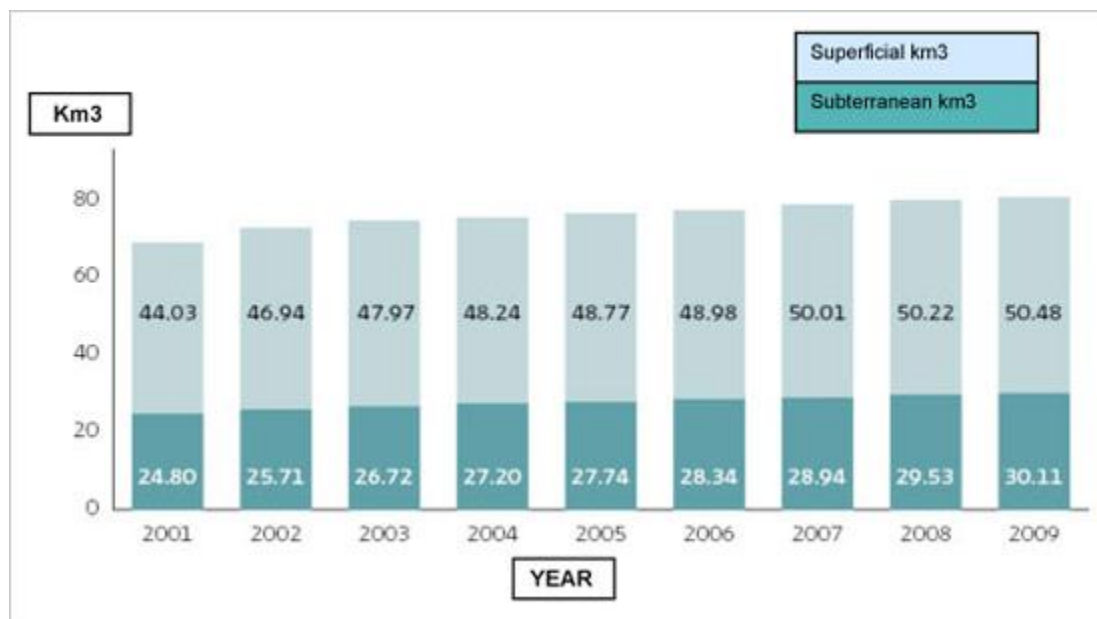


Uses and Sources of Water in Mexico

Water does not always exist where it needs to be used and often needs to be moved from source to site of use. Every economic activity requires water and this water comes from surface or subterranean sources. The graph below shows the amount of water used for all economic purposes (agriculture, public, industry and electric power generation) for 2001-2009 in Mexico and their source.

Nearly two-thirds of the water used in the country comes from surface sources (rivers, streams and lakes) while the other third comes from subterranean sources (aquifers). Surface water use grew by 15% from 44.03 km³ in 2001 to 50.48 km³ in 2009. At the same time, subterranean water used increased 21% from 24.8 km³ in 2001 to 30.11 km³ in 2009. The total amount of water used from both surface and subterranean sources in 2001 was 68.83 km³ and for 2009 the total increased to 80.59 km³, a 17% jump.



Past editions of the Mexico Water Report mentioned that agriculture uses the most water, more than three quarters of the total volume annually. It is interesting to note that at the same time, the United States uses only about 40% of its national water supply for agriculture. In Mexico in 2009, 61.8 km³ were assigned for agriculture with two thirds or 41 km³ coming from surface sources. Only 12% of

total resources, 11.4 km³, were used for public supply. Inverse to agriculture, almost two thirds (62.2%) of the water for public use came from ground water. While industry uses less than 9% of the total water supply in Mexico, the United States uses over 40% of its water supply for industrial applications. Surface and subterranean sources represent almost exactly 50% of water used by industry in Mexico.

