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The Tula River in the Framework of Regional Development

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Abstract: This article will address the pollution of the Tula River, located in the state of Hidalgo, Mexico. In the first part, brief theoretical aspects of water pollution are addressed, the geographical factors such as the territorial area of the Central Region where this entity is located and the other entities of this area are discussed. The development of this chapter continues with demographic elements such as the population, density and poverty, of the states of this región. Some economic aspects are touched, such as the total GDP, manufacturing and services, foreign trade and foreign investment of this region are also mentioned, to make a comparison with the other states of this geographical demarcation, the geographical location of the Tula River and its high pollution is continued. The objective of this research is the following: to determine if this aquifer torrent is contaminated. As a preliminary conclusion, I consider the following: Hidalgo is located in the Central Region of Mexico, it is an entity, it does not bring together a significant volume of population, its population density is not high like that of Mexico City. In relation to the economic aspects Hidalgo does not have a strong economic presence, as is the generation of the total GDP, manufacturing and the service sector, compared to the other entities of this economic region. The Tula River, the most important in this state, it is very polluted.

Keywords: Pollution, water, rivers, environment.

INTRODUCTION

This article discusses aspects of the contamination of the Tula River located in the state of Hidalgo, which is located in the Central Region of Mexico.

In the first place, it approaches by dealing geographical factors to locate the state of Hidalgo, where the Tula River is situated, and the other states belonging to this economic region of Mexico, this chapter continues with demographic elements analyzing the total population, its population density and the inhabitants of this place registered in the official statistics in a situation of poverty; continuing with the text, some economic aspects such as the total GDP, manufacturing and the service sector are covered to economically situate Hidalgo, for this reason foreign trade and foreign investment captured by these states of this geographical zone are also mentioned. Consecutively, the very high contamination of this aquifer is studied, so important, not only for Hidalgo, but also, from my point of view, for Mexico.

The main hypothesis of this work is the following: the state of Hidalgo is not a consolidated entity in population volume, nor the economic aspect such as the generation of total GDP; the Tula River is very polluted by the discharges it receives from Mexico City and the city of Tula from the refinery and the thermoelectric plant.

The methodology used is a quantitative approach of statistical information provided by official sources and of a qualitative nature through descriptive documentary review.

THEORETICAL FRAMEWORK

Humanity today among the main challenges it has to face is the satisfaction of current and future needs, it has to use natural resources and see to their conservation, probably the most imperative objective of sustainable development is the one related to the integrated management of water. Worldwide, the sustainable management of aquatic ecosystems has been identified as an essential objective to conserve biodiversity and maintain ecological processes that ensure the long-term provision of the ecosystem services for all humanity. (Dyson, Bergkamp, & Scanlon, 2008; National Strategy for Ecologically Sustainable Development 1992; Ocampo Molina, López Medellín, Maldonado Almanza, Wehncke, 2019).

In Mexico, unfortunately," it is stated that 54% of wastewater is not treated and is dumped directly to natural water bodies, soils and irrigation canals." (Robledo Zacarías, V.H., Velázquez Machuca, M.A., Montañez Soto, J.L., Pimentel Equihua, J.L., Vallejo Cardona, A. A., López Calvillo, M.D. and Venegas González, J. 2017).

Indeed, equal access to water is a fundamental human right for the very survival of the human race, it cannot be denied to anyone, which is why it is necessary to appreciate the economic, social and environmental values of this resource.

The Political Constitution of Mexico establishes the right of all Mexican citizens to an environment appropriate for their well-being and development (Art. 115, III a,) in effect, sanitation is a public service that corresponds to the municipal jurisdiction. The General Law of Ecological Balance and Environmental Protection (LGEEPA) decrees that ecosystems and their elements are committed to be used in a way that ensures their optimal and sustainable productivity, in such a way that current conditions determine a good quality of life for future generations, so it is essential to prevent ecological imbalance. (Ramos, Córdova, & Sawyer, 2006).

A problem that is present is the quality of the water that is damaged by the discharges of the mills or those that use contaminated water from the Apatlaco River. Within this framework, the various surveys that have been carried out by the National Water Commission (CONAGUA), the population considers the lack of water in adequate quantity.

There is also a lack of cleaning culture in the citizens, in fact, in the Tula River, all kinds of waste are found in this aquifer, from wrappers of various products, various utensils, all kinds of materials such as tires, clothing, dead animals, etc., this causes the sewage system not to evacuate properly.

