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MEXICO WATER REPORT

Water Reuse in Mexico

In terms of wastewater reuse in agriculture, Mexico is second leading country in the world – but this is hardly an accolade since we are referring to untreated wastewater. 80% of the wastewater that is reused in Mexican agriculture is not treated and its use is highly unregulated. While rain water reclamation projects at government levels are at infant stages here, Mexico is making some strides with strategies and efforts to reuse treated water. Two reasons for this change are related first and foremost to the scarcity and then the price of potable water. While residential potable water prices remain extremely low in Mexico, the prices that companies have to pay is increasing significantly, supposedly increasing annually greater than inflation for the first time in Mexico`s history. Also, while the southern states in Mexico have over 15,000 m3 of per capita water, in the northern and central states per capita water is only 500 and 1700 m3 respectively which demonstrates the water stress severity outside of south, where 75% of the population lives and where 87% of the Mexican economy is located.

Reuse of Non-Treated Wastewater

The use of non-treated wastewater in agriculture is practiced today in more than 50 countries and irrigates a surface of 10% of the total cultivated surface on the planet. These practices are becoming more common place in countries in Africa, Asia and Latin America, allowing these governments to save on the cost of pumping subterranean water and at the same time saving the aquifers from over exploitation. In many cases, the construction of expensive hydraulic works for transport, extraction and distribution of water for irrigation also can be avoided or lessened.

After China, Mexico es the second country in the World for reuse of wastewater for agriculture, ten times more than in the US, four times more than India and three times more than in the 10 next countries (see table below). In Latin America, Mexico is the country with the largest number of hectares irrigated with non-treated wastewater. The National Water Commission (CONAGUA) estimates that in 2009, 350,000 hectares were irrigated using 160 m3/sec. of non-treated municipal and to a less extent industrial wastewater with some superficial waters.

COUNTRY	HECTARES IRRIGATED
China	1,330,000
Mexico	350,000
India	85,500

South Africa	18,000
Chile	16,000
United States	11,875
Australia	10,000
Israel	8,800
Peru	6,800
Tunisia	4,450
Argentina	3,700
Saudi Arabia	2,850

There are more than 30 major cities in Mexico where local agricultural irrigation depends on the wastewater it generates. All of these cities are located in the north or central parts of the country:

North - Monterrey, Obregón, Chihuahua, Cd. Juárez, Camargo, Delicias, Jiménez, y Ojinaga.

Center - Durango, Guadalajara, Aguascalientes, Morelia, Puebla, Querétaro, Tula/Valle de Mezquital.

The Valle del Mezquital in Hidalgo, is the largest agricultural area in the world (over 130,000 hectares) irrigated with untreated wastewater, all of it coming from Mexico City.

While water reuse standards exist, these regulations have very limited application to non-treated water for reuse. And where they do apply, enforcement is negligible or completely absent. While non-treated waters are only supposed to be used to irrigate grains and similar products that do not absorb the water and its nutrients, it is almost impossible for authorities to ensure that such waters are not been used for vegetables and fruits and there appears to be a dearth of moral authority that might provoke some better oversight in this area.

Water Reuse Dynamic - Limited Water Supplies and Low Prices
Currently, subterranean water is used for the following purposes in Mexico: (1) the irrigation of two million hectares (a third of the total irrigated surface), (2) the supply of almost 75% of the total water volume required in the cities for public-urban use servicing 55 million people, (3) the supply of most industrial installations, and (4) to satisfy almost all rural water demand. 75% of the water volume required for cities comes from subterranean waters, and the main cities of the country are supplied at the expense these overexploited aquifers and to a lesser extent from other surface sources. Nonetheless, according to Conagua, 104 aquifers or 15% of the total are already considered to be overexploited and by 2015, 25% of all national aquifers will be considered overexploited. Said overexploitation has been caused by limited water sources in the the north and center areas and because of the lack of treated water which has led to a less than efficient and effective program for treated water reuse.

