v. 4, n. 2, 2024

Journal of
Agricultural
Sciences
Research

CONSERVATION OF LAKE TLAHUAC-XICO, AS A NATURAL RESERVE WATER ECOSYSTEM AND NEW WATER SOURCE FOR THE EASTERN VALLEY OF MEXICO, IN FACE OF THE GLOBAL WATER CRISIS

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Abstract: Water is a natural resource, of great relevance for health, essential for life, for the development of societies, economic growth, the preservation and conservation of the environment, and to achieve human well-being, sustainable development and world social peace. However, the production and consumption of goods and services has not only brought with it a greater demand for the liquid, but also a greater generation of wastewater, which is discharged without any prior treatment into surface water bodies and, as a result, many freshwater ecosystems. and marine areas show signs of degradation, which has reduced the quantity and quality of their environmental services, in addition to the irreparable loss of their biodiversity. In this research, the quality of the water stored in the new Lake Tlahuac-Xico was evaluated, which as a result of the consolidation of the aquitard due to the effect of pumping in the main underlying aquifer due to the extraction of water and derived from this topographic depression and subsidence. differentials caused by the exploitation of the aquifer through 14 wells for the supply of drinking water, gave rise to its formation, where surface water from runoff is stored, whose evolution and current form is controlled by the extension and geometry of a basalt flow, from the Sierra de Santa Catarina, located 50 m deep within the lacustrine sequence. The results showed a high contamination index, due to wastewater discharges from the Amecameca River, raw wastewater discharges from the Serpentino Canal and the Ixtayopan plant, and runoff from surrounding agricultural areas.
Keywords: Lake, Nature Reserve, Rainwater, Climate Change, Pathogenic microorganisms, Water Crisis.

INTRODUCTION

Water-related ecosystems, such as lakes, rivers and vegetated wetlands, are among the most diverse environments in the world and provide a range of benefits and services to society. Furthermore, water-related ecosystems have significant economic, cultural, aesthetic, recreational and educational value. They help maintain global water, carbon and nutrient cycles. They support water security, provide natural fresh water, regulate flows and extreme conditions, purify water and replenish aquifers. Under this context, water must be analyzed, not only as a natural resource, but also in cultural, symbolic terms and as an essential element for all living beings (Velázquez, 2010; Paz, 2014). By allowing the development of society, contributing to equitable distribution, social justice and countering poverty, its quality is therefore of great relevance for health, economic growth, preservation and conservation of the environment, and for achieve human well-being, sustainable development and global social peace (Villena, 2018). Of the 1,400 million km3 of water on the planet, 2.5% correspond to fresh water (rivers, lakes, glaciers, ice sheets and aquifers).

Of which, about three-quarters of fresh water is contained in glaciers and ice sheets, the majority (97%) in Antarctica, the Arctic and Greenland. While surface waters (lakes, reservoirs, rivers, streams and wetlands) retain less than 1% of unfrozen fresh water; In the world's lakes alone, more than 40 times what is stored in rivers and streams (91,000 versus 2,120 km^3) and approximately nine times what is stored in swamps and wetlands are stored (UNEP-GEMS, 2007). Of the estimated 38 million cubic kilometers of fresh water, just over 75% is concentrated in polar caps, eternal snow and glaciers; 21% is stored in the subsoil, and the remaining 4% corresponds to bodies and surface water courses (lakes and rivers).

The water supply in Mexico comes from hydrological basins, aquifers, rivers, wetlands, lakes, etc. The country has a territorial area that includes 1,960,189 km², of which 1,959 million km² correspond to the continental surface and the rest to the island areas. Two thirds of the territory are considered arid or semi-arid, with annual rainfall of less than 500 mm, while the southeast of the country is humid with annual rainfall that exceeds 2000 mm per year. In addition, in most of the national territory, rain is more intense in summer, mainly torrential (CONAGUA, 2016a). According to an analysis carried out by the National Climatic Data Center of the United States, the world average of terrestrial precipitation was what occurred in 2010, with a record of 52 mm more precipitation than the average of 1,033 mm corresponding to the period. from 1961-1990. However, in Mexico, the normal precipitation during the period 1981-2010 was only 740 mm, with accumulated precipitation in the Mexican Republic from January 1 to December 31, 2015 of 872 mm, being 17.8 % higher than normal for the period from 1981 to 2010 (CONAGUA. 2016b). It is important to note that the monthly distribution of precipitation accentuates the problems related to the availability of the resource, because 68% of the normal monthly precipitation occurs between the months of June and September, during the dry period, drought is accentuated. which occurs when rainfall is significantly less than the normal recorded levels, which causes serious hydrological imbalances, which harm agricultural production systems. When rain is scarce and infrequent and the temperature increases, vegetation develops with difficulty.

Which is a serious problem, given that droughts are also considered part of the most costly natural disasters, which affect more people compared to other forms of natural disasters. Relating to phenomena of soil degradation and deforestation, and increased risks of forest fires (INEGI, 2013b). Both drought and intense rainfall, combined with factors such as topography, land use and the state of the vegetation cover, can affect society and economic activities. To meet the demand for water, in Mexico, as of December 31, 2015, the availability of 731 hydrological basins, 8 transboundary basins and 51 main rivers was reported (CONAGUA, 2016a). Of the 731 hydrological basins, 627 were in a situation of availability according to the Official Mexican Standard (NOM-011-CONAGUA-2000). These 731 basins are organized into 37 hydrological regions, grouped into the 13 hydrological-administrative regions (RHA) CONAGUA, (2016c). In addition to sharing 8 basins with neighboring countries: 3 with the United States of America (Bravo, Colorado and Tijuana), 4 with Guatemala (Grijalva-Usumacinta, Suchiate, Coatán and Candelaria) and one with Belize and Guatemala (Río Hondo). Under this context, Mexico receives approximately 1,489,000 million cubic meters of water in the form of precipitation. Of this water, it is estimated that 71.6% is evapotranspirated and returned to the atmosphere, 22.2% runs off through rivers or streams, and the remaining 6.2% infiltrates into the subsoil naturally and recharges the aquifers. Taking into account the outflows (exports) and inflows (imports) of water with neighboring countries, the country annually has 471.5 billion m³ of renewable fresh water, renewable water per capita was estimated in 2015 at 3692 m³ /room/day. Despite this, there are basins in the country with a water deficit and they are located in the central and northern areas, particularly in the RHA VI Rio Bravo and XIII Aguas del Valle de México (CONAGUA, 2016a). According to the World Meteorological Organization, the normal precipitation of the country in the period 1971-2000 was 760 mm (WMO, 2011), the normal values correspond to the averages calculated for a uniform and relatively long period, which must have at least 30 years to collect information, to be considered as the minimum representative climatological period, which must begin on January 1 of a year that ends in one and end on December 31 of a year that ends in zero (CONAGUA, 2014).

However, due to population growth, industrialization, energy generation and greater demand for water in the agricultural sector, there has been at the same time an increase in water extraction from basins and aquifers in the country, for different consumptive uses., particularly in the central and northern areas of the country, where the indicator reaches a value of 55%, which is estimated to continue increasing if current trends continue. The increase in water extraction in basins and aquifers in the country has caused a situation of overexploitation in 115 of the 653 aquifers and in 69 of the 731 hydrological basins the concessioned or assigned flow is greater than that of renewable water (deficit situation). Which has caused the level of springs to decrease, and the surface of wetlands has also been reduced by up to 10%, which harms endemic species; as is the case of the hinge turtle. On the other hand, with climate change, agriculture, tourism have been affected by the closure of springs and agricultural production by the reduction of water in irrigation canals (Ortiz and Romo, 2016). It is of great relevance to mention that the water in the subsoil aquifers is the result of a long and slow accumulation process of part of the surface waters, which penetrate through the soil particles and settle at the lowest levels. of sedimentary substrates. The speed of percolation of surface water into the subsoil (aquifer recharge) is of vital importance that is taken into account in the water balance between pumping and recharge, that is, the difference between what enters the aquifer and what is discharged. extracts from it, considering it as a measure of exploitation and renewability of the water resource.

Currently, the recharge of the aquifer is between 23 and 27 m^3/s, according to different sources of information, which shows a deficit of 29 m^3/s between what is extracted by pumping and what is recharged to the system. One of the main consequences of the deficit between pumping and recharge of the aquifer in the Mexico basin is differential subsoil subsidence. Pumping reduces the water content of the clays that form the sludge of the ancient lake beds in the Valley of Mexico. By losing moisture, clays and organic sediments contract and the soil decreases in volume and drops in level.

