastline	
Total length	11 122 km
Pacific Ocean	7 828 km
Gulf of Mexico and Caribbean Sea	3 294 km
International boundaries of the mainland territory	
With the United States of America	3 152 km
With Guatemala	956 km
With Belize	193 km
Extreme geographical coordinates	
To the north: 32° 43´ 06´´ latitude North. Monument 206, at the border with the United States of America.	
To the south: 14° 32´ 27´´ latitude North. Mouth of the Suchiate River, at the border with Guatemala.	
To the east: 86° 42´ 36´´ longitude west. Isla Mujeres.	
To the west: 118° 27´24´´ longitude west. Isla Guadalupe.	

Source: Inegi (2016a).

1 Internationally defined as 200 nautical miles (UN 1994). One nautical mile equals 1.852 km.

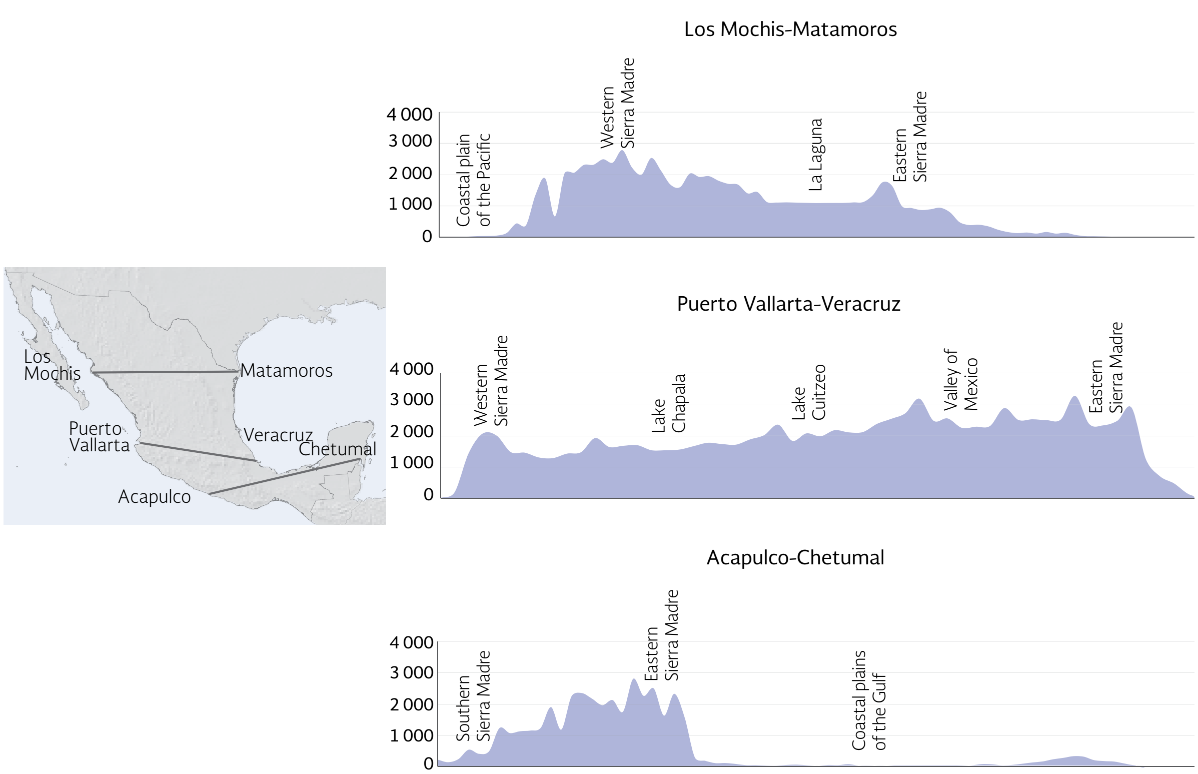
2 Defined as the low tide line along the coast (UN 1994).

Map 1.1 Mexico's geographical location



Source: Based on NASA (2016).

Figure 1.1 Elevation profiles (masl)



Source: Based on USGS (2016a).

Two thirds of the territory are considered arid or semi-arid, with annual precipitations lower than 500 mm, whereas one third, the southeast, is humid, with precipitations of over 2 000 mm per year. In most part of the territory, rainfall is more intense in the summer, mainly of the torrential type.

As of 2016, Mexico is composed of 31 states and Mexico City, made up of 2 442 municipalities and 16 precincts, respectively[3].

Mexico's population is estimated from nationwide surveys and enumerations, referred to as population and housing censuses and counts, conducted by the National Institute of Statistics and Geography (INEGI)[4] and from population projections carried out by the National Population Council (CONAPO)[5]. This edition considers information from INEGI's "2015 Intercensal Survey".

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 2015, the country's population quadrupled, and went from being largely rural to predominantly urban, as shown in Graph 1.1.

According to the 2010 Population and Housing Census, that year there were 192 247 inhabited localities, distributed according to size and latitude as shown in Table 1.2. Graph 1.2 shows that 53.2% of the population lived in areas over 1 500 meters above sea level.

Mexico has

2 442

municipalities and

16

precincts

TABLE 1.2 Distribution of the population by size of locality, 2010

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

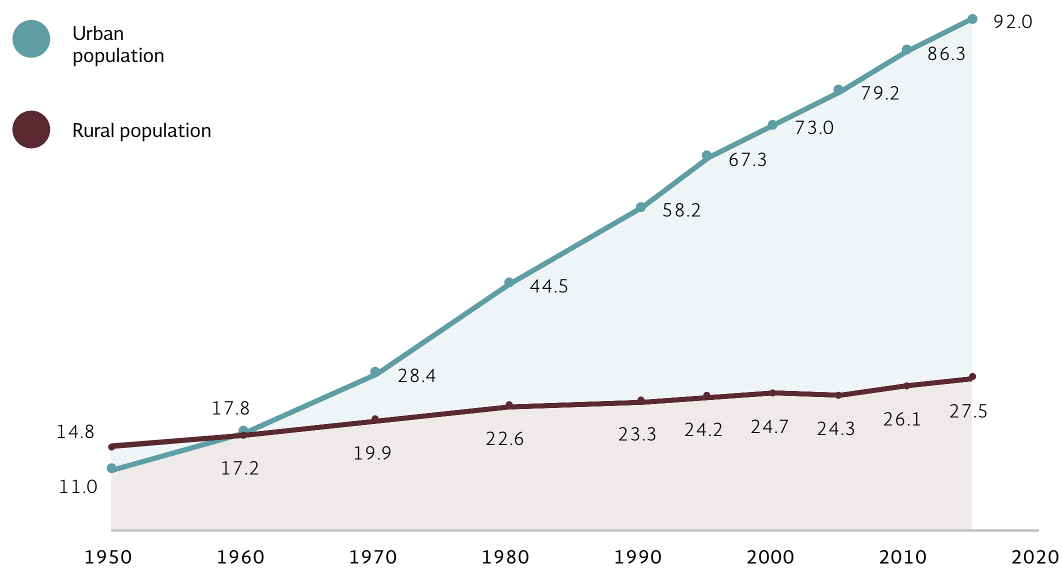
Source: INEGI (2016e).

3 According to INEGI (2016b) there are 2 458 municipalities and precincts with geographical representation. It should be noted that on January 29, 2016, the political reform of Mexico City was published in the *Official Gazette of the Federation*.

4 The last count was made in 2005. The last census, known as the 2010 Population and Housing Census, found a total population of 112.3 million inhabitants and generated as a by-product the location of all of the country's localities.

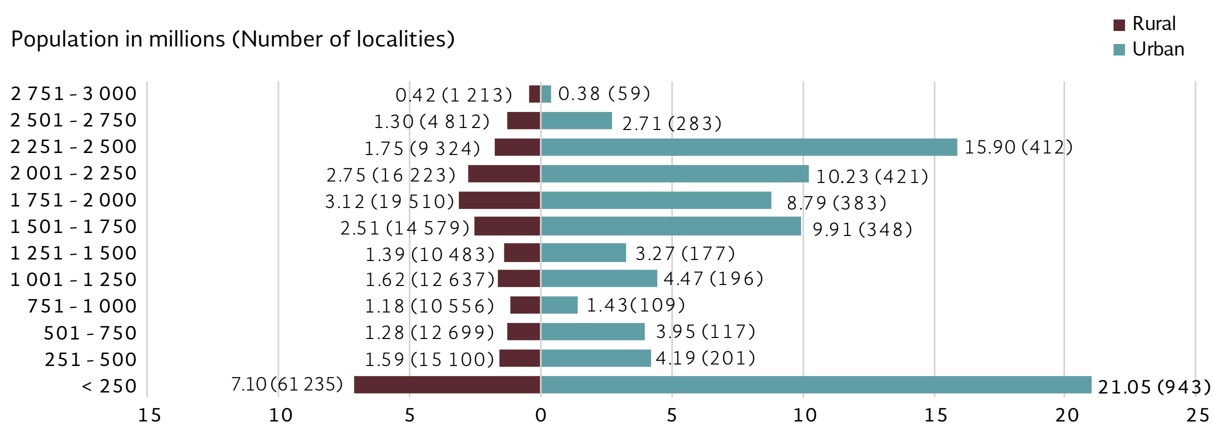
5 For the calculation of 2010-2050 population projections, CONAPO (2012) carried out a 1990-2010 demographic conciliation that allowed to establish that the population in mid-2010 was 114.3 million inhabitants. For 2016, the population projection was 122.27 million inhabitants, and for 2030 it is 137.5 million inhabitants.

Graph 1.1 Evolution of urban and rural population (millions of inhabitants)



Source: Based on INEGI (2016d), INEGI (2016c).

Graph 1.2 Distribution of the population and its localities by altitude range, 2010



Note: Data as of the date of the Census. In 2010 there were 277 localities (225 rural and 2 urban ones) with a total of 57 821 inhabitants, located at more than 3 000 meters above sea level. Rural localities are those with under 2 500 inhabitants.

Source: INEGI (2016e).

1.2 Population centers

[Tablero: Población]

Based on data from the 2010 Population and Housing Census, 59 Metropolitan Areas (MAs) were defined[6], for which CONAPO estimated a population of 69.66 million inhabitants in 2016, accounting for 56.97% of the total population projected for that year. Thirty-two MAs have more than 500 000 inhabitants, which represents a total of 62.08 million people and 50.77% of the national population. There are 36 localities with more than 100 000 inhabitants in localities that are not part of metropolitan areas, with a total population of 8.5 million people and 7% of the national population. Three localities that are not part of a MA (Hermosillo, Victoria de Durango and Culiacan Rosales) had more than 500 000 inhabitants in 2016. These population centers are shown in Map 1.2.

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

CONAPO estimated that in 2016, in the 15 metropolitan areas with a population of more than one million inhabitants, 40.14% of the population of Mexico, was concentrated; i.e., 49.09 million inhabitants.

As of 2016
15
metropolitan areas have more than **one million inhabitants**

Map 1.2 Main population centers, 2016

Note: Includes both MAs and localities outside MAs, with a population of more than 500 000 inhabitants.
Source: Based on CONAPO (2012), INEGI (2016e), SEDESOL *et al.* (2012).

6 An MA is defined as the sum of two or more municipalities in which a city of 50 000 or more inhabitants is located, and the urban area, functions and activities of which go beyond the limits of the municipality that it was originally part of, incorporating mainly urban neighboring municipalities as part of the municipality or of its area of direct influence, with which they maintain a high degree of socio-economic integration.

1.3 Economic indicators

[Tablero: Indicadores económicos]

Mexico's GDP grew

2.3%

in 2016

According to the Bank of Mexico (BANXICO), in 2016, the Mexican economy showed a greater expansion to that recorded in 2015. In particular, the external demand continued to improve as a result of the moderate recovery of world economic activities and of the germinal reactivation of international commerce, while private consumption continued by a positive path. In contrast, investment persisted with poor performance[7].

The depreciation of the real exchange rate and the incipient reactivation of global demand contributed to the recovery of manufacturing exports after the negative trend they had shown in 2015 and early 2016. Oil exports also showed a positive trend, although they maintained low levels. The increase obeys mainly to a higher average price of the Mexican crude oil mixture for exportation, since the crude oil platform remained relatively stagnant. Annual inflation was 3.36% (INEGI 2016h), exceeding BANXICO's inflation limit (3%). There was an annual growth of the Gross Domestic Product (GDP) of 2.3%, lower than the 2.6% rate recorded in 2015 (INEGI 2016g)[8].

The five-year trend of the main indicators can be observed in Table 1.3. It is worth noting that the previous edition used constant 2008 prices in order to keep consistency with INEGI (2016g); the reference year for this edition is 2016.

Throughout the 20th century, the contribution of agricultural, forestry and fishing activities to Mexico's GDP has progressively decreased, as opposed to industry and services, which have increased, as shown in Graph 1.3. This change is even more evident in the active population by economic sector[9], with a significant reduction in Mexicans that are active in the primary sector (from 58.3% to 13.1% in the 1950–2016 period), and the corresponding increase in those active in the tertiary sector (from 25.7% to 61.5% in the same period). The active population in Mexico as of the fourth trimester of 2016 was 50.3 million people.

7 BANXICO (2016a).

8 *Ibld*.

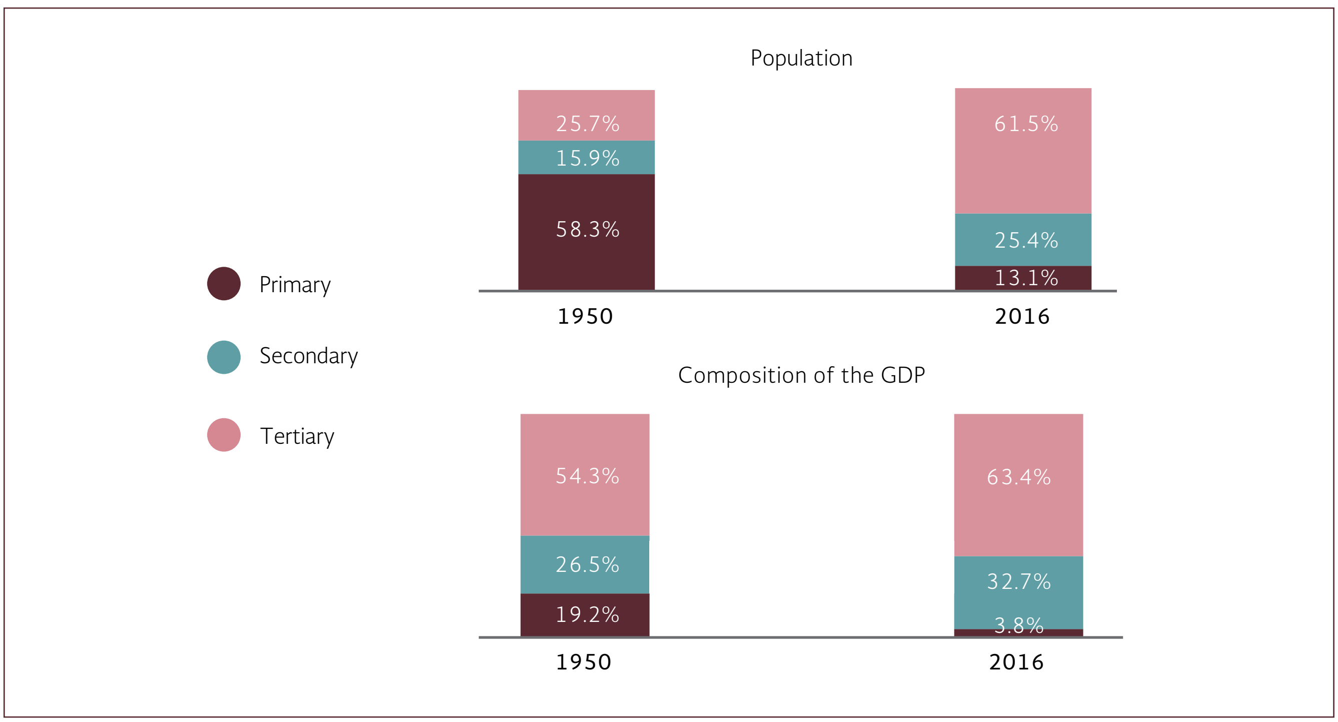
9 According to INEGI, the primary sector includes agriculture and livestock, forestry and fishing activities. The secondary sector considers mining, the manufacturing industry, construction, electricity, gas and water. The tertiary sector includes trade, restaurants and hotels, transport, storage and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

TABLE 1.3 Main economic indicators in Mexico

Year	Indicators		
	Gross Domestic Product (GDP) (trillions of pesos, constant 2016 prices)	Per-capita GDP (Pesos, constant 2016 prices)	Annual inflation based on the National Consumer Price Index
1995	10.266	108 649	51.97%
2000	12.536	124 247	8.96%
2005	14.400	134 386	3.33%
2010	16.308	142 730	4.40%
2015	18.757	155 007	2.13%
2016	19.523	159 664	3.36%

Source: Based on CONAPO (2012), INEGI (2016f), INEGI (2016g).

GRAPH 1.3 Composition of economic activity by sector, 1950 y 2016



Note: For illustrative purposes only, the calculation of the percentage of the active population by sector of economic activity does not consider the “Others” category, which represents 0.6% of the average active population in 2016. 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: Based on INEGI (2014a), INEGI (2016i), INEGI (2016g).

1.4 Sociodemographic conditions

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

In 2016

53.4

million people had some degree of

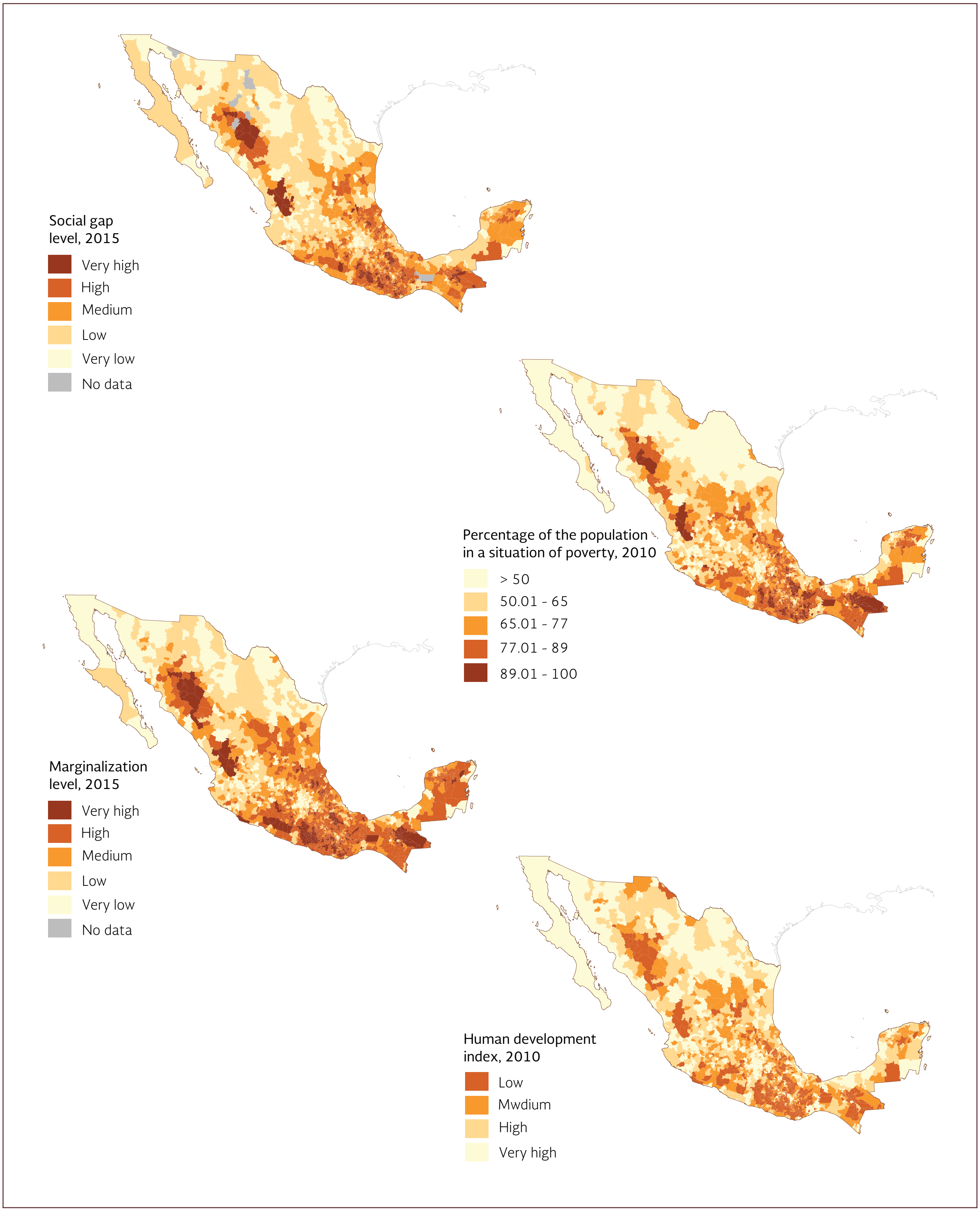
poverty

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 2016. At the municipal level it is carried out every five years, since it is calculated based on national censuses and counts.

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 2016, it was estimated nationwide that 55.3 million people (43.6% of the population) are in a state of poverty; 9.4 million of which are in a state of extreme poverty. (CONEVAL 2016a)

A complementary measurement is the Social Gap Index, developed also by CONEVAL. This measurement includes indicators of education, assets in the home and quality and services in the house. Also complementary is the Index of Marginalization, developed by CONAPO, which considers aspects of education, housing, income from work and distribution of the population. These two indices were updated to 2015 based on INEGI's Intercensal Survey. Another reference is the Human Development Index, developed by the United Nations Development Programme (UNDP) based on standard of living, education and life expectancy at birth. Figure 1.2 shows these four indicators at the municipal level.

FIGURE 1.2 Municipalities with adverse socioeconomic conditions



Source: Based on CONEVAL (2011b), CONEVAL (2016), CONAPO (2016), UN-UNDP (2014).

1.5 Hydrological-administrative regions (HARs) for water management

[Tablero: División hidrológico-administrativa]

The National Water Commission (CONAGUA), an administrative, regulatory, technical and consultative organization; in charge of water management in Mexico, carries out its functions through 13 river basin councils, whose scope of competence are the hydrological-administrative regions (HARs), which are composed of river basin councils, considered to be the basic units for water management. HARs respect municipal boundaries in order to facilitate the integration of socioeconomic information. (See the map on the first page of annexes.)

CONAGUA has 13 river basin **councils**

The table below shows the characteristics of HARs. It should be noted that the calculation of the contribution to the GDP is based on state contributions, the latest data on which is from 2015.

The municipalities that make up each of these HARs are indicated in the Territorial Constituency Agreement for River Basin Organizations, published in the *Official Gazette of the Federation* on April 1st, 2010. In addition, for those states with no river basin organization headquarters, CONAGUA has 20 local offices.

Table 1.4 Characteristics of HARs

HAR No.	Mainland area (km²)	2016 Renewable water resources (hm³/year)	Population in mid 2016 (millions of inhabitants)	Population density (inhab/km²)	2016 per capita renewable water resources (m³/inhab/year)	Contribution to the 2015 GDP (%)	Municipalities or Mexico City precincts
I	154 279	4 875.83	4.522	29.311	1 078.24	3.88	11
II	196 326	8 274.40	2.879	14.665	2 874.01	2.91	78
III	152 007	26 613.05	4.552	29.944	5 846.79	3.01	51
IV	116 439	21 670.78	11.926	102.422	1 817.12	6.22	420
V	82 775	30 836.07	5.093	61.529	6 054.53	2.31	378
VI	390 440	12 430.16	12.456	31.904	997.89	14.83	144
VII	187 621	7 926.45	4.608	24.561	1 720.08	4.37	78
VIII	192 722	34 896.99	24.449	126.862	1 427.33	19.90	332
IX	127 064	28 663.40	5.329	41.938	5 378.90	2.31	148
X	102 354	65 645.44	10.648	104.030	6 165.10	5.52	432
XI	99 094	175 912.22	7.752	78.229	22 692.45	4.04	137
XII	139 897	29 646.82	4.687	33.504	6 325.12	5.82	128
XIII	18 229	3 436.54	23.372	1 282.134	147.04	24.88	121
Total	1 959 248	450 828.00	122.273	62.408	3 687.05	100.00	2 458

Source: Based on CONAPO (2012), INEGI (2016b), INEGI (2016j), CONAGUA (2016b).

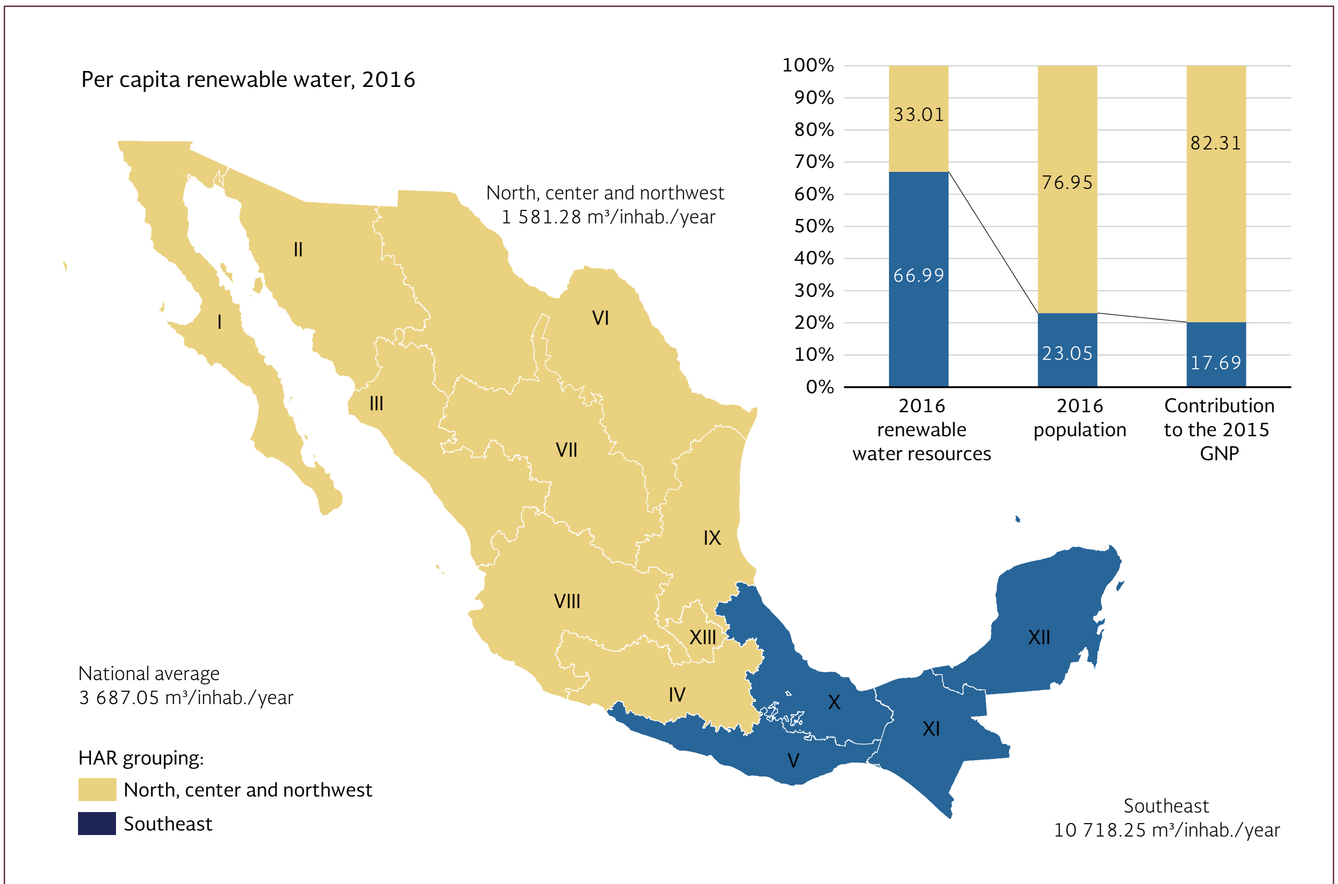
1.6 Regional contrast between development and renewable water resources (RWRs)

[Tablero: División hidrológico-administrativa, Agua renovable]

Population, renewable water resources (RWRs) and the GDP show significant variations at the regional level. By grouping hydrological-administrative regions V, X, XI and XII, located in the southeastern part of the country, the remaining regions can be contrasted.

The southeastern regions have two thirds of renewable water in the country, with a fifth part of the population contributing the fifth part of the national GDP. The northern, central and northeastern regions have a third part of the renewable water of the country, four fifths of the population and of the contribution to the GDP, shown in Figure 1.3. Considering the per capita renewable water, it is seven times greater in the southeast that that available in the rest of Mexico's hydrological-administrative regions.

FIGURE 1.3 Regional contrast between renewable water and development



Source: Based on CONAPO (2012), INEGI (2016b), INEGI (2016j), CONAGUA (2016b).

1.7 Summary of data by state

[Tablero: División hidrológico-administrativa]

The following table shows the main demographic, socioeconomic and renewable water resources (RWRs) data by state:

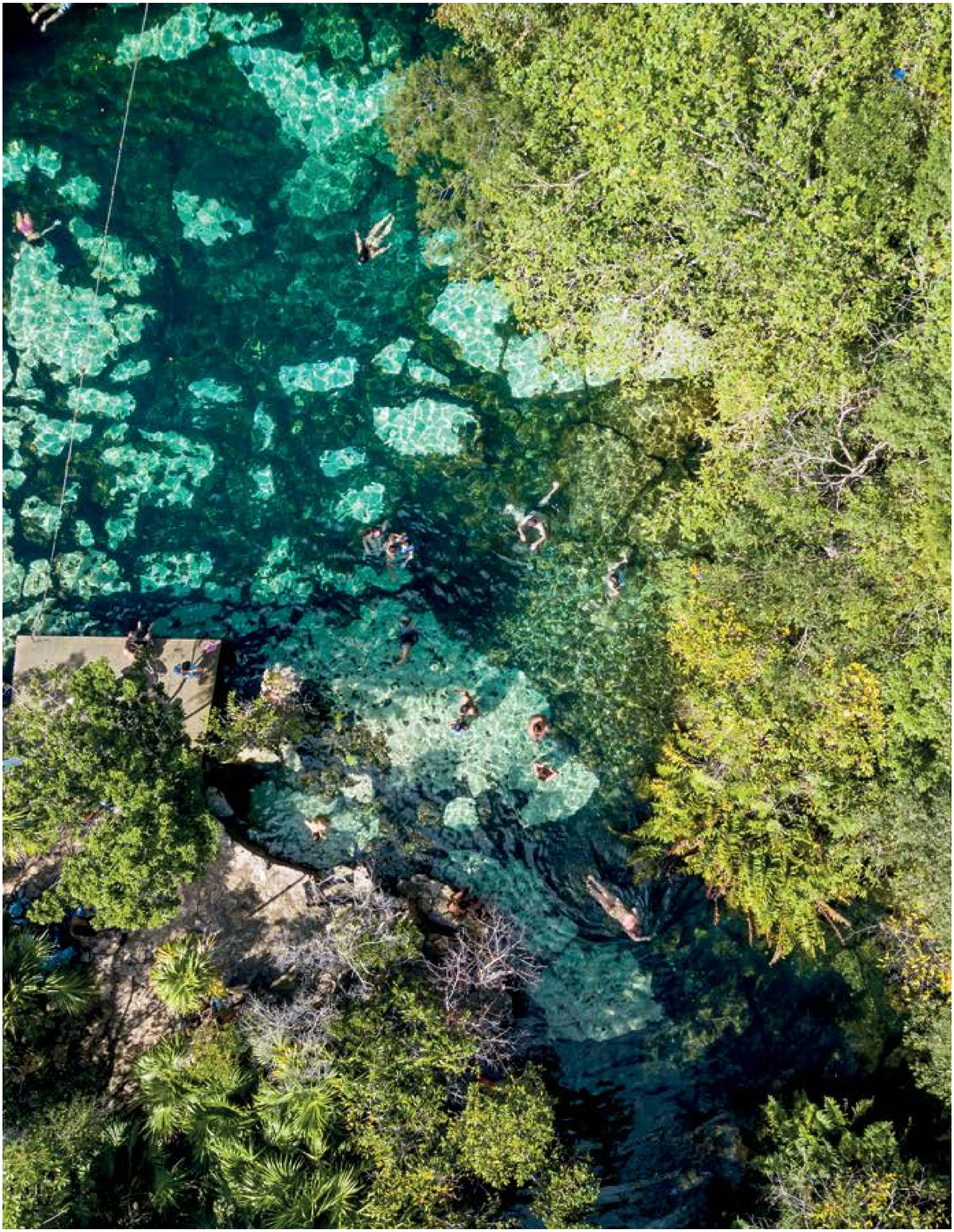
Table 1.5 Geographical and socioeconomic data by state

Key	Federative entity	Mainland area (km²)	Renewable water resources (hm³/year)	Population in mid 2016 (millions of inhabitants)	2016 per capita renewable water resources (m³/inhab/year)	Contribution to the 2015 GDP (%)	Municipalities or Mexico City precincts (Number)
01	Aguascalientes	5 618	520	1.30	398	1.27%	11
02	Baja California	71 446	3 018	3.53	854	3.02%	5
03	Baja California Sur	73 922	1 276	0.79	1 622	0.78%	5
04	Campeche	57 924	14 445	0.92	15 675	2.60%	11
05	Coahuila de Zaragoza	151 563	3 185	3.00	1 063	3.55%	38
06	Colima	5 625	2 155	0.74	2 930	0.61%	10
07	Chiapas	73 289	113 903	5.32	21 419	1.72%	118
08	Chihuahua	247 455	12 005	3.75	3 205	3.03%	67
09	Mexico City	1 486	484	8.83	55	16.74%	16
10	Durango	123 451	13 487	1.78	7 567	1.25%	39
11	Guanajuato	30 608	3 899	5.86	665	4.45%	46
12	Guerrero	63 621	21 276	3.59	5 929	1.52%	81
13	Hidalgo	20 846	7 325	2.91	2 514	1.76%	84
14	Jalisco	78 599	15 796	8.02	1 969	6.83%	125
15	State of Mexico	22 357	5 242	17.12	306	9.47%	125
16	Michoacán de Ocampo	58 643	12 663	4.63	2 736	2.40%	113
17	Morelos	4 893	1 816	1.94	934	1.18%	33
18	Nayarit	27 815	6 448	1.25	5 174	0.70%	20
19	Nuevo León	64 220	4 325	5.16	839	7.53%	51
20	Oaxaca	93 793	55 811	4.04	13 824	1.60%	570
21	Puebla	34 290	11 578	6.25	1 851	3.24%	217

Key	Federative entity	Mainland area (km²)	Renewable water resources (hm³/year)	Population in mid 2016 (millions of inhabitants)	2016 per capita renewable water resources (m³/inhab/year)	Contribution to the 2015 GDP (%)	Municipalities or Mexico City precincts (Number)
22	Querétaro	11 684	2 051	2.03	1 009	2.35%	18
23	Quintana Roo	42 361	8 097	1.62	4 999	1.66%	11
24	San Luis Potosí	60 983	10 691	2.78	3 848	2.02%	58
25	Sinaloa	57 377	8 759	3.01	2 910	2.20%	18
26	Sonora	179 503	7 091	2.97	2 385	2.96%	72
27	Tabasco	24 738	31 334	2.41	13 013	2.32%	17
28	Tamaulipas	80 175	9 005	3.58	2 513	3.06%	43
29	Tlaxcala	3 991	918	1.30	708	0.57%	60
30	Veracruz de Ignacio de la Llave	71 820	51 307	8.11	6 329	4.99%	212
31	Yucatán	39 612	7 016	2.15	3 269	1.57%	106
32	Zacatecas	75 539	3 904	1.59	2 458	1.07%	58
	Total	**1 959 248**	**450 828**	**122.27**	**3 687**	**100.00%**	**2 458**

Source: Based on CONAPO (2012), INEGI (2016B), INEGI (2016j), CONAGUA (2016b).

Girl playing with the water of the fountain in front of the Monument to the Mexican Revolution.

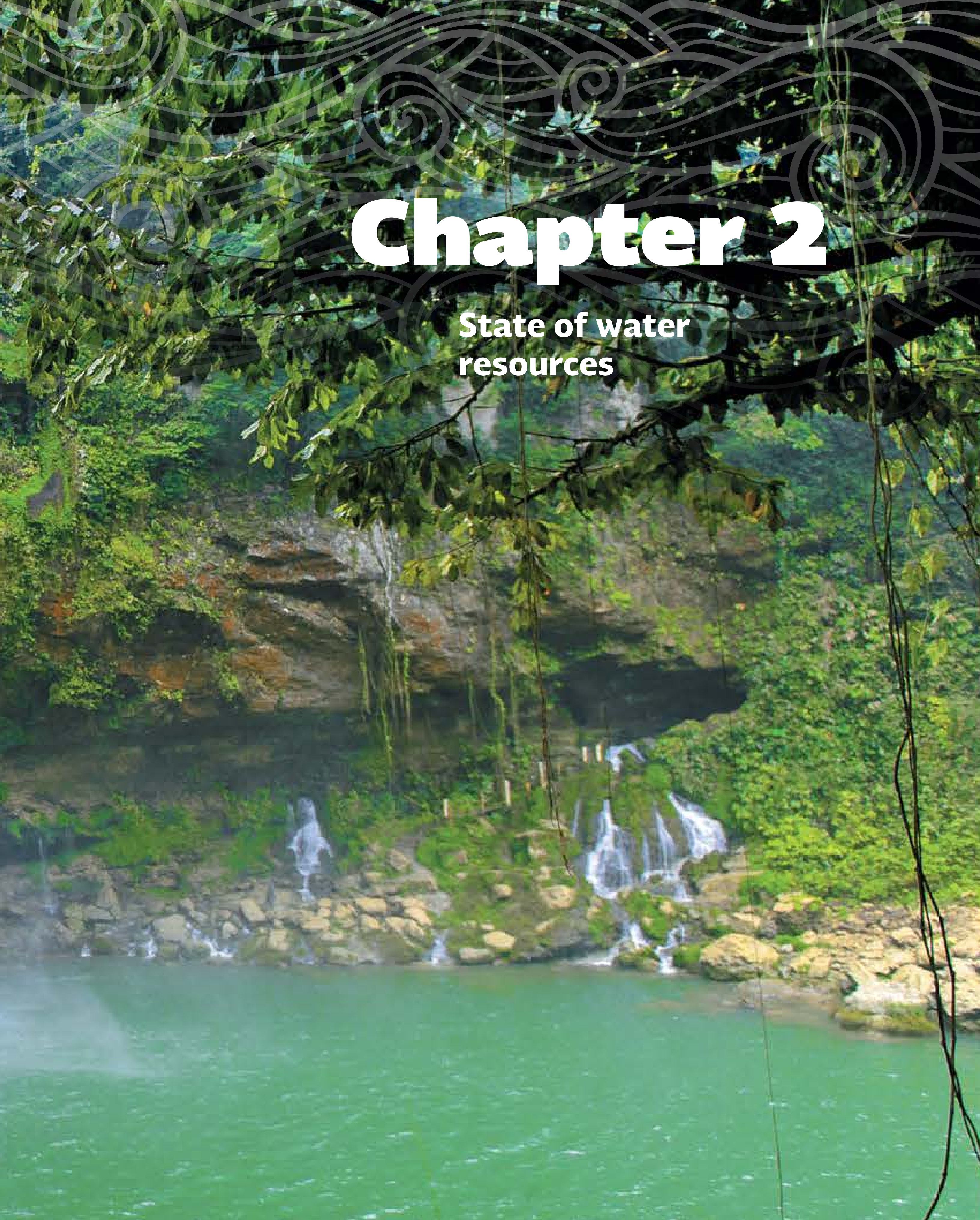


Aerial view of Cenote Azul in Quintana Roo.

Misol-Ha waterfall in the municipality of Salto de Agua, Chiapas.

Chapter 2

State of water resources



State of water resources

Renewable water

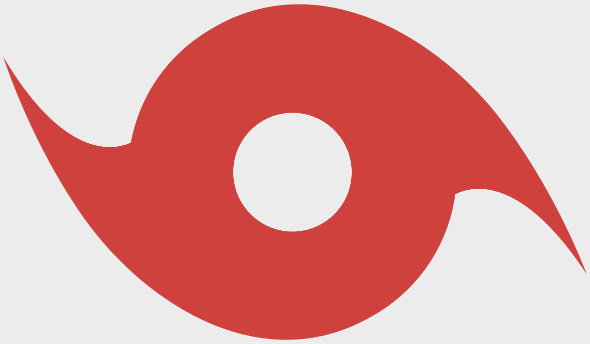
Water that may be feasibly and sustainably used in a region

Mexico in 2016:

450 828 hm^3
per year

Climate

	Normal 1981-2010
Precipitation	**740 mm**
2016	**744 mm**



Hydrometeorological events

Hurricanes:

- Cyclones with a wind speed greater than 119 km/h

Droughts:

- Rainfall with less than normal levels in any given region

Water quality

5 068

monitoring sites operated by CONAGUA

BOD_5

Biological Oxygen Demand

Indicates biodegradable organic matter

Caused by municipal wastewater discharges

COD

Chemical Oxygen Demand

Indicates organic matter

Caused by wastewater discharges in general

TSS

Total Suspended Solids

Indicates suspended solids and organic matter

Caused by wastewater discharges, agricultural waste and erosion

Groundwater

653 aquifers for groundwater management provide **39%** of the volume for consumptive uses

105 in conditions of overexploitation

32 with the presence of saline soils and brackish water

18 with seawater intrusion

Surface water

757 watersheds for the management of surface water

8 transboundary watersheds

51 main rivers

87% of runoff

65% of the territory is occupied by its watersheds

2.1 Mexico's watersheds and aquifers

[Tablero: Regiones hidrológicas, Cuencas]

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 streams and water bodies, following the contours of the land in the form of surface water, or filters to the subsoil as groundwater.

Watersheds are natural territorial units, defined by the existence of a continental divide of surface water as a result of the conformation of the landform. For the purpose of the management of the nation's water resources, especially the publication of availability[1], CONAGUA has defined 757 watersheds.

Up to May 27, 2016, the availability of all 757 watersheds had been published, in conformity with the standard NOM-011-CONAGUA-2015, of which 649 were in a situation of availability. The country's watersheds have been organized into 37 hydrological regions which are shown in Map 2.1, and 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 Gazette of the Federation (DOF) on December 5, 2001. In the 2003-2009 period their geographical limits were published (Map 2.2), whereas the publication of their availabilities and their updates have been carried out between 2003 and the present.

CONAGUA has 3 179 stations in operation to measure climatological variables, including temperature, rainfall, evaporation, wind speed and direction. Of these, 85 are observatories, which transmit meteorological information in real time. Hydrometric stations measure the flow of water in rivers, as well as the extraction of water through dam intakes. In Mexico there are 871 hydrometric stations, including some automatic ones. Furthermore, hydroclimatological stations measure climatic and hydrometric parameters. The measurement infrastructure allows the hydrological cycle to be measured (see Table 2.1).

There are

37

hydrological regions in Mexico

TABLE 2.1 Number of climatological and hydrometric stations in Mexico, 2016

Type of station	Number of stations
Climatological	3 179
Hydrometric	871

Source: CONAGUA (2016b), CONAGUA (2016f).

1 According to standard NOM-011-CONAGUA-2015 and the National Water Law, surface water is the value obtained from the difference between the mean annual volume of runoff from a watershed downstream and the current annual volume committed downstream.

Map 2.1 Hydrological regions

No.	Name
1	Baja California Noroeste
2	Baja California Centro-Oeste
3	Baja California Suroeste
4	Baja California Noreste
5	Baja California Centro-Este
6	Baja California Sureste
7	Río Colorado
8	Sonora Norte
9	Sonora Sur
10	Sinaloa
11	Presidio-San Pedro
12	Lerma-Santiago
13	Huicicila
14	Río Ameca
15	Costa de Jalisco
16	Armería-Coahuayana
17	Costa de Michoacán
18	Balsas
19	Costa Grande de Guerrero

No.	Name
20	Costa Chica de Guerrero
21	Costa de Oaxaca
22	Tehuantepec
23	Costa de Chiapas
24	Bravo-Conchos
25	San Fernando-Soto La Marina
26	Pánuco
27	Norte de Veracruz (Tuxpan-Nautica)
28	Papaloapan
29	Coatzacoalcos
30	Grijalva-Usumacinta
31	Yucatán Oeste
32	Yucatán Norte
33	Yucatán Este
34	Cuencas Cerradas del Norte
35	Mapimí
36	Nazas-Aguanaval
37	El Salado

Source: CONAGUA (2016b).

Map 2.2 Aquifer locations

Fuente: CONAGUA (2016b).

Panoramic view of Cañón del Sumidero, Chiapas, Mexico.

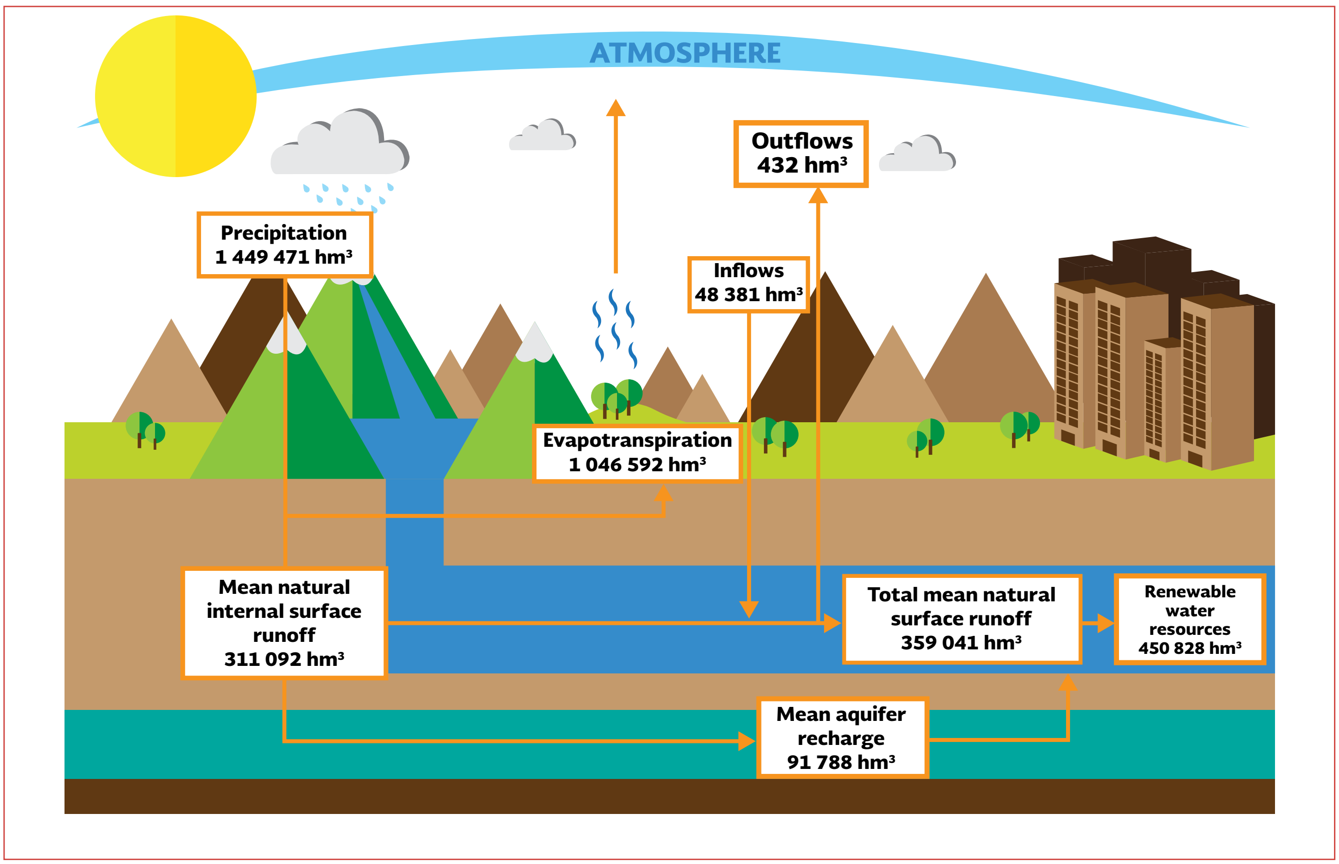
2.2 Renewable water resources[2]

[Tablero: 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 72.2% evapotranspires and returns to the atmosphere, 21.5% runs off into rivers and streams and the remaining 6.3% naturally filters through to the subsoil and recharges aquifers.[3] Taking into account the water outflows (exports) to and inflows (imports) from neighboring countries, every year the country has 450.828 billion cubic meters of renewable freshwater resources.

Figure 2.1 shows the components and values that make up the calculation of renewable water resources.

FIGURE 2.1 Mean annual values of the components of the water cycle in Mexico, 2016



Source: CONAGUA (2016b).

2 The maximum quantity of water that can feasibly be used in a region, i.e. 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 aquifer recharge, 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.

The inflows represent the volume of water which runs off to Mexico, generated in the transboundary watersheds that 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:

- Temporal Distribution: In Mexico there are significant variations in renewable water resources throughout the year. Most rainfall occurs in the summer, while in the rest of the year it is relatively dry.
- Spatial Distribution: Some regions of the country have abundant precipitation and low population density, whereas in others exactly the opposite occurs.
- The area of analysis: Water problems and their solution are predominantly local in scale. Indicators calculated at a large scale may hide some strong variations which exist throughout the country.

Per capita renewable water resources were estimated in 2016 at

3 687

m^3/inhab./day

In some HARs, such as Península de Baja California, VI Río Bravo, VII Lerma-Santiago-Pacífico and XIII Aguas del Valle de México, per capita renewable water resources are alarmingly low. Table 2.2 shows the mean values of renewable water resources in each of the regions of the country.

TABLE 2.2 Per capita renewable water resources, 2016

HAR No.	Renewable water resources (hm^3/year)	Population (million inhab.)	Per capita renewable water resources (m^3/inhab./year)	Total mean natural surface runoff (hm^3/year)	Total mean aquifer recharge (hm^3/year)
I	4 876	4.52	1 078	3 218	1 658
II	8 274	2.88	2 874	5 068	3 207
III	26 613	4.55	5 847	23 537	3 076
IV	21 671	11.93	1 817	16 798	4 873
V	30 836	5.09	6 054	28 900	1 936
VI	12 430	12.46	997	6 495	5 935
VII	7 926	4.61	1 720	5 551	2 376
VIII	34 897	24.45	1 427	25 241	9 656
IX	28 663	5.33	5 379	24 555	4 108
X	65 645	10.65	6 165	61 047	4 599
XI	175 912	7.75	22 692	153 195	22 718
XII	29 647	4.69	6 325	4 331	25 316
XIII	3 437	23.37	147	1 106	2 330
Total	**450 828**	**122.27**	**3 687**	**359 041**	**91 788**

Note: For HAR XIII Mexico City's wastewater is taken into account.
Source: Based on CONAGUA (2016b), CONAPO (2012).

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"*

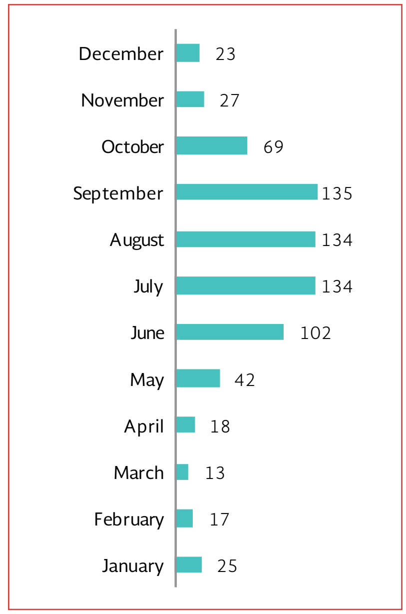
Precipitation

[Tablero: 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.

Tables 2.3 and 2.4 show the normal precipitation by HAR and by federative entity, respectively, in the period from 1981 to 2010. It is important to mention that the monthly distribution of precipitation accentuates the problems related to 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. In Table 2.3 it may be observed, for example, that in hydrological-administrative region XI, Frontera Sur, which receives the greatest quantity of rain, the normal annual precipitation for 1981-2010 was 11 times higher than in hydrological-administrative region I, Península de Baja California, which is the driest one. This regional variation in the normal precipitation is highlighted in Figure 2.2 and Figure 2.3.

GRAPH 2.1
Normal monthly precipitation, 1981-2010 (mm)



Source: CONAGUA (2016f).

TABLE 2.3 Normal monthly precipitation, 1981-2010 (mm)

HAR No.	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	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	8	8	6	15	71	230	200	219	242	113	20	7	1 139
VI	19	11	11	17	28	40	63	61	64	32	12	15	372
VII	18	9	6	12	27	56	79	71	67	29	11	13	398
VIII	22	11	4	6	23	131	197	180	153	60	13	10	808
IX	26	20	19	38	67	120	137	119	166	89	30	23	855
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
Nacional	**25**	**17**	**13**	**18**	**42**	**102**	**134**	**134**	**135**	**69**	**27**	**23**	**740**

Source: CONAGUA (2016f).

To illustrate the regional variation in rainfall, Figure 2.2 shows three cross-sections of the normal precipitation profiles of 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 pluvial precipitation over the 1981-2010 period throughout these cross-sections.

The accumulated precipitation in the Mexican Republic from January 1 to December 31, 2016, reached a sheet of 744 mm, which was 0.5% higher than the normal value for the 1981-2010 period (740 mm). The 2000-2016 annual series of accumulated precipitation is shown in Graph 2.2.

Figures 2.2 and 2.3 illustrate the characteristics of the distribution of precipitation in 2016 and its relation to the 1981-2010 normal precipitation. The 2016 precipitation may be compared with the 1981-2010 normal value. Map 2.3 shows the anomaly, that is, the difference between both precipitations. The color scale goes from red, which means annual rain in 2016 that was lower than the 1981-2010 normal value, 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 in the area that drains towards the Pacific, in the states of Guerrero, Oaxaca and Chiapas, with regional effects in the Yucatán Peninsula and parts of Veracruz and Tamaulipas. Precipitation higher than the normal value occurred mainly in Tabasco, in the Papaloapan River watershed, between Oaxaca and Veracruz, and the Central Watersheds of the North.

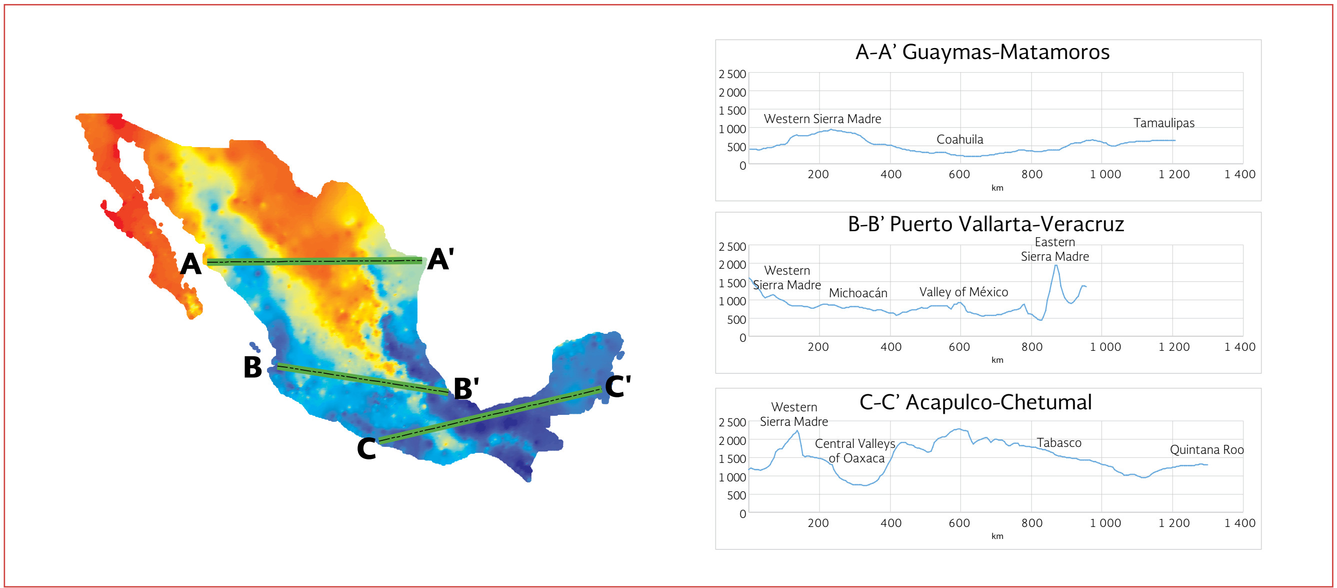
Mexico had

744 mm

of annual

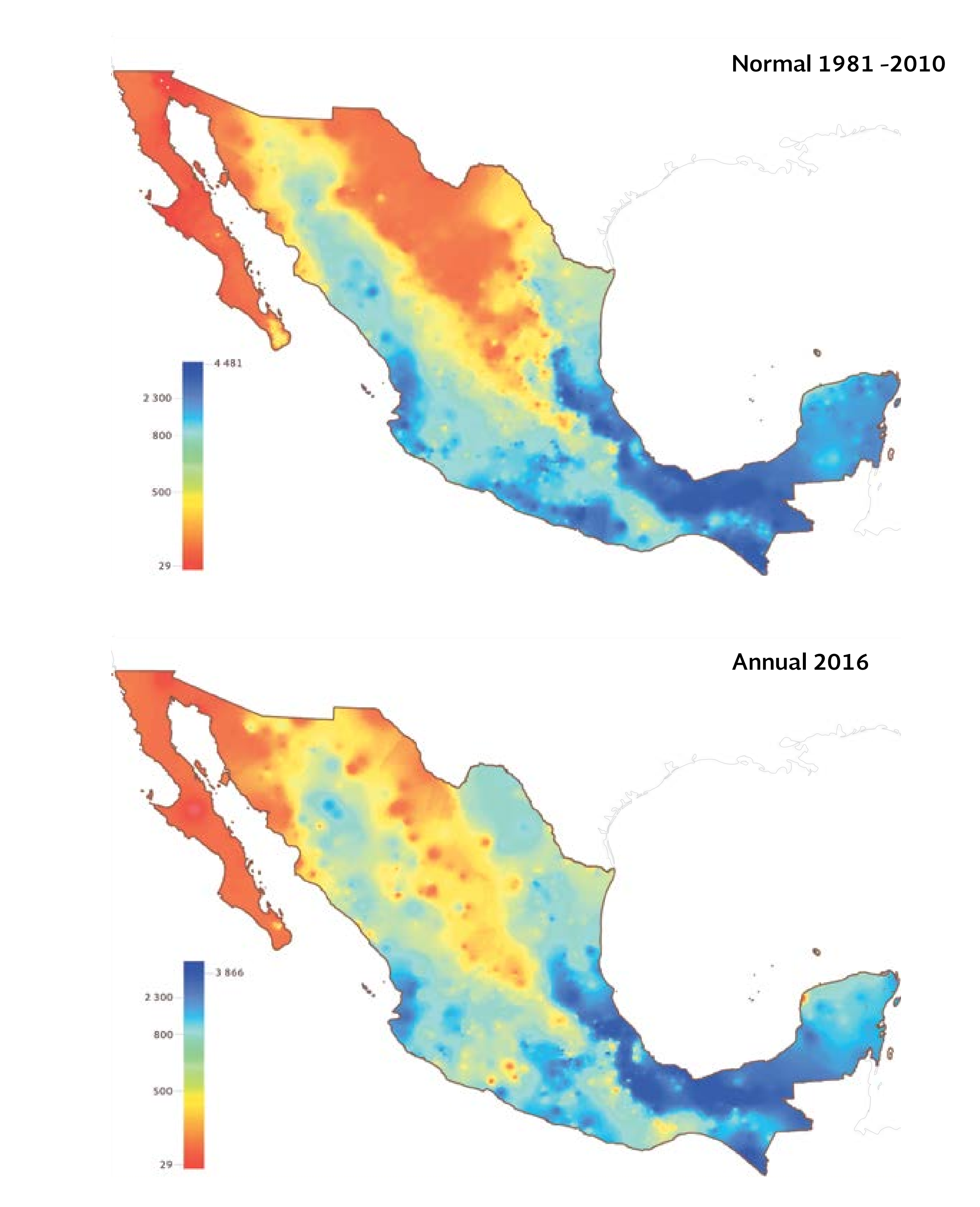
precipitation in 2016

FIGURE 2.2 Normal annual precipitation profiles 1981-2010 (mm)



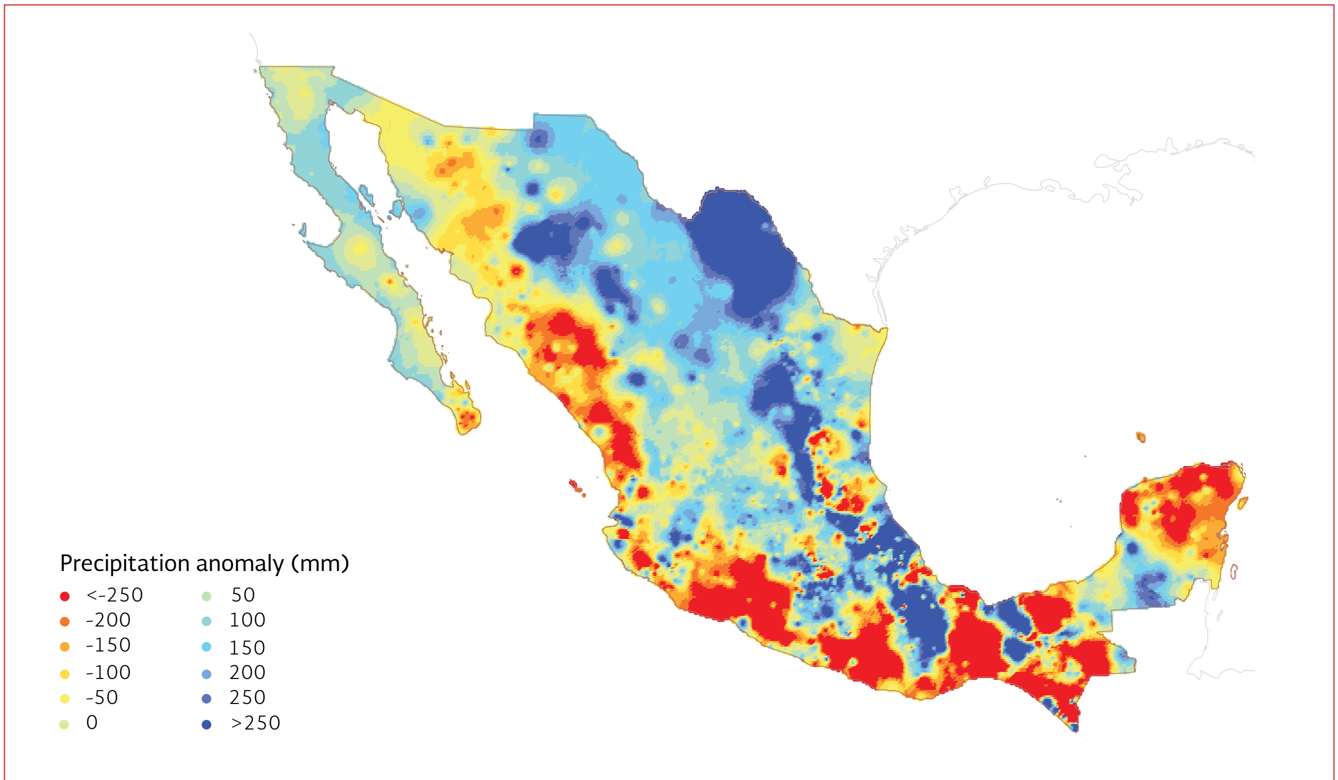
Source: Based on CONAGUA (2016f).

Figure 2.3 Distribution of pluvial precipitation



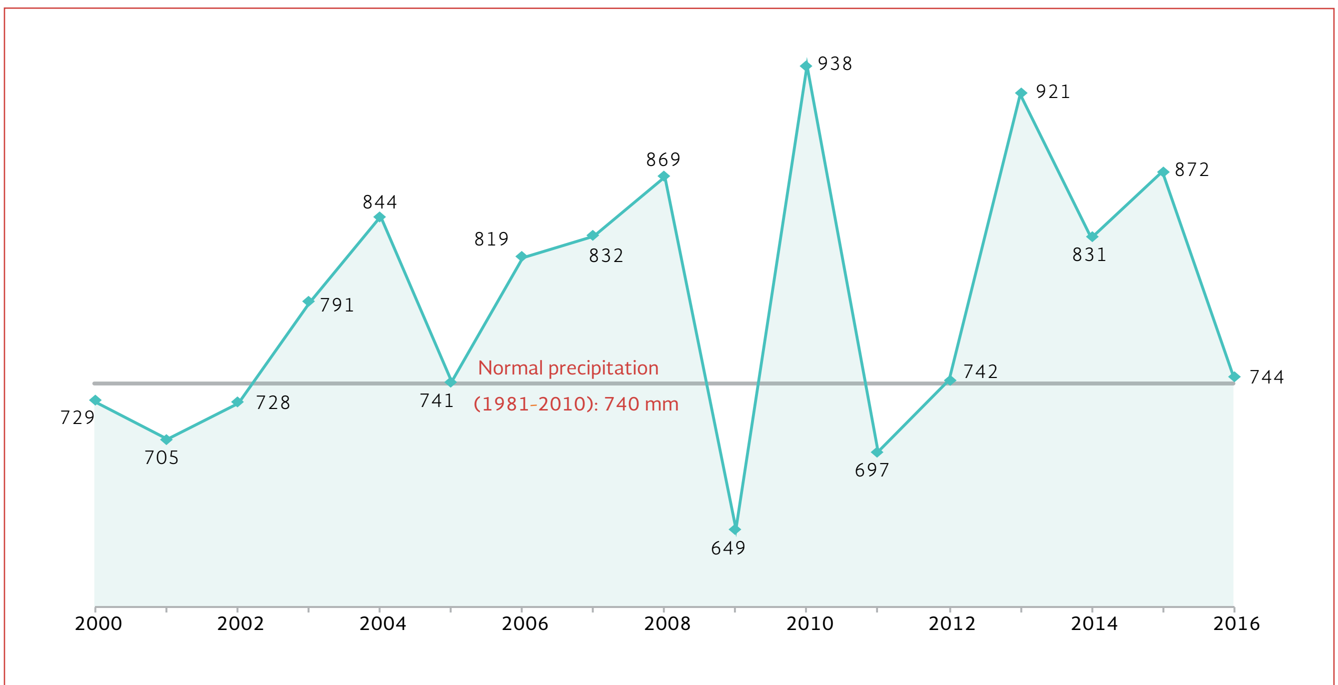
Source: Based on CONAGUA (2016f).

Map 2.3 Precipitation anomaly, 2016



Source: Based on CONAGUA (2016f).

Graph 2.2 Annual pluvial precipitation, 2000-2016 (mm)



Source: CONAGUA (2016f).

2.3 Hydrometeorological phenomena

Tropical cyclones

[Tablero: Ciclones tropicales]

Tropical cyclones are natural phenomena that generate most of the humidity transport from the sea to the inland part of the country. In several regions of Mexico, cyclonic rains account for most of the annual rainfall.

Cyclones are classified according to the intensity of the maximum sustained winds. When they are lower than 62 km/h they are referred to as tropical depressions (TDs), when they are between 63 km/h and 118 km/h they are termed tropical storms (TSs), 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 reach up to 100 km. Hurricanes are classified using the Saffir-Simpson scale.

230

tropical cyclones hit Mexico's coasts between

1970 and 2016

Between 1970 and 2016, 230 tropical cyclones hit the coasts of Mexico. Table 2.5 presents their occurrence on the Atlantic and Pacific oceans, and shows that a greater number of cyclones have hit the Pacific coast.

Map 2.4 shows the hurricanes that have hit Mexican territory between 1970 and 2016. Identified by name are those with the greatest intensity that reached categories 3, 4 and 5. During the 2016 cyclone season (from May 15 to November 30), the two most intense hurricanes were Newton in the Pacific coast and Earl in the Atlantic, both category 1 and with maximum sustained winds of 150 and 130 km/h, respectively.

Table 2.4 Hurricanes and the Saffir-Simpson scale

Category	Maximum winds (km/h)	Storm tide normally produced (m)	Characteristics of possible material damages and floods
One (H1)	From 119 to 153	1.2–1.8	Small trees fall down, some floods occur on the lowest-laying coastal highways.
Two (H2)	From 154 to 177	1.8–2.5	In addition, damaged roofs, doors and windows. Trees are uprooted.
Three (H3)	From 178 to 208	2.5–4.0	In addition, cracks appear in small buildings, floods occur in low-lying, flat grounds.
Four (H4)	From 209 to 251	4.0–5.5	In addition, house roof tiles blown away, significant erosion on beaches, rivers and streams. Imminent damages to drinking water and sanitation services.
Five (H5)	Greater than 252	Higher than 5.5	In addition, quite severe and extensive damages to windows and doors. Total failure of roofs in many houses and industrial buildings.

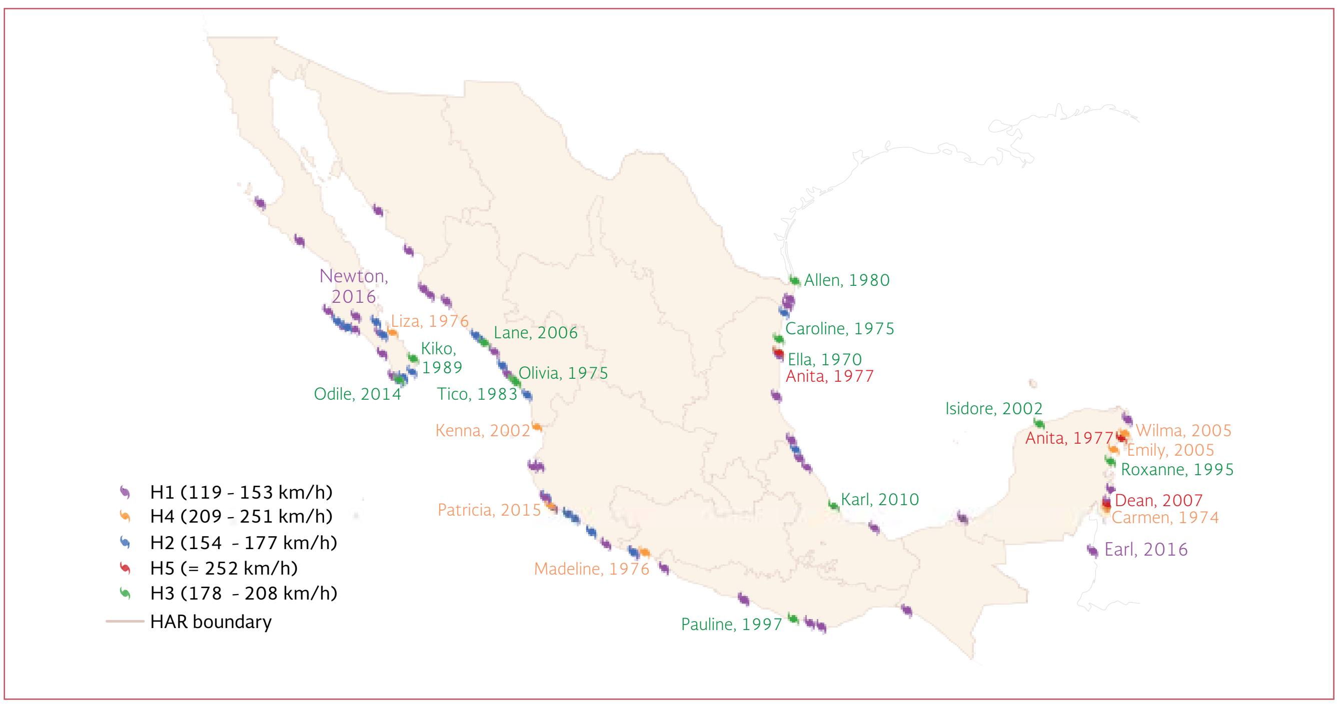
Source: Based on CONAGUA (2016f).

Table 2.5 Tropical cyclones that hit Mexico between 1970 and 2016

Ocean	Tropical depressions	Tropical storms	Moderate hurricanes (H1 y H2)	Intense hurricanes (H3-H5)	Total
Atlantic	27	33	15	12	87
Pacific	33	50	47	13	143
Total	60	83	62	25	230

Source: Based on CONAGUA (2016f).

Map 2.4 Hurricanes, 1970-2016



Source: Based on CONAGUA (2016f).

Droughts

[Tablero: Sequías]

Drought occurs when rainfall is significantly lower than levels normally recorded, causing serious hydrological imbalances that harm 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 partnership with the United States and Canada, Mexico takes part in the North American Drought Monitor (NADM), which analyzes climate conditions in order to continuously monitor drought at a large scale in North America. The drought intensity levels considered by the NADM (Conagua 2016g) are:

- Abnormally dry (D0): This is a condition of dryness, but not a drought category. It occurs at the start or the end of a drought period. At the start of a drought period: due to the short-term dryness, it may lead to a delay in the sowing of annual crops, as well as to a limited growth of crops or grazing areas, and there is a risk of fires. At the end of the drought period: there may continue to be a deficit of water, grazing areas or crops may not completely recover.

- Moderate drought (D1): Some damage to crops and grazing areas occurs; there is a high risk of fires, low levels in rivers, streams, reservoirs, drinking troughs and wells, and voluntary restriction in the use of water is suggested.

- Severe drought (D2): Probable losses in crops and grazing areas, high risk of fires, water scarcity is common, water use restrictions should be imposed.

- Extreme drought (D3): major losses in crops and grazing areas, the risk of forest fires is extreme, restrictions in the use of water are widespread due to its scarcity.

- Exceptional drought (D4): exceptional and widespread losses of crops and grazing areas, exceptional risk of fires, total scarcity of water in reservoirs, streams and wells, a situation of emergency is likely due to the absence of water.

The North American Drought Monitor considers

5

types of drought

Additionally, the Monitor identifies the types of the drought impact: short-term (S), typically less than six months, with possible alterations in agriculture and pastures, and long-term (L), typically longer than six months, with potential impacts on regional hydrology and ecology. These impacts may be combined, i.e. short- and long-term (S-L). The polygons that outline dominant impacts are also identified in the Monitor.

An interesting time of year is the month of May, when the dry season usually ends and the rainy season begins. May 2016 was drier than usual, except in the northeast, the central regions and Chiapas. From the west to the north and northwest of the country, rainfall conditions were close to normal, whereas the greatest deficits were seen in the Gulf of Mexico, from Veracruz to Tabasco, Oaxaca, and the coast of Guerrero, plus the Yucatán Peninsula (Figure 2.4). Total rainfall during this month was 37.2 mm, 8.2% or 3.3 mm below the long-period average for that month, ranking as the thirtieth driest May according to statistics kept since 1941, while the mean temperature of 25.1 °C was 1.5 °C above the 1981–2010 average and was the 4th warmest May since 1971.

Area affected by forest fires

272 183

hectares from January to November

2016

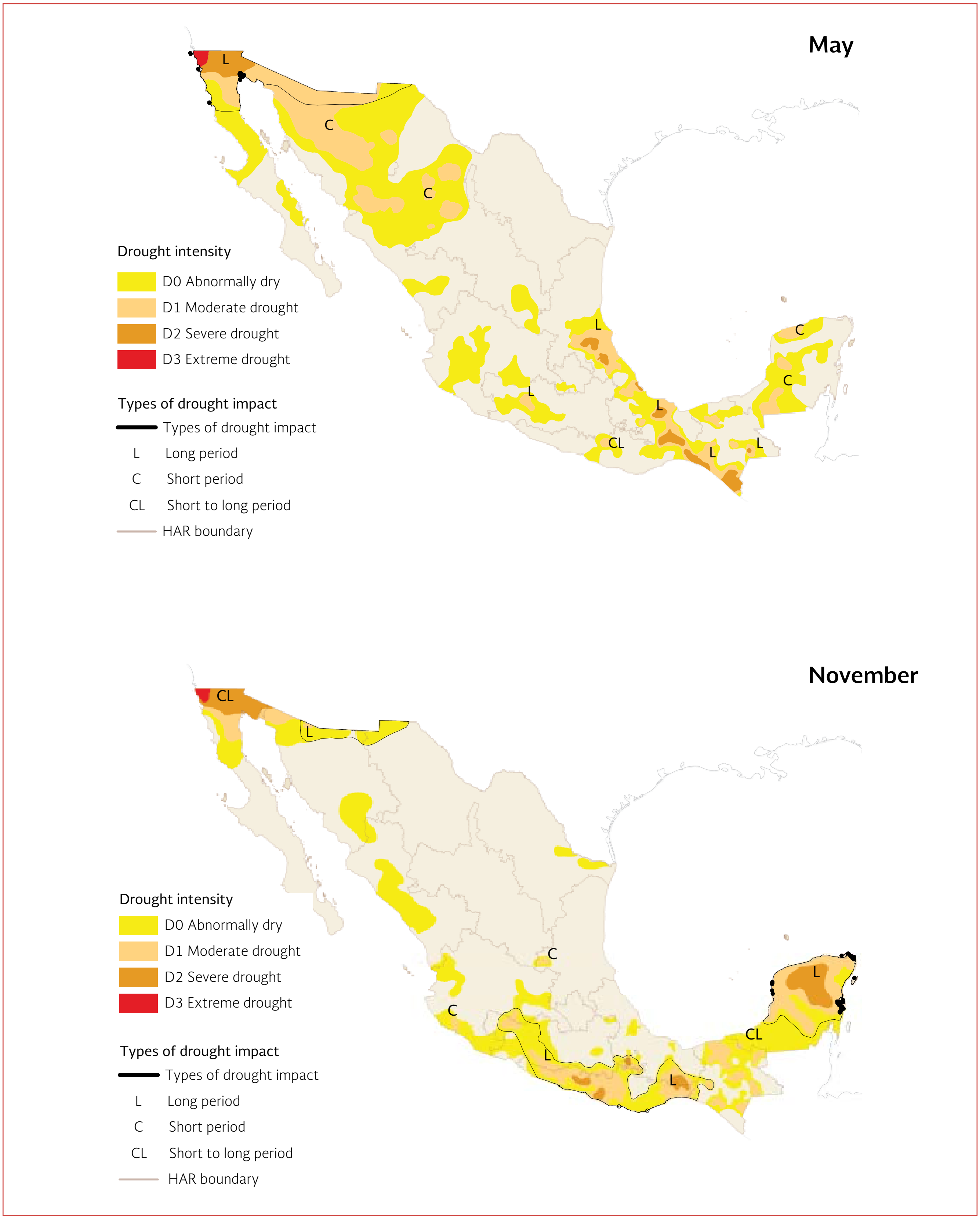
By late May, drought coverage, from moderate to extreme (D1–D3) was 14.3% of Mexico's surface area, 0.1% less of what was recorded by April 30th of that year. By the end of May, drought increased in Campeche and Yucatán, but decreased in the central region of the country and had light changes in Vercruz, Oaxaca and Chiapas. The Agri-food and Fisheries Information Service (SIAP) informed that damages to crops reached 48.5 thousand hectares, caused by frosts, drought, excessive humidity and low temperatures. Delayed rains in May brought increased forest fires in the country, with around 166 519 hectares burnt in the period between January 1st and June 2nd 2016, placing this period as the ninth with greatest burnt area according to the National Forestry Commission's (CONAFOR) weekly forest fire report (NADM 2016a).

Another interesting moment to review the evolution of drought is the month of November, when the rainy season usually ends and the dry season begins. An improvement or disappearance of the drought conditions that existed before precipitation started is to be expected.

In November 2016 (Figure 2.4) there were above-average precipitations from the central region to the northeast of the country. Contrastingly, Tabasco and the Yucatán Peninsula continued with rainfall deficit, which translated into an increased moderate drought (D1) and the onset of severe drought (D2). Nationwide, November 2016 was set in mean historical data as the fortieth driest month according to records taken since 1941. CONAFOR reported an area affected by forest fires of 272 183 hectares, 7% less than the average burnt area between January 1st and December 1st of the 1998–2015 period. With regards to agriculture, the area sown in the first two months of the autumn–winter cycle amounted to 734.7 thousand hectares, 2.4% more than what was sown in the same date of the previous homologous cycle according to SIAP's report (NADM 2016b).

Drought in Aljojuca, Puebla, Mexico.

FIGURE 2.4 Drought conditions, 2016



Source: Based on CONAGUA (2016f), NADM (2016a), NADM (2016b).

Mexico's most drought-prone areas

Both drought and intense rainfall, in addition to factors such as topography, land use and vegetation cover, may cause impacts on society and economic activities.

In Mexico there are procedures in place for the issuing of declarations[5] in the face of these drought[6] or intense rainfall events, in categories that describe their effects. Climate contingencies affect productive activities. Emergencies imply risks to life and public health, whereas disasters concentrate the State's and society's resources on the reconstruction of affected areas.

In 2012, based on the results of regional planning for water sustainability in the medium and long terms in the 13 hydrological-administrative regions, CONAGUA performed a spatial identification of the areas of the country that are most vulnerable to drought using a model with three components:

1. Exposure level. This component was assessed by quantifying the difficulty to meet water demands by 2030 and by analyzing the historic frequency of droughts reported by the National Meteorological Service through the North American Drought Monitor.

2. Sensitivity. This component assesses the magnitude of damages in case of a drought and integrates information of the population to 2030: estimation of the impact on economic, commercial and industrial activities and the impact on agriculture.

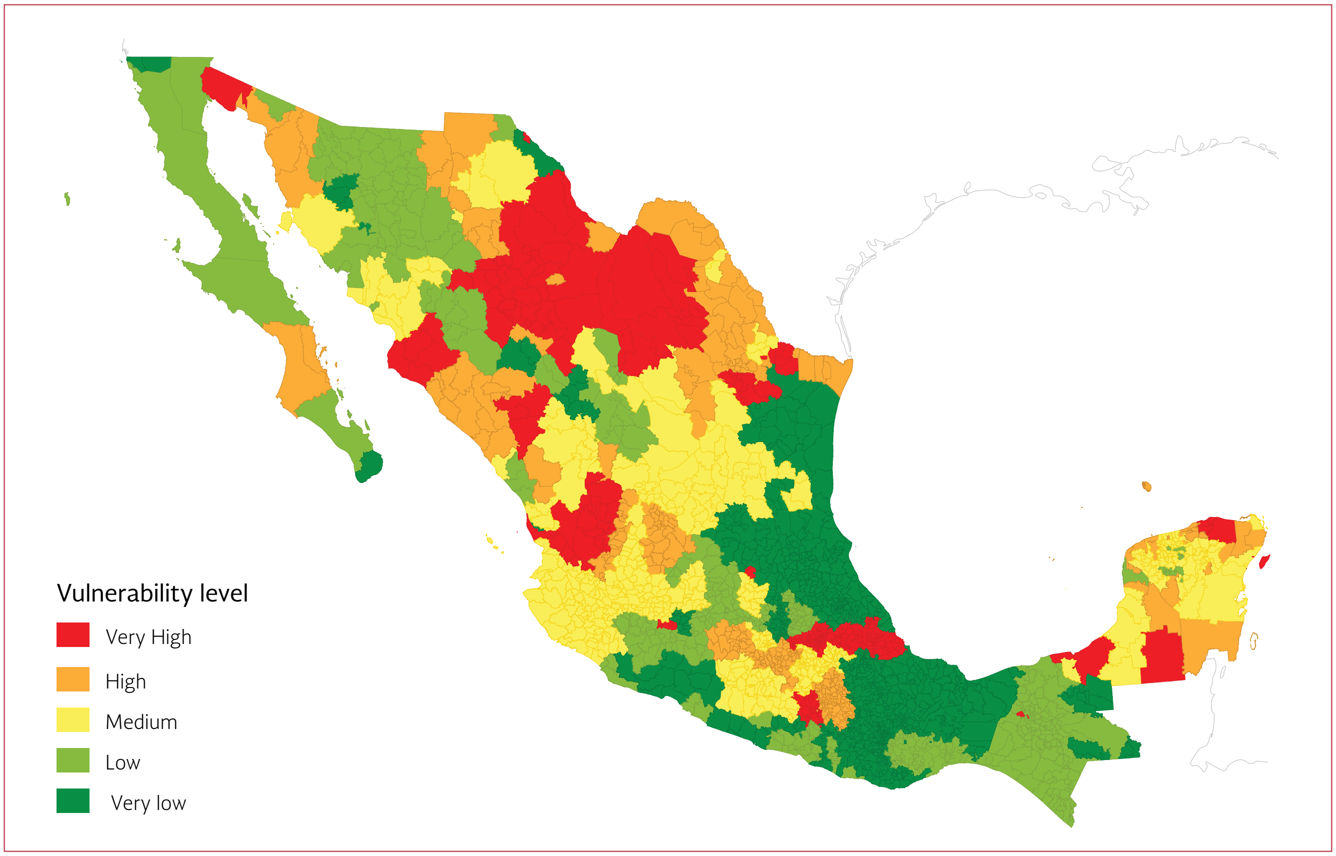
3. Adaptation capacity. This component refers to the resilience of the study area to water scarcity conditions; i.e., the potential of adaptation to the stress caused by drought. Aquifer exploitation degree is taken into account.

The knowledge of these regions will allow to determine the places where it is crucial to implement contingency plans in the face of drought, as well as adaptation efforts to enhance their resilience level.

5 Declarations make it possible to use public program resources for attending damages.

6 It should be noted that the drought reported by the NADM monitor is developed with a different methodology to that used for issuing the declarations.

Map 2.5 Mexico's most drought-prone areas, 2012



Source: CONAGUA (2016b).

Corn plantation in Mexico affected by drought.

2.4 Surface water

Main rivers

[Tablero: Ríos principales]

Mexico's rivers and streams form a 633 000 km-long hydrographic network, with 51 main rivers through which 87% of the country's surface runoff flows, and whose watersheds cover 65% of the country's mainland surface area (Map 2.6).