It is also important to mention, black water has benefits, because it is rich in nutrients, such as nitrates from urea, fecal matter has nitrites, phosphorus and potassium, which help to grow plants and crops in the geographical area where the Tula River is located, ..."This water is very nutritious, this has increased agricultural production in the Mezquital Valley. Thanks to this fountain that is not all bad; what is bad is that there is no adequate treatment and this does generate pollution." (Sánchez, 2021).

Indeed, wastewater can be a renewable resource by providing clean and safe reusable water, the cleaning of sewage has aimed to eliminate harmful chemicals,

therefore, it does not constitute any negative footprint for the environment when entering the subsoil.

In the particular case of this aquifer, "it is a red light that should concern us all as a society, since it is one of the most polluted in the world, even in 2006 the (UN) United Nations declared Tula as the most polluted city in the world. Health strategies must be a priority for the legislation of laws that cover the well-being needs of the inhabitants of the area." (Sánchez, 2021).

For the study of this tributary, I consider it is essential to allude to the difference between economic development and regional development.

In the theoretical definition of regional development, it can be considered as a process of structural socioeconomic and environmental changes, whose main purpose is to improve the well-being of the population of the geographical area and reduce social and economic inequality within a context of sustainable development.

The economic development of a region must be aimed at reducing poverty, it must be the main priority of the sustainable development goals. (Duarte Sánchez D. and Guerrero Barreto, R., 2024).

Regional development is a process located in a sustained social change where its objective is the firm progress of a given region: The development is solidly related to a process of economic growth; it also allows problems such as poverty, unemployment and productivity to be dealt with in a more efficient way.

Regional development examines in particular the progress of a geographical region, taking into account its needs, culture and own characteristics. Economic development in general terms, economic policies and their strategies at the level of the whole country. Regional development is an integral part of economic development, but it is concentrated at a more limited level, with the aim of directly benefiting specific geographical areas. (VYMSA, November 2023).

> *"When we talk about regional development, it must be understood as something multidimensional and dynamic. Which is closely related in political, social, environmental, technological and territorial issues. Its main function is the distribution of opportunities for the population and the perseveration of the environment, strengthening the territorial organization of society; that is, it is the process of improvement and transformation of a specific geographical region, with the aim of achieving a higher level of economic, social and environmental development". (Vázquez Vidal, V. Hernández Govea, L. and Martínez Prats, G. 2024: p. 3)*

Regional development,

> *"necessarily implies a process of consultation in which both the State and the regional actors share responsibilities, through concrete forms of articulation between them, from which recommendations are derived on the specific policies that will be most appropriate to promote the economic and social development of the territory in question... In Mexico, regional development presents a weak articulation with economic policy, over time, which is expressed with a poor infrastructure, a product of the*

centralizing criterion of economic processes; this has also prevented the consolidation of regional markets as a support for growth and a recurrent waste of regional potential." (6).

GEOGRAPHICAL LOCATION OF THE STATE OF HIDALGO

The state of Hidalgo located in the Central Region of Mexico, it has an area of almost 21,000 square kilometers, it represents almost 16% of the total area of this region to which it belongs and a little more than 1% of the total area of Mexico; unlike Puebla that corresponds to 26% of this geographical area and 1.74% of the country's surface. See Table 1 and Figure 1. The state of Hidalgo is bordered to the north by San Luis Potosí and Veracruz, to the east by Puebla, to the south by Tlaxcala and the state of Mexico, and to the west by Querétaro (Ministry of the Interior 2010). See map 1 of Mexico and map 2 of Hidalgo. It has 84 municipalities and the largest is Zimapán and the smallest territorial area is Tlahuelilpan. (National Institute for Federalism and Municipal Development, 2010)

Table 1: Territorial area in square kilometers, in percentages, of the entities of the Central Region and in percentages in relation to the total area of Mexico, 2020.

Entity	Surface	Percentage of the total area of the Central Region of Mexico	Percentage of the total area of the country.
Mexico City	1,494.30	1.14	0.07
State of Mexico	22,351.80	17.17	1.13
Guanajuato	30,606.70	23.51	1.55
Hidalgo	20,813.00	15.99	1.05
Morelos	4,878.90	3.74	0.24
Puebla	34,309.60	26.36	1.74
Queretaro	11,690.60	8.98	0.59
Tlaxcala	3,996.60	3.07	0.20
Central Region Total	130,141.50		6.62
National Total	1,964,375.00		100.00

Source: INEGI. *Sociodemographic Panorama*. Various Entities, 2020.