Reductions in ground level depend on the local speed at which water is extracted from the subsoil, the depth, and nature of the sediments. In some parts of the metropolitan area, subsoil drying has been of such magnitude that it has produced subsidence of up to 8 m so far this century (Guerrero et al., 1982). Historically, the first well drilling in Mexico dates back to 1847, marking the beginning of the history of the uses of groundwater extracted from the subsoil (Domínguez & Carrillo, 2007). Where a total of 653 aquifers are housed, which contribute 38.9% of the total volume concessioned for consumptive uses (33,311 hm^3 per year as of 2015). Of the total aquifers, 105 are in conditions of overexploitation, 32 with the presence of saline soils and brackish waters and 18 with marine intrusion.

In this sense, groundwater sources that play a role of increasing importance in the socioeconomic growth of the country, thanks to their physical characteristics that allow them to be used in a versatile way, function as storage dams and distribution networks, which allow the extraction of water at any time of the year from any point on the aquifer surface (CONAGUA, 2016d). Among the attributes that groundwater presents by nature are: less loss due to evaporation and exposure to pollution, its availability is not affected by climatic variations, wide spatial distribution, no loss of storage capacity and constant water temperature. However, aquifers, which are the best way to store water to face dry years, are running out of reserves because they are overexploited to meet water demands as mentioned above. Other sources of water supply for the national territory of Mexico are the country's rivers and streams, which constitute a hydrographic network of 633 thousand km in length, in which fifty-one main rivers stand out, through which 87% of the runoff flows. surface of the country and whose basins cover 65% of the continental territorial surface. In terms of surface area, the basins of the Bravo and Balsas rivers stand out, and in terms of length, the Bravo and Grijalva-Usumacinta rivers, the Lerma and Nazas-Agua naval rivers, belong to the inland slope. In the case of transboundary basins, the basin area and the length of the river correspond to the Mexican part of the basin, strictly to the basin itself.

Another source of water is wetlands, which include ecosystems such as lakes and rivers, underground aquifers, swamps, coral reefs and many others; but also, artificial sites created by man such as fish ponds or reservoirs. Although they only cover about 6% of the Earth's surface, 40% of all plant and animal species live or reproduce in them. Thus, wetlands are considered ecosystems that crucially contribute to biodiversity, climate mitigation, freshwater availability and economic resilience. They are a refuge for fauna, filter pollution and are important carbon deposits. They store more carbon than any other ecosystem, absorb excess water and help prevent floods and droughts, are essential for climate change mitigation, adaptation, biodiversity, human health and prosperity, are also vital for well-being and the safety of human beings.

In the literature it is reported that more than one billion people around the world depend on them for their subsistence, approximately one in eight people on Earth. However, they are also one of the most threatened habitats on Earth. Around 85% of the wetlands present in 1700 were lost in the year 2000, many of them drained to convert them into urbanized areas, agriculture or other "productive" uses. Their disappearance, three times faster than that of forests, represents an existential threat for hundreds of thousands of animal and plant species (UN, 2022). And as mentioned before, they are a key ally to stop the loss of biodiversity, More than 140,000 species including 55% of all fish depend on freshwater habitats for their survival. In 1970, there was a 70% increase in the number of invasive alien species in wetlands (Asian carp, water hyacinth, otter, among others) (IPBES, 2018). As for freshwater species, these are important to local ecosystems, provide sources of food and income for humans, and are key to flood and erosion control. However, wetland species have been observed to become extinct faster than terrestrial or marine species, and almost a third of all freshwater biodiversity faces extinction due to invasive species, pollution, loss of habitat and overexploitation.

According to the UN Environment Programme, wetlands are the most forgotten part of the climate crisis (UN, 2022). Another natural body of water is lakes, which are bodies of water formed when natural depressions or basins on the earth's surface fill with water over time.

These depressions (basins) are the result of catastrophic events of glaciers, volcanic activity, tectonic movements or differential subsidence in endorheic basins due to their soil composition, due to overexploitation of the aquifer mantle. The natural process of "glacial erosion", important for the formation of lakes in temperate zones, in which the slow movement of large volumes of glacial ice during and after the Ice Age produced depressions in the earth's surface that, later filled with water.

Tectonic movement also influences its formation, with the slow movements of the Earth's crust, depressions are produced that, over time, fill with water. However, their lifespan is limited by changes and alterations in climatic and geological conditions. Most lakes are freshwater, but there are also saltwater lakes, such as the Dead Sea, the Great Salt Lake (USA), the Aral Sea and the Caspian Sea.

Lakes tend to create their own ecosystem, with certain endemic species and others specific to the lakes. Most of them have shallow waters, in which sunlight reaches the bottom, making them very conducive to the development of life, especially plankton and bacteria. The following table 1 shows the main lakes in Mexico.

With more than 90% of liquid freshwater on the world's surface, natural and artificial lakes (reservoirs) offer many sustainable uses for human life and economic development. They provide direct and indirect benefits to many segments of society, they are of great ecological importance, because they offer a habitat for fish, aquatic species and amphibians, migratory birds, biodiversity of flora and fauna, as a reserve of drinking water, control floods and for carrying out recreational and religious activities. It must be noted that the demand for water continued to grow, just from 1950 to 2020, the country's population more than increased, and went from being mostly rural to predominantly urban, with a population of 126,014,024 (INEGI, 2016d). In 2016, a population of 122.7 million was estimated, and it is expected that in 2030, it will reach 138.1 million and by 2050, the population in Mexico will reach 148.2 million people (Muradás et al., 2018). Due to the growing global population and its increasing economic capacity, it has brought about the need to have greater volumes of water to supply urban areas, for energy generation and for productive activities, mainly agriculture. and the industry (SEMARNAT, 2020). Therefore, scarcity tends to manifest first in regions with high rates of demographic growth and expansion of industrial and agricultural activities (IDEAM, 2010). With population growth, economic development, changes in consumption patterns, the intensification of agricultural production and the expansion of cities, a substantial increase in water demand will be generated (Wada & Bierkens, 2014), while water availability becomes increasingly erratic and uncertain (FAO, 2017a; IPCC, 2018a).

In the literature it is reported that global water use has multiplied by six in the last 100 years and will continue to increase at a constant rate of 1% annually due to demographic growth, economic development and changes in consumption patterns.

According to current trends, feeding a largely urban population requires increasing food production by around 70% (Godfray et al., 2010), which implies that water withdrawals would increase by 55% by the year 2050 (FAO, 2011; Guijarro Sánchez, 2015; Leyva et al., 2018). On the other hand, the lack of access to water and sanitation has an enormous human cost, both in social and economic terms (UNESCO, 2009). With the recognition of the United Nations General Assembly on the human right to water and sanitation, on July 28, 2010 through Resolution 64/292, it was reaffirmed that clean drinking water and sanitation are essential for the realization of all human rights. With this resolution, States and international organizations were urged to provide financial resources, to promote training and the transfer of technology to help countries, particularly developing countries, to provide a supply of drinking water and

No	Lake	Basin Area (km^2)	Storage capacity (Millions of m3)	Administrative hydrological region	Federal entities
1	Chapala	116	8126	VIII Lerma-Santiago-Pacific	Jalisco and Michoacán de Ocampo
2	Cuitzeo	306	920	VIII Lerma-Santiago-Pacific	Michoacán de Ocampo
3	Patzcuaro	97	550	VIII Lerma-Santiago-Pacific	Michoacán de Ocampo
4	Yuriria	80	188	VIII Lerma-Santiago-Pacific	Guanajuato
5	Catemaco	25	454	X Central Gulf	Veracruz of Ignacio de la Llave
6	Tequestitengo	8	160	IV Rafts	Morelos
7	Nabor Carrillo	10	12	XII Waters of the Valley of Mexico	Mexico

Table 1. Storage areas and volume of the main lakes in Mexico

Source: CONAGUA, 2009.