The watersheds of the Rio Grande and Balsas rivers stand out for the size of their areas, while the Rio Grande and Grijalva-Usumacinta rivers stand out for their length. The Lerma and Nazas-Aguanaval rivers are inland-flowing rivers. Tables 2.6, 2.7 and 2.8 show the most relevant data of Mexico's main rivers, according to the water body into which they flow. It should be noted that the mean natural surface runoff represents the mean annual value of its historical record and the maximum stream order was determined according to the Strahler method. In the case of transboundary watersheds, the area and length of the river correspond to the Mexican side of the watershed.

Rivers and streams form a hydrographic network with a length of

633

thousand km

Map 2.6 Mexico's main rivers

Source: CONAGUA (2016b).

Table 2.6 describes the rivers that flow into the Pacific and Gulf of California. For the transboundary watersheds (Colorado, Suchiate, Coatán and Tijuana), the mean natural surface runoff includes the inflows from other countries, with the exception of the Tijuana River, the runoff from which corresponds only to the Mexican part.

TABLE 2.6 Characteristics of the main rivers that flow into the Pacific and Gulf of California, ordered by their mean natural surface runoff, 2016

No.	River	HAR No.	Mean natural surface runoff (hm^3/year)	Watershed area size(km^2)	River length (km)	Maximum order
1	Balsas	IV	16 363	112 039	770	7
2	Santiago	VIII	7 349	76 277	562	7
3	Verde	V	6 073	18 570	342	6
4	Ometepec	V	5 094	7 016	115	4
5	El Fuerte	III	4 995	36 124	540	6
6	Papagayo	V	4 333	7 554	140	6
7	San Pedro	III	3 369	27 416	255	6
8	Yaqui	II	3 148	74 640	410	6
9	Culiacán	III	3 129	18 821	875	5
10	Suchiate	XI	1 581	4 89	75	2
11	Ameca	VIII	2 231	12 632	205	5
12	Sinaloa	III	2 064	13 152	400	5
13	Armería	VIII	1 750	10 258	240	5
14	Coahuayana	VIII	1 730	6 989	203	5
15	Colorado	I	1 922	14 552	160	6
16	Baluarte	III	1 872	5 359	142	5
17	San Lorenzo	III	1 624	9 983	315	5
18	Acaponeta	III	1 438	8 827	233	5
19	Piaxtla	III	1 417	6 888	220	5
20	Presidio	III	1 071	6 479	ND	4
21	Mayo	II	1 204	15 113	386	5
22	Tehuantepec	V	927	10 319	240	5
23	Coatán	XI	745	570	75	3
24	Tomatlán	VIII	1 161	2 118	ND	4
25	Marabasco	VIII	499	2 526	ND	5
26	San Nicolás	VIII	483	2 330	ND	5
27	Elota	III	452	2 324	ND	4
28	Sonora	II	360	27 740	421	5
29	Concepción	II	119	25 808	335	6
30	Matape	II	87	6 606	205	4
31	Tijuana	I	100	3 241	186	4
32	Sonoyta	II	24	7 653	311	5
33	Huicicila	VIII	467	663	50	3
	Total		**79 179**	**581 076**		

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 (2016b).

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

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

TABLE 2.7 Characteristics of the main rivers that flow into the Gulf of Mexico and Caribbean Sea, ordered by their mean natural runoff, 2016

No.	River	HAR number	Mean natural surface runoff (hm^3/year)	Area of the watershed (km^2)	River length (km)	Maximum order
34	Grijalva-Usumacinta	XI	104 089	87 690	1 521	7
35	Papaloapan	X	42 018	46 022	354	6
36	Coatzacoalcos	X	28 717	21 336	325	5
37	Pánuco	IX	20 224	88 814	510	7
38	Tecolutla	X	6 127	7 786	375	5
39	Bravo	VI	5 672	222 194	ND	7
40	Tonalá	X	4 105	5 631	82	5
41	Nautla	X	2 269	2 934	124	4
42	La Antigua	X	2 150	2 196	139	5
43	Jamapa	X	2 136	4 061	368	4
44	Tuxpan	X	2 046	6 719	150	4
45	Candelaria	XII	1 872	10 525	150	4
46	Soto La Marina	IX	1 823	21 084	416	6
47	Cazones	X	1 748	2 825	145	4
48	San Fernando	IX	1 605	17 992	400	5
49	Hondo	XII	954	8 161	115	4
	Total		**227 555**	**555 970**		

Note: The length reported for the Río Hondo River belongs to the border between Mexico and Belize.
NA: Not available.
Source: CONAGUA (2016b).

TABLE 2.8 Characteristics of the main inland-flowing rivers, ordered by the mean natural surface runoff, 2016

No	River	HAR Number	Mean natural surface runoff (hm^3/year)	Area of the watershed (km^2)	River length (km)	Maximum order
50	Lerma	VIII	4 701	48 132	708	6
51	Nazas-Aguanaval	VII	2 101	90 865	1 081	7
	Total		**6 802**	**138 997**		

Source: CONAGUA (2016b).

Mexico's transboundary watersheds

Mexico shares eight watersheds with its neighboring countries: three with the United States of America (Grande, Colorado and Tijuana), four with Guatemala (Grijalva-Usumacinta, Suchiate, Coatán and Candelaria) and one with both Belize and Guatemala (Hondo River). Their data is presented in Figure 2.5 and Table 2.9. The data on mean natural surface runoff and the watershed area in Table 2.9 were obtained from available hydrological studies.

The United States of America has to deliver

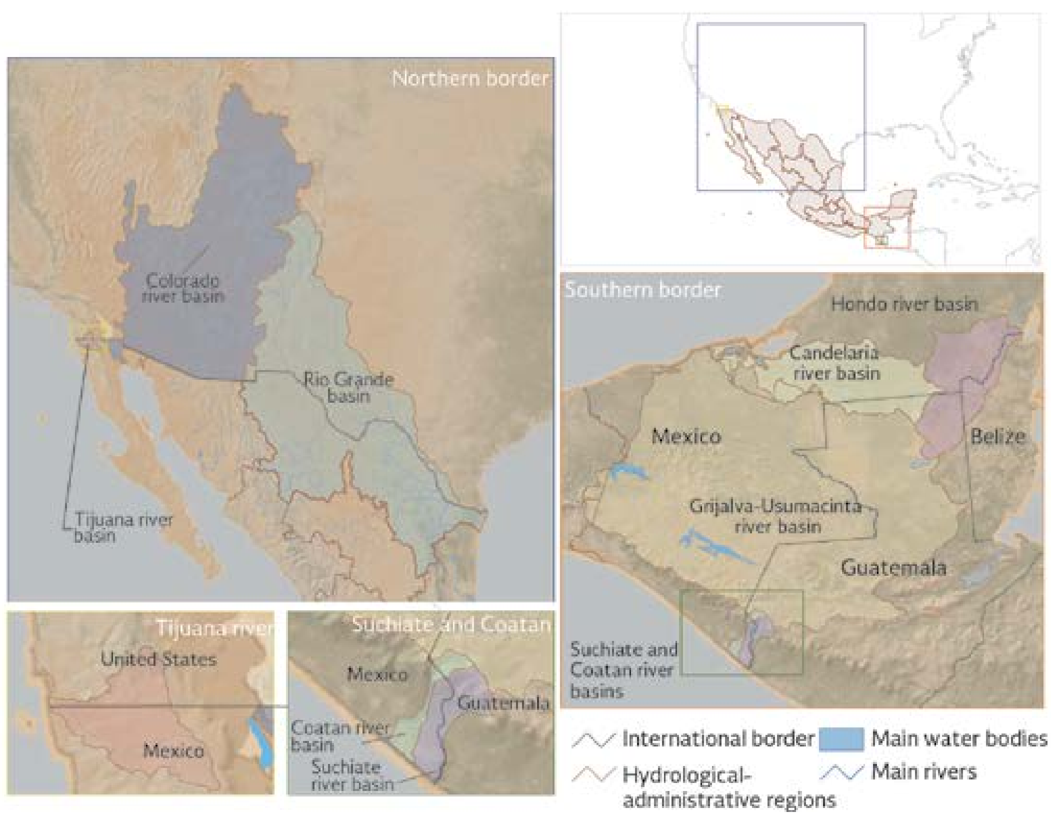
1 850.2 hm^3

in the Colorado River every year

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 stipulations 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 has to deliver 1.85 billion cubic meters (1.5 million acre feet) every year to Mexico. The annual series of this delivery from 1945 to 2015 is shown in Graph 2.3.

FIGURE 2.5 Transboundary watersheds



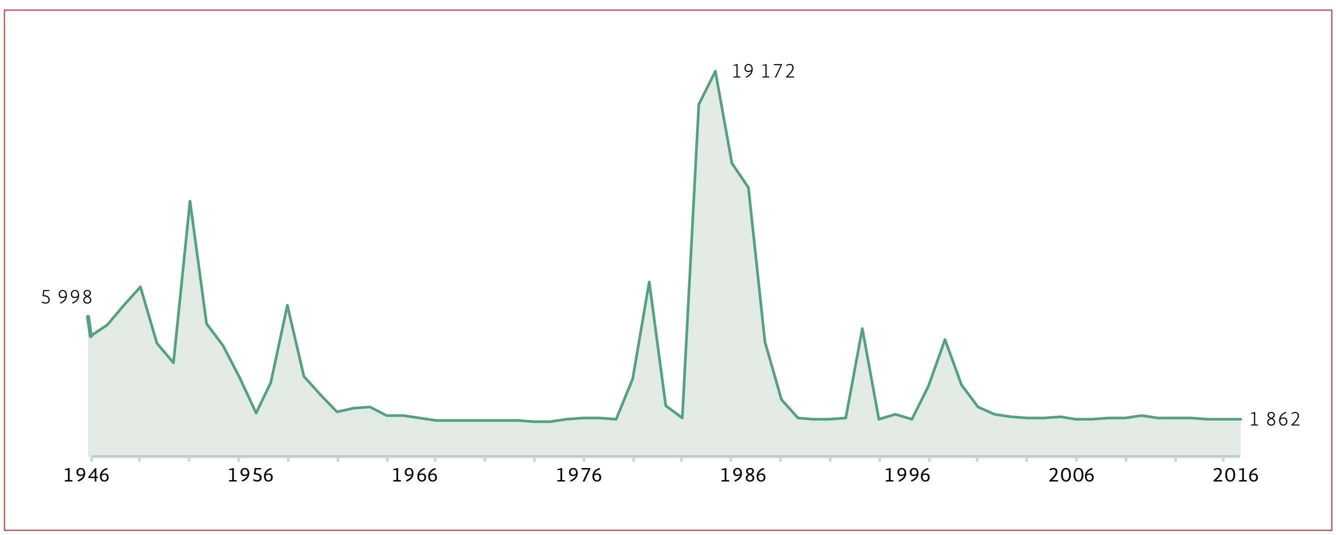
Source: Based on CEC (2016), USGS (2016a), USGS (2016b), VITO (2014).

Table 2.9 Characteristics of the main rivers with transboundary watersheds, 2016.

No.	River	HAR number	HAR	Country	Mean natural surface runoff (hm³/year)		Area of the wathershed (km²)	River length (km)	
1	Suchiate	XI	XI Frontera Sur	Mexico	287		203	75	a
				Guatemala	1 294		1 084	60	
2	Colorado	I	I Península de Baja California	Mexico	72		3 840	160	
				USA	1 850	*	626 943	2 140	
				Binational	NA		NA	0	
3	Coatán	XI	XI Frontera Sur	Mexico	453		605	75	
				Guatemala	292		280	12	
4	Tijuana	I	I Península de Baja California	Mexico	82		3 231	186	
				USA	17		1 221	9	
5	Grijalva-Usumacinta	XI	XI Frontera Sur	Mexico	60 270		83 553	1 521	
				Guatemala	43 820		44 837	390	
6	Grande	VI	VI Río Bravo	Mexico	5 672		225 242	-	
				USA	74	*	241 697	1 074	
				Binational	NA		NA	2 034	
7	Candelaria	XII	XII Península de Yucatán	Mexico	1 611		13 790	150	
				Guatemala	261		1 558	8	
8	Hondo	XII	XII Península de Yucatán	Mexico	954		7 614	115	b
				Guatemala	-		2 873	45	
				Belize	-		2 978	16	

Note: * 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 (2016b).

Graph 2.3 Volume delivered from the Colorado River (hm³)



Source: CONAGUA (2016b).

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.

Regarding the Rio Grande, Table 2.10 describes the distribution of its waters as defined in the treaty.

Three considerations are established regarding the six Mexican rivers mentioned in table 2.10, 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 rivers, 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, or the equivalent of supplying a minimum volume of 2.158 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 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.

TABLE 2.10 Water distribution of the Rio Grande according to the 1944 treaty.

To the United Mexican States belong:	To the United States of America belong:
The total runoff from the Alamo and San Juan rivers.	The total runoff from the Pecos and Devils rivers, the Goodenough spring and the Alamito, Terlingua, San Felipe and Pinto streams.
Two thirds of the water that flows into the main current of the Rio Grande from the following six Mexican rivers: Conchos, San Diego, San Rodrigo, Escondido, Salado and Arroyo de las Vacas.	One third of the water that flows into the main current of the Rio Grande from the following six Mexican rivers: Conchos, San Diego, San Rodrigo, Escondido, Salado and Arroyo de las Vacas.
Half of the runoffs not allocated by the Treaty that reach the main current, between Quitman and Falcon.	Half of the runoffs not allocated by the Treaty that reach the main current, between Quitman and Falcon.
Half of the runoff from the Rio Grande watershed, downstream of Falcon.	Half of the runoff from the Rio Grande watershed, downstream of Falcon.

Source: IBWC (2016).

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 of the reservoirs, the allocations by country are shown in Table 2.11

Table 2.11
Capacities allocated to the international reservoirs (hm^3)

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

Source: CONAGUA (2016b).

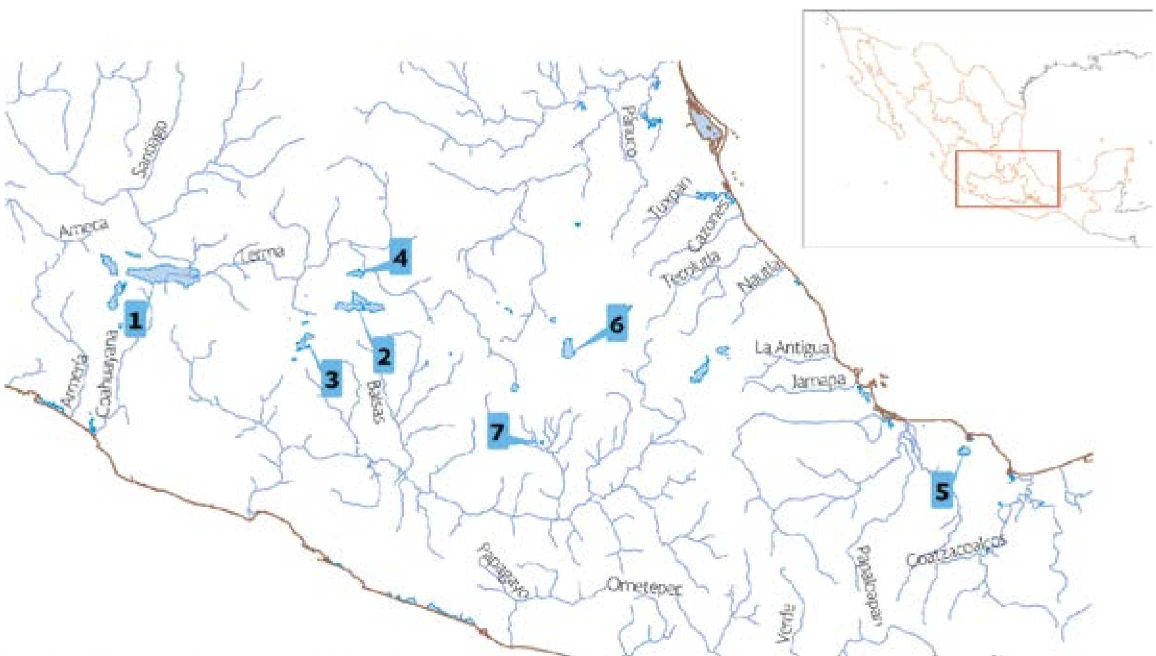
La Amistad international dam, Coahuila, Mexico.

Mexico's main lakes

[Tablero: Lagos principales]

Figure 2.6 shows some of Mexico's main lakes in the central area of the country by the extension of their watershed. The data presented correspond to the available hydrological studies, and the watershed area corresponds to the water body's own. Lake Chapala is the largest 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 supply sources for the Guadalajara Metropolitan Area. The behavior of its annual stored volumes is shown in Graph 2.4.

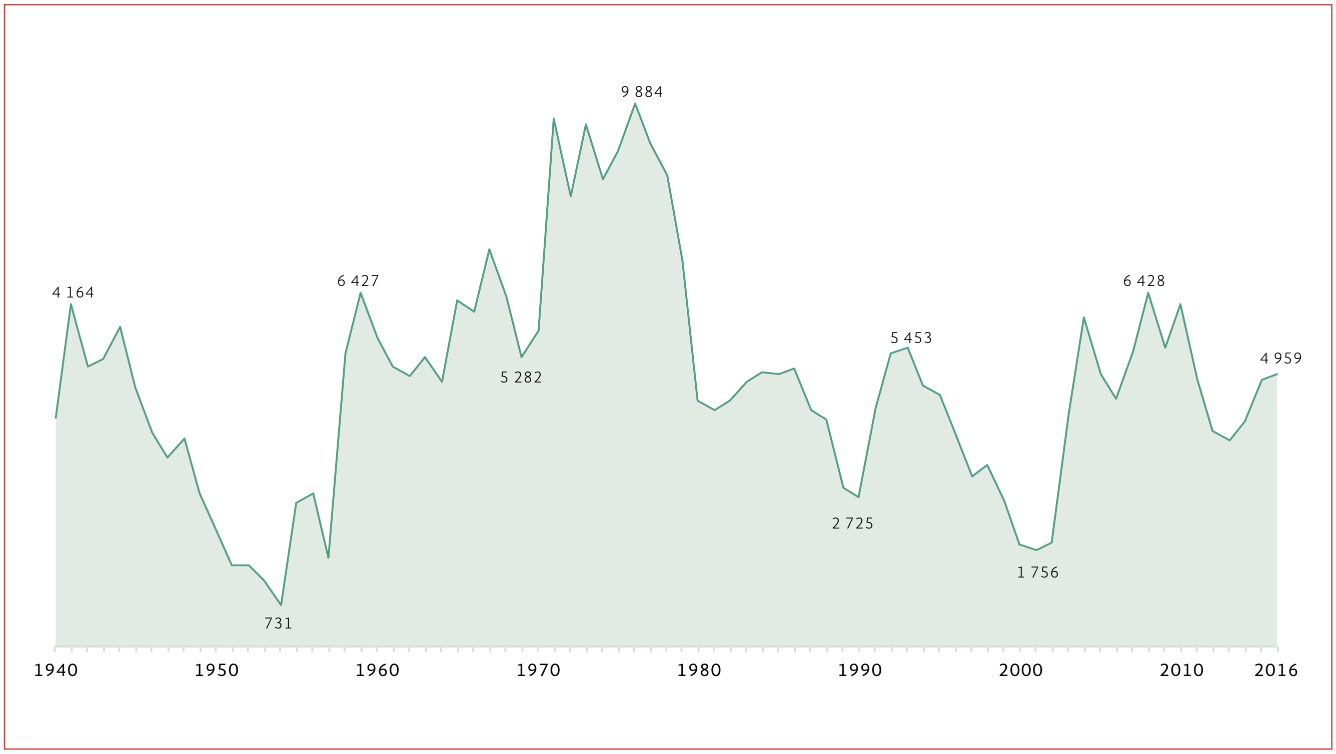
FIGURE 2.6 Main lakes in the central area



Number	Name	Watershed km²	Capacity hm³
1	Chapala	1 116	8 126
2	Cuitzeo	306	920
3	Pátzcuaro	97	550
4	Yuriria	80	188
5	Catemaco	75	454
6	Dr. Nabor Carrillo	10	12
7	Tequesquitengo	8	160

Source: CONAGUA (2016b).

Graph 2.4 Volume stored in Lake Chapala (hm³)



Note: Values shown correspond to December 1st of every year.
Source: CONAGUA (2016b).

Boats anchored at dawn close to the wharf on Lake Chapala, Jalisco, Mexico.

2.5 Groundwater

[Tablero: 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 reservoir and a distribution network, being possible to extract water at any time 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. 39% of the total volume allocated for consumptive uses (33 819 hm^3 per year in 2016) 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 Official Gazette of the Federation (DOF) on December 5, 2001.

There are

653

aquifers in Mexico

From that point onwards, a process for outlining and studying the aquifers was set in motion in order to officially make their mean natural availability public, following the official Mexican standard NOM011-CONAGUA-2000. As of December 31, 2016, the availability of groundwater in all 653 aquifers had been published in the DOF[8]. Worth highlighting is the publication, on December 20, 2013, of the updated calculation of availability of all the nation's aquifers.

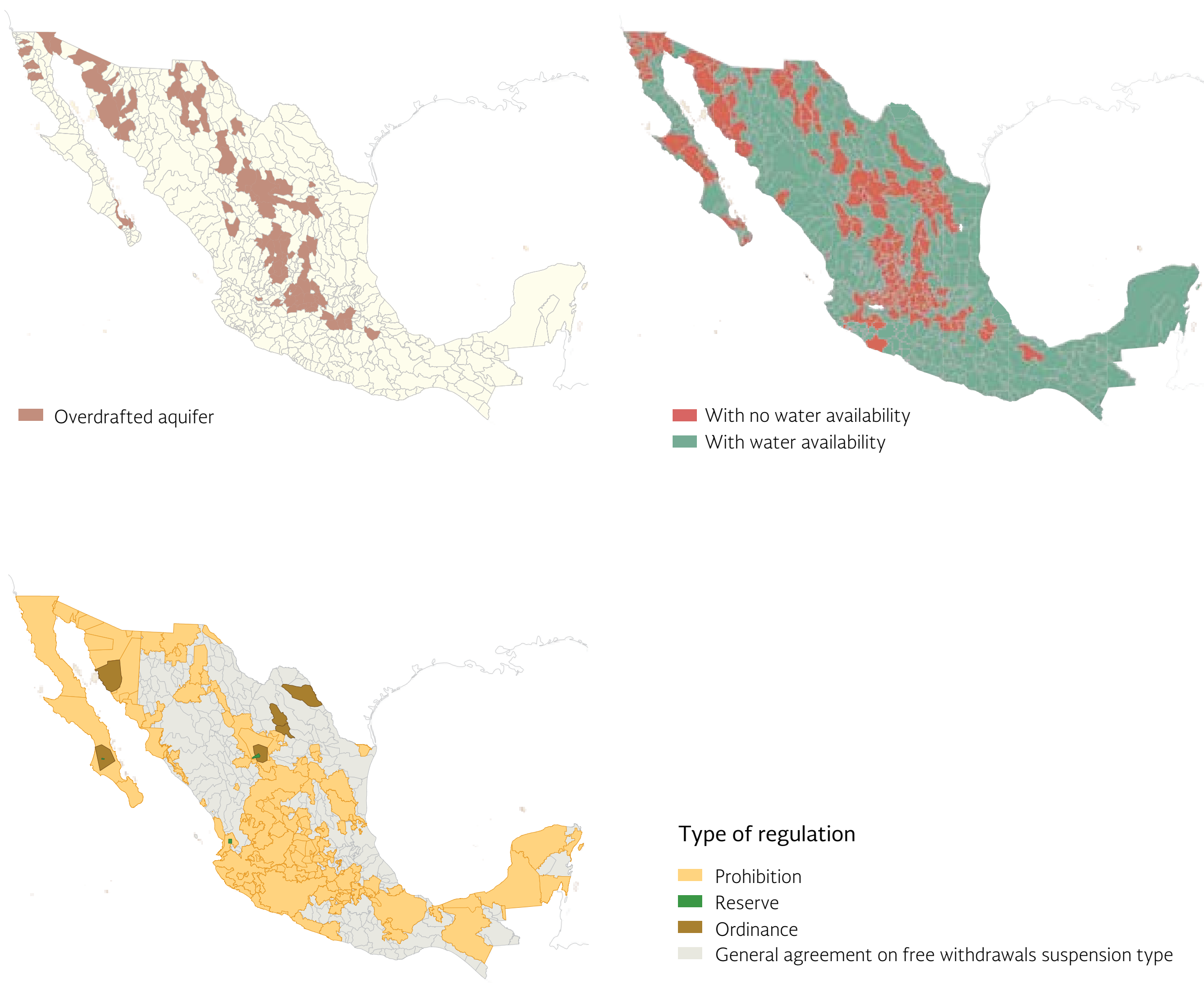
Availability is a basic indicator for the preservation of the resource through the management of the nation's water resources, by means of the instruments of concession or allocation of rights for the use of the nation's water resources, as well as regulatory measures for the use of aquifers, such as the suspension of free extraction (i.e. a suspension of the free extraction of the nation's groundwater) prohibition zones, regulations, regulated zones and reserve zones (Figure 2.7 and Subchapter 5.2 Legal framework for the use of water in Mexico). In Mexico, there are 448 aquifers in availability conditions.

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.

Aquifer overdraft

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, 2016, it was reported that there were 105 overdrafted aquifers (Figure 2.7). According to the results of recent studies, whether aquifers are considered overdrafted or cease to be so is based on the pumping/recharge ratio. The statistics on aquifers are presented in Table 2.12

Figure 2.7 Aquifers, 2016



Source: CONAGUA (2016b).

Table 2.12 Mexico's aquifers, 2016

HAR No.	Number of aquifers				Mean recharge (hm³)
	Total	Overdrafted	With seawater intrusion	Under the phenomenon of soil salinization and brackish groundwater	
I	88	14	11	5	1 658
II	62	10	5		3 207
III	24	2			3 076
IV	45	1			4 873
V	36				1 936
VI	102	18		8	5 935
VII	65	23		18	2 376
VIII	128	32			9 656
IX	40	1			4 108
X	22				4 599
XI	23				22 718
XII	4		2	1	25 316
XIII	14	4			2 330
Total	**653**	**105**	**18**	**32**	**91 788**

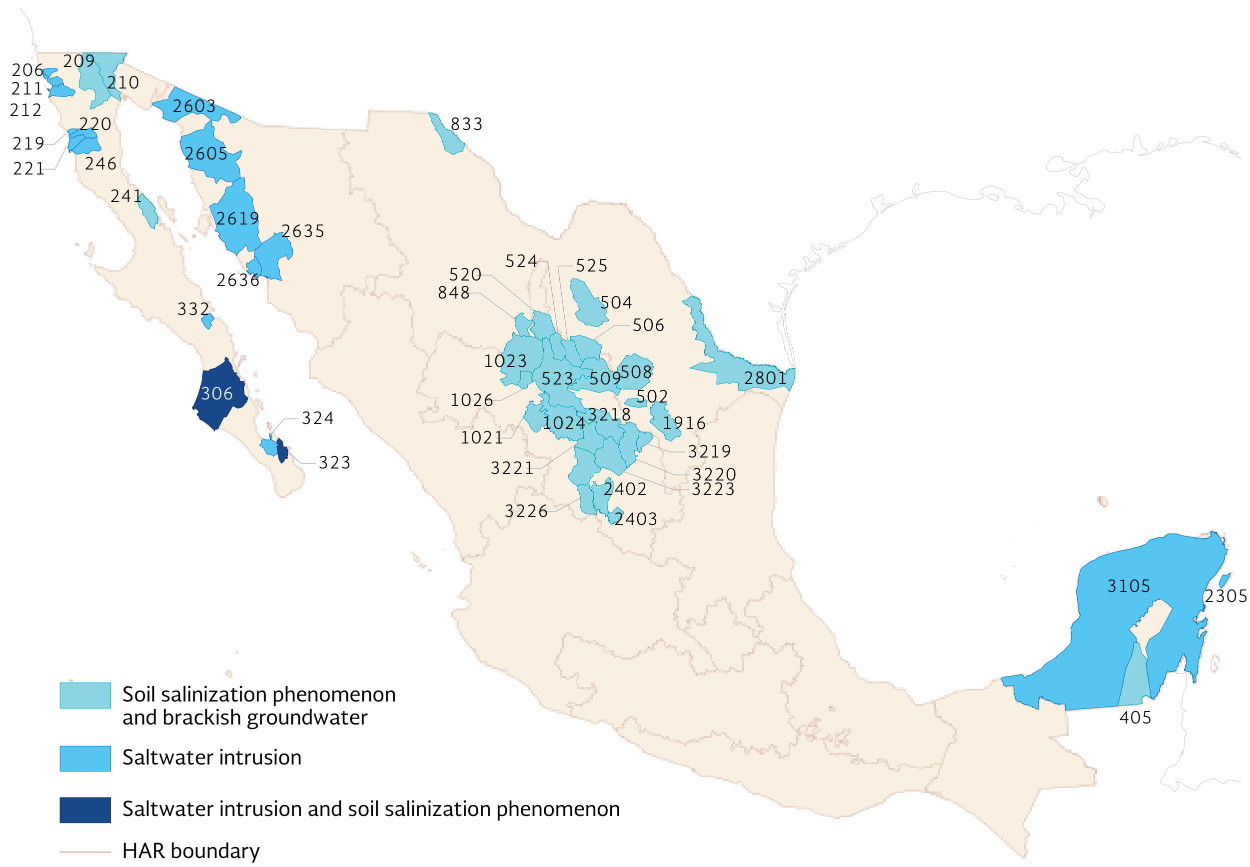
Source: CONAGUA (2016b).

Aquifers with saltwater intrusion and/or under the phenomenon 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 highly saline connate water. Brackish water occurs specifically in those aquifers located in geological provinces characterized by ancient sedimentary formations that are, shallow, of marine and evaporitic origin, in which the interaction of groundwater with the geological material produces the higher salt content. Saline intrusion is the process by which coastal aquifers are connected with seawater; saltwater flows into the ground, mixing with fresh water.

In late 2016, 32 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 18 coastal aquifers nationwide, as shown in Figure 2.8

Figure 2.8 Aquifers with salt-water intrusion and/or soil salinization and brackish groundwater, 2016



Key	Aquifer
206	La Misión
209	Laguna Salada
210	Valle de Mexicali
211	Ensenada
212	Maneadero
219	Camalú
220	Colonia Vicente Guerrero
221	San Quintín
241	Agua Amarga
246	San Simón
306	Santo Domingo
323	Los Planes
324	La Paz
332	Mulegé
405	Xpujil
502	Cañón del Derramadero

Key	Aquifer
504	Cuatrociénegas - Ocampo
506	El Hundido
508	Paredón
509	La Paila
520	Laguna del Rey-Sierra Mojada
523	Principal - Región Lagunera
524	Acatita
525	Las Delicias
833	Valle de Juárez
848	Laguna de Palomas
1021	Pedriceña - Velardeña
1023	Ceballos
1024	Oriente Aguanaval
1026	Vicente Suárez
1916	Navidad - Potosí - Raíces
2305	Isla de Cozumel

Key	Aquifer
2402	El Barril
2403	Salinas de Hidalgo
2603	Sonoyta - Puerto Peñasco
2605	Caborca
2619	Costa de Hermosillo
2635	Valle de Guaymas
2636	San José de Guaymas
2801	Bajo Río Bravo
3105	Península de Yucatán
3218	Cedros
3219	El Salvador
3220	Guadalupe Garzarón
3221	Camacho
3222	El Cardito
3223	Guadalupe de las Corrientes
3226	Chupaderos

Source: Based on CONAGUA (2016b).

2.6 Water quality

[Tablero: Calidad del agua, Playas limpias]

Water quality is determined by the physical and chemical characterization of water samples and their comparison with quality standards. Thus, it can be determined if the water is ideal for the quality requirements associated with a given use; for example, for human consumption or for the environment, and the possible treatment processes required to remove undesirable or risky elements (UN 2016). The deterioration in water quality occurs as a result of both natural and anthropic processes.

Water quality monitoring

In 2016, the National Monitoring Network had 5 068 sites, 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 assessed, using simple low-cost methods, such as the benthic organism diversity index. The number of samplings made in 2016 are shown in Table 2.14.

The water quality monitoring network had

5 068

sites in 2016

TABLE 2.13 National Monitoring Network sites, 2016

Network	Area	Sites (number)
Surface	Surface	2 644
Underground	Underground	1 080
Special studies	Groundwater bodies	74
	Surface water bodies	41
Coastal	Coastal	951
Discharges	Underground	9
Discharges	Surface	269
Total		**5 068**

Source: CONAGUA (2016b).

TABLE 2.14 Sampling for biological monitoring, 2016

HAR		No. of samplings
IV	Balsas	82
VI	Río Bravo	24
VII	Cuencas Centrales del Norte	8
IX	Golfo Norte	3
X	Golfo Centro	2
Total		119

Source: CONAGUA (2016b).

Water quality assessment

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 containing non-biodegradable organic matter.

TSS measure the quantity of sedimentable solids, solids and organic matter that are in suspension and/or colloidal. They 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 range from a relatively normal condition or with no influence of human activity, to water that shows significant signs or manifestations of municipal and non-municipal wastewater discharges, as well as areas with severe deforestation.

57.5%

of the sites monitored for BOD_5 had excellent quality in **2016**

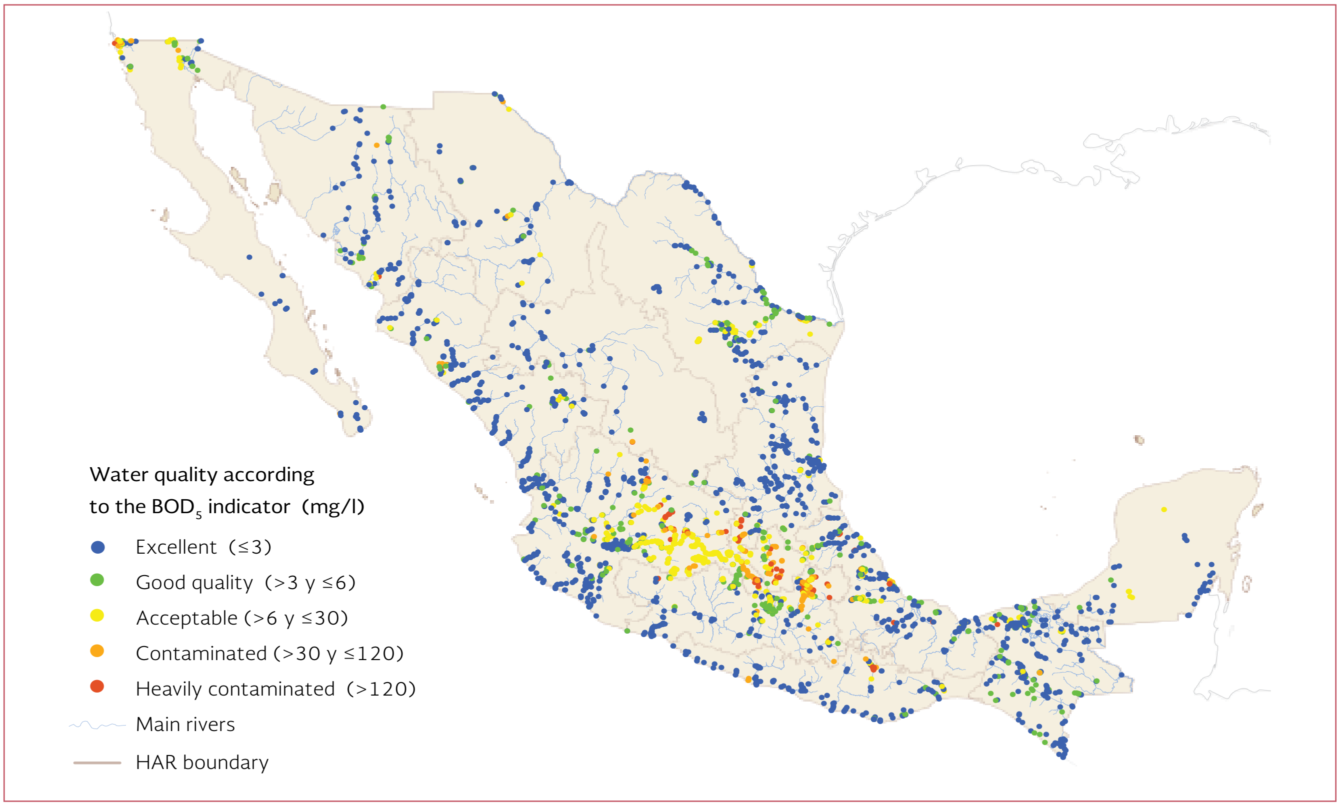
It should be mentioned that the water quality monitoring sites are situated in areas with a high anthropic influence. The water quality classification scale is shown in Tables 2.16, 2.17 and 2.18. The evaluation for 2016 of the water quality indicators was carried out according to the terms established in Table 2.15, with the results recorded in the following maps and tables: Maps 2.6, 2.7 and 2.8; Tables 2.16, 2.17 and 2.18.

Table 2.15 Number of monitoring sites with data for each water quality indicator, 2016

Water quality indicator	Number of monitoring sites
Biochemical Oxygen Demand (BOD_5)	2 772
Chemical Oxygen Demand (COD)	2 779
Total Suspended Solids (TSS)	3 810

Source: CONAGUA (2016b).

Map 2.7 Water Quality: Biochemical Oxygen Demand (BOD_5), 2016



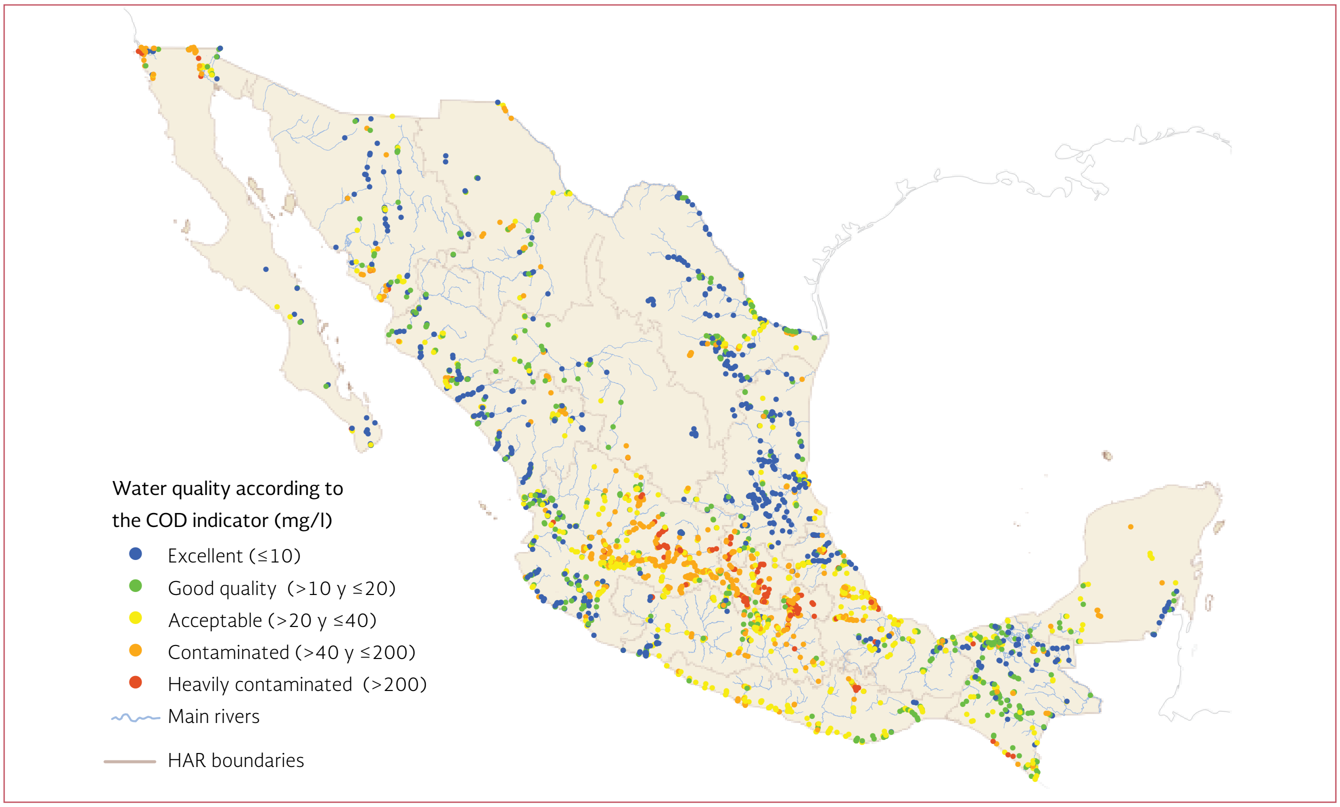
Source: CONAGUA (2016b).

Table 2.16 Percentage distribution of monitoring sites in surface water bodies by hydrological-administrative region, according to the BOD_5 indicator, 2016

	Hydrological-administrative region	Excellent	Good quality	Acceptable	Contaminated	Heavily contaminated
I	Península de Baja California	46.4	18.6	27.8	6.2	1
II	Noroeste	71.5	15.8	9.5	1.1	2.1
III	Pacífico Norte	83.2	9.9	4.3	1.7	0.9
IV	Balsas	32.7	19.1	21.9	18.2	8.1
V	Pacífico Sur	79.9	6.7	6.0	3.4	4
VI	Río Bravo	58.0	20.8	16.8	4.4	0
VII	Cuencas Centrales del Norte	83.2	11.1	1.9	1.9	1.9
VIII	Lerma Santiago Pacífico	41.6	10.5	35.9	7.1	4.9
IX	Golfo Norte	77.4	6.3	10.3	2.4	3.6
X	Golfo Centro	59.4	18.0	13.2	6.4	3.0
XI	Frontera Sur	73.3	19.0	6.5	0.8	0.4
XII	Península de Yucatán	85.1	4.3	10.6	0	0
XIII	Aguas del Valle de México	2.9	14.5	39.1	27.5	16.0
	National	**57.5**	**13.9**	**18.6**	**6.4**	**3.6**

Source: CONAGUA (2016b).

Map 2.8 Water quality: Chemical Oxygen Demand (COD), 2016



Source: CONAGUA (2016b).

Table 2.17 Percentage distribution of monitoring sites in surface water bodies by hydrological-administrative region, according to the COD indicator, 2016

	Hydrological-administrative region	Excellent	Good quality	Acceptable	Contaminated	Heavily contaminated
I	Península de Baja California	23.7	14.4	17.5	39.2	5.2
II	Noroeste	39.9	23.2	15.8	17.9	3.2
III	Pacífico Norte	43.5	25.0	20.3	9.5	1.7
IV	Balsas	11.4	12.3	29.0	31.5	15.8
V	Pacífico Sur	2	17.4	57.7	17.4	5.5
VI	Río Bravo	37.5	27.4	15.7	19.0	0.4
VII	Cuencas Centrales del Norte	27.8	37.0	25.9	7.4	1.9
VIII	Lerma Santiago Pacífico	13.4	13.2	24.1	40.1	9.2
IX	Golfo Norte	58.1	12.6	11.5	14.2	3.6
X	Golfo Centro	16.0	12.4	36.7	28.5	6.4
XI	Frontera Sur	23.9	42.6	24.0	7.6	1.9
XII	Península de Yucatán	25.5	31.9	27.7	14.9	0
XIII	Aguas del Valle de México	0	4.1	17.8	43.8	34.3
	National	**24.2**	**19.3**	**24.8**	**24.9**	**6.8**

Source: CONAGUA (2016b).

Map 2.9 Water quality: Total Suspended Solids (TSS), 2016

Source: CONAGUA (2016b).

Table 2.18 Percentage distribution of monitoring sites in surface water bodies by hydrological-administrative regions, according to the TSS indicator, 2016

	Hydrological-administrative region	Excellent	Good quality	Acceptable	Contaminated	Heavily contaminated
I	Península de Baja California	71.4	19.8	6.6	2.2	0
II	Noroeste	51.9	29.2	9.1	9.1	0.7
III	Pacífico Norte	48.2	39.8	7.5	3.9	0.6
IV	Balsas	46.0	28.2	10.6	12.9	2.3
V	Pacífico Sur	26.9	45.0	17.9	6.6	3.6
VI	Río Bravo	59.9	25.3	10.9	3.5	0.4
VII	Cuencas Centrales del Norte	65.4	25.5	5.5	1.8	1.8
VIII	Lerma Santiago Pacífico	48.0	31.2	15.1	4.6	1.1
IX	Golfo Norte	60.4	30.7	7.3	1.0	0.6
X	Golfo Centro	55.1	37.3	5.4	2.1	0.1
XI	Frontera Sur	40.9	39.3	16.1	3.7	0
XII	Península de Yucatán	68.8	27.6	3.1	0.5	0
XIII	Aguas del Valle de México	24.7	43.8	16.4	13.7	1.4
	National	**50.0**	**33.1**	**11.1**	**4.8**	**1.0**

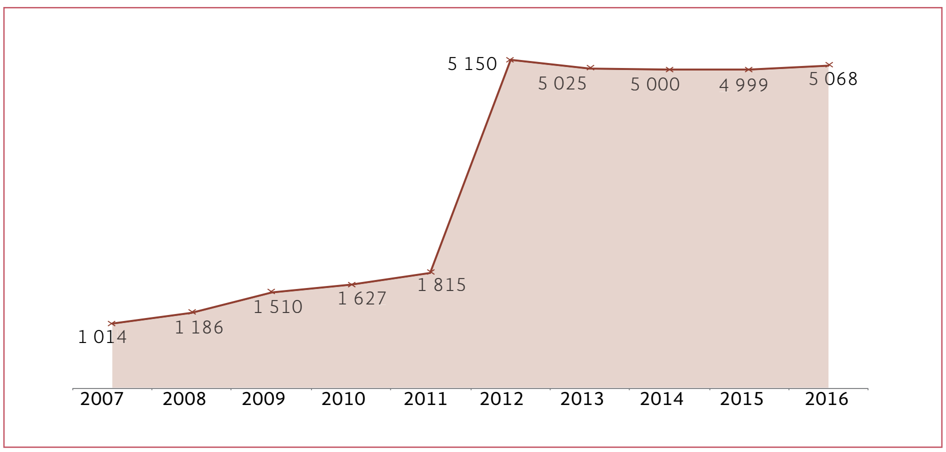
Source: CONAGUA (2016b).

Summary of water quality

In 2016 there were 5 068 water quality monitoring sites, the result of a trend in recent years to increase this measurement, as can be seen in Graph 2.5.

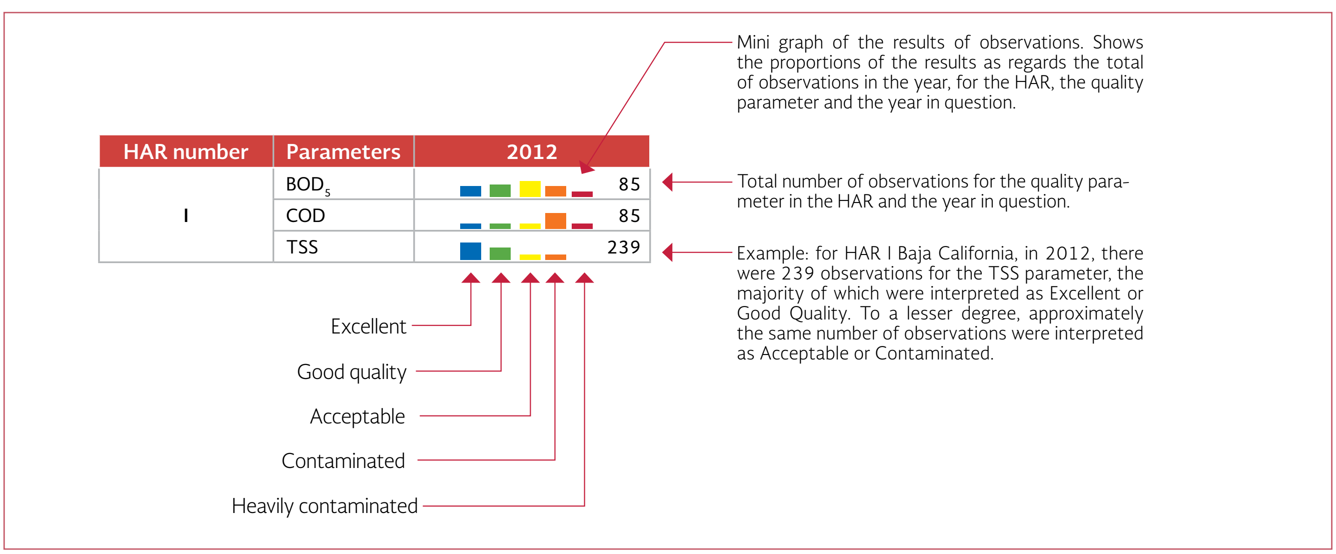
For the 2011–2016 period, water quality results are presented regionally, summarized in Table 2.19, which indicates, for each hydrological-administrative region, parameter (BOD_5, COD or TSS) and year, the observations with the interpretation of water quality (excellent, good quality, acceptable, contaminated and heavily contaminated) through a mini graph, as well as the total number of observations with data. Figure 2.9 has an example of the interpretation of the data in Table 2.19.

GRAPH 2.5 National Monitoring Network stations, 2007-2016



Source: CONAGUA (2016b).

FIGURE 2.9 Key to interpret Table 2.19



Source: CONAGUA (2016d).

Table 2.19 Summary of water quality 2012-2016

HAR	Param.	2012	2013	2014	2015	2016
I	BOD_5	85	84	76	84	97
	COD	85	84	76	84	97
	TSS	239	210	202	216	227
II	BOD_5	71	76	73	84	95
	COD	71	76	73	84	95
	TSS	116	128	126	140	154
III	BOD_5	195	215	206	214	232
	COD	184	215	206	214	232
	TSS	269	303	307	311	332
IV	BOD_5	337	312	310	352	324
	COD	338	312	310	353	324
	TSS	349	325	319	364	341
V	BOD_5	116	122	142	142	149
	COD	142	122	142	142	149
	TSS	373	361	358	366	391
VI	BOD_5	221	286	244	284	274
	COD	222	287	244	284	274
	TSS	233	293	255	294	285
VII	BOD_5	43	46	46	49	54
	COD	43	46	46	49	54
	TSS	44	46	46	49	55
VIII	BOD_5	672	639	647	654	649
	COD	671	641	647	654	651
	TSS	773	733	743	758	757
IX	BOD_5	235	242	242	252	253
	COD	235	243	241	251	253
	TSS	306	292	295	309	313
X	BOD_5	238	249	247	262	266
	COD	232	249	247	262	267
	TSS	285	306	307	325	332
XI	BOD_5	253	256	252	261	263
	COD	256	256	252	261	263
	TSS	350	353	349	357	354
XII	BOD_5	67	53	53	53	47
	COD	67	53	53	53	47
	TSS	225	199	202	202	196
XIII	BOD_5	55	67	98	75	69
	COD	55	67	98	75	73
	TSS	55	67	98	75	73
Nal.	BOD_5	2 588	2 647	2 636	2 766	2 772
	COD	2 601	2 651	2 635	2 766	2 779
	TSS	3 617	3 616	3 607	3 766	3 810

Source: Based on CONAGUA (2016b).

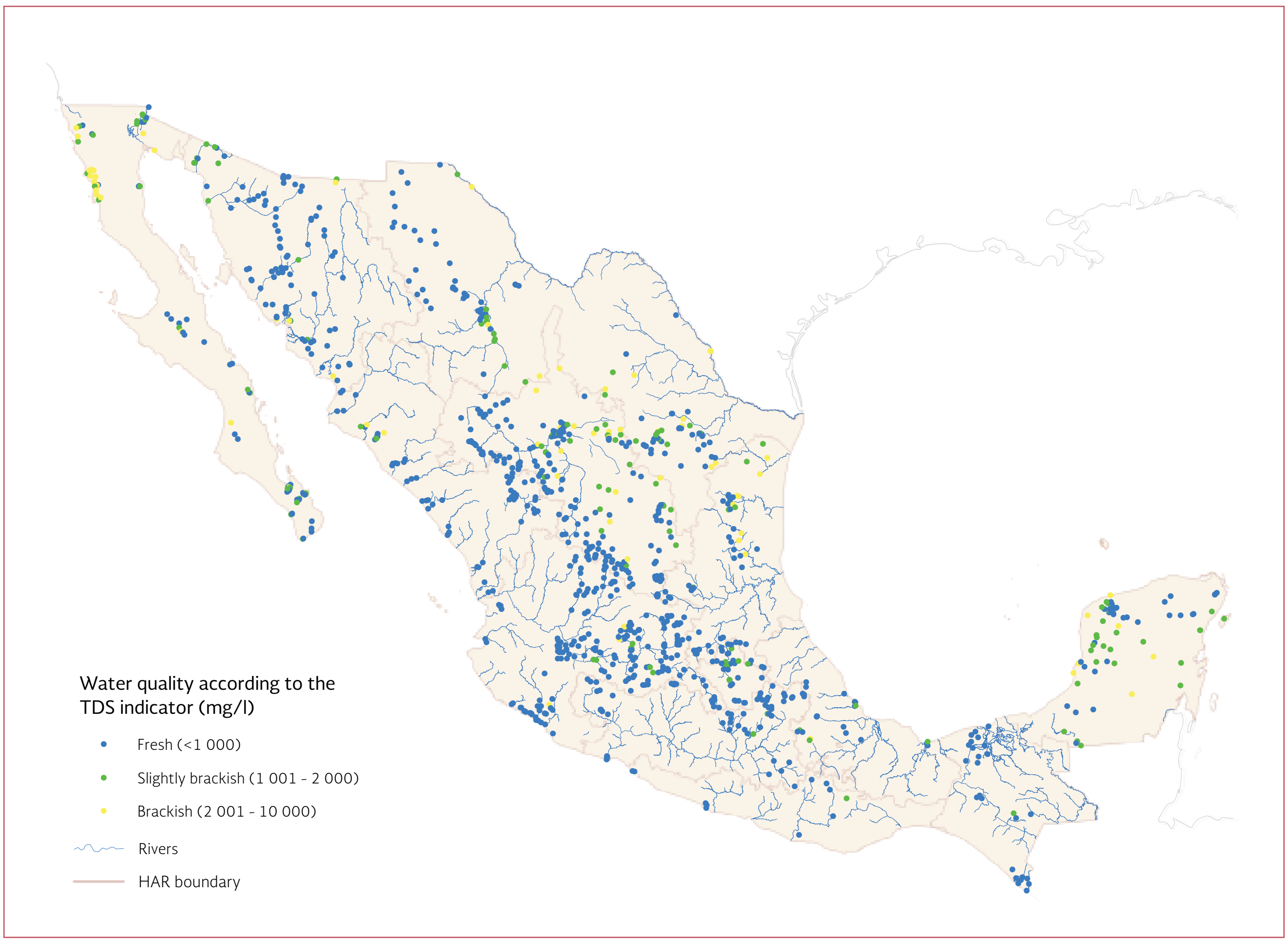
Groundwater quality

One of the parameters that allows groundwater salinization to be evaluated is the total disolved solids (TDS). 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 (higher than 10 000 mg/l)

The limit between freshwater and slightly brackish water coincides with 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.

The annual monitoring of groundwater quality is shown in Map 2.10.

Map 2.10 Groundwater quality: Total Dissolved Solids, 2016



Source: CONAGUA (2016b).

Water quality on beaches

Within the framework of the Clean Beaches Program, since 2003 the cleaning up of beaches and their associated watersheds and aquifers has been promoted. The aim of the program is to prevent and revert the contamination of Mexico's beaches, respecting biodiversity, making them competitive for national and international tourism, as well as raising the quality and standard of living of the local population.

For the development of the program, have been set up, auxiliary bodies of the River Basin Councils (see chapter 5), which are chaired by the President of the municipality and have the active presence of representatives of SEMARNAT, PROFEPA, SEMAR, SECTUR, COFEPRIS and CONAGUA, as well as representatives of associations and the private sector.

In order to evaluate water quality on beaches for first-contact recreational use, the bacteriological indicator of *Enterococcus faecalis* is used. In 2003, the Ministry of Health set the maximum limit for recreational use at 500 MPN[9]/100 ml. As of 2010, in conformity with studies carried out by the World Health Organization (WHO), it was reduced to 200 MPN/100 ml)

Water quality classification criteria on beaches:

- 0-200 MPN/100 ml, the beach is considered SUITABLE for recreational use.
- Higher than 200 MPN/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 shows that from 2006 to 2016, water quality on beaches tended to improve, as shown in Graph 2.6.

The tourist destinations monitored in 2016 are shown in Map 2.11. That year, all sites monitored were found to be appropriate for recreational use. Similarly, the SEMARNAT published the Mexican standard NMX-AA-120-SCFI-2006 (voluntarily observed), which establishes the sustainable beach quality requirements and specifications for the modalities of recreational uses and priority for conservation. In order to be able to be certified with this

9 MPN (Most probable number).

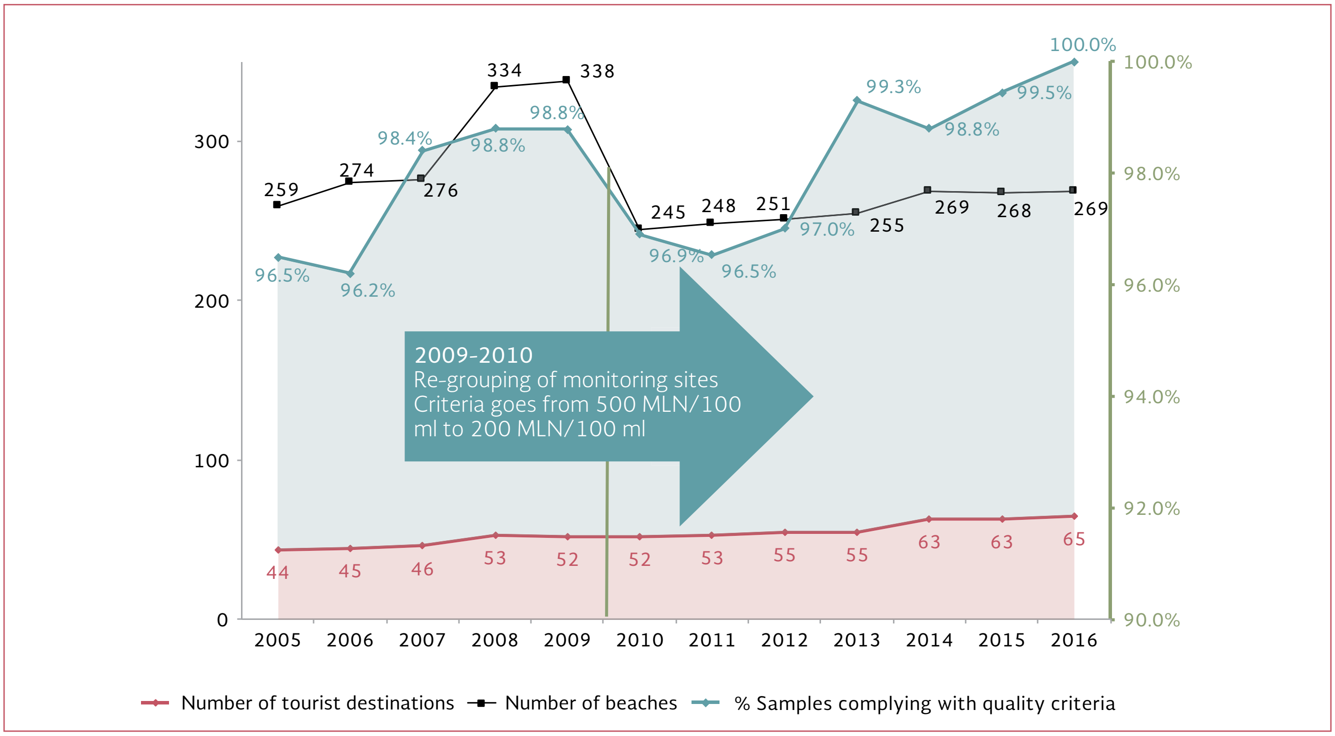
standard, the maximum limit of enterococci is even lower than the Clean Beach Program, with 100 MPN/100 ml. The certification has a two-year validity. As of 2016, 37 beaches had this certification.

Another certification that Mexican beaches can aspire to is the *Blue Flag*, which rewards coastal resorts with excellence in environmental management, safe and hygienic facilities, educational activities and environmental information and water quality. As of 2016, 25 beaches had this certification.

Beaches with certifications are shown in Map 2.12.

Punta Esmeralda beach, Q.Roo, Mexico.

Graph 2.6 Results of the monitoring program for water quality on beaches, 2005-2016



Source: Based on SEMARNAT *et al.* (2016).

Map 2.11 Monitored tourist destinations, 2016

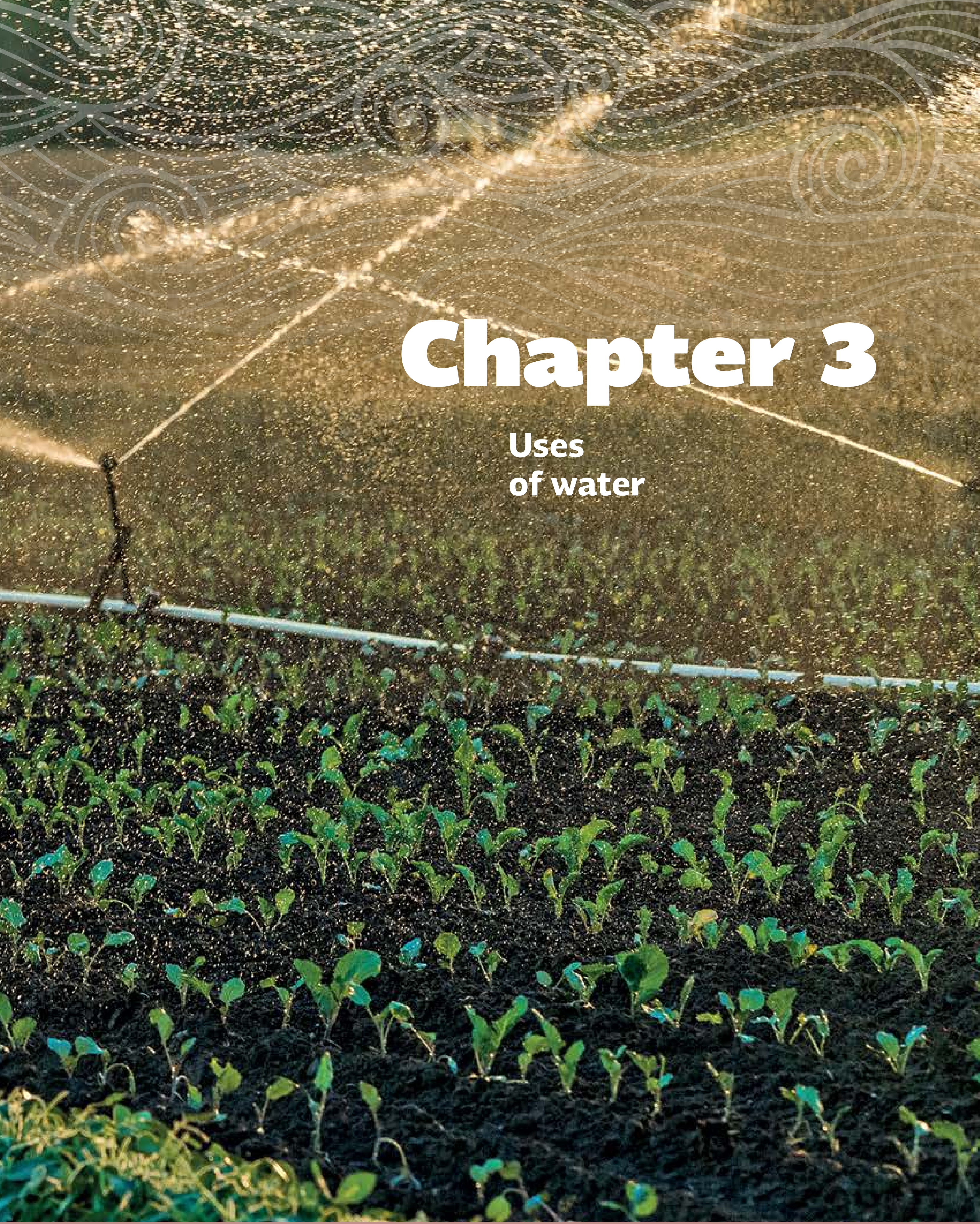
Source: Based on SEMARNAT *et al.* (2016).

Map 2.12 Certified beaches, 2016

Source: Based on CONAGUA (2016b).

Laguna Salada, Baja California, México.

Irrigation system in a bean plantation. Zacatecas is the main national producer of this seed.



Chapter 3

Uses of water

Uses of water

Uses of water in Mexico

variation between regions

15 852 hm³
Highest allocated volume:
VIII Lerma - Santiago - Pacífico

1 570 hm³
Lowest allocated volume:
V Pacífico Sur

Classification

Consumptive

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

Non-consumptive

The activity does not modify the volume

Consumptive water-use sources

Surface water
61% of consumptive uses consuntivos

Groundwater
39% of consumptive uses consuntivos

Grouped consumptive uses

76%
Agriculture

5%
Electric energy, excluding hydropower

15%
Public supply

4%
Self-supplying industry

Virtual water

- Quantity of water employed in the productive process of a good or service.
- Virtual water exchanges due to product trade.
- Mexico: net importer of virtual water, **25 221** hm³ in 2016.

Water and the economy

Environmental and economic accounting

- Relates the environment with the economy.
- Facilitates comparisons and decision making.

Degree of water stress

Sources of consumptive uses

Higher than
40%
is considered high or very high water stress

Higher degree:
XIII Aguas del Valle de México
139%
(very high)

Regions

Mexico
19%
(medium)

Lowest degree:
XI Frontera Sur
2%
(no stress)

3.1 Classification of the uses of water

[Tablero: Registro Público de Derechos de Agua (Repda) / Volúmenes inscritos]

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 recorded in the Public Registry of Water Duties (REPDA). 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 consumptive and non-consumptive uses.[2] The non-consumptive use, ecological conservation, has an allocated volume of 9.46 hm^3/year. The data on allocated volumes for 2016 are as of December 31, 2016. 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

In 2016 there was an allocated volume of

269 289

hm^3

Table 3.1 Grouping of uses in the Repda classification, 2016

Code	Category of the REPDA classification	Volume allocated (hm^3)
A	Agriculture (registered + pending)	58 981
B	Agro-industry	4
C	Domestic	39
D	Aquaculture	1 153.09
E	Services	1 550
F	Industry	6 397
F1	Industry, excluding thermopower	2 248
F2	Thermopower	4 149
G	Livestock	210
H	Public urban	12 539
I	Multiple	5 704
K	Trade	0.08
L	Others	0.48
	Consumptive subtotal	**86 577**
J	Hydropower	182 703
N	Ecological conservation	9.46
	Non-consumptive subtotal	**182 712**
	Total	**269 289**

Grouped consumptive uses	Definition	Volume allocated (hm^3)
Agriculture	A+D+G+I+L	66 049
Public supply	C+H	12 577
Self-supplying industry	B+E+F1+K	3 802
Energy generation excluding hydropower	F2	4 149
	Consumptive subtotal	**86 577**
Hydropower	J	182 703
Ecological conservation	N	9.46
	Non-consumptive subtotal	**182 712**
	Total	**269 289**

Nota: The F1 and F2 arbitrary codes were added as components in the REPDA code F Industry. These two arbitrary codes allow the consumptive generation of electricity (in thermoelectric plants) to be distinguished from non-consumptive generation (hydropower).

Source: Based on CONAGUA (2016c).

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

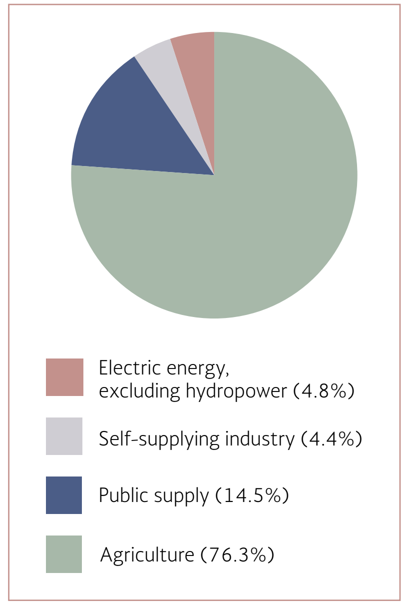
2 Consumptive use: The volume of water of a given quality that is consumed during the implementation of a specific activity, which is determined as the difference between the volume of a given quality that is extracted, minus the volume of a given quality that is discharged, and which is shown in the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

shows the evolution in the volume allocated for consumptive uses in the period from 2007 to 2016 and indicates that 60.9% of the water used for consumptive uses comes from surface water sources (rivers, streams and lakes), whereas the remaining 39.1% corresponds to groundwater sources (aquifers). Compared to 2007, in 2016 the volume of surface water allocated was 5.6% higher, whereas the groundwater allocated was 16.8% higher.

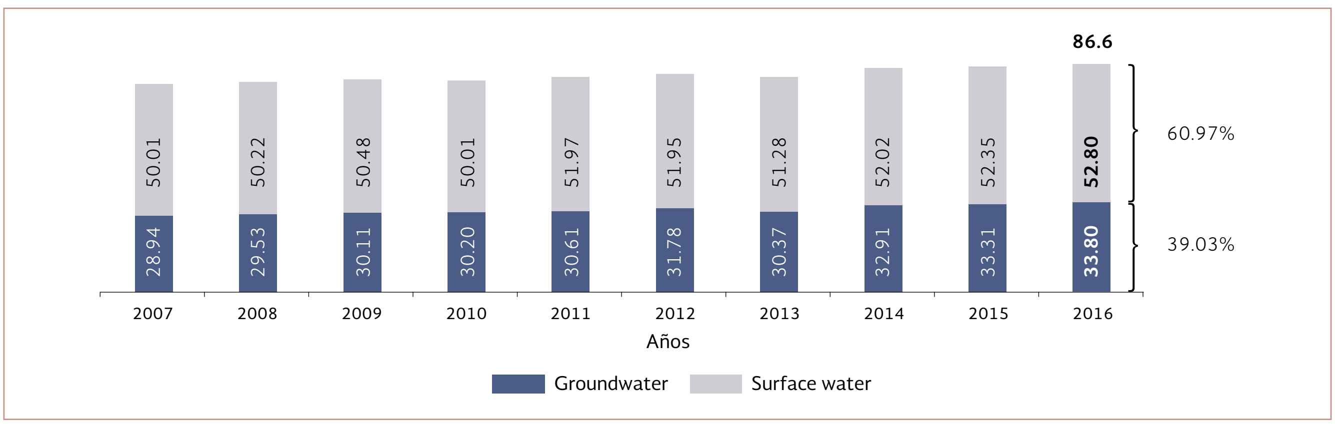
The greatest volume allocated for consumptive uses is for the grouped use for agriculture, mainly for irrigation, as can be observed in Table 3.2 and Graph 3.2. It is also worth mentioning that Mexico is one of the countries with the most substantial irrigation infrastructures in the world (see chapters 4 and 8).

As regards hydropower, which represents a non-consumptive use of water resources, 125 623 cubic hectometers of water were used nationwide in 2016. For this use, the same water may be employed several times in the country's plants.

GRAPH 3.2 Distribution of volumes allocated for grouped consumptive uses, 2016



GRAPH 3.1 Volume allocated for consumptive uses by type of source, 2007-2016 (thousands of hm³)



Source: Based on CONAGUA (2016c).

TABLE 3.2 Grouped consumptive uses by type of source, 2016,

Grouped use	Origin: Surface water (thousands of hm³)	Origin: Groundwater (thousands of hm³)	Total volume (thousands of hm³)	Percentage of extraction
Agriculture	42.21	23.84	66.05	76.30
Public supply	5.22	7.36	12.58	14.50
Self-supplying industry	1.64	2.16	3.80	4.40
Electric energy, excluding hydropower	3.70	0.45	4.15	4.80
Total	**52.77**	**33.81**	**86.58**	**100.00**

Source: Based on CONAGUA (2016c).

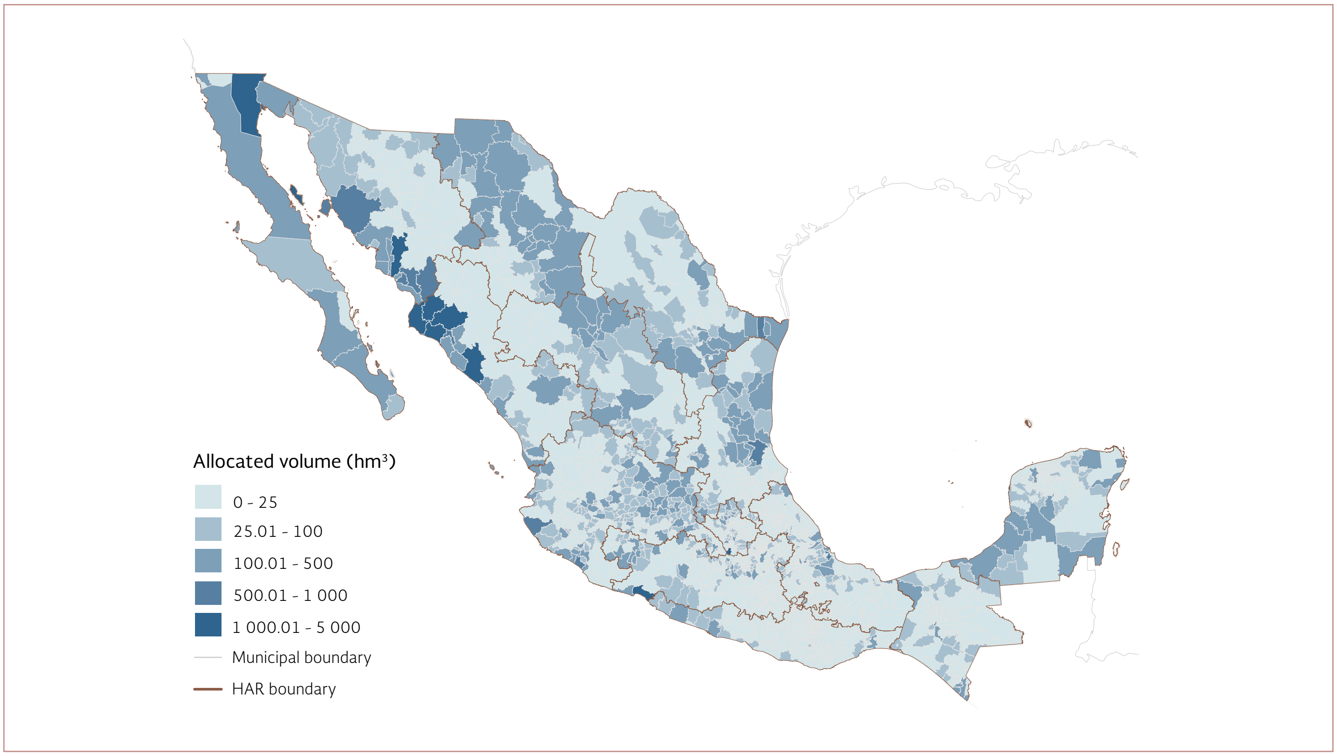
3.2 Distribution of uses throughout Mexico

[Tablero: Registro Público de Derechos de Agua (REPDA) / Volúmenes inscritos]

Map 3.1 shows the volume allocated for consumptive uses in 2016 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.

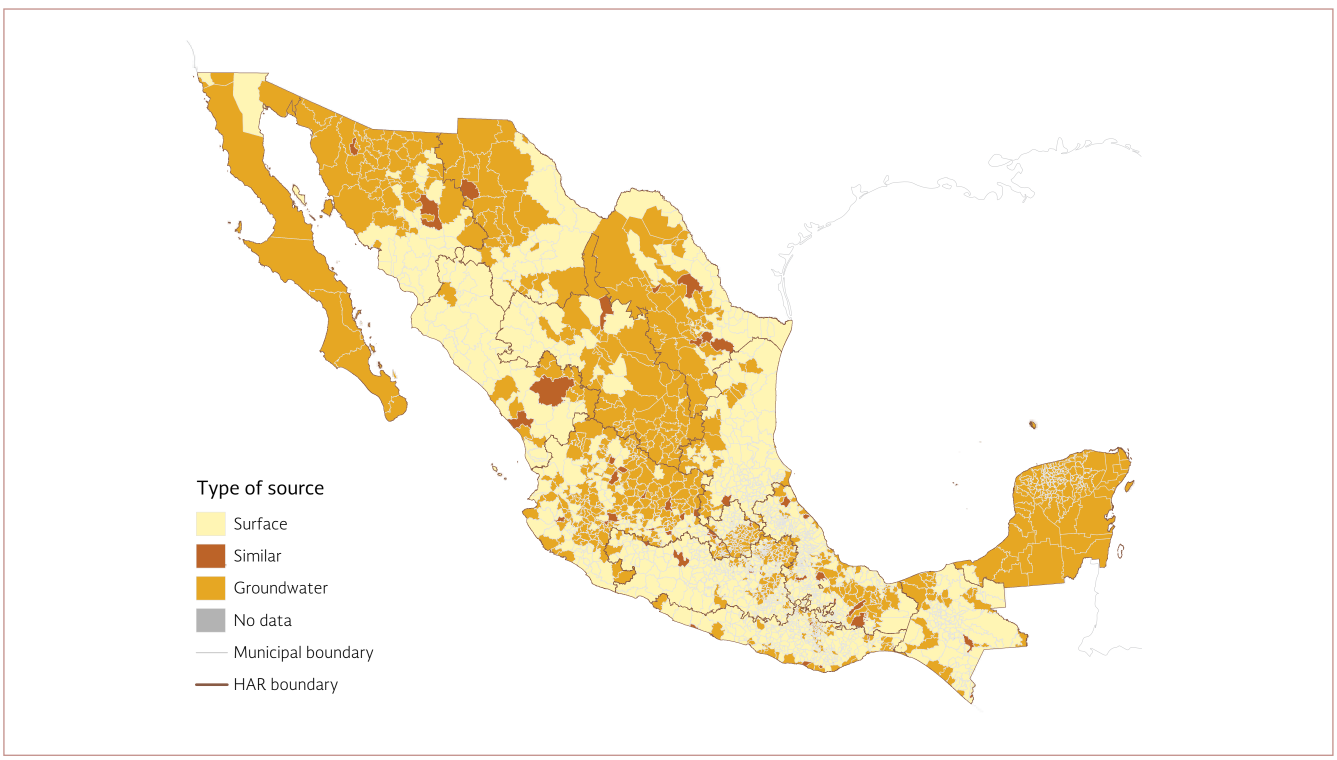
Aquaculture in Ensenada, Baja California, México.

MAP 3.1 Intensity of consumptive uses by municipality, 2016



Source: Based on CONAGUA (2016c).

MAP 3.2 Predominant source for consumptive uses by municipality, 2016



Source: Based on CONAGUA (2016c).

The grouped uses in agriculture and public supply represented in 2016 90.8% of the volume allocated nationwide.

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 2016 compared to the volume in 2005, in order to indicate if it increased or decreased.

Graphs 3.3 and 3.4 show how volumes of water have been allocated for grouped consumptive uses throughout the country. The hydrological-administrative regions (HARs) with the greatest allocations of water are: V Lerma-Santiago-Pacífico, IV Balsas, III Pacífico Norte and VI Río Bravo. It is worth noting that agriculture accounts for over 80% of the total allocations in those 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.

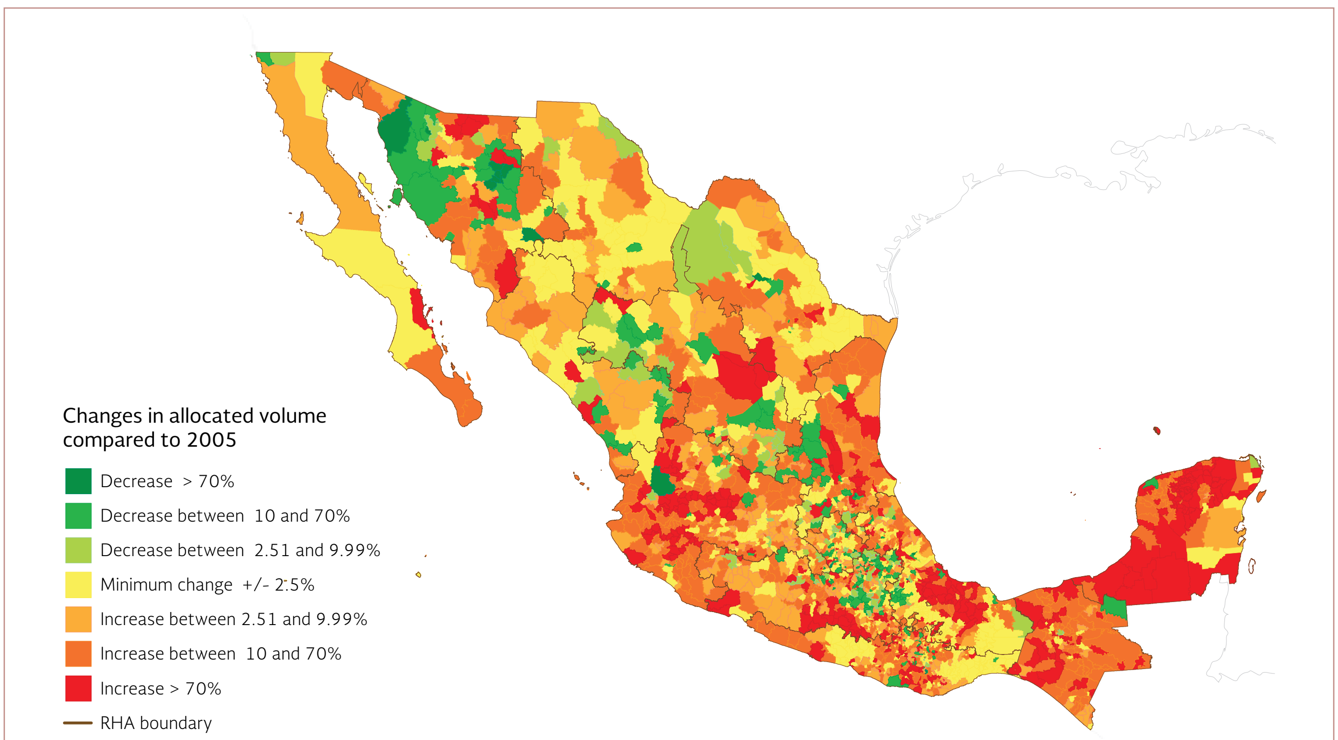
Table 3.3 shows the information on the volumes of water allocated by state, among which Sinaloa and Sonora stand out, due to their large areas under irrigation.

90.8%

of the allocated volume

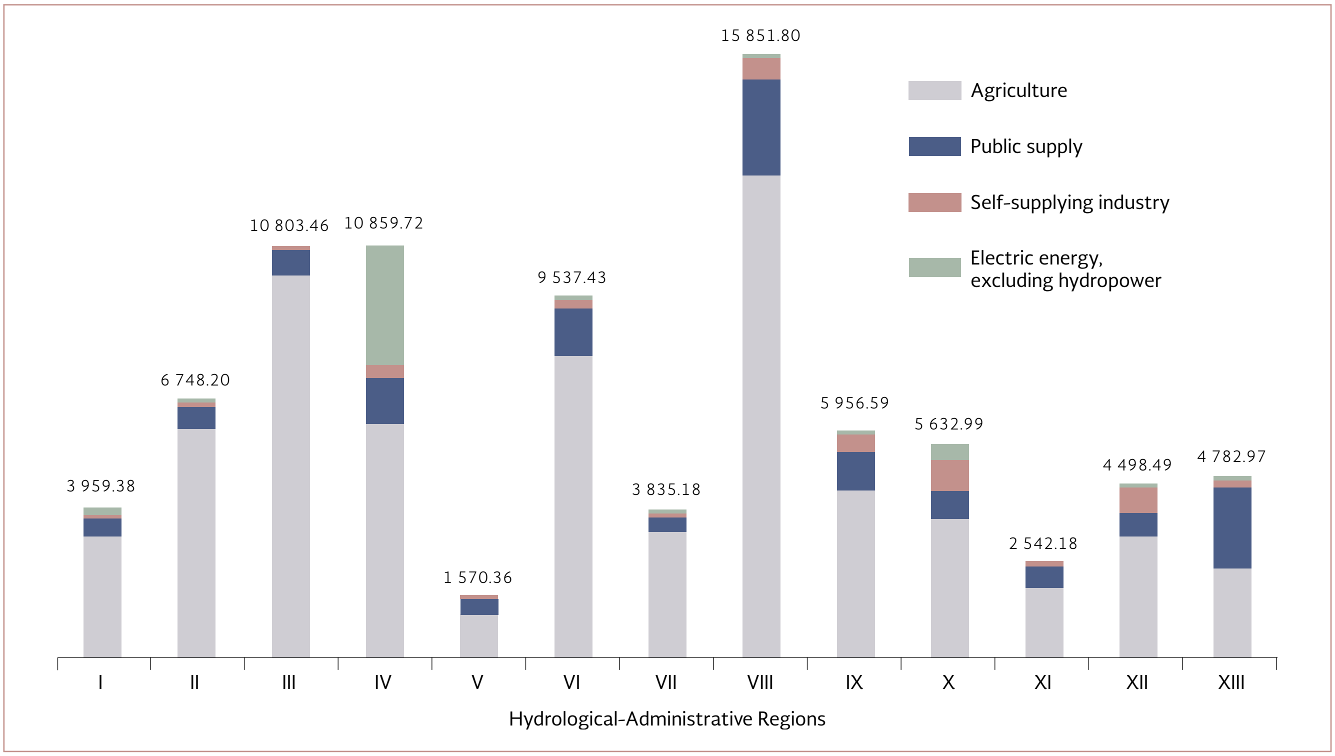
nationwide is agricultural and public supply uses

Map 3.3 Changes in consumptive uses by municipality 2005-2016



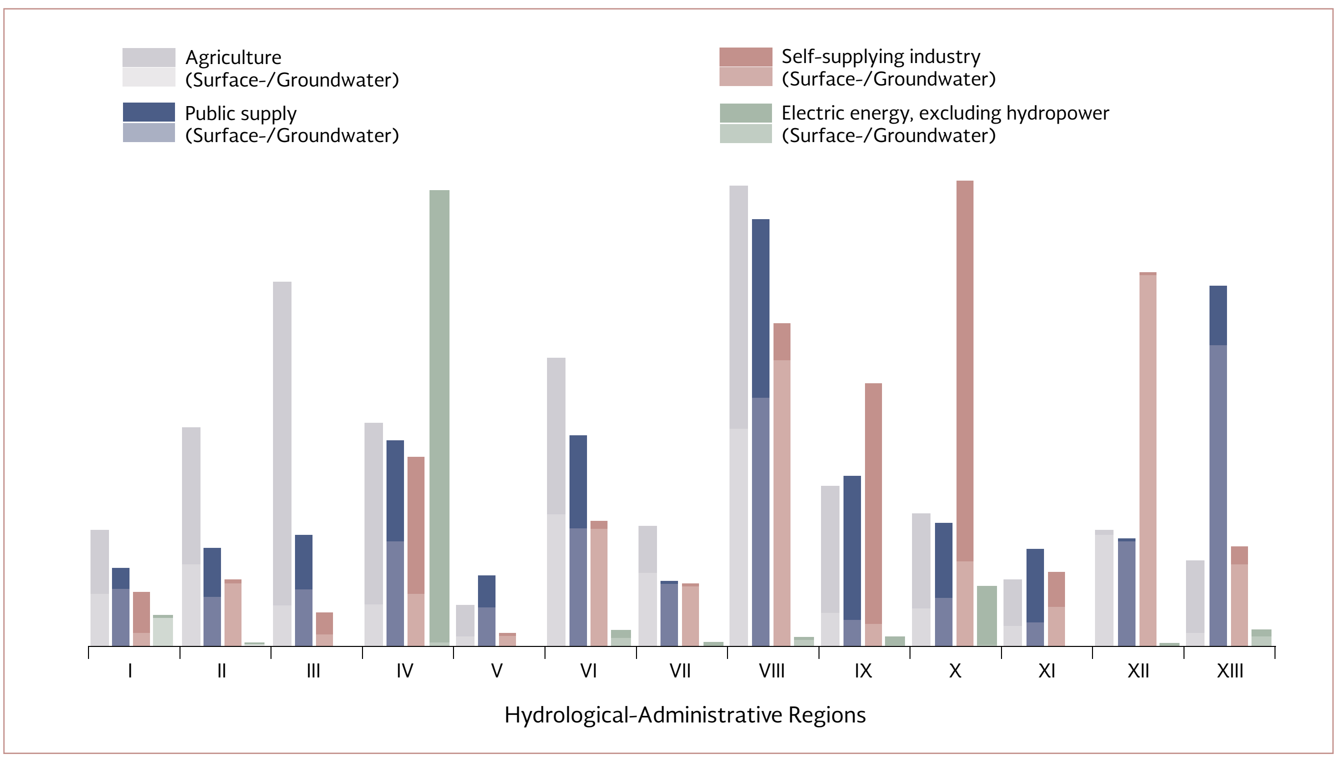
Source: Based on CONAGUA (2016c).