Aqueducts

In Mexico there are more than 3,000 km of aqueducts with a total capacity of 112 m³/second that bring water to different cities, rural communities, and other economic activities. Length of an aqueduct has almost no relation to capacity amongst the major Mexican aqueducts. The Vizcaino aqueduct, at 206 kms, is the longest aqueduct in Mexico but it has one of the lowest capacities with only 62 l/s. On the other hand, the Uxpanapa aqueduct has the highest capacity in Mexico with 20,000 l/s but is only 40 km in length.

Largest Mexican Aqueducts by Capacity

Aqueduct	Length (km)	Capacity (l/s)	Location	Region
1.Uxpanapa-La Cangrejera	40	20000	Veracruz	Southeast
2.Sistema Cutzamala	162	19000	Valley of Mexico	Central
3. Lerma	60	14000	Valley of Mexico	Central
4.Chapala-Guadalajara	42	7500	Guadalajara	Central
5.Linares - Monterrey	133	5000	Monterrey	North
6.El Cuchillo - Monterrey	91	5000	Monterrey	North
7.Rio Colorado- Tijuana	130	4000	Baja California	Northwest
8.Chicbul-Ciudad del Carmen	122	390	Campeche	Southeast
9.Vizcaino-Pacifico Norte	206	62	Baja California	Northwest

Three of the four highest capacity aqueducts are located in the Central region. This region contains the highest population, industrial, and agricultural concentrations in the country. The second and third largest aqueducts are focused almost exclusively on water supply for the greater Mexico City area and the fourth largest serves the Guadalajara area, the second most populous city in the country and its major agricultural focus.

The North region has the fifth and sixth most important aqueducts that supply the city of Monterrey, Mexico's third most populous city and the second most important industrial center. The seventh largest aqueduct is in the very arid and industrial north of Mexico.

Cutzamala System

In any discussion of Mexican aqueducts, one has to discuss the Cutzamala, the aqueduct that provides Mexico City with a major portion of its water supply. The Cutzamala aqueduct is 2nd nationally in both length and capacity. While rivers and streams provide Mexico City with only 3% of its total water supply, the Cutzamala System provides 18% for all four water uses in the Valley of Mexico basin. In fact, Cutzamala together with the Lerma Aqueduct System provide the greater

Mexico City with 25% of its water supply. The rest of the water supply in the region, 73%, is extracted from ever dwindling and sensitive aquifers.

The Cutzamala system is formed by seven dams for storage, six pumping stations, and several water treatment plants. The Cutzamala System consumes almost 1% of the total electric power generation of the country. This system overcomes considerable challenges in moving over 485 million m³ annually to one of the largest and most congested urban areas in the world. The altitude of Mexico City and the drastic altitude changes from source to end user present further challenges. The system climbs over 1,100 meters from the lowest part of the system at Pumping Plant 1 at 1,600 meters above sea level to Oscillation Tower 5 at 2,700 meters above sea level. Once the water is pumped and treated through the different stages of the system, it then falls by gravity to Mexico City users located at almost 2,300 meters above sea level.

The California Aqueduct, considered one of the longest and highest capacity aqueducts in the United States, also faces similar altitude issues. However, while the California aqueduct climbs some 2000 feet, Cutzamala Aqueduct climbs almost 3,500 feet and has more staggered and irregular altitude changes. However, the California Aqueduct moves considerably more volume, with a capacity of 370m³/s.

Dams

Mexico has about 4,500 dams with 536 considered large according to the International Commission on Large Dams (ICOLD). Mexico ranks 13th in the world numbers of large dams, i.e. those that have at least 15 meters of depth and/or capacity of 3 million m³ or higher. It is interesting to note that Conagua says that Mexico actually has 677 such dams, which would place Mexico 9th overall in this category and between Brazil (635) and Canada (793). None the less, Mexico's large dams still represent only about 7.5% of U.S. totals and just under 15% of the dams in China or India.