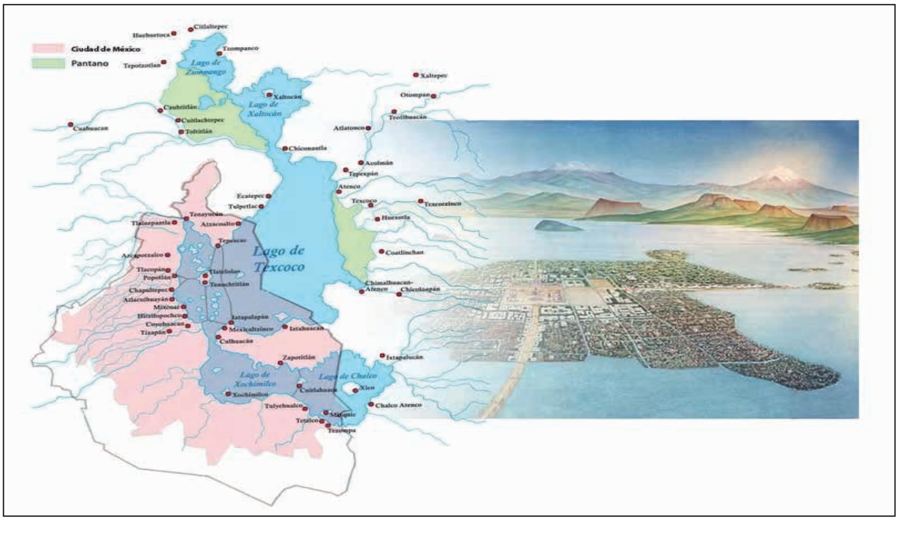


Figure 1. Formation of the 5 great lakes.

healthy, clean, accessible and affordable sanitation for all (UN, 2015). Therefore, the human right to the supply of drinking water and environmental sanitation is of vital importance, by guaranteeing at the same time that lakes and rivers for recreational use and even the seas; do not contain harmful levels of fecal contamination, algal blooms or the presence of dangerous and toxic pollutants, to save many lives and have broad direct and indirect economic benefits, both at the level of households and at the level of national economies, reducing damage ecological, environmental and climate change, among others (WHO, 2019).

In this context, water quality is of great relevance and is measured according to different parameters through which the degree of alteration of natural qualities is quantified and classified for a specific use. According to Salazar et al (2023), the Water Quality Index (WQI) indicates the degree of contamination of the water on the sampling date and is expressed as a percentage of pure water; Thus, highly contaminated water will have a value close to or equal to 0%, while water in excellent condition will have a value of this index close to 100%. Some authors, such as Sharma & Chhipa (2012), mention that water quality can be classified as excellent, good, poor, very poor and unsuitable based on the ICA value.

For its part, Mititelu (2010) mentions that the type of water quality is defined based on the values of the physical, chemical and biological parameters.

Establishing quality before use is crucial for various purposes, such as: drinking water, water used in agriculture, water used for leisure (fishing, swimming) or water used in industry. For the analysis of the quality of surface water, CONAGUA (National Water Commission, in Mexico), considered 8 indicator parameters: Five-day Biochemical Oxygen Demand (BOD5), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), *Fecal Coliforms, Escherichia coli,* Fecal Enterococci, percentage of Dissolved Oxygen saturation (DO%) and Acute toxicity (CONAGUA, 2023). And because in Mexico, 1,781 m3/s (56.2 km3 per year) are allocated for agricultural use, of which 67.2% comes from surface sources, it is very important to evaluate its quality, while 32.8% comes from groundwater supply.

The reuse of water in agriculture constitutes a highly relevant alternative in the arid and semi-arid states of the country since currently a total of 200 m3/s (6.3 km3 per year) is discharged, of which a total volume of 108 m3 /s (3.4 km3 per year) are used in agricultural irrigation. However, only 8.2% have any treatment process, while 91.8% is applied without any treatment in 254,597 hectares distributed in 26 Irrigation Districts (DR). In Mexico, reuse in agricultural irrigation is a widespread practice that began in 1896; But it was not until 1920 that the economic importance of taking advantage of it for agricultural purposes began to be seen. It can be said that the use of this water was a spontaneous, unforeseen or unplanned consequence of the drainage works from the Valley of Mexico to the Mezquital Valley located in the north of Mexico City, where approximately 90,000 Ha (Jiménez et al., 1997 & 1999). Due to its high content of nutrients and organic matter, this water is highly valued by farmers, as it allows agricultural productivity to be significantly increased. For the evaluation of water quality, it is carried out using three indicators: the five-day Biochemical Oxygen Demand (BOD5), the Chemical Oxygen Demand (COD) and the Total Suspended Solids (TSS).

The evaluation of microbiological parameters to estimate water quality is of great relevance from the point of view of the health sector due to its impact on the proliferation of diseases (mainly gastrointestinal) and its possible dissemination in the environment and the population, being a focus of infection in communities or affected areas. For its part, air pollution by microorganisms of fecal origin, produced both by the high degree of open-air fecalism that still persists in the city and by the sewage at the bottom of the valley, is still a common problem and dust devils They are a potential source of infections and a cause for public health concern. The concentration of fecal bacteria in the rainwater of Mexico City is 100 to 150 microorganisms per liter, while samples of the microbiological flora suspended in the atmosphere of Mexico City have frequently shown a high concentration of pathogenic microorganisms (Bravo, 1987). The presence of *Fecal coliforms* in water, are indicative of fecal contamination of humans and warm-blooded animals and can be divided into total and fecal. Its main difference is the ability of feces to grow at higher temperatures under laboratory conditions and to produce gas from lactose (Madigan et al., 2016; Pelczar, 2010). Another microorganism of interest is Salmonella spp. which is a genus of Gram-negative bacilli, facultative anaerobes, associated with diarrheal diseases, which continue to be one of the most important causes of morbidity and mortality, especially in infants, children and the elderly (Parra et al., 2002). The probability that a child will die from diarrheal disease before the age of 7 can be up to 50% (Mead et al., 1999). In the case of the species of greatest clinical relevance, the species stand out: Typhi, Paratyphi and Enterica, with an estimate of 99% of salmonellosis cases being caused by Salmonella enterica subspecies I (Yim. et al, 2010). Moeller & Ferat (2000) confirmed the presence of high quantities of the Salmonella and Shigella genera, protozoan pathogens to humans such as E. hystolitica and G. lamblia and more persistent parasites such as: Ascaris and Strongyloides. Salmonella spp is the genus with the highest incidence of salmonellosis with doubling times of 23 minutes for Salmonella typhi and 150 minutes for Salmonella pollorus. With survival times of 2 months in wastewater and up to 8 months in soil. For their part, helminths represent a high risk to human health because their various infectious stages (embrionated eggs or larvae) are highly persistent in contaminated water. Thus, water constitutes a direct or indirect vehicle for the spread of helminths, even when they are found in low concentrations, giving rise to gastrointestinal diseases, especially when it is used to irrigate crops. Helminth eggs come from the gastrointestinal tract of bovines, from the excrement of pigs, from Ascaris lumbricoides, Necator americanus from the small intestine of humans, pigs, dogs and cats. In the case of Ascaris lumbricoides, they can remain viable for 22 months in surface and deep waters, and 1 to 2 months in cultures. Therefore, water depletion and pollution are the main causes of biodiversity loss and ecosystem degradation, which, in turn, reduce their resilience, making societies more vulnerable to climate and non-climate risks.

Climate change is likely to increase stress on global wetlands and aquatic ecosystems with negative implications for fisheries and aquaculture (Poff et al., 2002). Such changes in water quality not only affect economic and social well-being, but also the sustainability of vital environmental flows, ecosystems and biodiversity (WWAP, 2017). Climate change represents a growing threat to the country's natural and human capital. The scale and speed of climate variations requires us to have an understanding of how these changes will impact human communities, ecosystems and their biodiversity, which entails the need to define actions for their conservation and

Journal of Agricultural Sciences Research ISSN 2764-0973 DOI: https://doi.org/10.22533/at.ed.973422408028

the maintenance of goods and services. that they provide. In this context, climate change and a more erratic and uncertain supply will aggravate the situation in the regions where water is most scarce and will create scarcity in regions where water is still abundant today.