Graph 3.3 Allocated volumes by grouped consumptive uses, 2016 (hm³)



Source: Based on CONAGUA (2016c).

Graph 3.4 Allocated volume for grouped consumptive uses by extraction source, 2016 (hm³)



Source: Based on CONAGUA (2016c).

Table 3.3 Allocated volumes by grouped consumptive uses, 2016 (hm^3)

Key	Federative entity	Allocated volume	Agriculture	Public supply	Self-supplied industry	Electric energy, excluding hydropower
1	Aguascalientes	623.4	479.1	127.2	17.1	0
2	Baja California	3 050.2	2 588.3	187.5	82.9	191.5
3	Baja California Sur	423.8	340.8	65.2	13.5	4.3
4	Campeche	1 323.9	1 140.6	155	24.6	3.6
5	Coahuila de Zaragoza	2 045.8	1 654.5	239.7	76.8	74.9
6	Colima	1 800.1	1 675.2	99.7	25.2	0
7	Chiapas	1 997.4	1 565.3	391.2	40.9	0
8	Chihuahua	5 164.2	4 590.8	489.9	56.0	27.5
9	Mexico City	1 122.3	1,2	1 089.6	31.5	0
10	Durango	1 575.2	1 376.3	170.8	16.6	11.5
11	Guanajuato	4 125.5	3 482.0	548.2	74.7	20.5
12	Guerrero	4 440.4	911.1	384.8	22.4	3 122.1
13	Hidalgo	2 373.6	2 095.2	163.2	32.6	82.6
14	Jalisco	4 993.9	3 718.9	1 064.1	210.8	0.1
15	State of Mexico	2 761.7	1 181.7	1 365.8	183.7	30.6
16	Michoacán de Ocampo	5 483.5	4 807.3	376.9	251.3	47.9
17	Morelos	1 315.8	986.6	281.1	48.2	0
18	Nayarit	1 356.1	1 123.5	124	108.6	0
19	Nuevo León	2 075.5	1 476.2	511.9	87.1	0.2
20	Oaxaca	1 336.8	1 033.1	268.6	35.1	0
21	Puebla	2 138.8	1 628.4	428.6	75.3	6.5
22	Querétaro	1 011.9	640.2	305.2	60.9	5.7
23	Quintana Roo	1 111.0	316.2	213.1	581.7	0
24	San Luis Potosí	2 000.6	1 279.6	655.2	34.7	31
25	Sinaloa	9 558.9	9 005.3	509.3	44.4	0
26	Sonora	7 039.6	6 136.8	770.7	115.5	16.5
27	Tabasco	507.1	231.2	184.4	91.5	0
28	Tamaulipas	4 236.6	3 730.3	334.9	116	55.5
29	Tlaxcala	271.5	164.1	90.2	17.2	0
30	Veracruz de Ignacio de la Llave	5 577.6	3 519.3	551.6	1 098.9	407.8
31	Yucatán	2 063.5	1 744.5	256.4	53.7	9.1
32	Zacatecas	1 670.5	1 425.0	173.2	72.3	0
Total		**86 576.8**	**66 048.7**	**12 577.1**	**3 801.6**	**4 149.3**

Source: Based on CONAGUA (2016c).

Water for supplying public spaces.

3.3 Grouped use for agriculture

[Tablero: Registro Público de Derechos de Agua (REPDA) / Volúmenes inscritos]

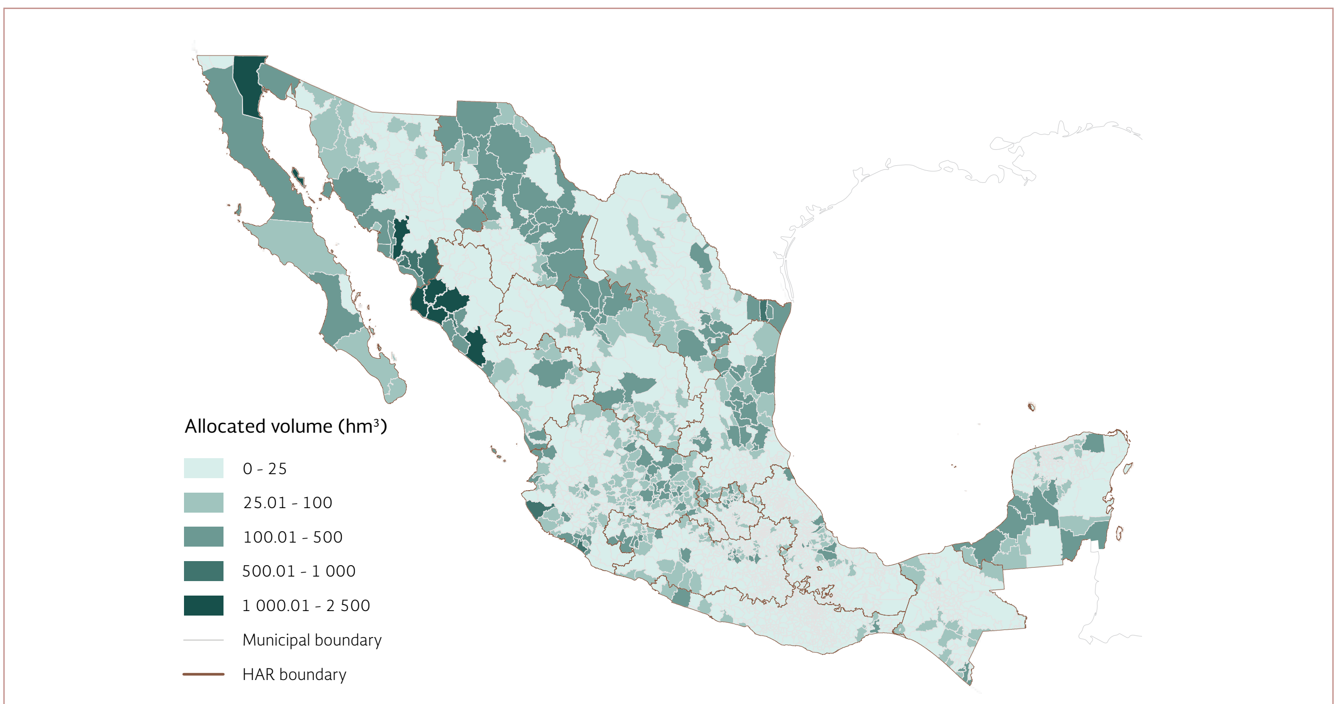
The largest use of water in Mexico is in agriculture. According to the VII Agricultural, Livestock and Forest Census from 2007 (the latest one available nationwide), the surface area in agricultural production units was 30.2 million hectares, of which 18% was for irrigation and the remainder was rainfed.

The area sown every year (considering the agricultural year and perennial crops, under both irrigated and rainfed regimes) has varied between 21.4 and 21.9 million hectares during the 2006-2016 period (SIAP 2017).

Every year the area harvested in this same period (considering the agricultural year and perennial crops, under both irrigated and rainfed regimes) varied between 19.9 and 21.2 million hectares per year (SIAP 2017). At constant prices, the contribution of the agriculture, livestock, forest use, fishing and hunting sector to the Gross Domestic Product (GDP) was 3.8% in 2016 (INEGI 2016g).

Map 3.4 shows the allocated volume nationwide for the grouped agricultural use.

MAP 3.4 Distribution of the consumptive use for agriculture



Source: Based on CONAGUA (2016c).

According to the National Inquiry of Occupation and Employment (ENOE in Spanish), the population occupied in this sector of primary activities (agriculture, livestock, forest use, fishing and hunting) up to the fourth trimester of 2016 was 6.9 million people, which represents 13.3% of the active population at that point (INEGI 2016i)

The yield in tons per hectare of irrigation agriculture is 2.2 to 3.3 times higher than in areas under a rainfed regime (see Chapter 4).

By 2016, the area sown under irrigation in Mexico was 6.05 million hectares, of which slightly more than half are located in 86 irrigation districts, and the remainder in more than 40 thousand irrigation units (see Glossary).

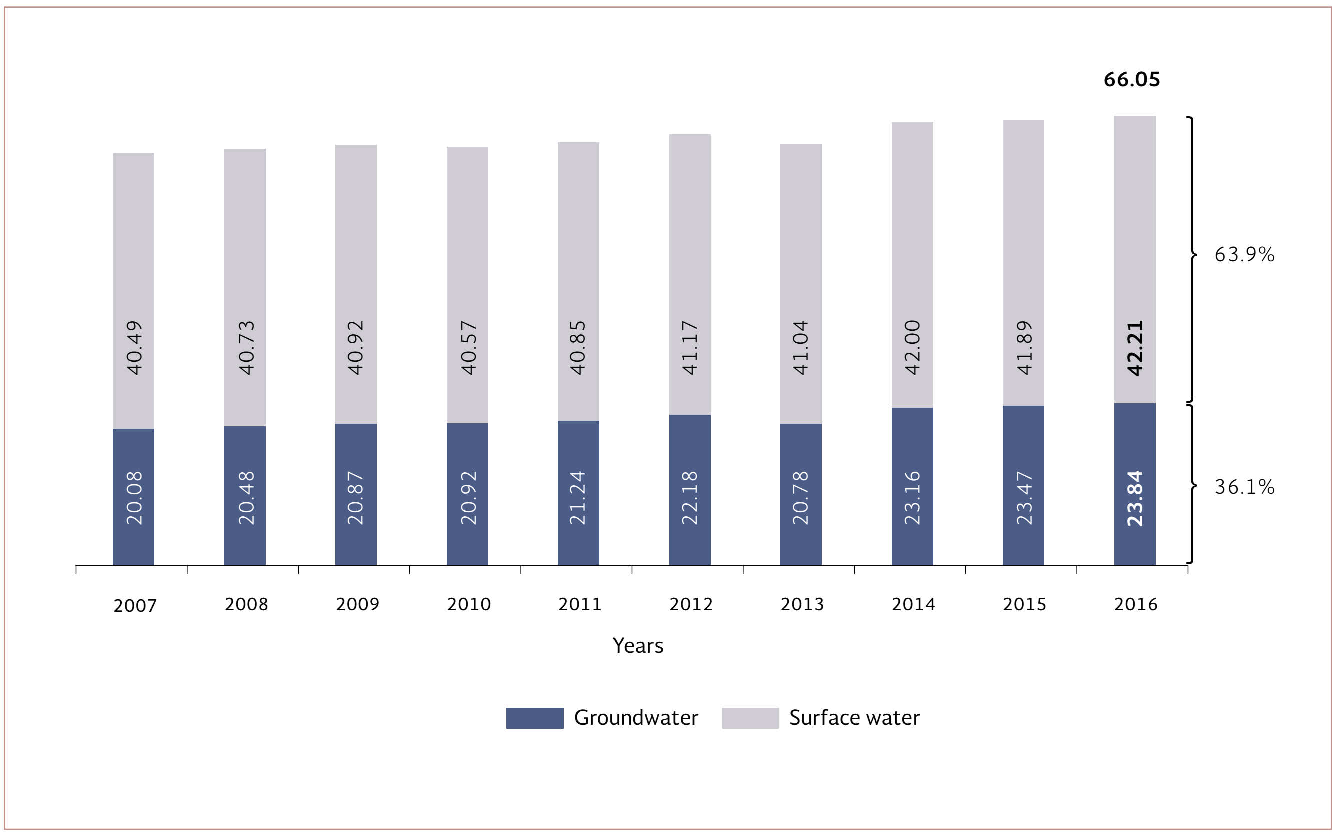
Graph 3.5 shows that 36.0% of water allocated for agricultural group use is of underground origin. Taking into account that there are annual variations, the volume of groundwater concession for this grouped use is 18.5% greater than that of 2007, the initial year of the graph.

Mexico has more than

40 000

irrigation units

GRAPH 3.5 Evolution of the allocated volume of agricultural grouped use by type of source, 2007-2016 (thousands of hm^3)



Source: Based on CONAGUA (2016c).

3.4 Grouped use for public supply

[Tablero: Registro Público de Derechos de Agua (Repda) / Volúmenes inscritos]

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.

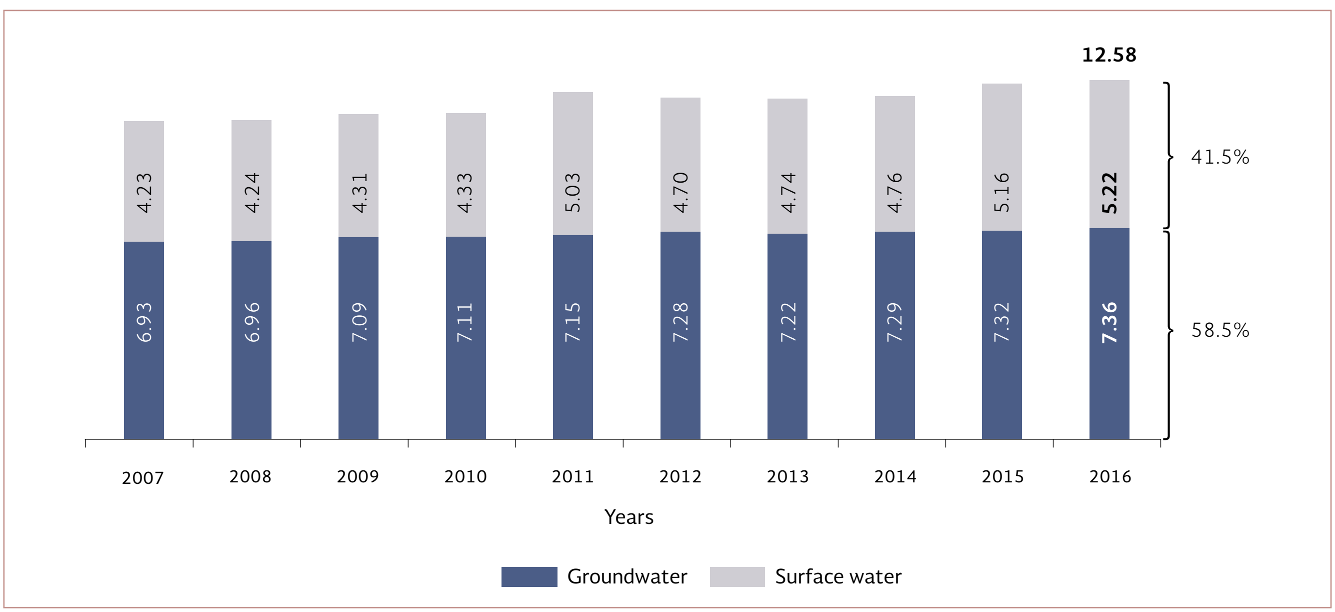
The availability of water in sufficient quantity and quality for human consumption is one of the basic demands of the population, since it directly affects their health and well-being in general. This characteristic is recognized by the national planning guiding instruments: the National Development Plan 2013-2018 and the National Hydrological Plan 2014-2018.

In the grouped use public supply, the predominant source is the underground source with 58.7% of the volume, as shown in Graph 3.6. It should be noted that from 2007 to 2016 the surface water allocated for this use grew by 22.9%.

In Mexico, the drinking water, drainage, sewage, treatment and disposal of wastewater service is in charge of the municipalities, generally through water utilities.

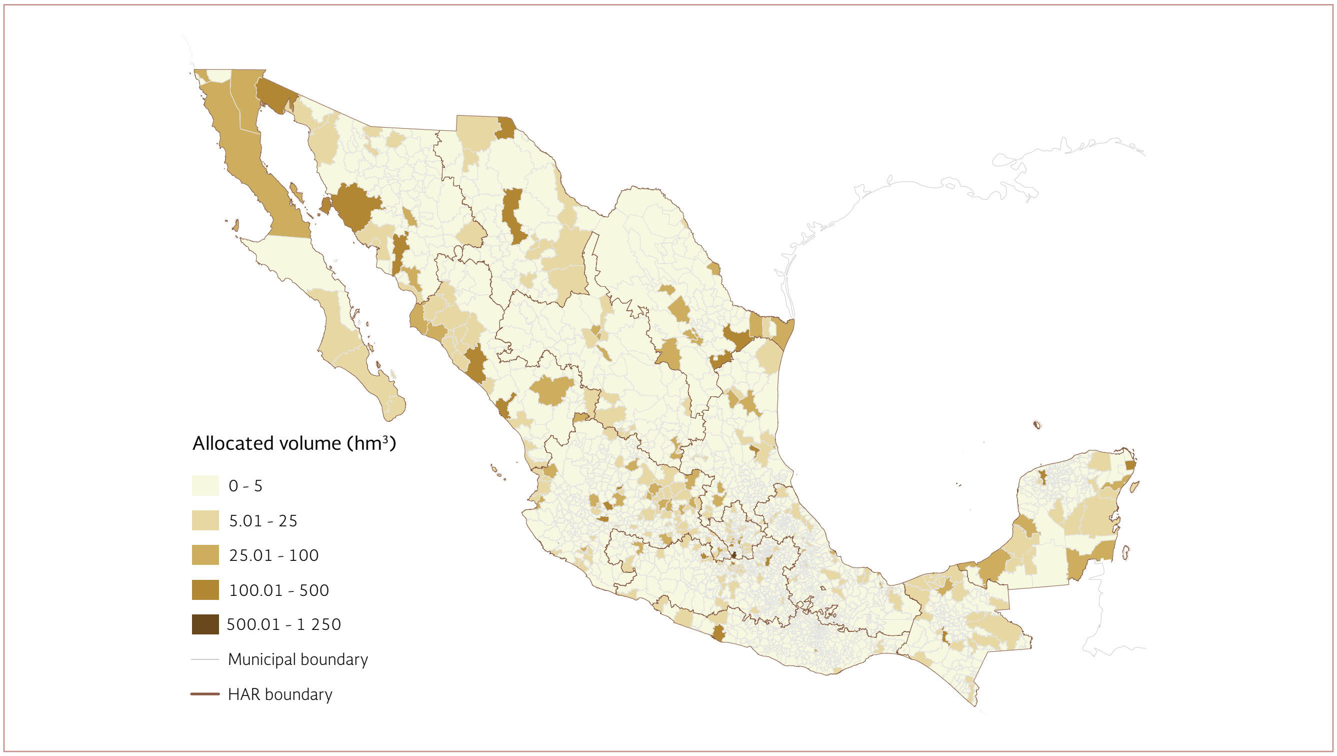
Map 3.5 shows the allocated volume at the national level of the grouped use of public supplies.

Graph 3.6 Evolution of the allocated volume of grouped use public supply by source type, 2007-2016 (thousands of hm^3)



Source: Based on CONAGUA (2016c).

Map 3.5 Distribution of the consumptive use for public water supply



Source: Based on CONAGUA (2016c).

Domestic use of water.

3.5 Grouped use for the self-supplying industry

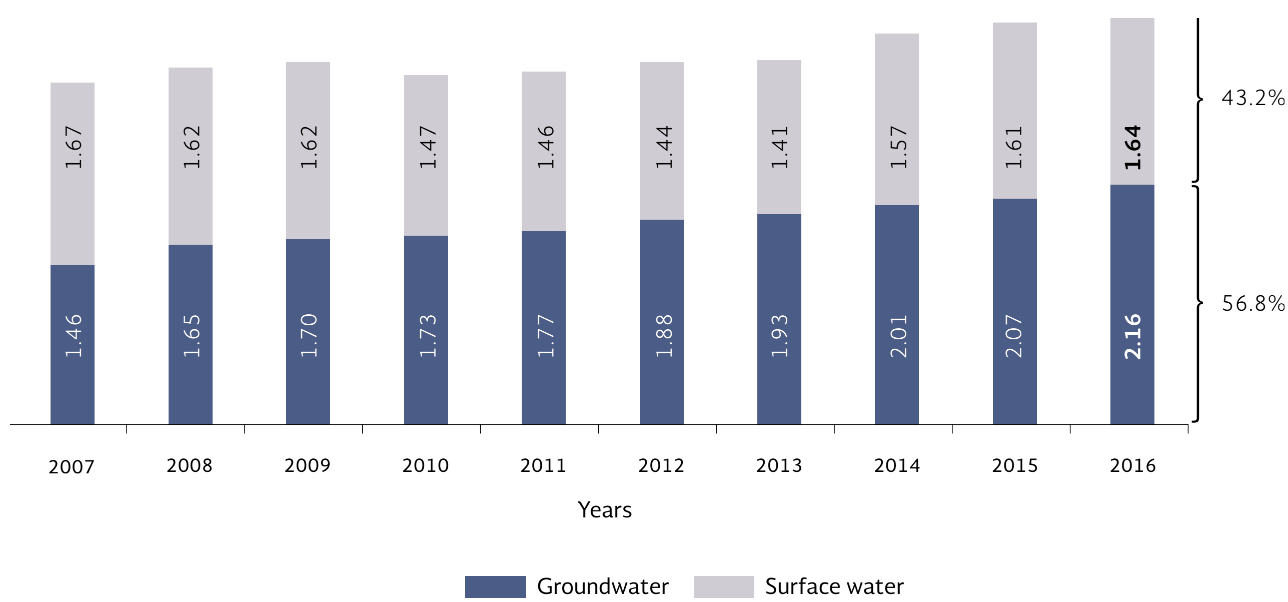
[Tablero: Registro Público de Derechos de Agua (Repda) / Volúmenes inscritos]

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 sectors of mining, electricity, water and piped gas supply to end users, as well as the construction and manufacturing industries (INEGI 2013f). It should be added that the REPDA classification of uses does not exactly follow this classification, although it is considered that there is a reasonable degree of correlation.

Although it represents only 4.4% of total consumptive use, self-supplied industrial grouped use presents the growth dynamics shown in Graph 3.7. It should be noted that in the period 2007-2016, the volume of underground allocation was significantly increased, with a 50.7% growth in that period.

Graph 3.7 Evolution in the volume allocated for the grouped use for self-supplying industry by type of source, 2007-2016 (thousands of hm^3)



Source: Based on CONAGUA (2016c).

3.6 Grouped use for electric energy, excluding hydropower

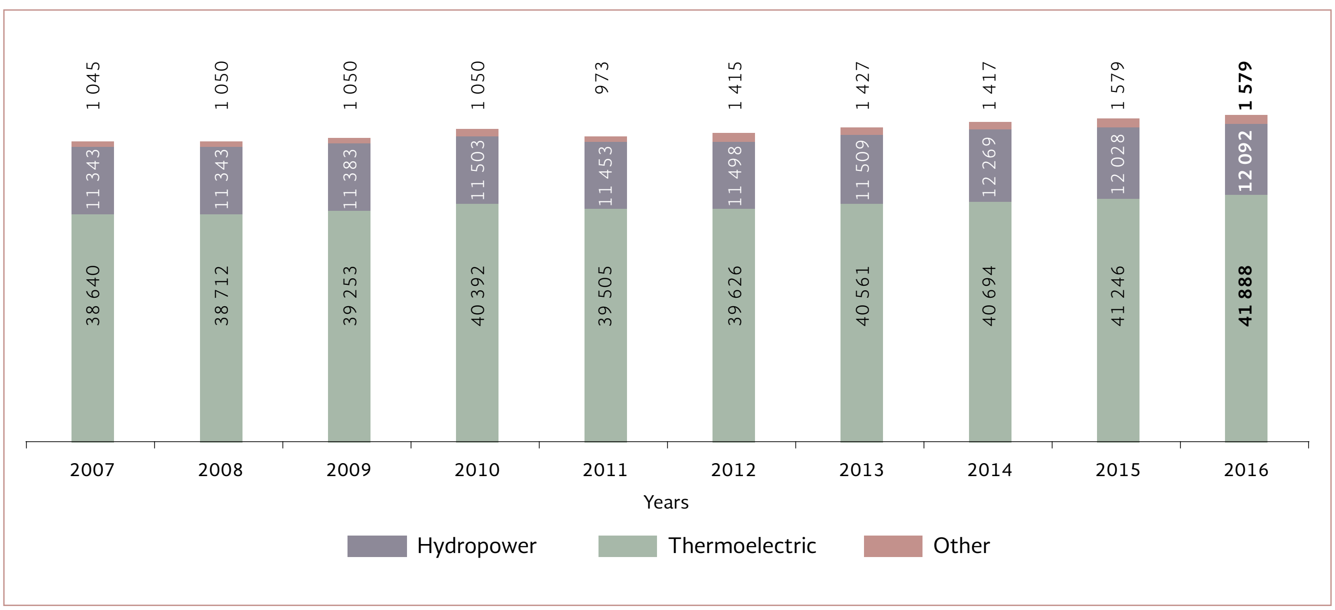
[Tablero: Registro Público de Derechos de Agua (Repda) / Volúmenes inscritos]

This grouped use refers to dual steam, coal-electric, combined cycle, turbo-gas and internal combustion plants, which represent a consumptive use of water, and includes renewable technologies (wind, photovoltaic solar and geothermal). Hydropower is excluded, which will be dealt with under 3.7, since it represents a non-consumptive use of water resources.

According to the information provided by the Secretary of Energy (SENER 2016) in 2016, the Federal Electricity Commission (CFE) plants considered in this use, including independent power producers (IPPs) for the public service, had an effective capacity it is 43 467 MW, which represented 78.2% of the national total. The gross generation of these plants in that year was 226 TWh, 88.6% of the national total.

It is worth mentioning that 75.2% of the water allocated for this use corresponds to the Petacalco coal plant, located on the coast of Guerrero, near the mouth of the Balsas River. Graph 3.8 shows the annual evolution of the effective generation capacity of this use in the period from 2007 to 2016, while Graph 3.9 shows the gross generation for this same period.

Graph 3.8 Effective capacity for energy generation, 2007-2016 (MW)



Note: The effective thermoelectric generation capacity includes the nuclear, coal, dual, internal combustion, turbo, combined cycle and steam. While the "other" heading includes the measurement of geothermal, wind and photovoltaic power plants.

Source: Based on CONAGUA (2016c).

3.7 Use for hydropower

[Tablero: Registro Público de Derechos de Agua (Repda) / Volúmenes inscritos, Generación de energía. Volúmenes declarados]

At the national scale, the RHA XI Frontera sur and IV Balsas have the most important water concession in this use, since they contain the largest rivers and the largest hydroelectric power stations in the country, as shown in Table. 3.4. The volume granted for this use at the national scale is 182 703 cubic hectometers (CONAGUA 2016c), of which variable quantities are used annually.

In 2016, hydroelectric plants used a volume of water of 125 623 cubic hectometers (Table 3.4), which allowed the generation of 29.1 TWh of electric power, which corresponded to 11.4% of the national total at that time. The installed capacity in hydroelectric power plants in 2016 was 12 092 MW, which corresponded to 21.8% of the installed capacity in the country (see Graphs 3.8 and 3.9).

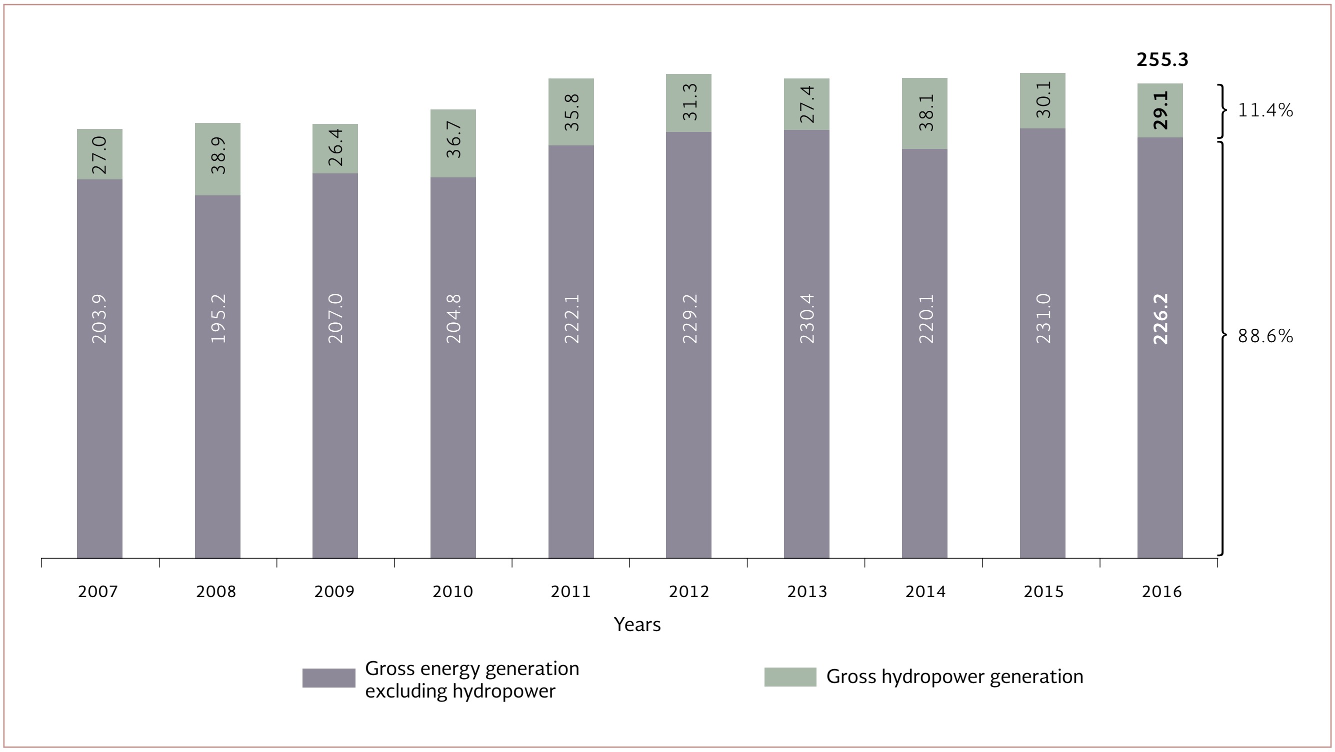
In 2016,
125 623
hm³
were used for hydropower generation

Table 3.4 Volumes declared for the payment of duties for hydropower production, 2007-2016

ARH No.	Volume of water declared (hm³)									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
I	0	0	0	0	0	0	0	0	1.7	71.5
II	3 350.7	3 404.7	3 127.7	4 140.6	3 416.5	3 032.7	2 627.2	2 456.3	3 963.2	3 695.8
III	11 183.9	13 216.7	11 405.1	11 912.1	11 100.3	5 176.6	6 127.9	7 475.4	11 050.9	11 025.5
IV	31 099.4	30 572.8	28 059.6	34 487.9	35 539.9	32 177.7	28 126.2	29 688.3	31 076.7	29 820.4
V	2 139.6	2 244.7	2 063.4	15 029.1	16 313.8	2 028.2	1 716.9	26,3	242.0	234.9
VI	2 889.6	1 967.7	2 960.4	2 987.7	3 350.1	3 771.8	2 556.8	2 125.5	1 652.6	2 243.7
VII	0	0	0	0	0	0	0	0	0	0
VIII	10 516.6	13 516.9	9 030.9	11 764.6	7 741.4	5 733.5	5 598.0	10 693.3	15 070.4	13 900.9
IX	1 105.3	2 912.1	1 441.0	1 525.9	1 243.0	1 312.4	1 273.5	1 225.7	1 911.6	1 870.8
X	14 279.1	14 040.5	13 673.7	3 528.0	4 254.6	17 286.7	16 463.1	12 319.4	15 472.3	14 242.6
XI	46 256.8	68 793.3	64 304.7	49 406.9	81 813.4	85 197.3	48 325.9	67 007.6	58 220.7	48 516.2
XII	0	0	0	0	0	0	0	0	0	0
XIII	10.6	0	18.8	0,5	0	0	0.3	0.5	0.3	0.3
Total	**122 831.6**	**150 669.4**	**136 085.3**	**134 783.3**	**164 773.0**	**155 716.9**	**112 815.9**	**133 018.3**	**138 662.4**	**125 622.6**

Source: Based on CONAGUA (2016c).

Graph 3.9 Gross energy generation, 2007-2016 (TWh)



Source: Based on CONAGUA (2016c).

The Manuel Moreno Torres "Chicoasén" hydropower plant, Chiapas, part of the Grijalva River hydropower system.

3.8 Degree of water stress

[Tablero: Registro Público de Derechos de Agua (REPDA) / Volúmenes inscritos, Generación de energía. Volúmenes declarados]

The percentage of water used for consumptive uses as compared to the renewable water resources is an indicator of the degree of water stress in any given country, watershed 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 3.6).

Nationwide, Mexico is experiencing a degree of water stress of 19.2%, 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 3.6, this indicator is shown for each of the country's HARs.

Nationwide, the degree of water stress in 2016 was

19.2%

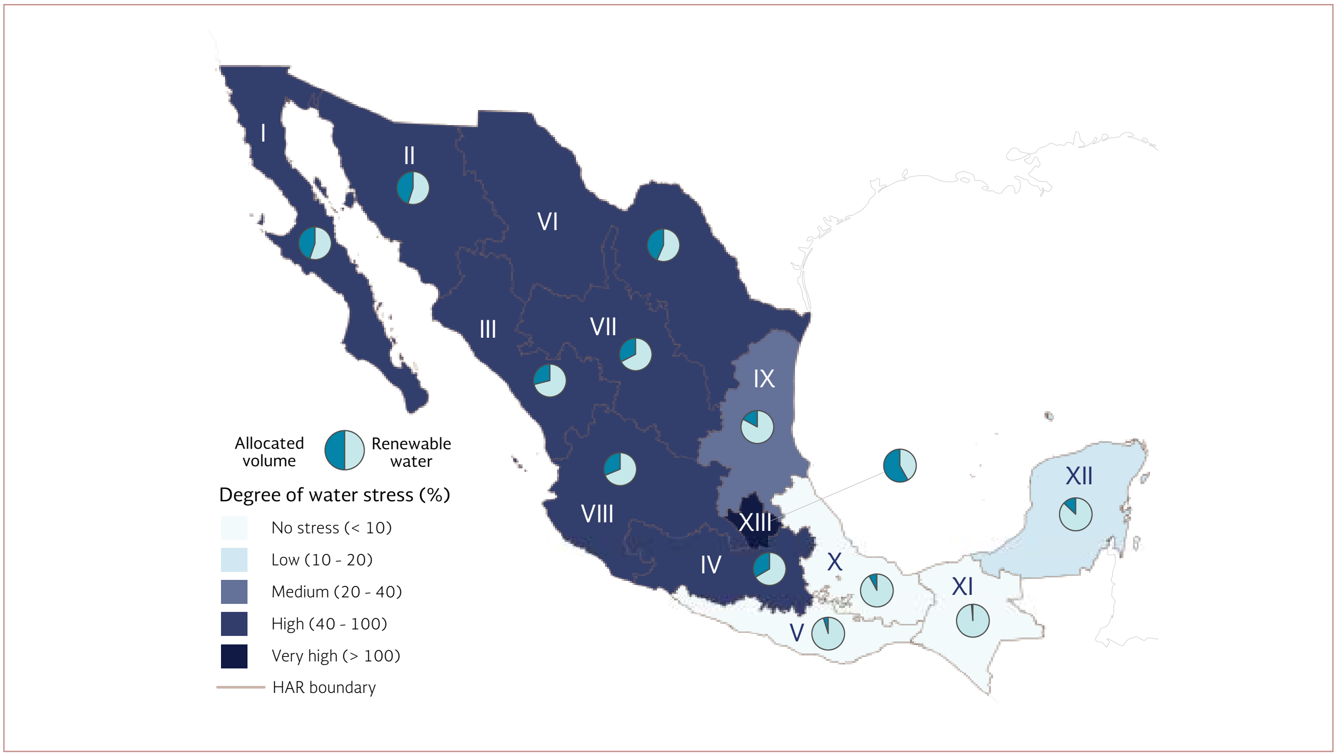
which is considered low

TABLE 3.5 Degree of water stress, 2016

HAR	Hydrological-Administrative Region	Total allocated water volume (millions of m³)	Mean renewable water (billions of m³)	Degree of water stress (%)	Classification of water stress
I	Península de Baja California	3 959	4.876	81.20	High
II	Noroeste	6 748	8.274	81.60	High
III	Pacífico Norte	10 803	26.613	40.60	High
IV	Balsas	10 860	21.671	50.10	High
V	Pacífico Sur	1 570	30.836	5.10	No stress
VI	Río Bravo	9 537	12.430	76.70	High
VII	Cuencas Centrales del Norte	3 835	7.926	48.40	High
VIII	Lerma-Santiago-Pacífico	15 852	34.897	45.40	High
IX	Golfo Norte	5 957	28.663	20.80	Medium
X	Golfo Centro	5 632	65.645	8.60	No stress
XI	Frontera Sur	2 542	175.912	1.50	No stress
XII	Península de Yucatán	4 498	29.647	15.20	Low
XIII	Aguas del Valle de México	4 782	3.437	139.20	Very high
	National total	**86 577**	**450.828**	**19.20**	**Low**

Source: Based on CONAGUA (2016b), CONAGUA (2016c).

Map 3.6 Degree of water stress, 2016



Source: Based on CONAGUA (2016b), CONAGUA (2016c).

The Falcon International Dam is located on the Rio Grande, in the municipality of Nueva Ciudad Guerrero, Tamaulipas, Mexico, and in the county of Starr, Texas, United States, it is part of the group of international dams destined to the use of the waters of the Rio Grande for multiple use in both countries, as well as for flood control.

3.9 Virtual water in Mexico

[Tablero: Agua virtual/Huella hídrica]

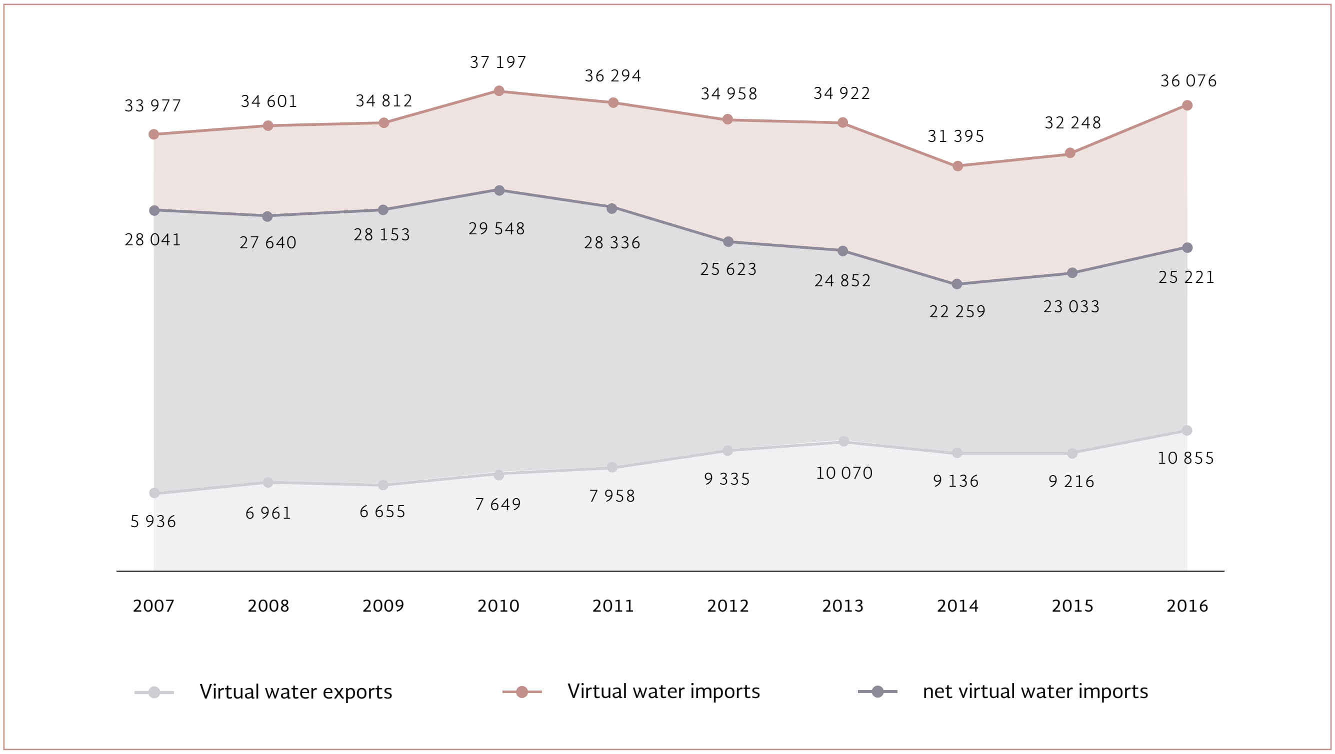
Virtual water is defined as the total amount of water that is used or integrated into a product, good or service. For example, a kilogram of corn in Mexico requires an average of 1 860 liters of water (Mekonnen and Hoekstra 2010a), while a kilogram of beef requires 15 415 liters (Mekonnen and Hoekstra 2010b); these values vary by country.

Due to Mexico's commercial exchanges with other countries in the world, in 2016 Mexico exported 10 855 cubic hectometers of virtual water (EVW), and imported 36 076 (IVW), that is, it had a net import of virtual water of 25 221 cubic hectometers of water (NIVW). Graph 3.10 shows the evolution in the period 2007-2016.

Of the resulting net virtual water import, the evolution recorded in the period 2007-2016 shows significant variations, with a general downward trend in the import of agricultural products, which affects a similar reduction in total imports, as can be seen in Graph 3.11.

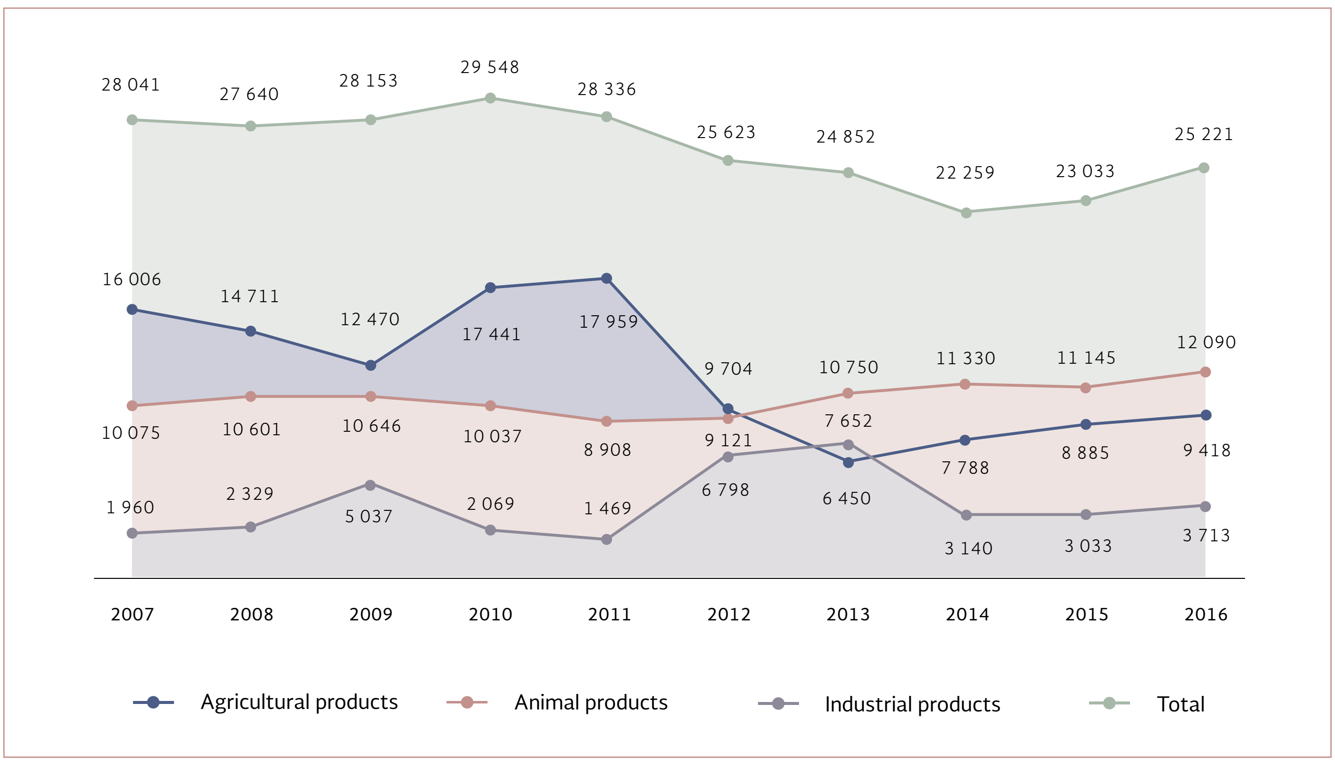
Virtual water is water that we do not see in food production.

Graph 3.10 Virtual water imports and exports in Mexico, 2007-2016 (hm³)



Note: SWM uses Economía 2016 as source and SINA uses SGT.

Graph 3.11 Net virtual water imports from 2007 to 2016 (hm³)



Source: CONAGUA. Deputy Director General's Office for Technical Affairs. National Water Information System (SINA).

3.10 Water accounts

The System of Environmental-Economic Accounting (SEEA), developed through international collaboration (United Nations, European Commission, Organization for Economic Cooperation and Development, World Monetary Fund and World Bank), is a statistical framework which guides the compilation of comparable and consistent statistics and indicators for the formulation of policies, analysis and research on the interaction between the economy and the environment (UNSTATS 2016a). Using the concept of physical flows established in the SEEA, the flows of materials and energy between the economy and the environment can be described, which allows them to be analyzed in parallel to the flows of products in monetary terms, compiled in turn in the National Accounting Systems (see Figure 3.1).

At present, the SEEA consists of a central framework and subsystems which provide greater detail on specific topics. The SEEA-Water, known as "Water Accounts", is one such subsystem of the SEEA, the finality of which is to standardize concepts and methods of water accounting and to provide information on economic and hydrological aspects so as to make a systematic analysis of water's contribution to the economy possible, as well as the effects of the economy on water resources.

Figure 3.2 shows the general scheme of flows between the economy and water, employing the standard SEEA-Water terminology. Based on the information generated by CONAGUA, the physical flows of water are registered in tables of use and supply of water and of transfers within the economy. The economic activities follow the North American Industrial Classification System (NAICS).

In a simplified way, Figure 3.3 shows the interactions between water and the economy in Mexico, in terms of physical flows of water. It is observed that in total 216 593 hm^3 of water are extracted from the environment, of which 178 379 are superficial (82%), 33 819 underground (16%) and 4 395 rainwater (2%). 29 937 hm^3 are consumed by evapotranspiration and integration to the goods produced, in Figure 3.3 they are the difference between extraction and return.

Given that the hydropower plants return almost 100% of the water used to the environment, the total returns amount to 61 034 hm^3, consisting of 23 877 untreated wastewater (39%), 6 292 treated water (10%) and 30 866 of losses (51%), due to leaks in the collection and distribution systems.

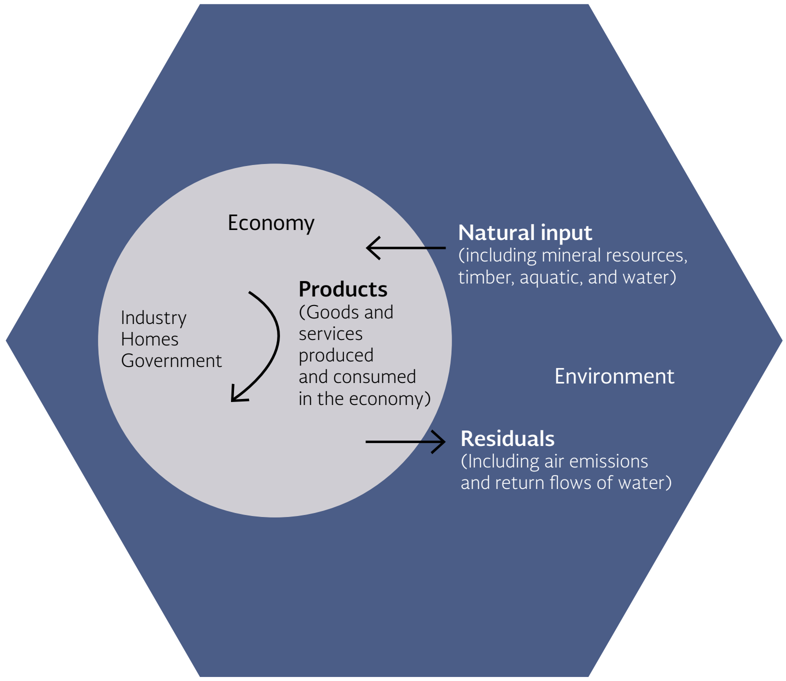
According to water accounts,

29 937

hm^3

were consumed in 2016

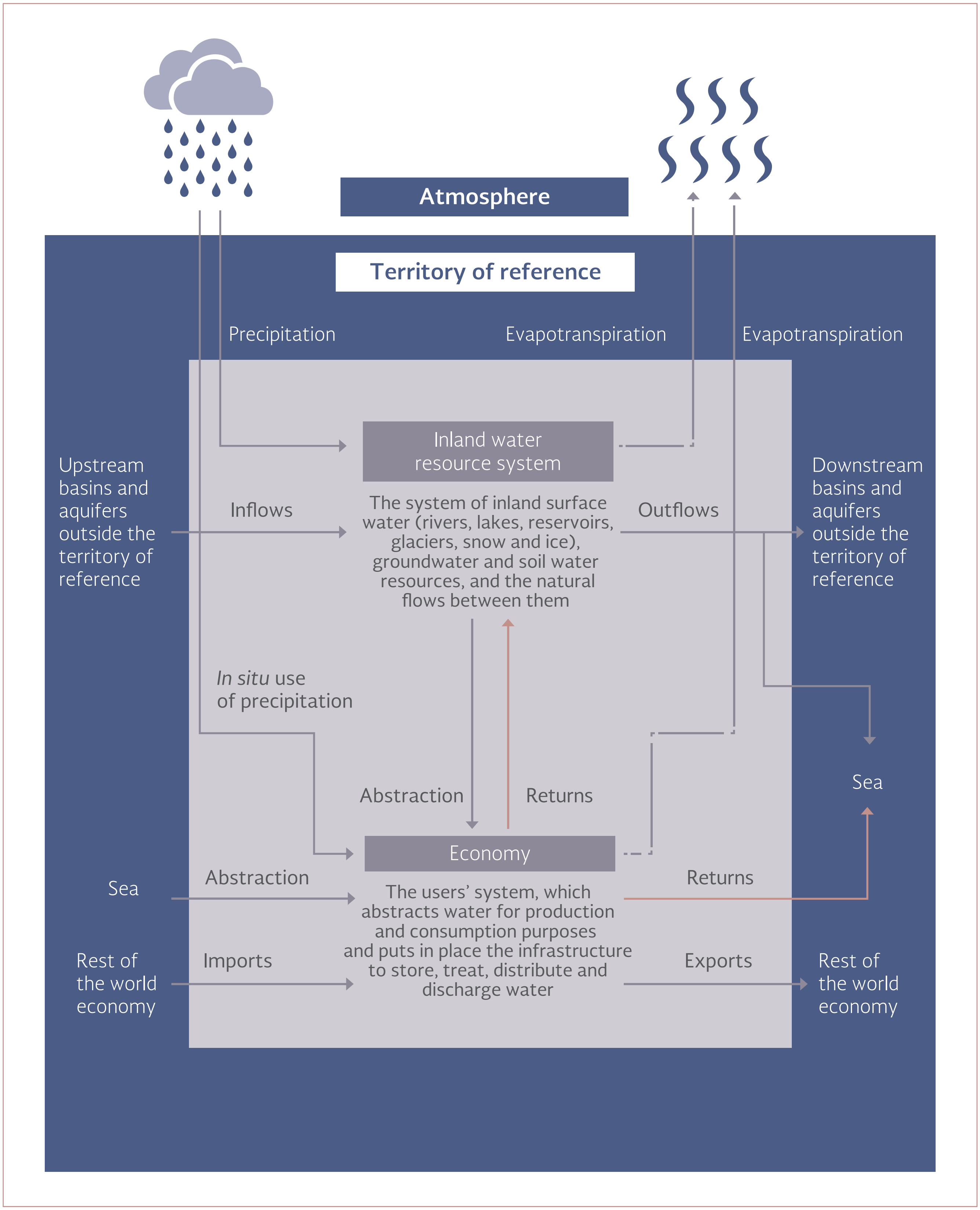
FIGURE 3.1 Physical flows of natural inputs, products and residuals



Source: UNSTATS (2016a).

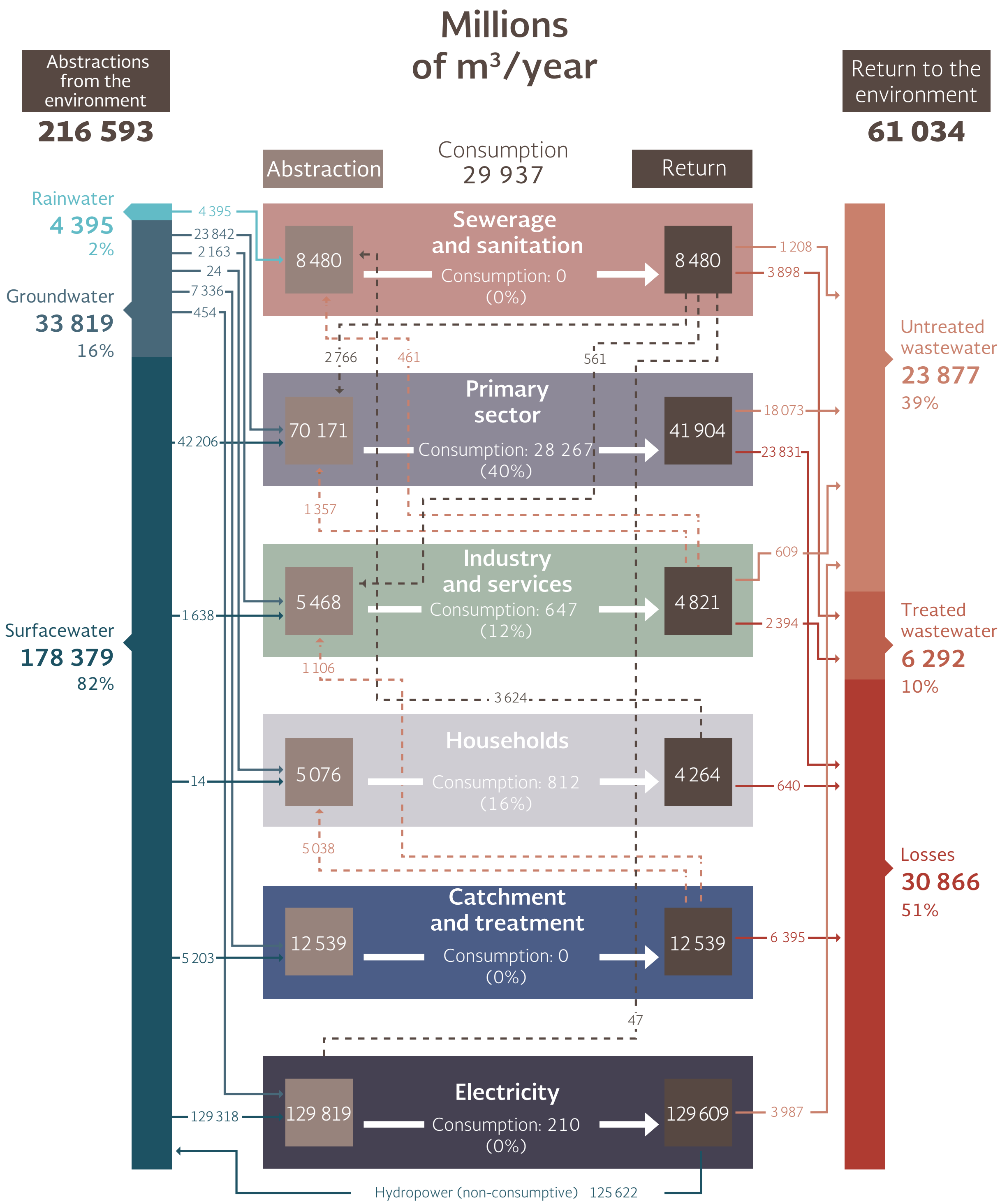
Distribution of water for irrigation use.

FIGURE 3.2 General scheme of flows between the economy and water



Source: UNSTATS (2013).

FIGURE 3.3 Simplified flow of water between the environment and the economy in Mexico 2016, (hm³/year)



Source: Based on INEGI (2013g), INEGI (2016k).

By combining physical flows with economic ones, the hybrid charts[3] of supply (Table 3.6) and use (Table 3.7) are obtained, which allow water economy to be studied, through the presentation of conventional national accounts together with physical information on water extraction, meaning its supply and use of its economy and the discharge of wastewater and contaminants towards the environment.

As an example of the way in which the hybrid supply and use tables can be interpreted, it is observed in the primary sector (Agriculture, breeding and exploitation of animals, forestry, fishing and hunting) that it generated in the year 2016, a gross production of 1.058 trillion pesos; of which 384.159 billion pesos corresponded to an intermediate consumption, generating in this way an added value of 673.975 billion pesos.

For its part, the primary sector extracted 66 048 hm³ of water from the environment to carry out its productive activities; additionally received 4 123 hm³ from other economic units (industry and services and sewerage and sanitation). On the other hand, the agricultural sector returned to the environment a volume of 41 904 hm³. The difference between the extraction and the return is the consumption of water, by 28 267 hm³ in the course of the year.

TABLE 3.6 Hybrid chart of supply for water-related activities and products, 2016

Description	Primary sector	Industry and services	Electric energy	Water collection and water treatment	Sewerage and sanitation	Homes	Imports	Taxes minus subsidies on production	Total supply at buyer price
1. Total production and supply (million of current pesos)	1 058 133	32 042 785	375 794	55 656	55 656	NA	7 859 104	1 258 368	42 705 496
2. Total supply of water (hm³)	41 904	4 821	129 609	12 539	8 480	4 264			201 617
2.a Supply of water to other economic units	0	1 818	0	6 144	3 374	3 624			14 961
2.b Total returns	41 904	3 003	129 609	6 395	5 106	640			186 656
3. Total emissions of BOD_5 (million of tons)	UD	1	UD	UD	9	UD	NA	NA	10

Note: UD: Unavailable data. NA: Not applicable.

Source: Based on INEGI (2016k).

3 So called because they present both monetary (pesos) and physical information (cubic meters of water) at the same time.

This project complements the statistical heritage as regards environmental accounting, since additional information is made available on the environmental impact as a consequence of the production, distribution and consumption of goods and services. As regards the environmental accounting of water resources, it is possible to quantify in monetary values the annual depletion of groundwater, which for 2016 was estimated at 35.561 billion pesos. Another element of environmental accounts refers to the estimation of the cost of treating untreated wastewater treatment in 2016, for 45.456 billion pesos. The information thus produced provides context for decision making on public policy. In 2016, the total costs for environmental depletion and degradation (921.814 billion pesos) are more than five times higher than expenditure in environmental production for that year (130.770 billion pesos) (CONAGUA 2016d, INEGI 2016k).

TABLE 3.7 Hybrid chart of use for water-related activities and products, 2016

Description	Intermediate consumption by industries					Final effective consumption		Gross formation of fixed capital	Exports	Variation of existences and statistical discrepancies	Total uses at buyer prices
	Primary sector	Industry and services	Electric energy	Water collection and water treatment	Sewerage and sanitation	Homes	Government				
1. Intermediate consumption and total use (millions of current pesos)	384 159	14 173 949	144 591	22 050	22 050	13 164 335	2 436 363	4 609 364	7 461 454	287 182	42 705 496
Of which: 1.a Drinking water	747	32.895	14	236	0	25 458	0	0	0	NA	59 349
1.b Severage and sanitation services	99	382	0	0	0	0	0	0	0	NA	482
2. Total Value added (millions of current pesos)	673 975	17 869 036	231 204	33 606	33 606	NA	NA	NA	NA	NA	18 841 427
3. Total use of water (hm³)	70 171	5 468	129 819	12 539	8 480	5 076	0	NA	0	NA	231 554
3.a Total extraction	66 048	3 801	129 772	12 539	4 395	38	0	NA	NA	NA	216 593
3.b Use of water collection and treatment	4 123	1 667	47	0	4 085	5 038	0	NA	0	NA	14 961
Of which: water collection and treatment	0	1.106	0	0	0	5 038	0	0	0	NA	6 144
7. Consuption (hm³)	28 267	647	210	0	0	812	0	0	0	NA	29 937

Note: NA: Not applicable. UD: Unavailable data.

Source: Based on INEGI (2016k).

Chapter 4

Water Infrastructure

Wastewater treatment plant in Atotonilco, Hidalgo.

Water infrastructure

2015 coverage

Access to services

Tap water
95.3%
97.8% urban
87.0% rural

Sewerage and basic sanitation
92.8%
97.4% urban
77.5% rural

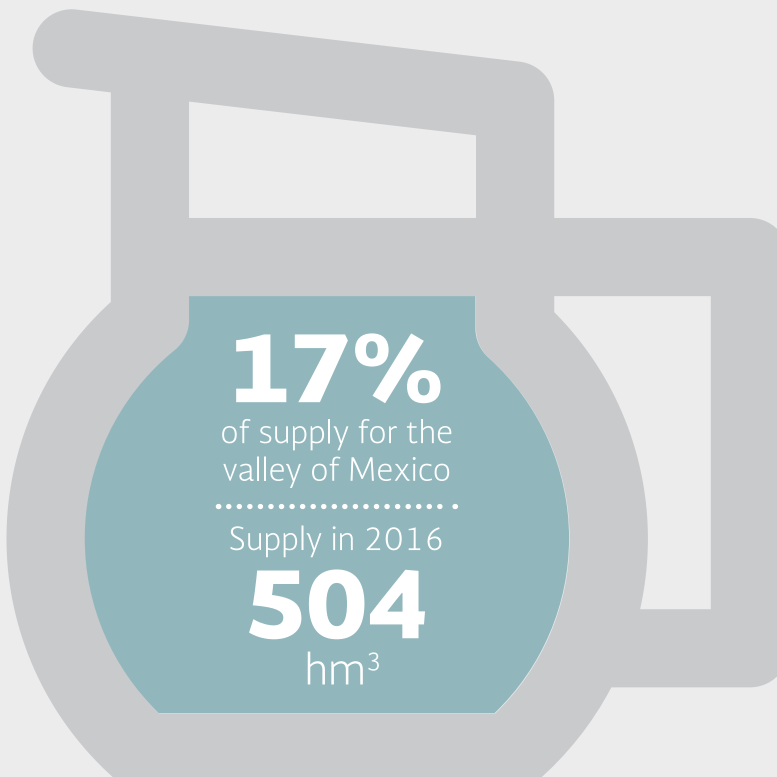
In homes

Drinking water
94.4%
97.2% urban
85.0% rural

Sewerage
91.4%
96.6% urban
74.2% rural

21
regional emergency
response centers

Cutzamala System



Water treatment

Purification

908
purification plants

101.4
m³/s of treated water

Wastewater treatment

2 536
municipal plants

123.6
m³/s of treated water

3 041
industrial plants

75.9
m³/s of treated wastewater

Dams and Levees

More than
5 mil
dams and levees

Total storage: approximately
150 mil
hm³

180
main dams representing **80%** of storage

Hydroagricultural infrastructure

6.5
million hectares of irrigated land

86
irrigation districts

More than
40 mil
irrigation units

2.8
million hectares of technified rainfed land

23
technified rainfed districts

4.1 Water infrastructure

The country's hydraulic infrastructure for providing the required water to different national users include:

- More than 5 thousand storage dams and levees[1]
- 6.5 million hectares of irrigated land
- 2.8 million hectares of technified rainfed land
- 908 purification plants in operation
- 2 536 municipal wastewater treatment plants in operation
- 3 041 industrial wastewater treatment plants in operation
- More than 3 000 km of aqueducts

Box 4.1 Main water infrastructure projects, 2016

- Sanitation of the Valley of Mexico: Tunel Emisor Oriente (TEO) for 150 m^3/s, Tunel Emisor Poniente II for 112 m^3/s and Tunel Canal General for 20 m^3/s
- El Zapotillo: Dam and aqueduct of 140 km to supply Guadalajara, León and the highlands Jalisco
- El Purgatorio: Dam and infrastructure to take advantage of 5.6 m^3/s in conjunction with El Zapotillo to supply the metropolitan area of Guadalajara
- Cutzamala System: 3rd line of the system (12 m^3/s and 77.6 km) to offer greater security in the supply to the Valley of Mexico
- La Paz: Treatment plant of 0.7 m^3/s, with a possible second stage in order to reach 1.05 m^3/s
- Ensenada: Desalination plant with a capacity of 0.25 m^3/s

Source: Based on CONAGUA (2016h).

1 Approximate number due to levee undercount.

4.2 Dams and levees

[Tablero: Presas principales]

There are more than 5 000 dams and levees 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 levees. Efforts are currently underway to register these small, mainly earthen storage structures.

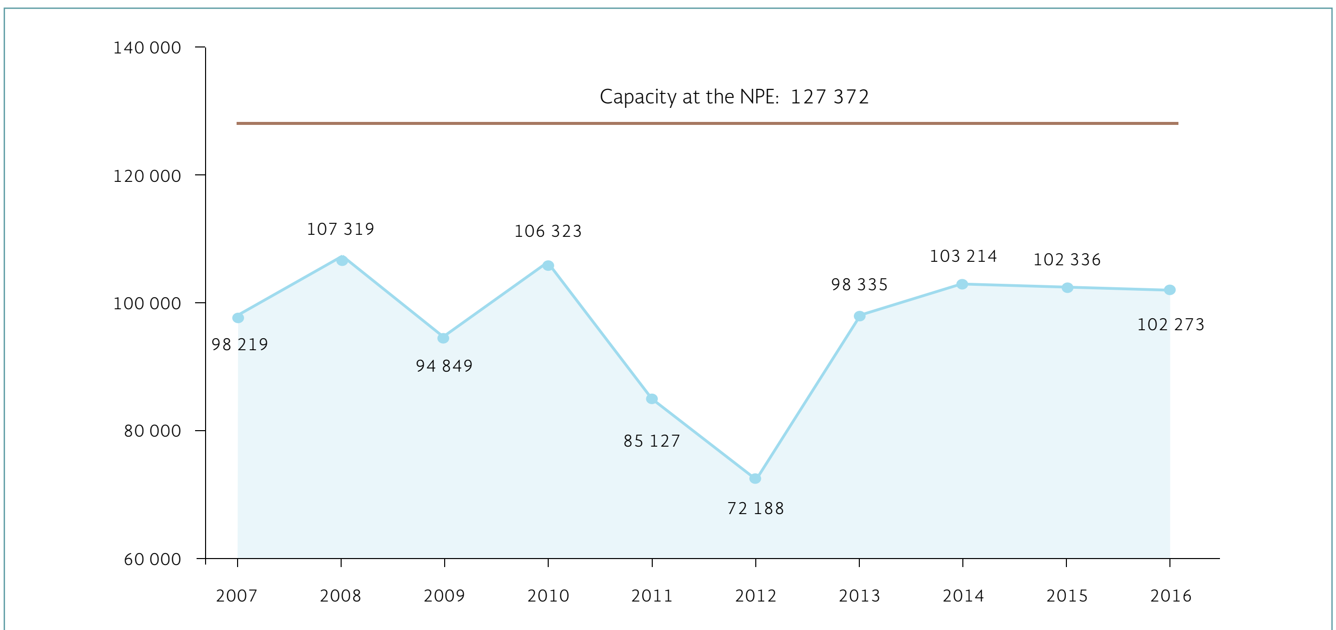
The storage capacity in the country's reservoirs is approximately 150 000 hm³. This edition presents statistics on the 180 reservoirs that represent 80% of the national storage capacity. The annual volume stored in these 180 reservoirs in the period from 2007 to 2016 is shown at the national scale in Graph 4.1. 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).

180 large dams represent

80%

of the storage capacity

GRAPH 4.1 Volume in the 180 main reservoirs (hm³)



Source: CONAGUA (2016b).

2 The dam should be at least 15 meters high; or between 10 and 15 meters high with a storage volume of more than 3 hm³ (ICOLD 2007).

The location of these reservoirs 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 uses the following abbreviations: G: Electricity generation. I: Irrigation. A: Public supply. C: Flood control; P: Pisciculture and aquaculture; N: Navigation; O: Other uses; R: Recreational; Ab: Animal watering. The code corresponds to the one used in the inventory of CONAGUA's Deputy Director General's Office for Technical Affairs.

MAP 4.1 Mexico's main dams

Note: The names of the reservoirs with a capacity greater than 1 000 hm^3 are shown.

Source: CONAGUA (2016b).

Table 4.1 Volume in the 180 main dams (hm^3)

No.	SGT code	Official name	Common name	Capacity at the NPE (hm^3)	HAR	Uses
1	693	Dr. Belisario Domínguez	La Angostura	13 169	Frontera Sur	G
2	706	Netzahualcóyotl	Malpaso	12 373	Frontera Sur	I, G, P, N, O
3	1453	Infiernillo	Infiernillo	9 340	Balsas	G
4	2754	Presidente Alemán	Temascal	8 119	Golfo Centro	I, G
5	1810	Lago de Chapala	Chapala	7 634	Lerma-Santiago-Pacífico	I, A, P, R, N
6	2516	Aguamilpa Solidaridad	Aguamilpa	5 540	Lerma-Santiago-Pacífico	I, G, O
7	345	Internacional La Amistad	La Amistad	4 040	Río Bravo	I, G, A, R, O
8	3617	Vicente Guerrero Consumador de la Independencia Nacional	Las Adjuntas	3 910	Golfo Norte	I, A, O
9	3440	Internacional Falcón	Falcón	3 265	Río Bravo	I, G, A, P, R
10	3148	Adolfo López Mateos	El Humaya	3 086	Pacífico Norte	I, G, P, R
11	3243	Álvaro Obregón	El Oviachic	2 989	Noroeste	I, G, A
12	3218	Miguel Hidalgo y Costilla	El Mahone	2 921	Pacífico Norte	I, G, C
13	3216	Luis Donaldo Colosio	Huites	2 908	Pacífico Norte	I, G, P, R
14	750	La Boquilla	Lago Toronto	2 894	Río Bravo	I, G, R
15	1084	Lázaro Cárdenas	El Palmito	2 873	Cuencas Centrales del Norte	I
16	3320	Plutarco Elías Calles	El Novillo	2 833	Noroeste	I, G
17	2742	Miguel de la Madrid Hurtado	Cerro de Oro	2 600	Golfo Centro	G, P
18	3210	José López Portillo	El Comedero	2 580	Pacífico Norte	I, G, A
19	2538	Leonardo Rodríguez Alcaine	El Cajón	2 552	Lerma-Santiago-Pacífico	G
20	2519	Ing. Alfredo Elías Ayub	La Yesca	2 293	Lerma-Santiago-Pacífico	G
21	3203	Gustavo Díaz Ordaz	Bacurato	1 860	Pacífico Norte	I, G, O
22	1463	Ing. Carlos Ramírez Ulloa	El Caracol	1 458	Balsas	G
23	1679	Ing. Fernando Hiriart Balde-rrama	Zimapán	1 390	Golfo Norte	G
24	701	Manuel Moreno Torres	Chicoasén	1 385	Frontera Sur	G
25	494	Venustiano Carranza	Don Martín	1 313	Río Bravo	I
26	2689	Cuchillo - Solidaridad	El Cuchillo	1 123	Río Bravo	I, A
27	688	Ángel Albino Corzo	Peñitas	1 091	Frontera Sur	G
28	2708	Presidente Benito Juárez	El Marqués	964	Pacífico Sur	I, O
29	3241	Adolfo Ruiz Cortines	Mocuzari	950	Noroeste	I, G, A
30	1436	Solís	Solís	800	Lerma-Santiago-Pacífico	I
31	3490	Marte R. Gómez	El Azúcar	782	Río Bravo	I, R, O
32	3302	Lázaro Cárdenas	Angostura	703	Noroeste	I, A
33	3229	Sanalona	Sanalona	673	Pacífico Norte	I, G, A, O
34	3211	Josefa Ortiz de Domínguez	El Sabino	595	Pacífico Norte	I, P, R
35	2206	Constitución de Apatzingán	Chilatán	590	Balsas	I, G
36	3557	Estudiante Ramiro Caballero Dorantes	Las Ánimas	571	Golfo Norte	I, O
37	2257	Jose María Morelos	La Villita	541	Balsas	I, G
38	1710	Cajón de Peñas	Tomatlán	511	Lerma-Santiago-Pacífico	I, A
39	3693	Paso de Piedras	Chicayán	457	Golfo Norte	I

No.	SGT code	Official name	Common name	Capacity at the NPE (hm³)	HAR	Uses
40	2382	Tepuxtepec	Tepuxtepec	425	Lerma-Santiago-Pacífico	I, G
41	3154	Ing. Aurelio Benassini Vizcaíno	El Salto	415	Pacífico Norte	I
42	1825	Manuel M. Diéguez	Santa Rosa	403	Lerma-Santiago-Pacífico	G
43	1477	El Gallo	El Gallo	400	Balsas	I
44	2126	Valle de Bravo	Valle de Bravo	394	Balsas	A, O
45	813	Francisco I. Madero	Las Vírgenes	355	Río Bravo	I, R
46	49	Plutarco Elías Calles	Calles	340	Lerma-Santiago-Pacífico	I, Ab, R
47	1045	Francisco Zarco	Las Tórtolas	309	Cuencas Centrales del Norte	I, P
48	2826	Manuel Ávila Camacho	Valsequillo	304	Balsas	I, R
49	3202	Ing. Guillermo Blake Aguilar	El Sabinal	300	Pacífico Norte	I
50	2631	José López Portillo	Cerro Prieto	300	Río Bravo	I, A
51	825	Ing. Luis L. León	El Granero	292	Río Bravo	I, Ab
52	1507	Vicente Guerrero	Palos Altos	250	Balsas	I, A
53	1782	General Ramón Corona Madrigal	Trigomil	250	Lerma-Santiago-Pacífico	I, G
54	1035	Federalismo Mexicano	San Gabriel	245	Río Bravo	I
55	3478	Lic. Emilio Portes Gil	San Lorenzo	231	Golfo Norte	I
56	4365	Solidaridad	Trojes	220	Lerma-Santiago-Pacífico	I, G
57	3239	Abelardo Rodríguez Luján	Hermosillo	220	Noroeste	A
58	2167	El Bosque	El Bosque	202	Balsas	I, A, P
59	2286	Melchor Ocampo	El Rosario	200	Lerma-Santiago-Pacífico	I, O
60	1328	Laguna de Yuriria	Tavamatacheo	188	Lerma-Santiago-Pacífico	I
61	2136	Villa Victoria	Villa Victoria	186	Balsas	A
62	1583	Endhó	Endó	182	Aguas del Valle de México	I
63	3197	Lic. Eustaquio Buelna	Guamuchil	175	Pacífico Norte	I, A
64	3662	Canseco	Laguna de Catemaco	164	Golfo Centro	G
65	1315	Ignacio Allende	La Begoña	150	Lerma-Santiago-Pacífico	I
66	1926	Tacotán	Tacotán	149	Lerma-Santiago-Pacífico	I, G, R
67	1702	Basilio Vadillo	Las Piedras	146	Lerma-Santiago-Pacífico	I, O
68	3747	El Chique	El Chique	140	Lerma-Santiago-Pacífico	I
69	917	El Tintero	El Tintero	138	Río Bravo	I
70	3308	Ing. Rodolfo Félix Valdés	El Molinito	130	Noroeste	I
71	1203	Santiago Bayacora	Santiago Bayacora	130	Pacífico Norte	I
72	1499	Revolución Mexicana	El Guineo	127	Pacífico Sur	I, C
73	2011	Huapango	Huapango	119	Golfo Norte	I
74	3790	Gobernador Leobardo Reynoso	Trujillo	118	Cuencas Centrales del Norte	I
75	1365	La Purísima	La Purísima	110	Lerma-Santiago-Pacífico	I
76	1459	Andrés Figueroa	Las Garzas	103	Balsas	I, Ab, P
77	711	Juan Sabines	Cuxtepeques	100	Frontera Sur	I
78	836	Las Lajas	Las Lajas	90	Río Bravo	I, O
79	731	Abraham González	Guadalupe	85	Noroeste	I, O
80	5133	Der. Las Blancas	Derivadora Las Blancas	84	Río Bravo	I, O
81	1887	El Salto	El Salto	83	Lerma-Santiago-Pacífico	A, P
82	1800	Ing. Elías González Chávez	Puente Calderón	82	Lerma-Santiago-Pacífico	A
83	237	Rodríguez	Tijuana	77	Península de Baja California	A
84	2202	Cointzio	Cointzio	77	Lerma-Santiago-Pacífico	I, A
85	1057	Presidente Guadalupe Victoria	El Tunal	76	Pacífico Norte	I, A, P, R
86	1040	Francisco Villa	El Bosque	73	Pacífico Norte	I, O

No.	SGT code	Official name	Common name	Capacity at the NPE (hm^3)	HAR	Uses
87	3807	Miguel Alemán	Excamé	71	Lerma-Santiago-Pacífico	I
88	2113	San Andrés Tepetitlán	Tepetitlán	68	Lerma-Santiago-Pacífico	I
89	2886	Constitución de 1917	Hidalgo	65	Golfo Norte	I, O
90	2359	San Juanico	La Laguna	60	Balsas	I
91	2005	Guadalupe	Guadalupe	57	Aguas del Valle de México	I
92	3562	República Española	Real Viejo	55	Golfo Norte	I
93	3639	San José Atlanga	Atlanga	55	Balsas	I
94	1639	Requena	Requena	53	Aguas del Valle de México	I
95	4531	Ing. Guillermo Lugo Sanabria	La Pólvora	52	Lerma-Santiago-Pacífico	I
96	867	Pico del Águila	Pico del Águila	51	Río Bravo	I
97	2931	San Ildefonso	El Tepozán	48	Golfo Norte	I
98	381	La Fragua	La Fragua	47	Río Bravo	I
99	2782	Yosocuta	San Marcos Arteaga	47	Balsas	I, A, P
100	981	Caboraca	Canoas	45	Pacífico Norte	I, Ab, P
101	1918	Ing. Santiago Camarena	La Vega	44	Lerma-Santiago-Pacífico	I, P
102	1666	La Laguna	Tejocotal	44	Golfo Centro	G
103	1664	Taxhimay	Taxhimay	43	Aguas del Valle de México	I, R
104	3267	Cuauhtémoc	Santa Teresa	42	Noroeste	I
105	241	El Carrizo	El Carrizo	41	Península de Baja California	A, C
106	2668	Rodrigo Gómez	La Boca	39	Río Bravo	A
107	1505	Valerio Trujano	Tepecoacuilco	39	Balsas	I, A, O
108	514	Laguna de Amela	Tecomán	38	Lerma-Santiago-Pacífico	I, Ab, P
109	4559	Guaracha	San Antonio	38	Lerma-Santiago-Pacífico	I
110	3782	Ing. Julián Adame Alatorre	Tayahua	38	Lerma-Santiago-Pacífico	I
111	2408	Zicuirán	La Peña	36	Balsas	I
112	2024	José Antonio Alzate	San Bernabé	35	Lerma-Santiago-Pacífico	I
113	1602	Javier Rojo Gómez	La Peña	32	Aguas del Valle de México	I
114	3524	Pedro José Méndez	Pedro José Méndez	31	Golfo Norte	I, A, Ab
115	1995	Danxhó	Danxhó	31	Golfo Norte	I
116	1757	El Cuarenta	El Cuarenta	30	Lerma-Santiago-Pacífico	I
117	2829	Necaxa	Necaxa	29	Golfo Centro	G
118	1945	El Tule	El Tule	29	Lerma-Santiago-Pacífico	I
119	3661	La Cangrejera	La Cangrejera	29	Golfo Centro	O
120	1120	Peña del Águila	Peña del Águila	28	Pacífico Norte	I
121	3827	Ramón López Velarde	Boca del Tesorero	27	Lerma-Santiago-Pacífico	I, O
122	2848	Tenango	Tenango	27	Golfo Centro	G, O
123	1107	Los Naranjos	Naranjos	26	Cuencas Centrales del Norte	I, O
124	363	El Centenario	El Centenario	25	Río Bravo	I
125	2840	Los Reyes	Omiltepec	24	Golfo Centro	G
126	2282	Malpaís	La Ciénega	24	Lerma-Santiago-Pacífico	I
127	777	Chihuahua	Chihuahua	23	Río Bravo	A
128	1237	Villa Hidalgo	Villa Hidalgo	23	Cuencas Centrales del Norte	I, A
129	3739	El Cazadero	El Cazadero	23	Cuencas Centrales del Norte	I
130	4677	Ing. Juan Guerrero Alcocer	Vinoramas	23	Pacífico Norte	I, R, C
131	1462	La Calera	La Calera	22	Balsas	I
132	1799	Hurtado	Valencia	22	Lerma-Santiago-Pacífico	I
133	1673	Vicente Aguirre	Las Golondrinas	22	Golfo Norte	I

No.	SGT code	Official name	Common name	Capacity at the NPE (hm³)	HAR	Uses
134	461	San Miguel	San Miguel	21	Río Bravo	I, Ab
135	1337	Mariano Abasolo	San Antonio de Aceves	21	Lerma-Santiago-Pacífico	I
136	2013	Ignacio Ramírez	La Gavia	21	Lerma-Santiago-Pacífico	I
137	2161	Aristeo Mercado	Wilson	19	Lerma-Santiago-Pacífico	I, G
138	2671	Salinillas	Salinillas	19	Río Bravo	I
139	1950	Vicente Villaseñor	Valle de Juárez	19	Lerma-Santiago-Pacífico	I
140	2458	La Laguna	El Rodeo	18	Balsas	I
141	3297	Ignacio R. Alatorre	Punta de Agua	18	Noroeste	I, C
142	1357	Peñuelitas	Peñuelitas	17	Lerma-Santiago-Pacífico	I
143	2045	Ñadó	Ñadó	17	Golfo Norte	I
144	152	El Niágara	El Niágara	16	Lerma-Santiago-Pacífico	I
145	2037	Madín	Madín	16	Aguas del Valle de México	A
146	2144	Agostitlán	Mata de Pinos	16	Balsas	I
147	2194	Tercer Mundo	Chincua	16	Lerma-Santiago-Pacífico	I
148	1078	Insurgente José G. Hernández	Santa Elena	15	Pacífico Norte	I
149	2	Abelardo L. Rodríguez	Abelardo L. Rodríguez	15	Lerma-Santiago-Pacífico	I, Ab
150	142	Media Luna	Media Luna	15	Lerma-Santiago-Pacífico	I
151	1879	La Red	La Red	14	Lerma-Santiago-Pacífico	I
152	2881	El Centenario	El Centenario	14	Golfo Norte	I
153	2400	Urepetiro	Urepetiro	13	Lerma-Santiago-Pacífico	I
154	2830	Nexapa	Nexapa	13	Golfo Centro	G, O
155	1989	La Concepción	La Concepción	12	Aguas del Valle de México	I
156	2263	Laguna del Fresno	Laguna del Fresno	12	Lerma-Santiago-Pacífico	I
157	2903	La Llave	Divino Redentor	11	Golfo Norte	I, Ab
158	118	Der. Jocoqui	Der. Jocoqui	11	Lerma-Santiago-Pacífico	I, Ab
159	3850	Santa Rosa	Santa Rosa	10	Cuencas Centrales del Norte	I
160	2298	Los Olivos	Los Olivos	10	Balsas	I
161	2253	Jaripo	Jaripo	10	Lerma-Santiago-Pacífico	I
162	3019	Ing. Valentín Gama	Ojo Caliente	10	Cuencas Centrales del Norte	I, Ab, O
163	3780	José María Morelos	La Villita	10	Lerma-Santiago-Pacífico	I
164	1354	El Palote	El Palote	10	Lerma-Santiago-Pacífico	A, O
165	2321	Pucuato	Pucuato	10	Balsas	I
166	1487	Laguna de Tuxpan	Laguna de Tuxpan	9	Balsas	I
167	2847	La Soledad	Apulco	9	Golfo Centro	G
168	1762	Cuquío	Los Gigantes	8	Lerma-Santiago-Pacífico	I
169	2039	El Molino	Arroyo Zarco	7	Lerma-Santiago-Pacífico	I
170	881	El Rejón	El Rejón	7	Río Bravo	A
171	2003	Francisco José Trinidad Fabela	Isla de las Aves	7	Lerma-Santiago-Pacífico	I
172	1773	El Estribón	El Estribón	7	Lerma-Santiago-Pacífico	I, A
173	1935	Tenasco	Boquilla de Zaragoza	6	Lerma-Santiago-Pacífico	I
174	2207	Copándaro	Copándaro de Corrales	6	Lerma-Santiago-Pacífico	I
175	2347	Sabaneta	Sabaneta	5	Balsas	I
176	1307	La Golondrina	La Golondrina	5	Lerma-Santiago-Pacífico	I
177	67	La Codorniz	La Codorniz	5	Lerma-Santiago-Pacífico	I
178	1585	La Esperanza	La Esperanza	4	Golfo Norte	I, O
179	242	Emilio López Zamora	Ensenada	3	Península de Baja California	A, P
180	2954	La Venta	La Venta	3	Golfo Norte	I, Ab
		Total		**127 372**		

Source: CONAGUA (2016b).