Country	Number of Large Dams
United States	9 265
China	4 688
India	4 636
Spain	1 267
South Korea	1 205
Japan	1 121
South Africa	915
Canada	793
Brazil	635
Turkey	625
France	597
Italy	549

Mexico 536
United Kingdom 517

World's Highest Dams

While one might say that Mexico has average capacity dams, it clearly has some of the highest dams in the world. Mexico has the 7th and 9th highest dams in the world.

10 Highest Dams	Height (meters)	Country
Rogun	335	Tajikistan
Nurek	300	Tajikistan
Xiaowan(Yunnan)	292	China
Grande Dixence	285	Switzerland
Inguri	272	Georgia
Vajont	262	Italy
Manuel M. Torres	261	Mexico
Tehri	261	India
Alvaro Obregon	260	Mexico
Mauvoisin	250	Switzerland

Mexico also has the second highest Rock Fill (Type ER) dam (Aguamilpa) in the world at 187 meters, the second highest gravity (Type PG) dam at 260 meters (Alvaro Obregon), the third highest Earth (Type TE) dam at 261 meters (Manuel M. Torres), and the fourth highest Arch (Type VA) dam at 207 meters (Zimapan).

Mexico's Largest Dams

Of the 536 large dams in Mexico, available information only exists on the top 100 dams according to storage capacity. These 100 dams are also classified by their use: electric power generation, irrigation, public supply, flood control, or combination of two or more areas. Mexico does not rely on hydroelectric sources nearly as much as Brazil which generates 40% of its electricity from hydroelectric dams. Nonetheless, 27 of these top 100 dams and 22 of the top 30 dams are used at least partially for power generation and they tend to be the largest dams.

Basin	Total Dams	Regions	Total capacity per Region (hm3)
Golfo Norte	10	North	25,876
Cuencas Centrales del Norte	4		
Rio Bravo	1		
Pacifico Norte	15	Northwest	24,522
Peninsula de Baja California	1		
Noroeste	8		
Lerma-Santiago-Pacifico	23	Center	12,698

Valle de Mexico	2	
Frontera Sur	5	Southeast 37,208
Golfo Centro	3	
Balsas	14	Southwest 17,757
Pacifico Sur	2	
Total	100	118,061

The region with the most large dams is the Central region with a total of 25 followed closely by the Northwest Region with 24. While the difference in number of dams between these two regions is just one, the difference in capacity is considerable with the Northwest region dams having almost double the capacity of those of the Central region. On the other hand, the Southeast region, with only 8 dams, has three times the capacity of the 25 dams in the Central region and 50% more capacity than the dams in the North and Northwest regions, the 2nd and 3rd most important regions.

The first and the third largest dams by capacity are located in the Southeast region, specifically in the Frontera Sur basin. The North and Northwest regions, are areas with the most extreme climatic conditions, the most exploited aquifers, and some of the lowest surface water sources, making the storage of water imperative for agriculture, public and industrial supply.