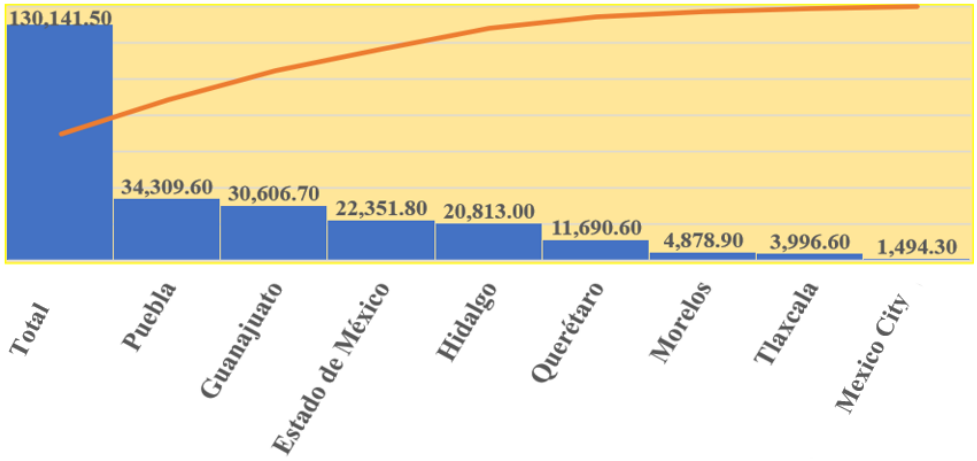


Figure 1: Surface area in km2 of the entities of the Central Region, 2020.

Source: Table 1.

Map 1: of Mexico.

Source: Miguel de Cervantes Virtual Library. Available in: https://www.cervantesvirtual.com/portales/constituciones_hispanoamericanas/imagenes_mapas/imagen/imagenes_mapas_06-mexico_mapa_de_los_estados/

Map 2: Hidalgo.

Download maps. Red. Available in: https://descargarmapas.net/mexico/hidalgo/mapa-estado-hidalgo-municipios

DEMOGRAPHICS

The Central Region where the state of Hidalgo is located has almost 48 million inhabitants, which represents 37.9% of the total population of Mexico, for the year 2020, Hidalgo has almost 6.5% of the population of this region and its population density is 148.4 inhabitants per square kilometer, very different for Mexico City whose population density is 6,163 inhabitants per kilometer; in relation to the population in poverty, almost 46% of the population of our study entity is in this context, a little lower than the total of the Central Region with 48% of its population in poverty. See table 2.

Table 2: Entities of the Mexico 's Central Region. Population, density, and percentage of population with respect to the total of the Central Region, 2020.

Entity	Population	Population Density	Percentage of the total for the Central Region	Population in poverty, 2020	Percentage of the population living in poverty in relation to the total population, 2020
Mexico City	8,721,320	6,163.3	19.3	2,981,772	34.2
State of Mexico	18,136,090	760.0	35.6	9,206,181	50.8
Guanajuato	6,045,151	201.5	12.9	2,687,205	44.5
Hidalgo	3,054,428	148.1	6.5	1,394,749	45.7
Morelos	2,036,707	404.1	4.1	1,071,977	52.6
Puebla	6,497,223	191.9	13.8	4,117,279	63.4
Queretaro	2,368,467	202.6	5.0	708,272	32.9
Tlaxcala	1,367,993	336.0	2.8	797,311	58.3
Central Region Total	47,777,379			22,964,746	48.0
National Total	126,014,124			56,647,981	44.9

Source: CONEVAL. *Concentrate of poverty indicators, 2020.* Available in: Concentrado_indicadores_de_pobreza_2020 (2).zip - ZIP file, uncompressed size 5,022,512 bytes

Now, for the year 2020, in relation to the most populated municipalities in Hidalgo, is Pachuca with almost 300 thousand inhabitants and is followed in order of importance by Mineral de la Reforma with almost 195 thousand inhabitants and Tula de Allende, which is the municipality under study, has a population of a little more than 110 thousand inhabitants. See figure 2.