4.3 Hydro-agricultural infrastructure

In Mexico, the area with infrastructure that allows irrigation is approximately 6.5 million hectares, of which 3.3 million correspond to 86 irrigation districts (IDs) and the remaining 3.2 million to more than 40 000 irrigation units (IUs).

Irrigation infrastructure covers

6.5

million hectares

IDs considered the prevailing technology at the time of their design for the application of water to plots by means of gravity. In some cases, only the networks of channels and main drains were built, with the construction on the plots being 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 noted that the yield in areas under irrigation regimes is higher than in areas using rainfed agriculture. In 2016, for the main crops by harvested area—corn grain, sorghum grain and beans—the yield in areas under irrigation, measured in tons/ha, was 1.9 to 3.4 times higher than in rainfed areas. (Based on SIAP 2014).

The agricultural year in Mexico includes the period from October to September of the following year.

Irrigation districts (IDs)

[Tablero: 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.

There are currently 86 IDs, which are shown in Map 4.2. ID 113 Alto Río Conchos, inaugurated on January 17, 2012, is the latest one constituted. Table 4.2 describes the main characteristics of the IDs by HAR. In that table, an estimation is included of the economic productivity measured in pesos per cubic meter: this is the value of the agricultural production divided by the volume of water employed in its irrigation.

Map 4.2 Irrigation districts, 2016

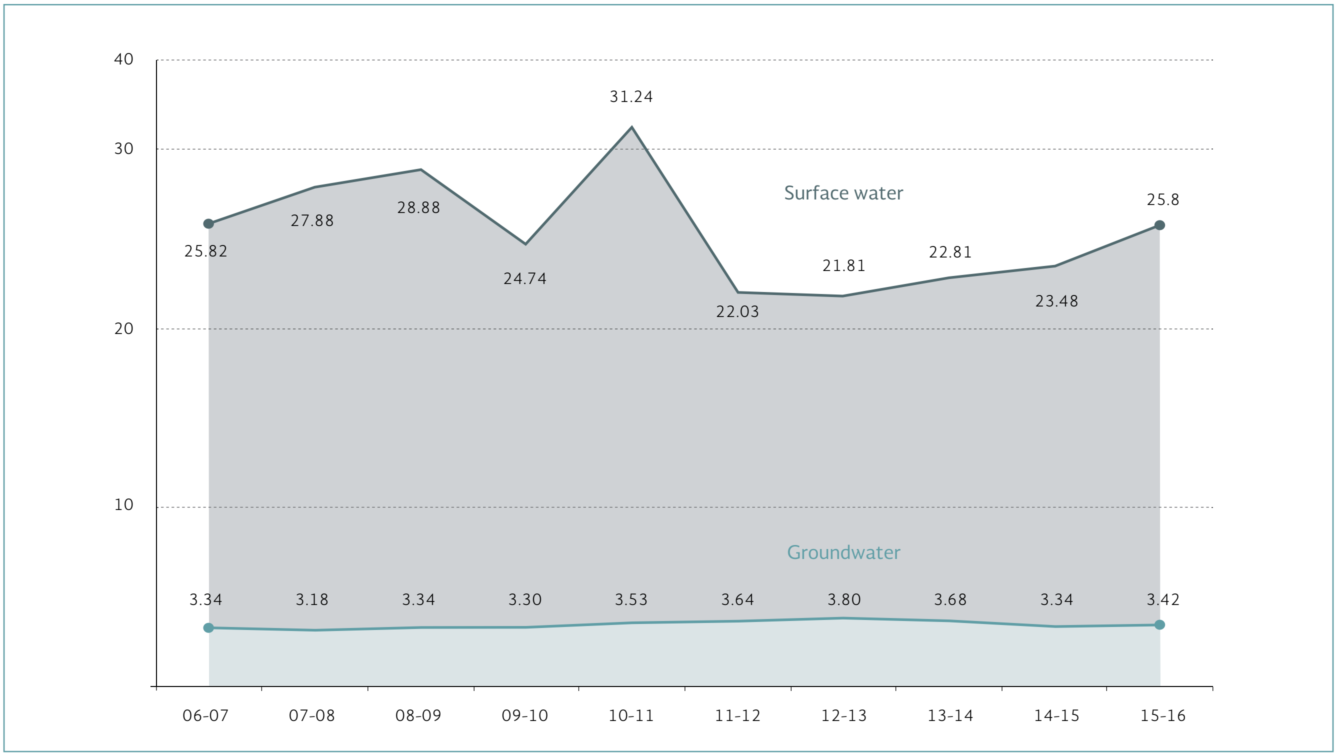
Source: CONAGUA (2016i).

Table 4.2 Irrigation districts by hydrological-administrative region, agricultural year 2015-2016

HAR number	Number of irrigation districts	Total area (ha)	Users	Physical irrigated area (ha)	Distributed volume (hm³)	Value of crops (million of pesos)	Economic productivity ($/m³)
I	2	245 693	18 619	223 594	2 515	10 356	4.12
II	7	466 855	38 202	408 551	4 643	24 659	5.31
III	10	862 295	87 872	774 968	8 937	41 871	4.69
IV	9	199 390	59 878	170 818	2 633	8 190	3.11
V	5	71 914	10 516	26 571	427	435	1.02
VI	13	467 397	35 326	321 542	2 435	11 466	4.71
VII	1	71 964	33 387	49 835	800	2 225	2.78
VIII	13	456 446	75 750	299 808	3 155	17 896	5.67
IX	11	230 569	19 339	115 540	1 115	5 907	5.30
X	2	41 830	6 471	30 335	624	1 337	2.14
XI	4	37 158	7 395	27 674	334	2 901	8.67
XII	2	17 785	4 793	14 612	78	660	8.42
XIII	7	122 180	65 038	90 876	1 521	3 560	2.34
Total	**86**	**3 291 475**	**462 586**	**2 554 725**	**29 217**	**131 463**	**4.50**

Note: Pesos at constant 2012 prices due to compatibility with the methodology of the National Catalogue of Indicators.
Source: CONAGUA (2016i).

Graph 4.2 Volume employed in IDs by source and agricultural year (thousands of hm^3)



Source: CONAGUA (2016i).

Automated spray irrigation in fields of Baja California, Mexico.

The water used in IDs is used by gravity or by pumping. Graph 4.2 illustrates the evolution of the water used in the IDs, distinguishing its surface or underground origin, for the agricultural years 2006-2007 to 2015-2016. In turn, the surface source can be a dam, derivation or direct pumping of the stream; while the underground source is exploited through the pumping of wells.

The physical productivity of water in the IDs measures the relationship between agricultural production and water distributed in the irrigation districts, with the purpose of influencing the improvement of the efficiency in the use of water resources. This key indicator evaluates the efficiency of a cubic meter of water extracted from supply sources in agricultural production under irrigation; it is expressed in kilograms per cubic meter of water and takes into account the production of around 160 cyclical and perennial crops in the irrigation districts, the most representative being corn, wheat, sorghum, alfalfa, sugar cane and beans (INEGI 2016m). Graph 4.3 shows the behavior of this indicator for the period of agricultural years from 2006-2007 to 2015-2016.

In the current context in which a decrease in availability is predicted as a result of climate change, it is imperative to increase conveyance efficiencies. It is worth noting that water productivity may fluctuate significantly according to the meteorological conditions, as well as the phenological characteristics of each crop.

For the 2015-2016 agricultural year in IDs, the main crops by harvested area were corn and wheat, which together accounted for approximately 50% of the harvested area. It should be noted that both crops were 25% of the production in tons and 34% of the production value.

The transfer of IDs to the users started with the creation of 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 has been licensed via irrigation modules to irrigation user associations.

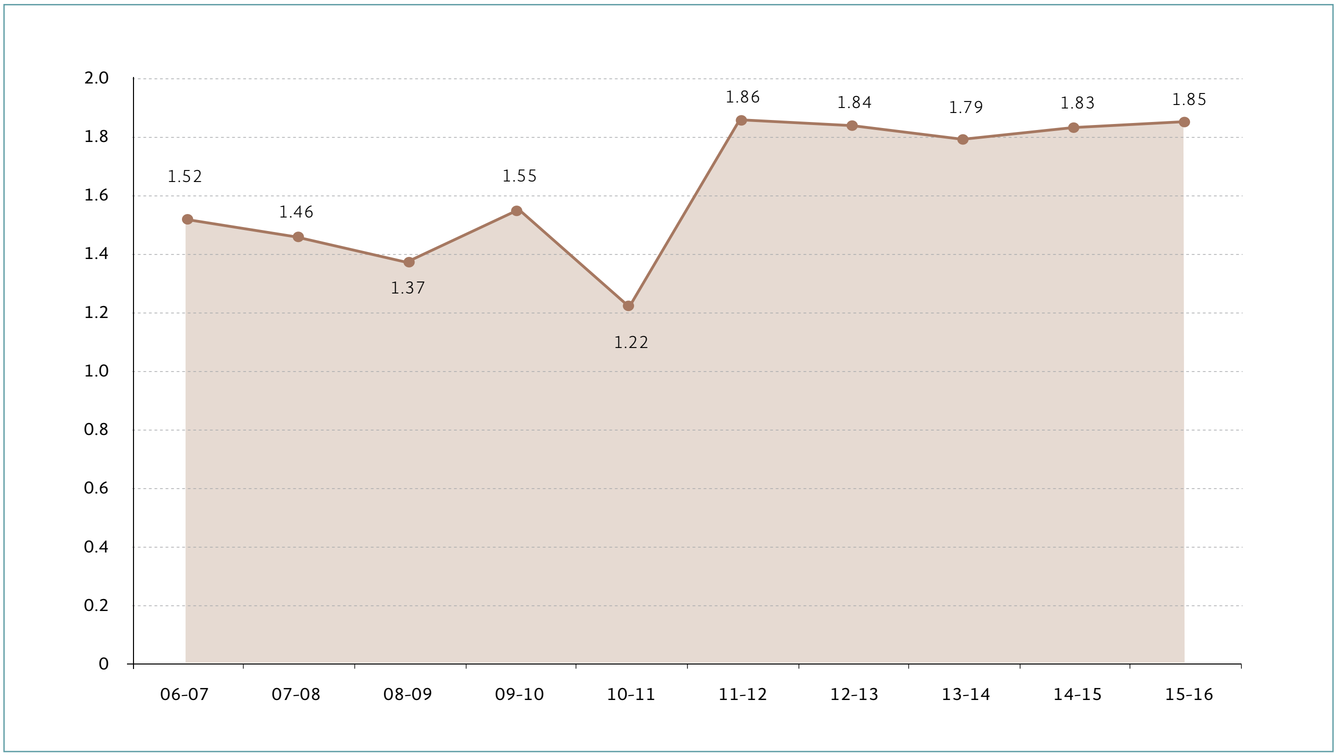
By December 2016, more than 99% of the total area of IDs had been transferred to users. Up until that date, only two districts had not been fully transferred to users: 003 Tula and 018 Colonias Yaquis, in the states of Hidalgo and Sonora, respectively.

In 2015-2016

50%

of the harvested area was **corn grain and sorghum grain**

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



Source: CONAGUA (2016i).

Map 4.3 Irrigation units, 2014

Source: CONAGUA (2016i).

Irrigation units (IUs)

[Tablero: Distritos de temporal y unidades de riego]

IUs are agricultural areas with infrastructure and irrigation systems, different from irrigation districts and usually smaller than these. They can be integrated by user associations or other figures of organized producers, who join forces to provide irrigation services with autonomous management systems and operate hydraulic structures for the collection, diversion, conduction, regulation and distribution and removal of national waters destined for agricultural irrigation. For the 2014-2015 agricultural year, an area of 3.9 million hectares was harvested in the IUs (CONAGUA 2016i). Map 4.3 shows the irrigation units.

In that year a production of 83.2 million tons was estimated. IU statistics distinguish between products accounted for by tons (representing 99.7% of the harvested area and 96.8% of the production value) of other crops that are accounted for in plants, bunches, grosses or square meters. These crops accounted for by tons are summarized in Table 4.3. It should be noted that the sown area was greater than the total area due to second crops and to the inventory in process of IUs. The economic productivity of the IUs was estimated at 5.84 pesos per cubic meter[3] for the 2014-2015 agricultural year, while physical productivity was calculated at 2.93 kilograms per cubic meter for that year.

Table 4.3 Irrigation units by hydrological-administrative region, agricultural year 2014-2015

HAR number	Sown area (ha)	Harvested area (ha)	Production (tons)	Yield (tons/ha)	Production value (billions of pesos)
I	82 190	75 945	1 652 532	21.76	13.984
II	194 116	188 012	2 527 529	13.44	10.393
III	415 536	401 984	5 100 853	12.69	13.114
IV	343 401	327 608	8 361 466	25.52	27.377
V	68 505	67 244	884 394	13.15	2.013
VI	888 705	862 684	10 343 803	11.99	31.633
VII	280 920	271 837	8 916 748	32.80	17.636
VIII	1 048 029	1 021 557	25 076 006	24.55	45.268
IX	286 150	266 896	9 473 330	35.49	10.259
X	115 035	113 944	5 237 034	45.96	4.837
XI	39 351	38 799	1 736 553	44.76	3.192
XII	73 772	71 463	1 324 810	18.54	2.189
XIII	89 132	88 266	2 541 010	28.79	2.152
Total	**3 924 843**	**3 796 239**	**83 176 068**	**21.91**	**184.047**

Note: Considers only the crops counted by ton.
Source: CONAGUA (2016i).

3 In pesos at constant 2012 prices to make them compatible with the National Catalogue of Indicators.

Technified rainfed districts (TRDs)

[Tablero: 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 water 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, TRDs have gradually been transferred to organized users.

TABLE 4.4 Characteristics of the technified rainfed districts, 2016

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

Source: CONAGUA (2016i).

4.4 Drinking water and sewerage infrastructure

Drinking water coverage

[Tablero: Cobertura universal]

In 2015

94.4%

of the population had **tap water coverage in homes or plots**

The provision of water for human consumption in the necessary quantity and quality has a direct incidence on public health and wellbeing. This fact is recognized through the inclusion of information related to water for supply to the population in the National Catalogue of Indicators, which is a series of key indicators for the design, follow up and evaluation of public policies stipulated by the Law of the National System of Statistical and Geographic Information, administered by INEGI.

Among the indicators for measuring the coverage of potable water there is i) tap water access coverage and ii) tap water coverage in homes and plots.

The tap water access coverage[4] includes the population that has tap water within their homes or plots, from a public faucet or hydrant or from another household. The information for the calculation of this coverage is obtained based on the various censuses and the 2015 intercensal survey, for the 1990-2015 period.

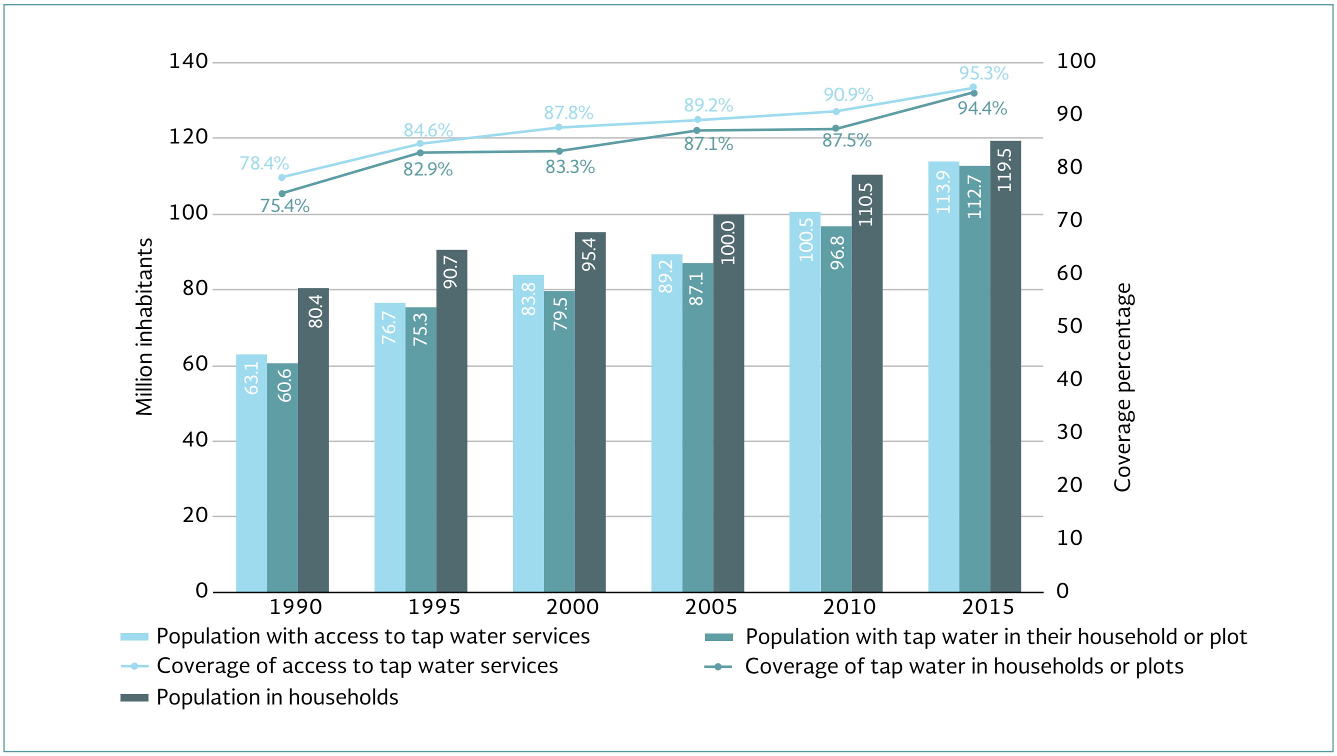
Based on this definition of coverage of access to tap water, a subset of information can be calculated, the coverage of tap water in the household or plot.[5]

The behavior of the coverage of access to tap water and the coverage of tap water in the household or plot for the 1990-2015 period can be contemplated in Graphs 4.4, 4.5 and 4.6, nationwide, and in urban and rural contexts, respectively. The evolution in the percentages of coverage should be contemplated in the context of population growth and urban concentration.

4 Corresponds to the indicator "Population with access to tap water services" (PAP) from the National Catalogue of Indicators.

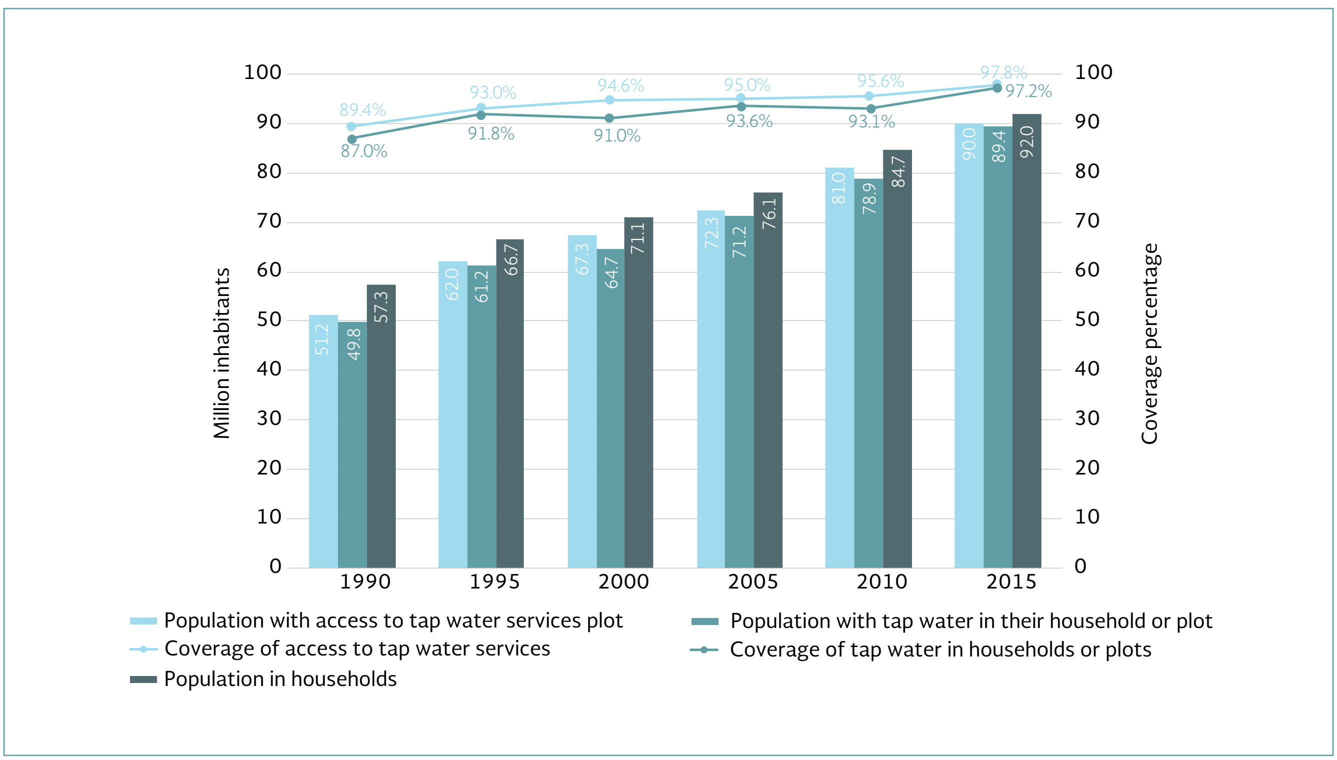
5 This has been proposed as the indicator "Percentage of the population with tap water in their household or plot" (PAENT) in the National Catalogue of Indicators.

Graph 4.4 National population with tap water coverage



Source: Based on CONAGUA (2007), CONAGUA (2016k), INEGI (2016c), INEGI (2016d).

Graph 4.5 Urban population with tap water coverage



Source: Based on CONAGUA (2007), CONAGUA (2016k), INEGI (2016c), INEGI (2016d).

As of 2015, the national coverage of access to tap water was 95.3% (97.8% urban, 87.0% rural), whereas the national coverage of tap water in households or plots was 94.4% (97.2% urban, 85.00% rural).

The urban population generally speaking has a higher coverage than the rural one (Graph 4.5). The increase in the urban population with water services is relatively favored by the concentration of the population, in contrast with the dispersion of the rural population in multiple, smaller localities. However, the increase of services in the rural context should be highlighted (Graph 4.6).

Sewerage coverage

[Tablero: Cobertura universal]

Similarly to drinking water, the sanitation of wastewater generated in homes also determines the health and quality of life of the population, so information related to sanitation is included in the National Catalogue of Indicators.

In 2015, the sewerage coverage through a public network or septic tank was of 91.4%. In addition there is the coverage of access to sewerage and basic sanitation services,[6] which considers the population with sanitation connected to the public network, a septic tank or with a wastepipe connected to the ground, a ravine, crack, river, lake or sea. The information for the calculation of this coverage is generated in the various censuses and 2015 intercensal survey (see Chapter 1), for the 1990-2015 period. The behavior of sanitation coverage through a public network or a septic tank and the coverage of sanitation services during the 1990-2015 period is illustrated in Graphs 4.7, 4.8 and 4.9, nationwide and in the urban and rural contexts, respectively.

Similarly to drinking water, the evolution in the percentages of coverage is shown in conjunction with the demographic dynamic and the urban concentration.

In 2015, the national coverage of access to sewerage services was

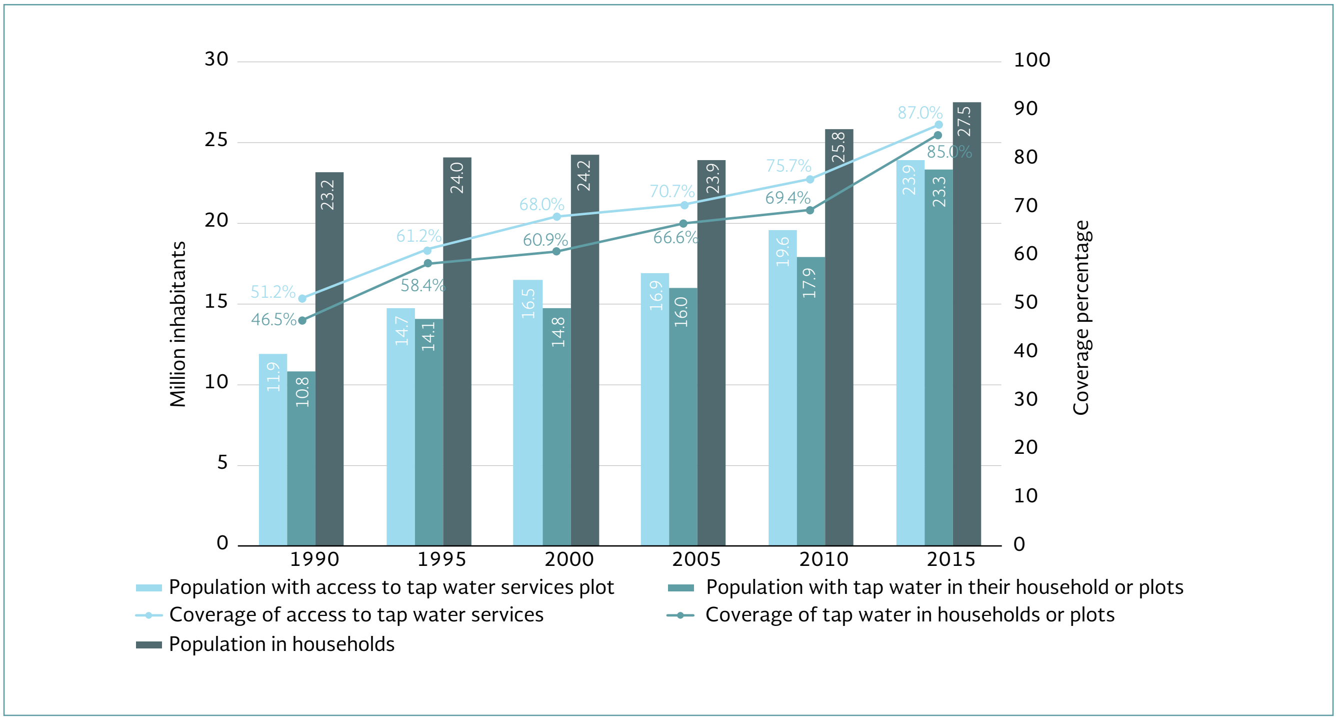
In 2015

91.4%

of the population had **sewerage coverage through a public network or septic tank**

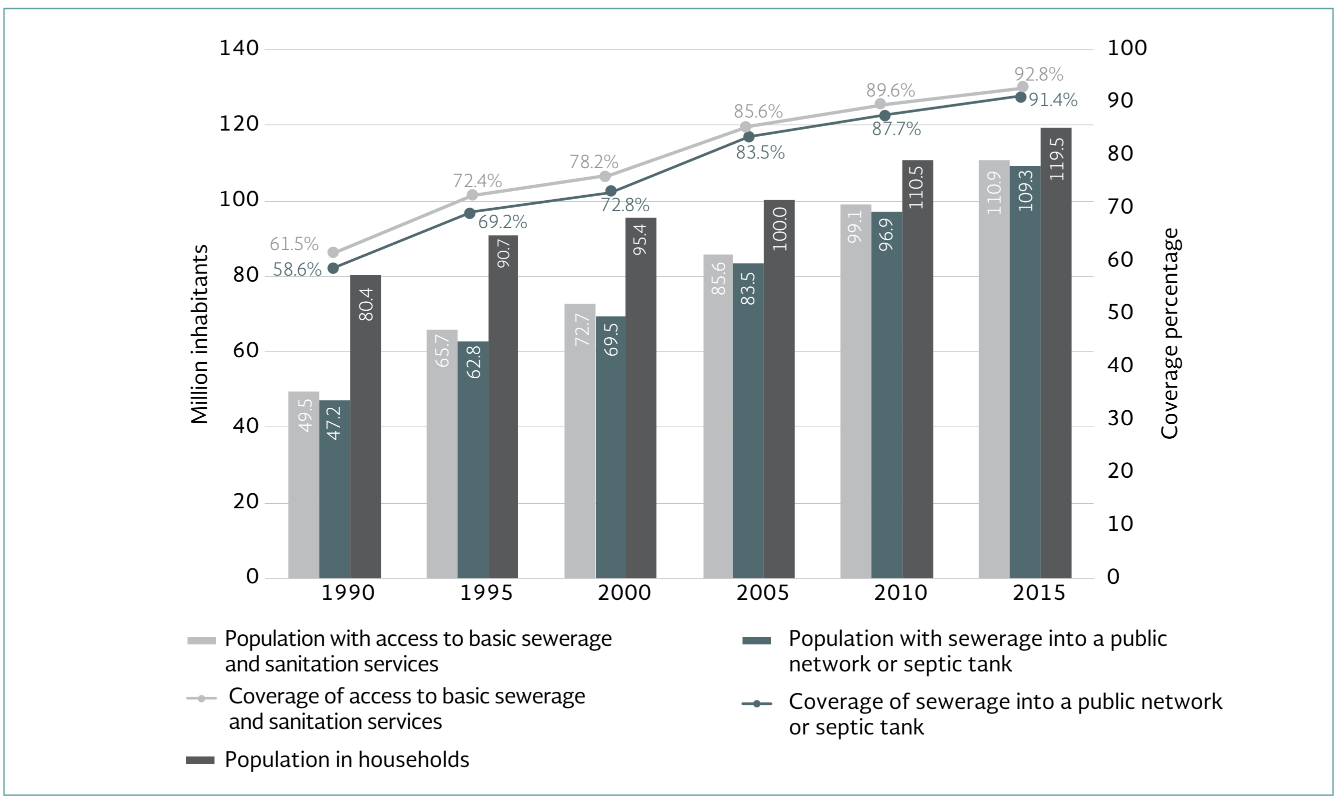
6 Corresponds to the indicator "Population with access to sewerage and basic sanitation services" (PAS) from the National Catalogue of Indicators.

Graph 4.6 Rural population with tap water coverage



Source: Based on CONAGUA (2007), CONAGUA (2016k), INEGI (2016c), INEGI (2016d).

Graph 4.7 National population with sewerage coverage



Source: Based on CONAGUA (2007), CONAGUA (2016k), INEGI (2016c), INEGI (2016d).

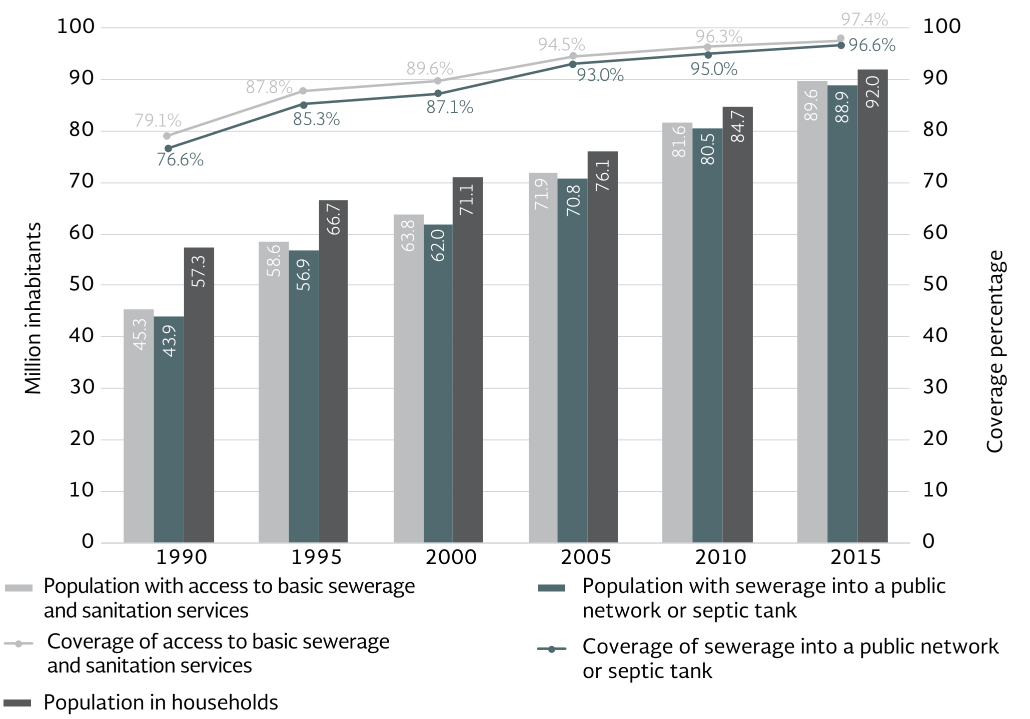
92.8% (97.4% urban, 77.5% rural), whereas the national sanitation coverage through a public network or septic tank was 91.4% (96.6% urban, 74.2% rural).

The urban setting generally possesses a higher coverage than the rural one (Graph 4.8). The provision of sanitation services in urban areas is relatively favored by the concentration of the population, in contrast with the dispersion of the rural population in multiple, smaller localities. However, the rural context has shown significant increases in this area (Graph 4.9).

The coverage by HAR and state is presented in annexes A and B for drinking water and sanitation.

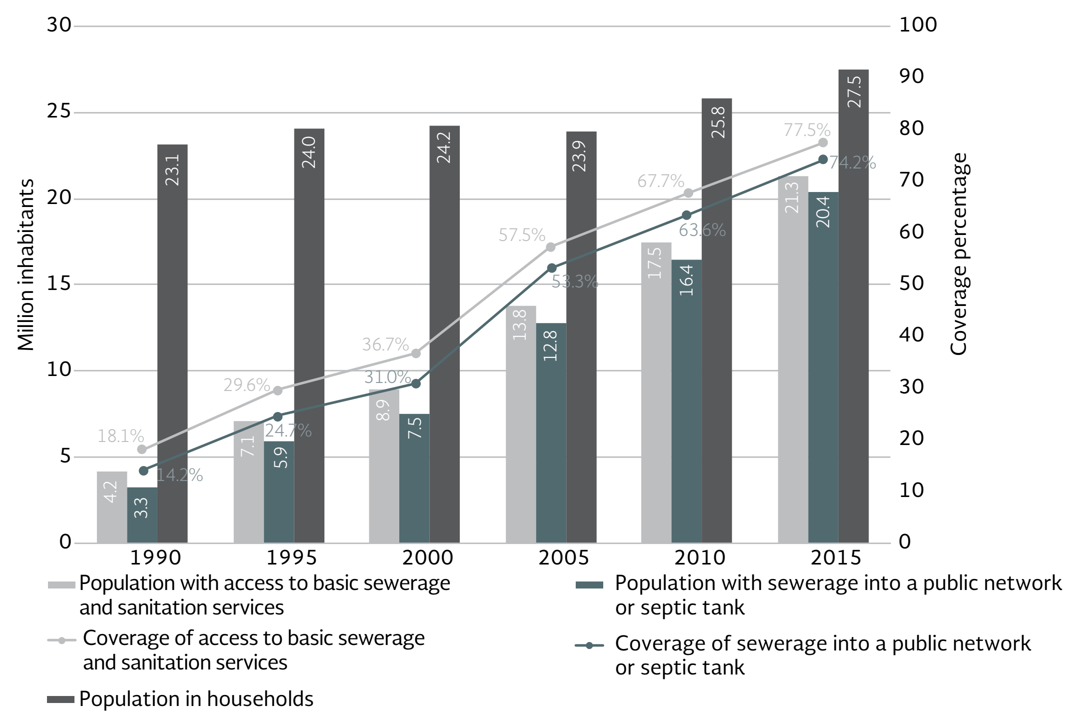
The Marte R. Gómez or “El Azúcar” dam, Camargo, Tamaulipas.

Graph 4.8 Urban population with sewerage coverage



Source: Based on CONAGUA (2007), CONAGUA (2016k), INEGI (2016c), INEGI (2016d).

Graph 4.9 Rural population with sewerage coverage



Source: Based on CONAGUA (2007), CONAGUA (2016k), INEGI (2016c), INEGI (2016d).

Aqueducts

[Tablero: 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 4.5.

TABLE 4.5 Main aqueducts in Mexico, 2016

No.	Aqueduct	Region	Length (km)	Design flow (l/s)	Year of completion	Supplies:	Operated by:
1	Lerma	VIII Lerma Santiago Pacífico y XIII Aguas del Valle de México	60	14 000	1975	Mexico City with water from the aquifers located in the upper area of the Lerma River	Sistema de Aguas de la Ciudad de México.
2	Chicbul-Ciudad del Carmen	XII Península de Yucatán	122	390	1975	Sabancuy, Isla Aguada and Ciudad del Carmen, Cam.	Sistema Municipal de Agua Potable de Ciudad del Carmen, Cam.
3	Río Colorado-Tijuana	I Península de Baja California	130	4 000	1982	The cities of Tijuana and Tecate and the village of La Rumorosa, BC.	Comisión de Servicios de Agua del Estado de Baja California (COSAE).
4	Linares-Monterrey	VI Río Bravo	133	5 000	1984	The metropolitan area of the city of Monterrey, NL, with water from The Cerro Prieto dam.	Servicios de Agua y Drenaje de Monterrey, I.P.D.
5	Uxpanapa-La Cangrejera	X Golfo Centro	40	20 000	1985	22 industries located in the southern part of the state of Veracruz	CONAGUA
6	Yurivia-Coatzacoalcos y Minatitlán	X Golfo Centro	64	2 000	1987	Coatzacoalcos and Minatitlán, Ver, with water from the Ocotal and Tizizapa rvers.	Comisión Municipal de Agua y Saneamiento de Coatzacoalcos Ver. (CMAPS Coatzacoalcos).
7	Armería-Manzanillo	VIII Lerma Santiago Pacífico	50	250	1987	Manzanillo, Colima.	Comisión de Agua Potable, Drenaje y Alcantarillado de Manzanillo, Col.
8	Vizcaíno-Pacífico Norte	I Península de Baja California	206	62	1990	Localities of Bahía Asunción, Bahía Tortugas and fishing communities of Punta Abreojos, BC.	Organismo operador del municipio de Mulegé, BC.
9	Chapala-Guadalajara	VIII Lerma Santiago Pacífico	42	7 500	1991	Metropolitan area of Guadalajara with water from Lake Chapala.	Sistema Intermunicipal para los Servicios de Agua Potable y Alcantarillado (SIAPA).
10	Presa Vicente Guerrero-Ciudad Victoria	IX Golfo Norte	54	1 000	1992	Ciudad Victoria, Tamaulipas with water from the Vicente Guerrero Dam.	Comisión Municipal de Agua Potable y Alcantarillado (COMAPA Victoria).
11	Sistema Cutzamala	IV Balsas y XIII Aguas del Valle de México	162	19 000	1993	Metropolitan area of the Valley of Mexico with water from the Valle de Bravo, Villa Victoria and El Bosque dams, among others.	CONAGUA

Source: CONAGUA (2016i).

No.	Aqueduct	Region	Length (km)	Design flow (l/s)	Year of comple-tion	Supplies:	Operated by:
12	El Cuchillo-Monterrey	VI Río Bravo	91	5 000	1994	Metropolitan area of the city of Monterrey with water from the El Cuchillo dam.	Servicios de Agua y Drenaje de Monterrey, I.P.D.
13	Río Huitzilapan-Xalapa	X Golfo Centro	55	1 000	2000	Xalapa-Enríquez, Ver.	Comisión Municipal de Agua y Saneamiento de Xalapa (CMAS Xalapa).
14	Conejos-Médanos	VI Río Bravo	25	1 000	2009	Ciudad Juárez, Chih.	Junta Municipal de Agua y Saneamiento de Ciudad Juárez, Chihuahua - Administradora de Proyectos Hidráulicos de Ciudad Juárez, S. A. de C. V. (Grupo CARSO).
15	Acueducto II Querétaro	VIII Lerma Santiago Pacífico	122	1 500	2011	Santiago de Querétaro, Qro.	Comisión Estatal de Aguas - Controladora de Operaciones de Infraestructura S.A. de C.V. (ICA).
16	Independencia	II Noroeste	135	2 380	2013	Hermosillo, Son.	CONAGUA
17	Lomas de Chapultepec	V Pacífico Sur	34	1 250	2014	Acapulco, Gro.	Comisión de Agua Potable, Alcantarillado y Saneamiento del Estado de Guerrero (CAPASEG)
18	Paralelo Chicbul-Ciudad del Carmen	XII Península de Yucatán	120	420	2014	Sabancuy, Isla Aguada and Ciudad del Carmen, Camp.	Sistema Municipal de Agua Potable de Ciudad del Carmen, Campeche.
19	Realito San Luis Potosí	VII Cuencas Centrales del Norte	133	1 000	2015	San Luis Potosí, SLP	Comisión Estatal del Agua de San Luis Potosí - Aquos El Realito S. A. de C. V.
	Total		**1 778**	**86 752**			

Source: Based on CONAGUA (2016a), CONAGUA (2016h), SEMARNAT (2010), CAPASEG (2014), Gobierno de la República (2014).

The Río Colorado aqueduct in Tijuana, B.C., with a view of pumping plants 5, 4 and 3.

The Cutzamala system

[Tablero: Sistema Cutzamala]

The Cutzamala System, which supplies 11 precincts of 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 4.6–), 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 watershed, calculated at 88 m^3/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. The evolution in storage in the main reservoirs is shown in Graph 4.10.

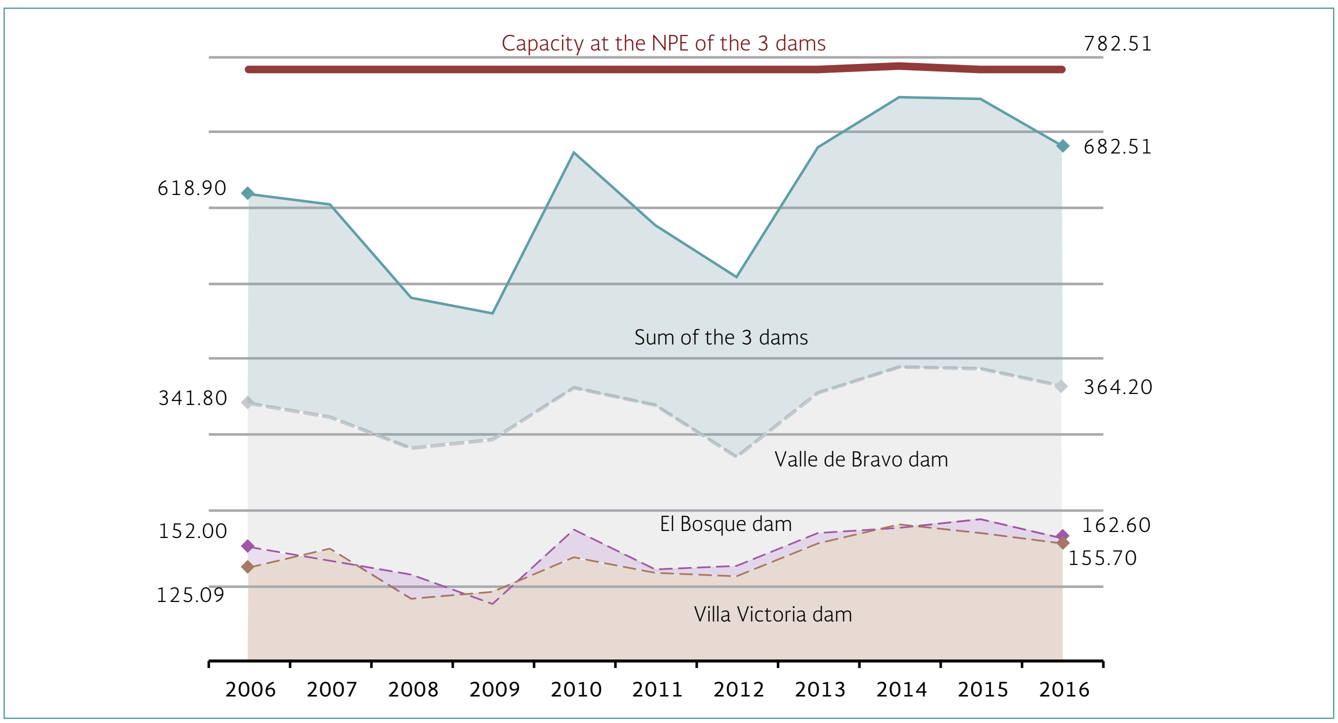
Figure 4.1 shows the location of the system and the difference in elevation that has to be overcome from the lowest point of Pumping Plant No. 1 to convey water to Oscillation Tower No. 5 and subsequently by gravity to the Metropolitan Area of the Valley of Mexico (MAVM).

TABLE 4.6
Volumes and flows supplied by the Cutzamala system (hm^3)

Year	Delivered to Mexico City	Delivered to the State of Mexico	Total
2007	303.90	174.56	478.46
2008	306.25	179.47	485.72
2009	244.60	155.38	399.98
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
2015	303.26	194.15	497.41
2016	308.66	195.57	504.23

Source: CONAGUA (2016n).

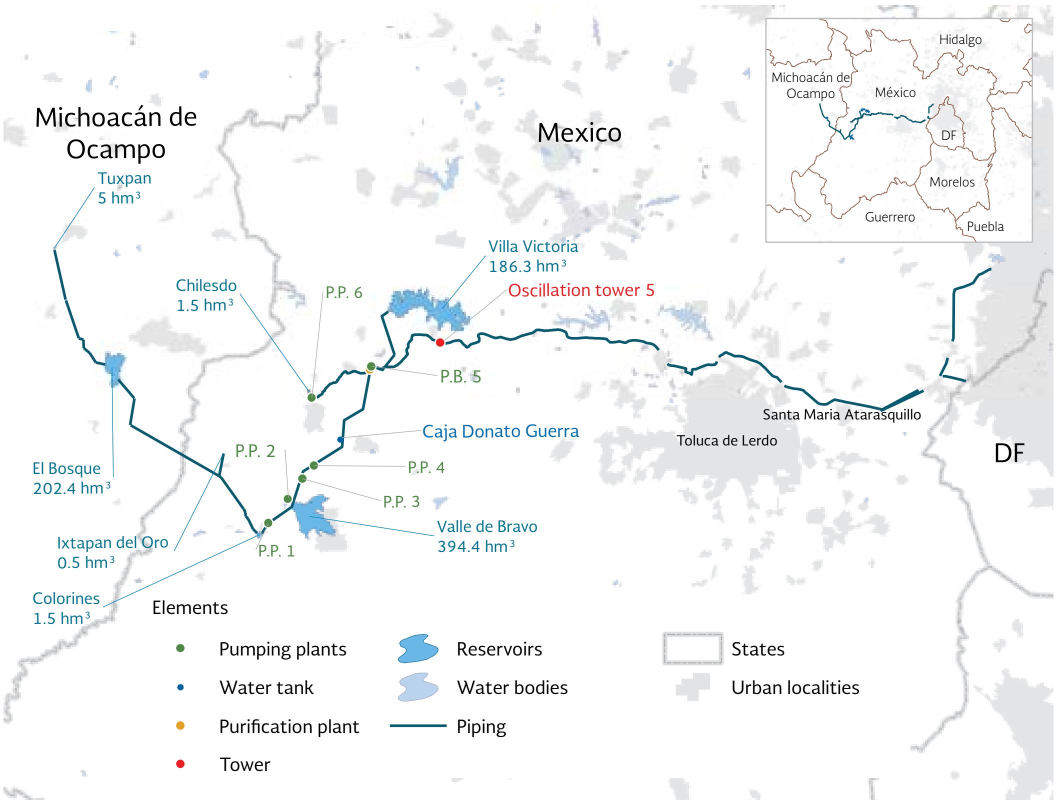
GRAPH 4.10 Evolution in the storage of the reservoirs of the Cutzamala system (hm^3)



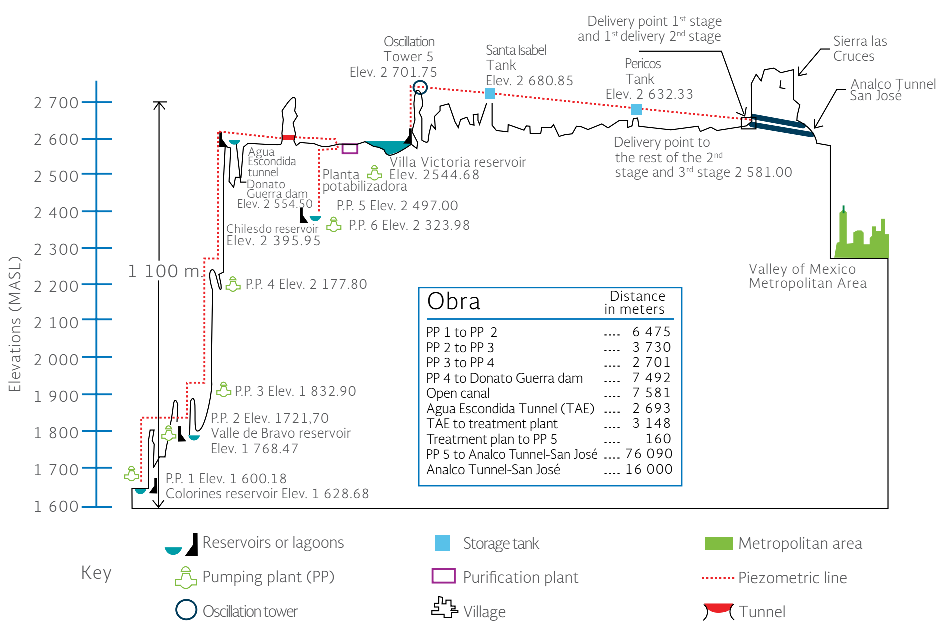
Source: Based on CONAGUA (2016n).

Figure 4.1 Cutzamala System

Plant



Cross - section



Source: Based on CONAGUA (2016l), INEGI (2013c), INEGI (2013d).

Purification plants

[Tablero: Plantas potabilizadoras]

Municipal purification plants improve the water quality in surface and/or groundwater sources to make them suitable for human consumption. In 2016, 101.4 m^3/s were treated in the 908 plants in operation in Mexico. The evolution in the flow treated annually is illustrated in Graph 4.11.

The distribution of purification plants is listed in Table 4.7 by hydrological-administrative region. It should be noted 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 Aguas del Valle de Mexico Watershed Organization.

Table 4.8 illustrates the main treatment processes applied in those plants.

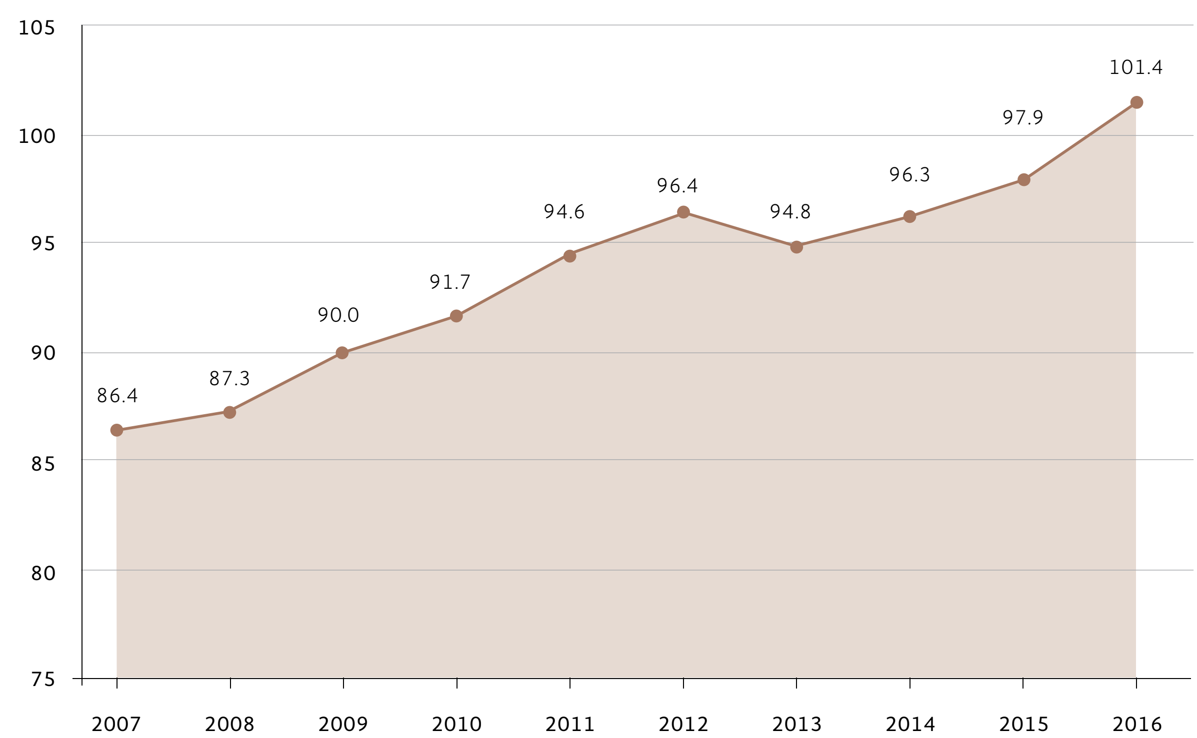
In 2016

101.4

m^3/s

were treated in 908 plants

GRAPH 4.11 Treated municipal flow (m^3/s)



Source: CONAGUA (2016a).

Table 4.7 Purification plants in operation, 2016

HAR number	Number of plants in operation	Installed capacity (m^3/s)	Treated flow (m^3/s)
I	51	12.38	7.40
II	23	5.55	2.61
III	159	9.99	8.58
IV	23	22.82	17.18
V	19	3.46	2.78
VI	121	28.07	18.14
VII	164	2.48	1.92
VIII	163	19.89	14.96
IX	48	8.19	7.19
X	14	7.47	5.19
XI	50	13.28	10.37
XII	1	0.005	0.005
XIII	72	6.75	5.08
Total	**908**	**140.33**	**101.41**

Source: CONAGUA (2016a).

Table 4.8 Main purification processes applied, 2016

Central process	Purpose	Plants		Treated volume	
		No.	%	(m^3/s)	%
Softening	Elimination of hardness	19	2.1%	0.58	0.06%
Adsorption	Elimination of organic traces	3	0.3%	0.06	0.01%
Conventional clarification	Elimination suspended solids	217	23.9%	69.73	7.68%
Patented clarification	Elimination suspended solids	163	18.0%	6.43	0.71%
Direct filtration	Elimination suspended solids	102	11.2%	19.74	2.17%
Slow filtering	Elimination suspended solids	13	1.4%	0.10	0.01%
Activated Carbon filters	Elimination of organic traces	33	3.6%	0.03	0.00%
Inverse osmosis	Elimination of dissolved solids	323	35.6%	1.88	0.21%
Removal of iron and manganese		19	2.1%	2.64	0.29%
Other	Elimination of dissolved solids	16	1.8%	0.22	0.02%
	Total	**908**	**100.0%**	**101.41**	**11.17%**

Source: CONAGUA (2016a).

4.5 Water treatment and reuse

Wastewater discharge

[Tablero: Descarga de aguas residuales]

Wastewater discharges are classified as either municipal or non-municipal. Municipal ones are those which are generated in population centers and are collected in urban and rural sanitation systems, whereas the non-municipal discharges are those that are generated by other uses, such as self-supplying industry, and which are discharged directly to national receiving water bodies, without being collected by sewerage systems.

The sequence of wastewater generation, its collection in sewerage systems and its treatment/disposal is shown in Table 4.9. The table employs the abbreviation BOD_5, which corresponds to the parameter of 5-day Biochemical Oxygen Demand.

In 2016,

123.6

m^3/s

of wastewater were treated in 2 536 municipal plants

Municipal wastewater treatment plants

[Tablero: Plantas de tratamiento de agua residual]

During 2016, the 2 536 plants in operation throughout the country treated 123.6 m^3/s; that is, 58.3% of the 212.0 m^3/s collected through sewerage systems. The evolution in the flow treated annually can be appreciated in Graph 4.12. Table 4.10 shows the wastewater treatment plants in operation by hydrological-administrative region.

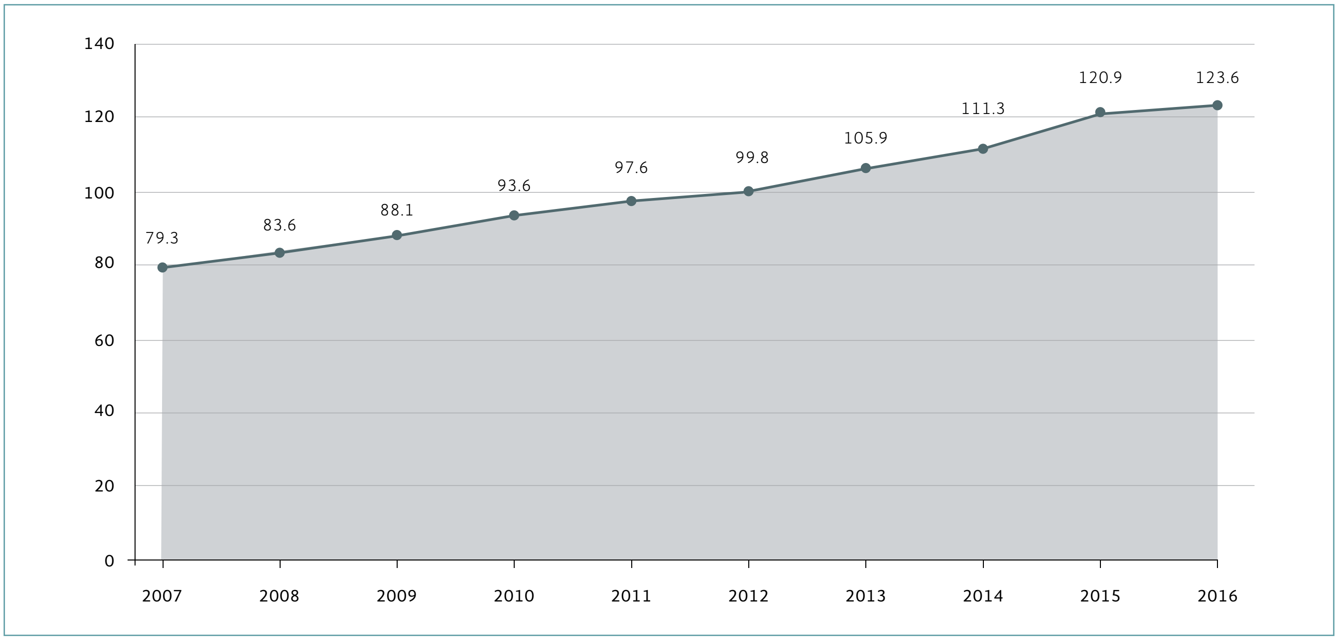
TABLE 4.9 Municipal and non-municipal wastewater discharges, 2016

Urban centers (municipal discharges):		
Volume		
Wastewater	7.22	thousand hm^3/year (229.12 m^3/s)
Collected in sewerage systems	6.69	thousand hm^3/year (212.00 m^3/s)
Treated	3.90	thousand of hm^3/year (120.90 m^3/s)
Contamination load		
Generated	1.95	million tons of BOD_5 per year
Collected in sewerage systems	1.81	million tons of BOD_5 per year
Removed in treatment systems	0.84	million tons of BOD_5 per year
Non-municipal uses, including industry:		
Volume		
Wastewater	6.86	thousand hm^3/year (214.64 m^3/s)
Treated	2.39	thousand hm^3/year (70.50 m^3/s)
Contamination load		
Generated	10.28	million tons of BOD_5 per year
Removed in treatment systems	1.62	million tons of BOD_5 per year

Source: CONAGUA (2016a), CONAGUA (2016b).

The distribution of treatment plants is shown in Map 4.4, in which the names of the main plants by the flow treated are labelled. The main treatment processes are illustrated in Graph 4.13.

Graph 4.12 Treated municipal wastewater flow (m^3/s)



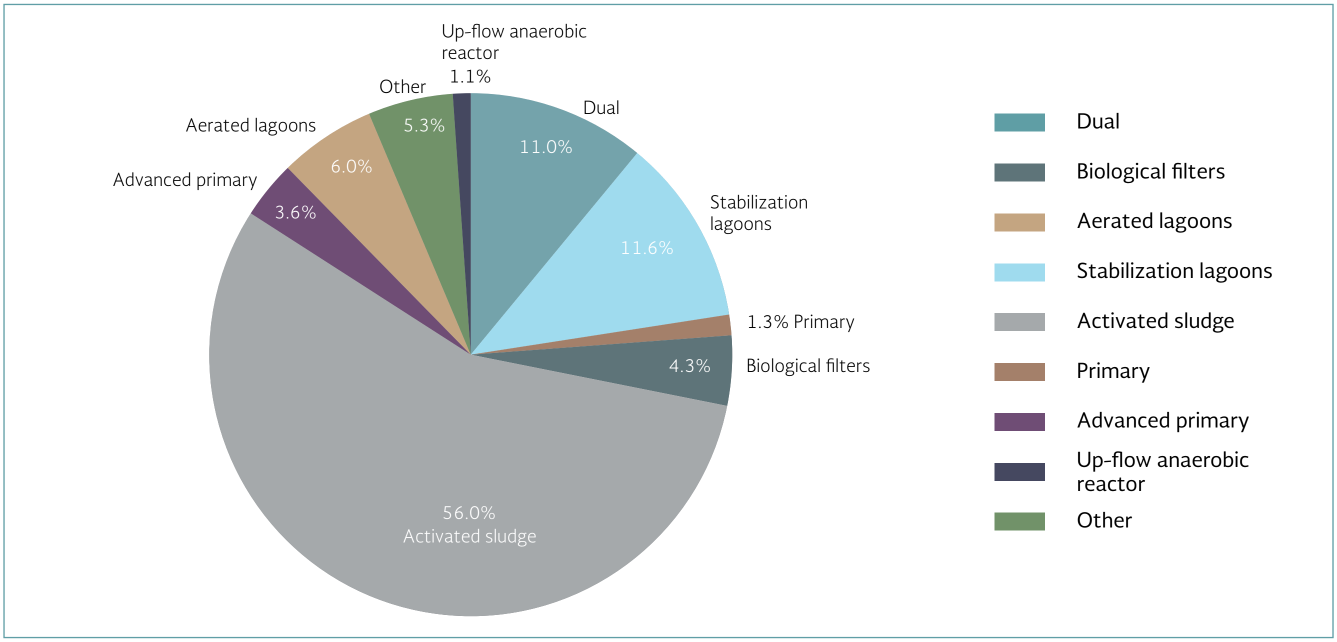
Source: CONAGUA (2016a).

Table 4.10 Municipal wastewater treatment plants in operation, 2016

HAR number	Number of plants in operation	Installed capacity (m^3/s)	Treated flow (m^3/s)
I	72	9.55	6.98
II	123	8.13	4.83
III	444	10.70	8.55
IV	222	10.75	8.66
V	95	4.78	3.77
VI	238	32.81	24.30
VII	160	6.98	5.47
VIII	587	41.82	30.69
IX	107	5.30	4.17
X	161	7.53	5.37
XI	116	4.74	3.85
XII	78	3.16	2.11
XIII	133	34.32	14.84
Total	**2 536**	**180.57**	**123.59**

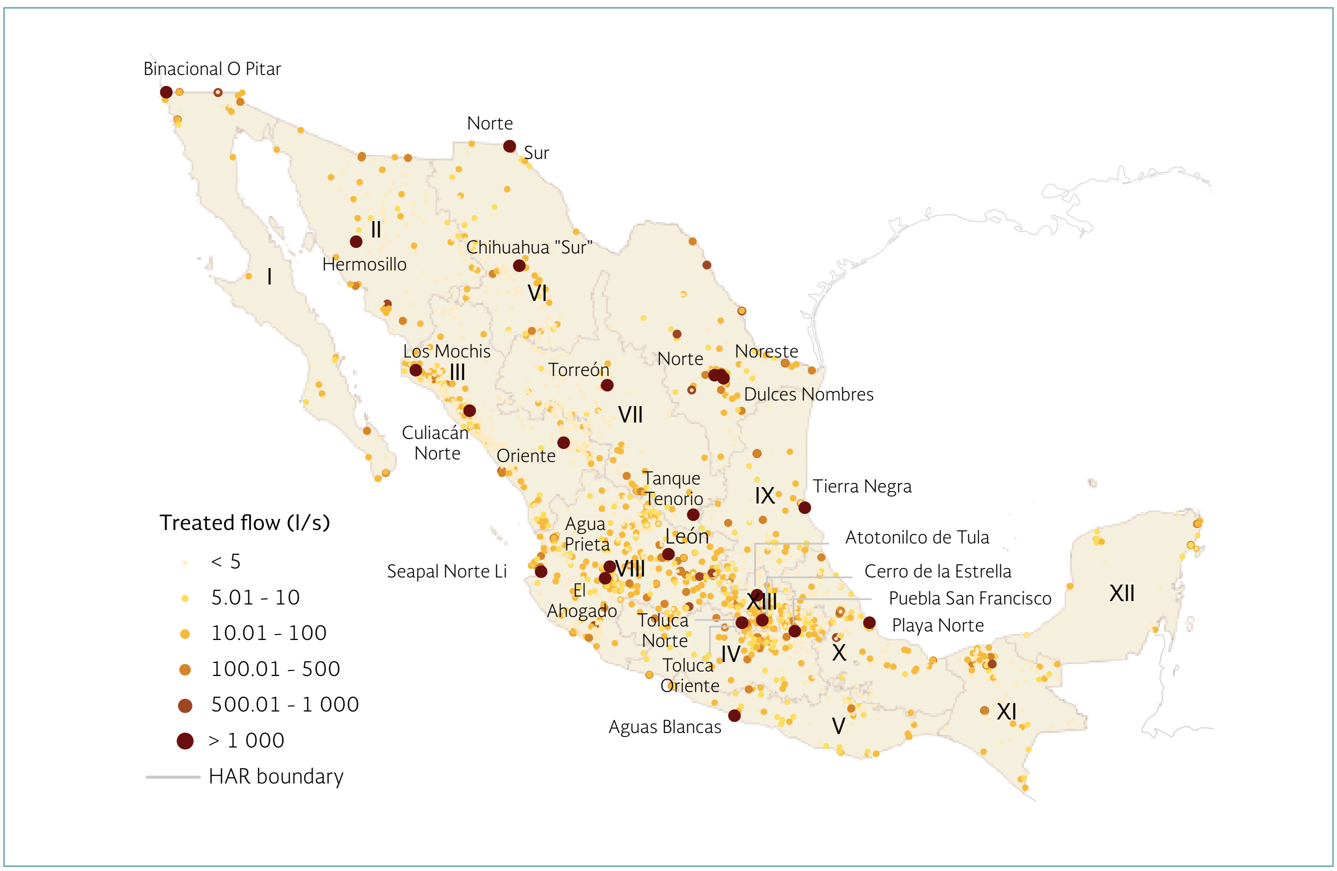
Source: CONAGUA (2016a).

Graph 4.13 Main municipal wastewater treatment processes by treated flow, 2016



Source: CONAGUA (2016a).

Map 4.4 Municipal wastewater treatment plants, 2016



Source: CONAGUA (2016a).

Industrial wastewater treatment plants

[Tablero: Plantas de tratamiento de agua residual]

In 2016, the industry treated 75.9 m^3/s of wastewater in 3 041 plants in operation nationwide.

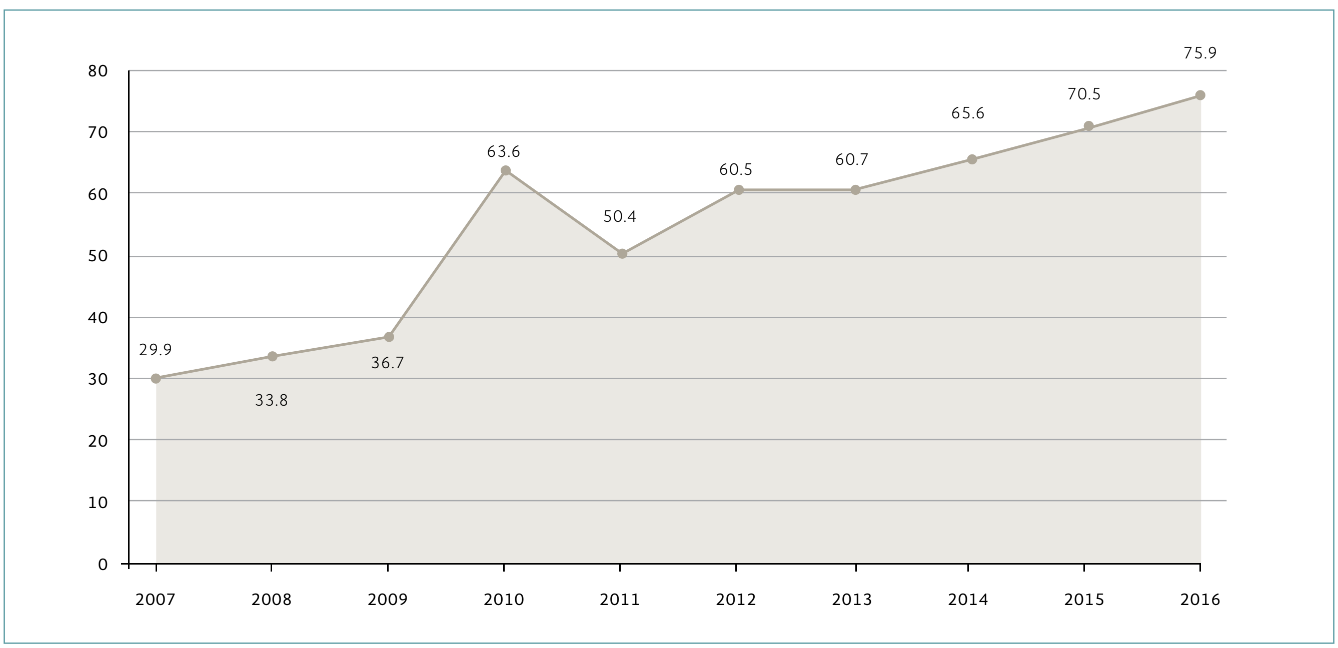
Table 4.11 illustrates the main processes in which industrial treatment is broken down; the evolution 2007-2016 is shown in Graph 4.14, while the distribution by federal entities is illustrated in Table 4.12.

Table 4.11 Types of industrial wastewater treatment, 2016

Type of treatment	Purpose	Number of plants	Operating flow (m^3/s)	Percentage of flow
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	947	25.84	34
Secondary	To remove colloidal and dissolved organic materials.	1 847	46.20	61
Tertiary	To remove dissolved materials, including gases, natural and synthetic organic substances, ions, bacteria and viruses.	102	1.55	2
Not specified		145	2.31	3
	Total	**3 041**	**75.90**	**100**

Source: CONAGUA (2016a).

Graph 4.14 Treated industrial wastewater flow (m^3/s)



Source: Based on CONAGUA (2016a).

Table 4.12 Industrial wastewater treatment plants in operation by state, 2016

State	Number of plants in operation	Installed capacity (m^3/s)	Treated flow (m^3/s)
Aguascalientes	69	0.338	0.167
Baja California	120	13.092	13.075
Baja California Sur	29	4.965	4.965
Campeche	174	3.423	3.423
Coahuila de Zaragoza	62	0.797	0.534
Colima	14	0.451	0.292
Chiapas	114	2.320	1.988
Chihuahua	15	0.655	0.283
Mexico City	8	0.008	0.006
Durango	43	1.078	0.622
Guanajuato	120	0.881	0.630
Guerrero	7	0.023	0.019
Hidalgo	45	1.841	1.377
Jalisco	96	1.841	1.735
State of Mexico	281	3.300	2.428
Michoacán de Ocampo	136	3.730	3.191
Morelos	104	0.608	0.569
Nayarit	16	0.803	0.803
Nuevo León	97	4.113	2.976
Oaxaca	22	3.388	3.068
Puebla	219	1.102	0.961
Querétaro	156	1.246	0.662
Quintana Roo	4	0.060	0.055
San Luis Potosí	60	0.972	0.592
Sinaloa	105	8.647	6.295
Sonora	235	6.458	6.255
Tabasco	144	0.963	0.906
Tamaulipas	115	8.459	7.917
Tlaxcala	71	0.303	0.219
Veracruz de Ignacio de la Llave	159	12.619	9.315
Yucatán	182	0.450	0.410
Zacatecas	19	0.193	0.168
Total	**3 041**	**89.127**	**75.904**

Source: CONAGUA (2016a).

Box 4.2 Wastewater reuse and exchange

- CONAGUA estimates that in 2016, 28.5 m^3/s were directly reused (before being discharged)
- On the other hand, 78.9 m^3/s were indirectly reused (after their discharge to a receiving body).
- The exchange of treated wastewater, in which it replaces first-use water, was estimated at 8.2 m^3/s.
- Among the advantages of reuse is its lower cost, that it reduces the pressure on sources and meets needs that do not require drinking water quality

Source: CONAGUA (2016a).

4.6 Emergency response and flood protection

[Tablero: Atención a emergencias]

CONAGUA has installed **21** regional emergency **response centers**

As part of the Infrastructure Protection and Emergency Attention program (IPEA), CONAGUA has set up 21 regional emergency response 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 4.5 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 CONAGUA in coordination with the states, municipalities and federal agencies

As regards the impacts of extreme hydro-meteorological phenomena, the most obvious manifestation of which is floods, 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.

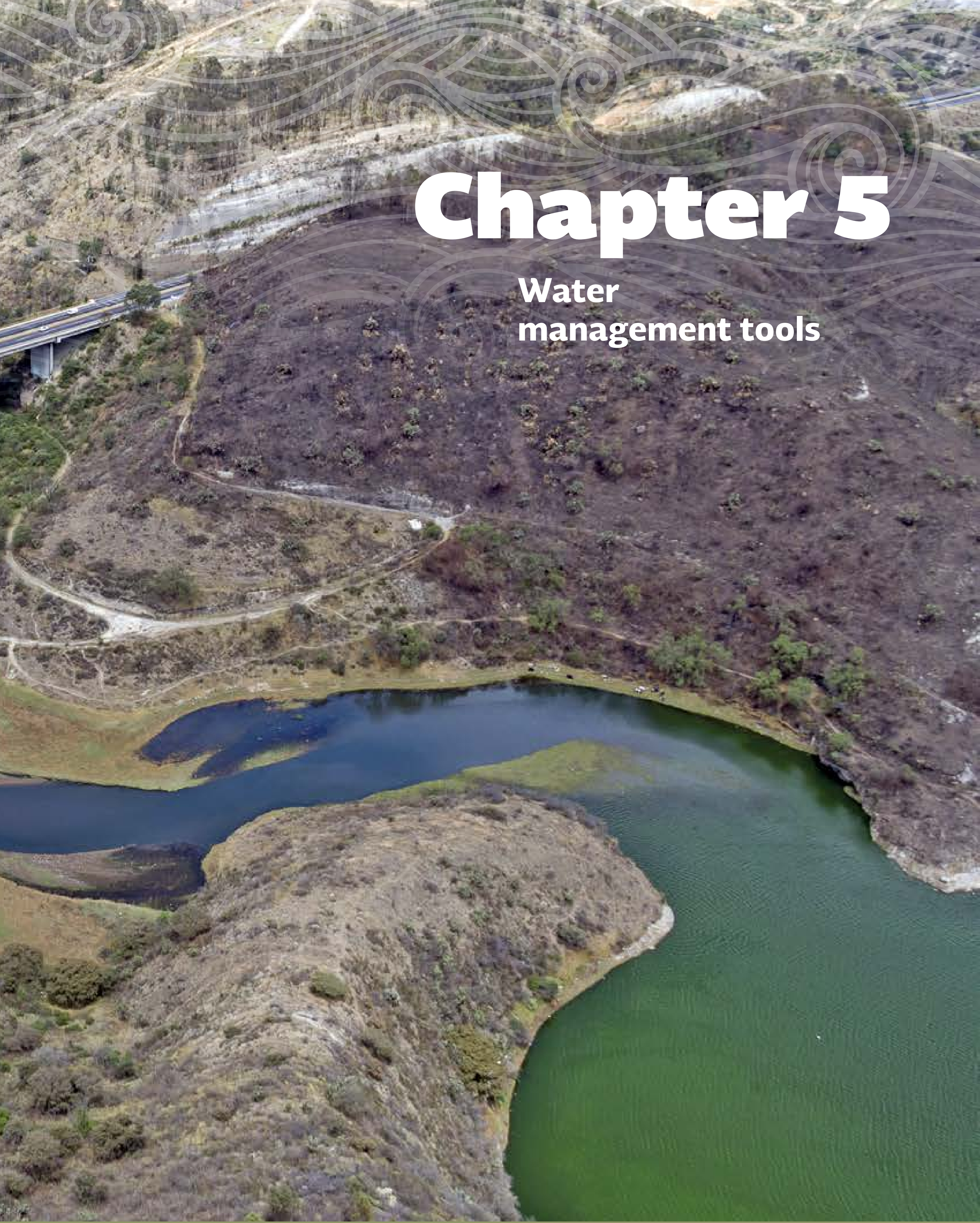
MAP 4.5 Regional emergency response centers, 2016

Source: Based on CONAGUA (2016a).

Aerial view of the highway that crosses the Tlalnepantla River, which, together with the Sifón River, discharges into the Madín dam.

Chapter 5

Water management tools



Water management tools

Legal framework

Availability to extract additional volumes:

649 out of **757** watersheds

448 out of **653** aquifers

Legal instruments

146 groundwater prohibition zones

7 aquifer regulations and regulated zones

3 reserve declarations

333 aquifers with suspension of free withdrawal

344 Surface water prohibition zones

Deeds in REPDA

Surface water

122 051 deeds

Groundwater

280 406 deeds

Discharge permits

17 197

Federal zone and material extraction permits

114 585

Participation mechanisms

26 River basin **councils**

Auxiliary bodies

36 commissions (for watersheds)

50 committees (for microwatersheds)

88 technical committees (for aquifers)

41 clean beaches committees

Water economy and finances

In 2016

18.36

billion pesos were collected in duties, corresponding to

135 961 hm^3

The budget for water-related government functions in 2016 was

10.888

billion pesos

Water pays for water: duties collection provided enough resources for financing water-related government functions.

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:[1]

Mission

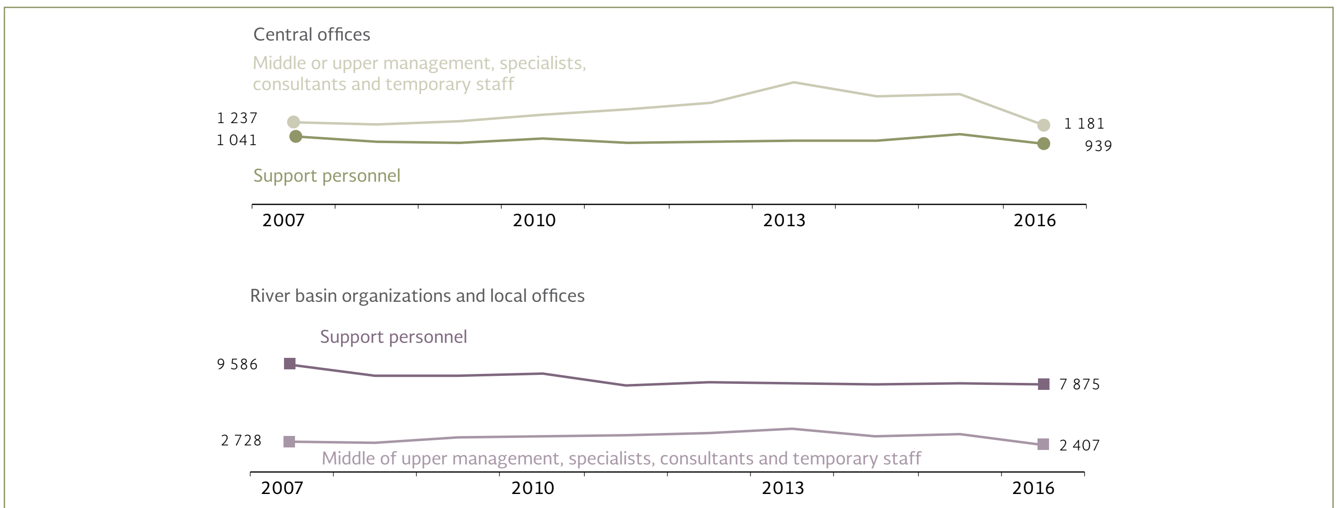
To preserve the nation's water resources and its inherent public goods for its sustainable administration and to guarantee water security with the responsibility of the tiers of government and society-at-large.

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 conagua was created, it had 38 188 employees, which in recent years has been reduced. Thus in December 2016, CONAGUA had 12 402 employees, of which 2 120 (939 support personnel and 1 181 middle or upper management, specialists, consultants and temporary staff) were assigned to its central offices and the remainder to the river basin organizations (RBOs) and local offices (LOs). This trend can be observed for the last ten years in Graph 5.1.

Graph 5.1 CONAGUA's personnel, 2007-2016



Source: Based on CONAGUA (2016m).

1 CONAGUA (2016o).

In order to carry out the functions assigned to it, 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 CONAGUA, whereas Figure 5.2 indicates the main institutions with which CONAGUA coordinates for meeting 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 2014 economic census found that in 2013 the number of people employed for the provision of drinking water, sewerage and sanitation services was 122 798 (INEGI 2016l).