In 2003, the price of treated water in Mexico varied from $1.48 to $5 pesos per cubic meter (m3) depending on the level and type of treatment. In comparison, the cost of potable water fluctuated between $2.5 to $14 pesos per cubic meter depending on the region. While we were unable to confirm current treated water prices, the general consensus was that it is about 50% of the cost of residential water. With that context, it is important to analyze 2010 residential and industrial water prices. In Mexico City, residential water cost about 5.26 pesos per m3 (assuming 30 m3/month consumption) or about 45 cents US while industrial water prices were almost 4 times higher at 20.16 pesos or about $1.85 US. Prices in Guadalajara seem to be very similar to those in Mexico City. Meanwhile, residential water prices in Monterrey were almost double those of Mexico City while for some reason their industrial prices were about 2/3 of Mexico City at 14.39 pesos. The most expensive water in Mexico was found in Tijuana (37 pesos or over $3 US for residential or industrial water) followed by Leon, Morelia and Aguascalientes (residential: 25-28 pesos, industrial: 32-35 pesos).

If indeed treated water costs are half of potable residential water costs, then they are probably a third of industrial potable water costs. This cost differential would seem to offer significant cost savings to businesses that use a significant amount of water and do not require high quality water sources for their manufacturing processes. However, we are not uncertain if delivery costs are included in these reuse figures. And, despite the above mentioned savings associated with water reuse, residential and even industrial potable water prices are still too low relative to resuse prices to properly stimulate more effective and comprehensive water reuse at this time. These price realities together with the Mexican government´s willingness to use and dependence on untreated water in agriculture (80% of reuse water for agriculture is untreated) creates disincentives for companies, municipalities, and farmers to seriously turn to water reuse strategies.

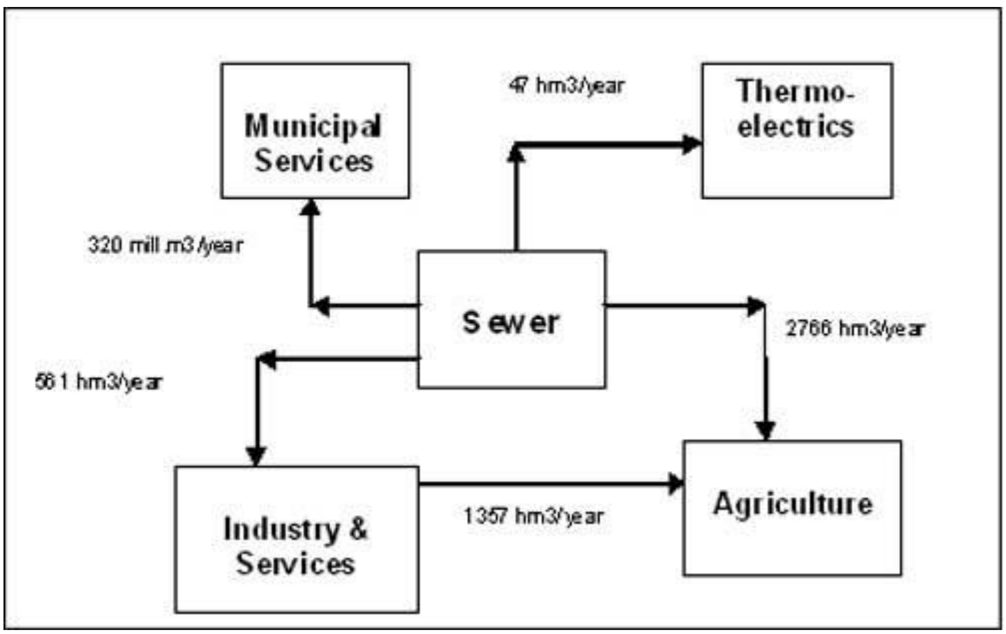
Water Reuse Activities

Treated water reuse is mainly carried out in large cities and areas with greater water requirements and water scarcity like in the north of the country. Treated wastewater has several applications. In industry, it is used extensively for cooling and washing in production processes. Treated wastewaters are also used in recreational applications like fountains, lakes and other water channels. Or course, a large amount of water reuse ends up in agricultural activities. And, it is worth mentioning that in most of Mexico, there is either extremely inconsistent or no vigilance over water quality and reuse activities for treated reuse water.