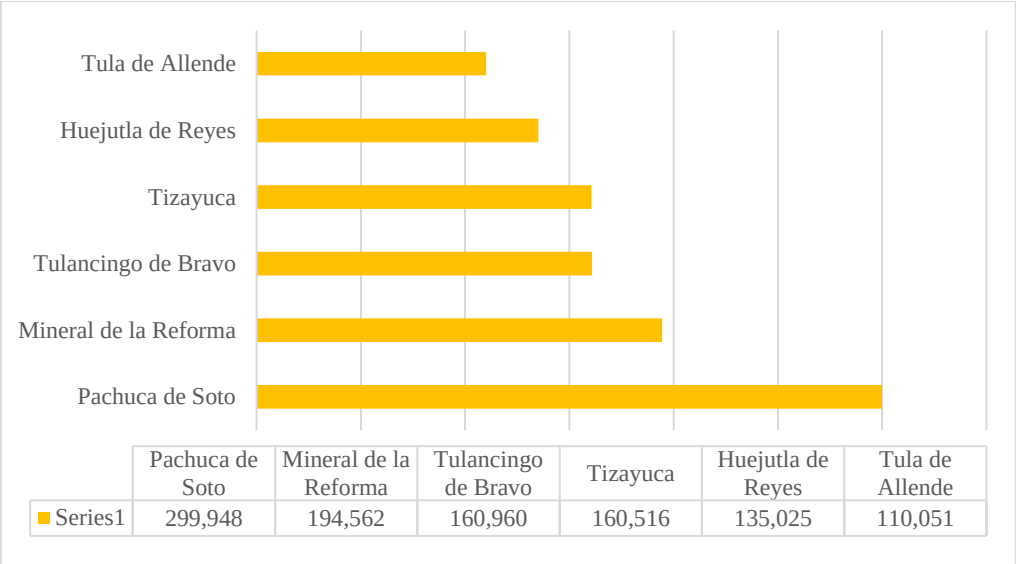


Figure 2: Most populous municipalities in the state of Hidalgo, 2020.

Source: INEGI. Sociodemographic overview of the state of Hidalgo, 2020

For the same year, the composition of the population of this state of Hidalgo is as follows: there are 92 men for every 100 women, half of the population is 30 years old or younger and the dependency ratio is 52 dependency people for every 100 of productive age. National Institute of Statistics and Geography. (INEGI, 2020).

ECONOMIC ASPECTS

At this point, some economic aspects of the state of Hidalgo will be addressed and a brief comparison will be made with the other entities of the Central Region where Hidalgo is located.

The most important state in the generation of the total GDP of this region is Mexico City, in manufacturing it is the State of Mexico, Hidalgo only generates 10% of that of Mexico City and with respect to manufacturing it contributes almost 21% of that generated by the State of Mexico compared to the State of Mexico almost 21%. See Table 3, Figure 3 and Figure 4.

Table 3: Central Region. Total GDP, manufacturing and tertiary activities, 2007-2022. Millions of dollars.

	Mexico City	State of Mexico	Guanajuato	Hidalgo	Morelos	Puebla	Queretaro	Tlaxcala
Total GDP	187,871	106,543	50,386	18,798	13,373	40,006	27,272	6,953
Manufacturing GDP	11,046	20,001	12,114	4,110	2,356	9,233	6,824	1,542
GDP Tertiary Activities	158,519	68,118	27,049	10,619	8,602	23,856	14,475	4,127

Source: INEGI. National Institute of Geography and Statistics. *System of National Accounts.*

The growth rate of Hidalgo's total GDP for the period 2010-2023 has been 95.3, Mexico's total for these same years is 94.4, based on 2018=100, (INEGI, 2025). Faced with this situation, regional development has not been presented, as it presents very precarious growth rates of these indicators.