In 2013,

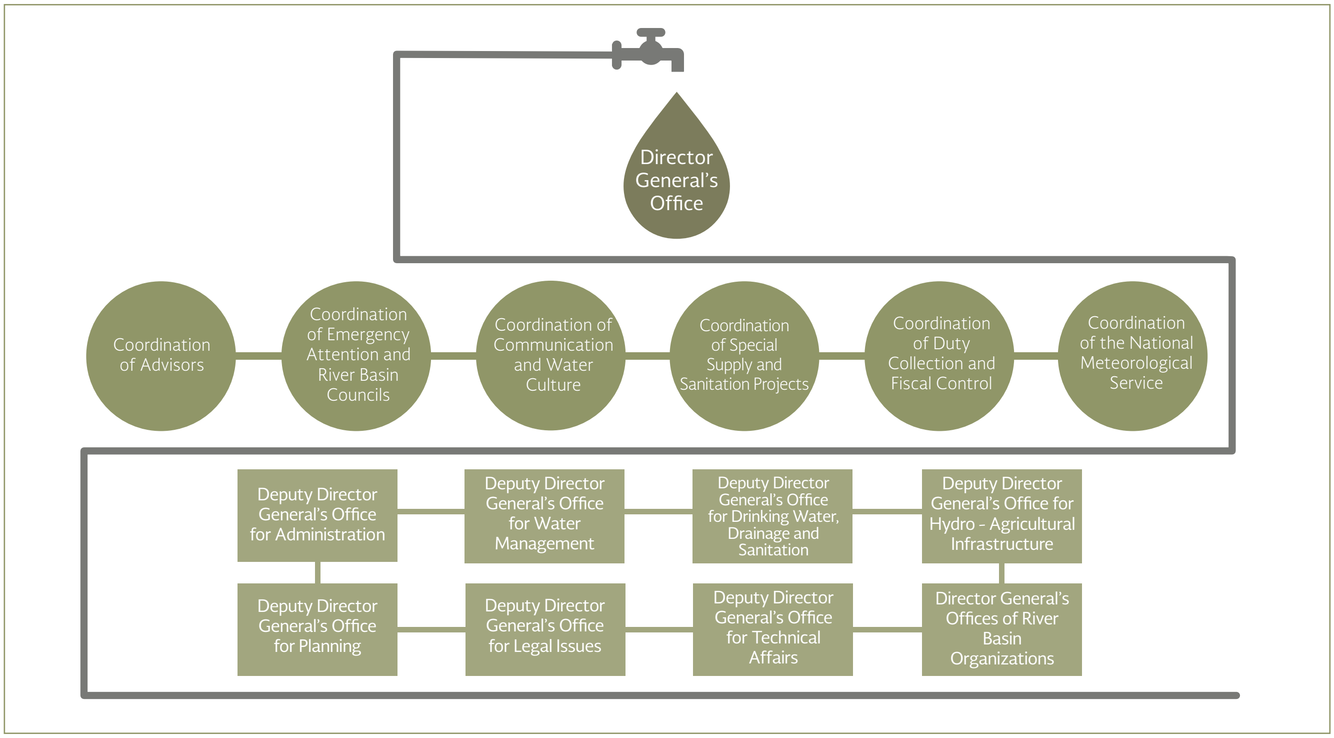
122 798

people were employed

for the provision of drinking water services

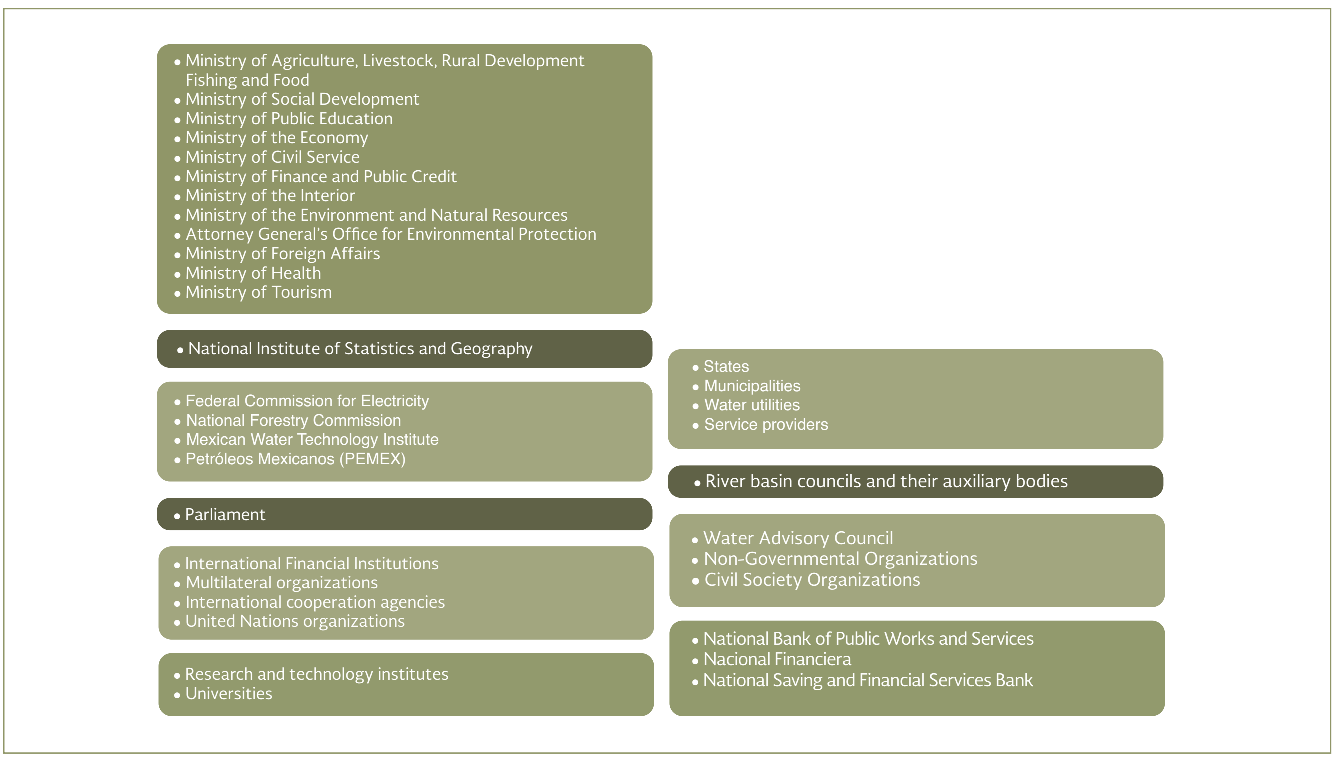
Headquarters of the National Water Commission in Mexico City.

Figure 5.1 CONAGUA's organizational chart, 2016



Source: Based on INAI (2016), National Water Law

Figure 5.2 Main institutions, entities and agencies in coordination with the CONAGUA, 2016



Source: 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 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.

In 2016 there were

529 786

deeds registered at REPDA

Deeds registered in the Public Registry of Water Duties (REPDA)

[Tablero: Registro Público de Derechos de Agua (REPDA) /Volúmenes inscritos, Registro Público de Derechos de Agua (REPDA) / Títulos inscritos]

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

Up to December 2016, there were 529 786 allocation deeds for the use of the nation's water resources registered at REPDA, which corresponded to a volume of 86 577 cubic hectometers (hm^3) allocated for consumptive uses and 182 712 hm^3 for non-consumptive uses (see Chapter 3).

The distribution of deeds by use is shown in Table 5.1. In Table 5.2 they are grouped by hydrological-administrative region (HAR), considering discharge permits, federal zone permits and material extraction permits. By number, regions VI Río Bravo, VIII Lerma-Santiago-Pacífico and X Golfo Centro concentrate 40% of the total number of allocation and/or assignment 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) for their analysis. The grouped use for agriculture includes the agricultural, livestock, aquaculture, multiple and others headings of 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 REPDA was consulted.

Table 5.1 Allocation or assignment deeds registered at REPDA, 2016

Grouped uses	Deeds registered at REPDA	
	Number	Percentage
Public supply	161 708	30.52
Agriculture	334 149	63.07
Self-supplying industry	33 697	6.36
Thermoelectric	55	.01
Subtotal of consumptive uses	**529 609**	**99.96**
Ecological conservation (Non-consumptive use)	1	.00
Hydropower (Non-consumptive use)	176	.03
Total	**529 786**	**100.00**

Source: CONAGUA (2016c).

Table 5.2 Deeds by hydrological-administrative region at REPDA, 2016

HAR number	Allocations and/or assignments				
	Surface water	Groundwater	Discharge permits	Federal zone	Material extractions
I	2 411	9 394	606	1 659	217
II	3 973	18 238	548	2 666	93
III	12 165	13 850	703	7 879	482
IV	14 872	14 354	1 589	8 218	407
V	10 414	19 322	666	10 659	207
VI	6 056	37 514	763	6 300	67
VII	3 683	28 233	947	3 583	121
VIII	19 153	60 254	3 159	22 577	765
IX	9 462	14 788	875	13 857	179
X	13 113	19 746	1 821	19 068	688
XI	25 370	9 472	1 077	12 457	463
XII	213	32 866	3 584	80	3
XIII	1 166	2 375	859	1 890	0
Total	**122 051**	**280 406**	**17 197**	**110 893**	**3 692**

Source: CONAGUA (2016c).

Legal instruments

[Tablero: Ordenamientos]

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

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 allocations or assignments 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 2016
there were

146

groundwater prohibitions

Up to December 2016, there were 146 current groundwater prohibition decrees, seven aquifer regulations, three regulated zones and three declarations of reserve zones for public urban use, which together cover approximately 55% of the national territory (see Map 5.1). It is established that to use groundwater within the territories outlined within them, it is necessary to request the corresponding concession or allocation. CONAGUA, considering the results of the studies it carries out, may authorize or reject the allocation or assignment.

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 is 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 CONAGUA to increase the volume (271 aquifers). This measure is collectively known as the suspension of free extraction, meaning the free extraction of the nation's groundwater resources.

Surface water prohibition zones are those specific areas of regions of watersheds in which no additional uses of water other than those that are legally established are 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. 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.

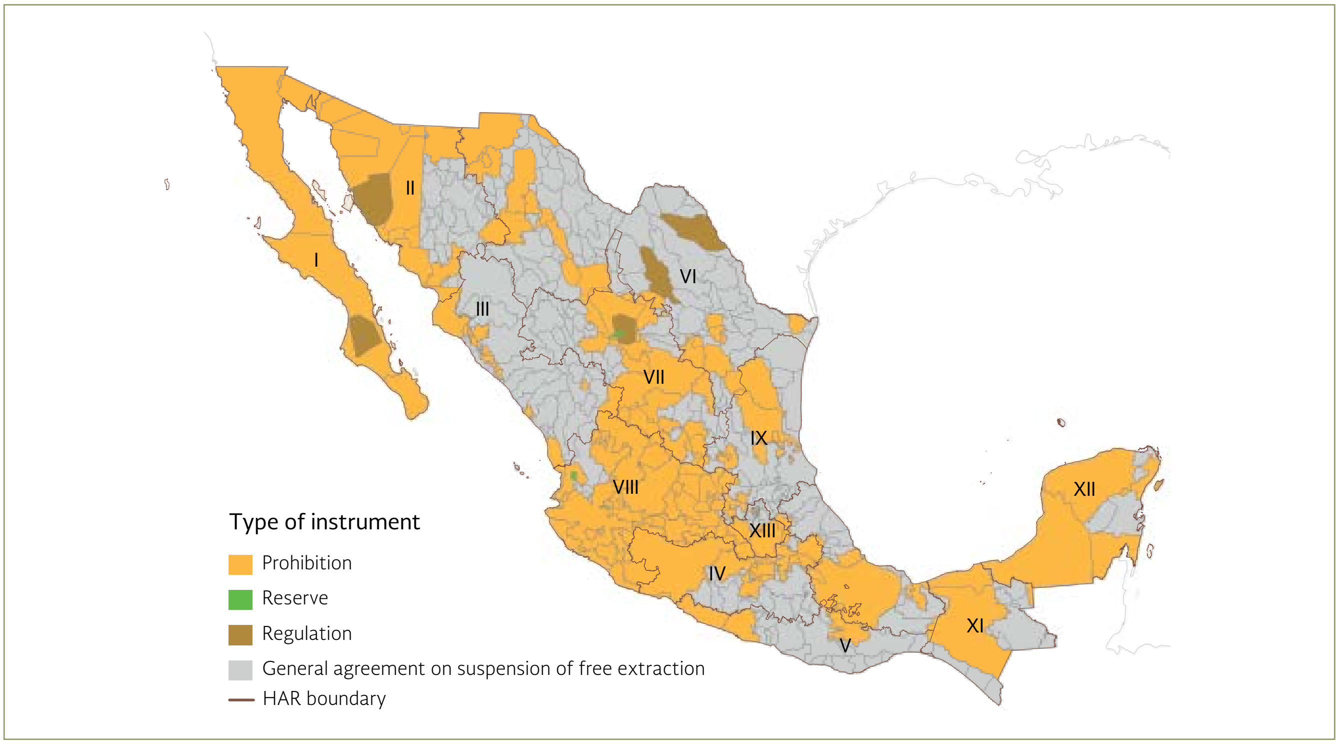
In 2016 there were

344

surface water prohibition zones

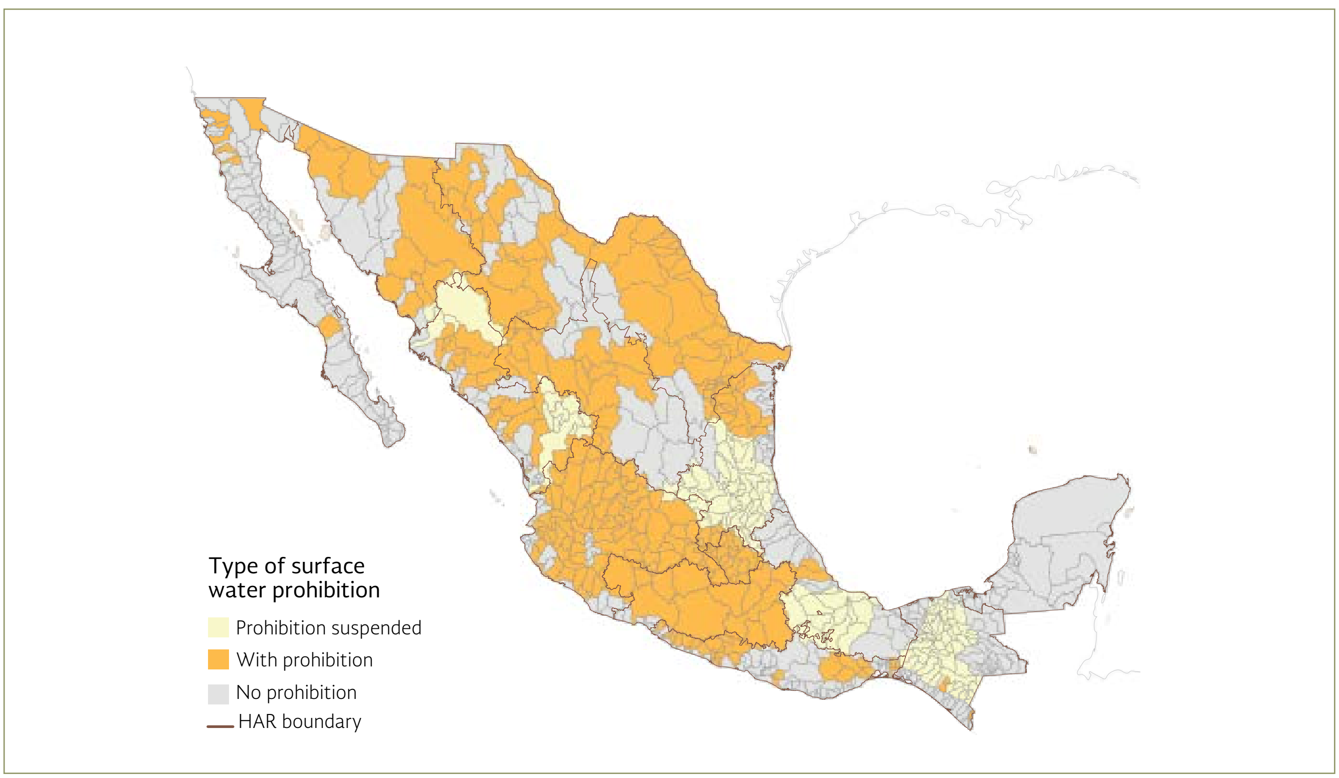
Aerial view of the water regulation pond in the urban area of Mexico City.

Map 5.1 Groundwater instruments, 2016



Source: Based on CONAGUA (2016b).

Map 5.2 Areas with surface water prohibitions, 2016



Source: Based on CONAGUA (2016b).

Publication of mean annual water availabilities

[Tablero: Cuencas]

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". 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".

In 2016, the availabilities of the 653 hydrogeological units or aquifers into which the country has been divided had been published in the Official Gazette of the Federation (DOF), as well as that of the 757 watersheds into which Mexico is subdivided.

Maps 5.3 and 5.4 show the location of Mexico's watersheds and aquifers whose availability was been published in the DOF.

For the management of its water resources, Mexico has been divided into

757

watersheds

and

653

aquifers

Classification declarations for Mexico's water bodies

[Tablero: Acuíferos]

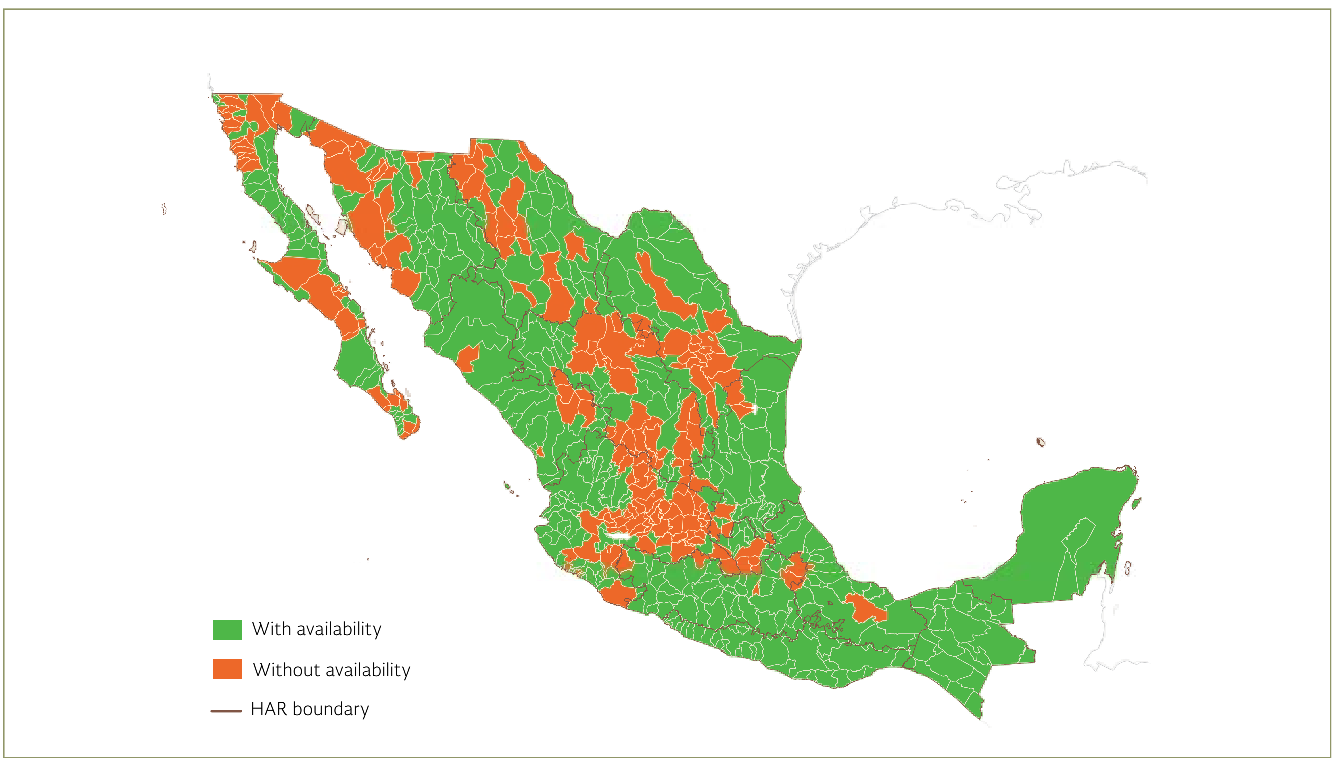
The NWL establishes that in order to grant wastewater discharge permits, the classification declarations of the national water bodies should be consulted. CONAGUA has the responsibility of drawing up and publishing these declarations in the DOF.

According to article 87 of the NWL, classification declarations contain the outlines 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, 2016

Source: Based on CONAGUA (2016b).

Map 5.4 Aquifers with availability published in the DOF, 2016



Source: Based on CONAGUA (2016b).

5.3 Water economic and financing

Duties for the use of the nation's water resources

Both companies and individuals that make use of Mexico's water resources are bound to pay the corresponding duties, be it with or without the benefit of allocation or assignment deeds, authorizations or permits issued by the Federal Government. The same also applies to those who discharge wastewater into rivers, watersheds, reservoirs, seawater or water currents, as well as into the soil or into grounds which are public property or which could contaminate the subsoil or aquifers, be it permanently, intermittently or on a one-off basis. In the same case are those who make use of 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.

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. As a consequence of this reform, each watershed is classified into one of four possible availability zones for surface water. Similarly, each aquifer is classified into one of four possible availability zones for groundwater. Since 2014 CONAGUA publishes no later than the second month of every fiscal 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 groundwater and Table 5.4 for surface water. In both tables, "General regime" refers to any use other than those mentioned. The values are taken from the publication in the DOF (23/12/2015) of Annex 19 of the tax law for 2016—Updated quantities established in the 2016 Federal Duties Law. It should be noted 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 CONAGUA).

The availability zones are shown in Map 5.5 for surface water and in Map 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 greatest effects. The list of the receiving bodies that belong to each category can be found in the Federal Duties Law (FDL).

The rates for wastewater discharges are related to the volume of the discharge and the contaminant load; to make this calculation, both 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.

Table 5.3 Duties for the use of the nation's groundwater resources, by availability zone, 2016 (cents per cubic meter)

Use	Zone			
	1	2	3	4
General regime	1 981.99	767.19	267.13	194.18
Drinking water, consumption of more than 300 l/inhab./day	91.27	42.08	23.72	11.06
Drinking water, consumption equal to or less than 300l/inhab./day	45.63	21.04	11.86	5.53
Agriculture and livestock, without exceeding the allocation	.00	.00	.00	.00
Agriculture and livestock, for every m^3 that exceeds the allocation	16.68	16.68	16.68	16.68
Water parks and recreation centers	1.28	.63	.31	.14
Hydropower generationv	.00	.00	.00	.00
Aquaculture	.40	.18	.09	.04

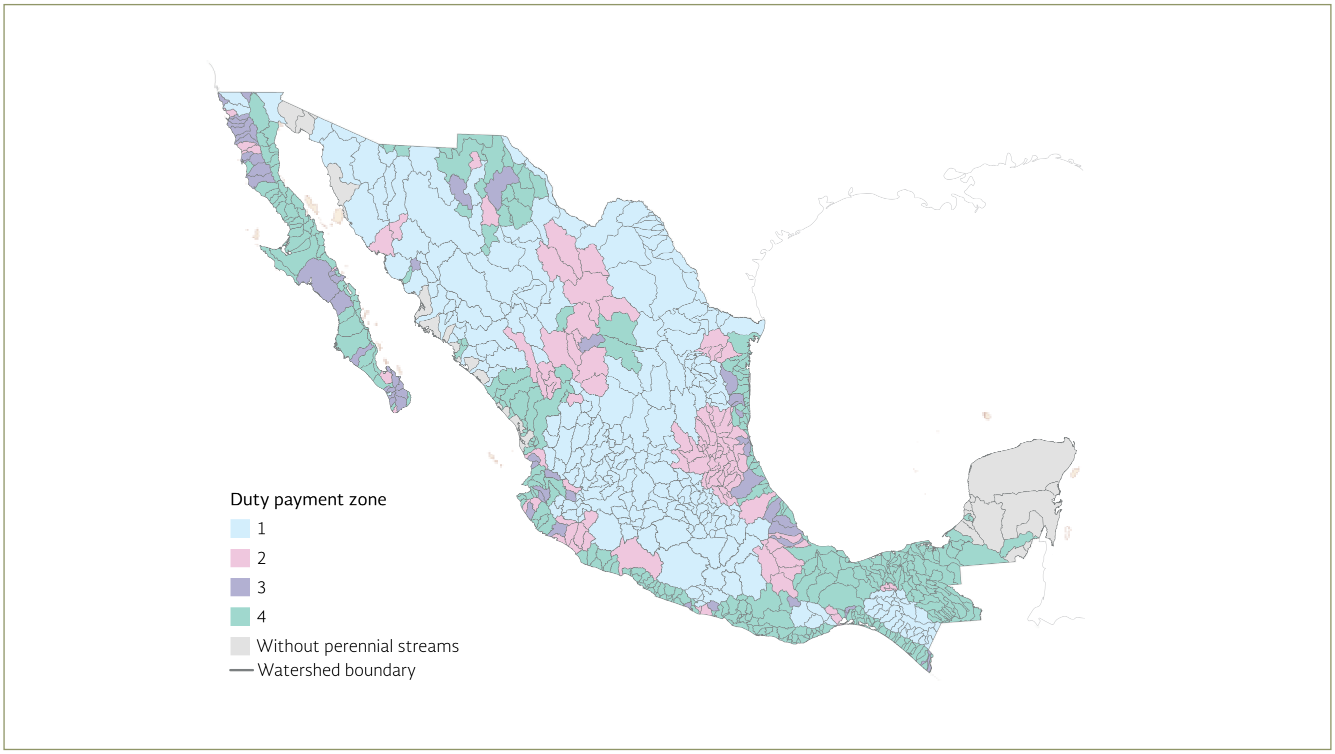
Source: CONAGUA (2016n).

Table 5.4 Duties for the use of the nation's surface water resources, by availability zone, 2016 (cents per cubic meter)

Use	Zone			
	1	2	3	4
General regime	1 470.90	677.16	222.03	169.78
Drinking water, consumption of more than 300 l/inhab./day	87.43	41.93	20.94	10.42
Drinking water, consumption equal to or less than 300l/inhab./day	43.72	20.97	10.47	5.21
Agriculture and livestock, without exceeding the allocation	.00	.00	.00	.00
Agriculture and livestock, for every m^3 that exceeds the allocation	16.68	16.68	16.68	16.68
Water parks and recreation centers	1.08	.60	.28	.12
Hydropower generation	5.05	5.05	5.05	5.05
Aquaculture	.36	.18	.08	.04

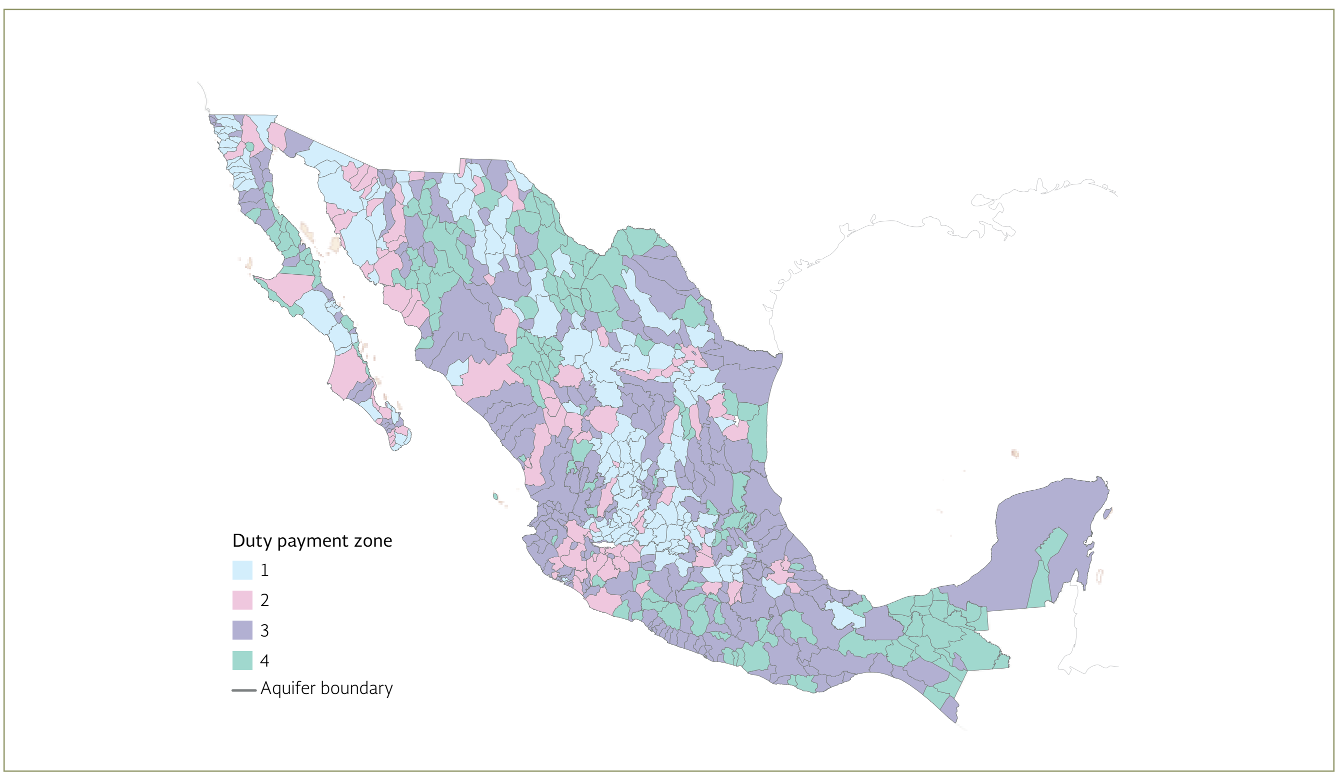
Source: CONAGUA (2016n).

Map 5.5 Availability zones for surface water, 2016



Source: Based on CONAGUA (2016n).

Map 5.6 Availability zones for groundwater, 2016



Source: Based on CONAGUA (2016n).

CONAGUA's income collection

[Tablero: Recaudación de la Conagua, Volúmenes declarados]

As a fiscal authority, CONAGUA intervenes in the charging of duties for the use of Mexico's water resources and its inherent public goods. Tables 5.5 and 5.6 show its income through the charging of duties, 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 noted that since 2013, the "Programa Ponte al Corriente" (Catch-Up-On-Your-Payment Program) has been 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.

In 2016,

18.36

billion pesos were collected

The conversions to constant 2016 prices used hereinafter were carried out based on the average National Consumer Price Index for each year.

TABLE 5.5 CONAGUA's income collection through the charging of duties and concepts, 2009-2016 (millions of pesos at constant 2016 prices)

Concept	2009	2010	2011	2012	2013	2014	2015	2016
Use of the nation's water resources	10 152.1	9 685.2	10 210.2	10 803.0	10 173.2	11 300.2	10 850.4	11 798.5
Bulk water supply to urban And industrial centers	2 653.1	2 967.9	3 300.8	3 214.1	3 086.6	3 644.8	3 830.7	4 016.8
Irrigation services	288.6	270.1	325.7	238.0	212.9	232.9	251.4	308.9
Material extraction	58.4	60.3	35.8	42.4	23.9	25.2	25.2	23.7
Use of receiving bodies	229.4	272.6	317.9	341.6	428.8	686.3	1 186.4	1 369.2
Use of federal zones	48.8	45.2	46.6	52.7	46.3	55.3	62.6	76.0
Various (transaction services, regularization and fines, among others)	273.5	253.7	257.7	805.5	471.8	581.4	560.4	614.4
Income through fiscal credits	116.4	94.8	519.6	663.9	523.2	219.7	100.0	90.7
Income through the "Ponte al Corriente" Program					1 207.1	0.0	0.0	0.0
Inter-basin transfer of the nation's waters						10.7	56.6	62.0
Total	**13 820.4**	**13 649.6**	**15 014.3**	**16 161.2**	**16 173.8**	**16 756.5**	**16 923.8**	**18 360.2**

Source: Based on CONAGUA (2016n).

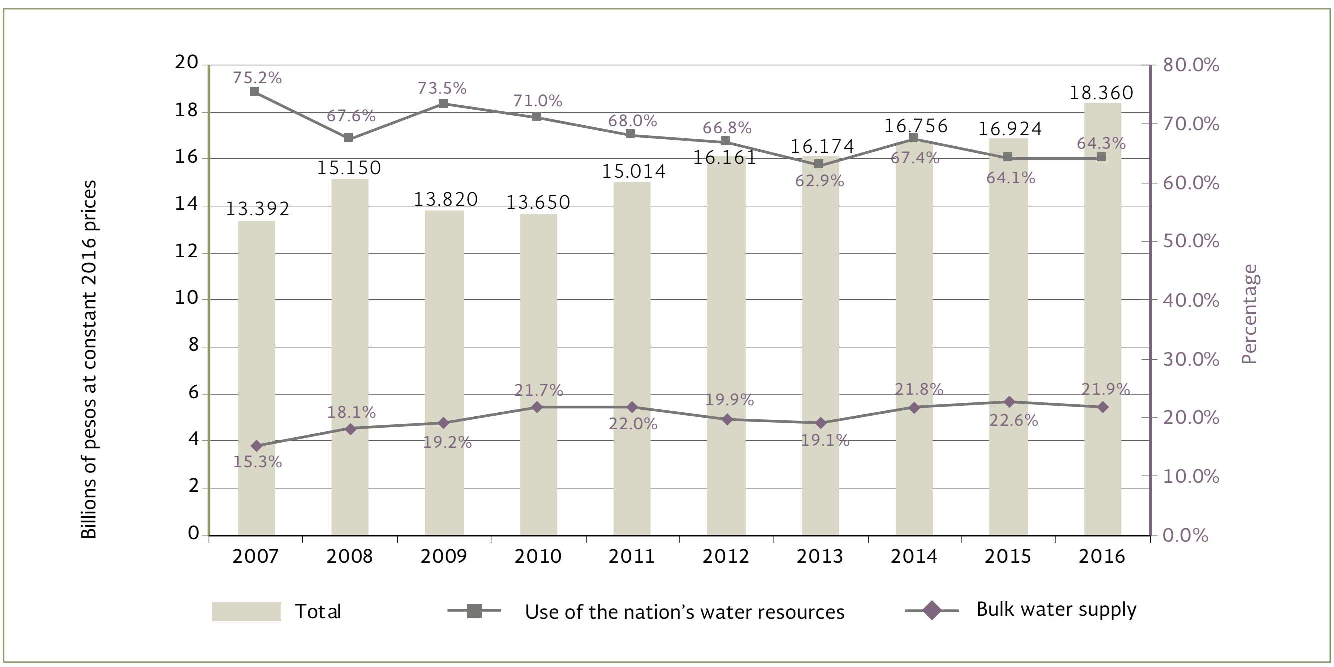
Periodically, the Ministry of Finance and Public Credit (SHCP in Spanish) authorizes CONAGUA to apply charges for services, for example: bulk water supply from the Cutzamala System to the Metropolitan Area of the Valley of Mexico or to irrigation district (ID) modules.

CONAGUA's income collection followed a growing trend through the 2007-2016 period, at constant 2016 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 75.2% per year in 2007 to 64.3% in 2016.

Since the creation of CONAGUA in 1989, income collection through the charging of duties has increased every year. In Graph 5.2 the period from 2007 to 2016 can be observed, during which it increased from 13.392 to 18.360 billion pesos, at constant 2016 prices.

By hydrological-administrative region, the income collection for 2016 is presented in Table 5.6. Particularly worth highlighting is that regions VIII Lerma-Santiago-Pacífico, XIII Aguas del Valle de México and VI Río Bravo contribute 63% of the income. In that table the concept of "Various" refers to transaction services, regularizations and fines, among others.

Graph 5.2 Evolution in CONAGUA's income collection, showing the two main components by amount, 2007-2016 (billions of pesos at constant 2016 prices)



Source: Based on CONAGUA (2016n).

Table 5.7 shows the evolution in the 2007-2016 period in income 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 2016 by HAR.

The volumes reported by users in their declarations for the payment of duties are shown in Table 5.8 for the 2007-2016 period, classified by uses, as well as in table 5.10 by hydrological-administrative region for 2016.

TABLE 5.6 Income collection by hydrological-administrative region, 2016 (millions of pesos)

HAR No.	Concepts									Total
	Use of the nation´s water resources	Bulk water supply to urban and industrial centers	Irrigation service	Material extraction	Use of receiving body	Use of federal zones	Inter-basin transfers of the nation's water resources	Income from fiscal credits	Various (transaction services, regularization and fines, among others)	
I	218.59	0.00	78.11	2.70	66.64	10.29	0.00	2.00	26.26	**404.58**
II	1 402.44	0.00	31.99	0.53	29.40	0.84	0.03	7.32	9.80	**1 482.35**
III	211.29	0.00	80.35	11.41	11.29	6.17	0.04	1.65	10.92	**333.11**
IV	746.25	35.38	8.04	0.25	118.95	1.84	2.34	4.84	60.98	**978.88**
V	317.05	0.00	2.52	1.05	10.63	0.79	0.00	1.71	11.77	**345.52**
VI	1 730.92	0.00	23.51	0.92	22.88	11.87	5.53	9.09	34.99	**1 839.71**
VII	680.07	0.00	18.30	0.43	23.24	1.86	0.12	4.05	92.58	**820.65**
VIII	2 766.02	163.21	29.78	2.16	195.63	19.94	3.83	16.22	86.31	**3 283.09**
IX	695.57	0.00	16.25	0.83	35.57	5.43	1.46	3.82	13.62	**772.54**
X	632.60	0.00	4.26	0.88	89.47	0.88	17.60	4.27	114.51	**864.47**
XI	377.85	0.00	0.77	2.53	133.09	1.55	0.00	2.65	18.18	**536.61**
XII	111.92	0.00	1.45	0.00	56.79	0.04	0.00	0.95	21.56	**192.72**
XIII	1 907.94	3 818.22	13.52	0.00	575.62	14.54	31.06	32.14	112.91	**6 505.96**
Total	**11 798.51**	**4 016.82**	**308.86**	**23.68**	**1 369.18**	**76.04**	**62.00**	**90.71**	**614.39**	**18 360.18**

Source: CONAGUA (2016n).

TABLE 5.7 Collection for the use of the nation's water resources, 2007-2016 (millions of pesos at constant 2016 prices)

Use	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
General regime	7 005.6	7 007.5	6 884.0	6 468.1	6 861.6	7 541.0	7 510.2	8 344.9	8 024.6	8 518.1
Public urban	2 421.0	2 483.5	2 574.0	2 548.6	2 571.0	2 497.1	2 126.5	2 111.9	2 125.6	2 645.4
Hydropower	616.0	706.5	653.7	637.6	752.7	745.2	533.9	841.5	698.5	632.2
Water parks and recreation centers	27.7	37.0	39.8	30.2	24.1	19.1	2.2	1.2	0.9	0.7
Aquaculture	0.8	0.9	0.7	0.7	0.7	0.7	0.5	0.7	0.8	0.8
Agriculture and livestock	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1.3**
Total general	**10 071.0**	**10 235.4**	**10 152.1**	**9 685.2**	**10 210.2**	**10 803.0**	**10 173.2**	**11 300.2**	**10 850.4**	**11 798.5**

Source: CONAGUA (2016n).

TABLE 5.8 Volumes declared for the payment of duties, 2007-2016 (hm^3)

Use	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
General regime	1 764	1 796	1 939	1 675	1 373	1 132	1 180	1 082	1 029	1 045
Urban public	7 584	7 639	5 609	5 617	6 967	6 185	10 262	8 010	8 841	8 814
Hydropower	122 832	150 669	136 085	134 783	164 773	155 717	112 816	133 018	138 662	125 622
Water parks and recreation centers	84	86	64	56	109	78	85	94	129	115
Aquaculture	308	309	344	222	218	256	258	338	415	358
Agriculture and livestock	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**7**
Total	**132 571**	**160 499**	**144 041**	**142 353**	**173 440**	**163 368**	**124 602**	**142 542**	**149 076**	**135 961**

Source: CONAGUA (2016n).

TABLE 5.9 Duty collection for the use of the nation's water resources, by hydrological-administrative region, 2016 (millions of pesos)

HAR number	General regime	Public urban	Hydropower	Water parks and recreation centers	Aquaculture	Agriculture and livestock	Total
I	100.1	117.9	0.4	0.0	0.0	0.152794	218.6
II	1 305.2	78.6	18.6	0.0	0.0	0.033	1 402.4
III	100.3	55.4	55.4	0.0	0.0	0.083283	211.3
IV	415.0	179.0	149.9	0.2	0.5	0.085606	744.7
V	270.0	47.4	1.2	0.0	0.0	0.212043	318.8
VI	1 230.8	490.1	11.3	0.0	0.0	0.140951	1 732.3
VII	573.5	105.0	0.0	0.0	0.0	0.021105	678.5
VIII	2 136.5	558.5	70.0	0.3	0.1	0.360878	2 765.7
IX	624.2	62.0	9.4	0.0	0.0	0.034527	695.7
X	511.6	49.2	71.6	0.1	0.0	0.049167	632.6
XI	94.4	35.4	244.4	0.0	0.0	0.004999	374.2
XII	81.2	34.2	0.0	0.0	0.0	0.116083	115.6
XIII	1 075.2	832.7	0.0	0.1	0.0	0.003311	1 907.9
Total	**8 518.1**	**2 645.4**	**632.2**	**0.7**	**0.8**	**1.297747**	**11 798.5**

Source: CONAGUA (2016n).

Corn plantation at the bank of the Papaloapan River on the Oaxaca side.

Table 5.10 Volumes declared for the payment of duties for the use of the nation's water resources, by hydrological-administrative region, 2016 (hm^3)

HAR number	Use						
	General regime	Public urban	Hydropower	Water parks and recreation centers	Aquaculture	Agriculture and livestock	Total
I	12.9	296.4	71.5	0.3	0.9	1.0	383.0
II	93.7	231.5	3 695.8	0.2	11.0	0.2	4 032.5
III	14.3	276.1	11 025.5	1.9	36.5	0.5	11 354.8
IV	86.9	766.6	29 814.5	35.6	139.8	0.6	30 844.0
V	22.8	252.9	240.7	0.0	1.9	1.3	519.7
VI	99.2	1 160.8	2 243.7	0.8	3.0	0.0	3 507.4
VII	68.4	252.7	0.0	1.5	0.6	0.1	323.4
VIII	149.8	1 550.0	13 900.9	26.3	46.9	1.8	15 675.6
IX	105.4	250.8	1 870.8	3.8	46.1	0.2	2 277.1
X	211.5	398.0	14 242.6	30.0	47.2	0.3	14 929.5
XI	46.5	293.4	48 516.2	0.0	5.3	0.0	48 861.4
XII	31.4	287.6	0.0	8.6	6.5	0.7	334.9
XIII	101.8	2 796.9	0.3	6.1	12.1	0.0	2 917.3
Total	**1 044.8**	**8 813.7**	**125 622.4**	**115.0**	**357.9**	**6.7**	**135 960.6**

Source: CONAGUA (2016n).

CONAGUA' s budget

[Tablero: Presupuesto ejercido, Presupuesto invertido]

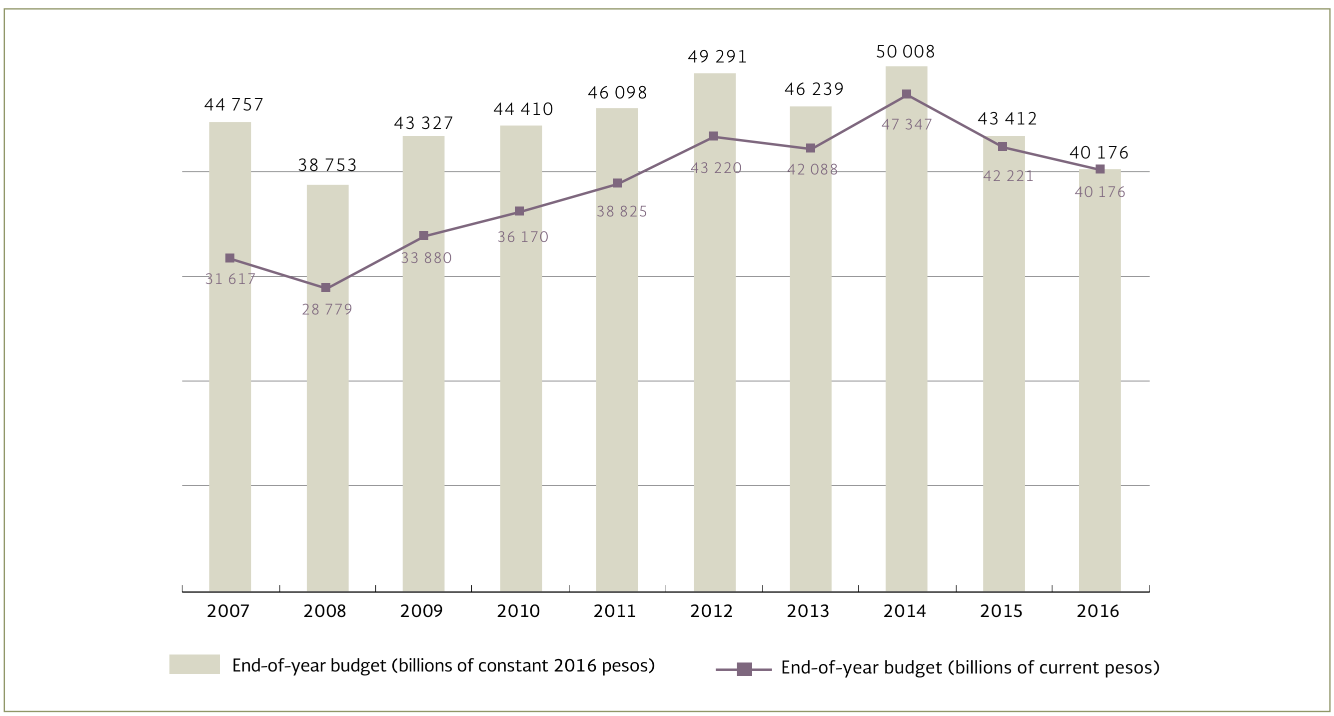
The budget authorized for CONAGUA for any given fiscal year is defined at the end of the previous year. Throughout the fiscal year budgetary adjustments take place, as a result of which the end-of-year budget, the evolution of which is shown in Graph 5.3, may vary from the originally authorized budget.

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 governance functions, which are part of the budget assigned by 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.

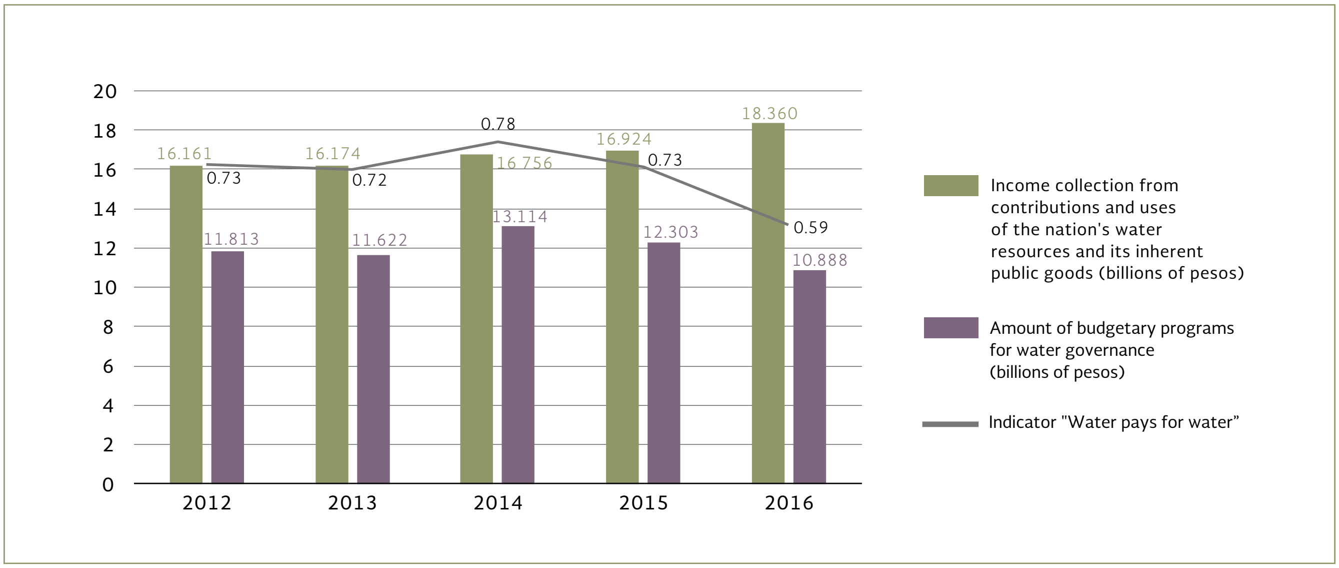
GRAPH 5.3 Evolution in the CONAGUA's end-of-year budget (millions of pesos)



Source: Based on CONAGUA (2016m).

This way, the amount of the budgetary programs linked with water governance is divided by the collection. When the result of the indicator is lower than the unit, it is considered that the income provides sufficient resources to finance the water governance activities, as shown in Graph 5.4.

Graph 5.4 Indicator "Water pays for Water" (at constant 2016 prices)



Source: Based on CONAGUA (2016m), CONAGUA (2016n).

Table 5.11 Investments by budget line in the drinking water, sewerage and sanitation sub-sector, 2002-2016 (millions of pesos at constant 2016 prices)

Year	Drinking water	Sewerage	Sanitation	Efficiency improvement	Other	Total
2002	6 193	7 016	2 659	2 077	142	**18 086**
2003	8 602	8 190	2 008	1 553	292	**20 644**
2004	8 490	8 632	2 441	1 720	112	**21 394**
2005	12 799	12 564	4 982	2 429	179	**32 955**
2006	8 014	8 570	2 680	3 521	363	**23 148**
2007	13 229	10 505	2 456	3 468	802	**30 460**
2008	14 135	12 600	3 114	4 107	1 486	**35 442**
2009	12 738	13 873	2 913	6 941	2 216	**38 681**
2010	11 245	15 192	3 506	5 971	2 763	**38 677**
2011	10 739	16 577	9 151	5 447	2 582	**44 496**
2012	12 409	8 441	18 148	4 309	2 884	**46 191**
2013	11 672	14 046	8 153	5 061	1 841	**40 774**
2014	10 938	10 581	5 890	6 691	2 028	**36 128**
2015	9 768	13 354	5 774	5 570	1 628	**36 094**
2016	11 243	11 748	5 248	5 282	1 279	**34 800**

Source: CONAGUA (2016a).

The evolution in the investment in the drinking water, drainage and sanitation sub-sector is shown in Table 5.11. The table considers the programs operated through CONAGUA, SEDESOL, CDI, BANOBRAS, state bodies, the private sector and credits. The “Others” concept considers studies, projects and supervision.

It should be mentioned that this investment has diverse origins, as can be observed in Table 5.12. 70.8% of the investment was of federal origin, whereas state contributions were 12.6%, municipalities 11.3% and other sources, including state commissions, housing developers, credits, contributions of the private sector and others, accounted for the remaining 5.3%. 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.

Table 5.12 Investments reported by program and agency by the sector of origin of the resources, 2016 (millions of pesos)

Concept	Federal	State	Municipal	Credit/PI/Others	Total
CONAGUA investments	**20 825.75**	**3 693.28**	**3 310.83**	**1 553.61**	**29 383.47**
Agua Limpia	90.47	53.03	0.00	0.00	143.50
APAZU	4 622.72	2 438.40	590.51	460.53	8 112.16
PRODDER	2 991.90	368.09	320.02	0.00	3 680.02
PROMAGUA	2 171.29	0.00	2 171.29	0.00	4 342.58
PROME	149.41	196.11	0.00	90.02	435.54
PROSSAPYS	355.41	229.57	0.00	0.00	584.97
PROTAR	1 581.23	408.07	229.01	0.00	2 218.31
Valley of Mexico	8 380.46	0.00	0.00	1 003.06	9 383.51
Other projects	482.88	0.00	0.00	0.00	482.88
Other agencies	**2 580.83**	**381.32**	**332.81**	**2 121.16**	**5 416.12**
CDI	2 398.10	283.28	216.64	0.00	2 898.01
CONAVI	0.00	0.00	0.00	2 109.51	2 109.51
SEDESOL	182.74	98.04	116.17	11.64	408.59
Total	**23 406.59**	**4 074.60**	**3 643.63**	**3 674.77**	**34 799.59**

Source: CONAGUA (2016a).

Drinking water and sanitation tariffs

[Tablero: 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.

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.

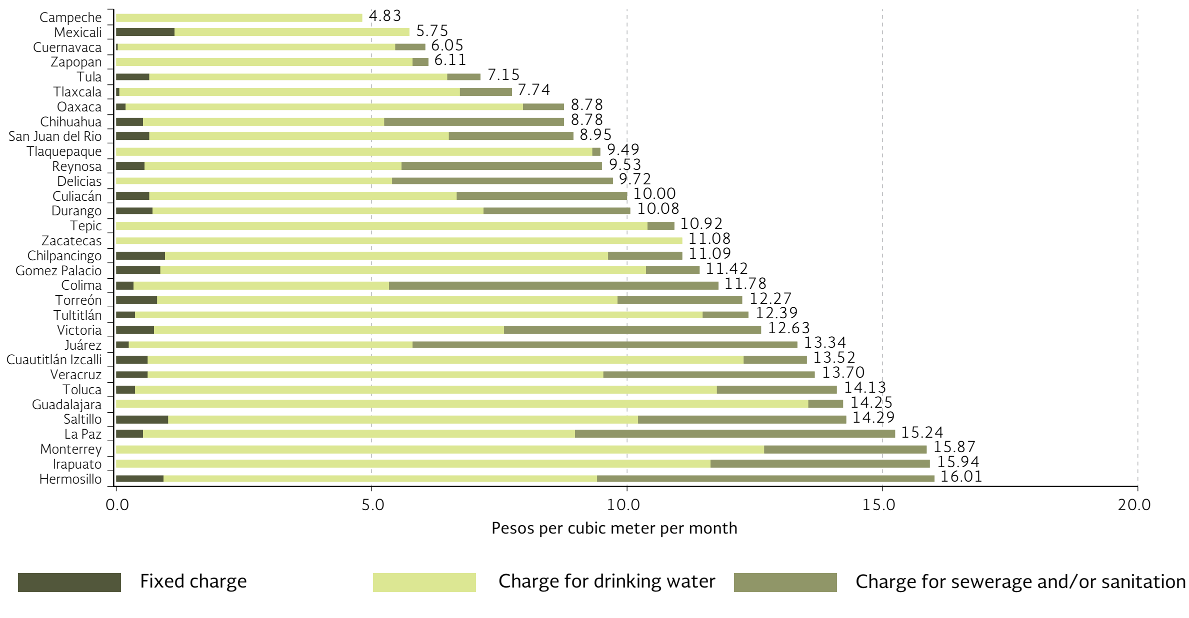
Tariff structures for metered services (when the charge is calculated based on the volume consumed) are generally in increasing blocks, meaning that the price per cubic meter is higher for a greater consumption of water. It should be mentioned that there is a great variety of mechanisms, including the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

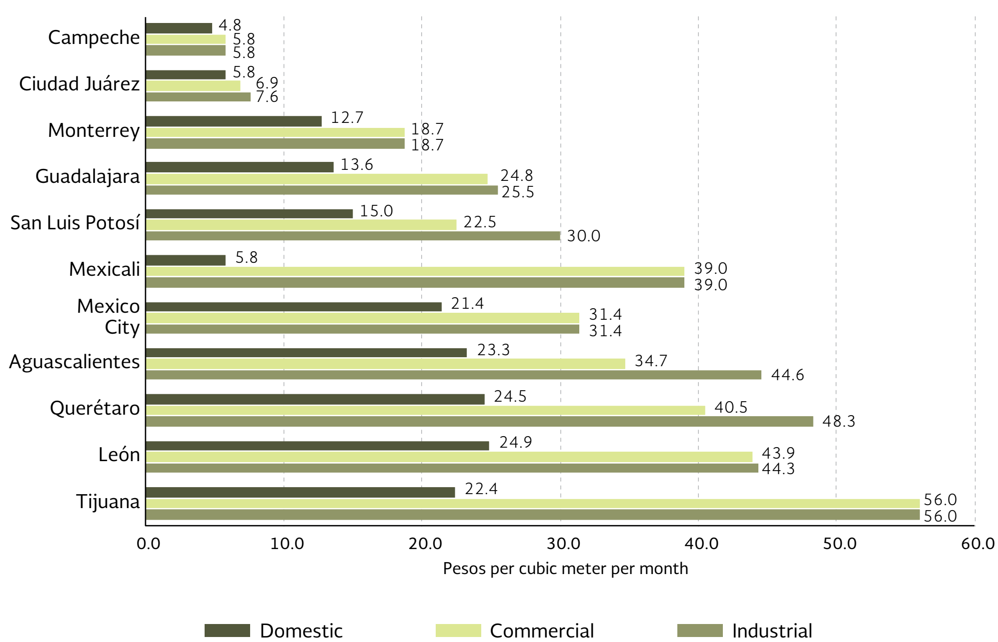
Graph 5.5 indicates, for some cities in Mexico, the drinking water, sewerage and/or sanitation tariffs for a consumption of 30 m^3/month for domestic use, as well as the highest tariff applicable.

GRAPH 5.5 Domestic drinking water, sewerage and/or sanitation tariffs in selected cities, 2016



Source: CONAGUA (2016a).

GRAPH 5.6 Comparison between tariffs for domestic, industrial and commercial use in selected cities, 2016



Source: Based on CONAGUA (2016a).

Graph 5.6 shows the tariffs for domestic, industrial and commercial use in several localities in Mexico, assuming a consumption of 30 m^3/month, as well as the highest tariff applicable for that consumption.

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 for the water sector include loans and technical cooperation from international financial organizations, through which knowledge and skills are transferred. In this regard, in 2016, CONAGUA spent 127 million dollars in the following projects:

- Improving efficiencies of water utilities (PROME), financed by the IBRD

- Sustainability of the Drinking Water and Sanitation Services for Rural Communities (PROSSAPYS IV), financed by the IDB.

- Integrated Development of Water and Sanitation Utilities (PRODI), financed by the IDB

In 2016,

127

million dollars were spent on external credit

As for technical cooperation with international financial institutions, with the IDB, a georeferenced system for the follow-up of structures during the stages of construction and post-construction of PROSSAPYS IV was designed with the aim of promoting the sustainability of investments on infrastructure. A study was conducted on strategies for enhancing drinking water and sanitation services in rural communities. Also, a support tool was developed for the selection of appropriate technologies for the supply of drinking water and sanitation services in rural areas.

Regarding bilateral cooperation, with the governments of El Salvador and Peru, three projects were completed that had to do with drinking water and sanitation and with water-related information and dissemination systems. With France, a project was started on Technical Support for the Consolidation of the Metropolitan Commission for Drainage in the Valley of Mexico, coordinated by CONAGUA, with the participation of Mexico City's Water System and the Water and Sanitation Comission of the State of Mexico. With China, a joint study was completed on Flood Risk Reduction in the Balsas River Watershed.

Three Memoranda of Understanding for Cooperation in Water Resources Matters were signed with the Governments of Korea, Spain and Hungary, in order to strengthen the exchange relations in several priority issues for the water sector of Mexico.

In the trilateral modality, the project "Reuse of Treated Wastewater for Agricultural Irrigation" was concluded, which was carried out with Bolivia, with the support of the GIZ from Germany and AMEXCID, with the participation of this Commission and IMTA. With regard to multilateral issues, 14 initiatives were launched related to the challenges facing the sector that are the result of the Action Plan of the High Level Panel on Water (HLPW) co-chaired by Mexico and the Mauritius Islands, comprising 11 countries. The technical capabilities of the sector and of Mexican specialists were enhanced through the exchange of knowledge and experiences at the 16th World Water Congress of the International Water Resources Association (IWRA) and the 23rd International Congress on Irrigation and Drainage and the 68th Meeting of the International Executive Council of the International Irrigation and Drainage Commission (IIDC); events which were held in Mexico. The creation of the Regional Center for Water Security, a Category II Center, was approved under the auspices of the United Nations Educational, Scientific and Cultural Organization (UNESCO).

Aerial view of the "La Yesca" dam, located in the Río Grande de Santiago, in the municipality of La Yesca, Nayarit, and Hostotpaquillo, Jalisco

5.4 Participation mechanisms

[Tablero: Mecanismos de participación]

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 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 2016, there were 26 river basin councils. 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, auxiliary bodies were created, known as river basin commissions, to attend sub-basins; river basin committees for micro-basins; technical groundwater committees (COTAS) and clean beaches committees in the country's coastal areas.

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 biodiversity and making the beaches competitive for tourism, both nationally and internationally, as well as raising the standard and quality of living of the local population.

Regarding auxiliary bodies, up to 2016 there was a total of 215 auxiliary bodies of the river basin councils, with 36 commissions, 50 committees, 88 COTAS and 41 clean beaches committees.

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. Table 5.13 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.

NOM-011-CONAGUA-2000 is a standard worth mentioning, given that it lays the foundations for the calculation of the availability of water in watersheds and aquifers, and it thus makes it possible to comply with one of CONAGUA's legal obligations. Similarly, 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 organoleptic characteristics (color, smell, taste and turbidity); 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. 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-127-SSA1-1994
in order to ensure water supply for human use and consumption, considers

34

chemical parameters

Table 5.13 Mexican standards related with the water sector

No.	Group: SEMARNAT
1	NOM-001-SEMARNAT-1996 - Maximum permissible limits of contaminants in wastewater discharges in the nation's water resources and goods.
2	NOM-002-SEMARNAT-1996 - Maximum permissible limits of contaminants in wastewater discharges to urban and municipal sewerage systems.
3	NOM-003-SEMARNAT-1997 - Maximum permissible limits of contaminants for treated wastewater that is reused in services to the public.
4	NOM-004-SEMARNAT-2002 - Environmental protection. Sludge and biosolids. Specifications and maximum permissible limits of contaminants for their use and final disposal.
5	NOM-022-SEMARNAT-2003 - Preservation, conservation, sustainable use and restoration of coastal wetlands in areas of mangrove swamps.
6	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 toilets.
7	NOM-010-CONAGUA-2000 - Specifications and testing methods for toilet valves.
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: Energy**
1	NOM-006-ENER-2015 - Electromechanical energy efficiency in pumping systems for deep wells in operation. Limits and testing methods.
No.	**Group: Health**
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, drainage 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.

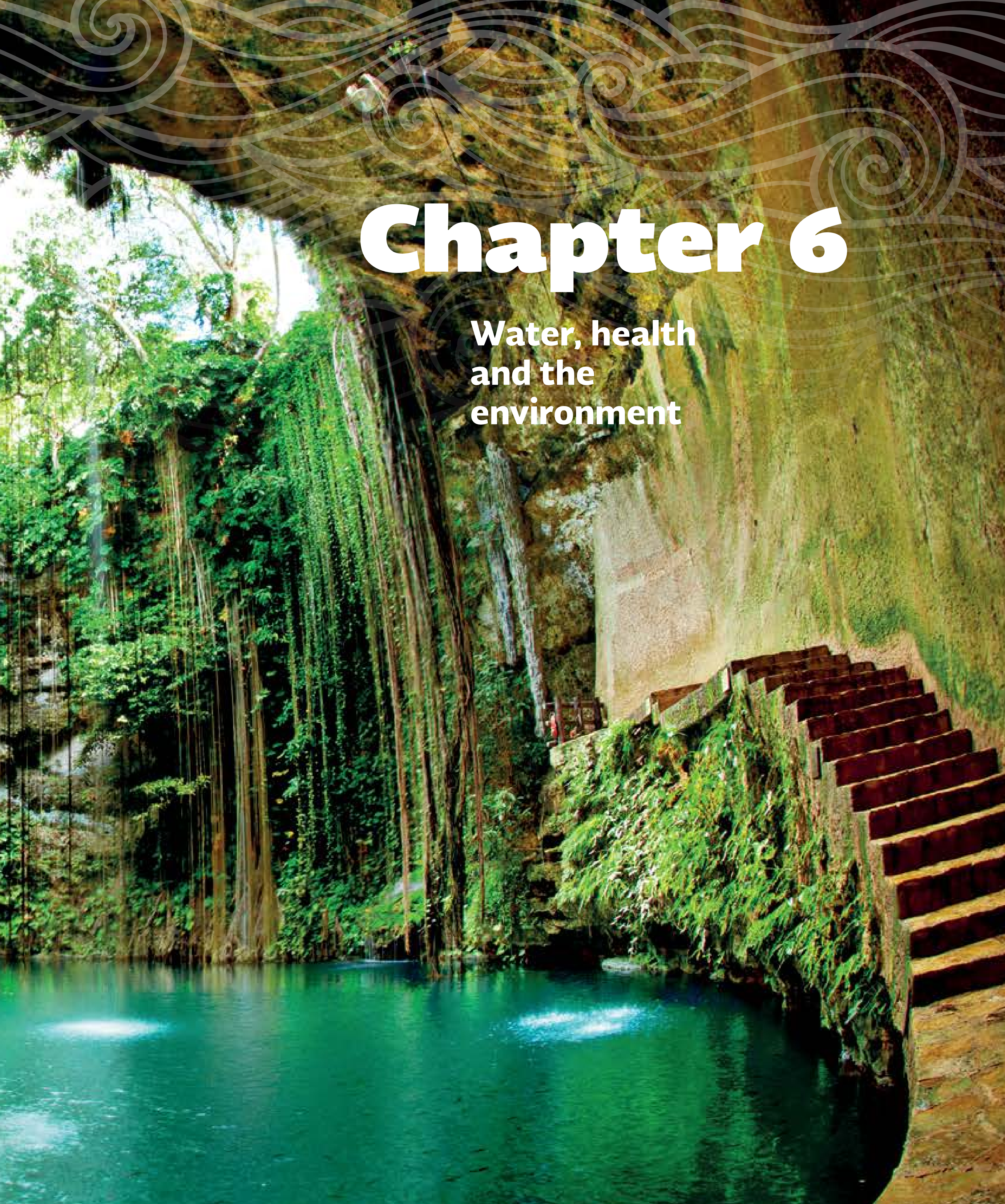
Source: Based on CONAGUA (2016n).

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

Municipal discharges		
Modified compliance dates from:	**Population range (according to the 1990 census)**	**Number of localities (according to the 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 per day (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	Less than 1.2	Less than 1.2

Source: CONAGUA (2016d).

Located three kilometers from the Chichén Itzá archeological zone, the sacred blue cenote Ik Kil is one of the most spectacular sites on Yucatán.



Chapter 6

Water, health and the environment

Water, health and the environment

Environmental protection

The National Forest Program provides support for plots in overdrafted aquifers and watersheds with low availability

Protected **natural areas**

182 under federal jurisdiction

90 839 522 hectares

Area

370 voluntarily allocated

400 000 hectares

Use of soil and **vegetation**

Vegetation cover

- Protects the soil and intercepts rainfall

Soil

- Its degradation decreases the capacity to provide goods and services
- Subject to water and wind erosion

Water and **health**

	1990		2015
Coverage of access to tap water services	78.4%	^	95.3%
Coverage of access to sewerage and basic sanitation services	61.5%	^	92.8%
Child mortality rate due to diarrheal diseases	122.7%	v	7.3%

Wetlands

Ecosystems with biological richness that render environmental services

6 331 wetlands in the national inventory, with **10 million** hectares

142 Ramsar sites, **8.6 million** hectares

6.1 Health

[Tablero: 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 the consumption of pathogenic chemical components (arsenic, nitrates or fluoride).

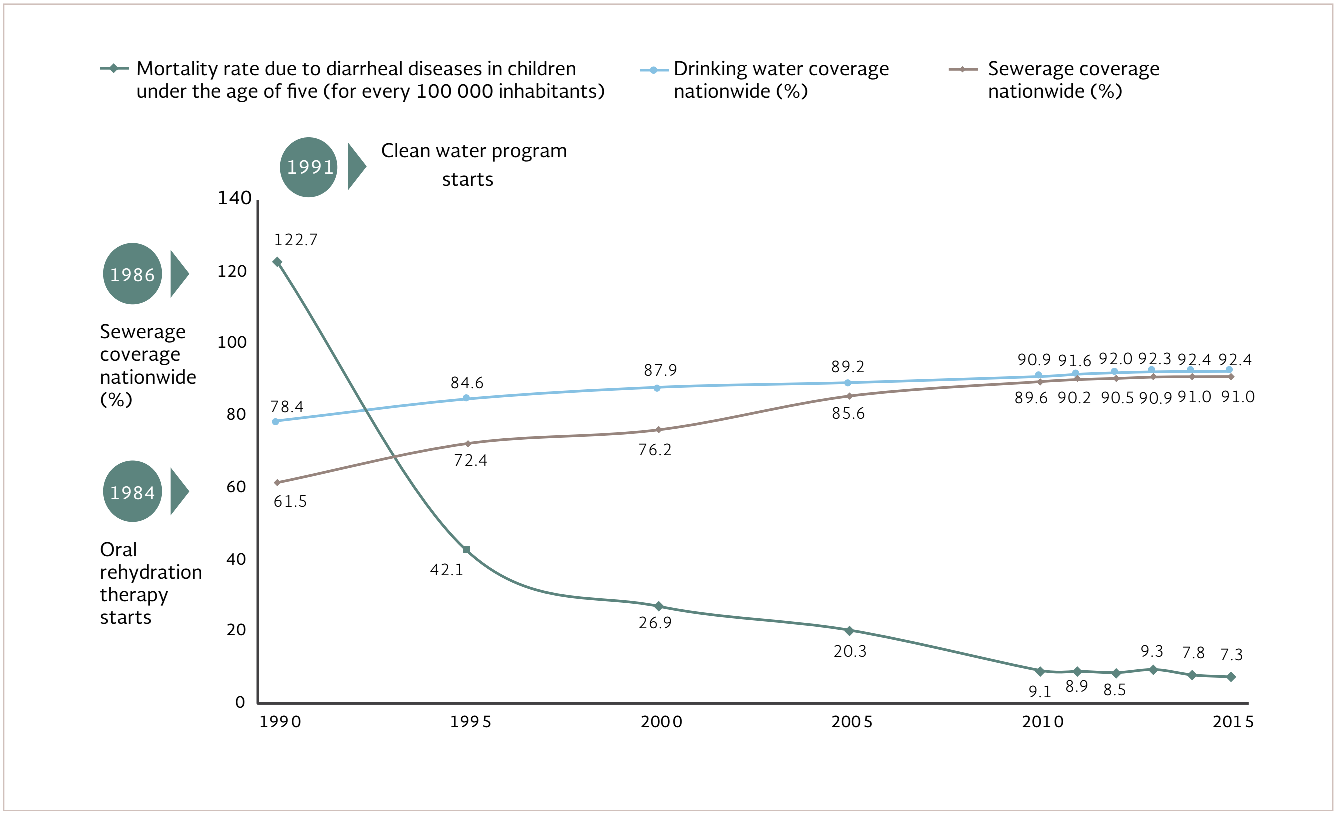
According to the World Health Organization (WHO), diarrheal diseases are the second leading cause of death in children under the age of five. Around 1 700 million cases of diarrheal diseases are produced each year worldwide. Diarrhea is one of the main causes of malnutrition. As for diarrheal diseases in Mexico, infant mortality per 1,000 live births has decreased from 28.0 in 2003 to 9.0 in 2010 and 7.3 in 2015. This achievement is due in large part to the various interventions aimed at reducing these figures. Among these is the Program for the Prevention of Infant Mortality, which includes the prevention and treatment of acute diarrheal diseases in children under one. The distribution of oral rehydration therapy since 1984, the vaccination campaigns since 1986, the Clean Water Program since 1991 and the increase of potable water, sewerage and sanitation coverage (Sepulveda *et al*., 2007) have also contributed. In addition to these factors there are aspects such as hygiene, education, access to health services and improvement in socioeconomic and environmental conditions.

1991

Start of the Clean Water Program

It is interesting to compare the increasing trend in the coverage of access to tap water services and access to sewerage and basic sanitation services against the reduction in the mortality rate caused by diarrheal diseases in children under the age of five, which can be observed in Graph 6.1. In our country, drinking water service providers, usually the municipalities, carry out disinfection of water by chlorination (necessary to destroy or inactivate pathogenic agents or microscopic parasites), in accordance with NOM-127-SSA1-1994. The water disinfection procedure is evaluated by the determination of residual free chlorine in the domiciliary intake. Figure 6.1 shows the evolution of the percentage of samples of drinking water with residual chlorine within the range required by said standard.

Graph 6.1 Drinking water and sewerage coverage and mortality rate due to diarrheal diseases in children under the age of five, 1990 to 2015



Source: Based on CONAGUA (2016a), Salud (2016).

Girl drinking water from a hose of the rainwater harvesting system known as “ecotecnias”, which has improved water supply in the rural communities of Chitejé de Garabato, Querétaro, Mexico.

Figure 6.1 Drinking water samples with residual chlorine within the parameters of the NOM-127-SSA1-1994 standard

Code	Federative entity	2002 (%)	Evolution 2002-2016	2016 (%)
01	Aguascalientes	88.9		96.4
02	Baja California	57.4		99.2
03	Baja California Sur	44.7		96.3
04	Campeche	89.4		98.7
05	Coahuila de Zaragoza	88.4		88.4
06	Colima	81.4		97.0
07	Chiapas	47.2		86.7
08	Chihuahua	77.9		96.8
09	Mexico City (formerly Federal District)	67.0		94.3
10	Durango	49.9		94.7
11	Guanajuato	62.7		98.7
12	Guerrero	60.8		79.5
13	Hidalgo	87.3		93.3
14	Jalisco	78.8		86.9
15	State of Mexico	91.3		88.1
16	Michoacán de Ocampo	67.4		83.1
17	Morelos	88.4		94.9
18	Nayarit	70.5		83.9
19	Nuevo León	83.8		97.2
20	Oaxaca	71.0		83.5
21	Puebla	93.5		96.7
22	Querétaro	69.1		99.1
23	Quintana Roo	89.1		100.0
24	San Luis Potosí	86.6		99.9
25	Sinaloa	79.3		92.4
26	Sonora	71.0		83.8
27	Tabasco	40.9		82.6
28	Tamaulipas	71.6		99.2
29	Tlaxcala	95.1		97.3
30	Veracruz de Ignacio de la Llave	69.6		94.4
31	Yucatán	64.9		87.2
32	Zacatecas	61.5		86.7
	National	**75.3**		**92.1**

Source: Based on Salud (2016), COFEPRIS

6.2 Vegetation

[Tablero: Uso de suelo y vegetación]

According to data from the “Charter of Soil and Vegetation Use” (INEGI 2013a), 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; therefore, to date, we have series I (updated in the 1980-1990 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 Land and Vegetation Use and updated based on Landsat satellite images from 2011. The series is updated every year and a new edition is issued.

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 considerably disturbed. Induced vegetation is that which develops when the original vegetation has been eliminated, or in abandoned agricultural areas.

Graph 6.2 reflects the progressive increase in induced and secondary vegetation, of agricultural areas and urban zones, linked to the corresponding decrease in primary vegetation. The years correspond to the period in which the information used in each series was captured.

Soil degradation is a degenerative process that reduces its present or future capacity to continue to provide its characteristic functions. 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, alkalization as well as eutrophication, which reduce the fertility and the content of organic matter in the soil.

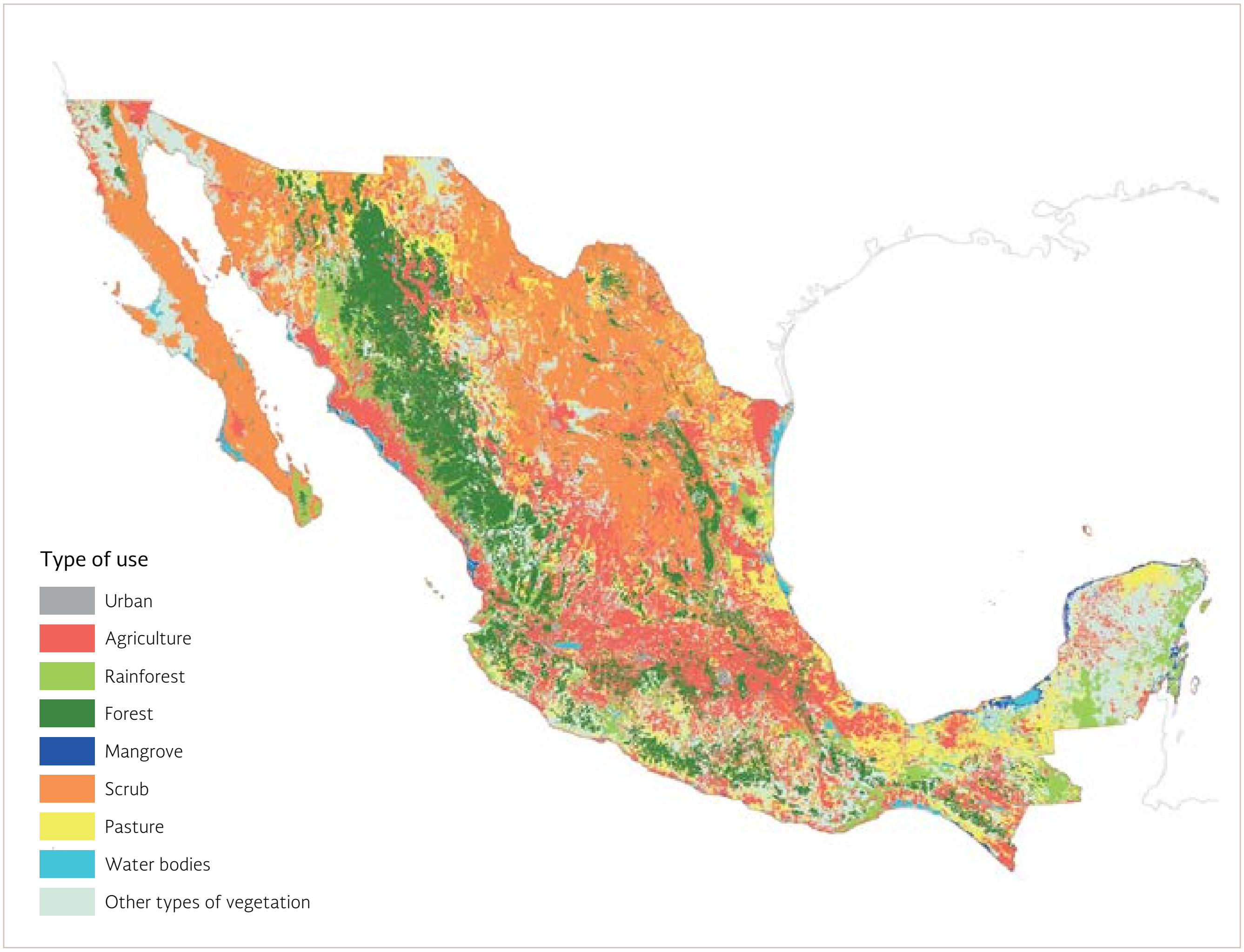
When the loss of the vegetation cover which acts as a protective layer occurs, the soil is more vulnerable to water-based and wind erosion. The effects of erosion and degradation, estimated in 2002 and updated in October 2016 (the latest year available), are shown in Table 6.1

The change in land use is evident by the increase in secondary and induced vegetation in urban and agricultural areas. The process of erosion gradually reduces the capacity of rivers and water bodies, leading to flood impacts during intense or sustained rainfall. Another vector of change in vegetation is forest fires. Graph 6.3 shows the areas that are affected every year in Mexico.

It is estimated that in the 1990-2000 period, almost 190 400 hectares of forest changed to a different land use in Mexico. For the 2000- 2010 period, the rate of change slowed down to 135 800 hectares per year, and for the latest reported period on, from 2010 to 2015, it dropped to 91 600 hectares per year (FAO 2016a).

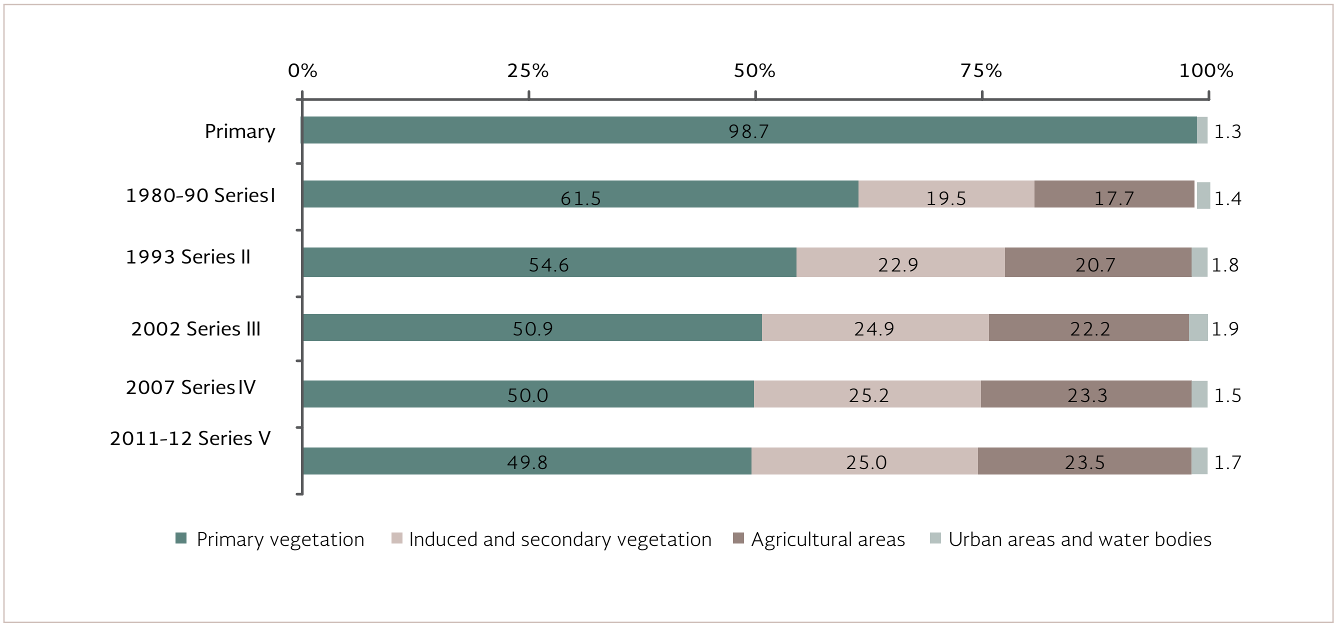
Every year
91 600
hectares of forest change to another land use

Map 6.1 Main uses of land and vegetation, INEGI series V (2011-2012)



Source: Based on INEGI (2013a).

Graph 6.2 Evolution in the use of soil and vegetation based on INEGI's charters (percentage of the national territory)



Source: Based on INEGI (2015a).

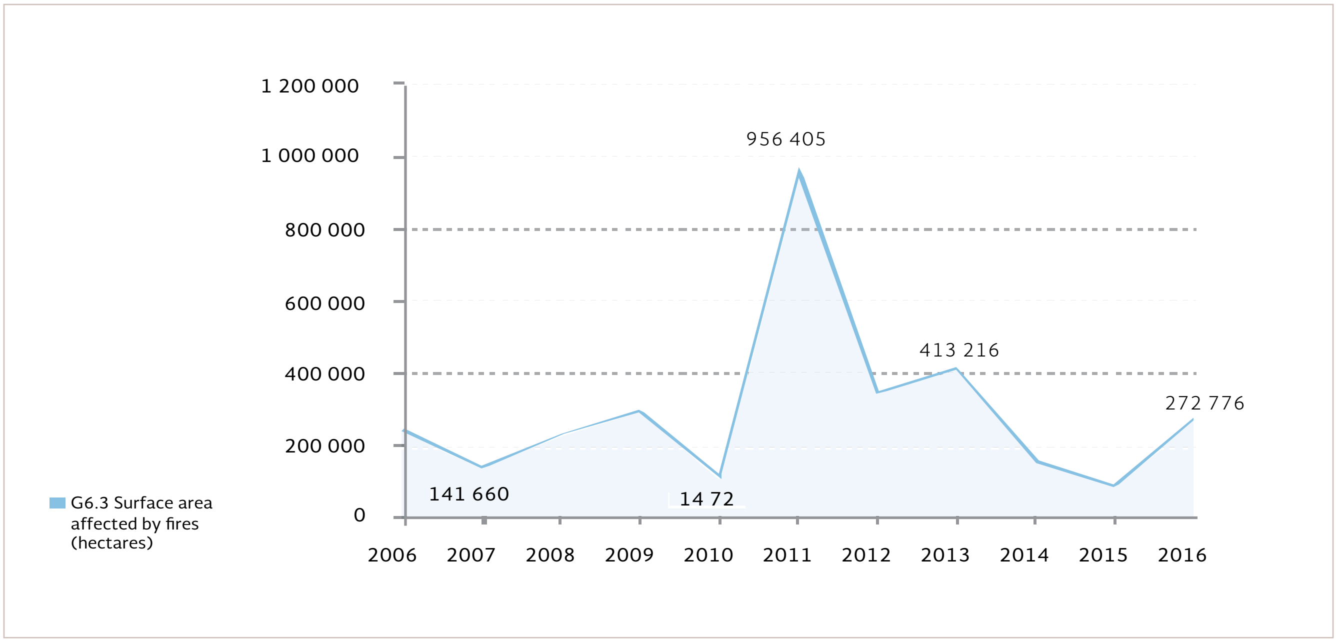
Table 6.1 Soil degradation: surface area affected by processes, types and levels of degradation (percentage of the national territory)

Degradation process	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 erosion	6.54	4.61	0.43	0.02	11.60

Source: SEMARNAT (2015).

View of the Rodrigo Gómez "La Boca" dam, which supplies the municipality of Santiago, Nuevo León, Monterrey.

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



Sourse: SEMARNAT (2016a).

The Río Lagartos Reserve, natural park in Yucatán, Mexico.

6.3 Biodiversity

[Tablero: Humedales]

Nature provides water-related environmental services, since soil and vegetation cover impacts upon 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.

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, they are subject to special regimes of protection, conservation, restoration and development (CONANP 2016c).

In core areas of PAs it is possible to limit or prohibit extractions 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 Law 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 370 areas voluntarily allocated for conservation, covering 399 643 hectares.

Hydrological environmental services are the objective of the National Forestry Program (Operating Rules of the National Forestry Program 2015). 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 a low availability of surface water.

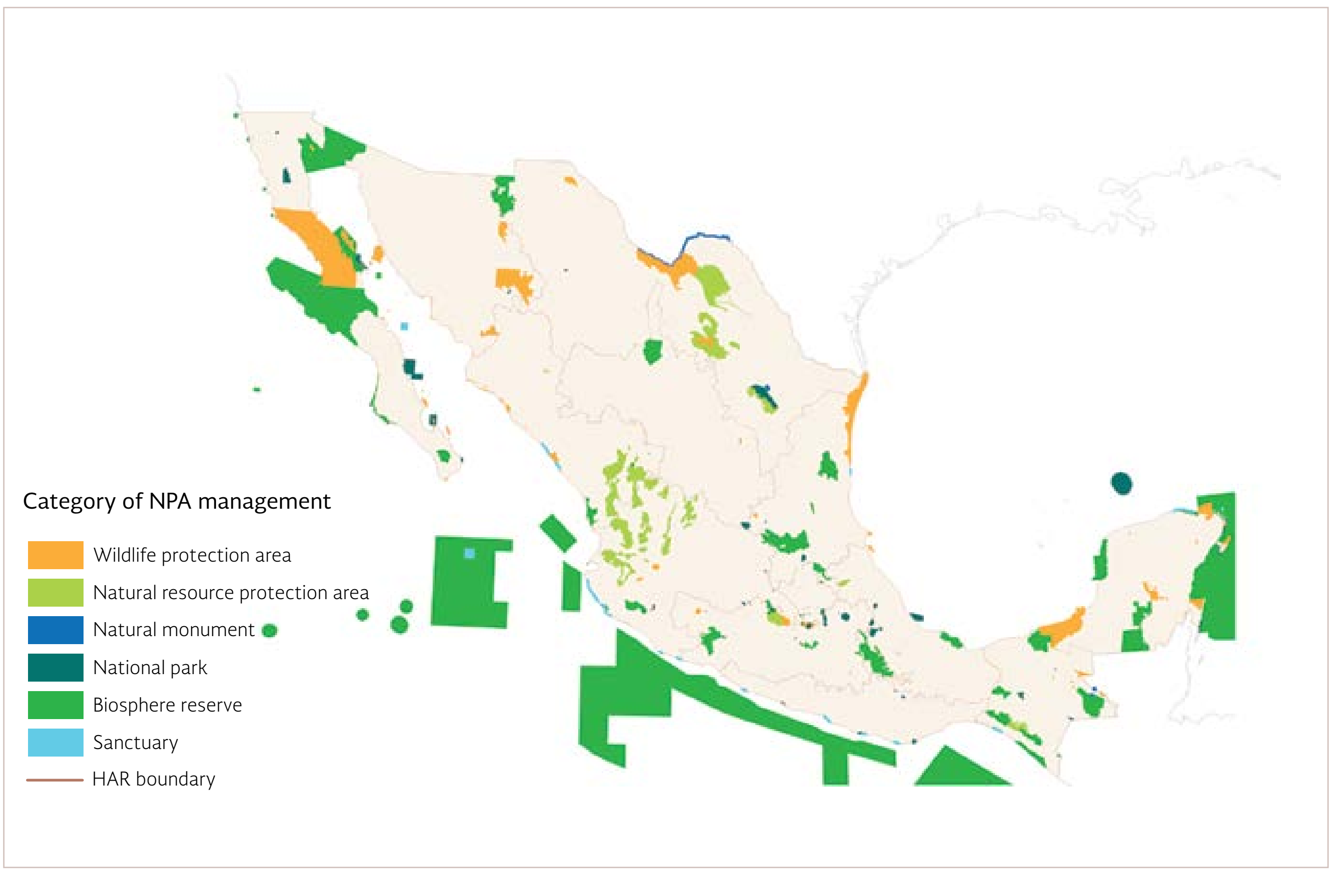
Map 6.2 shows the PAs under federal jurisdiction, as well as the eligible zones determined by the CONAFOR for 2015.