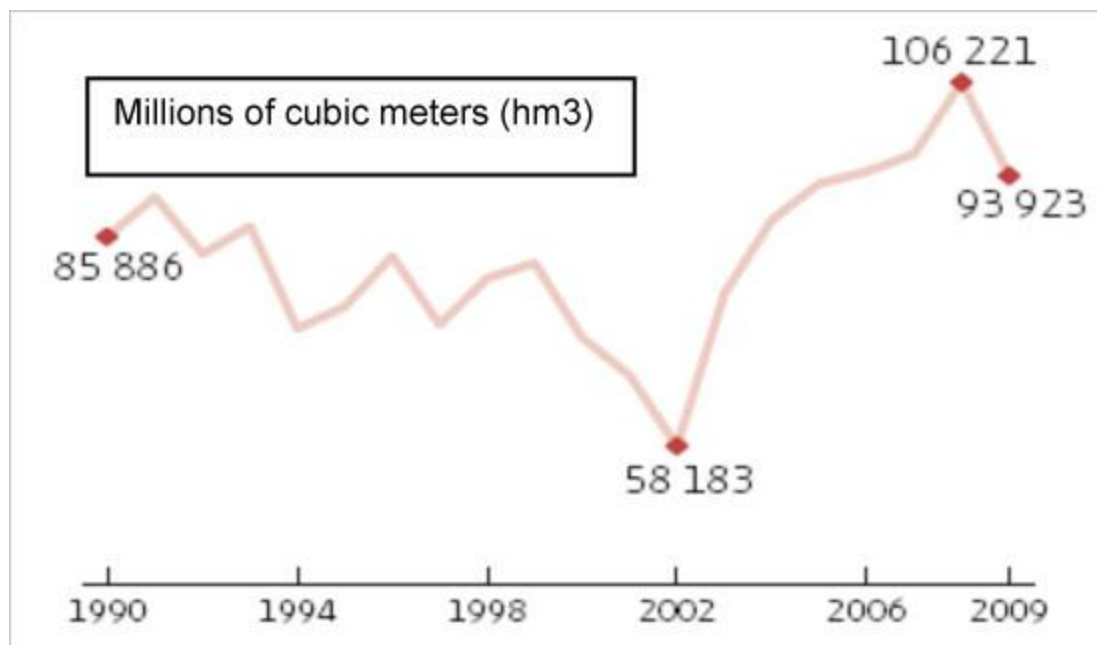
Largest Dams in Mexico by Water Capacity		
Official Name and common names	Capacity (hm³)	Basin / Region
La Angostura (Dr. Belisario Dominguez)	12,762	Frontera Sur / Southeast
Infiernillo	12,500	Balsas / Southwest
Malpaso (Netzahualcóyotl)	10,596	Frontera Sur / Southeast
Temascal (Presidente Miguel Alemán)	8,119	Golfo Centro / Southeast
Agamilpa (Solidaridad)	5,540	Lerma-Santiago-Pacifico / Center
La Amistad	4,462	Rio Bravo / North
Falcón	3,912	Rio Bravo / North
Las Adjuntas (General Vicente Guerrero)	3,910	Golfo Norte / North
El Palmito (Lázaro Cardenas)	3,336	Cuencas Centrales del Norte / North
El Humaya (Adolfo López Mateos)	3,072	Pacifico Norte / Northwest

The largest dam in Mexico is La Angostura Dam (also known as the “Dr. Belisario Dominguez Dam”) located in Chiapas in the Frontera Sur river basin and one of the few dams in the country used exclusively for electric power generation. The second largest dam, “Infiernillo”, is a multipurpose dam with almost identical capacity. Both dams have similar capacities of around 12,500 hm³, each representing just over 10% of the total capacity of these 100 largest dams. In fact, the top four dams,

all located in southern Mexico and unfortunately far from Mexico's important urban bases, make up 37% of the total capacity of these top 100 dams.

How do Mexico's two largest dams compare to other major dams in the world? The world's largest dam, the Three Georges Dam in China, has a capacity of 39,300 hm³. and the largest dam in the United States, Hoover Dam, has a capacity of 35,200 hm³. The two largest dams in Mexico have less than 1/3 of Three Georges Dam capacity and just about 1/3 of Hoover Dam. In fact, the three largest Mexico dams would fit inside of Hoover Dam. While Mexico has large dams, one would not characterize them as mega dams.

Volume of water in the 100 most important Mexican dams (2009)



The maximum storage capacity of all 100 dams is 118,061 hm³. (hm³ = 1 million m³). The lowest storage volume in the last 20 years was in 2002 with 58,183 hm³, just under 50% of total storage capacity. The highest volume of water stored in the same period was in 2008 with 106,221 hm³ that represented almost 90% of total 2009 storage capacity. In 2009, this amount dropped 11.6% to 80% of capacity. Mexico's very high rainfall totals, and the country's growing and increasingly urban population suggest that Mexico must continue to invest significantly in building new and maintaining or expanding current dams in order to meet its water storage needs.