Material water scarcity is typically a seasonal rather than chronic phenomenon, and climate change is likely to alter the seasonal availability of water throughout the year in several locations. Previous studies predict that water scarcity will continue to increase in the future, with around 52% of the world's population living in water-stressed regions by 2050 (Kölbel et al., 2018). It is evident that climate change and land use change will undoubtedly significantly affect natural resources and water supply sources in all regions of the country. The increase in temperature and the alteration in rainfall could impact the availability and quality of water. The quality of the water will be negatively affected by the increase in its temperatures, the lower amount of dissolved oxygen and, consequently, the lower self-purification capacity of freshwater tanks. Flooding and increased concentration of pollutants during droughts will increase the risk of water pollution and pathogenic contamination. As the planet warms, water has become one of the main ways we experience climate change, which affects and continues to affect the world's water resources. Which reduces the availability and quality of water, increases the occurrence of extreme meteorological phenomena such as hurricanes classified according to the speed and damage produced (Saffir Simpson, 1969), threatening sustainable socioeconomic development and biodiversity anywhere in the world. This, in turn, has profound implications for water resources (WWDR, 2020). The scientific evidence is clear: the climate is changing and will continue to change (IPCC, 2018a), affecting societies and the environment. This occurs directly through changes in hydrological systems that are affecting water availability, water quality and extreme events, and indirectly through changes in water demand, which in turn can have impacts on energy production, food security and the economy, among others. The effects of climate change, the rapidly occurring degradation of ecosystems due to pollutants from industrial, mining and agricultural activities, untreated urban and rural waste, oil spills and toxic discharges, negatively impact biodiversity. and freshwater ecosystems, putting essential ecosystem services at risk. Around a million animal and plant species are in danger of extinction, freshwater species are those that have suffered the greatest decline, falling by 84% since 1970.

Humans have also been affected: around 4 billion people currently experience severe water shortages for at least one month a year, a situation that has been aggravated by the climate crisis (UNESCO-UN-Water, 2020). In the period from 2011 to 2013, Mexico was severely affected by a drought that covered 90% of the national territory (CONAGUA, 2012). In this sense, the most vulnerable regions that are most affected by drought are the north, northwest and center of the country; mainly the states of Chihuahua, Coahuila, Nuevo Leon, Durango and Zacatecas (CONAGUA, 2016a).

In much of the country, groundwater extraction exceeds recharge, which means that the water heritage is being undermined by approximately 9.5 billion m3/year. In addition to the loss of important areas for recharge due to deforestation, the change in land use, the disorderly expansion of human settlements and the replacement of green areas with paved areas that prevent infiltration. Soil salinization and the presence of brackish groundwater occur as a result of high evaporation rates in areas with shallow groundwater levels, dissolution of evaporitic minerals and the presence of congenitally high salinity water. Brackish waters occur specifically in those aquifers located in geological provinces characterized by ancient, shallow sedimentary formations, of marine and evaporitic origin, in which the interaction of groundwater with the geological material produces its enrichment in salts. As mentioned previously, at the end of 2015, 32 aquifers were identified with the presence of saline soils and brackish water, located in the Baja California Peninsula and the Mexican highlands, where conditions of low rainfall, high rates of solar radiation and, therefore, converge. both evaporation, as well as the presence of congenital waters and easily dissolving evaporitic minerals. In that year, marine intrusion occurred in 18 coastal aquifers nationwide (CONAGUA, 2016a). With the formation of the Chichinautzin mountain range 700,000 years ago, when the only exit from the Valley of Mexico was blocked, a closed basin was created, with the natural tendency to retain its waters from rivers and streams that flowed into a flat, low terrain within. of the basin. There were two rivers that fed the basin: the Cuautitlán River and the Coyotepec River that flowed into Zumpango and Xaltocan and that, in turn, poured their waters into Lake Texcoco. This is how the 5 great lakes (Xaltocán, Zumpango, Texcoco, Xochimilco and Chalco) were formed (figure 1), which joined together in the rainy season (Ezcurra, 1990.

But, as a result of the great flood that Tenochtitlan suffered in the year 1449, the inhabitants built a dam and a system of gates to control the passage of water. However, the lakes of Chalco, Xochimilco, of San Lázaro, which was destroyed in the war of 1521, the year in which the Spanish obtained victory over the Mexica. This dam served to control the water level in the vicinity of the islet on which the city was located, and it also divided salt water from fresh water. These floods continued even later, affecting the population settled in the region, as happened in 1555, 1586, 1604 and 1607. It was in this last year that Viceroy Luis de Velasco ordered the construction of the first drainage in Mexico, known as the Tagus. from Nochistongo, with which water began to be removed from the largest lakes: Zumpango and Xaltocan. The work was designed by Enrico Martínez. Years later, both bodies of water began to be channeled, in addition to the Citlaltépetl lagoon and the Cuautitlán River towards the Tula River. Although the work worked for a time, it was not enough to prevent floods in the valley, such as that of 1629, caused by the so-called San Mateo flood. For this reason, the decision was made to dry up the entire Lake Texcoco, which was the largest body of water in the Valley of Mexico basin, drained over five centuries.

It must be noted that although in the year 1861, Lake Chalco reached an approximate area of 10,448 hectares, due to the currents of the rivers that flowed into the Lake and the waters coming from the rainy season that They increased its level, causing flooding of the surrounding towns, as happened in 1866 in the town of Chalco.

To avoid the above, in 1877 the eastern canal was built in the Chalco-Texpepan section passing through Texcoco, which favored the gradual recovery of land on the periphery of the Lake, additionally constructing 8 km of the "Riva Palacio Canal", between Chalco and Ayotla, and 4 km through the port of San Isidro. Which were the first attempts at desiccation, starting with the construction of the canals, caused part of Lake Chalco to flow towards those of Lake Xochimilco and Texcoco, causing the bottom of the Ciénega to decrease. On the other hand, the modernization of agriculture, as a means to increase the productivity of the land and have products to supply the large cities, led to the drying up of Lake Chalco (Beltrán, 1998).

Since colonial times, the Zumpango Lagoon had the function of draining the Valley of Mexico Basin, due to the floods that affected Mexico City. However, with the beginning of the project called "Los Insurgentes" in 1976, which consisted of the transfer of wastewater from the Valley of Mexico, to the Northeast region of the State of Mexico, using the Zumpango Lagoon as a receiving center to expand the peripheral irrigation zone, considered a priority in the hydraulic plans; In 1978 and as a result of hydraulic works, the lagoon was drained.

It is subsequently reactivated with the discharge of wastewater; The introduction of residual water resulted in the proliferation of water lilies, causing the Lake to be drained again in 1997 in order to eradicate the lily (Correa et al. 2018). On June 23, 2003, in the Government Gazette of the State of Mexico, the Zumpango Lagoon was declared a Protected Natural Area with the category of State Park for the Protection and Promotion of the Water Sanctuary. 10 years after that declaration, the objective of maintaining its role as environmental regulator, of promoting the habitat of aquatic flora and fauna, of conserving native and endemic biodiversity, as well as of recharging the aquifers and improving the quality of life of the riversides, is not being fulfilled. With its 20 hectares of extension and 18.5 kilometers of border, the lagoon was appreciated daily by the inhabitants of at least 10 municipalities that share it, mainly in Zumpango. However, due to the water crisis, high temperatures, lack of rain and the appearance of the water lily, which is a plant that adsorbs extraordinary amounts of liquid to survive, it caused the definitive drying out of Lake Zumpango.

With the pumping of the unconfined aquifer on the periphery of the lake aquitard in the Chalco sub-basin, which began in the early 1940s for local agricultural and urban use. Historical information indicates that the southern end was an area of groundwater discharge, coming from the Sierra de Chichinautzin, before the intense extraction of groundwater below the lake aquitard in the 1950s.

The first wells that were built to provide drinking water to Mexico City were drilled in the basaltic aquifer of the foothills of the Sierra de Chichinautzin and Santa Catarina in the early sixties, which caused the springs located at the foot of of the Sierra de Chichinautzin, disappeared (Durazo & Farvolden, 1989). Between the early 1960s and the mid-1970s, total extraction in the Chalco sub-basin was approximately 5 m3/sec. When major extraction of groundwater beyond the periphery of the aquitard began, and the beginning in 1982 of intense pumping of the aquifers below the aquitard, the land surface sank by approximately 3 m.

An additional 2 m subsidence occurred between 1984 and 1989, resulting in the formation of a shallow lake that gradually expanded. The operation of fourteen wells that were drilled in the Chalco lake plain at depths of 400 m, in the early 1980s, called the Mixquic-Santa Catarina System, in the Chalco Plain located southeast of Mexico City (figures 2 and 3), it caused one of the most important environmental transformations of the landscape of the Basin of Mexico in the last two decades, with profound social and economic implications associated with the progressive risk of subsidence and flooding. Beneath the lacustrine sediments, defined in hydrogeological terms as an aquitard, on which Mexico City is located, an important regional granular aquifer extends from which water is extracted, mainly for drinking water supply, from which a total of 50 m^3/sec (INEGI-INE, 2000), of which Chalco contributes about 3%.