Table 6.2 Protected areas under federal jurisdiction, 2016

Category	Description	Quantity	Surface area (ha)
Biosphere reserves	Non-altered ecosystems or which need to be preserved or restored, with species that are representative of the national biodiversity.	44	62 952 751
National parks	Ecosystems with scenic beauty, scientific, educational, recreational or historic value, with the existence of wildlife or suitable for the development of tourism.	67	16 220 099
Natural monuments	Areas with unique or exceptional natural elements with esthetic, scientific or historic value. Does not require the variety of ecosystems or total area of other categories.	5	16 269
Natural resource 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
Wildlife protection areas	Places with habitat on whose balance and preservation the existence, transformation and development of forest species depends.	40	6 996 864
Sanctuaries	Areas with considerable wealth of flora and fauna or species, sub-species or habitat with restricted distribution.	18	150 193
Total		**182**	**90 839 522**

Source: Based on CONANP (2016c), General Law on Ecological Balance and Environmental Protection.

Map 6.2 Conservation of nature and its services, 2016



Source: CONANP (2016a), CONAFOR (2015).

6.4 Wetlands

[Tablero: Humedales]

Mexico has

142

wetlands on the Ramsar list

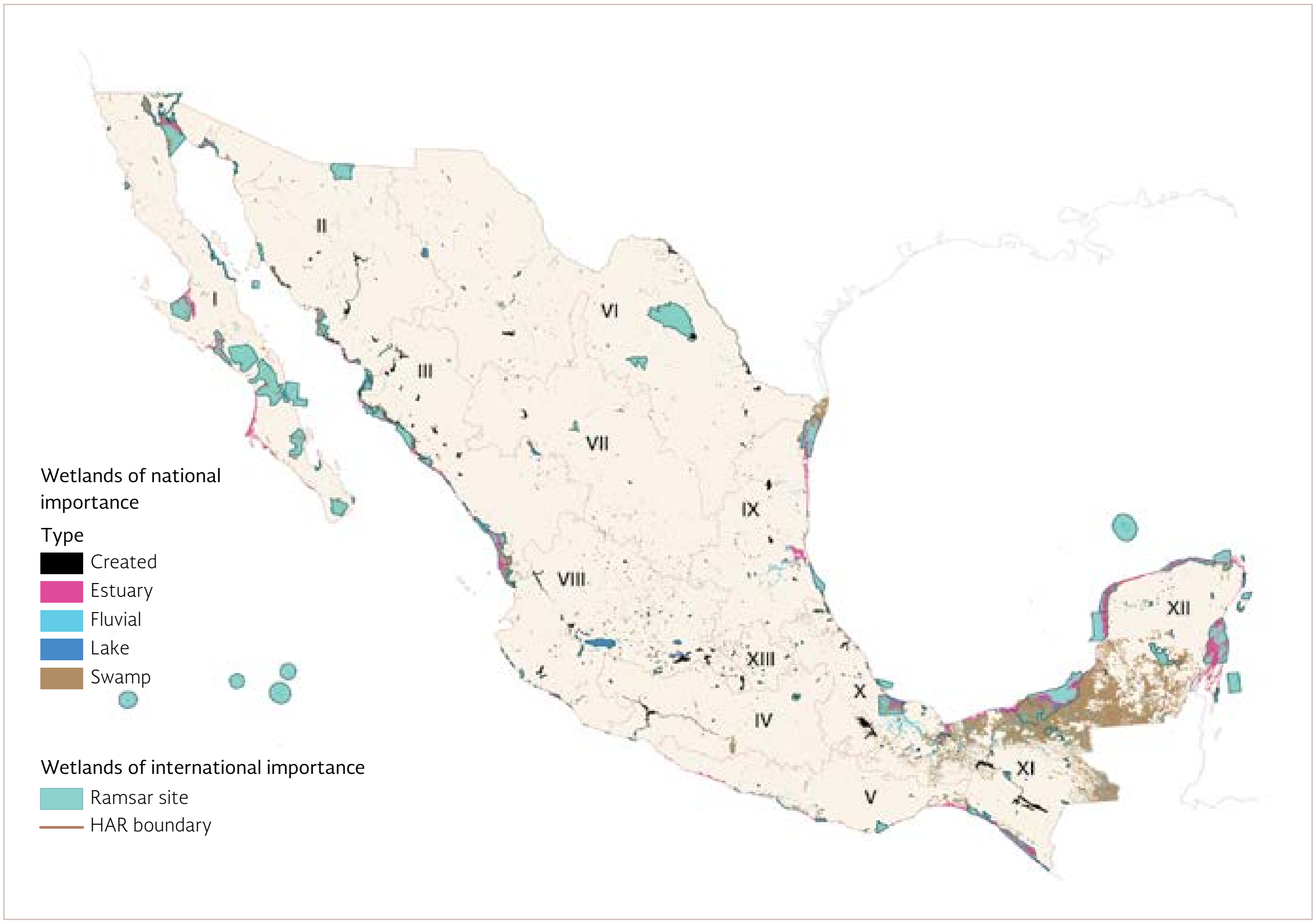
The National Water Law defines wetlands as transition areas between aquatic and terrestrial systems, constituting temporary or permanent flood zones, subject or not to the influence of tides, such as swamps and marshlands, whose limits are made of the type of permanent or seasonal hydrophilic vegetation. This includes the areas where the soil is predominantly hydric and lake areas or soils that are permanently humid due to the discharge of aquifers. 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 contaminants, 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 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, which found 6 331 wetlands with a total surface area of 10 million hectares.

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 2016). A List of Wetlands of International Importance (also called the Ramsar List) is maintained, in which wetlands of recognized value are registered, through criteria of representability and conservation of biological wealth. A wetland registered in this list is known as a Ramsar site.

To date, 142 Mexican wetlands have been registered in the Ramsar List, with a total surface area of 8.6 million hectares (CONANP 2016d). Map 6.3 shows the Ramsar sites in Mexico, as well as the wetlands in the NIW.

Map 6.3 Wetlands and Ramsar sites in Mexico



Source: Based on CONAGUA and UNAM (2012), CONANP (2016b).

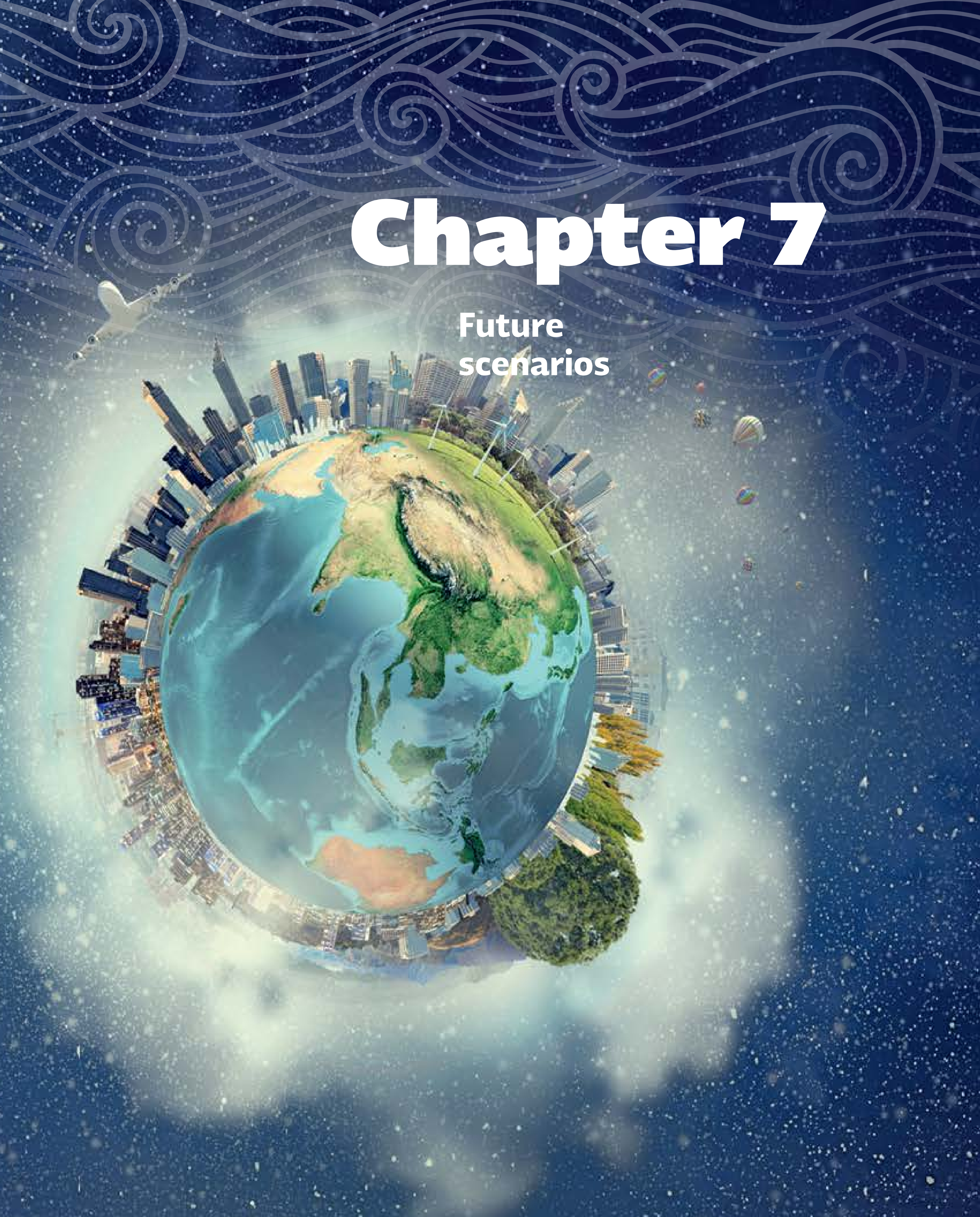
Cuatro Ciénegas, Coahuila, springs that form extensive swamps in the middle of the desert as a result of the sea that millions of years ago emerged at the same time as the Sierra Madre Oriental.

Tzentzénguaro, Michoacán.

What awaits newer generations regarding access to water?

Chapter 7

Future scenarios



Future scenarios

Trends

Concentration of urban localities

2030

73.7 million Mexicans in

38

population centers

Population growth from 2016 to 2030

Affects the per capita renewable water

2016
3 687m^3/inhab./year

2030
3 279m^3/inhab./year

15.21 million people

2.21 million
rural

13 million
urban

Sustainable water policy

20th Century
Supply-oriented

Late 20th Century
Focused on demand and decentralization

21st Century
Targeting water sustainability

National Water Plan 2014 - 2018

- Based on the **2013 - 2018 National Development Plan**
- Articulates public policy around the water sector

6 Objectives

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 of the sector.
5. Ensure the sustainability of water for agricultural irrigation, energy, industry, tourism and other economic and financial activities
6. Consolidate Mexico's participation in the international context on water issues.

7.1 Sustainable water policy

There are three phases in the history of Mexico's water policy:

First stage: At the beginning of the 20th Century, the emphasis was placed on the supply side, thus explaining 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 focused more on demand and decentralization. The responsibility for providing drinking water, sewerage and sanitation services was transferred to the municipalities, and 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 came to the fore focused on water sustainability, in which wastewater treatment is icreasing significantly, 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.

A hydraulics specialist working in the construction of Mexico City's deep drainage system, known as Tunel Emisor Oriente (TEO)

7.2 Trends

[Tablero: 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 CONAPO, between 2016 and 2030, the population of Mexico will increase by 15.2 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 rural population is considered that which lives in localities of less than 2 500 inhabitants, whereas the urban population refers to that of 2 500 inhabitants or more.

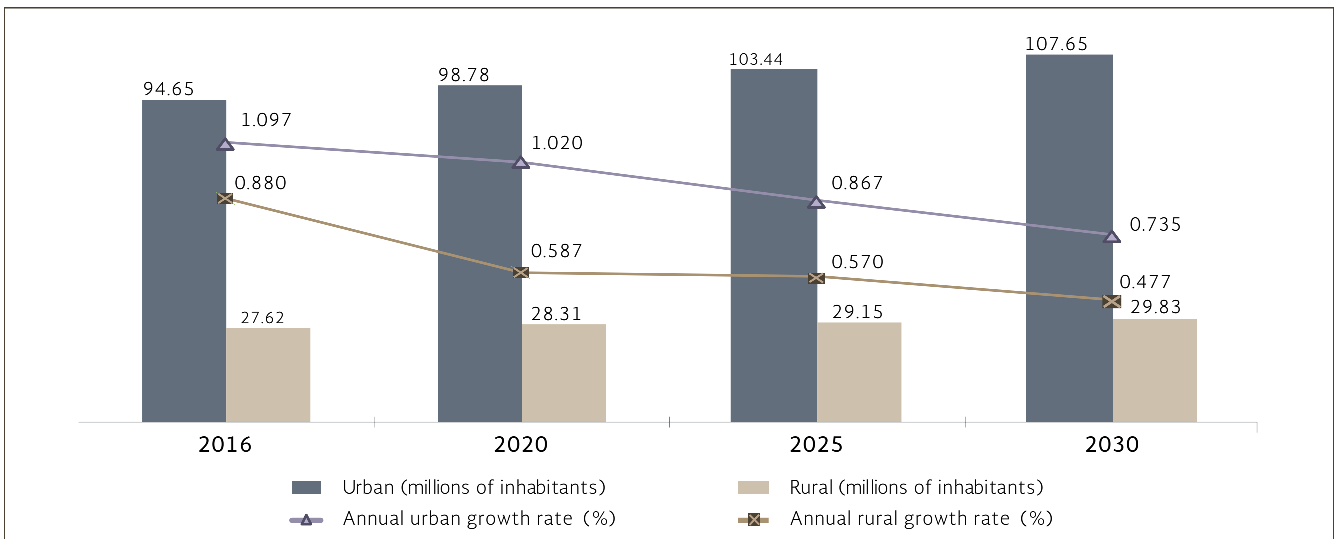
It is calculated that for the 2016-2030 period, more than half of the population growth will occur in the hydrological-administrative regions (HARs) IV Balsas, VI Río Bravo, VIII Lerma-Santiago-Pacífico and XIII Agual del Valle de Mexico. On the other hand, the four HARs with the lowest growth (II Noroeste, III Pacífico Norte, V Pacífico Sur and VII Cuencas Centrales del Norte) 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 Pacífico Sur, XI Frontera Sur, X Golfo Centro, IV Balsas, IX Golfo Norte and VIII Lerma-Santiago-Pacífico, whereas in the remaining HARs the proportion of urban growth is above the national rate.

Between 2016 and 2030 the population will increase by

15.2

million people

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



Source: Besed on CONAPO (2012).

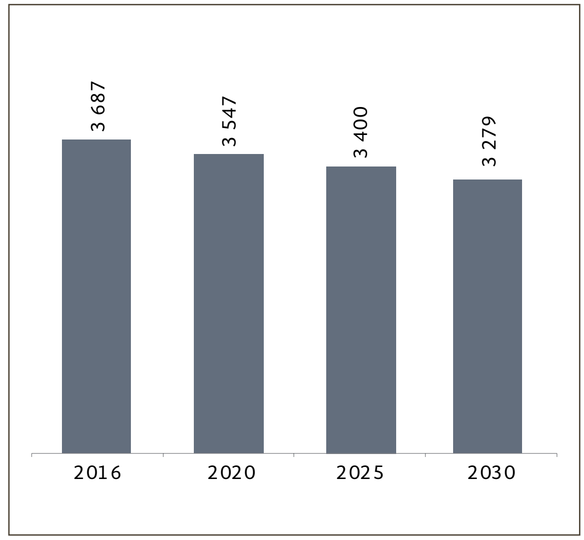
It should be noted that some of the HARs in which the highest population growth is expected are at the same time those where there is already a degree of water stress that is higher than the national average, as can be appreciated in Graph 7.2. In contrast, in some HARs with a lower degree of water stress (V Pacífico Sur and X Golfo Centro) 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-conurbation localities) 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 3 687 m³/inhabitant/year in 2016 to 3 257 in 2030. The value of renewable water resources calculated for 2016 is 450 828 hm³.

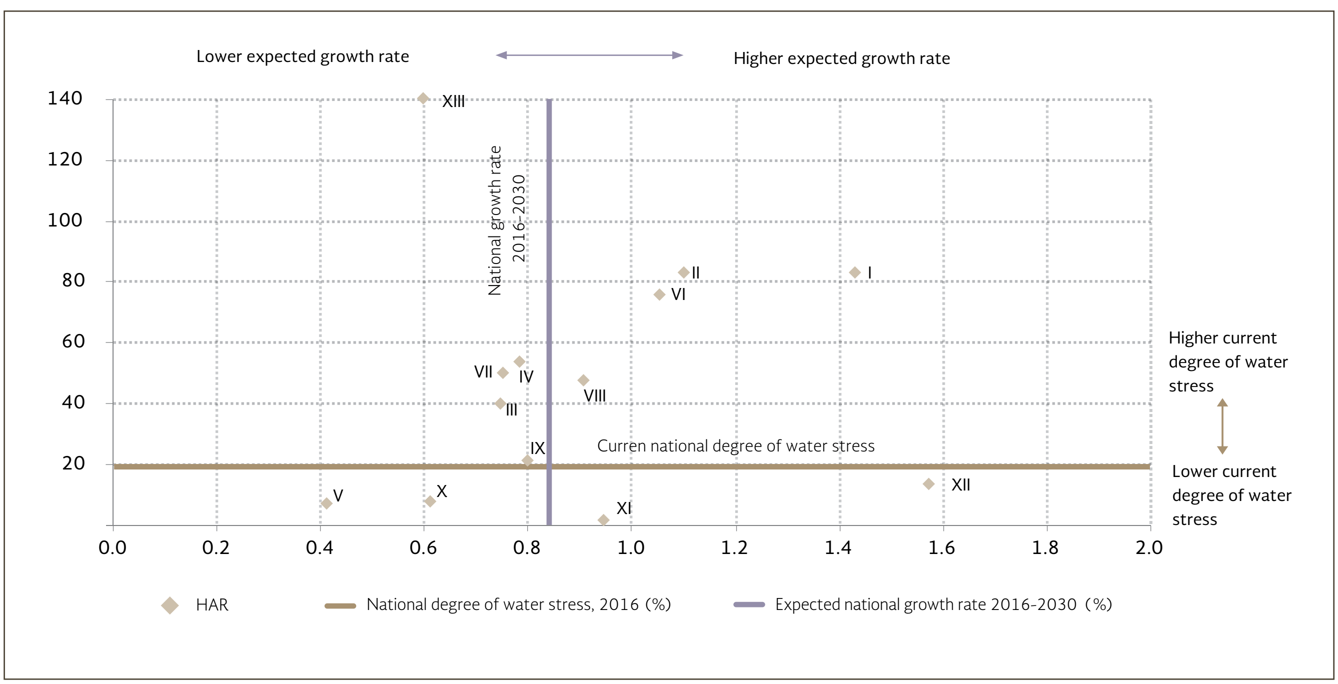
It is estimated that by 2030 in some of the country's HARs, the per capita renewable water resources will reach levels close to or even lower than 1 000 m³/inhab./year, a condition classified as scarcity.

Graph 7.3 Projections of the per capita renewable water resources in Mexico, selected years, 2016-2030 (m³ /inhab./year)



Source: Based on CONAGUA (2016b), CONAPO (2012).

Graph 7.2 Current degree of water stress and growth rate, 2016-2030



Source: Based on CONAGUA (2016b), CONAGUA (2016c), CONAPO (2012).

Map 7.1 Main population centers by 2030

Source: Based on CONAPO (2012), SEDESOL *et al.* (2012).

Table 7.1 Population in 2016 and by 2030 (thousands of inhabitants)

HAR No.	Rural population			Urban population			Total population		
	2016	2030	Increase 2016-2030	2016	2030	Incremento 2016-2030	2016	2030	Increase 2016-2030
I	402	537	135	4 120	4 975	856	4 522	5 513	991
II	466	524	58	2 413	2 833	420	2 879	3 357	478
III	1 389	1 395	6	3 163	3 662	499	4 552	5 057	505
IV	3 489	3 844	355	8 437	9 471	1 034	11 926	13 315	1 389
V	2 020	2 143	123	3 073	3 257	183	5 093	5 400	307
VI	846	925	79	11 610	13 443	1 832	12 456	14 368	1 912
VII	1 147	1 202	56	3 461	3 922	461	4 608	5 125	517
VIII	5 297	5 839	542	19 152	21 860	2 708	24 449	27 699	3 250
IX	2 420	2 488	68	2 909	3 475	566	5 329	5 963	634
X	4 486	4 727	241	6 162	6 880	718	10 648	11 607	959
XI	3 690	4 001	311	4 062	4 843	781	7 752	8 844	1 092
XII	738	830	92	3 949	5 004	1 055	4 687	5 834	1 147
XIII	1 235	1 378	143	22 137	24 023	1 886	23 372	25 401	2 029
Total	**27 625**	**29 834**	**2 209**	**94 649**	**107 647**	**12 999**	**122 273**	**137 481**	**15 208**

Source: Based on CONAPO (2012).

Table 7.2 and Figure 7.1 show the evolution in renewable water resources between 2016 and 2030. As can be observed, the HARs I Península de Baja California, VI Río Bravo and XIII Aguas del Valle de Mexico will present low levels of per capita of renewable water 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 be dug ever deeper. The majority of the rural population, especially in arid areas, depends almost exclusively on groundwater.

With the aim of addressing the decrease in the availability of water in the coming years, it will be necessary to carry out actions to reduce demand, by increasing the efficiency in the use of water in 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 allocated.

In addition, in order to continue ensuring social development, it will be necessary to significantly increase drinking water, drainage and sanitation coverage in rural settings. These trends should be contemplated while taking into account climate change, the effects of which will impact upon the global water cycle in an uneven manner, as a result of which there is expected to be greater variability in the quality and quantity of water available for society (see chapters 2 and 8).

By 2030, the per capita renewable water will be

3 279

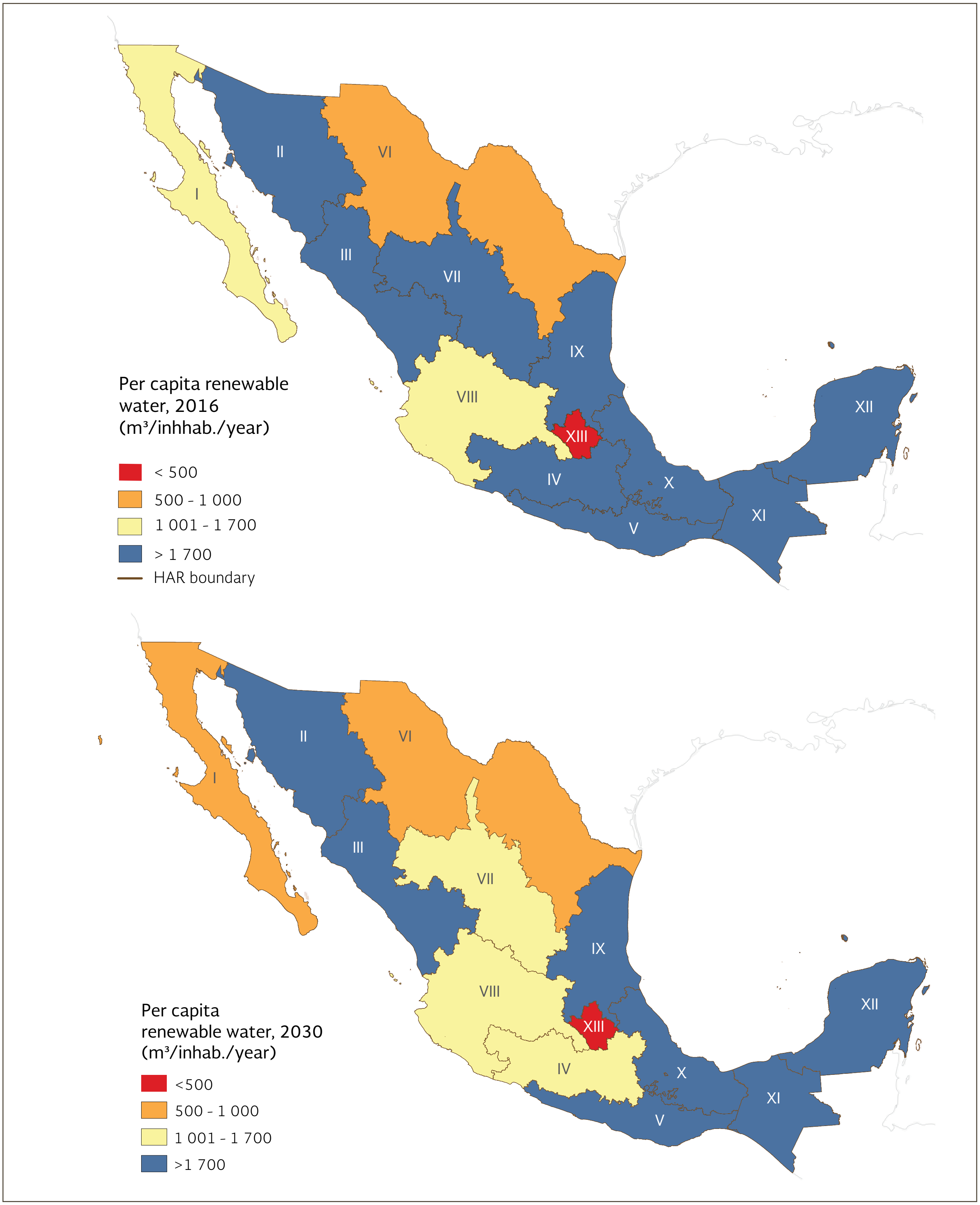
m^3/inhab./year

Table 7.2 Per capita renewable water, 2016 and 2030

	Hydrological-administrative region	Total renewable water (hm^3/year)	Per capita renewable water 2016 (m^3/inhab./year)	Per capita renewable water by 2030 (m^3/inhab./year)
I	Península de Baja California	4 876	1 078	884
II	Noroeste	8 274	2 874	2 465
III	Pacífico Norte	26 613	5 847	5 263
IV	Balsas	21 671	1 817	1 628
V	Pacífico Sur	30 836	6 055	5 711
VI	Río Bravo	12 430	998	865
VII	Cuencas Centrales del Norte	7 926	1 720	1 547
VIII	Lerma Santiago Pacífico	34 897	1 427	1 260
IX	Golfo Norte	28 663	5 379	4 807
X	Golfo Centro	65 645	6 165	5 656
XI	Frontera Sur	175 912	22 692	19 891
XII	Península de Yucatán	29 647	6 325	5 081
XIII	Aguas del Valle de México	3 437	147	135
	National total	**450 828**	**3 687**	**3 279**

Source: Based on CONAGUA (2016b), CONAPO (2012).

FIGURE 7.1 Per capita renewable water



Source: Based on CONAGUA (2016b), CONAPO (2012)..

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 framework of the National System of Democratic Planning, the 2014-2018 National Water Plan (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.

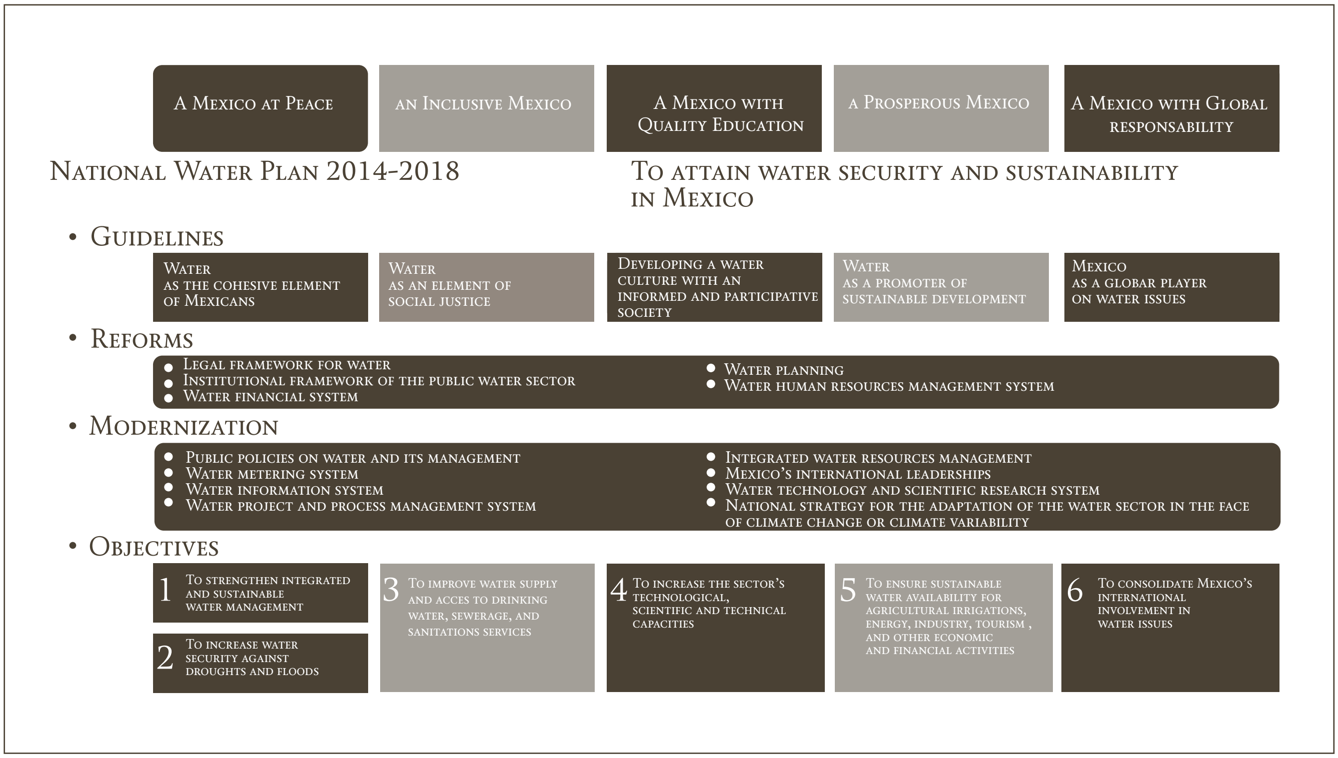
The NWP was developed with the collaboration of and contributions from institutions and agencies, experts as well as a public consultation process carried out in regional fora with the participation of water users, academicians, civil society organizations, communicators, legislators and scholars.

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.

The "Northern" wastewater treatment plant in Monterrey, Nuevo León. May, 2016.

[1] Due to its publication date, it is referred to as 2014–2018.

Figure 7.2 Alignment between the NDP and the NAW



Source: CONAGUA (2014).

Table 7.3 Indicators for the follow up and evaluation of the NWP's impacts

Objective	Indicator
1. To strengthen integrated and sustainable water management	1. Global Water Sustainability Index
2. To increase water security against 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. To improve water supply and access to drinking water, sewerage, and sanitation services	5. Global Index of Access to Basic Water Services
4. To increase the sector's technological, scientific, and technical capacities	6. Influence of the technological development of the water sector in decision making
5. To ensure sustainable water availability for agricultural irrigation, energy, industry, tourism, and other economic and financial activities	7. Productivity of water in irrigation districts (kg/m³)
6. To consolidate Mexico's international involvement in water issues	8. International cooperation projects completed

Source: CONAGUA (2014), CONAGUA (2016d).

Chapter 8

Water in the world

Water in the world

Water and health

Reduction in annual child mortality due to diarrheal diseases:

1.5 million (1990) > **600** thousand (2012)

Water cycle

Mexico

3 687 m³/inhab./year
per capita renewable water

93rd Place in the world

Water in the world

1 386 billion km³

97.5% saltwater

2.5% Freshwater

Climate change

- Intensification of the water cycle worldwide
- Non-uniform changes between countries and regions
- Collaboration is necessary to mitigate risks

Place in the World

Socioeconomic and demographic Mexico 2016:

Population	Per capita GDP	Total GDP
122.3 million inhabitants	**8 555** dollars	**1.05** trillion dollars
11th	70th	15th

Uses of water and infrastructure

	Mexico	United States
Water consumption footprint:	1 978 m³/inhab./year	2 842 m³/inhab./year

Industrial use 19%

Agricultural use 70%

Virtual water:	1 222 liters for 1 kg of corn	15 415 liters for 1 kg of beef

Millennium Development Goals (1990 - 2015)

By 2015, reduce by half the population without safe access as compared to 1990:

	Worldwide	Mexico
Drinking water:	✓	✓
Sanitation:	✗	✓

8.1 Socioeconomic and demographic aspects

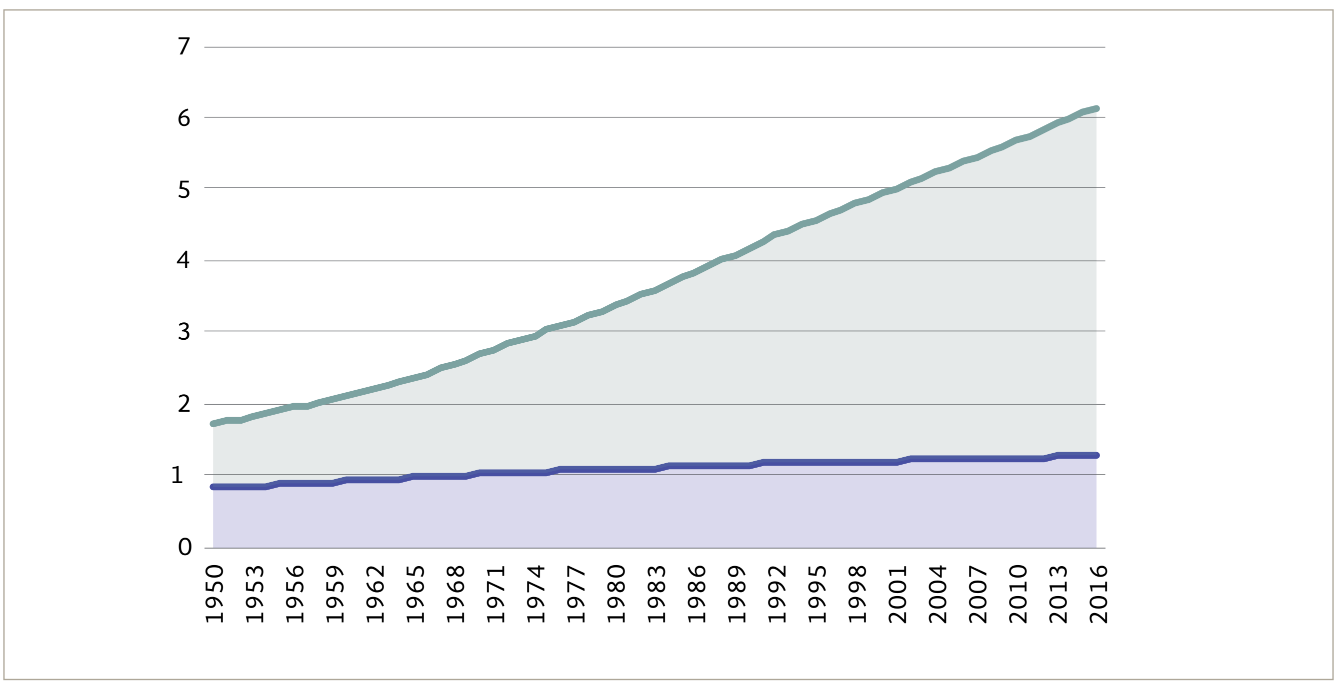
[Tablero: Indicadores económicos]

The United Nations periodically updates estimations of the world population. In the latest exercise (UN-DESA 2016), it is estimated that in 1950 the world population was 2.5 billion people, whereas for 2016, it will have increased to 7.4 billion. Over the last 66 years, this growth has been mainly concentrated in developing regions, as can be observed in Graph 8.1

By the year 2100, UN-DESA (2016) estimates that the world population will have risen to approximately 11.2 billion inhabitants, with an increasingly slower growth, as shown in Graph 8.2. Like any population projection, there is an associated range of uncertainty. With a 95% degree of certainty, the population in that year will be between 9.5 and 13.3 billion people..

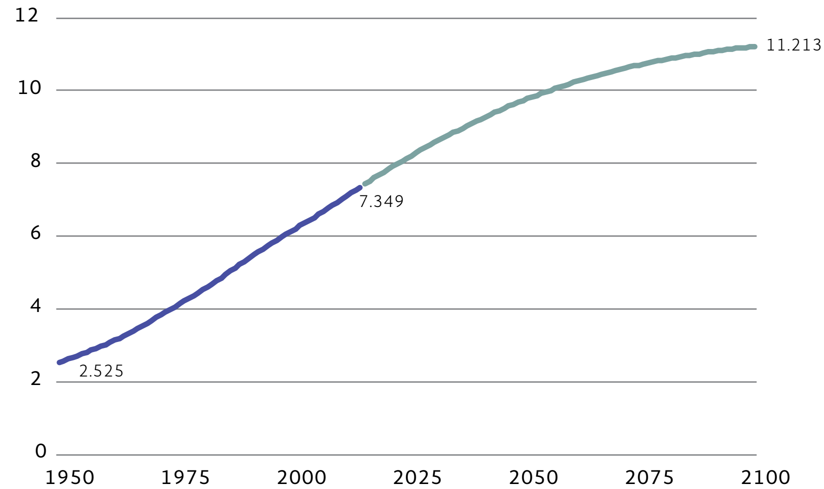
It should be noted that there is a growing concentration of the population in urban areas, reason why the rural population tends to decrease. The pressure placed on the environment by cities is significant: as readily-available water resources are exhausted, cities will have to transport water from greater distances or extract it from greater depths, or depend on advanced technologies to desalinize or reuse water (WWAP 2015).

Graph 8.1 World population, according to level of development 1950-2016 (billions of inhabitants)



Source: Based on UN-DESA (2016).

Graph 8.2 World population 1950-2100 (billions of inhabitants)



Source: Based on UN-DESA (2016).

Table 8.1 Countries with the highest population, 2016

No.	Country	Population (million inhabitants)	Population density (Inhab./km²)
1	China	1 416.66	147.59
2	India	1 252.14	380.90
3	United States of America	320.05	33.22
4	Indonesia	249.86	131.19
5	Brazil	200.36	23.53
6	Pakistan	182.14	228.79
7	Nigeria	173.61	187.94
8	Bangladesh	156.59	1 087.46
9	Russia	142.83	8.35
10	Japan	127.14	336.42
11	**Mexico**	**122.27**	**60.84**
12	Philippines	98.39	327.98
13	Ethiopia	94.10	85.21
14	Vietnam	91.68	276.80
15	Germany	82.72	231.65
16	Egypt	82.05	81.93
17	Iran	77.44	44.37
18	Turkey	74.93	95.63
19	Democratic Republic of the Congo	67.51	28.79
20	Thailand	67.01	130.59
21	France	64.29	117.06
22	United Kingdom	63.38	260.18
23	Italy	60.99	202.39
24	Myanmar	53.25	78.71
25	South Africa	52.77	43.29

Source: Based on FAO (2016b), CONAPO (2012), INEGI (2016a).

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 (2012).

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 70th worldwide in terms of its per capita GDP. In terms of the total GDP, the country is ranked fifteenth worldwide.

Mexico is the country with the

15th

Highest GDP in the world

TABLE 8.2 Countries with the highest total and per capita GDP, 2016

Total GDP			Per capita GDP		
No.	Country	GDP (billions of US dollars)	No.	Country	Per capita GDP (US dollars)
1	United States of America	18 569.10	1	Luxembourg	103 198.82
2	China	11 218.28	2	Switzerland	79 242.28
3	Japan	4 938.64	3	Norway	70 391.57
4	Germany	3 466.64	4	Ireland	62 562.27
5	United Kingdom	2 629.19	5	Qatar	60 786.72
6	France	2 463.22	6	Iceland	59 629.05
7	India	2 256.40	7	United States of America	57 436.41
8	Italy	1 850.74	8	Denmark	53 743.97
9	Brazil	1 798.62	9	Singapore	52 960.73
10	Canada	1 529.22	10	Australia	51 850.27
11	South Korea	1 411.25	11	Sweden	51 164.51
12	Russia	1 280.73	12	San Marino	46 446.62
13	Australia	1 258.98	13	Netherlands	45 282.63
14	Spain	1 232.60	14	Austria	44 498.37
15	**Mexico**	**1 046.00**	15	Finland	43 169.22
16	Indonesia	932.45	16	Canada	42 210.13
17	Turkey	857.43	17	Germany	41 902.28
18	Netherlands	771.16	18	Belgium	41 283.27
19	Switzerland	659.85	19	United Kingdom	40 095.95
20	Saudi Arabia	639.62	20	Japan	38 917.29
21	Argentina	545.12	21	New Zealand	38 345.40
22	Sweden	511.40	22	France	38 127.65
23	Poland	467.59	23	United Arab Emirates	37 677.91

Total GDP			Per capita GDP		
No.	Country	GDP (billions of US dollars)	No.	Country	Per capita GDP (US dollars)
24	Belgium	466.96	24	Israel	37 262.40
25	Thailand	406.95	61	Turkey	10 742.70
26	Nigeria	405.95	69	Brazil	8 726.90
27	Austria	386.75	**70**	**Mexico**	**8 554.62**
28	Iran	376.76	71	China	8 113.26
29	United Arab Emirates	371.35	91	South Africa	5 260.90
30	Norway	370.45	131	Nigeria	2 210.64
31	Egypt	332.35	165	Ethiopia	795.23
32	Israel	318.39	186	Malawi	294.76
37	South Africa	294.13	187	Republic of South Sudan	233.15

Source: Based on FAO (2016b), CONAPO (2012), INEGI (2016a).

Pumps and motors for pumping water supply in a water treatment plant in Bangkhen, Bangkok, Thailand.

8.2 Components of the water cycle

[Tablero: Distribución global del agua en el mundo]

The mean annual availability of water in the world is approximately 1 386 billion km^3, of which 97.5% is saltwater and only 2.5%, or 35 million km^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).

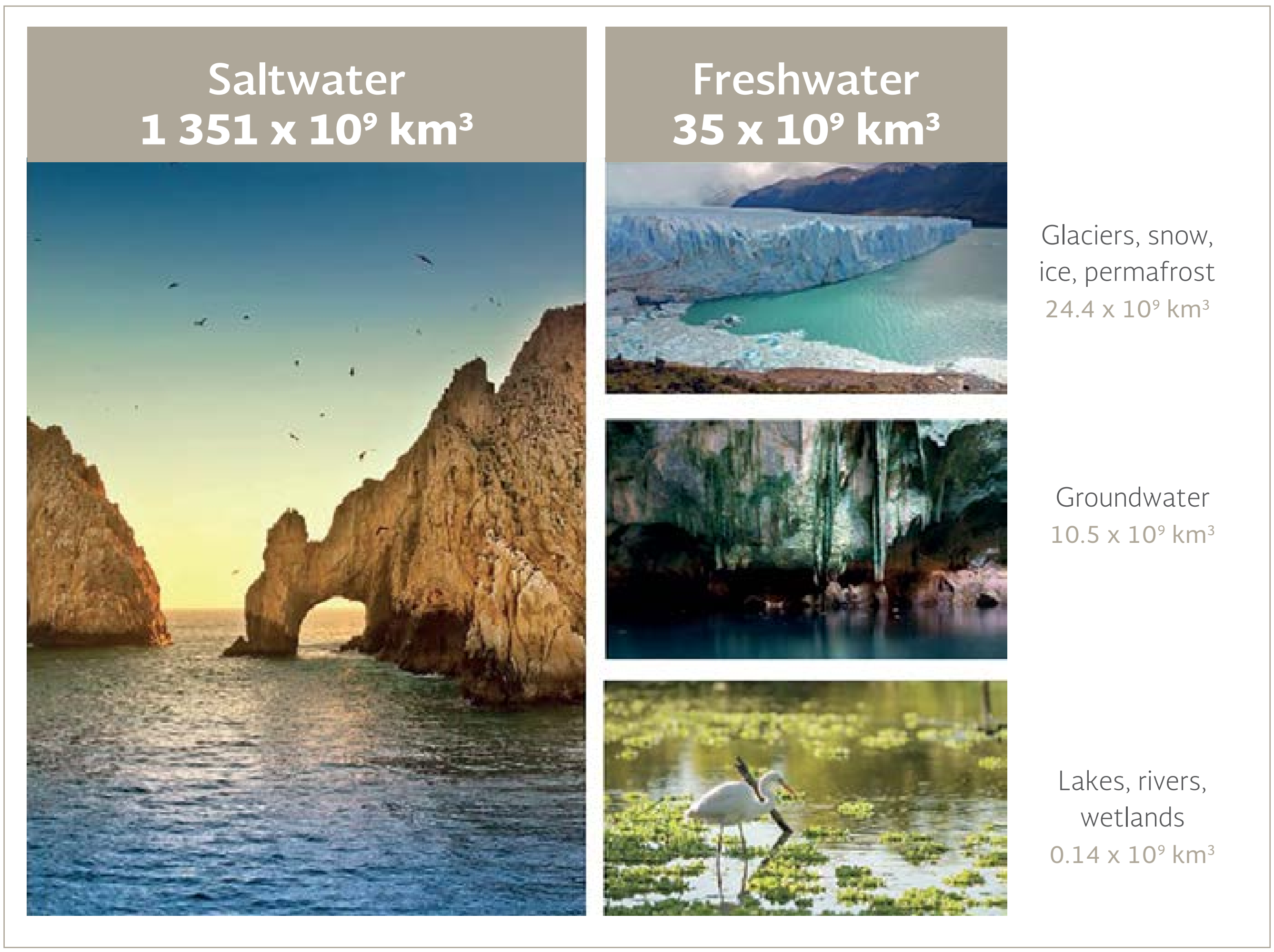
Of the water that is technically available for human consumption, only a small percentage is found in lakes, rivers, soil humidity and relatively shallow groundwater deposits, the replenishment of which is the result of infiltration. Much of this theoretically usable water is far from populated areas, making it difficult or expensive to effectively use. It is estimated that only 0.77% is freshwater accessible to humans.

Of the world's water, only

0.77%

is fresh water that is accessible to humans

FIGURE 8.1 Distribution of water in the world



Source: Based on Clarke and King (2004).

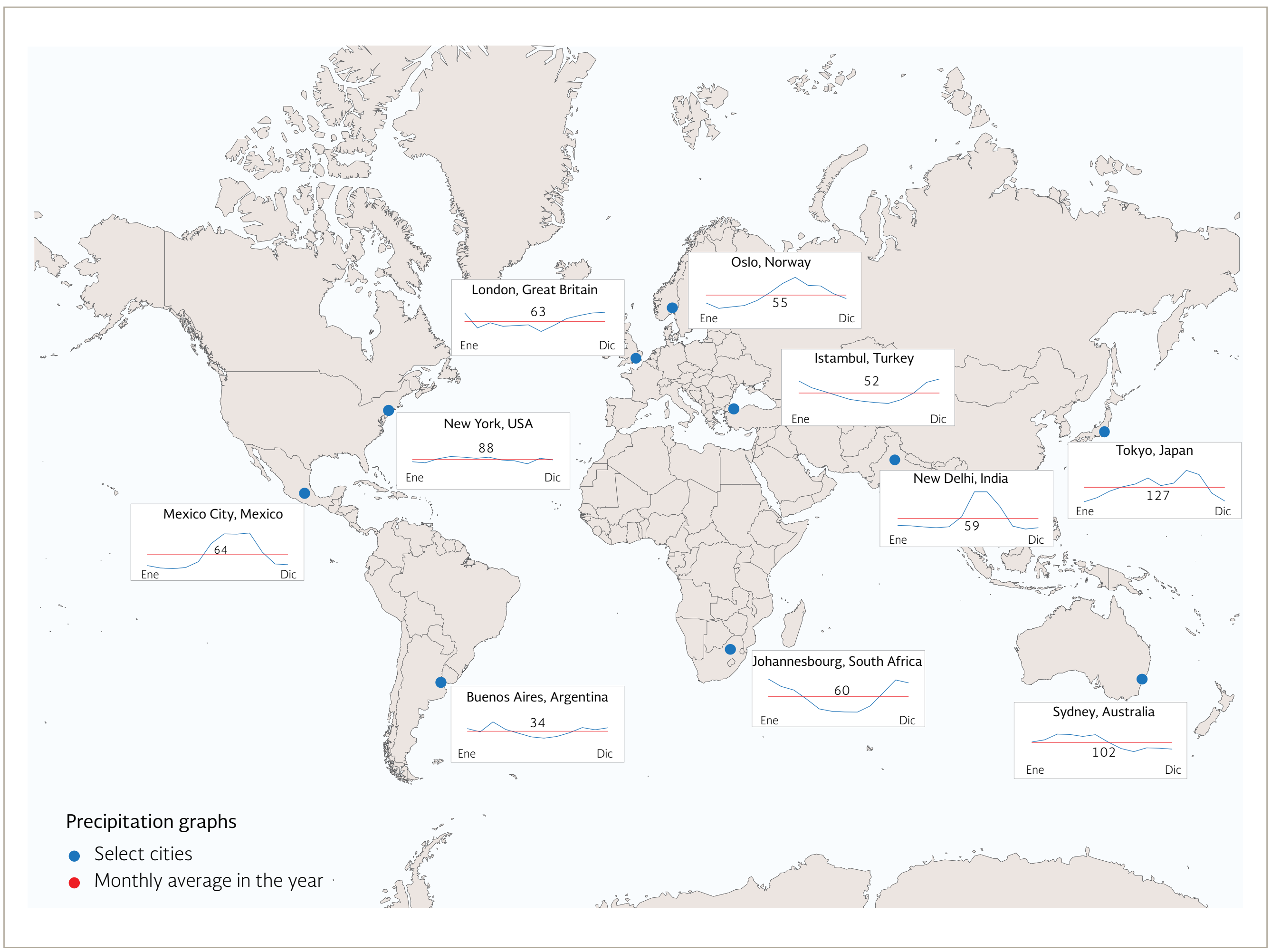
Precipitation

Pluvial precipitation constitutes an important part of the water cycle, since it produces the planet's renewable water resources. However, precipitation varies according to region and season.

In Figure 8.2 the different patterns of annual rainfall (in green) in selected cities around the world can be observed, as well as their monthly averages (in red).

In general, cities at higher latitudes are characterized by having a uniform pluvial precipitation throughout the year, whereas cities closer to the Equator have an accentuated precipitation in the summer.

FIGURE 8.2 Variability in precipitation



Source: Based on World Climate (2011).

Renewable water resources

[Tablero: 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 93rd 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 2016, and from other countries the value is the latest one available.

Of 200 countries, Mexico occupies the

93rd

place in per capita renewable water

TABLE 8.3 Countries with the most per capita renewable water

No	Country	Population (thousands of inhabitants)	Renewable water (thousands of hm³)	Per capita renewable water (m³/inhab./year)
1	Iceland	329	170	516 090
2	Guyana	767	271	353 279
3	Surinam	543	99	182 320
4	Congo	4 620	832	180 087
5	Papua New Guinea	7 619	801	105 132
6	Bhutan	775	78	100 671
7	Gabon	1 725	166	96 232
8	Canada	35 940	2 902	80 746
9	Solomon Islands	584	45	76 594
10	Norway	5 211	393	75 417
11	New Zealand	4 529	327	72 201
12	Belize	359	22	60 479
13	Peru	31 377	1 880	59 916
14	Paraguay	6 639	388	58 412
15	Bolivia	10 725	574	53 520
16	Liberia	4 503	232	51 521
17	Chile	17 948	923	51 432
18	Uruguay	3 432	172	50 175
19	Lao People's Democratic Republic	6 802	334	49 030
20	Colombia	48 229	2 360	48 933
22	Brazil	207 848	8 647	41 603
61	United States of America	321 774	3 069	9 538
93	**Mexico**	**122 273**	**451**	**3 687**
98	France	64 395	211	3 277
108	Turkey	78 666	212	2 690
151	South Africa	54 490	51	942

Source: Based on FAO (2016b), CONAPO (2012), CONAGUA (2016b).

Climate change

According to the 2014 Climate Change Synthesis Report (IPCC 2014), corresponding to the fifth cycle of climate change reporting, the warming of the climate system is considered unequivocal, with changes without any historical precedent. The atmosphere and oceans have warmed,[1] snow and ice cover have diminished, and the sea level has risen. The emission of man-made greenhouse gases has increased since the pre-industrial era, driven by economic and demographic growth. The concentration in the atmosphere of carbon dioxide, methane and nitrous oxide has no comparison in the last 800 000 years. It is considered as highly likely that these emissions, in conjunction with other anthropogenic factors, is the predominant cause of the warming observed in the second half of the 20th century.

The report considers 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 hydrometeorological 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. 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.

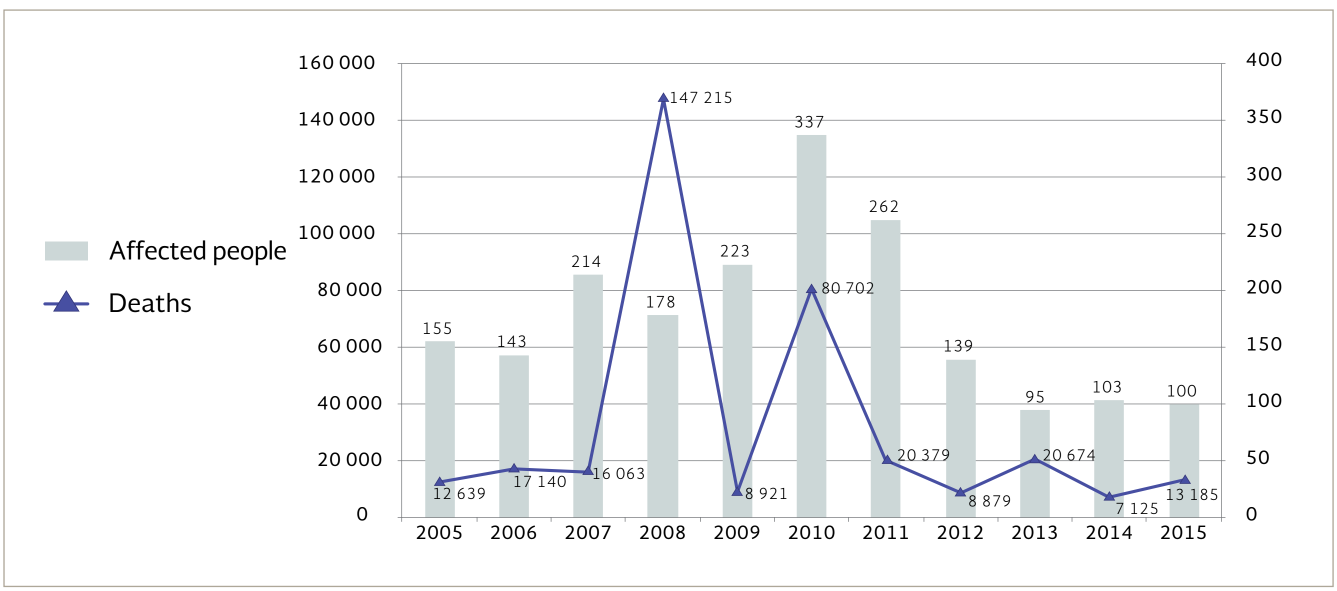
1 The report *State of the Climate* (NOAA 2016) establishes that 2015 surpassed 2014 as the warmest year since the mid-19th century

Extreme hydrometeorological events

Extreme hydrometeorological events, 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 underdeveloped 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 2015). This type of events represents a significant proportion of the estimated damage caused by disasters, which in 2015 (the latest year available of the source) represented 63.642 billion dollars, or 93% of the total damage related to some type of natural phenomenon.

The number of people affected by climate and hydro-meteorological disasters in the period between 2005 and 2015 is shown in Graph 8.3, which reveals the annual variability in the occurrence of major disasters due to hydrometeorological 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 8.3 People affected by climate-related and hydrometeorological disasters



Source: Based on IFRC (2015).

8.3 Uses of water and infrastructure

[Tablero: Volúmenes Inscritos Repda]

With population growth in the 20th century, water extractions increased exponentially, 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 2016. The main use of water resources worldwide, according to estimations from FAO (2011), is agriculture, with 70% of the total extraction.

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 (thousands of hm^3/year)	% use for agriculture	% use for the industry	% use for public supply
1	India	761.00	90.41	2.23	7.36
2	China	607.80	64.53	23.13	12.34
3	United States of America	485.60	36.06	51.15	12.79
4	Pakistan	183.50	93.95	0.76	5.26
5	Indonesia	113.30	81.87	6.53	11.59
6	Iran (Islamic Republic of)	93.30	92.18	1.18	6.65
7	**Mexico**	**86.58**	**76.30**	**9.12***	**14.50**
8	Vietnam	82.03	94.78	3.75	1.47
9	Philippines	81.56	82.23	10.12	7.65
10	Japan	81.45	66.83	14.25	18.92
11	Egypt	78.00	85.90	2.56	11.54
12	Brazil	74.83	60.00	17.00	23.00
13	Iraq	66.00	78.79	14.70	6.52
14	Russian Federation	61.00	19.94	59.82	20.24
15	Thailand	57.31	90.37	4.85	4.78
16	Uzbekistan	56.00	90.00	2.68	7.32
17	Italy	53.75	44.07	35.87	17.58
18	Turkey	42.01	80.93	10.72	15.46
19	Canada	38.80	12.24	80.15	14.23
20	Argentina	37.78	73.93	10.59	15.48
21	Spain	37.35	68.19	17.60	14.21
22	Bangladesh	35.87	87.82	2.15	10.04
26	France	30.23	10.40	71.49	18.13
37	South Africa	15.50	62.52	10.48	27.00

* Includes the use of water know as: lectric energy, except hydropower.
Source: Based on FAO (2016b), CONAGUA (2016c).

Industrial use

[Tablero: 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).

Worldwide,

40%

of crops are produced by irrigated agriculture

Agricultural use

[Tablero: 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 the contamination of soil and aquifers.

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.

Table 8.5 Countries with the largest irrigation infrastructure

No.	Country	Area with full control irrigation infrastructure (thousands of ha)	Farmed area (thousands of ha)	Irrigation infrastructure compared to the farmed area
1	India	66 103	169 360	39.0
2	China	58 449	122 524	47.7
3	United States of America	22 590	157 205	14.4
4	Pakistan	19 270	31 252	61.7
5	Indonesia	6 722	46 000	14.6
6	Iran	6 423	16 476	39.0
7	**Mexico**	**6 485**	**25 670**	**25.3**
8	Thailand	5 060	21 310	23.7
9	Vietnam	4 585	10 232	44.8
10	Brazil	4 454	86 589	5.1
11	Turkey	4 206	23 944	17.6
12	Russia	4 095	124 722	3.3
13	Uzbekistan	3 700	4 770	77.6
14	Spain	3 504	17 188	20.4
15	Egypt	3 422	3 745	91.4
16	Italy	2 866	9 121	31.4
17	Bangladesh	2 738	8 499	32.2
18	Japan	2 600	4 519	57.5
19	Australia	2 378	47 307	5.0
20	Argentina	2 162	40 200	5.4
21	Myanmar	2 083	12 339	16.9
22	Turkmenistan	1 991	2 000	99.6
27	France	1 424	19 328	7.4
28	South Africa	1 399	12 913	10.8

Source: Based on FAO (2016b).

The Hoover dam, located in the course of the Colorado River, in the border of the states of Arizona and Nevada, USA.

Power generation

[Tablero: Generación de energía]

The Paris Agreement on climate change, which came into force in November 2016, is basically an energy agreement. In order to achieve the objectives of this agreement, a transformational change in the energy sector is necessary, a source of at least two thirds of greenhouse gas emissions. The changes already underway in the energy sector demonstrate the promise and potential of low-CO_2 energy and confer credibility on meaningful action on climate change. The increase of CO_2 emissions related to energy came to a complete standstill in 2015. This was mainly due to a 1.8% improvement in the energy intensity of the world economy, a trend reinforced by the benefits derived from the energy efficiency, as well as the widespread use of cleaner energy sources, essentially renewable, throughout the world. At a time when investment in exploration and production of oil and gas has fallen sharply, clean energy has attracted a growing share of the approximately 1.8 trillion dollars that are invested each year in the energy sector. The value of fossil fuel subsidies was reduced in 2015 to US 325 billion dollars from the nearly 500 billion USD of the previous year, which reflects the decline in fossil fuel prices, but also a process of reform of subsidies that has gained momentum in several countries.

The transformation of the electricity sector led by renewable energy has focused attention on a new debate on the design of the electricity market and electrical safety, although traditional concerns about energy security have not disappeared. If we add the issues of access to energy and its affordability, climate change and environmental contamination, in addition to the problems of public acceptance of the different types of energy projects, there are many commitments, additional benefits and conflicting priorities in the energy sector that should be unraveled.

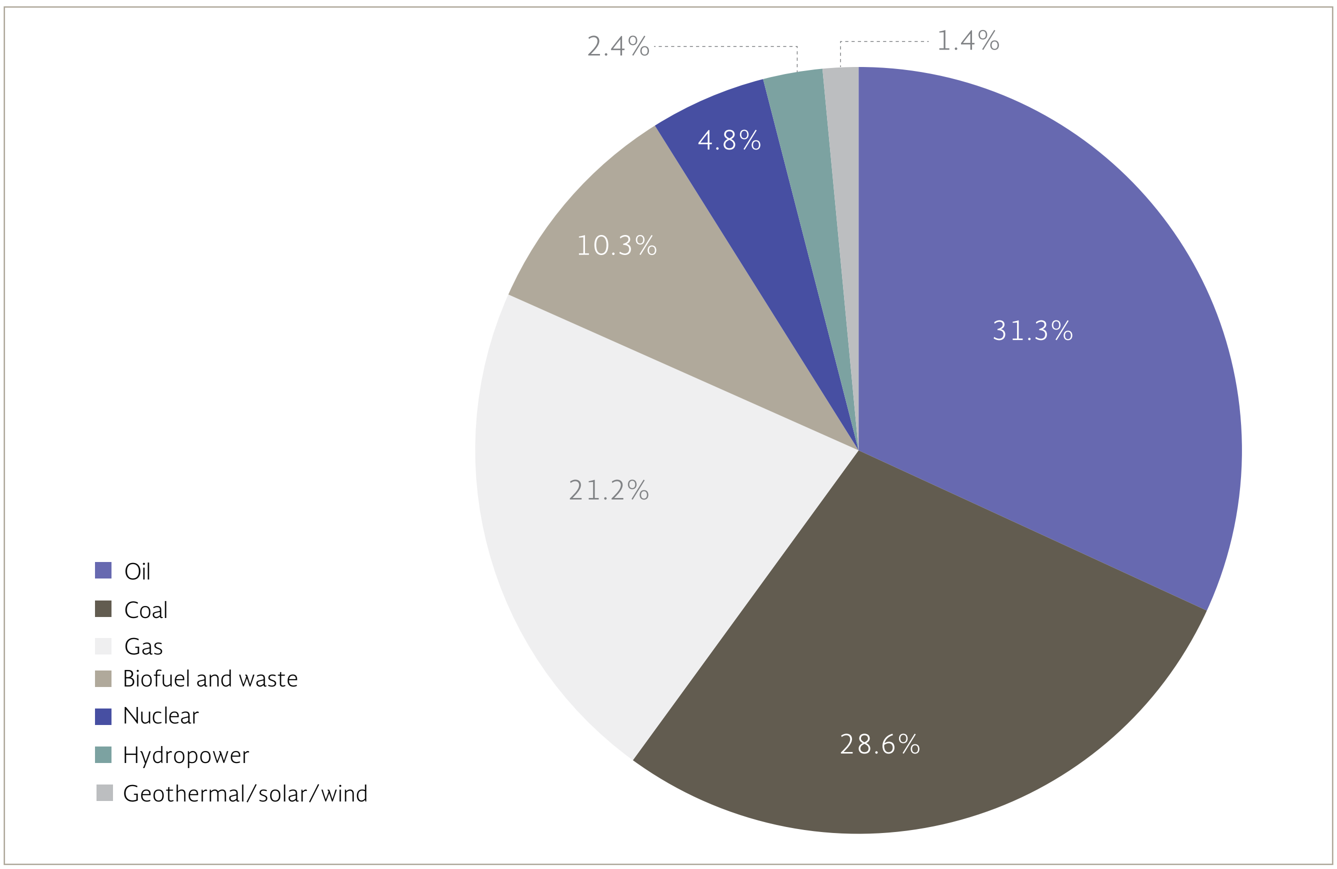
It is estimated that electricity represents between 5 and 30% of the total cost of operation of water and sanitation services, and in some countries like in India and Bangladesh, that figure may even reach 40% (WWAP 2015).

In fuel production, water 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 of which 2.4% 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).

The composition of the total energy supply in 2015 can be observed in Graph 8.4.

Energy generation should be considered from the perspective of greenhouse gas emissions, which cause climate change. Hydropower is considered a source of renewable energy, together with geothermal, solar and wind energy.

Graph 8.4 Sources of energy supply, 2015



Source: IEA (2016).

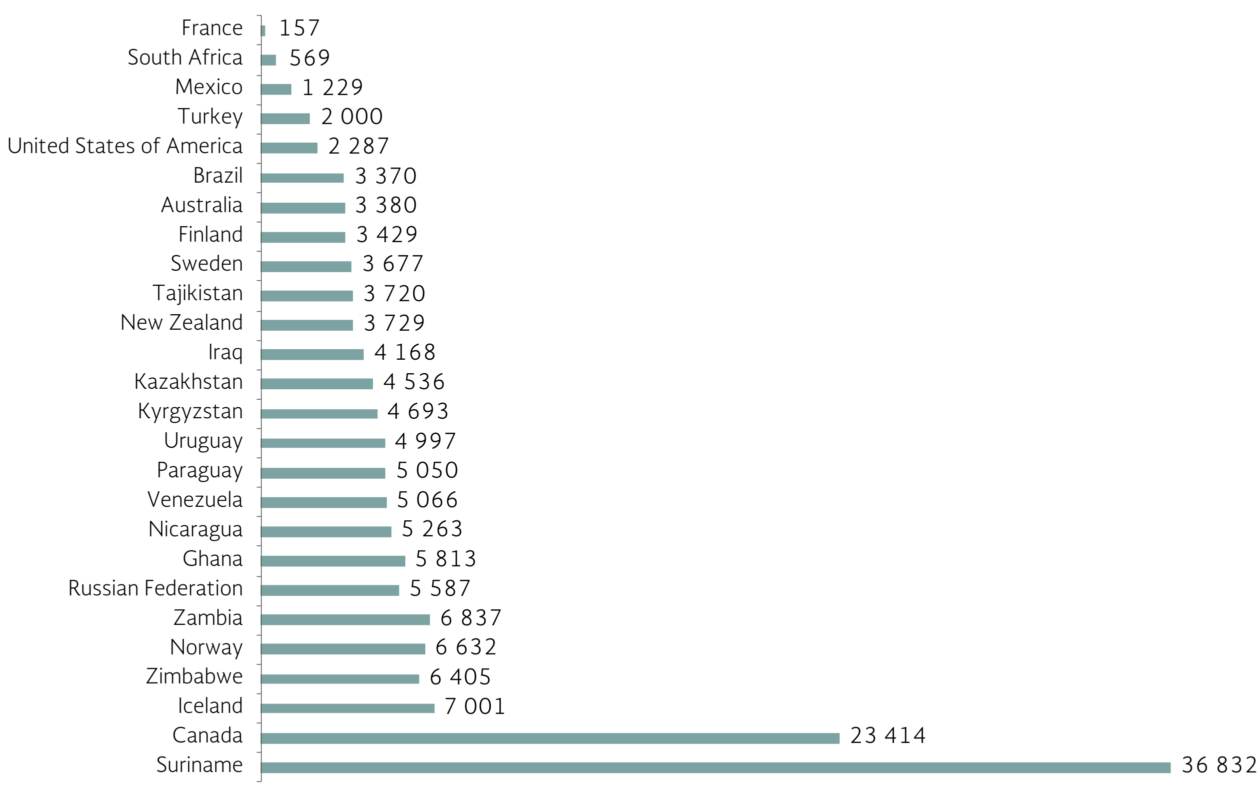
Storage reservoirs in the world

[Tablero: Presas principales]

The main objective of a dam is to regulate the flow of water in rivers. Stored water can have one or several uses at a time, such as generating electricity, providing volumes of water for irrigation and public supply. The storage capacity of the dams in the country is approximately 150 billion cubic meters. There are 180 major dams, which represent 80% of the national storage capacity.

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 per capita storage capacity, as shown in Graph 8.5. This graph shows the latest data available for each country

GRAPH 8.5 Per capita storage capacity (m³/inhabitant)



Source: FAO (2016b).

Water footprint

[Tablero: Agua virtual / Huella hídrica]

One way of measuring the impact of human activities on water resources is the so-called water footprint. This concept, created in 2002 by Hoekstra (WFN 2016a), 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 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.

Mexico's water footprint is

1 978

m^3/inhab./year

The average worldwide water footprint, associated to consumption and estimated for the 1996-2005 period, is 1 385 m^3 per person per year. The annual value for the United States is 2 842 m^3, for China it is 1 071 m^3 and for Mexico it is 1 978 m^3 (Mekonnen and Hoekstra, 2011).

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.

View of rice terraces throughout the hills of So'n La (North Vietnam) at an altitude of 2000 meters above sea level.

Virtual water

[Tablero: Agua virtual / Huella hídrica]

A concept that is closely related to the water footprint is that of virtual water. 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 million hm^3 per year, of which approximately 76% corresponds to agricultural products, and the remainder to industrial and livestock products (Mekonnen and Hoekstra 2011).

Growing one kilogram of corn requires on average 1 222 liters of water in all the world. In Mexico the amount of water to produce one kilogram of corn is 1 860 liters, whereas one kilogram of white rice uses 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 from country to country, depending on the climate conditions and the efficiency in the use of water.

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

[Tablero: 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 countries of the Middle East suffer a higher stress, unlike Mexico, which presents a lower degree of stress; this is due to the fact that the amount of renewable water that it has (450 000 hm^3) is greater than the total extraction (86 000 hm^3), so the degree of pressure is 19.2%.

Drinking water, sewerage and wastewater treatment

[Tablero: Cobertura universal]

The Millennium Development Goals (MDGs) were established in 2000, with the aim of reducing extreme poverty by 2015. Goal number 7, "Ensuring environmental sustainability", includes target 7.C, which establishes the aim of reducing by half the proportion of people without sustainable access to safe drinking water[2] and improved sanitation services,[3] between 1990, the reference year, and 2015.

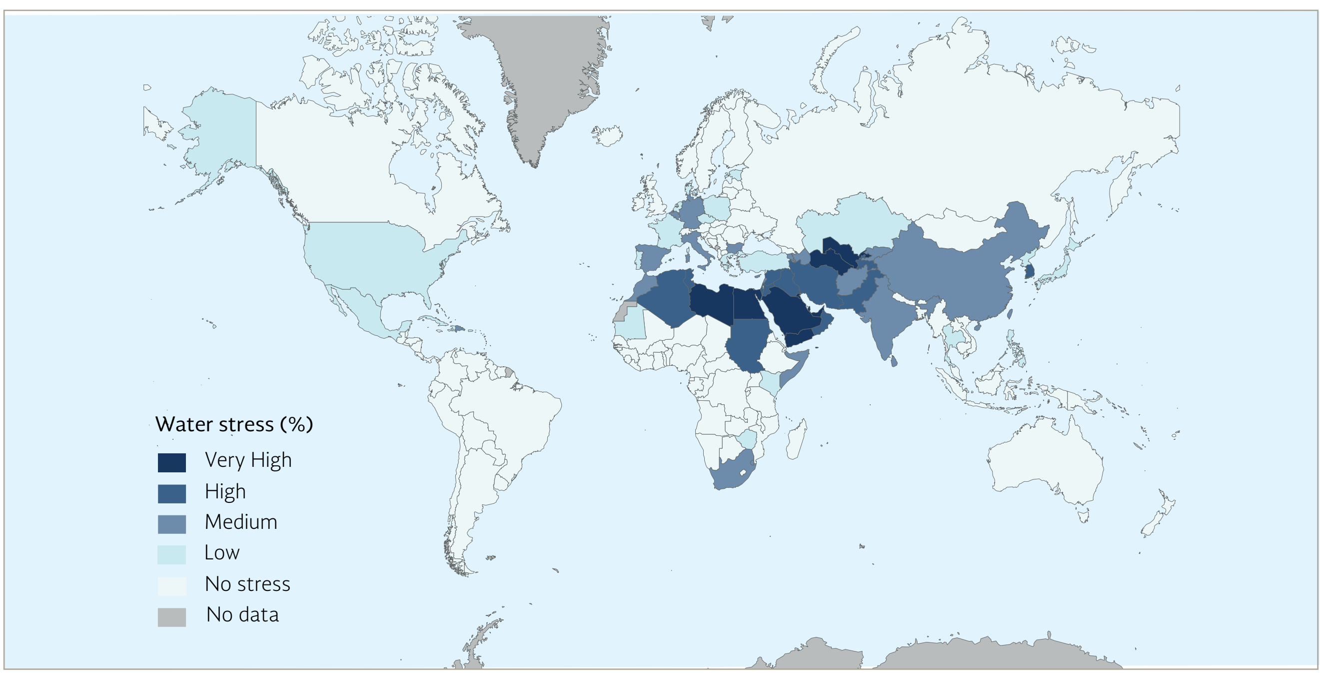
In 2015 the period of the MDGs concluded. For drinking water, the global target was met in 2010. It is estimated that in 2015, 91% of the world population employed an improved drinking water source, which can be broken down into 96% of the urban population and 84% of the rural population. In the 1990-2015 period, 2.6 billion people obtained access to those 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. The final results are shown in Table 8.6 and Map 8.2.

Table 8.6 Final results of the MDG target on access to improved drinking water sources, 2015

Group	Number of countries
Met the target	151
Good progress	11
Moderate progress	14
Limited or no progress	17
Unavailable	32
Total	**225**

Source: Based on WHO-UNICEF (2015).

Map 8.1 Degree of water stress

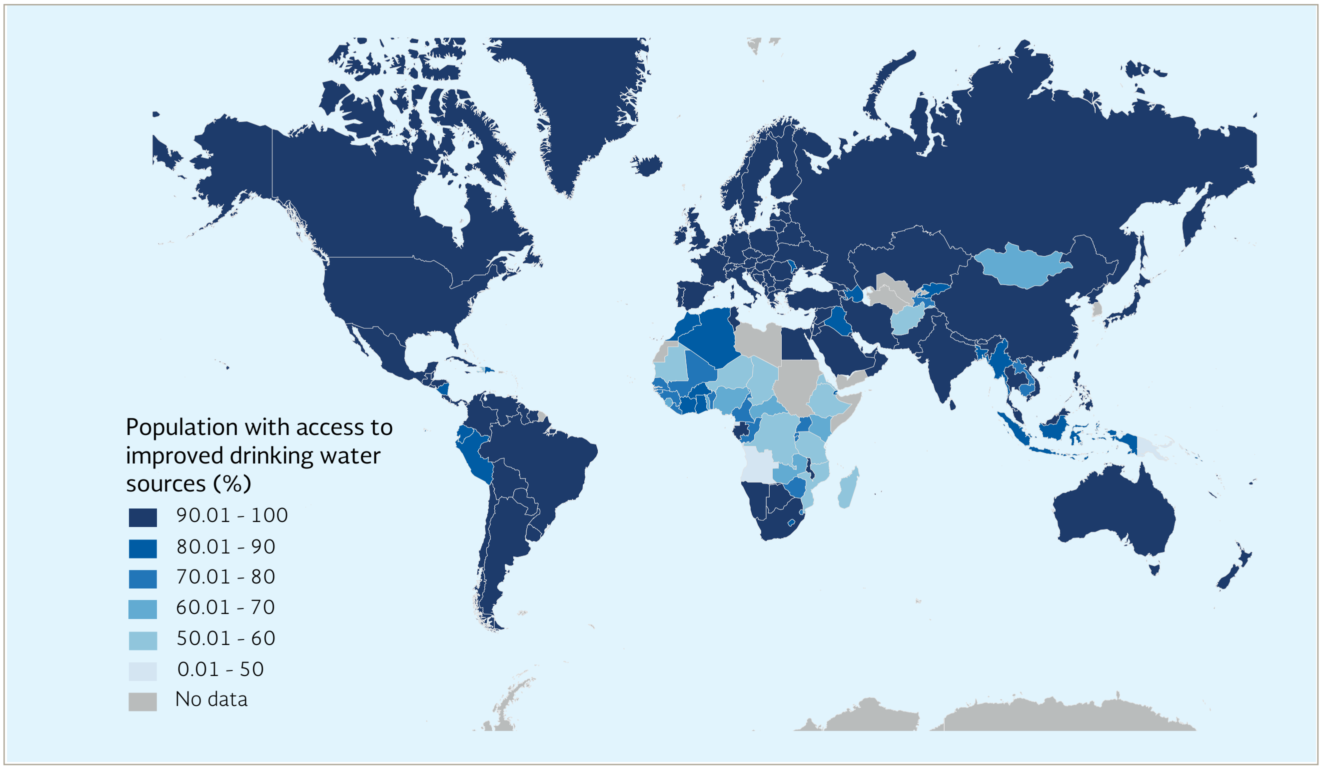


Source: Based on FAO (2016b).

2 Those that are protected against external contamination, especially fecal matter

3 Those that hygienically ensure that there is no contact between people and fecal matter.

Map 8.2 Access to improved drinking water sources



Source: Based on WHO-UNICEF (2015).

Mexico was one of the countries that met the target. Up to 2015, 96% of the population of Mexico (96% urban and 92% rural) had access to improved drinking water sources. As regards sanitation, at the end of 2015, the MDG period, unlike the drinking water target, globally the sanitation target was not met, with 700 million people missing up to that point.

It is estimated that in 2015, 68% of the world population used improved sanitation services, composed of 82% of urban population and 51% of rural population. In the 1990-2015 period, 2.1 billion people obtained access to those services. 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 final results are shown in Table 8.7 and Map 8.3.

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. In 2015, the United Nations resolution “Transforming our world: the 2030 Agenda for Sustainable Development” defined the goals and targets that succeed the

MDGs, now known as the Sustainable Development Goals (SDGs). Goal 6 of the SDGs "Ensure availability and sustainable management of water and sanitation for all" contains six technical targets.

Technical target 6.1 aims to complete and complement the MDGs as regards drinking water, and is defined as "By 2030, achieve universal and equitable access to safe and affordable drinking water for all". Technical target 6.2 is a complement of the MDG sanitation target, and is defined as follows: "By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations".

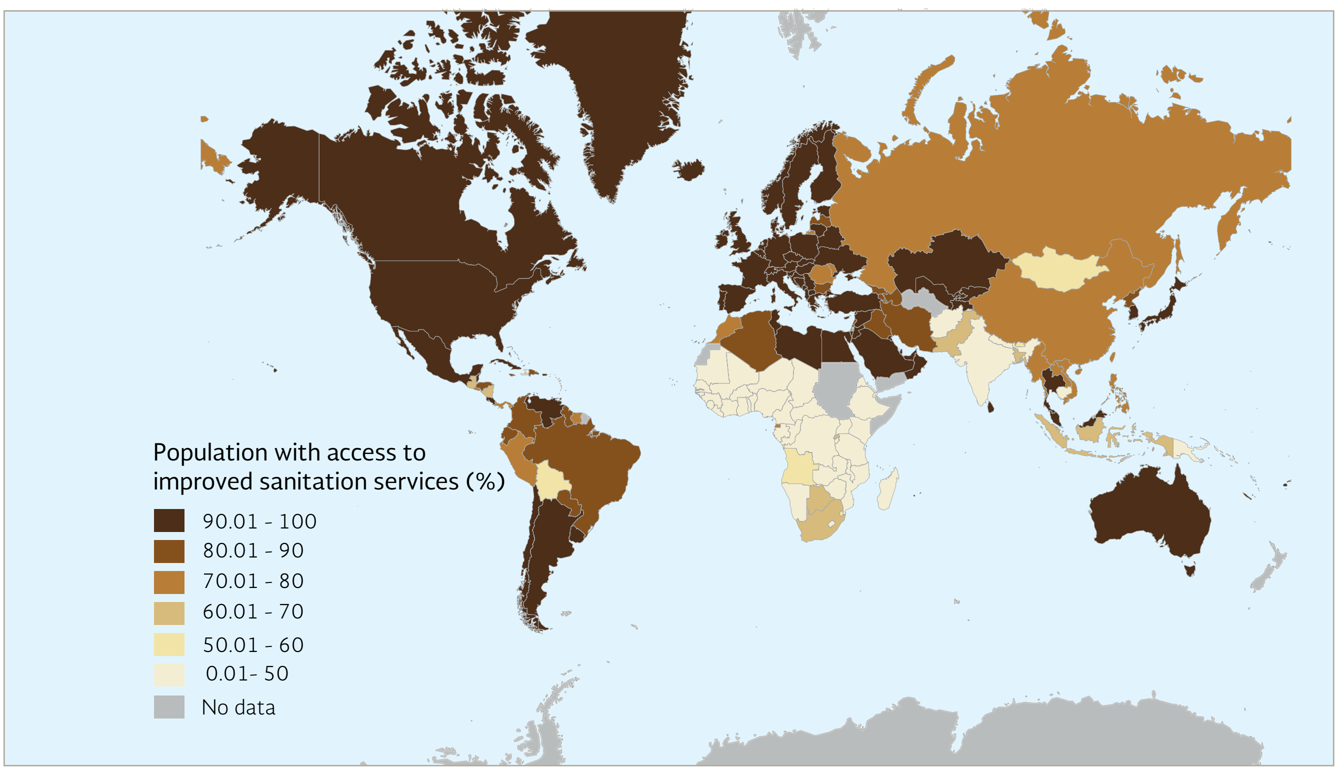
The other targets refer to water quality, water-use efficiency, integrated water resources management and ecosystem protection. Similarly, there are targets on international cooperation and the participation of local communities.

Table 8.7 Final results of the MDG target on access to improved sanitation services, 2015

Group	Number of countries
Met the target	98
Good progress	19
Moderate progress	17
Little or no progress	55
Unavailable	36
Total	**225**

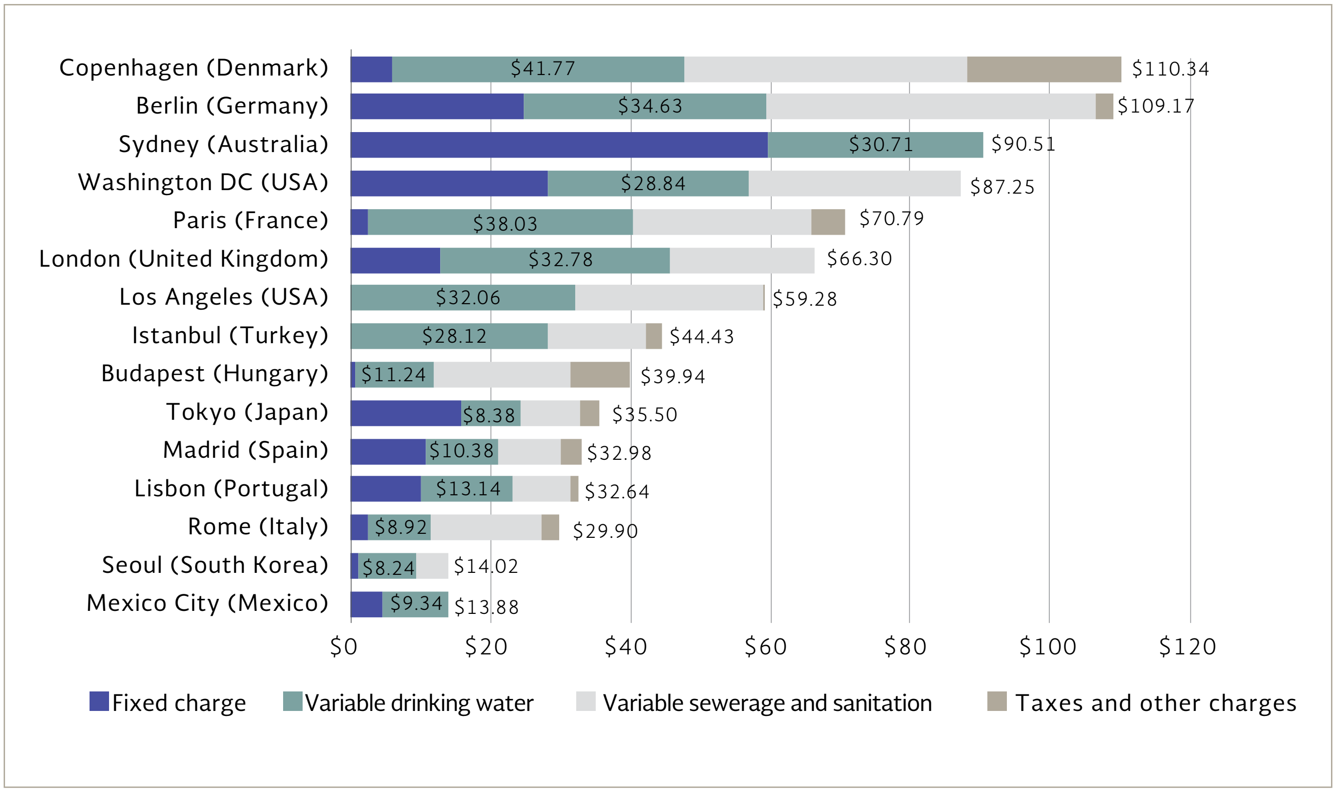
Source: Based on OMS-UNICEF (2015).