Reused water quality levels and water reuse activities are regulated by two standards or NOMs. NOM-001-ECOL-1996 regulates discharges into federal bodies and includes important detail about permissible limits for pollutants for water reuse activities. NOM-003-ECOL-1997 deals exclusively with wastewater reuse including the conditions and criteria for sampling, testing, disposal, and parameters for fecal coliform and helminth eggs. Together, these standards establish the maximum permissible limits of chemical and biological pollutants in surface water bodies for reuse activities.

While NOM 003 is known as the water reuse standard for Mexico, NOM 003 depends extensively on the parameters established in two tables in NOM-001-ECOL-1996. These parameters are based on two categories: (1) place of disposal and reused water use/activity, and (2) quantities of pollutant/water characteristics. The place for disposal includes rivers, natural and artificial reservoirs, coastal waters, or directly into the ground. Use or activities includes the following activities: irrigation, public use, urban use, aquatic life protection, fishing, recreation, estuaries and wetlands. The quantities of pollutant and water characteristics, at the moment of disposal, include: temperature, oils and fats, settled solids, TSS, BOD, nitrogen, phosphorous, arsenic, cadmium, cyanide, copper, chromium, quicksilver, nickel, lead and zinc. It is worth mentioning that the pollutants and water characteristics are sampled in milligrams per liter either based on a daily or a monthly average. If you are interested in a translated copy of NOM-001-ECOL-1996 to further review the parameters for each disposal location and activity, please contact us.

Below there is a graphic that shows the sources and uses of the reused wastewater in Mexico in 2009. During that year, 5,051 million cubic meters were reused, equivalent to 160 m3 per second. Of the total volume reused, 3,694 million, or 73%, came from municipal wastewater sources while 1,357 million or 27% came from industry and services. 74% of the total municipal wastewater volume was used in agriculture, 16% was used by industry, 9% for municipal services, and the remaining 1% for power generation. 100% of the treated and reused wastewater from industry went to agriculture.



Estadísticas del Agua 2010-CONAGUA

According to information from a 2003 studied carried out by IMTA (Mexican Institute for Water Technologies), of total treated wastewater, around 33% was used for agricultural irrigation. The states that used more treated wastewater for irrigation (crops and green areas) were the State of Mexico, Queretaro, Baja California Sur, the Federal District, Michoacan and Puebla. While things could have changed during he last 9 years, in 2003 the states of Campeche, Chiapas, Colima, Guerrero, Morelos, Tabasco, Tlaxcala, and Yucatan did not reuse any treated wastewater. At that time and probably still, the states Nuevo Leon, State of Mexico and Coahuila were leaders in the use of treated wastewater for industrial applications, the most important reuse area in Mexico. In fact, these three states industrial reuse volumes represented almost 30% of total reuse in the country. Treated water used in green areas irrigation was the second priority, representing almost 20% of the total. The states that reused more water for this purpose were Quintana Roo, San Luis Potosi, Nuevo Leon and the Federal District.

Treatment and Reuse per State

According to information from CONAGUA, in 2009 the following 5 states had the largest volumes of treated water:

STATE	VOLUME
Nuevo León	10,877.2 l/s
Chihuahua	5,937.3 l/s
Baja California	5,620.0 l/s
Estado de México	5,190.3 l/s
Sinalóa	4,574.3 l/s

For obvious reason, wherever there is more treated water, one will find more treated water reused. It is worth noting that these states, except for the State of Mexico, are located in northern Mexico, the driest part of the country where there are severe problems with the water supply, surface waters contamination, overexploitation of aquifers, high water costs. As a result, in the arid north, reuse is not just a profitable option, it is a necessary one.