The extraction of groundwater in this aquifer in the 19th and 20th centuries caused total subsidence of close to 10 m in the center of Mexico City. In the Chalco plain, extensive groundwater extraction began in the mid-1980s, equaling the total subsidence of Mexico City in less than 20 years (Ortega et al., 1999).

With subsidence of up to 40 cm/year in the center of the Chalco plain, where the thickness of the lake sediments is 300 m, (figure 4), as a result of the consolidation of the aquitard due to the effect of pumping in the main aquifer underlying due to the extraction of water and derived from this topographic depression, gave rise to the formation of a new lake, today called Lake Tlahua-Xico, due to the accumulation of surface water, whose evolution and current form is controlled by the extension and geometry of a basalt flow, from the Sierra de Santa Catarina, located 50 m deep within the lacustrine sequence (figure 5).

With the passage of time, from 2003 to 2009, the extension of Lake Tláhuac-Xico became from 292 to 568 hectares (figures 6 and 7) according to the water plan, 2011 (Water Plan, 2011).

The Tláhuac-Xico lake, recently formed due to the subsidence generated by the overexploitation of the aquifers, functions as a recipient of precipitation and surrounding runoff, composed of rainwater that accumulates on both sides of the line of wells. It is located a height of 2230 meters above sea level, it has a maximum length of 4km, a maximum width of 3.20km, and a depth of 3m. With an extraordinary rainfall (return period 50 years, duration 24 hours), 7 Mm3 of runoff would be generated in the Amecameca and Tláhuac-Xico Subbasins, which drain directly to the Lake. The Río La Compañía Subbasin would receive another 3.7 Mm3, which would also drain into the Lake (given that its deepest point is 5 meters above the Lake).

With rain events of this magnitude, it can reach a storage capacity of 34.2 Mm3 if the depth is of the order of 6.5m, leaving the surface of the lake between 1 and 5m below the level of the Valle de Chalco and Tláhuac colonies. Precipitation in the basin is concentrated in the summer, mostly from June to September. Accompanied by a pronounced precipitation gradient within the Basin, from areas of high rainfall towards the southwest (approximately 1500 mm/year), to areas of semi-arid climate towards the northeast (about 600 mm/year).

The average annual temperatures at the bottom of the Basin are approximately 15oC, with a variation of 8oC between summer and winter. (Jáuregui, 1987). Starting with the rainfall that occurred in the early morning of April 17, 2011, the level of the lake gradually increased during the following months until reaching 68 cm (figure 8), which represented a significant increase in the volume of water stored.

Under this panorama, the objective of this research work was to evaluate the quality of the water stored in Lake Tlahuac-Xico, which supports its conservation as an ecosystem and natural reserve of fresh water in the face of the water crisis, in order to ensure that the glass of the Lake has a storage capacity of up to 34.2 Mm3 and a depth of 6.5 m, to guarantee that its surface is always between 1 and 5 meters below the level of the colonies in Valle de Chalco and Tláhuac, acting as a regulating vessel., avoiding its effects due to flooding in extraordinary rains and providing environmental services to the environment.

MATERIALS AND METHODS

WATER SAMPLING FROM LAKE TLAHUAC-XICO

During the monitoring of Lake Tlahuac-Xico, samples of 1 liter of water were taken at 5 different points (in total there were 5 samples taken), in amber glass containers, which

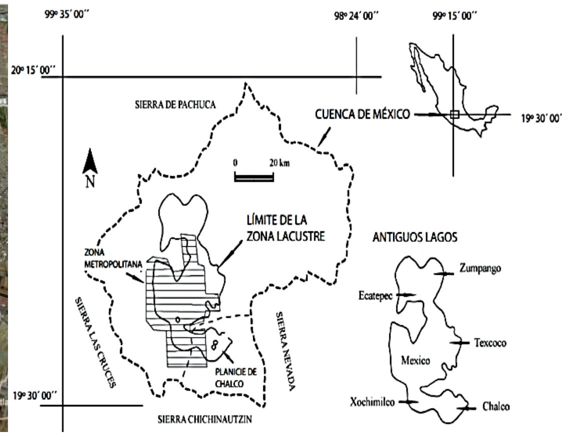
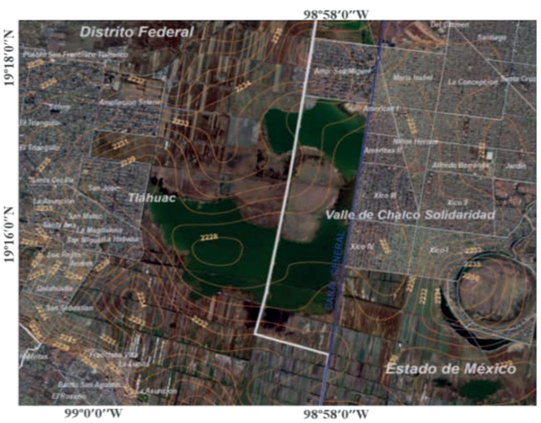


Figure 2. Well battery. **Figure 3.** Chalco Plain.



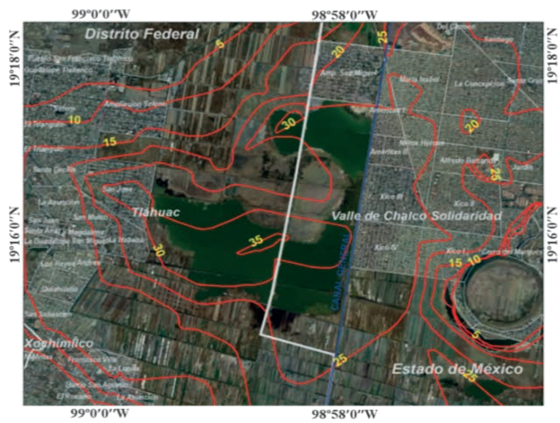


Figure 4. Differential collapse. **Figure 5.** Contour lines.

Figure 6. 292 hectares (April 21, 2003) **Figure 7.** 568 hectares (December 29, 2009)

Source: Water plan for the Amecameca, La Compañía and Tlahuac-Xico sub-basins, 2011

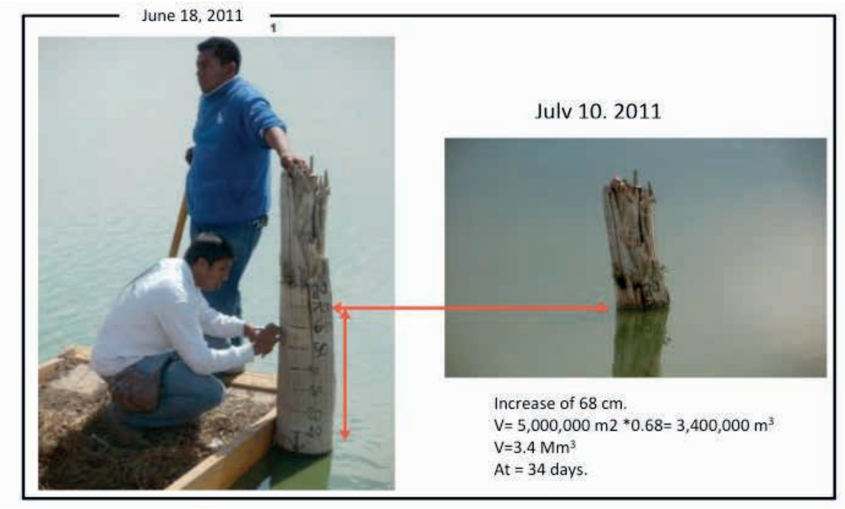


Figure 8. Increase in lake level during the rainy season

Parameter	13/Oct/2010	10/Jul/2011	19/Aug/2015	30/Sep/2015	30/Jan/2024
pH	9.39	9.1	9.69	9.54	9.9
DQO (mg/L)	274.8	229	384	312.5	673
DBO_5 (mg/L)	87.7	119.3	198	153,4	322.8
SST (mg/L)	78	64	114	84	145.8
SSV (mg/L)	45.4	38.5	69	47.5	69.8
SDT (mg/L)	779	542	748	690	789
SAAM (mg/L)	0.8	0.5	0.7	0.93	0.98
Fecal coliforms (CFU/100mL)	153	100	296	155	214

Table 2. General characteristics of the water of Lake Tlahuac-Xico.