Map 8.3 Access to improved sanitation services



Source: Based on WHO-UNICEF (2015).

Graph 8.6 Domestic tariffs (pesos/m^3 for a consumption of 15 m^3/month)



Source: Based on GWI (2016).

Drinking water and sanitation tariffs

[Tablero:Tarifas]

It may be considered that drinking water, sewerage and sanitation services are financed through tariffs, transfers and taxes (known collectively as the 3 Ts). 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.

In Graph 8.6 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 = 18.11 pesos, as of July 1, 2015.

Water and health

[Tablero: 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 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 contaminated 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 updated, 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 calculated 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).

Maintaining freshwater quality is crucial for drinking water supply and health.

Vista de flamingos rosados en Reserva de la Biosfera Ría Celestún, Yucatán.

Annexes

HYDROLOGICAL ADMINISTRATIVE REGIONS AND FEDERATIVE ENTITIES

Key	Hydrological-administrative region
I	Península de Baja California
II	Noroeste
III	Pacífico Norte
IV	Balsas
V	Pacífico Sur
VI	Río Bravo
VII	Cuencas Centrales del Norte
VIII	Lerma-Santiago-Pacífico
IX	Golfo Norte
X	Golfo Centro
XI	Frontera Sur
XII	Península de Yucatán
XIII	Aguas del Valle de México

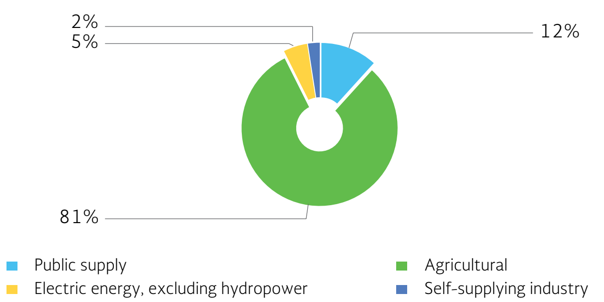
Key	Federative entity	Key	Federative entity
01	Aguascalientes	17	Morelos
02	Baja California	18	Nayarit
03	Baja California Sur	19	Nuevo León
04	Campeche	20	Oaxaca
05	Coahuila de Zaragoza	21	Puebla
06	Colima	22	Querétaro
07	Chiapas	23	Quintana Roo
08	Chihuahua	24	San Luis Potosí
09	Mexico City	25	Sinaloa
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	State of Mexico	31	Yucatán
16	Michoacán de Ocampo	32	Zacatecas

Annex A. Relevant data by hydrological-administrative region

Hydrological-administrative region: I. Península de Baja California
River basin organization headquartered in: Mexicali, Baja California.

Contextual data			Renewable water resources, 2016		
Number of municipalities	11		Normal annual precipitation 1981-2010	168	mm
Total population, 2016	4 522 014	inhabitants	Mean surface runoff	3 218	hm³/year
Urban	4 119 653	inhabitants	Number of aquifers	88	
Rural	402 361	inhabitants	Mean aquifer recharge	1 658	hm³/year
Total population, 2030	5 512 727	inhabitants	Per capita renewable water, 2016	1 078	m³/inhab./year
Irrigation districts	2		Per capita renewable water, 2030	884	m³/inhab./year
Surface area	245 693	hectares	Water stress	81.2	% (High)

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agricultural	1 443	1 761	3 203
Public supply	341	123	464
Self-supplying industry	25	72	97
Electric energy, excluding hydropower	195	<0.5	196
Total	**2 003**	**1 956**	**3 959**

Non consumptive	Surface water
Hydropower plants (Allocated volume)	126

Municipal plants, 2016

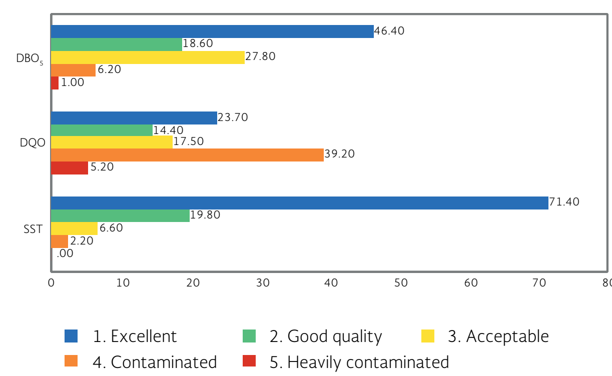
	Drinking water	Wastewater
Number of plants in operation	51	72
Installed capacity (m³/s)	12.38	9.55
Processed flow (m³/s)	7.40	6.98

Surface water quality, 2016

Number of monitoring sites by water quality indicator

BOD_5	97
COD	97
TSS	227

Site distribution by indicator and classification (%)



Coverage, 2015 (%)

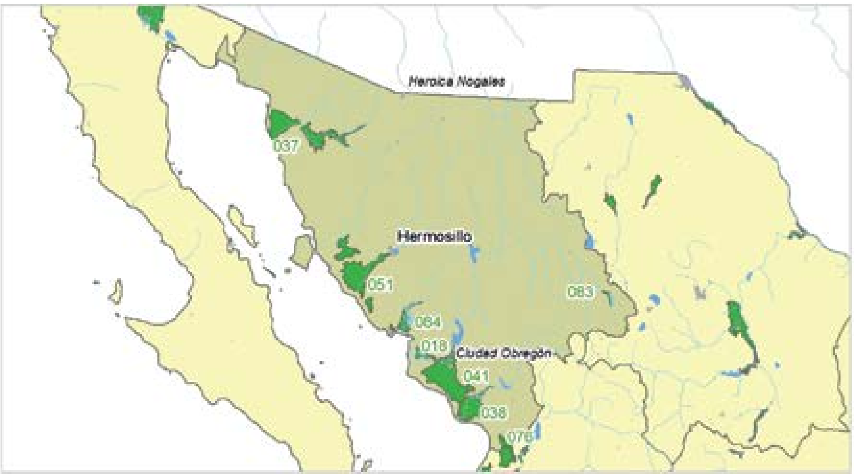
	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	97.03	96.44	96.33	96.07
Urban	97.87	97.37	97.61	97.43
Rural	88.72	87.18	83.70	82.66

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

Hydrological-administrative region: II. Noroeste
River basin organization headquartered in: Hermosillo, Sonora.

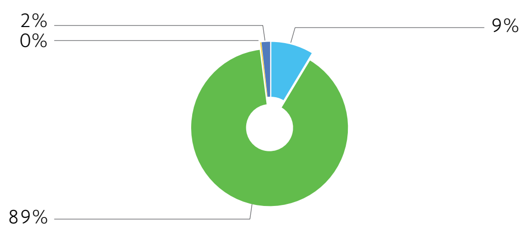
Contextual data		
Number of municipalities	78	
Total population, 2016	2 879 042	inhabitants
Urban	2 412 888	inhabitants
Rural	466 155	inhabitants
Total population, 2030	3 356 804	inhabitants
Irrigation districts	7	
Surface area	466 855	hectares

Renewable water resources, 2016		
Normal annual precipitation 1981-2010	428	mm
Mean surface runoff	5 068	hm³/year
Number of aquifers	62	
Mean aquifer recharge	3 207	hm³/year
Per capita renewable water, 2016	2 874	m³/inhab./year
Per capita renewable water, 2030	2 465	m³/inhab./year
Water stress	81.56	% (High)



- Urban localities
- Water bodies
- Main rivers
- Irrigation districs
- Regional limit

Water uses, 2016 (hm³/year)



- Public supply
- Electric energy, excluding hydropower
- Agricultural
- Self-supplying industry

Consumptive uses	Groundwater	Surface water	Total
Agricultural	2 246	3 785	6 031
Public supply	293	289	582
Self-supplying industry	112	7	119
Electric energy, excluding hydropower	9	7	16
Total	2 661	4 088	6 748

Non consumptive	Surface water
Hydropower plants (Allocated volume)	5 214

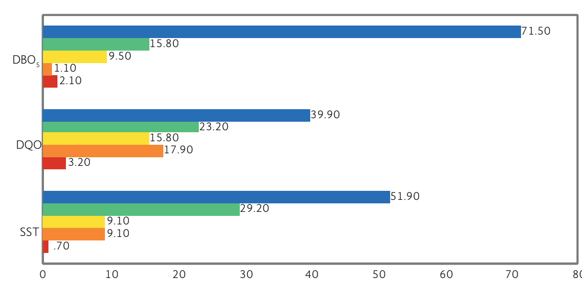
Municipal plants, 2016

	Drinking water	Wastewater
Number of plants in operation	23	123
Installed capacity (m³/s)	5.55	8.13
Processed flow (m³/s)	2.61	4.83

Surface water quality, 2016

Number of monitoring sites by water quality indicator	
BOD_5	95
COD	95
TSS	154

Site distribution by indicator and classification (%)



- 1. Excellent
- 2. Good quality
- 3. Acceptable
- 4. Contaminated
- 5. Heavily contaminated

Coverage, 2015 (%)

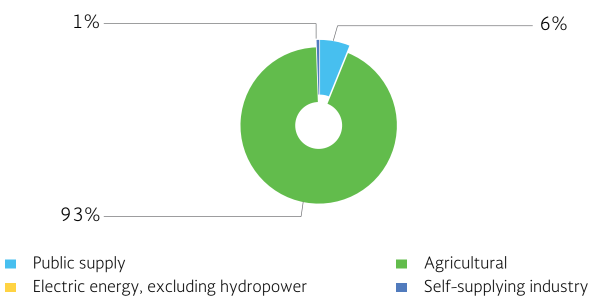
	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	97.09	96.30	91.03	90.78
Urban	97.92	97.35	95.79	95.70
Rural	92.28	90.18	63.26	62.13

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

Hydrological-administrative region: III. Pacífico Norte
River basin organization headquartered in: Culiacán, Sinaloa.

Contextual data			Renewable water resources, 2016		
Number of municipalities	51		Normal annual precipitation 1981-2010	765	mm
Total population, 2016	4 551 739	inhabitants	Mean surface runoff	23 537	hm³/year
Urban	3 162 743	inhabitants	Number of aquifers	24	
Rural	1 388 996	inhabitants	Mean aquifer recharge	3 076	hm³/year
Total population, 2030	5 056 867	inhabitants	Per capita renewable water, 2016	5 847	m³/hab/año
Irrigation districts	10		Per capita renewable water, 2030	5 263	m³/inhab./year
Surface area	862 295	hectares	Water stress	40.59	% (High)

Water uses, 2016 (hm³/year)



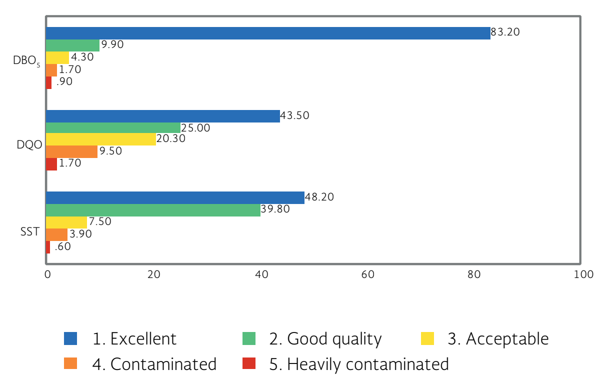
Consumptive uses	Groundwater	Surface water	Total
Agricultural	1 152	8 930	10 082
Public supply	339	323	661
Self-supplying industry	22	39	60
Electric energy, excluding hydropower	0	0	0
Total	1 512	9 291	10 803

Non consumptive	Surface water
Hydropower plants (Allocated volume)	12 970

Surface water quality, 2016

Number of monitoring sites by water quality indicator	
BOD_5	232
COD	232
TSS	332

Site distribution by indicator and classification (%)



Municipal plants, 2016

	Drinking water	Wastewater
Number of plants in operation	159	444
Installed capacity (m³/s)	9.99	10.70
Processed flow (m³/s)	8.58	8.55

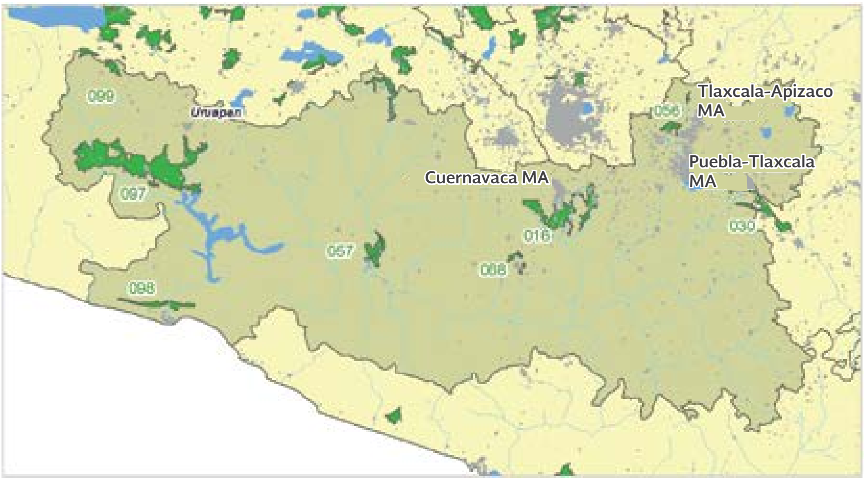
Coverage, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	96.47	95.35	91.04	90.11
Urban	99.46	98.65	97.84	97.28
Rural	89.48	87.60	75.13	73.33

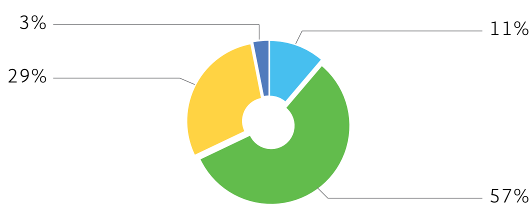
Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

Hydrological-administrative region: IV. Balsas
River basin organization headquartered in: Cuernavaca, Morelos.

Contextual data			Renewable water resources, 2016		
Number of municipalities	420		Normal annual precipitation 1981-2010	962	mm
Total population, 2016	11 925 898	inhabitants	Mean surface runoff	16 798	hm³/year
Urban	8 436 966	inhabitants	Number of aquifers	45	
Rural	3 488 933	inhabitants	Mean aquifer recharge	4 873	hm³/year
Total population, 2030	13 315 109	inhabitants	Per capita renewable water, 2016	1 817	
Irrigation districts	9		Per capita renewable water, 2030	1 628	m³/inhab./year
Surface area	199 390	hectares	Water stress	50.11	% (High)



Water uses, 2016 (hm³/year)



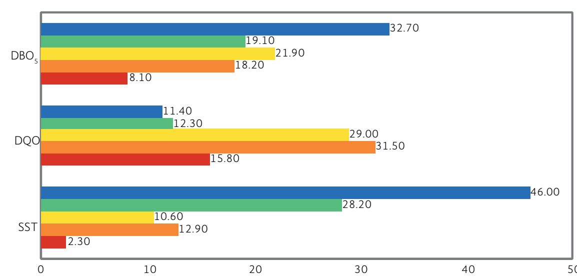
Consumptive uses	Groundwater	Surface water	Total
Agricultural	1 143	5 014	6 156
Public supply	622	597	1 219
Self-supplying industry	93	243	337
Electric energy, excluding hydropower	26	3 122	3 148
Total	1 884	8 976	10 860

Non consumptive	Surface water
Hydropower plants (Allocated volume)	34 232

Surface water quality, 2016

Number of monitoring sites by water quality indicator	
BOD_5	324
COD	324
TSS	341

Site distribution by indicator and classification (%)



Municipal plants, 2016

	Drinking water	Wastewater
Number of plants in operation	23	222
Installed capacity (m³/s)	22.82	10.75
Processed flow (m³/s)	17.18	8.66

Coverage, 2015 (%)

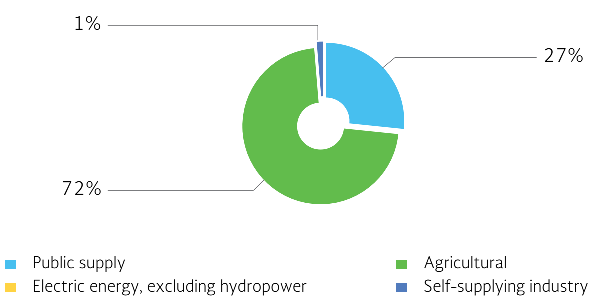
	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	93.77	92.50	91.58	89.02
Urban	96.51	95.53	96.53	94.94
Rural	87.29	85.32	79.86	74.97

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

Hydrologicaal-administrative region: V. Pacífico Sur
River basin organization headquartered in: Oaxaca, Oaxaca.

Contextual data			Renewable water resources, 2016		
Number of municipalities	378		Normal annual precipitation 1981-2010	1 139	mm
Total population, 2016	5 093 060	inhabitants	Mean surface runoff	28 900	hm³/year
Urban	3 073 371	inhabitants	Number of aquifers	36	
Rural	2 019 689	inhabitants	Mean aquifer recharge	1 936	hm³/year
Total population, 2030	5 399 686	inhabitants	Per capita renewable water, 2016	6 055	
Irrigation districts	5		Per capita renewable water, 2030	5 711	m³/inhab./year
Surface area	71 913	hectares	Water stress	5.09	% (No stress)

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agricultural	268	864	1 132
Public supply	231	188	418
Self-supplying industry	20	1	20
Electric energy, excluding hydropower	0	0	0
Total	518	1 052	1 570

Non consumptive	Surface water
Hydropower plants (Allocated volume)	11 151

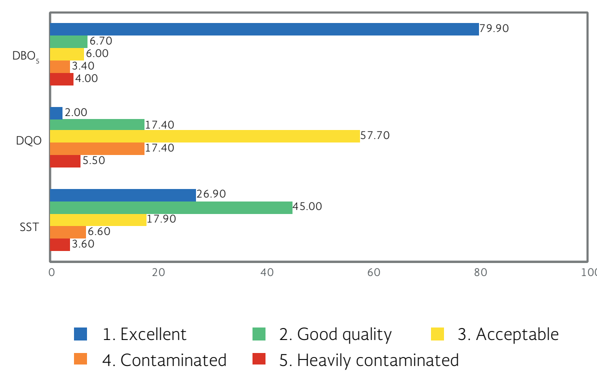
Municipal plants, 2016

	Drinking water	Wastewater
Number of plants in operation	19	95
Installed capacity (m³/s)	3.46	4.78
Processed flow (m³/s)	2.78	3.77

Surface water quality, 2016

Number of monitoring sites by water quality indicator	
BOD_5	149
COD	149
TSS	391

Site distribution by indicator and classification (%)



Coverage, 2015 (%)

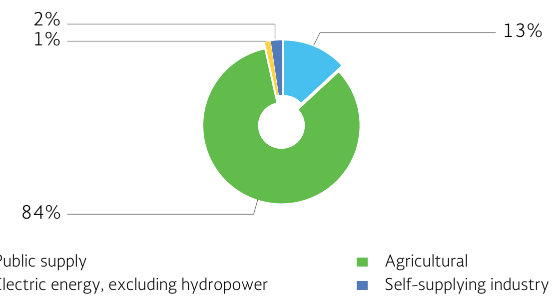
	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	89.37	87.64	79.13	76.79
Urban	92.08	90.86	92.60	91.06
Rural	85.29	82.77	58.80	55.24

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

Hydrological-administrative region: VI. Río Bravo
River basin organization headquartered in: Monterrey, Nuevo León.

Contextual data			Renewable water resources, 2016		
Number of municipalities	144		Normal annual precipitation 1981-2010	372	mm
Total population, 2016	12 456 423	inhabitants	Mean surface runoff	6 495	hm³/year
Urban	11 610 346	inhabitants	Number of aquifers	102	
Rural	846 077	inhabitants	Mean aquifer recharge	5 935	hm³/year
Total population, 2030	14 368 012	inhabitants	Per capita renewable water, 2016	998	
Irrigation districts	13		Per capita renewable water, 2030	865	m³/inhab./year
Surface area	467 397	hectares	Water stress	76.73	% (High)

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agricultural	3 636	4 320	7 956
Public supply	699	549	1 248
Self-supplying industry	209	14	223
Electric energy, excluding hydropower	58	53	111
Total	4 603	4 935	9 537

Non consumptive	Surface water
Hydropower plants (Allocated volume)	5 400

Municipal plants, 2016

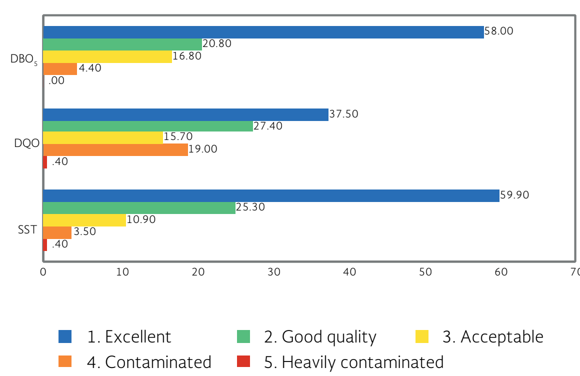
	Drinking water	Wastewater
Number of plants in operation	121	238
Installed capacity (m³/s)	28.07	32.81
Processed flow (m³/s)	18.14	24.30

Surface water quality, 2016

Number of monitoring sites by water quality indicator

BOD_5	274
COD	274
TSS	285

Site distribution by indicator and classification (%)



Coverage, 2015 (%)

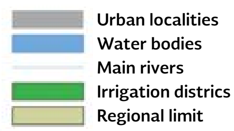
	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	98.51	97.96	96.86	96.76
Urban	99.15	98.68	98.10	98.03
Rural	89.56	87.83	79.54	78.99

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

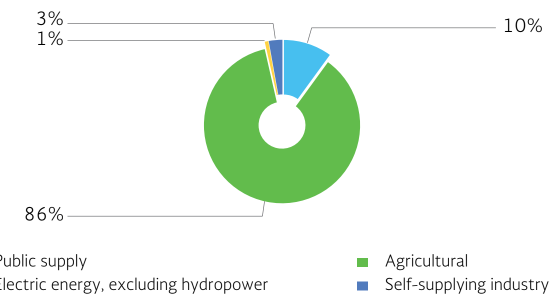
Hydrological-administrative region: VII. Cuencas Centrales del Norte
River basin organization headquartered in: Torreón, Coahuila de Zaragoza.

Contextual data		
Number of municipalities	78	
Total population, 2016	4 608 175	inhabitants
Urban	3 461 367	inhabitants
Rural	1 146 808	inhabitants
Total population, 2030	5 124 677	inhabitants
Irrigation districts	1	
Surface area	71 964	hectares

Renewable water resources, 2016		
Normal annual precipitation 1981-2010	398	mm
Mean surface runoff	5 551	hm³/year
Number of aquifers	65	
Mean aquifer recharge	2 376	hm³/year
Per capita renewable water, 2016	1 720	
Per capita renewable water, 2030	1 547	m³/inhab./year
Water stress	48.38	% (High)



Water uses, 2016 (hm³/year)



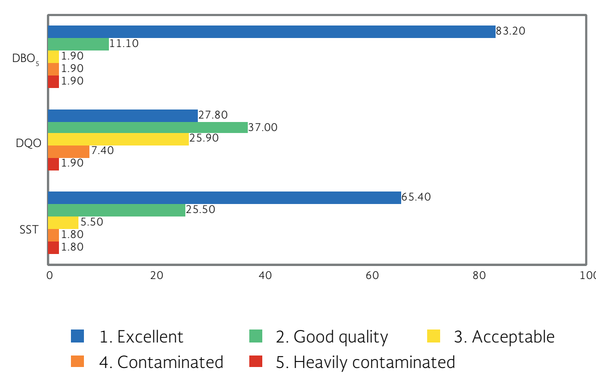
Consumptive uses	Groundwater	Surface water	Total
Agricultural	2 022	1 292	3 315
Public supply	372	12	384
Self-supplying industry	107	1	108
Electric energy, excluding hydropower	28	0	28
Total	2 530	1 306	3 835

Non consumptive	Surface water
Hydropower plants (Allocated volume)	0

Surface water quality, 2016

Number of monitoring sites by water quality indicator	
BOD_5	54
COD	54
TSS	55

Site distribution by indicator and classification (%)



Municipal plants, 2016

	Drinking water	Wastewater
Number of plants in operation	164	160
Installed capacity (m³/s)	2.48	6.98
Processed flow (m³/s)	1.92	5.47

Coverage, 2015 (%)

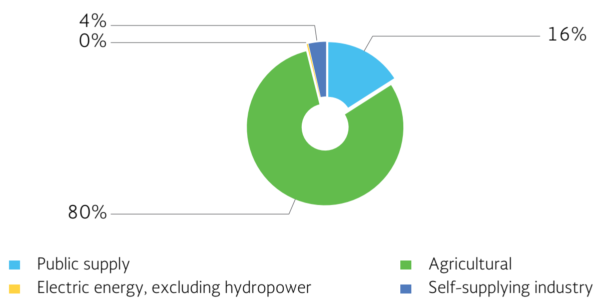
	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	97.18	96.18	94.09	93.74
Urban	99.12	98.43	98.08	97.95
Rural	91.26	89.35	81.92	80.94

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

Hydrological-administrative region: VIII. Lerma-Santiago-Pacífico
River basin organization headquartered in: Guadalajara, Jalisco.

Contextual data			Renewable water resources, 2016		
Number of municipalities	332		Normal annual precipitation 1981-2010	808	mm
Total population, 2016	24 449 109	inhabitants	Mean surface runoff	25 241	hm³/year
Urban	19 152 012	inhabitants	Number of aquifers	128	
Rural	5 297 097	inhabitants	Mean aquifer recharge	9 656	hm³/year
Total population, 2030	27 698 618	inhabitants	Per capita renewable water, 2016	1 427	m³/inhab./year
Irrigation districts	13		Per capita renewable water, 2030	1 260	m³/inhab./year
Surface area	456 445	hectares	Water stress	45.42	% (High)

Water uses, 2016 (hm³/year)



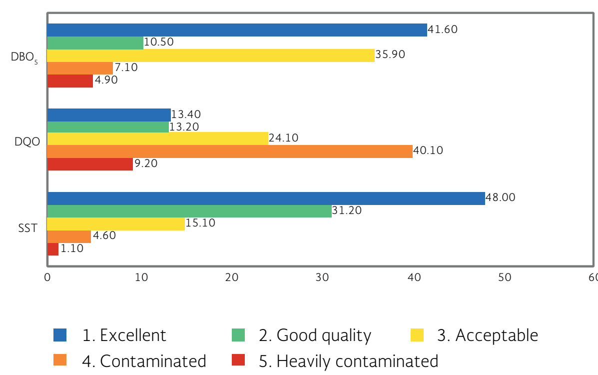
Consumptive uses	Groundwater	Surface water	Total
Agricultural	5 993	6 713	12 707
Public supply	1 471	1 057	2 528
Self-supplying industry	508	65	574
Electric energy, excluding hydropower	43	<0.5	43
Total	**8 016**	**7 835**	**15 852**

Non consumptive	Surface water
Hydropower plants (Allocated volume)	23 415

Surface water quality, 2016

Number of monitoring sites by water quality indicator	
BOD_5	649
COD	651
TSS	757

Site distribution by indicator and classification (%)



Municipal plants, 2016

	Drinking water	Wastewater
Number of plants in operation	163	587
Installed capacity (m³/s)	19.89	41.82
Processed flow (m³/s)	14.96	30.69

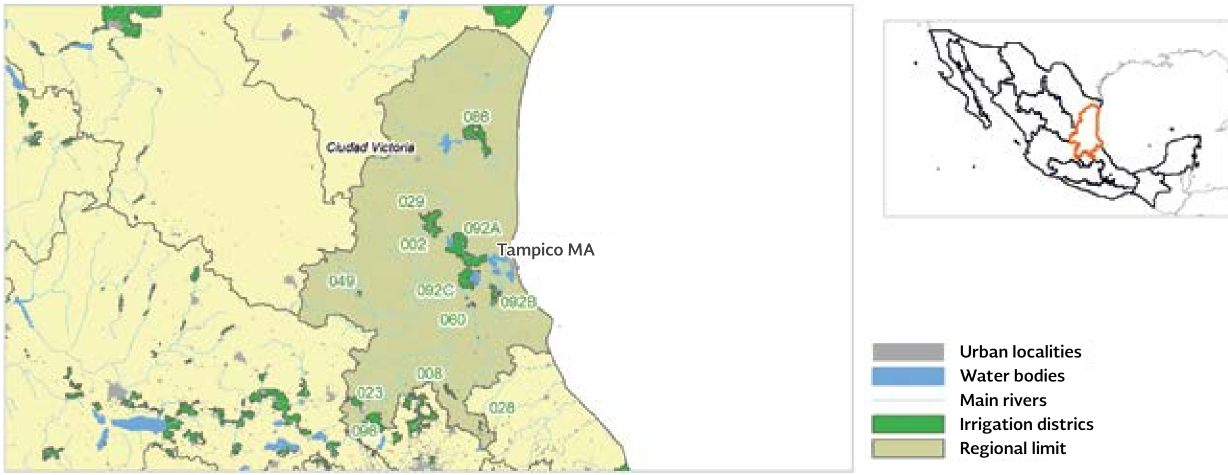
Coverage, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	97.50	96.72	95.55	95.12
Urbana	98.54	97.92	98.08	97.29
Rural	93.88	92.54	86.79	83.14

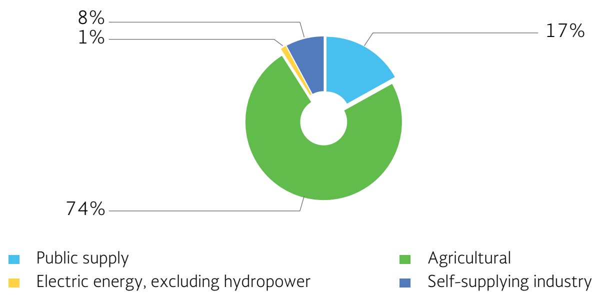
Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

Hydrological-administrative region: IX. Golfo Norte
River basin organization headquartered in: Ciudad Victoria, Tamaulipas.

Contextual data			Renewable water resources, 2016		
Number of municipalities	148		Normal annual precipitation 1981-2010	855	mm
Total population, 2016	5 328 863	inhabitants	Mean surface runoff	24 555	hm³/year
Urban	2 908 822	inhabitants	Number of aquifers	40	
Rural	2 420 040	inhabitants	Mean aquifer recharge	4 108	hm³/year
Total population, 2030	5 962 759	inhabitants	Per capita renewable water, 2016	5 379	m³/inhab./year
Irrigation districts	11		Per capita renewable water, 2030	4 807	m³/inhab./year
Surface area	230 569	hectares	Water stress	20.78	% (Medium)



Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agricultural	911	3 504	4 415
Public supply	156	851	1 008
Self-supplying industry	40	427	467
Electric energy, excluding hydropower	6	61	67
Total	1 113	4 844	5 957

Non consumptive	Surface water
Hydropower plants (Allocated volume)	1 959

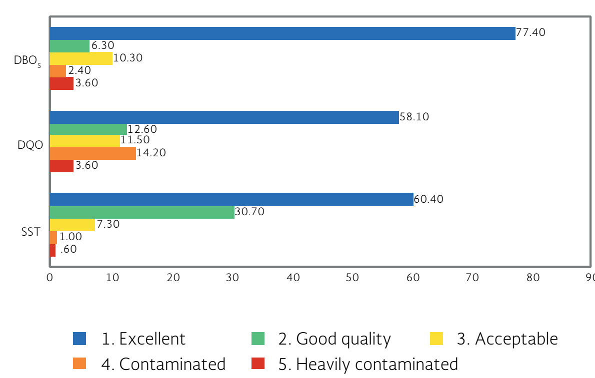
Municipal plants, 2016

	Drinking water	Wastewater
Number of plants in operation	48	107
Installed capacity (m³/s)	8.19	5.30
Processed flow (m³/s)	7.19	4.17

Surface water quality, 2016

Number of monitoring sites by water quality indicator	
BOD_5	253
COD	253
TSS	313

Site distribution by indicator and classification (%)



Coverage, 2015 (%)

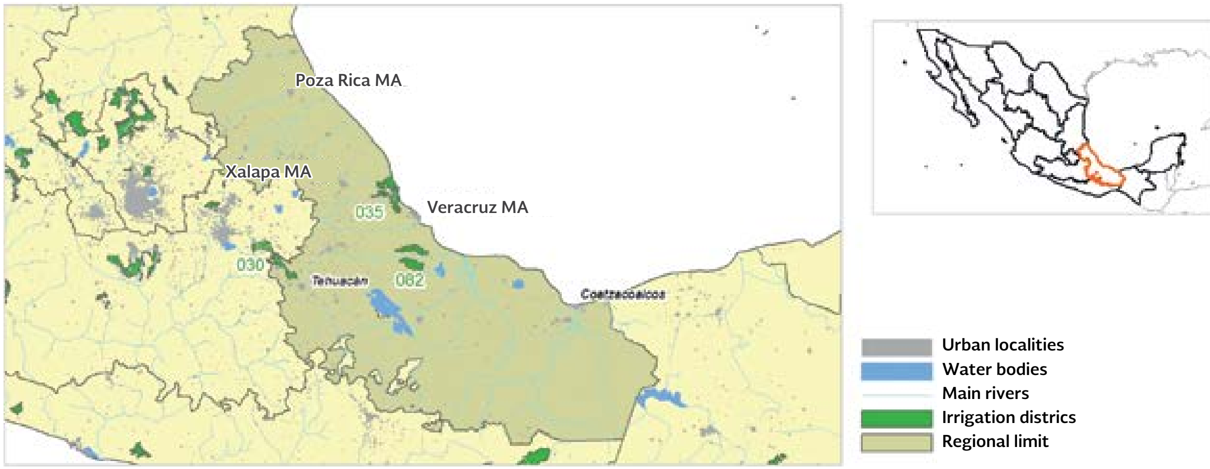
	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	90.52	89.06	80.91	79.75
Urban	98.43	97.40	90.37	94.90
Rural	81.19	79.22	63.84	61.87

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

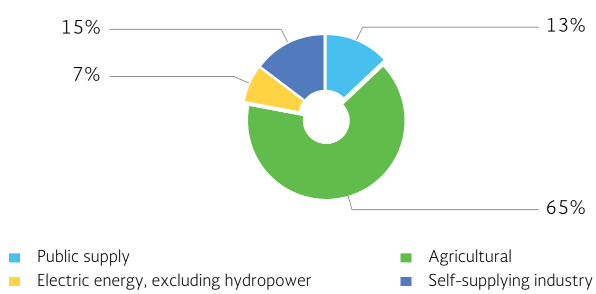
Hydrological-administrative region: X. Golfo Centro
River basin organization headquartered in: Xalapa, Veracruz.

Contextual data		
Number of municipalities	432	
Total population, 2016	10 647 905	inhabitants
Urban	6 161 861	inhabitants
Rural	4 486 044	inhabitants
Total population, 2030	11 606 944	inhabitants
Irrigation districts	2	
Surface area	41 830	hectares

Renewable water resources, 2016		
Normal annual precipitation 1981-2010	1 626	mm
Mean surface runoff	61 047	hm³/year
Number of aquifers	22	
Mean aquifer recharge	4 599	hm³/year
Per capita renewable water, 2016	6 165	m³/inhab./year
Per capita renewable water, 2030	5 656	m³/inhab./year
Water stress	8.58	% (No stress)



Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agricultural	1 041	2 620	3 660
Public supply	286	444	730
Self-supplying industry	151	676	827
Electric energy, excluding hydropower	8	406	414
Total	1 486	4 146	5 632

Non consumptive	Surface water
Hydropower plants (Allocated volume)	26 047

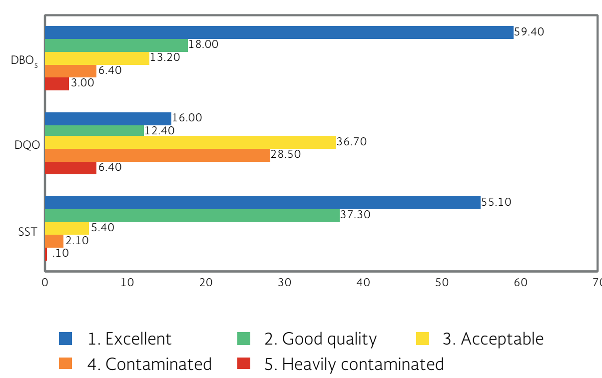
Municipal plants, 2016

	Drinking water	Wastewater
Number of plants in operation	14	161
Installed capacity (m³/s)	7.47	7.53
Processed flow (m³/s)	5.19	5.37

Surface water quality, 2016

Number of monitoring sites by water quality indicator	
BOD_5	266
COD	267
TSS	332

Site distribution by indicator and classification (%)



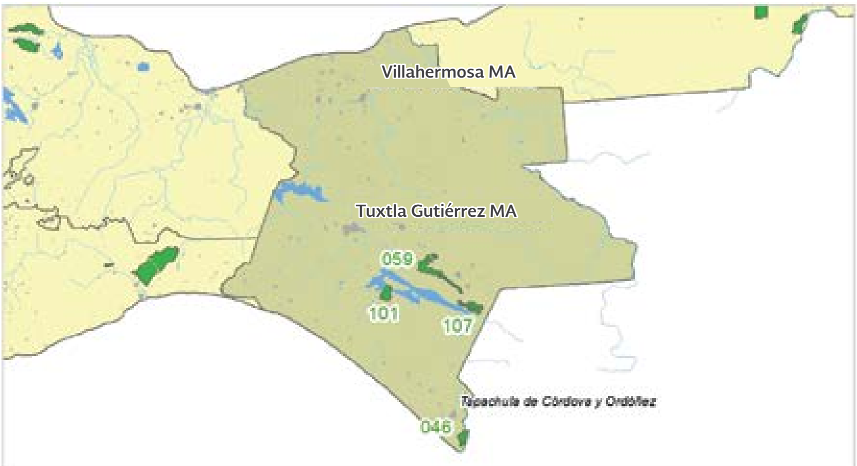
Coverage, 2015 (%)

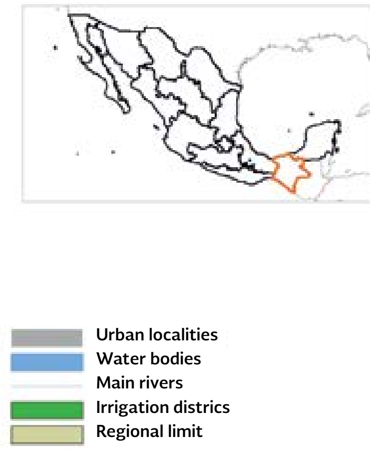
	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	88.74	87.21	86.33	82.87
Urban	95.16	94.20	96.05	93.49
Rural	80.04	77.74	73.15	68.49

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

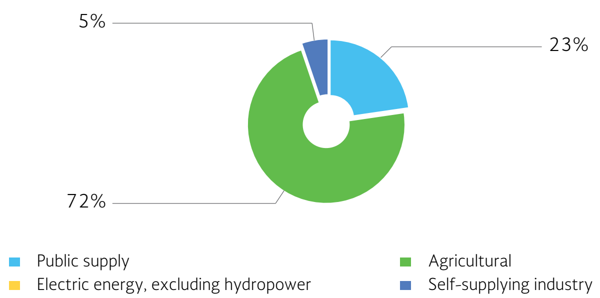
Hydrological-administrative: XI. Frontera Sur
River basin organization headquartered in: Tuxtla Gutiérrez, Chiapas.

Contextual data			Renewable water resources, 2016		
Number of municipalities	137		Normal annual precipitation 1981-2010	1 842	mm
Total population, 2016	7 752 015	inhabitants	Mean surface runoff	153 195	hm³/year
Urban	4 061 976	inhabitants	Number of aquifers	23	
Rural	3 690 039	inhabitants	Mean aquifer recharge	22 718	hm³/year
Total population, 2030	8 844 011	inhabitants	Per capita renewable water, 2016	22 692	m³/inhab./year
Irrigation districts	4		Per capita renewable water, 2030	19 891	m³/inhab./year
Surface area	37 158	hectares	Water stress	1.45	% (No stress)





Water uses, 2016 (hm³/year)



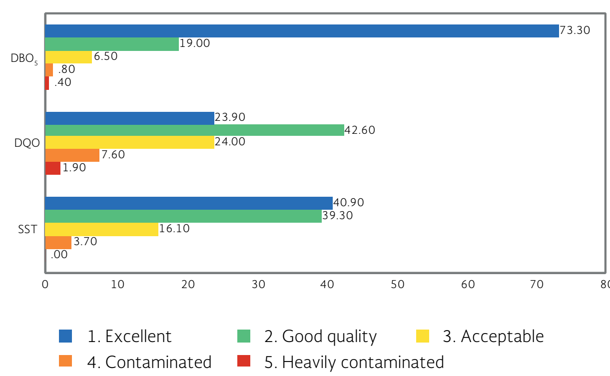
Consumptive uses	Groundwater	Surface water	Total
Agricultural	549	1 284	1 833
Public supply	142	435	577
Self-supplying industry	71	62	132
Electric energy, excluding hydropower	0	0	0
Total	762	1 781	2 542

Non consumptive	Surface water
Hydropower plants (Allocated volume)	61 969

Surface water quality, 2016

Number of monitoring sites by water quality indicator	
BOD_5	263
COD	263
TSS	354

Site distribution by indicator and classification (%)



Municipal plants, 2016

	Drinking water	Wastewater
Number of plants in operation	50	116
Installed capacity (m³/s)	13.28	4.74
Processed flow (m³/s)	10.37	3.85

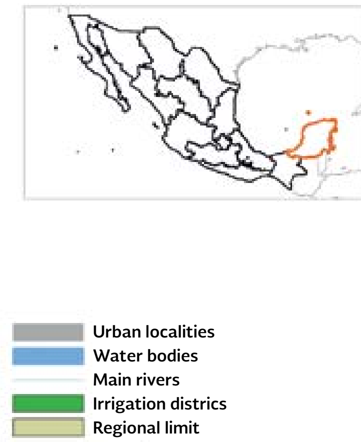
Coverage, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	89.30	87.51	90.20	87.93
Urban	94.93	93.98	97.82	96.62
Rural	83.00	80.29	81.69	78.23

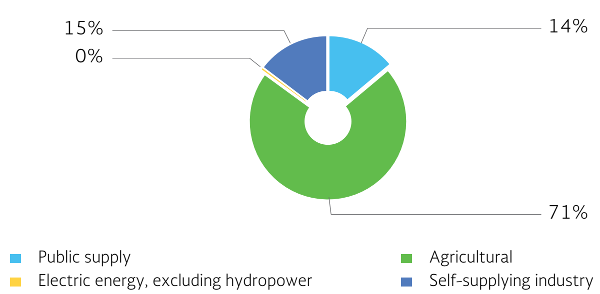
Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

Hydrological-administrative region: XII. Península de Yucatán
River basin organization headquartered in: Mérida, Yucatán.

Contextual data			Renewable water resources, 2016		
Number of municipalities	128		Normal annual precipitation 1981-2010	1 207	mm
Total population, 2016	4 687 157	inhabitants	Mean surface runoff	4 331	hm³/year
Urban	3 949 449	inhabitants	Number of aquifers	4	
Rural	737 708	inhabitants	Mean aquifer recharge	25 316	hm³/year
Total population, 2030	5 834 469	inhabitants	Per capita renewable water, 2016	6 325	m³/inhab./year
Irrigation districts	2		Per capita renewable water, 2030	5 081	m³/inhab./year
Surface area	17 785	hectares	Water stress	15.17	% (Low)



Water uses, 2016 (hm³/year)



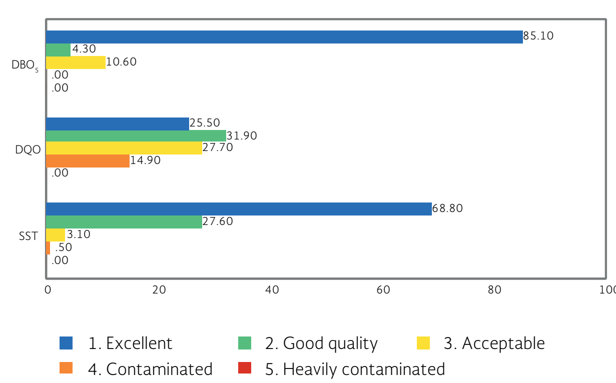
Consumptive uses	Groundwater	Surface water	Total
Agricultural	3 070	131	3 201
Public supply	624	<0.5	624
Self-supplying industry	660	<0.5	660
Electric energy, excluding hydropower	13	0	13
Total	4 367	132	4 498

Non consumptive	Surface water
Hydropower plants (Allocated volume)	0

Surface water quality, 2016

Number of monitoring sites by water quality indicator	
BOD_5	47
COD	47
TSS	196

Site distribution by indicator and classification (%)



Municipal plants, 2016

	Drinking water	Wastewater
Number of plants in operation	1	78
Installed capacity (m³/s)	0.01	3.16
Processed flow (m³/s)	0.01	2.11

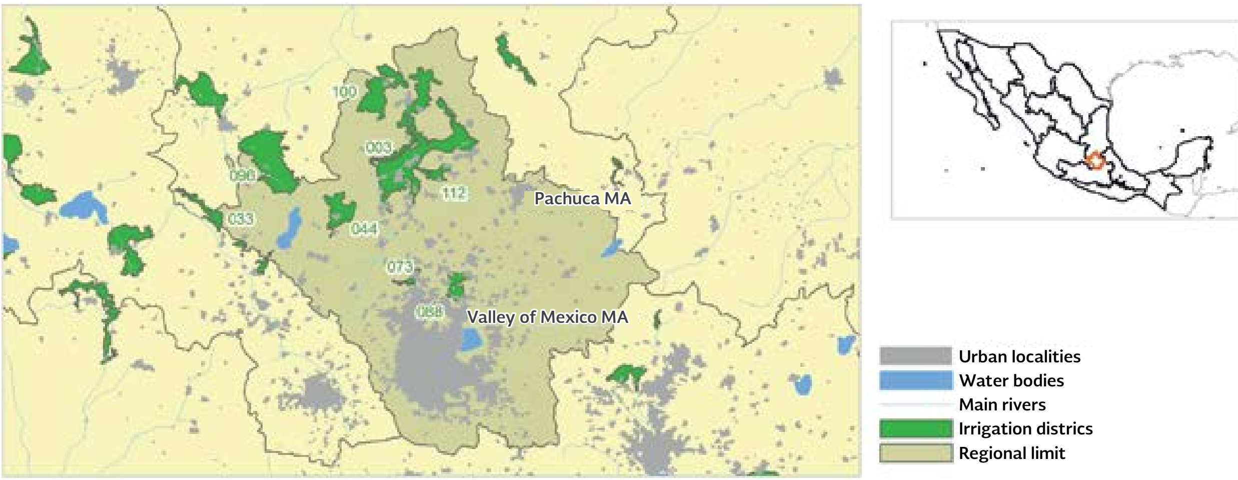
Coverage, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	97.98	96.99	91.12	90.67
Urban	98.58	97.82	93.88	93.43
Rural	94.81	93.08	76.48	76.03

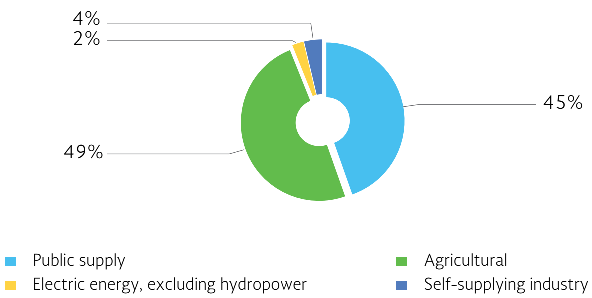
Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

Hydrological-administrative region: XIII. Aguas del Valle de México
River basin organization headquartered in: Mexico City.

Contextual data			Renewable water resources, 2016		
Number of municipalities	121		Normal annual precipitation 1981-2010	649	mm
Total population, 2016	23 372 072	inhabitants	Mean surface runoff	1 106	hm³/year
Urban	22 137 325	inhabitants	Number of aquifers	14	
Rural	1 234 747	inhabitants	Mean aquifer recharge	2 330	hm³/year
Total population, 2030	25 400 649	inhabitants	Per capita renewable water, 2016	147	m³/inhab./year
Irrigation districts	7		Per capita renewable water, 2030	135	m³/inhab./year
Surface area	122 179	hectares	Water stress	139.15	% (Very high)



Water uses, 2016 (hm³/year)



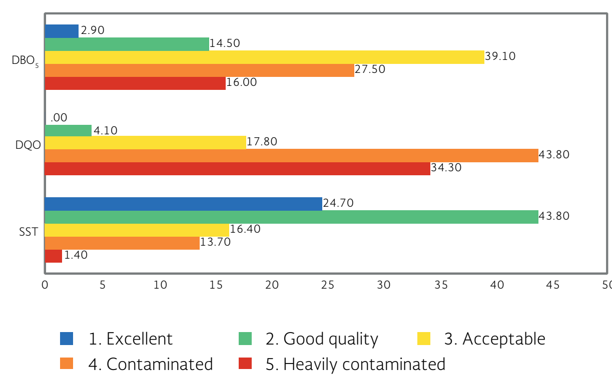
Consumptive uses	Groundwater	Surface water	Total
Agricultural	368	1 990	2 358
Public supply	1 783	350	2 133
Self-supplying industry	146	31	178
Electric energy, excluding hydropower	68	46	113
Total	2 365	2 417	4 782

Non consumptive	Surface water
Hydropower plants (Allocated volume)	221

Surface water quality, 2016

Number of monitoring sites by water quality indicator	
BOD_5	69
COD	73
TSS	73

Site distribution by indicator and classification (%)



Municipal plants, 2016

	Drinking water	Wastewater
Number of plants in operation	72	133
Installed capacity (m³/s)	6.75	34.32
Processed flow (m³/s)	5.08	14.84

Coverage, 2015 (%)

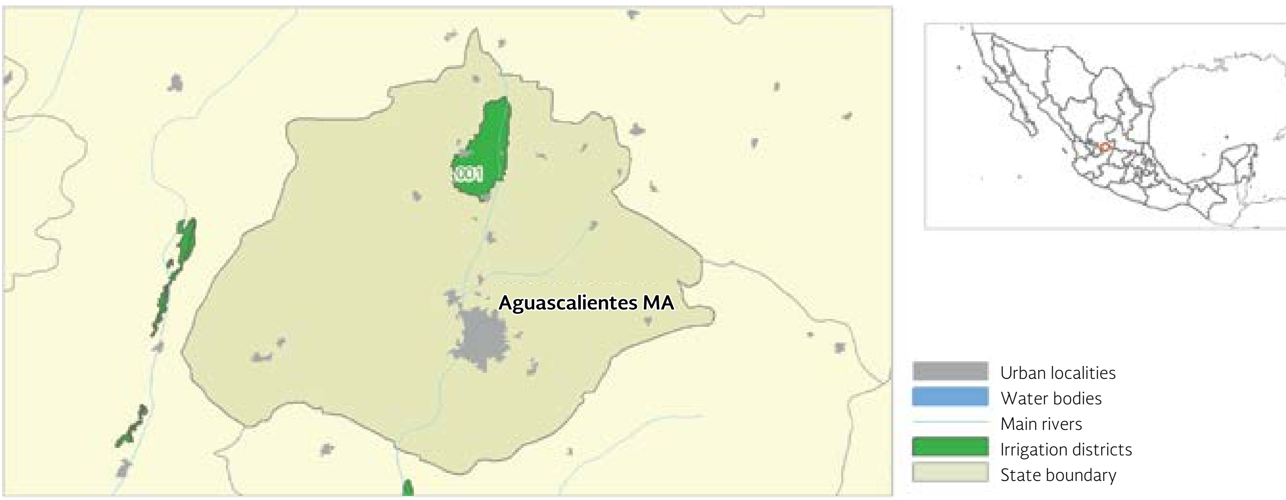
	Drinking water		Sewerage	
	Access	Tap water in homes and plots	Drainage	Public network or septic tank
State	97.90	97.50	98.06	97.32
Urban	98.30	98.00	98.55	97.99
Rural	91.56	89.68	90.28	86.92

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: "**Access**" for the coverage of the population in private homes with tap water in their household or plot or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "**drainage**" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "**public network or septic tank**" is used to distinguish these elements, "drainage" corresponds to "**sewerage coverage**" used in the 2015 and previous editions of SWM.

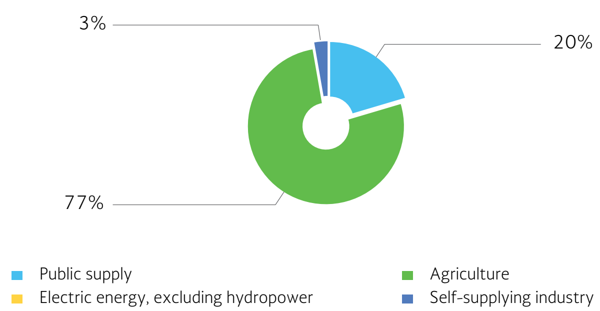
Annex B. Relevant data by federative entity

1. Aguascalientes

Contextual data			Wastewater treatment plants, 2016		
Number of municipalities	11			Municipal wastewater	Industrial wastewater
Total population, 2016	1 304 744	Inhabitants	Number of plants in operation	132	69
Urban	1 057 462	Inhabitants	Installed capacity (m³/s)	4.910	0.338
Rural	247 282	Inhabitants	Processed flow (m³/s)	1.664	0.167
Total population, 2030	1 507 807	Inhabitants			
Annual normal precipitation 1981-2010	515	mm			



Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	303	176	479
Public supply	127	<0.5	127
Self-supplying industry	15	2	17
Electric energy, excluding hydropower	0	0	0
Total	**445**	**178**	**623**

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	445

Municipal purification plants, 2016

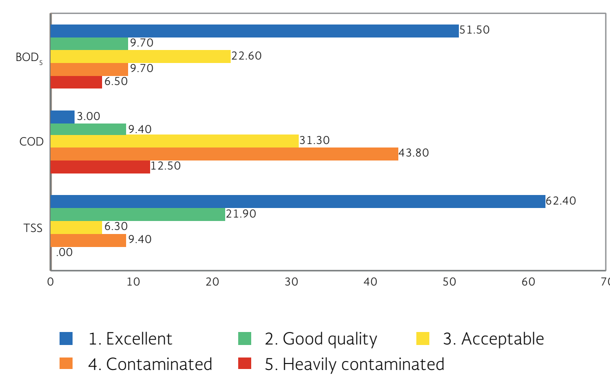
Number of plants in operation	3
Installed capacity (m³/s)	0.044
Processed flow (m³/s)	0.026

Surface water quality, 2016

Number of monitoring sites per water quality indicator

BOD_5	31
COD	32
TSS	32

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

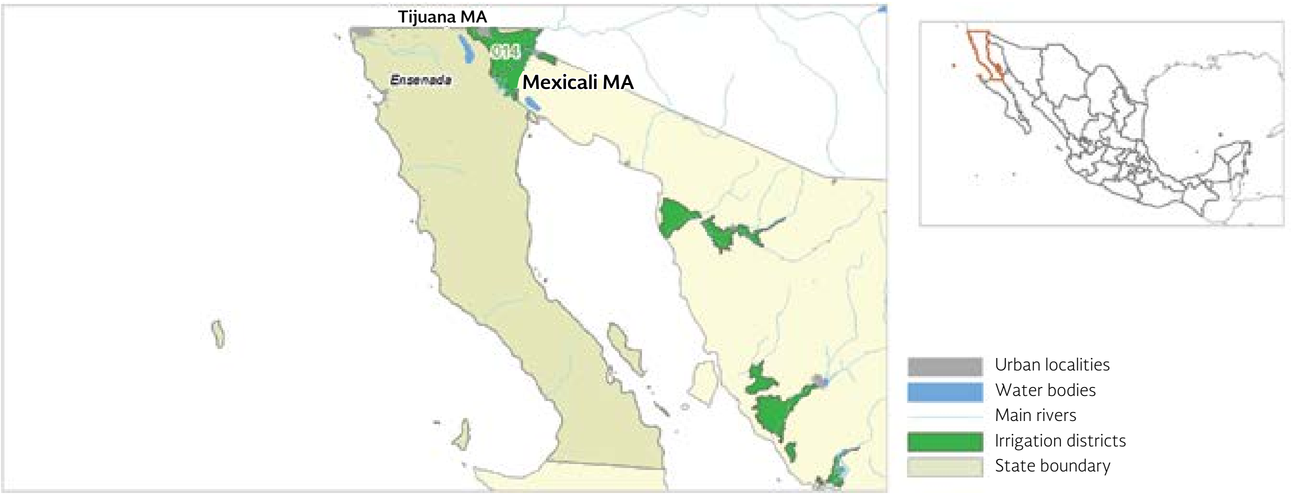
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	99.68%	99.14%	98.86%	98.47%
Urban	99.90%	99.51%	99.64%	99.51%
Rural	98.83%	97.67%	95.72%	94.31%

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

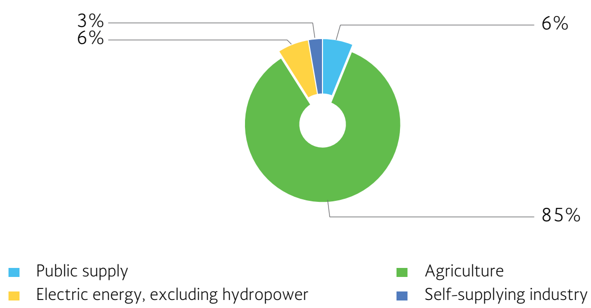
2. Baja California

Contextual data		
Number of municipalities	5	
Total population, 2016	3 534 688	Inhabitants
Urban	3 245 990	Inhabitants
Rural	288 698	Inhabitants
Total population, 2030	4 169 240	Inhabitants
Annual normal precipitation 1981-2010	173	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	43	120
Installed capacity (m^3/s)	7.788	13.092
Processed flow (m^3/s)	5.670	13.075



Water uses, 2016 (hm^3/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	1 067	1 521	2 588
Public supply	68	120	187
Self-supplying industry	14	69	83
Electric energy, excluding hydropower	192	0	192
Total	1 339	1 711	3 050

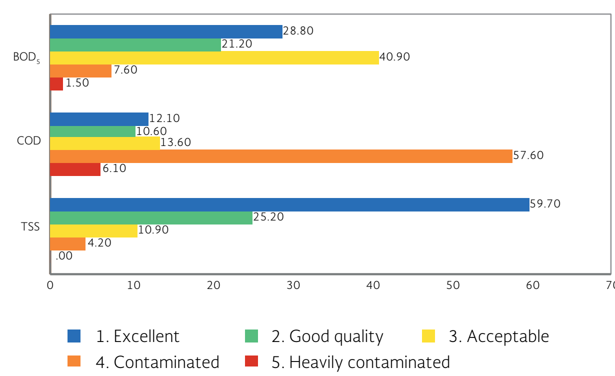
Non-consumptive	Surface water
Hydropower plants (Allocated volume)	1 339

Municipal purification plants, 2016	
Number of plants in operation	31
Installed capacity (m^3/s)	12.146
Processed flow (m^3/s)	6.984

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	66
COD	66
TSS	119

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	97.70	97.13	96.42	96.13
Urban	98.64	98.14	97.71	97.50
Rural	87.87	86.61	83.11	81.89

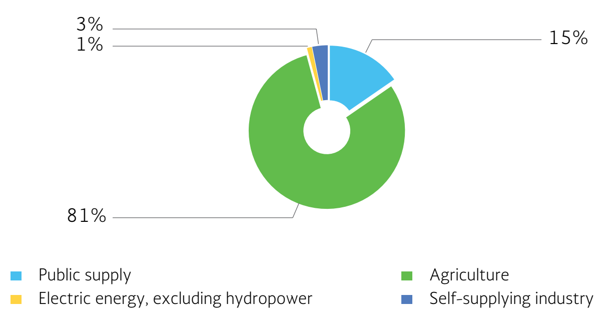
Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

3. Baja California Sur

Contextual data		
Number of municipalities	5	
Total population, 2016	786 864	Inhabitants
Urban	684 834	Inhabitants
Rural	102 030	Inhabitants
Total population, 2030	1 106 468	Inhabitants
Annual normal precipitation 1981-2010	222	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	29	29
Installed capacity (m³/s)	1.767	4.965
Processed flow (m³/s)	1.312	4.965

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	309	31	341
Public supply	62	3	65
Self-supplying industry	11	3	14
Electric energy, excluding hydropower	4	0	4
Total	386	37	424

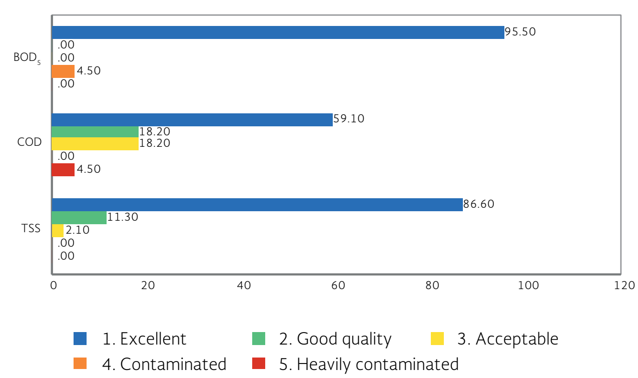
Non-consumptive	Surface water
Hydropower plants (Allocated volume)	0

Municipal purification plants, 2016	
Number of plants in operation	17
Installed capacity (m³/s)	0.215
Processed flow (m³/s)	0.195

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	22
COD	22
TSS	97

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

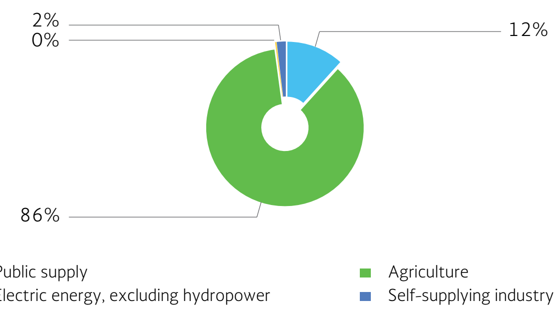
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	93.41	92.70	96.66	96.52
Urban	93.77	93.28	98.00	97.86
Rural	90.80	88.37	86.70	86.58

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

4. Campeche

Contextual data			Wastewater treatment plants, 2016		
Number of municipalities	11			Municipal wastewater	Industrial wastewater
Total population, 2016	921 517	Inhabitants	Number of plants in operation	15	174
Urban	690 027	Inhabitants	Installed capacity (m³/s)	0.147	3.423
Rural	231 490	Inhabitants	Processed flow (m³/s)	0.134	3.423
Total population, 2030	1 098 636	Inhabitants			
Annual normal precipitation 1981-2010	1 251	mm			

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	1 010	130	1 141
Public supply	155	<0.5	155
Self-supplying industry	24	<0.5	25
Electric energy, excluding hydropower	4	0	4
Total	1 193	131	1 324

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	1 193

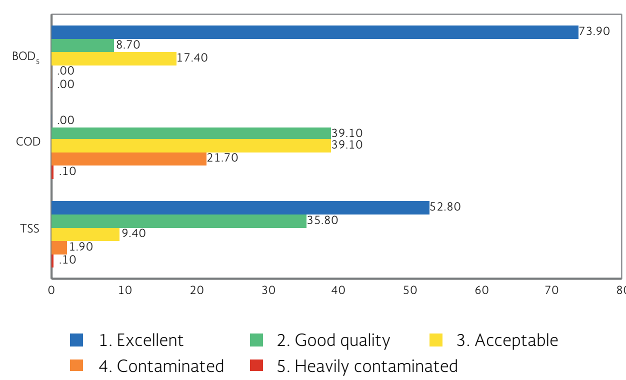
Municipal purification plants, 2016

Number of plants in operation	2
Installed capacity (m³/s)	0.025
Processed flow (m³/s)	0.023

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	23
COD	23
TSS	53

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	94.68	93.49	91.88	91.69
Urban	96.86	95.98	95.90	95.71
Rural	88.03	85.90	79.62	79.43

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

5. Coahuila de Zaragoza

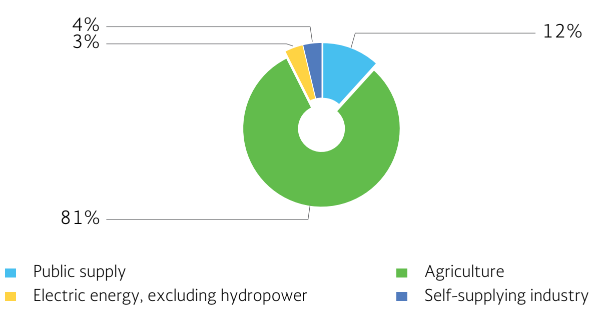
Contextual data

Number of municipalities	38	
Total population, 2016	2 995 374	Inhabitants
Urban	2 709 326	Inhabitants
Rural	286 048	Inhabitants
Total population, 2030	3 427 879	Inhabitants
Annual normal precipitation 1981-2010	332	mm

Wastewater treatment plants, 2016

	Municipal wastewater	Industrial wastewater
Number of plants in operation	25	62
Installed capacity (m^3/s)	5.658	0.797
Processed flow (m^3/s)	4.648	0.534

Water uses, 2016 (hm^3/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	815	839	1 654
Public supply	222	18	240
Self-supplying industry	75	1	77
Electric energy, excluding hydropower	27	47	75
Total	**1 140**	**906**	**2 046**

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	1 465

Municipal purification plants, 2016

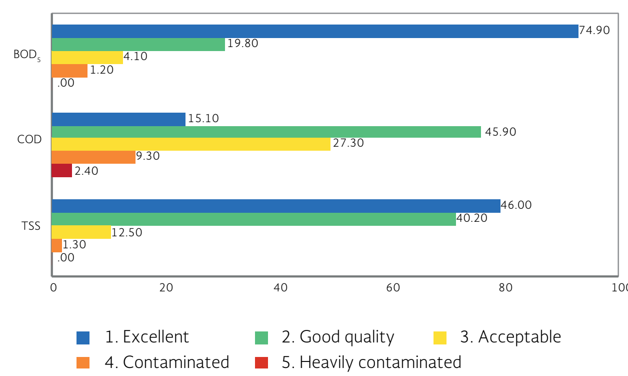
Number of plants in operation	98
Installed capacity (m^3/s)	2.608
Processed flow (m^3/s)	2.133

Surface water quality, 2016

Number of monitoring sites per water quality indicator

BOD_5	50
COD	50
TSS	50

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

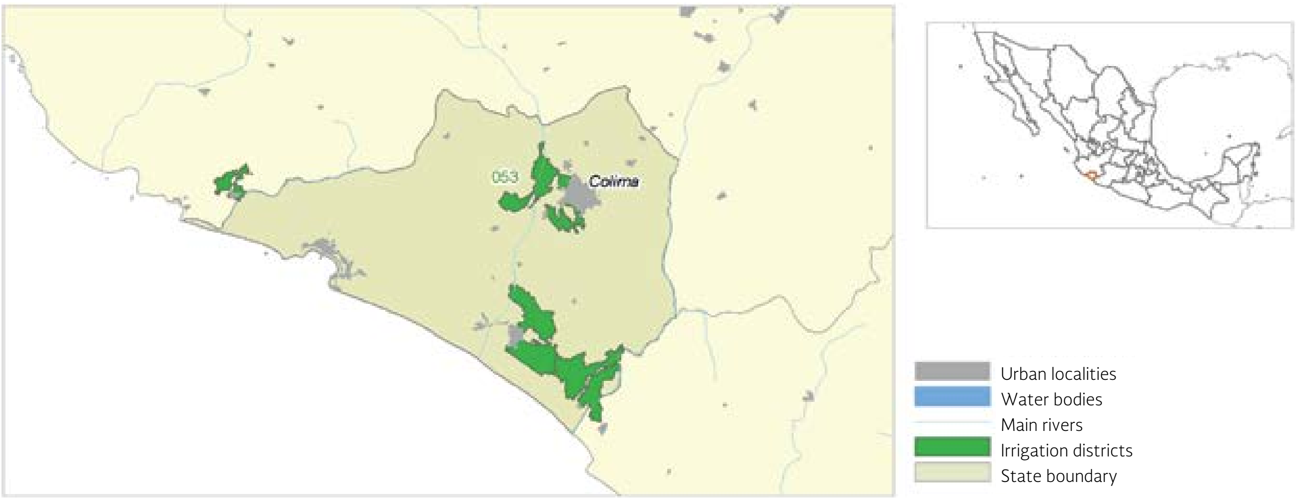
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	99.08	98.20	97.07	96.96
Urban	99.55	98.82	98.19	98.13
Rural	94.33	92.04	85.84	85.35

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

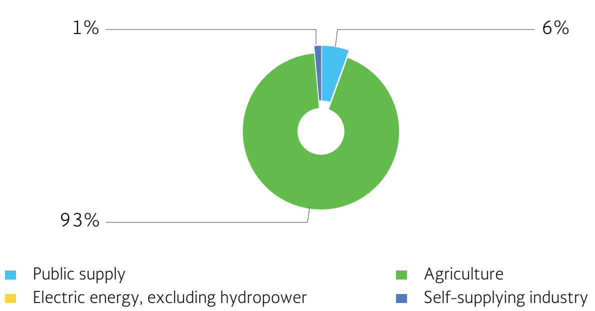
6. Colima

Contextual data		
Number of municipalities	10	
Total population, 2016	735 724	Inhabitants
Urban	661 444	Inhabitants
Rural	74 279	Inhabitants
Total population, 2030	891 050	Inhabitants
Annual normal precipitation 1981-2010	896	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	73	14
Installed capacity (m³/s)	2.386	0.451
Processed flow (m³/s)	1.662	0.292



Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	320	1 355	1 675
Public supply	59	41	100
Self-supplying industry	21	4	25
Electric energy, excluding hydropower	0	0	0
Total	400	1 400	1 800

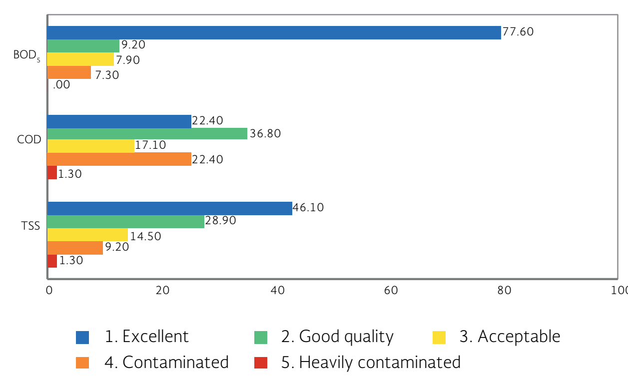
Non-consumptive	Surface water
Hydropower plants (Allocated volume)	400

Municipal purification plants, 2016	
Number of plants in operation	58
Installed capacity (m³/s)	0.014
Processed flow (m³/s)	0.005

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	27
COD	27
TSS	51

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

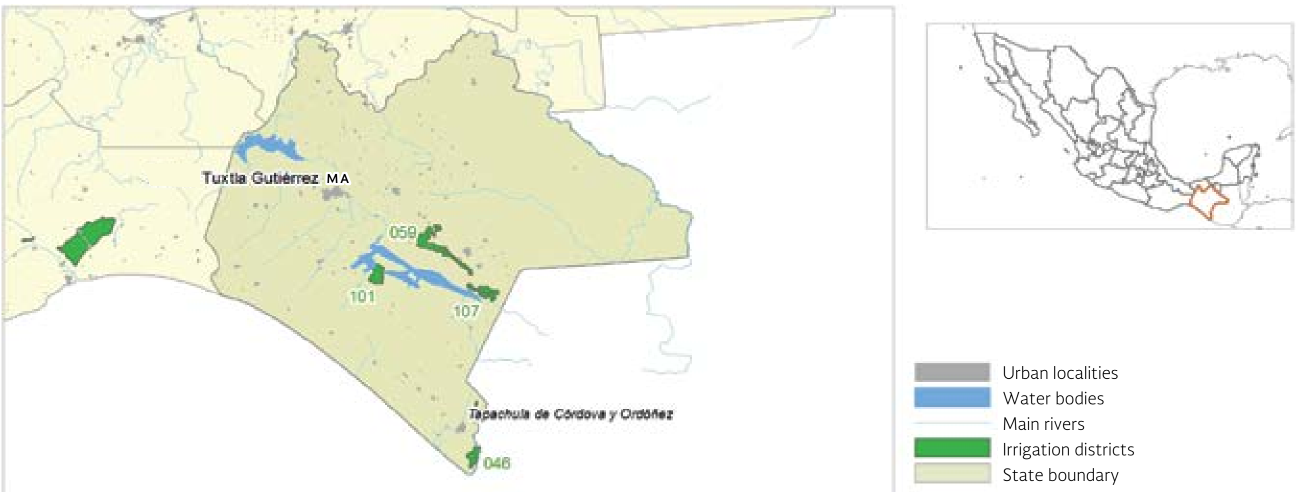
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	99.54	98.98	99.06	98.91
Urban	99.85	99.39	99.31	99.21
Rural	97.01	95.65	97.00	96.46

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

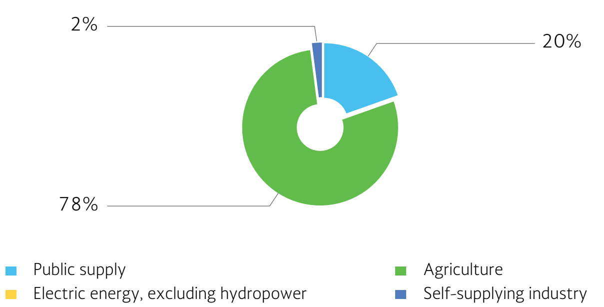
7. Chiapas

Contextual data		
Number of municipalities	118	
Total population, 2016	5 317 960	Inhabitants
Urban	2 630 682	Inhabitants
Rural	2 687 278	Inhabitants
Total population, 2030	6 129 218	Inhabitants
Annual normal precipitation 1981-2010	1 923	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	35	114
Installed capacity (m³/s)	1.923	2.320
Processed flow (m³/s)	1.285	1.988



Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	411	1 154	1 565
Public supply	63	328	391
Self-supplying industry	38	3	41
Electric energy, excluding hydropower	0	0	0
Total	512	1 485	1 997

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	512

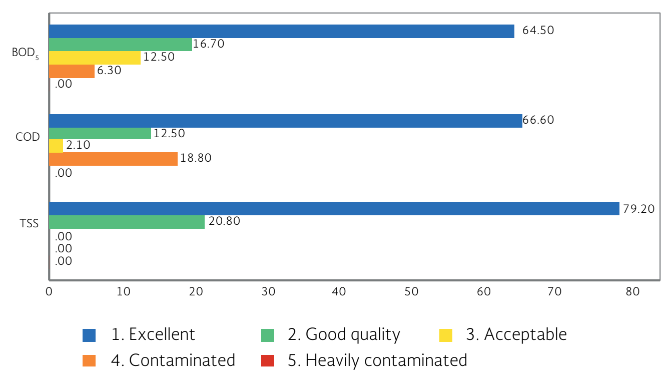
Municipal purification plants, 2016

Number of plants in operation	6
Installed capacity (m³/s)	4.740
Processed flow (m³/s)	2.608

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	172
COD	172
TSS	222

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	88.30	86.46	86.93	84.42
Urban	93.89	93.01	97.50	96.34
Rural	82.77	79.98	76.47	72.63

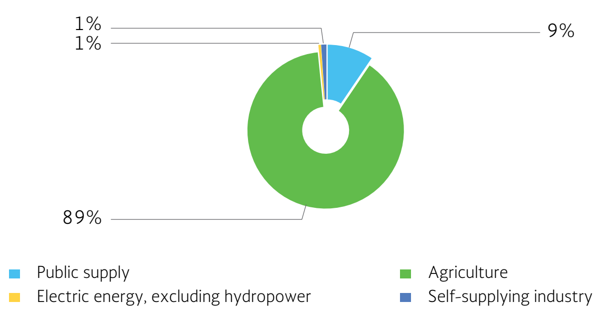
Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **“Access” for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as “tap water in household or plot”; in order to distinguish these forms, “Access corresponds to “Drinking water coverage” employed in the 2015 and previous editions of SWM. Similarly, for sewerage, “drainage” refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; “public network or septic tank” is used to distinguish these elements, “drainage” corresponds to **“sewerage coverage”** used in the 2015 and previous editions of SWM.