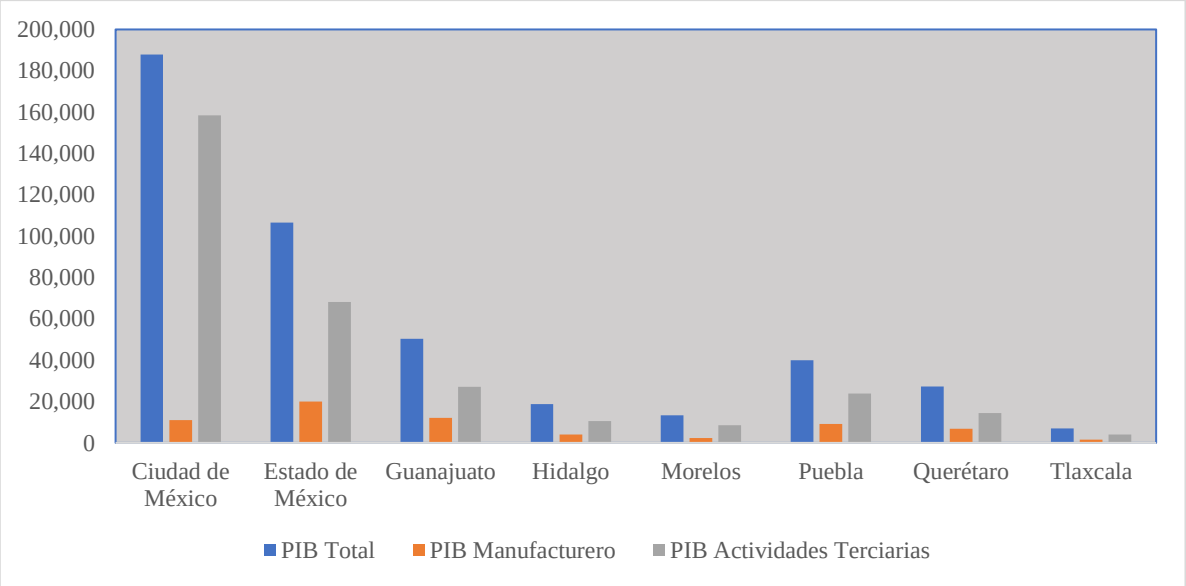
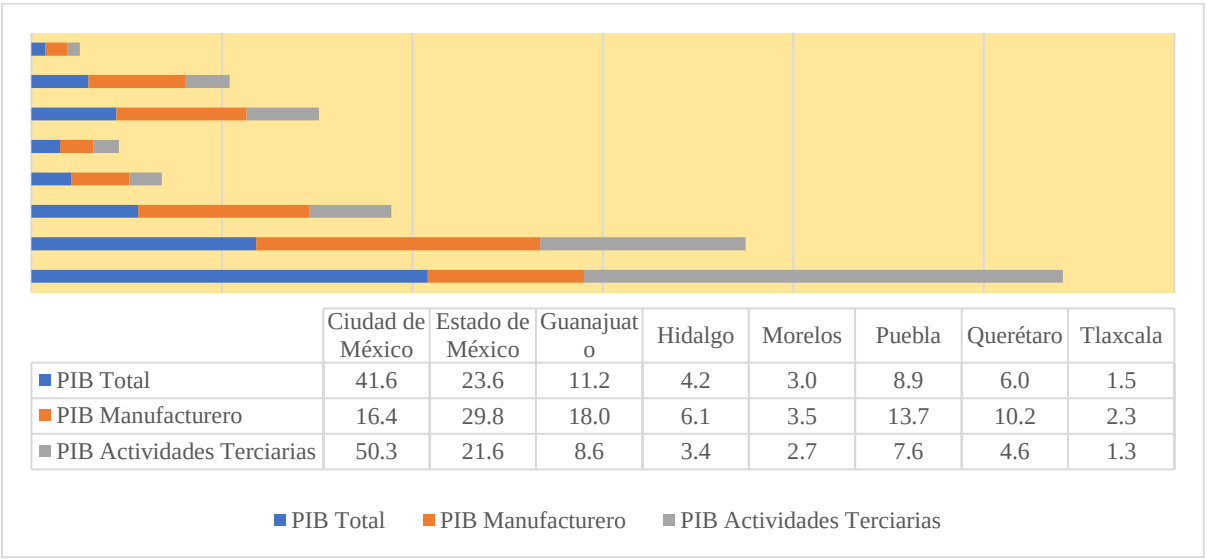


Figure 3: Central Region. Total GDP, manufacturing and tertiary activities, 2007-2022. Millions of dollars.

Source: Table 3.