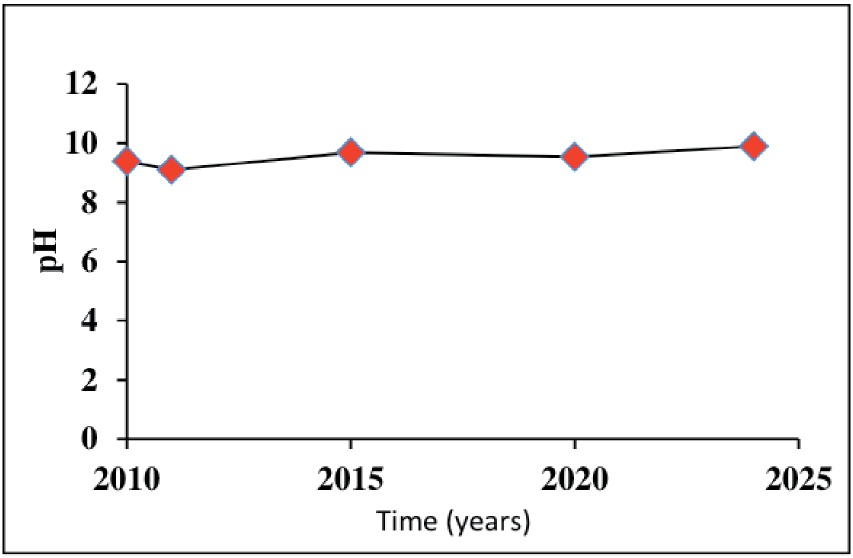


Figure 9. pH profile of Lake Tlahuac-Xico.

were preserved and transported in a cooler at 4 °C. for subsequent characterization in the laboratory. Lake Tláhuac-Xico is located southeast of Mexico City on the border with the State of Mexico. Its surface occupies part of the Mayor's Office of Tláhuac (Mexico City) and Valle de Chalco Solidaridad (State of Mexico). It borders the Mexican municipality of Chalco, and the municipalities of Milpa Alta and Xochimilco of Mexico City.

SAMPLE CHARACTERIZATION

To characterize the wastewater sampling, the main parameters were evaluated: pH using a potentiometer (Corning pH/ion Analyzer 455). Chemical Oxygen Demand (COD) according to NOM-030-SCFI-2001. The BOD5 was determined according to NMX-028-SCFI-2001. Total Suspended Solids (TSS) and Volatile Suspended Solids (SSV) were analyzed according to APHA (2012) standard methods. The determination of Total Dissolved Solids was determined according to NMX-AA-034-SCFI-2015, the analysis of detergents was determined by the Methylene Blue Active Substances technique according to NMX-AA- 039-SCFI-2001 and Fecal Coliforms, based on NOM-112-SSA1-1994.

RESULTS AND DISCUSSION

Before analyzing the results, Table 2 shows the averages of the main parameters evaluated in the water samples taken at 5 different points of the lake, at different times.

PH PROFILE OF WATER STORED IN LAKE TLAHUAC-XICO

Figure 9 shows the pH profile in the water samples analyzed at different time intervals. The determination of the pH in water indicates the tendency towards its acidity or alkalinity, however it does not measure the value of acidity or alkalinity. The determination of the acidity or alkalinity of an effluent allows the corrosivity of the effluent to be established. Furthermore, pH is an indicator of the trophic capacity of the water mass. Acidic waters are known as oligotrophic and alkaline waters are known as eutrophic. Most natural waters have a pH between 4 and 9, although many of them have a slightly basic pH due to the presence of carbonates and bicarbonates.

In this context, it is very important to determine the nature of the pH in the water of Lake Tlahuac-Xico and determine the possibility of development of biological activity, since this occurs within a generally strict pH range. At a pH value between 5 and 9, it does not have a significant effect on most species, although some are very strict in this regard. An important aspect of pH is the aggressiveness of acidic waters, which gives rise to the solubilization of substances by hydrolysis of the macromolecules present in the water (Lipids, Proteins, Carbohydrates). This way, an effluent with an adverse pH can alter the composition and modify the biological life of natural waters. It is also more difficult to treat by biological methods, which can only be carried out between pH values of 6.5 to 8.5. Urban wastewater usually has a pH close to neutral. Apart from the direct effect, pH has an indirect effect, influencing the toxicity of some substances, especially those in which the toxicity depends on the degree of dissociation. According to the pH value of the water samples taken in the lake at different time intervals (table 2), it does not comply with the drinking water regulations that establish a pH range between 6.5 to 8 as the maximum permissible limit. 5, in addition to having an algae smell and a slightly greenish color. These results coincide with what was reported by (De la Lanza & Hernández, 2019) in a sampling carried out from June 2008 to May 2009, reporting a pH of 8.81 to 9.63. and with those reported by the government of Mexico City in a sampling carried out in 2019, whose results showed pH values between 8.70 to 10.23, so it is concluded that the Lake water is alkaline, which can probably be attributed to the geological characteristics of the area, since as the Basin of Mexico was formed after a long period of volcanic activity, when the Sierra Chichinautzin was formed to the south of the Basin of Mexico, it became a closed or endorheic basin, in Consequently, it began to retain the waters that drained towards the south (Pacific Ocean), giving rise to the appearance of the lacustrine zone accumulating a thick layer of clay (Camarillo et al., 2013), composed of the fine matter carried by the waters. of the precipitated rains in the hills that surround the Basin and in accordance with the environmental characterization regarding soil degradation carried out by the Government of Mexico City, dry, cracked soils, saltpeter crusts and stratified soils were observed. Therefore, the alkaline pH was characterized by the presence of carbonates.

The second factor is probably due to the presence of high densities of microorganisms such as Cyanobacteria and *Bacillariophyta* (phytoplankton), which when photosynthesizing assimilate carbon dioxide (CO_2) from the atmosphere (biological effect), resulting at the same time in the formation of unstable carbonic acid (H2CO3), which shifts the reaction towards the formation of bicarbonates or carbonates that cause the alkaline condition.

PROFILE OF THE CHEMICAL OXYGEN DEMAND (COD) AND THE BIOCHEMICAL OXYGEN DEMAND (BOD5) OF THE WATER STORED IN LAKE TLAHUAC-XICO

The Biochemical Oxygen Demand (BOD5) and the Chemical Oxygen Demand (COD) are indicative of the amount of organic matter present in water bodies coming mainly from wastewater discharges of both municipal and non-municipal origin. The BOD5 is an indicator of the amount of biodegradable organic matter, it estimates the amount of oxygen required to oxidize it by biological action, which comes mainly from wastewater discharges of both municipal and non-municipal origin and establishes the speed with which that the organic matter will be metabolized by bacteria (Fischer et al., 1979). And it is proportional to the amount of biodegradable organic matter while the COD is the total amount of organic matter present in the water.

The increase in the concentration of these parameters affects the decrease in the content of dissolved oxygen in bodies of water with the consequent impact on aquatic ecosystems. According to what is reported in the literature, of the surface water bodies (2706), underground water bodies (1065), surface water bodies (32) and coastal zones (920), 55.9% of the sites monitored in BOD5 They present excellent quality in 2015, despite being located in areas with high anthropogenic influence.

COD monitoring is of great relevance since it is a way to estimate the magnitude of organic and inorganic matter in water. Consequently, the COD of water samples increases with the increase in the concentration of organic matter; a normal measurement presents a value of less than 10 mg/L, while a reading of the order of 60 mg/L can be considered. as rich in organic matter (kitchen waste, bathroom waste, farm waste, cheese factories, nixtamal factories), which serve as a substrate for the reproduction of microorganisms, consuming the oxygen dissolved in bodies of water. Therefore, high levels of COD indirectly manifest conditions tending to hypoxia or anoxia, which represents a risk for aquatic fauna (De la Lanza & Hernández, 2019). Figure 10 shows the results of COD and BOD5 found in the water samples of Lake Tlahuac-Xico, which showed high values (table 2) so the water stored inside the lake has a high contamination index. since according to the NATIONAL WATER QUALITY MEASUREMENT NETWORK (RENAMECA), a COD value greater than 200 mg/L and BOD5 greater than 120 (mg/L) in surface waters show a high index of contamination due to of municipal and non-municipal raw wastewater discharges (RENAMECA, 2022).