The 4 states with the lowest volume of treated water are:

STATE	VOLUME
Yucatán	82.0 l/s
Campeche	97.3 l/s
Hidalgo	289.2 l/s
Zacatecas	644.6 l/s

Two of the these four states (Yucatan and Campeche) are in the south of the country where there are almost no water supply problems, where per capita water is more than 15,000 cubic meters, the highest in the country and one of the highest in the world. As a consequence, the practices of reuse is not promoted nor needed in the south. In the case of Hidalgo and Zacatecas, even though their treatment numbers are not as low as those in the southern states, their volume of water treated is in terms of installed treatment capacity - 88% for Hidalgo and and 86% for Zacatecas. Nonetheless, treatment volumes in Hidalgo and Zacatecas respectively represent only 3% and 6% of the total volume treated in Nuevo Leon. Obviously, the level of wastewater infrastructure in these two states is very low and unquestionably insufficient. And, as mentioned earlier, if Conagua was stricter about the reuse of non-treated waters for agriculture where it is a world leader, it would have a distinct incentive to treat more water which would allow them a greater and healthier source of water for reuse.

Artificial Recharge of Aquifers and Its Regulations– A Start

When discussing how to deal with overexploited and contaminated aquifers, artificial aquifer recharge is a topic that Mexican water authorities and organisms have been discussing more and more. In fact, during the last decade, CONAGUA published two NOMs (NOM 014 and NOM 015) related specifically to the process of injection of water into aquifers which we describe in greater detail below. While CONAGUA is considering this alternative as a future solution for aquifer overexploitation, the reality is that it is being carried out in mostly pilot projects only and at relatively insignificant volumes. Aquifer recharge is an alternative that will require large investments to be significant and viable in helping solve Mexico´s aquifer overexploitation and contamination problems. And, it will have to compete against other, probably higher priority and less expensive water projects which will probably make it viable only in the medium-to-long term.

Nonetheless, CONAGUA has started the construction of two major wastewater treatment plants in the State of Mexico, El Caracol and Zumpango, whose purposes will be, amongst others, artificial aquifer recharge. Supposedly, within three, these two plants will be fully functional and functional with recharge activities. Once El Caracol plant initiates operations, it will begin to recharge one cubic meter per second into a nearby aquifer, representing 31.5 million cubic meters a year of treated wastewater recharge. CONAGUA is also working in feasibility projects and exploration of the best locations for artificial aquifer recharge, especially in the metropolitan area of Mexico City where the problem is persistent and becomes more serious every day with the rising water demand of its more than 25 million inhabitants. Also, CONAGUA is currently pushing for the construction of five catchment wells in the southern part of the Valley of Mexico where it has been determined that these types of wells would be feasible

Concerning the regulation of this process, the above mentioned artificial recharge NOMs establish the mandatory guidelines for the aquifer recharge. NOM-014-CONAGUA-2003 provides the requirements for the recharge with treated wastewater while NOM-015-CONAGUA-2007 provides the regulations regarding the characteristics and specifications for the water being injected and the systems and procedures employed. Unlike NOM 001 which only deals with discharges into federal bodies and unlikes NOM 002 which only deals with discharges into municipal bodies, NOMs 014 and 015 are applicable nationwide and establish the requirements that authorities must comply with regarding water quality, operation, and monitoring of aquifer recharge processes using treated wastewater.

Current Projections for Wastewater Reuse in the Valley of Mexico

Currently, the Mexico City metropolitan area generates more than 40m3 per second of wastewater. There is installed capacity for the treatment of only 25% or 10m3 per second and only about 12.5% or 5.2 m3 per second is actually treated. Unfortunately, the great majority of these wastewaters waters are simply returned to drainage channels and sent to the State of Hidalgo without treatment. Despite this situation, the treated wastewater in the Valley of Mexico is used extensively for filling channels and lakes, metropolitan agricultural and green area irrigation, parks and gardens, and of course industrial reuse. Mexico City´s most important and one of its oldest wastewater treatment plants, Cerro de la Estrella, generates a large portion of this treated water supply. Since the 1950´s it has been the most important source of treated water to help maintain the drying Xochimilco lake areas in the southern part of the city.