8. Chihuahua

Contextual data		
Number of municipalities	67	
Total population, 2016	3 746 281	Inhabitants
Urban	3 191 714	Inhabitants
Rural	554 568	Inhabitants
Total population, 2030	4 177 815	Inhabitants
Annual normal precipitation 1981-2010	377	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	184	15
Installed capacity (m³/s)	10.288	0.655
Processed flow (m³/s)	7.032	0.283

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	2 648	1 943	4 591
Public supply	439	51	490
Self-supplying industry	48	8	56
Electric energy, excluding hydropower	28	0	28
Total	3 162	2 002	5 164

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	3 162

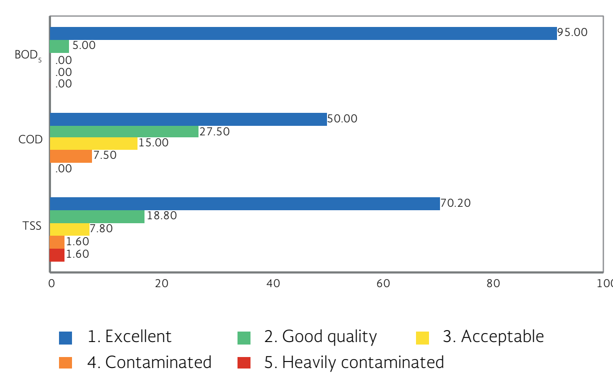
Municipal purification plants, 2016

Number of plants in operation	4
Installed capacity (m³/s)	0.650
Processed flow (m³/s)	0.380

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	76
COD	76
TSS	76

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	96.15	95.73	93.15	92.94
Urban	98.67	98.30	97.85	97.74
Rural	80.57	79.83	64.11	63.24

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

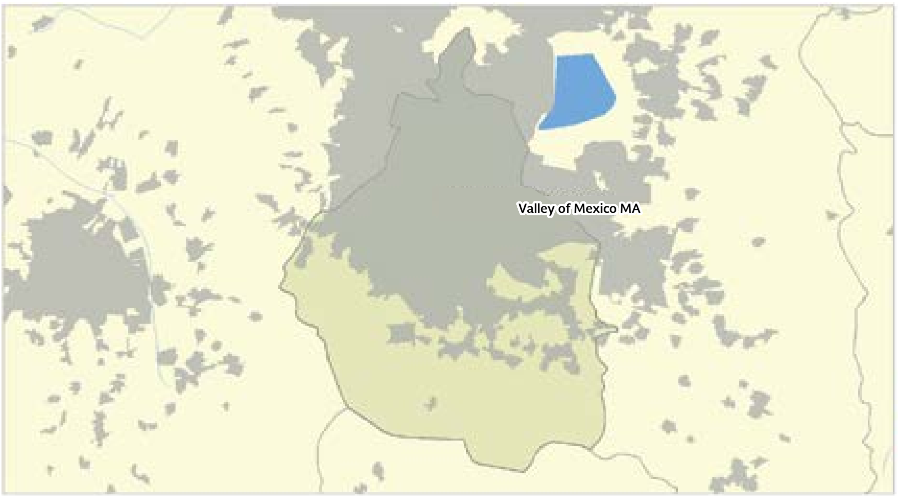
9. Mexico City

Contextual data

Number of municipalities	16	
Total population, 2016	8 833 416	Inhabitants
Urban	8 780 361	Inhabitants
Rural	53 055	Inhabitants
Total population, 2030	8 439 786	Inhabitants
Annual normal precipitation 1981-2010	869	mm

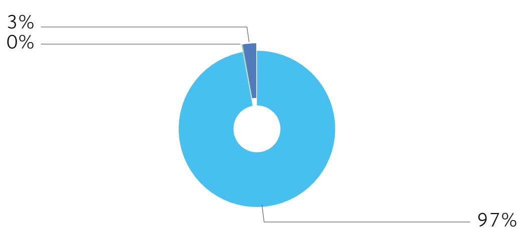
Wastewater treatment plants, 2016

	Municipal wastewater	Industrial wastewater
Number of plants in operation	29	8
Installed capacity (m³/s)	5.605	0.008
Processed flow (m³/s)	7.689	0.006



Urban localities
Water bodies
Main rivers
Irrigation districts
State boundary

Water uses, 2016 (hm³/year)



Public supply
Electric energy, excluding hydropower
Agriculture
Self-supplying industry

Consumptive uses	Groundwater	Surface water	Total
Agriculture	1	1	1
Public supply	781	309	1 090
Self-supplying industry	31	<0.5	31
Electric energy, excluding hydropower	0	0	0
Total	812	310	1 122

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	812

Municipal purification plants, 2016

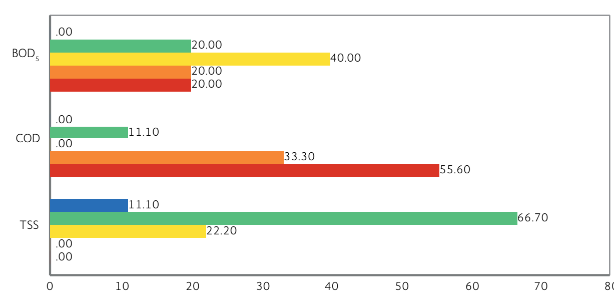
Number of plants in operation	47
Installed capacity (m³/s)	4.999
Processed flow (m³/s)	3.370

Surface water quality, 2016

Number of monitoring sites per water quality indicator

BOD_5	5
COD	9
TSS	9

Site distribution per indicator and classification (%)*



1. Excellent
2. Good quality
3. Acceptable
4. Contaminated
5. Heavily contaminated

Coverages, 2015 (%)

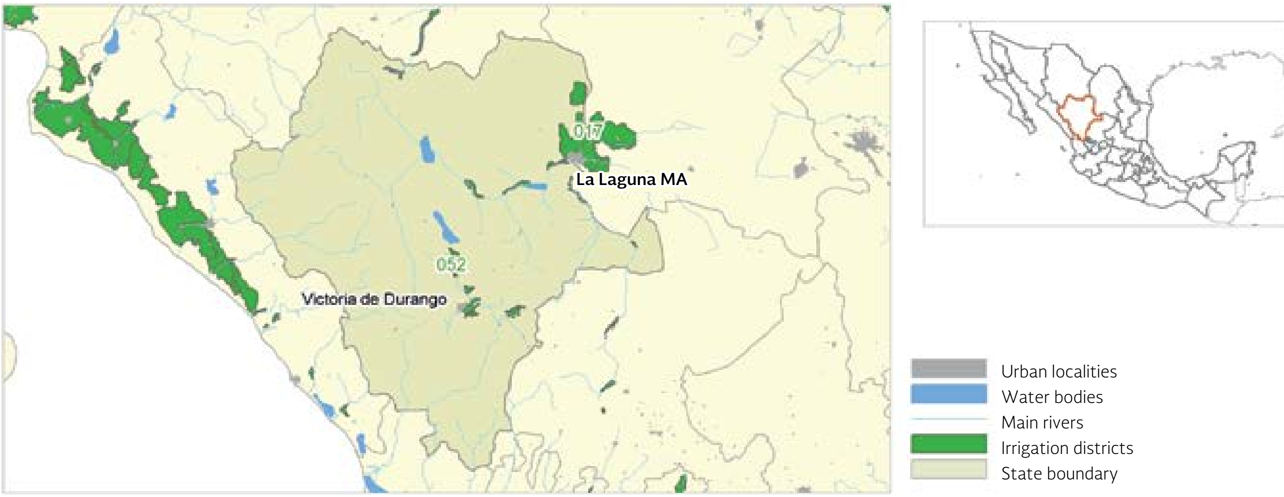
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	98.91	98.58	98.83	98.51
Urban	99.09	98.80	98.84	98.54
Rural	66.56	59.26	96.73	93.08

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

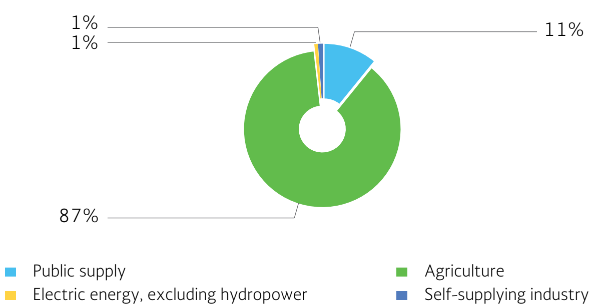
10. Durango

Contextual data		
Number of municipalities	39	
Total population, 2016	1 782 205	Inhabitants
Urban	1 247 012	Inhabitants
Rural	535 193	Inhabitants
Total population, 2030	1 983 389	Inhabitants
Annual normal precipitation 1981-2010	506	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	231	43
Installed capacity (m^3/s)	4.641	1.078
Processed flow (m^3/s)	3.508	0.622



Water uses, 2016 (hm^3/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	625	751	1 376
Public supply	142	29	171
Self-supplying industry	15	2	17
Electric energy, excluding hydropower	12	0	12
Total	793	782	1 575

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	793

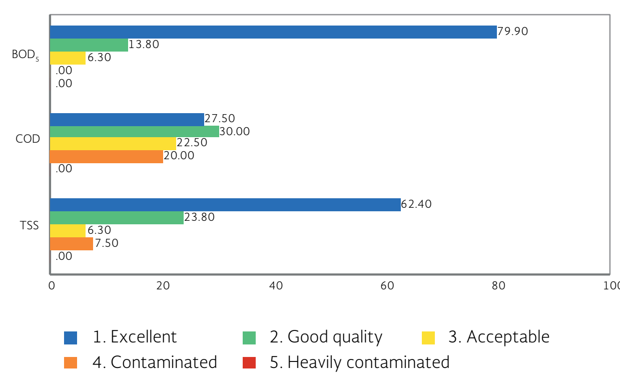
Municipal purification plants, 2016

Number of plants in operation	61
Installed capacity (m^3/s)	0.199
Processed flow (m^3/s)	0.195

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	80
COD	80
TSS	80

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

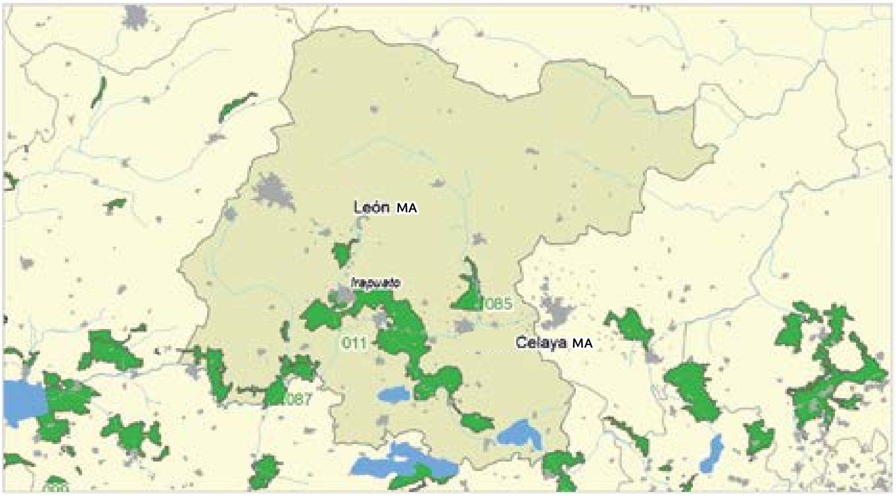
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	97.33	96.67	91.83	91.18
Urban	99.68	99.20	98.03	97.84
Rural	91.76	90.66	77.14	75.37

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

11. Guanajuato

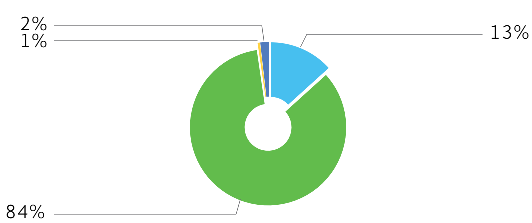
Contextual data		
Number of municipalities	46	
Total population, 2016	5 864 016	Inhabitants
Urban	4 105 930	Inhabitants
Rural	1 758 087	Inhabitants
Total population, 2030	6 361 401	Inhabitants
Annual normal precipitation 1981-2010	605	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	75	120
Installed capacity (m³/s)	7.560	0.881
Processed flow (m³/s)	5.523	0.630



Urban localities
Water bodies
Main rivers
Irrigation districts
State boundary

Water uses, 2016 (hm³/year)



Public supply
Electric energy, excluding hydropower
Agriculture
Self-supplying industry

Consumptive uses	Groundwater	Surface water	Total
Agriculture	2 122	1 360	3 482
Public supply	454	94	548
Self-supplying industry	74	<0.5	75
Electric energy, excluding hydropower	21	0	21
Total	2 671	1 455	4 125

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	2 671

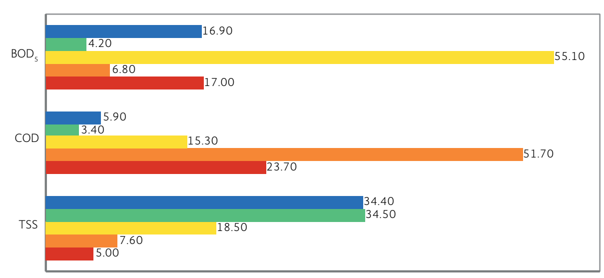
Municipal purification plants, 2016

Number of plants in operation	30
Installed capacity (m³/s)	0.680
Processed flow (m³/s)	0.493

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	121
COD	121
TSS	122

Site distribution per indicator and classification (%)*



1. Excellent
2. Good quality
3. Acceptable
4. Contaminated
5. Heavily contaminated

Coverages, 2015 (%)

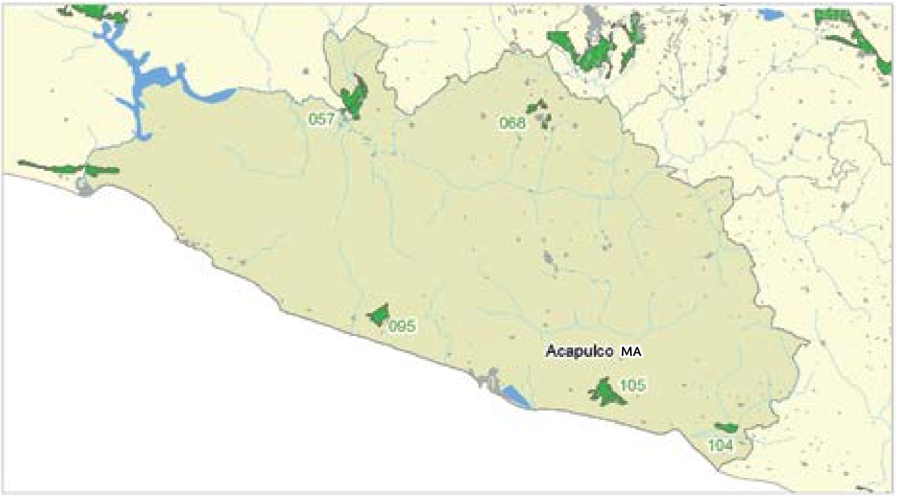
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	96.65	95.76	93.90	92.69
Urban	97.92	97.17	98.06	97.38
Rural	93.52	92.31	83.69	81.22

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

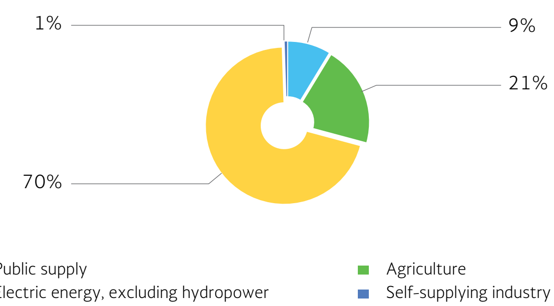
12. Guerrero

Contextual data		
Number of municipalities	81	
Total population, 2016	3 588 255	Inhabitants
Urban	2 118 847	Inhabitants
Rural	1 469 409	Inhabitants
Total population, 2030	3 772 110	Inhabitants
Annual normal precipitation 1981-2010	1 160	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	64	7
Installed capacity (m³/s)	4.394	0.023
Processed flow (m³/s)	3.721	0.019



Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	131	780	911
Public supply	173	212	385
Self-supplying industry	22	<0.5	22
Electric energy, excluding hydropower	0	3 122	3 122
Total	326	4 115	4 440

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	326

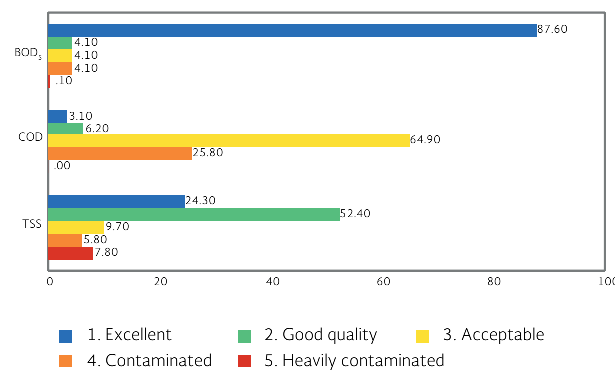
Municipal purification plants, 2016

Number of plants in operation	13
Installed capacity (m³/s)	3.548
Processed flow (m³/s)	3.186

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	97
COD	97
TSS	206

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

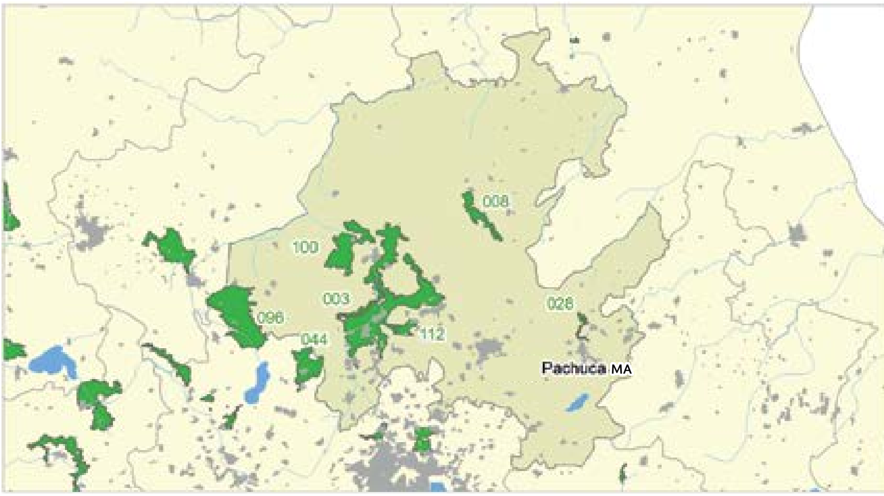
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	86.29	84.24	81.74	77.12
Urban	90.41	88.76	94.32	91.71
Rural	80.25	77.60	63.28	55.71

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

13. Hidalgo

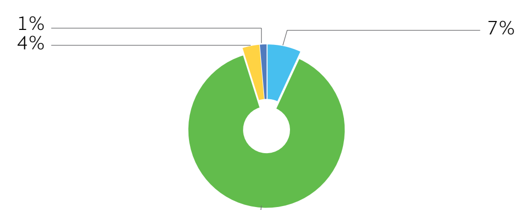
Contextual data		
Number of municipalities	84	
Total population, 2016	2 913 152	Inhabitants
Urban	1 601 469	Inhabitants
Rural	1 311 683	Inhabitants
Total population, 2030	3 329 765	Inhabitants
Annual normal precipitation 1981-2010	725	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	51	45
Installed capacity (m^3/s)	24.122	1.841
Processed flow (m^3/s)	0.657	1.377



Urban localities
Water bodies
Main rivers
Irrigation districts
State boundary

Water uses, 2016 (hm^3/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	200	1 896	2 095
Public supply	125	39	163
Self-supplying industry	19	14	33
Electric energy, excluding hydropower	61	22	83
Total	404	1 970	2 374

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	404

Municipal purification plants, 2016

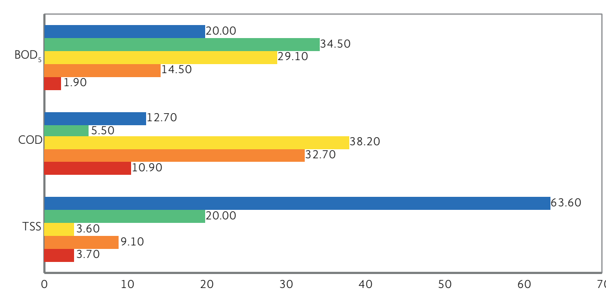
Number of plants in operation	20
Installed capacity (m^3/s)	0.393
Processed flow (m^3/s)	0.358

Surface water quality, 2016

Number of monitoring sites per water quality indicator

BOD_5	48
COD	48
TSS	48

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

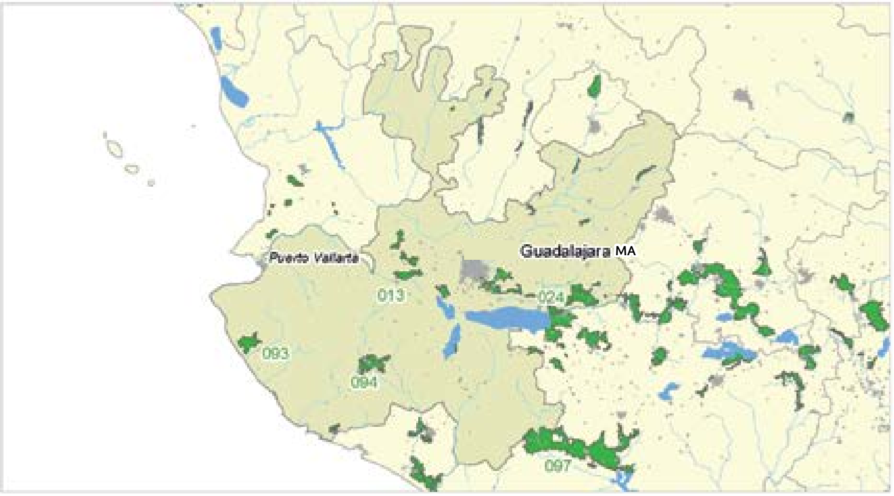
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	95.23	94.08	91.09	89.41
Urban	98.52	97.89	97.93	97.08
Rural	91.61	89.89	83.56	80.99

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

14. Jalisco

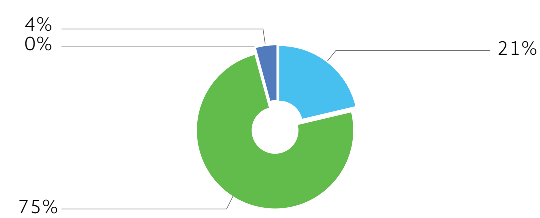
Contextual data		
Number of municipalities	125	
Total population, 2016	8 022 181	Inhabitants
Urban	6 987 669	Inhabitants
Rural	1 034 512	Inhabitants
Total population, 2030	9 102 259	Inhabitants
Annual normal precipitation 1981-2010	844	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	134	96
Installed capacity (m³/s)	15.277	1.841
Processed flow (m³/s)	12.701	1.735



Urban localities
Water bodies
Main rivers
Irrigation districts
State boundary

Water uses, 2016 (hm³/year)



Public supply
Electric energy, excluding hydropower
Agriculture
Self-supplying industry

Consumptive uses	Groundwater	Surface water	Total
Agriculture	1 990	1 729	3 719
Public supply	365	699	1 064
Self-supplying industry	203	8	211
Electric energy, excluding hydropower	0	<0.5	<0.5
Total	**2 557**	**2 436**	**4 994**

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	2 557

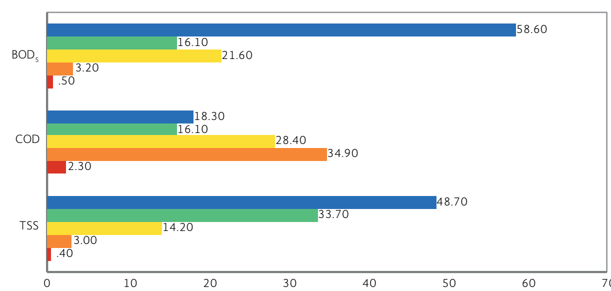
Municipal purification plants, 2016

Number of plants in operation	42
Installed capacity (m³/s)	16.281
Processed flow (m³/s)	12.281

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	230
COD	230
TSS	279

Site distribution per indicator and classification (%)*



1. Excellent
2. Good quality
3. Acceptable
4. Contaminated
5. Heavily contaminated

Coverages, 2015 (%)

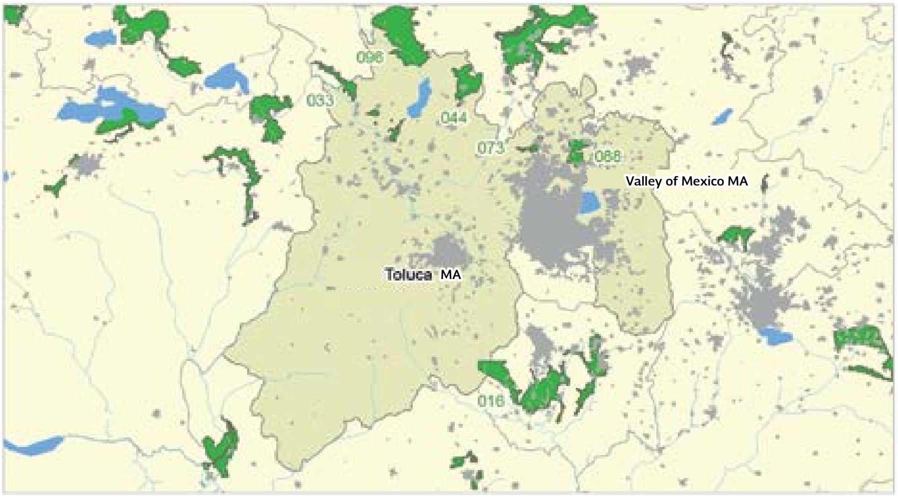
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	98.59	98.03	98.17	97.37
Urban	99.11	98.61	99.01	98.68
Rural	95.30	94.25	92.79	89.01

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

15. State of Mexico

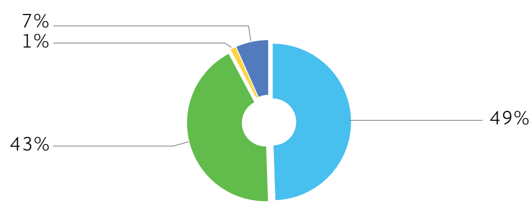
Contextual data		
Number of municipalities	125	
Total population, 2016	17 118 525	Inhabitants
Urban	15 039 591	Inhabitants
Rural	2 078 934	Inhabitants
Total population, 2030	20 167 433	Inhabitants
Annual normal precipitation 1981-2010	900	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	124	281
Installed capacity (m³/s)	9.234	3.300
Processed flow (m³/s)	10.073	2.428



Urban localities
Water bodies
Main rivers
Irrigation districts
State boundary

Water uses, 2016 (hm³/year)



Public supply
Electric energy, excluding hydropower
Agriculture
Self-supplying industry

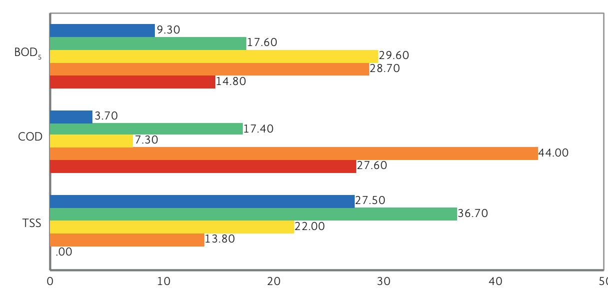
Consumptive uses	Groundwater	Surface water	Total
Agriculture	361	821	1 182
Public supply	1 032	334	1 366
Self-supplying industry	146	38	184
Electric energy, excluding hydropower	7	24	31
Total	1 546	1 216	2 762

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	1 546

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	111
COD	112
TSS	112

Site distribution per indicator and classification (%)*



1. Excellent
2. Good quality
3. Acceptable
4. Contaminated
5. Heavily contaminated

Municipal purification plants, 2016

Number of plants in operation	12
Installed capacity (m³/s)	22.171
Processed flow (m³/s)	16.744

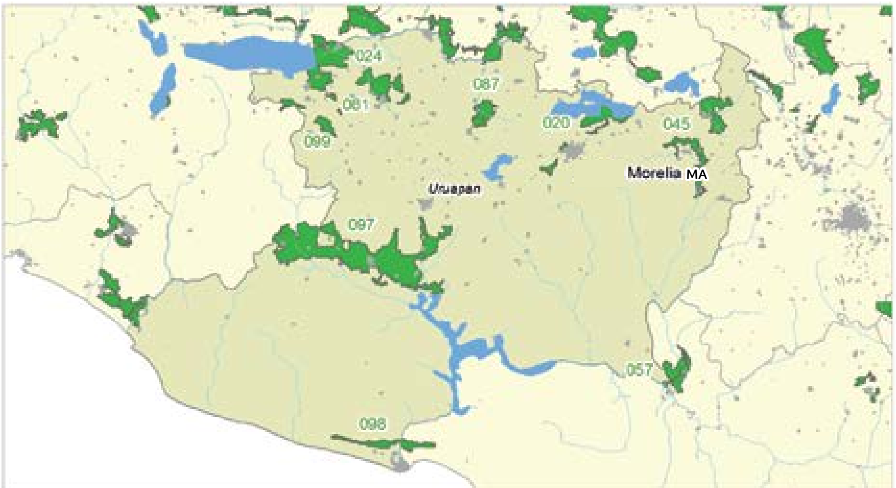
Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	96.30	95.66	95.54	93.65
Urban	97.51	97.10	97.70	96.54
Rural	88.83	87.72	82.20	75.77

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

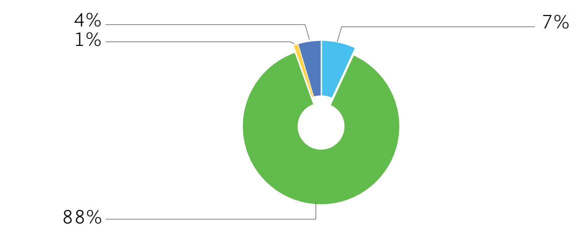
16. Michoacán de Ocampo

Contextual data			Wastewater treatment plants, 2016		
Number of municipalities	113			Municipal wastewater	Industrial wastewater
Total population, 2016	4 627 902	Inhabitants	Number of plants in operation	43	136
Urban	3 164 362	Inhabitants	Installed capacity (m³/s)	4.107	3.730
Rural	1 463 540	Inhabitants	Processed flow (m³/s)	3.147	3.191
Total population, 2030	4 960 773	Inhabitants			
Annual normal precipitation 1981-2010	848	mm			



Urban localities
Water bodies
Main rivers
Irrigation districts
State boundary

Water uses, 2016 (hm³/year)



Public supply
Electric energy, excluding hydropower
Agriculture
Self-supplying industry

Consumptive uses	Groundwater	Surface water	Total
Agriculture	1 092	3 715	4 807
Public supply	169	208	377
Self-supplying industry	39	213	251
Electric energy, excluding hydropower	48	0	48
Total	1 347	4 136	5 483

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	1 347

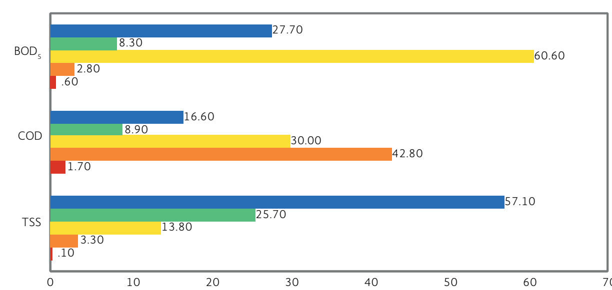
Municipal purification plants, 2016

Number of plants in operation	4
Installed capacity (m³/s)	2.690
Processed flow (m³/s)	2.060

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	180
COD	180
TSS	210

Site distribution per indicator and classification (%)*



1. Excellent
2. Good quality
3. Acceptable
4. Contaminated
5. Heavily contaminated

Coverages, 2015 (%)

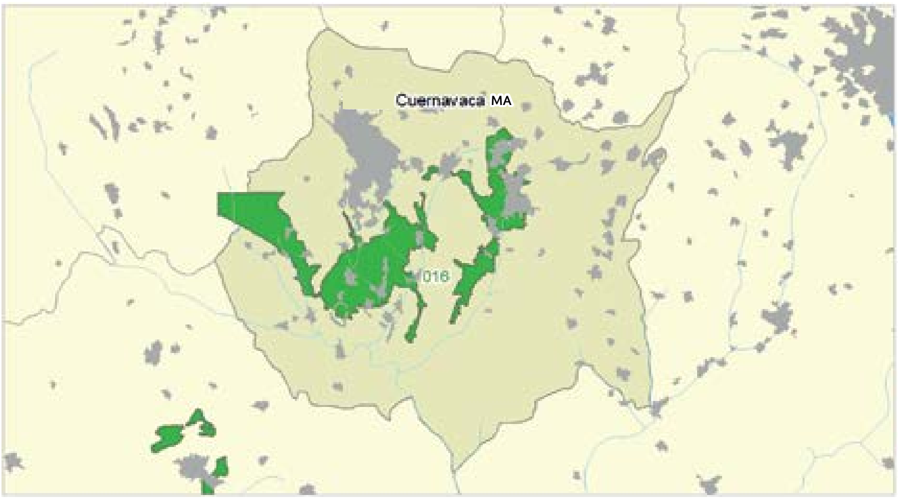
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	96.84	95.64	92.20	89.32
Urban	98.04	96.98	95.79	94.08
Rural	94.23	92.70	84.33	78.87

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

17. Morelos

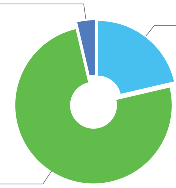
Contextual data		
Number of municipalities	33	
Total population, 2016	1 943 044	Inhabitants
Urban	1 614 350	Inhabitants
Rural	328 694	Inhabitants
Total population, 2030	2 222 863	Inhabitants
Annual normal precipitation 1981-2010	1 000	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	58	104
Installed capacity (m³/s)	2.922	0.608
Processed flow (m³/s)	1.979	0.569



Urban localities
Water bodies
Main rivers
Irrigation districts
State boundary

Water uses, 2016 (hm³/year)



Public supply
Electric energy, excluding hydropower
Agriculture
Self-supplying industry

Consumptive uses	Groundwater	Surface water	Total
Agriculture	110	877	987
Public supply	245	36	281
Self-supplying industry	24	25	48
Electric energy, excluding hydropower	0	0	0
Total	378	938	1 316

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	378

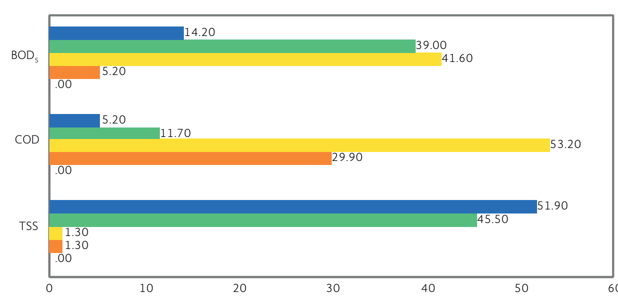
Municipal purification plants, 2016

Number of plants in operation	3
Installed capacity (m³/s)	0.006
Processed flow (m³/s)	0.003

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	76
COD	76
TSS	76

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

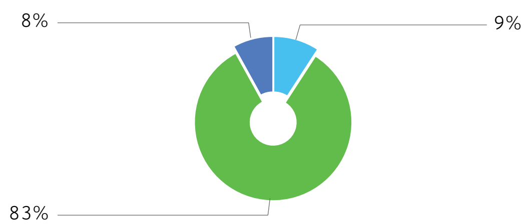
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	95.46	94.10	97.34	95.75
Urban	98.04	96.97	98.46	96.91
Rural	83.19	80.40	91.99	90.19

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

18. Nayarit

Contextual data			Wastewater treatment plants, 2016		
Number of municipalities	20			Municipal wastewater	Industrial wastewater
Total population, 2016	1 246 202	Inhabitants	Number of plants in operation	70	16
Urban	873 284	Inhabitants	Installed capacity (m³/s)	3.494	0.803
Rural	372 919	Inhabitants	Processed flow (m³/s)	2.510	0.803
Total population, 2030	1 544 709	Inhabitants			
Annual normal precipitation 1981-2010	1 227	mm			

Water uses, 2016 (hm³/year)



- Public supply
- Electric energy, excluding hydropower
- Agriculture
- Self-supplying industry

Consumptive uses	Groundwater	Surface water	Total
Agriculture	133	991	1 123
Public supply	104	20	124
Self-supplying industry	86	22	109
Electric energy, excluding hydropower	0	0	0
Total	323	1 033	1 356

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	323

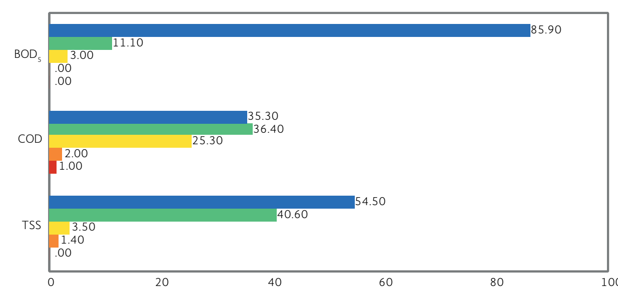
Municipal purification plants, 2016

Number of plants in operation	0
Installed capacity (m³/s)	0.000
Processed flow (m³/s)	0.000

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	97
COD	97
TSS	139

Site distribution per indicator and classification (%)*



- 1. Excellent
- 2. Good quality
- 3. Acceptable
- 4. Contaminated
- 5. Heavily contaminated

Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	96.66	95.59	94.04	93.44
Urban	99.39	98.72	98.67	98.43
Rural	90.49	88.53	83.57	82.18

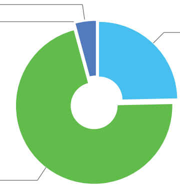
Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

19. Nuevo León

Contextual data		
Number of municipalities	51	
Total population, 2016	5 157 780	Inhabitants
Urban	4 878 911	Inhabitants
Rural	278 870	Inhabitants
Total population, 2030	6 097 769	Inhabitants
Annual normal precipitation 1981-2010	542	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	55	97
Installed capacity (m³/s)	15.030	4.113
Processed flow (m³/s)	11.771	2.976

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	646	830	1 476
Public supply	156	356	512
Self-supplying industry	87	0	87
Electric energy, excluding hydropower	<0.5	0	<0.5
Total	889	1 186	2 075

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	889

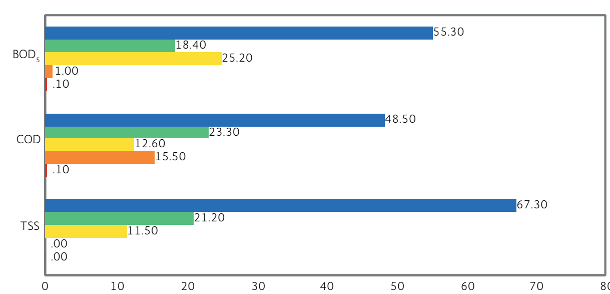
Municipal purification plants, 2016

Number of plants in operation	13
Installed capacity (m³/s)	15.348
Processed flow (m³/s)	6.082

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	102
COD	102
TSS	103

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

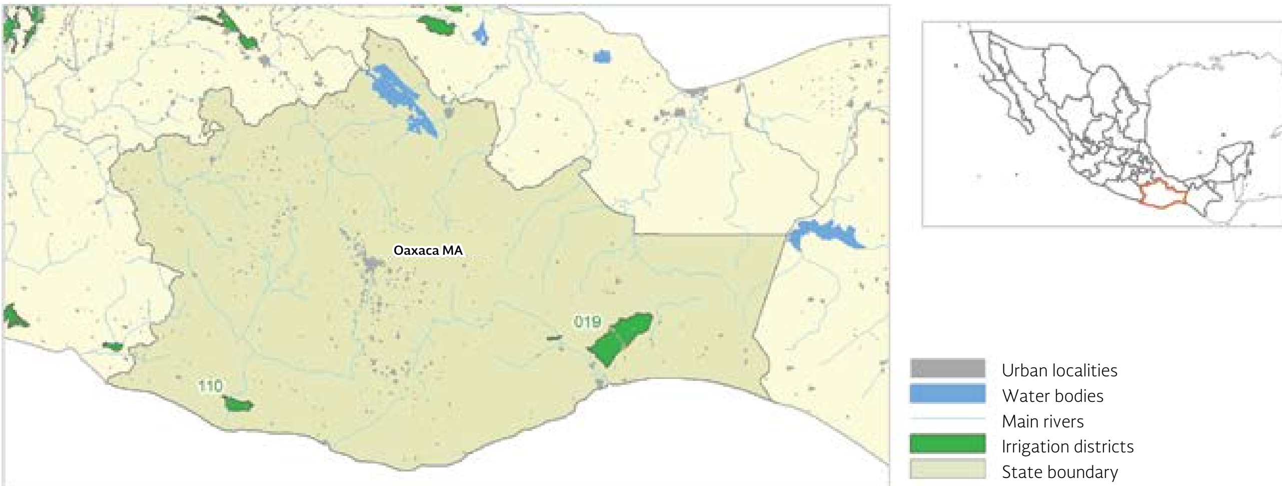
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	98.80	98.34	97.64	97.55
Urban	99.36	99.03	98.75	98.67
Rural	90.31	87.88	80.85	80.54

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

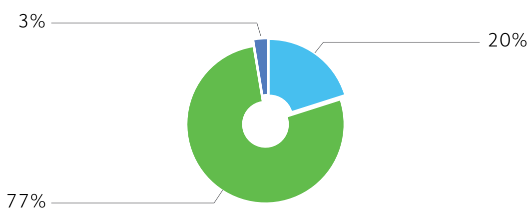
20. Oaxaca

Contextual data		
Number of municipalities	570	
Total population, 2016	4 037 357	Inhabitants
Urban	1 941 618	Inhabitants
Rural	2 095 739	Inhabitants
Total population, 2030	4 293 423	Inhabitants
Annual normal precipitation 1981-2010	977	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	75	22
Installed capacity (m³/s)	1.598	3.388
Processed flow (m³/s)	1.071	3.068



Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	252	781	1 033
Public supply	127	141	269
Self-supplying industry	27	8	35
Electric energy, excluding hydropower	0	0	0
Total	406	931	1 337

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	406

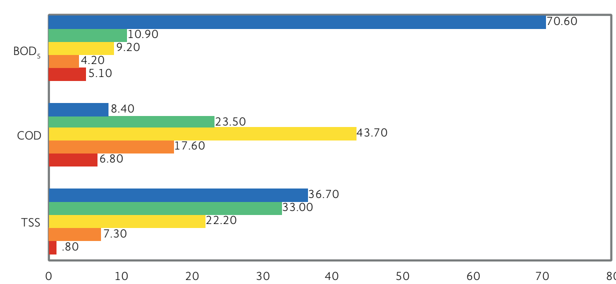
Municipal purification plants, 2016

Number of plants in operation	16
Installed capacity (m³/s)	1.516
Processed flow (m³/s)	0.949

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	119
COD	119
TSS	263

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	86.88	85.40	73.38	71.76
Urban	91.74	90.74	89.51	88.36
Rural	82.42	80.39	58.24	56.18

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

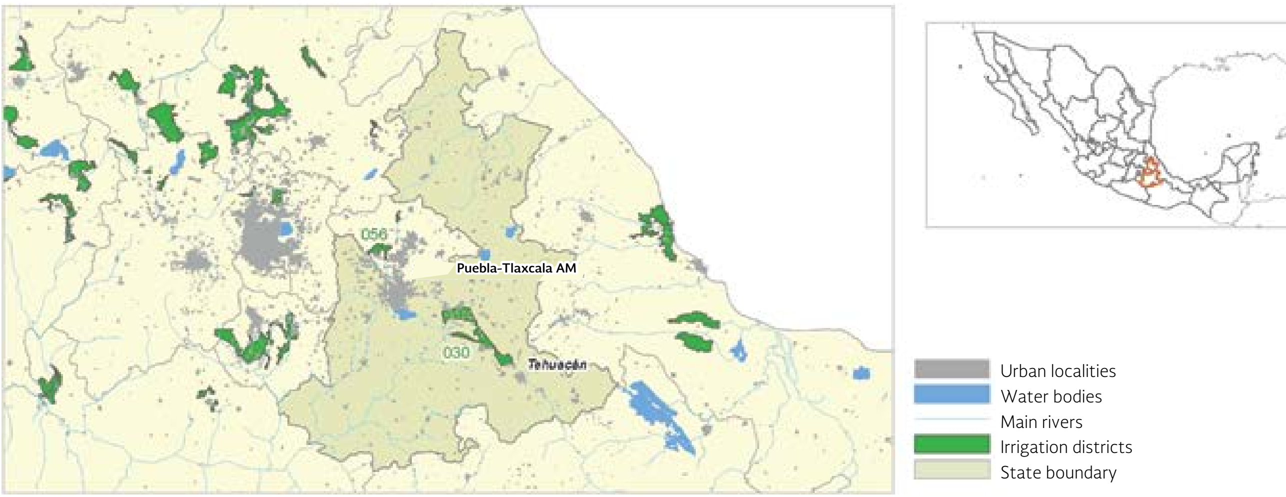
21. Puebla

Contextual data

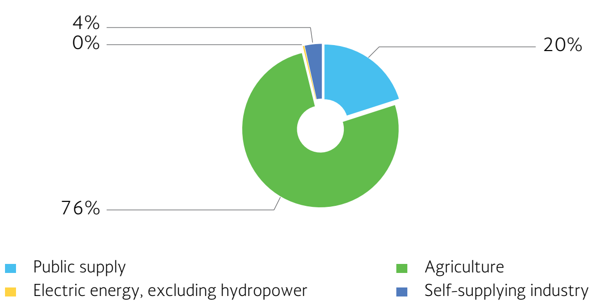
Number of municipalities	217	
Total population, 2016	6 254 597	Inhabitants
Urban	4 543 523	Inhabitants
Rural	1 711 074	Inhabitants
Total population, 2030	6 942 481	Inhabitants
Annual normal precipitation 1981-2010	947	mm

Wastewater treatment plants, 2016

	Municipal wastewater	Industrial wastewater
Number of plants in operation	85	219
Installed capacity (m^3/s)	3.517	1.102
Processed flow (m^3/s)	3.593	0.961



Water uses, 2016 (hm^3/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	619	1 010	1 628
Public supply	250	178	429
Self-supplying industry	45	31	75
Electric energy, excluding hydropower	6	0	6
Total	920	1 219	2 139

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	920

Municipal purification plants, 2016

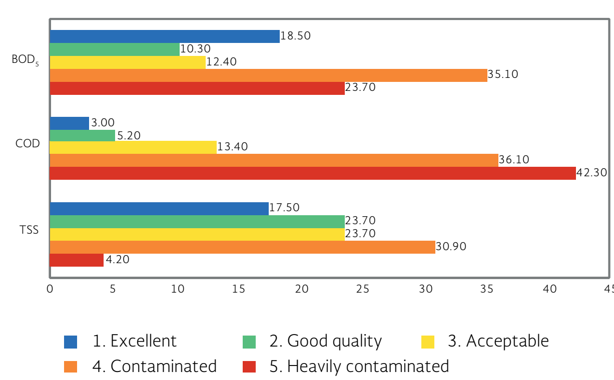
Number of plants in operation	5
Installed capacity (m^3/s)	0.815
Processed flow (m^3/s)	0.515

Surface water quality, 2016

Number of monitoring sites per water quality indicator

BOD_5	99
COD	99
TSS	99

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	93.87	92.77	90.83	88.79
Urban	96.24	95.47	95.90	94.40
Rural	87.75	85.80	77.77	74.31

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

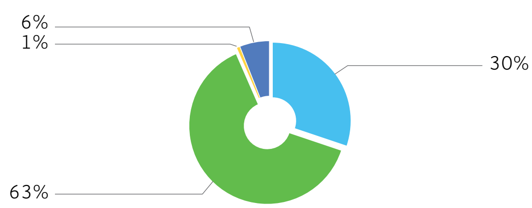
22. Querétaro

Contextual data		
Number of municipalities	18	
Total population, 2016	2 034 030	Inhabitants
Urban	1 444 469	Inhabitants
Rural	589 561	Inhabitants
Total population, 2030	2 403 016	Inhabitants
Annual normal precipitation 1981-2010	609	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	51	156
Installed capacity (m^3/s)	2.449	1.246
Processed flow (m^3/s)	1.892	0.662

Urban localities
Water bodies
Main rivers
Irrigation districts
State boundary

Water uses, 2016 (hm^3/year)



Public supply
Electric energy, excluding hydropower
Agriculture
Self-supplying industry

Consumptive uses	Groundwater	Surface water	Total
Agriculture	469	172	640
Public supply	153	152	305
Self-supplying industry	60	1	61
Electric energy, excluding hydropower	6	0	6
Total	688	324	1 012

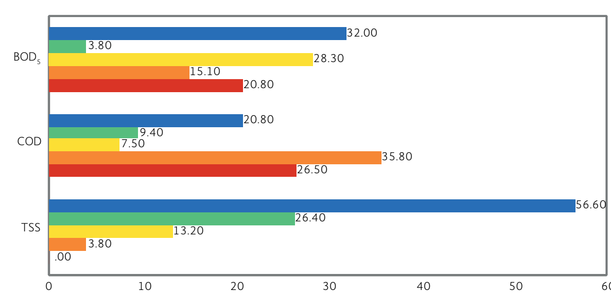
Non-consumptive	Surface water
Hydropower plants (Allocated volume)	688

Municipal purification plants, 2016	
Number of plants in operation	5
Installed capacity (m^3/s)	1.602
Processed flow (m^3/s)	1.592

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	56
COD	56
TSS	56

Site distribution per indicator and classification (%)*



1. Excellent
2. Good quality
3. Acceptable
4. Contaminated
5. Heavily contaminated

Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	97.62	96.63	95.08	94.64
Urban	99.25	98.72	98.34	98.25
Rural	94.04	92.04	87.91	86.67

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

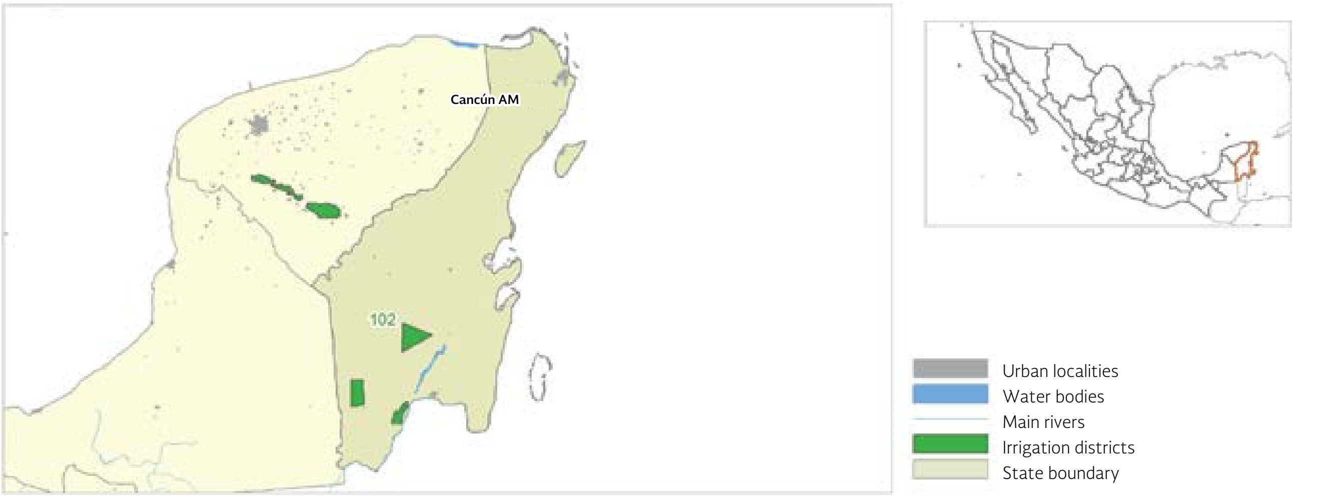
23. Quintana Roo

Contextual data

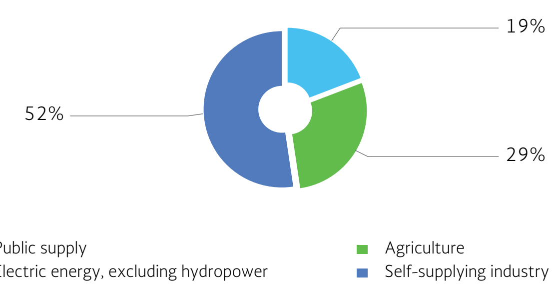
Number of municipalities	11	
Total population, 2016	1 619 762	Inhabitants
Urban	1 430 616	Inhabitants
Rural	189 147	Inhabitants
Total population, 2030	2 232 702	Inhabitants
Annual normal precipitation 1981-2010	1 267	mm

Wastewater treatment plants, 2016

	Municipal wastewater	Industrial wastewater
Number of plants in operation	36	4
Installed capacity (m³/s)	2.581	0.060
Processed flow (m³/s)	1.774	0.055



Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	315	1	316
Public supply	213	<0.5	213
Self-supplying industry	582	<0.5	582
Electric energy, excluding hydropower	0	0	0
Total	1 110	1	1 111

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	1 110

Municipal purification plants, 2016

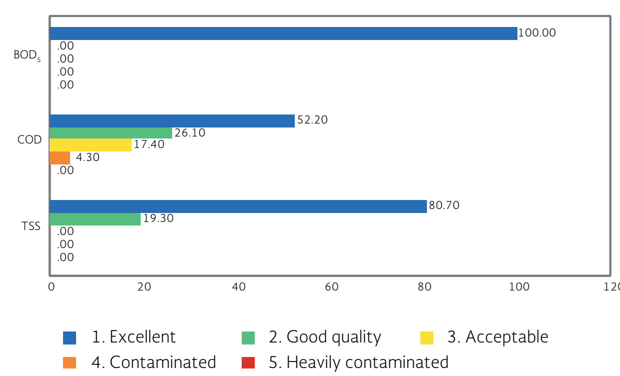
Number of plants in operation	0
Installed capacity (m³/s)	0.000
Processed flow (m³/s)	

Surface water quality, 2016

Number of monitoring sites per water quality indicator

BOD_5	23
COD	23
TSS	121

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	98.13	97.26	96.69	95.88
Urban	98.30	97.55	98.80	97.98
Rural	96.75	94.92	79.79	79.05

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

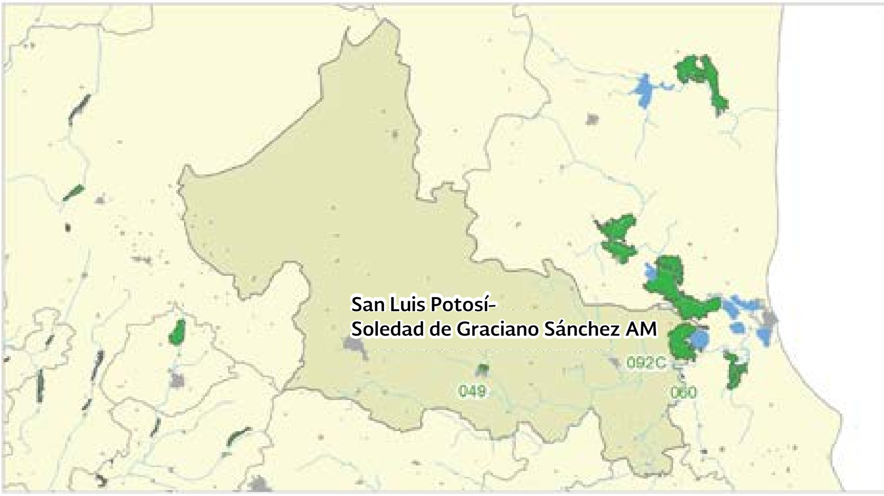
24. San Luis Potosí

Contextual data

Number of municipalities	58	
Total population, 2016	2 777 995	Inhabitants
Urban	1 811 772	Inhabitants
Rural	966 223	Inhabitants
Total population, 2030	3 055 130	Inhabitants
Annual normal precipitation 1981-2010	853	mm

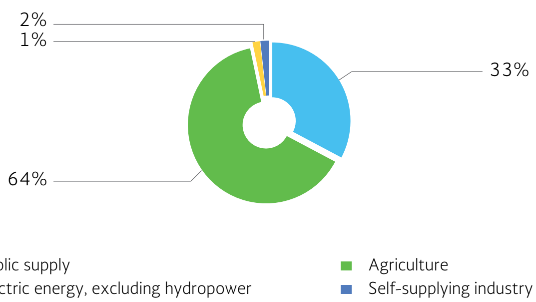
Wastewater treatment plants, 2016

	Municipal wastewater	Industrial wastewater
Number of plants in operation	43	60
Installed capacity (m³/s)	2.579	0.972
Processed flow (m³/s)	2.143	0.592



Urban localities
Water bodies
Main rivers
Irrigation districts
State boundary

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	551	728	1 280
Public supply	151	504	655
Self-supplying industry	23	12	35
Electric energy, excluding hydropower	17	14	31
Total	742	1 259	2 001

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	742

Municipal purification plants, 2016

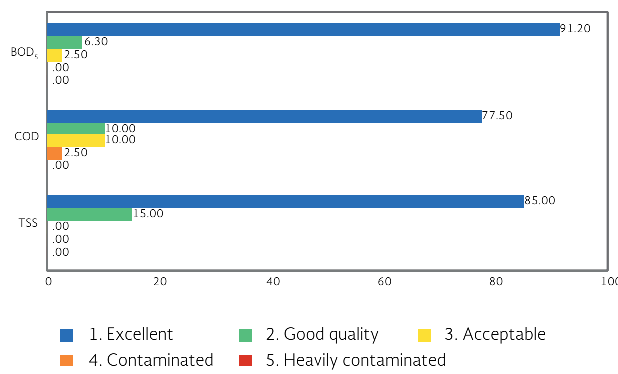
Number of plants in operation	15
Installed capacity (m³/s)	2.315
Processed flow (m³/s)	1.307

Surface water quality, 2016

Number of monitoring sites per water quality indicator

BOD_5	79
COD	79
TSS	79

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	90.72	89.24	86.01	85.25
Urban	98.08	97.10	97.06	96.89
Rural	77.10	74.70	65.56	63.71

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

25. Sinaloa

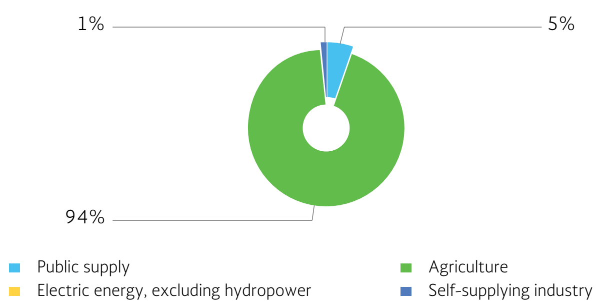
Contextual data

Number of municipalities	18	
Total population, 2016	3 009 952	Inhabitants
Urban	2 237 399	Inhabitants
Rural	772 553	Inhabitants
Total population, 2030	3 302 931	Inhabitants
Annual normal precipitation 1981-2010	728	mm

Wastewater treatment plants, 2016

	Municipal wastewater	Industrial wastewater
Number of plants in operation	282	105
Installed capacity (m³/s)	6.737	8.647
Processed flow (m³/s)	5.738	6.295

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	850	8 155	9 005
Public supply	229	280	509
Self-supplying industry	9	35	44
Electric energy, excluding hydropower	0	0	0
Total	1 088	8 470	9 559

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	1 088

Municipal purification plants, 2016

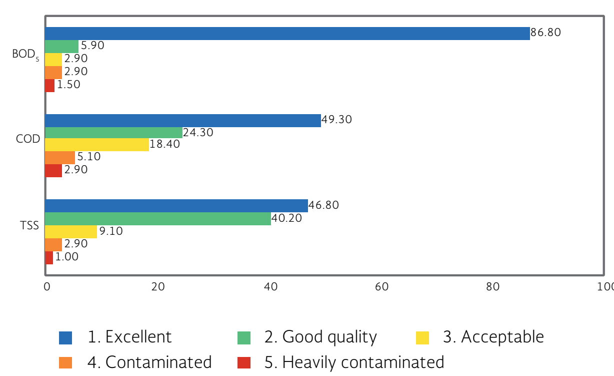
Number of plants in operation	143
Installed capacity (m³/s)	9.364
Processed flow (m³/s)	8.332

Surface water quality, 2016

Number of monitoring sites per water quality indicator

BOD_5	136
COD	136
TSS	211

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	98.17	96.90	93.96	92.85
Urban	99.54	98.67	97.73	97.01
Rural	94.15	91.73	82.97	80.70

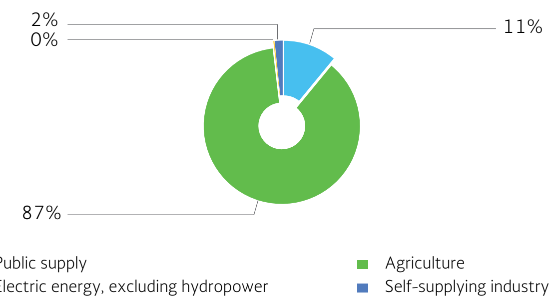
Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

26. Sonora

Contextual data		
Number of municipalities	72	
Total population, 2016	2 972 580	Inhabitants
Urban	2 559 798	Inhabitants
Rural	412 782	Inhabitants
Total population, 2030	3 476 930	Inhabitants
Annual normal precipitation 1981-2010	465	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	101	235
Installed capacity (m³/s)	7.995	6.458
Processed flow (m³/s)	4.725	6.255

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	2 184	3 952	6 137
Public supply	493	277	771
Self-supplying industry	112	4	116
Electric energy, excluding hydropower	9	7	16
Total	2 799	4 241	7 040

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	2 799

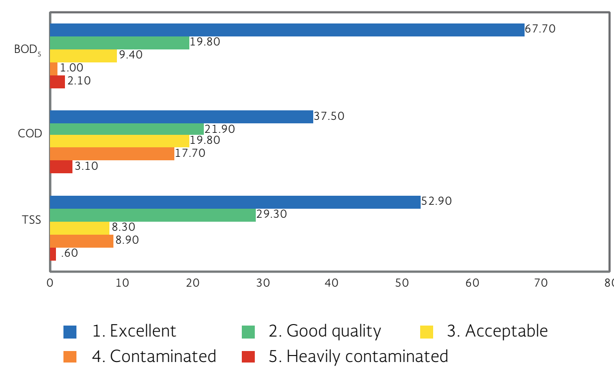
Municipal purification plants, 2016

Number of plants in operation	24
Installed capacity (m³/s)	5.577
Processed flow (m³/s)	2.293

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	96
COD	96
TSS	157

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	97.56	96.77	91.93	91.72
Urban	97.98	97.42	95.88	95.79
Rural	94.58	92.26	64.51	63.40

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

27. Tabasco

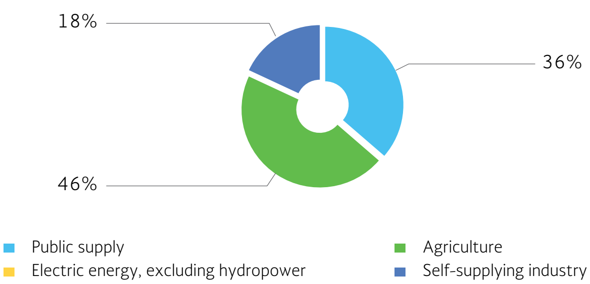
Contextual data

Number of municipalities	17	
Total population, 2016	2 407 860	Inhabitants
Urban	1 412 349	Inhabitants
Rural	995 511	Inhabitants
Total population, 2030	2 687 426	Inhabitants
Annual normal precipitation 1981-2010	2 184	mm

Wastewater treatment plants, 2016

	Municipal wastewater	Industrial wastewater
Number of plants in operation	80	144
Installed capacity (m^3/s)	2.816	0.963
Processed flow (m^3/s)	2.565	0.906

Water uses, 2016 (hm^3/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	129	102	231
Public supply	78	107	184
Self-supplying industry	32	59	92
Electric energy, excluding hydropower	0	0	0
Total	239	268	507

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	239

Municipal purification plants, 2016

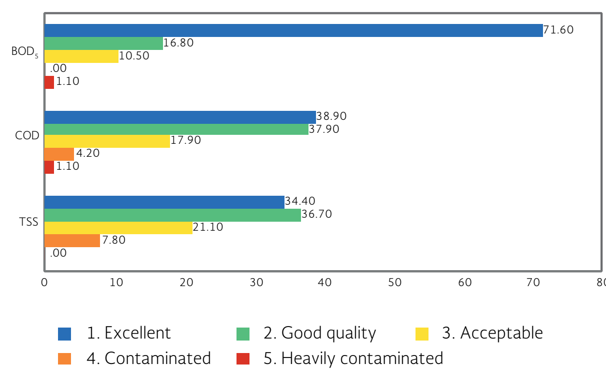
Number of plants in operation	39
Installed capacity (m^3/s)	9.960
Processed flow (m^3/s)	8.465

Surface water quality, 2016

Number of monitoring sites per water quality indicator

BOD_5	94
COD	94
TSS	127

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

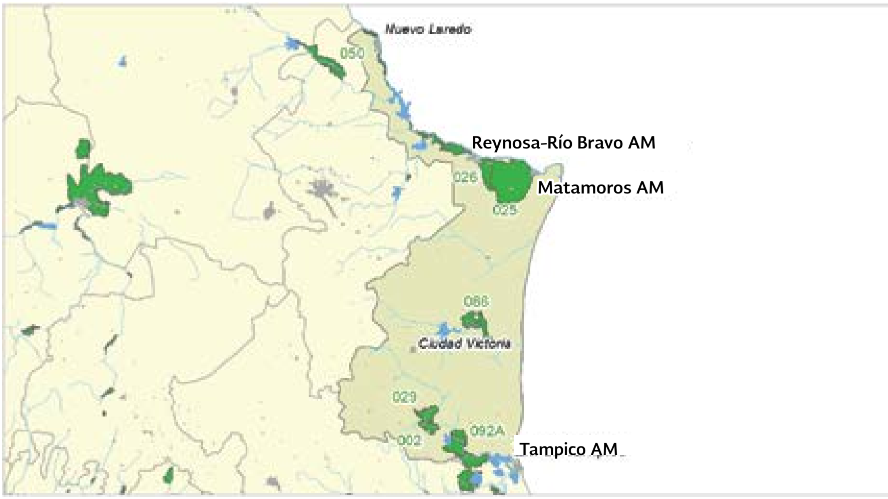
	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	91.94	89.78	97.27	95.50
Urban	96.87	95.80	98.42	97.13
Rural	83.57	81.07	95.61	93.14

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

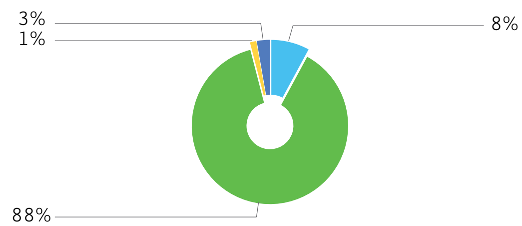
28. Tamaulipas

Contextual data		
Number of municipalities	43	
Total population, 2016	3 583 295	Inhabitants
Urban	3 140 378	Inhabitants
Rural	442 917	Inhabitants
Total population, 2030	4 069 115	Inhabitants
Annual normal precipitation 1981-2010	783	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	35	115
Installed capacity (m³/s)	7.760	8.459
Processed flow (m³/s)	5.372	7.917



Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	406	3 325	3 730
Public supply	42	293	335
Self-supplying industry	16	100	116
Electric energy, excluding hydropower	3	52	55
Total	467	3 770	4 237

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	467

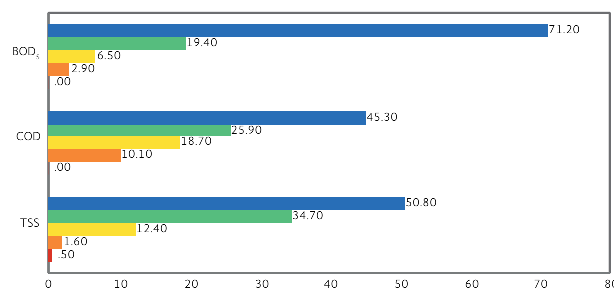
Municipal purification plants, 2016

Number of plants in operation	54
Installed capacity (m³/s)	15.091
Processed flow (m³/s)	11.899

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	138
COD	138
TSS	191

Site distribution per indicator and classification (%)*



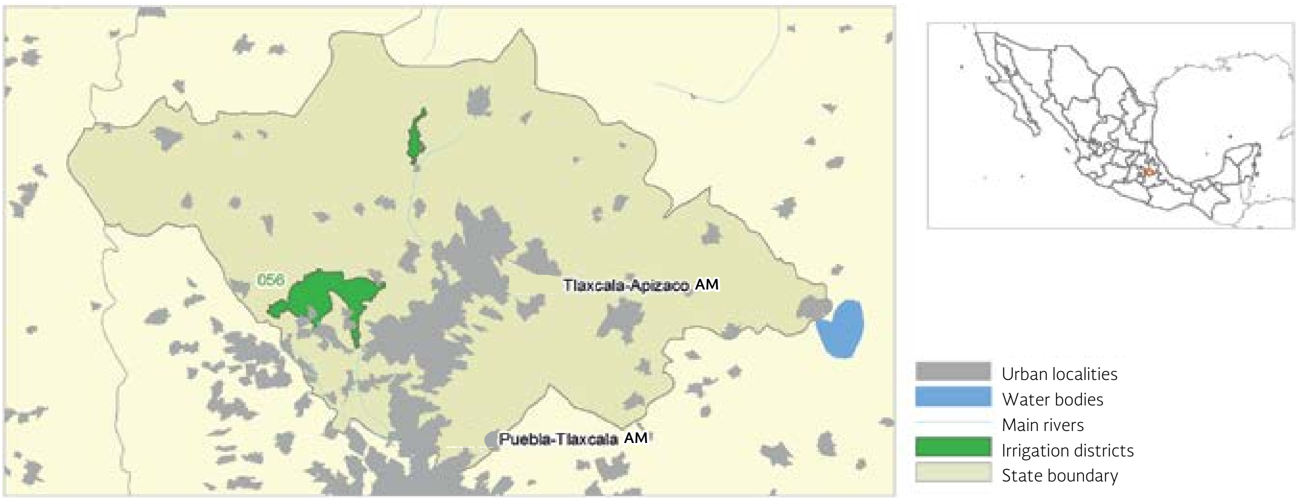
Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	98.02	97.16	91.21	91.06
Urban	99.30	98.56	96.21	96.10
Rural	87.76	85.85	50.87	50.40

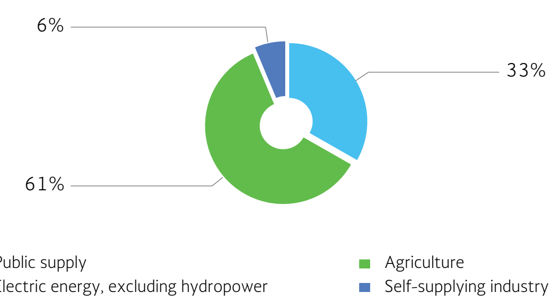
Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

29. Tlaxcala

Contextual data			Wastewater treatment plants, 2016		
Number of municipalities	60			Municipal wastewater	Industrial wastewater
Total population, 2016	1 295 781	Inhabitants	Number of plants in operation	57	71
Urban	1 048 901	Inhabitants	Installed capacity (m³/s)	1.466	0.303
Rural	246 880	Inhabitants	Processed flow (m³/s)	0.958	0.219
Total population, 2030	1 516 712	Inhabitants			
Annual normal precipitation 1981-2010	703	mm			



Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	105	59	164
Public supply	82	8	90
Self-supplying industry	17	<0.5	17
Electric energy, excluding hydropower	0	0	0
Total	204	67	271

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	

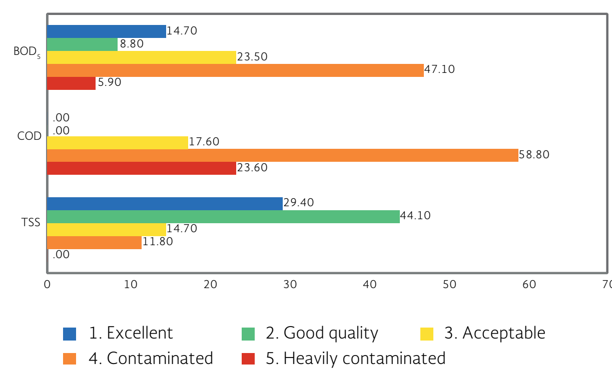
Municipal purification plants, 2016

Number of plants in operation	0
Installed capacity (m³/s)	0.000
Processed flow (m³/s)	0.000

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	34
COD	34
TSS	34

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	99.26	98.76	96.69	95.54
Urban	99.40	98.95	97.72	96.80
Rural	98.72	98.02	92.63	90.54

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

30. Veracruz de Ignacio de la Llave

Contextual data

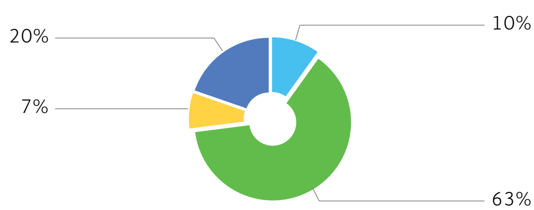
Number of municipalities	212	
Total population, 2016	8 106 138	Inhabitants
Urban	5 000 379	Inhabitants
Rural	3 105 760	Inhabitants
Total population, 2030	8 781 620	Inhabitants
Annual normal precipitation 1981-2010	1 544	mm

Wastewater treatment plants, 2016

	Municipal wastewater	Industrial wastewater
Number of plants in operation	120	159
Installed capacity (m³/s)	7.387	12.619
Processed flow (m³/s)	5.218	9.315

Urban localities
Water bodies
Main rivers
Irrigation districts
State boundary

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	847	2 672	3 519
Public supply	231	320	552
Self-supplying industry	124	975	1,099
Electric energy, excluding hydropower	1	406	408
Total	1 204	4 374	5 578

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	1 204

Municipal purification plants, 2016

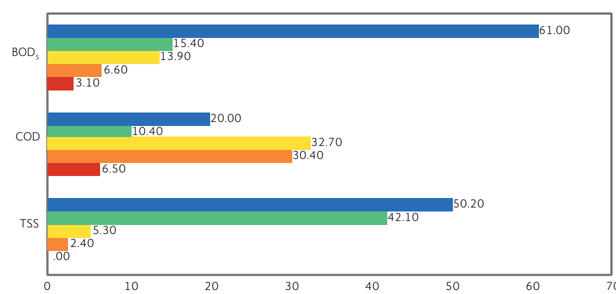
Number of plants in operation	16
Installed capacity (m³/s)	7.580
Processed flow (m³/s)	5.281

Surface water quality, 2016

Number of monitoring sites per water quality indicator

BOD_5	261
COD	262
TSS	343

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	88.10	86.55	87.56	84.34
Urban	95.19	94.13	97.16	94.70
Rural	76.95	74.60	72.44	68.05

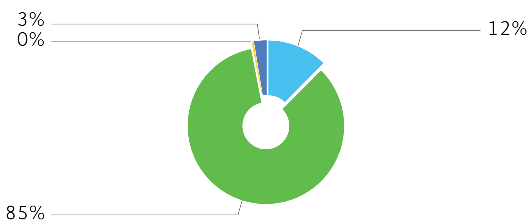
Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

31. Yucatán

Contextual data		
Number of municipalities	106	
Total population, 2016	2 145 878	Inhabitants
Urban	1 828 807	Inhabitants
Rural	317 071	Inhabitants
Total population, 2030	2 503 132	Inhabitants
Annual normal precipitation 1981-2010	1 056	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	27	182
Installed capacity (m³/s)	0.431	0.450
Processed flow (m³/s)	0.199	0.410

Water uses, 2016 (hm³/year)



Public supply
Electric energy, excluding hydropower
Agriculture
Self-supplying industry

Consumptive uses	Groundwater	Surface water	Total
Agriculture	1 744	0	1 744
Public supply	256	0	256
Self-supplying industry	54	0	54
Electric energy, excluding hydropower	9	0	9
Total	2 064	0	2 064

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	2 064

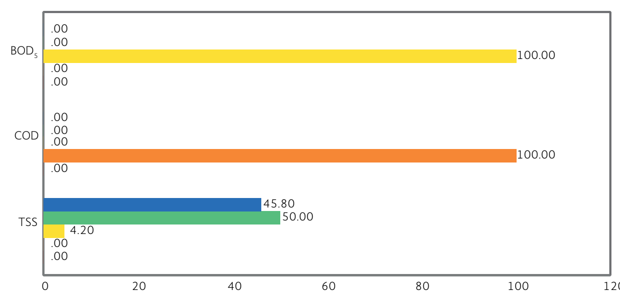
Municipal purification plants, 2016

Number of plants in operation	0
Installed capacity (m³/s)	0.000
Processed flow (m³/s)	0.000

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	1
COD	1
TSS	22

Site distribution per indicator and classification (%)*



1. Excellent
2. Good quality
3. Acceptable
4. Contaminated
5. Heavily contaminated

Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	99.29	98.29	86.82	86.50
Urban	99.44	98.52	89.41	89.13
Rural	98.47	97.06	72.63	72.14

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

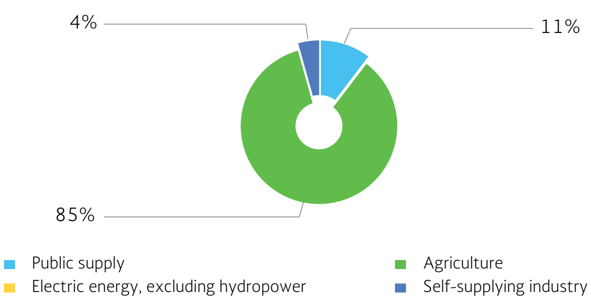
32. Zacatecas

Contextual data		
Number of municipalities	58	
Total population, 2016	1 588 418	Inhabitants
Urban	965 508	Inhabitants
Rural	622 909	Inhabitants
Total population, 2030	1 726 347	Inhabitants
Annual normal precipitation 1981-2010	496	mm

Wastewater treatment plants, 2016	Municipal wastewater	Industrial wastewater
Number of plants in operation	74	19
Installed capacity (m³/s)	2.003	0.193
Processed flow (m³/s)	1.651	0.168

Urban localities
Water bodies
Main rivers
Irrigation districts
State boundary

Water uses, 2016 (hm³/year)



Consumptive uses	Groundwater	Surface water	Total
Agriculture	1 077	348	1 425
Public supply	114	59	173
Self-supplying industry	71	1	72
Electric energy, excluding hydropower	0	0	0
Total	1 263	407	1 671

Non-consumptive	Surface water
Hydropower plants (Allocated volume)	1 263

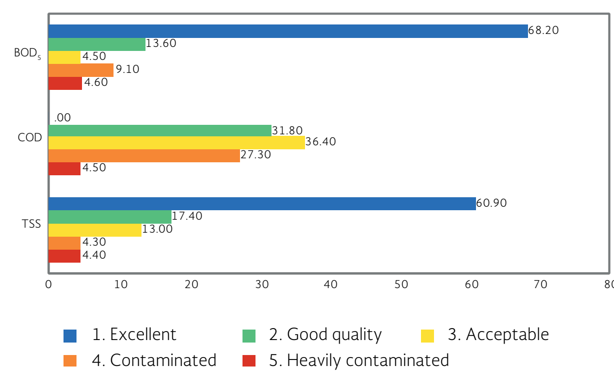
Municipal purification plants, 2016

Number of plants in operation	93
Installed capacity (m³/s)	0.164
Processed flow (m³/s)	0.139

Surface water quality, 2016

Number of monitoring sites per water quality indicator	
BOD_5	22
COD	22
TSS	23

Site distribution per indicator and classification (%)*



Coverages, 2015 (%)

	Drinking water		Sewerage	
	Access	Tap water in homes or property	Drainage	Public network or septic tank
State	97.60	96.80	93.14	92.44
Urban	99.04	98.35	98.33	98.12
Rural	95.32	94.35	84.93	83.46

Note: The projection considers the population at the mid-point of the indicated year. The coverage is calculated based on the 2015 Inter-Censal Survey. For drinking water there are two estimates: **"Access" for the coverage of the population in private homes with tap water in their household or plot** or from a public faucet or hydrant or another house, as well as "tap water in household or plot"; in order to distinguish these forms, "Access corresponds to "Drinking water coverage" employed in the 2015 and previous editions of SWM. Similarly, for sewerage, "drainage" refers to the population in private homes with drainage connected to the public network, to a septic tank, to the ground, to a ravine, crack, river, lake or to the sea; "public network or septic tank" is used to distinguish these elements, "drainage" corresponds to **"sewerage coverage"** used in the 2015 and previous editions of SWM.

Annex C. Characteristics of the hydrological-administrative regions, 2016

Key	HAR	Mainland territorial extension (km²)	Normal precipitation 1981 -2010 (mm)	Mean natural internal surface runoff (hm³/year)	Inflows (+) or outflows (-) from other countries (hm³/year)	Total mean natural surface runoff (hm³/year)	Number of watersheds
1	B.C. Noroeste	28 492	209	353		353	16
2	B.C. Centro-Oeste	44 314	116	243		243	16
3	B.C. Suroeste	29 722	200	356		356	15
4	B.C. Noreste	14 418	151	122		122	8
5	B.C. Centro-Este	13 626	132	95		95	15
6	B.C. Sureste	11 558	291	186		186	14
7	Río Colorado	6 911	98	72	1 850	1 922	4
8	Sonora Norte	61 429	297	180		180	9
9	Sonora Sur	139 370	483	4 828		4 828	16
10	Sinaloa	103 483	747	14 696		14 696	30
11	Presidio-San Pedro	51 717	819	8 841		8 841	26
12	Lerma-Santiago	132 916	717	13 062		13 062	58
13	Río Huicicila	5 225	1 400	1 266		1 266	6
14	Río Ameca	12 255	1 063	2 231		2 231	9
15	Costa de Jalisco	12 967	1 144	3 591		3 591	11
16	Armería-Coahuayana	17 628	866	3 480		3 480	10
17	Costa de Michoacán	9 205	944	1 612		1 612	6
18	Balsas	118 268	947	16 798		16 798	15
19	Costa Grande de Guerrero	12 132	1 215	5 171		5 171	28
20	Costa Chica de Guerrero	39 936	1 282	18 260		18 260	32
21	Costa de Oaxaca	10 514	951	2 894		2 894	19
22	Tehuantepec	16 363	884	2 575		2 575	15
23	Costa de Chiapas	12 293	2 220	12 551	1 586	14 137	25
24	Bravo-Conchos	229 740	399	5 672	- 432	5 240	37
25	San Fernando-Soto la Marina	54 961	703	4 713		4 713	45
26	Pánuco	96 989	855	20 224		20 224	77
27	Norte de Veracruz (Tuxpan-Nautla)	26 592	1 422	14 378		14 378	12
28	Papaloapan	57 355	1 440	47 394		47 394	18
29	Coatzacoalcos	30 217	2 211	34 708		34 708	15
30	Grijalva-Usumacinta	102 465	1 703	61 881	44 080	105 961	83
31	Yucatán Oeste	25 443	1 175	756		756	7
32	Yucatán Norte	58 135	1 143	22		22	2
33	Yucatán Este	38 308	1 210	1 078	864	1 942	6
34	Cuencas Cerradas del Norte	90 829	298	1 255		1 255	22
35	Mapimí	62 639	292	581		581	6
36	Nazas-Aguanaval	93 032	393	2 101		2 101	16
37	El Salado	87 801	393	2 869		2 869	8
	Total	1 959 248	740	311 092	48 812	359 041	757

Source: CONAGUA (2016 b).

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 Mexico City 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, using specially designed 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 consumptive and non-consumptive.

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]

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.

Connate water. Connate or formation water is saltwater that is found inside rocks, 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]

Consumptive 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]

Contamination. Incorporation of foreign agents in water, which may modify its physical and chemical composition and quality.[c]

Coverage of access to water services. Percentage of the population that lives in private housing and that has tap water within the household or on the grounds, or that has supply from a public faucet or another household. It is determined by means of the censuses or inter-censal surveys carried out by INEGI.

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 societyto be focused on the reconstruction of affected areas.

Discharge. The action of emptying, infiltrating, depositing or injecting wastewater into a receiving body.[a]

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]

Drainage. Natural or artificial conducts that are an outlet or vent for water.

Drinking water and sewerage system. A series of works and actions that allow public drinking water and sewerage 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 grounds, or from a public water faucet or from another household. It is determined by means of censuses and inter-censal surveys carried out by INEGI and by CONAGUA estimates for in-between 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 fit to drink. 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 262 Statistics on Water in Mexico, 2016 edition 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 rates payers for the use of the nation's water resources, as well as wastewater discharges and for the use of inherent water-related assets.

Emergency. In terms of declarations related to extreme hydrometeorological 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. A ten-meter wide strip adjacent to channels, currents or reservoirs which belong to the nation, measured horizontally from the normal pool elevation.[a]

Federative entity. The 31 states and the Federal District, which together make up the Federation.[f]

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 119 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. Usually 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, Mexico City 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]

Hydrometeorological 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]

Hydrometric station. A place in which volumes of water are measures and recorded by means of different instruments and/or apparatuses.[c]

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 levees, 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. Application of water to crops through infrastructure, in comparison with crops that only receive precipitation, which are known as rainfed crops.

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 (consumptive use = evapotranspiration + water in the fabric of the plant).

Irrigation surface. An area with irrigation infrastructure.

Irrigation unit. An agricultural area which has irrigation infrastructure and 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]

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 m3 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 households, 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 feeds 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 agency, 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. These 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]

Mexico's System of National Accounts. A scheme to organize statistical information on macro-economic aspects of the country: production, consumption, saving, investment in sectors of economic activity and primary and secondary distributions of income; as well as the financial transactions and the economic relationship with the outside, through institutional sectors, during a given period of time. Its information is derived from censuses, surveys and administrative registers, as well as following theoretical-methodological models of international validity and comparability.[ae]

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.

National catalogue of indicators. A set of key indicators with their corresponding metadata and statistical series, which have 264 Statistics on Water in Mexico, 2016 edition the objective of providing the Mexican State and society-at-large with information that is necessary for the design, follow up and evaluation of public policies of national scope; similarly indicators can be integrated that allow the Mexican State to attend information commitments as requested by international organizations. It is part of the National System of Statistics and Geography.[af]

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]

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 CONAGUA or by the corresponding river basin organization, 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 National Water Law and its by-laws derived from that Law.[a]

Perennial crops. Crops whose maturation cycle lasts more than a year.

Permits. Granted by the Federal Executive Branch through 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 others 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.

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, 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 apart from 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 reservoirs, 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, reservoir, 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 contaminate 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 be feasibly 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 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 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 filters into 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 equal to or greater than 10 000 mg/l.[aa]

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]

Sewerage coverage. Percentage of the population that lives in private housing, whose housing has an outlet connected to the public sewerage network or a septic tank. Determined by means of the different types of census and inter-censal surveys carried out by INEGI and estimations from CONAGUA for intermediate years.

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.

Storage. Volume or quantity of water that can be captured, in millions of cubic meters.[c]

Stream. Water current 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 watercourses 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, levees or canals.[c]

Sustainable development. As regards water resources, this is the process that may be evaluated 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, the preservation of which in both quantity and quality and its sustainability is a fundamental task of the State and Society, as well as a priority and a matter of national security.[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 dam. The volume of water that a dam 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.

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 anthropic 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]

Watercourse. 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]

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 levees, 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 use. Application of water in activities that do not imply its total consumption.[a]

Water utility. An agency 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 continental 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. Watersheds together with aquifers constitute the management unit of water resources.[a]

Weather station. A given area or zone of open-air ground, with the particular weather conditions of the area, meant for measuring weather 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.

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.

[g] USGS (2016c).

[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.

[n] NOM-002-CNA-1995.

[p] Arreguín et al. (2009).

[q] NOM-014-CONAGUA-2003.

[r] NOM-143-SEMARNAT-2003.

[s] Higueras and Oyarzun (2013).

[t] RAE (2015).

[u] CONAGUA (2012).

[v] SEMARNAT (2008).

[w] CONAPO (2012).

[x] Sanchez et al. (2010).

[y] IPCC (2007).

[z] WB (1996).

[aa] CONAGUA (2016b).

[ab] AEMET (2015).

[ac] General Law of Civil Defense.

[ad] 2014-2018 Program for national security.

[ae] INEGI (2013e).

[af] INEGI (2016m).

Annex E. Abbreviations and acronyms

APAZU	Drinking water and sanitation in urban zones
BANOBRAS	National Bank of Works and Services
BANXICO	Bank of Mexico
BOD_5	Five-day Biochemical Oxygen Demand
CAPASEG	Drinking Water, Sewerage and Sanitation Commission of the State of Guerrero
CDI	National Commission for the Development of Indigenous Peoples
CEC	Commission for Environmental Cooperation
CFE	Federal Electricity Commission
CMAS	Municipal Drinking Water and Sanitation Commission
COD	Chemical Oxygen Demand
CODIA	Conference of Ibero-American Water Directors
COFEPRIS	Federal Commission for Protection against Health Risks
CONAFOR	National Forestry Commission
CONAGUA	National Water Commission
CONANP	National Commission for Protected Areas
CONAPO	National Population Council
CONAVI	National Housing Commission
CONEVAL	National Council for the Evaluation of the Social Development Policy
COP	Conference of Parties
COSAE	Commission of Water Services of the State of Baja California
DOF	Official Government Gazette
EEP	External Energy Producer (also known as IPP: Independent Power Producer)
EEZ	Exclusive Economic Zone
ENSO	El Niño - Southern Oscillation
FAO	Food and Agriculture Organization
FDL	Federal Duties Law
GDP	Gross Domestic Product
GWI	Global Water Intelligence
HAR	Hydrological-Administrative Region
IBRD	International Bank for Reconstruction and Development
IBWC	International Boundary and Water Commission
ICOLD	International Commission on Large Dams
ID	Irrigation district
IDB	Inter-American Development Bank
IEA	International Energy Agency
IFRC	International Federation of the Red Cross and Red Crescent Societies
INAI	National Institute of Access to Information
INEGI	National Institute of Statistics and Geography
IPCC	Intergovernmental Panel on Climate Change
IU	Irrigation Unit
LANDSAT	Land Satellite
LO	Local office
MA	Metropolitan Area
MAVM	Metropolitan Area of the Valley of Mexico
MDGS	Millennium Development Goals
MPN	Most probable number
MW	Megawatt
NA	Not applicable
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
NOAA	National Oceanic and Atmospheric Administration
NOM	Official Mexican Standard
NPE	Normal Pool Elevation
NVWI	Net virtual water import
NWL	National Water Law
NWP	National Water Plan
PA	Protected Area
PAENT	Percentage of the population with tap water in their household or plot
PAP	Population with access to tap water services
PAS	Population with access to sewerage and basic sanitation services
PIAE	Protection for Infrastructure and Emergency Response
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 Drought Prevention Program
PROSSAPYS	Program for the Construction and Rehabilitation of Drinking Water and Sanitation Systems in Rural Areas
PROTAR	Wastewater Treatment Program
RBO	River basin organization
REAC	Regional Emergency Attention Center
REPDA	Public Registry of Water Duties
RWR	Renewable water resources
SCFI	Ministry of Trade and Industrial Development (obsolete, employed in the names of NOMs)
SDGs	Sustainable Development Goals

SECTUR	Ministry of Tourism
SEDESOL	Ministry of Social Development
SEEA	System for Environmental-Economic Accounting
SEMAR	Ministry of the Navy
SEMARNAT	Ministry of the Environment and Natural Resources
SENER	Ministry of Energy
SGT	Deputy Director General's Office for Technical Affairs
SHCP	Ministry of Finances and Public Credit
SIAP	Agro-Food and Fishing Information Service
SIAPA	Inter-Municipal System for Drinking Water and Sanitation Services (Guadalajara MA)
SINA	National information system on water quality, quantity, uses and conservation
SST	Sea Surface Temperature
TD	Tropical depression
TEO	Eastern Drainage Tunnel
TRD	Technified rainfed district
TS	Tropical storm
TSS	Total Suspended Solids
UN	United Nations
UNAM	National Autonomous University of Mexico
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNSTATS	United Nations Statistics Division
USGS	United States Geological Service
VAT	Valued added tax
VWE	Virtual water export
VWI	Virtual water import
WB	World Bank
WFN	Water Footprint Network
WHO	World Health Organization
WMO	World Meteorological Organization
WQI	Water Quality Index
WSP	Water and Sanitation Program
WWAP	World Water Assessment Programme

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, 2015, except for specific cases, when the latest information available is not at the closing date, such as the state GDP (see the respective note).

Population: The population projection employed by CONAPO (2012), at the mid-year point, is used for the 2010-2030 period. According to that projection, in 2015 there were 121.01 million inhabitants of Mexico. It should be mentioned that the latest data from a census, a product of the 2015 Inter-censal Survey (one of the objectives of which was to maintain the comparability of national censuses), found that in 2015 there were 119.53 million inhabitants in Mexico. The use of data from the CONAPO populationprojection (2012) is continued until it is eventually replaced by a projection based on the 2015 Inter-censal Survey. The CONAPO projection considers 137.48 million inhabitants by 2030.

Precipitation: The values reported by the National Meteorological Service (total, regional and state-wide) are employed for both the normal 1981-2010 precipitation and the 2015 annual precipitation.

Gross Domestic Product (GDP): For the present document the national GDP available was calculated for the year 2015. 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 2014.

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 (2016a)", "CONAGUA (2016b)". Using this system results in space saving and allows the sources used to be rigorously cited.

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 2016o), 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 2015, 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 m² = 2.47 acres
hm³	cubic hectometer	1 hm³ = 1 000 000 m³
kg	kilogram	1 kg = 1 000 g
km/h	kilometer per hour	1 km/h = 0.2778 m/s
km²	square kilometer	1 km² = 1 000 000 m²
km³	cubic kilometer	1 km³ = 1 000 000 000 m³
L, l	liter	1 L = 0.2642 gal
L/s, l/s	liter per second	1 L/s = 0.001 m³/s
m	meter	1 m = 3.281 ft
m³	cubic meter	1 m³ = 0.000810 AF
m³/s	cubic meter per second	1 m³/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 m² kg/s³

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 pie = 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
msnm	meters above sea level	Not applicable
pesos	Mexican pesos	1 Mexican pesos = 0.05798 US dollars
ppm	parts per million	1 ppm = 0.001 g/L
USD	United States dollar	1 US dollar = 17.2487Mexican pesos*
* The FIX exchange rate as of December 31, 2015 was considered (Banxico 2016b).		

Measurement examples:
1 m^3 = 1 000 litros
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			

Annex G. Bibliographical references

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