PROFILE OF TOTAL SUSPENDED SOLIDS (SST) AND VOLATILE SUSPENDED SOLIDS (SSV)

It is the amount of solids that the water retains in suspension after 10 minutes of settling. They are mainly organic in nature, but they also include inorganic salts such as those formed with calcium, magnesium, potassium and sodium, bicarbonates, chlorides and sulfates, which are dissolved in water and is measured in ppm, parts per million.

Total Suspended Solids (TSS) include some of the most objectionable materials contained in wastewater, among them we find biological cells that form a mass of solids suspended in the water and particles of inert materials that adsorb organic substances on their surface (Sheng et al., 1994; Mokhtar et al., 2005). On the other hand, suspended solids are small particles that come from soil drift; their accumulation in Lake Tlahuac-Xico counteracts the volume of water to be stored. According to the National Water Quality Measurement Network (RENAMECA, 2022), an SST value greater than 400 (mg/L) in surface waters shows a high contamination index due to raw wastewater discharges. municipal and non-municipal. Figure 12 shows the results of SST and SSV obtained in this study (table 2), which presented a minimum concentration of 75mg/L with a maximum of 145.8mg/L. According to RENAMECA, at a TSS concentration greater than 75 and less than or equal to 150 mg/L, it is considered acceptable with an indication of contamination due to the presence of wastewater discharges, indicative of a regular condition for the development of fish and restricted agricultural irrigation.

Increased SST levels cause a body of water to lose its ability to support the diversity of aquatic life. For their part, volatile solids are particles that can be easily transformed from their solid phase to their vapor phase without passing through a liquid phase. Volatile solids usually represent the amount of organic solids in water and are of great importance in water and wastewater treatment. The amount of volatile solids in wastewater is often used to describe the rate of contamination from waste.

The more volatile solids are present in the wastewater, the stronger the water pollution index. If the volatile solids in the wastewater are mostly organic, the impact on a treatment plant is greater than if the solids are mostly inorganic. Generally, the volatile solids in domestic wastewater are around 50% organic, which in turn contaminates soil and freshwater. These volatile solids generally come from plants, dead animal matter, and synthetic organic compounds. They can be ignited or burned. Because the organic fraction can be eliminated at high temperatures, they are called volatile solids (CONAGUA, 2018). The results of Volatile Suspended Solids (SSV) found during the monitoring of Lake Tlahua-Xico in the different time intervals were 45.4 as a minimum, and as a maximum; 69.8 mg/L. which indicates that the lake water is of good quality, given that it has low SSV content, generally due to natural conditions, which favors the conservation of aquatic communities and unrestricted agricultural irrigation.

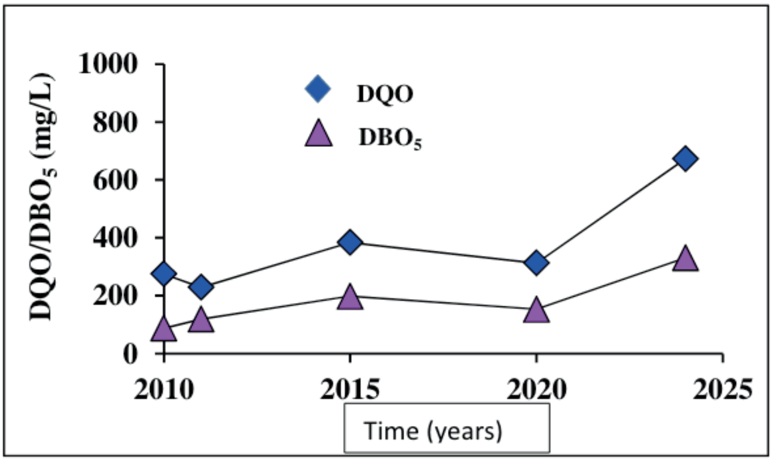


Figure 10. COD and BOD5 profile of the water of Lake Tlahuac-Xico.

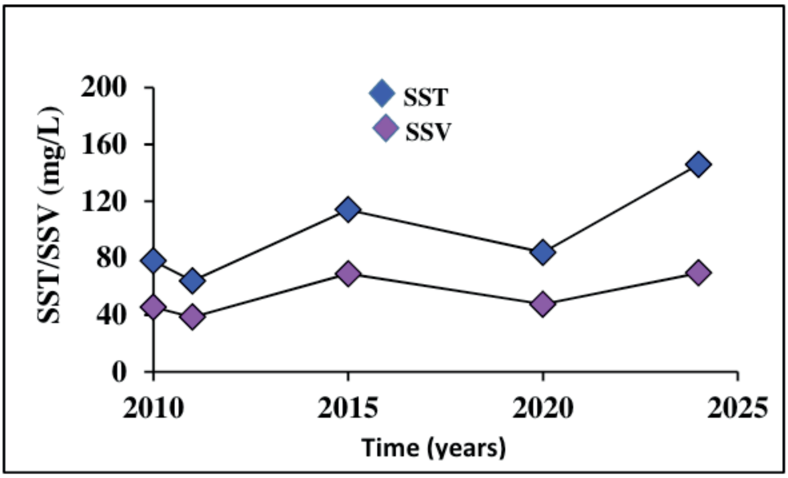


Figure 11. SST and SSV profile of the water of Lake Tlahuac-Xico.

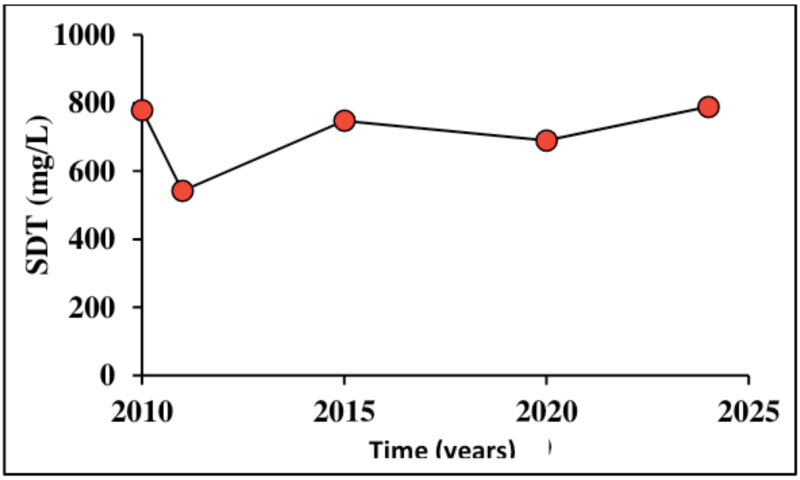


Figure 12. Profile of the TDS of the water of Lake Tlahuac-Xico.

TOTAL DISSOLVED SOLIDS (TDS) PROFILE

Figure 12 shows the TDS profile of the water stored in Lake Tlahuac-Xico. In determining the quality of groundwater, one of the parameters that allows evaluating groundwater salinization is total dissolved solids (TDS). According to their concentration, groundwater is classified as fresh (less than 1000 mg/l), slightly brackish (1,000 to 2,000 mg/l), brackish (2,000 to 10,000 mg/l) and saline (greater than 10,000 mg/l). Rain and runoff dissolve extremely fine matter (<5 NTU) "Nephthalomeric Units" in the soil, salts, fertilizers, pesticides, minerals from rocks, industrial waste, garbage leachates, which remain in suspension and cause turbidity.

These particles can serve as a refuge for pathogenic microorganisms. The results of the analyzed samples (table 2) showed the following values: 779 mg/L (year, 2010), 542 mg/L (year, 2011), which was when an extraordinary rain event occurred, causing a significant increase in the volume of water stored in Lake Tlahuac-Xico (figure 8), which is why the concentration of TDS decreases due to dilution. Since in later years, they are of the order of 748, 690 and 789 mg/L respectively. Despite this, it complies with the Official Mexican Standard (NOM-127-SSA1-1994), which establishes the maximum permissible limits that water for human consumption and treatment must meet in terms of quality of water for human consumption of 1000 mg/kg. L.