	Ciudad de México	Estado de México	Guanajuato	Hidalgo	Morelos	Puebla	Querétaro	Tlaxcala
PIB Total	41.6	23.6	11.2	4.2	3.0	8.9	6.0	1.5
PIB Manufacturero	16.4	29.8	18.0	6.1	3.5	13.7	10.2	2.3
PIB Actividades Terciarias	50.3	21.6	8.6	3.4	2.7	7.6	4.6	1.3

Figure 4: Central Region. Total GDP, manufacturing and tertiary activities, 2007-2022. In percentages.

Source: Table 3. Own elaboration of the percentages.

The foreign trade of this region of Mexico, for the period 2007-2022, the entities present different export coefficients, in fact, the most favored entity in this aspect is

Guanajuato, with 5.17, followed in order of importance by the State of Mexico, Hidalgo corresponds to 0.53, a little higher than Tlaxcala, presenting this entity 0.38. See Figure 5.

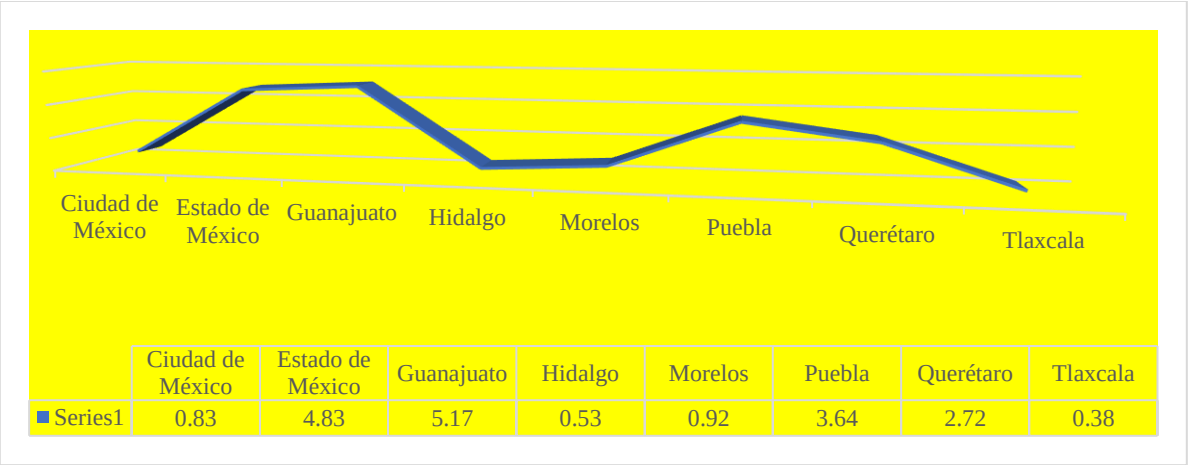


Figure 5: Export coefficient of the entities of the Central Region, with respect to the average of the 0065 total portions, 2007-2022.

Source: Prepared by the author's based on data provided by: Banco de México. Compilation of Quarterly Reports. Several years. INEGI. Economic Information Bank. (BIE). System of National Accounts. Available in: https://www.inegi.org.mx/app/indicadores/?tm=0#D133023_110001100190

In relation to foreign investment, the Central Region of Mexico received more than 255 billion dollars in the period 2006-2024, in particular the state of Hidalgo, alone captured almost 5 billion dollars and by 2024 the entry of these flows in our study entity was almost 300 million dollars. See Table 4 and Figure 6.

Table 4: Foreign Investment in the entities of the Central Region of Mexico. Cumulative 2006-2024. Millions of dollars.

Entity	Millions of dollars
Mexico City	133,800
State of Mexico	49,795
Guanajuato	23,881
Hidalgo	4,981
Morelos	5,508
Puebla	15,412
Queretaro	18,360
Tlaxcala	3,308
Total	255,045

Source: Ministry of Economy. National Commission on Foreign Investment. Fourth Quarter 2024. Table No. 5.