The Mexican Fund for Preservation of Nature, a non-profit research organization based in Mexico, has carried out a detailed study of the potential uses for current treated wasters from the Valley of Mexico, by volume, location and required water quality. The below the table describes these options and gives us a glimpse of how treated wastewater can and should be used in the future in Mexico´s most important urban area.

Activity for Reuse	**Vol. (m3/s)**	**Location**	**Quality Required**
Agricultural Irrigation	23.0	Agricultural land over recharge zones in north, east and south Valley areas.	Medium to low
Municipal and Industrial reuse	7.5	Local plants throughout the metropolitan area	High to medium
Infiltration lagoons	7.5	Recharge zones in north, east and south Valley areas	High
Expand small agricultural and lake areas	2.0	Southern and Western areas: Xochimilco, Tláhuac, Texcoco	Medium
Wells for the injection of treated waters	1.0	Recharge zones in north, east and south Valley areas	Very high
Total	41		

It is important to mention that Mexico City, despite being the area with the highest water demand in the country, does not have a solid reuse program. It also does not have currently have sufficient infrastructure to treat all of its wastewater to help avoid the further deterioration of its subterranean and close to surface sources. Monumental works like the Atotonilco wastewater treatment plant and the Tunel Emisor Oriente – TEO (East Issuer Tunnel) demonstrate the need the city has to make a better handle and make use of its water resources including its wastewater resources.

However, these mega projects only provide a partial solution to the Mexico City´s large and vast water problems. We are still left without sufficient treated water supply for the reuse demand that could and should exist. For example, once the Atotonilco plant comes on line, the great majority of the wastewater in the Valley of Mexico will be conducted through the TEO to the edge of the Valley and on to Atotonilco technically to the north of the Valley of Mexico. One has to ask whether the Mexican authorities want to return the treated water from Atotonilco to Mexico City for its resue needs and how and at what cost this will happen. Hidalgo will probably want to continue to use this wastewater source for agriculture as it has done for decades. However, in that case, one has to ask where the most important urban and industrial center in Mexico will continue to find access to sufficient reusable water sources?

Conclusions

Although water demand and the amount of wastewater in Mexico increases daily at almost exponential levels, there currently does not exist a serious reuse program capable of satisfying demand and seriously addressing the overexploitation of superficial sources and aquifers. Even though the reuse situation is not close to being what it should be in the Mexico City metropolitan area and while reuse in the south is practically non existent, it is important to point out that cities like Monterrey, Torreon and Ciudad Juarez in northern Mexico have implemented treated wastewater reuse as an important basis for their current and future development. The extreme weather in the region, the low water availability, the urban concentration and the high industrial activity of these cities require significant reuse measures and have so for sometime. Let´s hope that central Mexico water stress does not reach northern Mexican levels before Conagua and central Mexican state and municipal governments make the necessary commitment to water reuse.

As mentioned above, without higher potable water prices and more subsidies for treated water, it will be very difficult to effectively promote water reuse. Simply put and despite inevitable, initial political backlash, prices have to go up and Mexican residents, municipalities and businesses have to begin to understand and accept that water does not "grow on trees" and is a commodity that they have to pay full price for. Without this change, water reuse will not play the role that is needed in aquifer overexploitation prevention and we will all suffer in the medium term if not the short term.

The Mexican authorities are recognizing current water supply problems. Projects like Atotonilco and el Caracol in the Valley of Mexico and el Ahogado in Guadalajara are mega projects meant to at least partially address these problems. Pilot projects and programs focused on infiltration of treated waters directly into aquifers are some examples of this commitment. However, Conagua and Mexican municipal and state water agencies have to come up with a more extensive if not comprehensive reuse program if they are going to solve their aquifer problems. Without such a program and adequate funding, these mega project measures will not make significant dents in the problem nor become significant, medium-to-long term water reuse drivers.