PROFILE OF SURFACTANTS (DETERGENTS) IN THE WATER STORED IN LAKE TLAHUAC-XICO

Figure 13 shows the profile of surfactants (surfactants) in the analyzed water samples. Surfactants enter clean and wastewater primarily through discharge of aqueous residues from domestic and industrial laundry washing and other cleaning operations. Most of the surfactants in domestic wastewater combine with proportional amounts of the adsorbed particles. In waters, the concentration of surfactants is usually less than 0.1 mg/L except in the vicinity of a mouth or other point entry source. A high content of detergents in water can cause foaming, toxicity for aquatic life and excessive growth of aquatic flora due to the contribution of phosphates. It is reported that the exposure of coastal vegetation to surfactants results in an indirect absorption of sodium chloride and a reduction in the surface tension of water caused by the erosion of the epicuticular wax of the plants. In Hyacinth, it affects the inherent tolerance to water salinity, which is reduced by exposure to the surfactant.

Exposed vegetation could receive up to 0.1 mg of anionic detergents, 1.5 mg of petroleum products, and 20 mg of NaCl per square meter of leaf area daily (Badot et al. 1993). Therefore, concentrations in water of 2.5 mg/L affect the growth of plants and concentrations of 5 to 6 mg/L are toxic to algae and fish in general (Marin & Garrec, 1995).

According to the Official Mexican Standard (NOM-127-SSA1-1994), Water for human use and consumption, which establishes the permissible limits of water quality, the concentration of detergent must be of the order of 0.5mg/L. Therefore, the current concentration exceeds this limit, given that around Lake Tláhuac-Xico there are several sources of wastewater that can enter the basin, mainly due to runoff derived from agricultural irrigation in the surrounding ejidos, livestock activities on the riverbank. of the lake, uncontained discharges from irregular urban settlements and the entry of contaminated water through the Serpentino stream.

MICROBIOLOGICAL LOAD PROFILE (FECAL COLIFORMS)

Figure 14 shows the profile of fecal coliforms found in the water samples of Lake Tlahuac-Xico analyzed to estimate their microbiological contamination index. The waters in the Lake are mainly rainwater. However, the regional subsidence process has changed the slope of the drainage systems in the lake area, causing its wastewater to flow by gravity towards the Lake.

Which represents a problem of contamination of natural bodies of water, as mentioned above, around Lake Tláhuac-Xico there are several sources of wastewater that can enter the basin, mainly due to runoff derived from agricultural irrigation in the surrounding ejidos, livestock activities on the lake shore, uncontained discharges from irregular urban settlements, entry of contaminated wastewater from the Serpentino Canal and the San Juan Ixtayopan discharge, as well as the presence of fauna, mainly birds. To determine the microbiological quality of aquatic ecosystems, bacteria that indicate fecal contamination are used.

Among the most used are Total and Thermotolerant Coliforms, although the abundance of Escherichia coli has been more associated with health risk compared to the rest of the coliforms (Garcia et al., 2007; Farnleitner et al., 2010). The inadequate disposal of excreta, due to the absence or poor sewage and treatment system, is associated with water contamination and causes numerous diseases, such as cholera, amoebiasis, hepatitis, typhoid and paratyphoid fever, among others. (Chigor et al., 2012).

In Mexico, the regulations for controlling discharges seek to promote its reuse in agricultural irrigation as a strategy to conserve first-use water and take advantage of the nutrient content (nitrogen and phosphorus) and organic matter present in wastewater; However, irrigating with this type of water increases the risk of contracting gastrointestinal diseases, mainly among farmers and their families. The new regulations establish that for irrigation of all types of crops, treated black water containing <1000 NMP/100 mL of Fecal Coliforms and less than 1 Helminth Egg/L can be reused, additionally, in the case of irrigation of crops that They are not consumed raw, it is possible to accept up to 5 Helminth Egg/L. Therefore, coliform bacteria are used as an indicator of pollution from waste of human origin, since each person eliminates 100,000 to 400,000 million Fecal Coliforms daily through feces, in addition to other types of bacteria. The results in the study showed values of 153, 100, 296, 155 and 214 CFU/100mL, so it does not comply with NOM-127-SSA1-1994, Environmental Health.

Water for human use and consumption and establishes the permissible limits of quality and treatments to which the water must be subjected for its purification, but in accordance with what is established by the NATIONAL WATER QUALITY MEASUREMENT NETWORK (RENAMECA), since said values They are lower than what is established. A CF value greater than 10,000 in surface waters represents strong bacteriological contamination, accompanied by severe alteration.

CONCLUSIONS

The results showed a high concentration of contaminants in the lake that is mainly due to runoff from surrounding agricultural areas, rich in nutrients that has caused eutrophication, raw wastewater discharges from the Serpentino Canal and the Ixtayopan plant. However, with the reorientation of wastewater discharges, the conservation of Lake Tláhuac-Xico will allow the retention and storage of around 37.2 Mm3/year of the

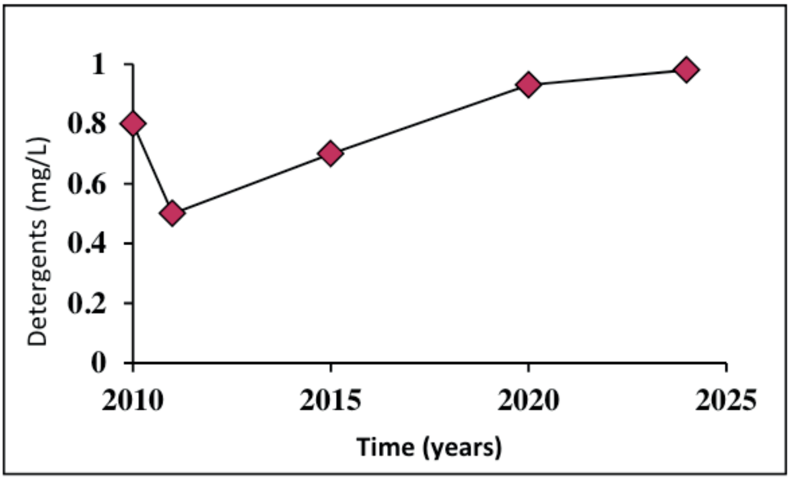


Figure 13. Detergent profile of the water of Lake Tlahuac-Xico.

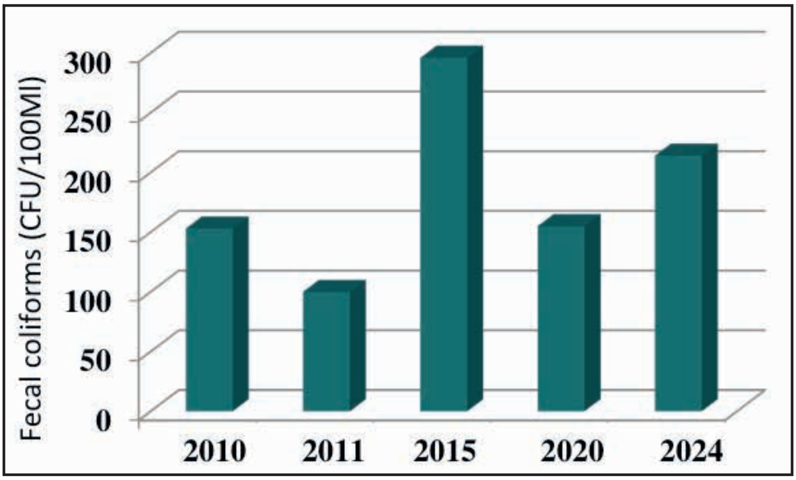


Figure 14. Profile of fecal coliforms in the water of Lake Tlahuac-Xico.

88 Mm3/year of rainwater that is currently being expelled from the Subbasin. Where its main source of water would be the runoff in the lower basin of the Tlahuac-Xico subbasin (16.6Mm3/year) and the 7.5 Mm3/year of rainwater that comes from the Amecameca River. And the 13.1 Mm3/year of rainwater coming from the Río La Compañía Subbasin, mainly from the San Francisco and Canal Microbasins. And with the reorientation of wastewater discharges, in addition to guaranteeing the availability of quality water, current and future, it will allow it to be its own ecosystem, with certain endemic species and others typical of the lakes, in addition to providing benefits to society, offer a habitat for fish, aquatic species and amphibians, migratory birds, biodiversity of flora and fauna, as a reserve for drinking water, flood control and for carrying out recreational and religious activities.

THANKS

The authors thank the Amecameca River Basin Commission and La Compañia for their support in taking samples from the Nuevo Lago Tlahuac-Xico during the study and the Technological University of Toluca Valley (UTVT), for providing their facilities. laboratory to carry out measurements of the main parameters.

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