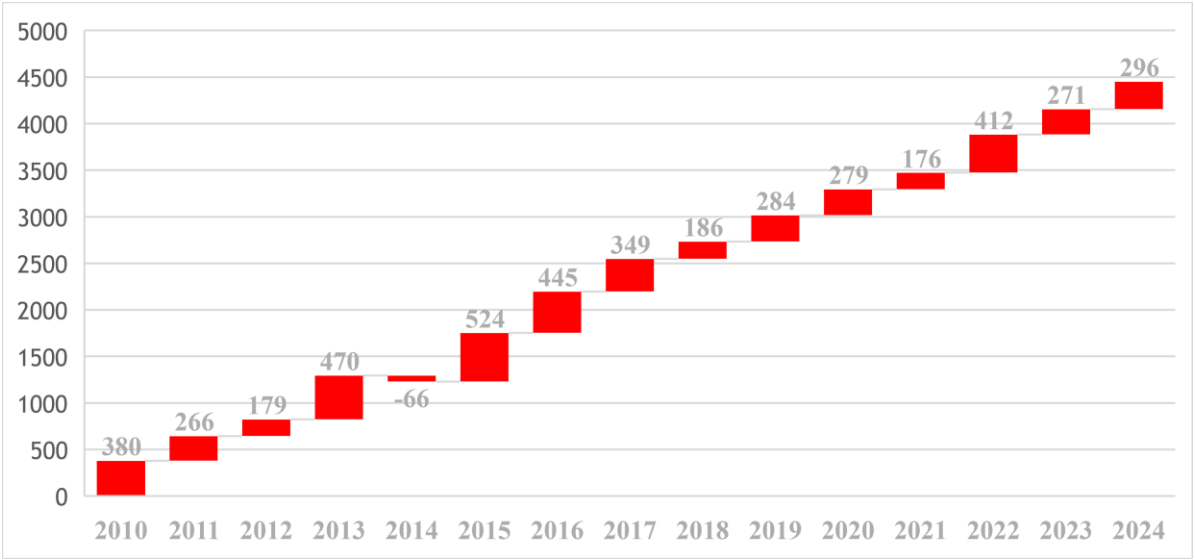


Figure 6: Foreign Direct Investment. 2010-2024. Millions of dollars. Millions of dollars.

Source: Data Mexico. Government of Mexico. Available in: https://www.economia.gob.mx/datamexico/es/profile/geo/hidalgo-hg?fdiTimeSelector=Year

GEOGRAPHICAL LOCATION OF THE TULA RIVER

The Tula River is a torrent of water that runs through the state of Hidalgo with an approximate length of 130 km, it is located in the Moctezuma River basin and the Tula River is the sub-basin, which has an area of 2,069.73km2 and an availability of 10.14Mm3.

Its main tributaries are the Rosas, Tlautla, Salto, Salado, Chicavasco and Alfajayucan rivers, it also receives contributions from the Requena dam, which is fed by the Tepeji River. (Environment and CONAGUA, 2024).

Previously, this river was born in the plains of Tula, however, with the construction of the drainage systems of Mexico City and its metropolitan area, it receives water contributions from the rivers of the Valley of Mexico, which once fed the lakes of Texcoco, Chalco, Xochimilco, Zumpango and Xaltocan.

The Tula River, whose main tributaries are the Rosas, Tlautla, Salto, Salado, Chicavasco and Alfajayucan rivers, also receives contributions from the Requema dam, which is supplied by the Tepeji River.

This tributary crosses the Mezquital Valley, in the state of Hidalgo, it also receives, as mentioned, the sewage from Mexico City, it crosses the municipalities of Tula de Allende, Progreso de Obregón, Chilcuautla and Ixmiquilpan, its wastewater from this aquifer is used for crop irrigation and this has generated health problems for the population living near this river. it is also important to mention that when it overflows it causes flooding and a lot of material damage to various municipalities in the Mezquital Valley.

CONTAMINATION OF THE TULA RIVER

According to the National Water Commission (Conagua), the Tula River is one of the most polluted in Mexico, generating 409.42 million cubic meters of wastewater (CONAGUA, 2007).

Its pollution is due to the fact that it receives wastewater from Mexico City and its metropolitan area, and also from the industrial areas of the city of Tula. The wastewater it receives is almost 60% raw wastewater and 40% is rainwater. The Endhó dam, to which "all the black water from all the places in Mexico City arrives and the only thing there is is disease and poverty... their neighbors are victims of deadly diseases such as cancer, by pollution... In the 70s a fatal decision was made for the population... was to derive wastewater from Mexico City, from all the industrial corridors in that area, which are many, the hospitals, a refinery and a thermoelectric plant, etc., to that dam. The result is a real landfill that has led to serious contamination and the worst thing is that this contamination seeped into the seven drinking water wells." (Valdés, 2024).

In this place there are no water treatment plants, for decades nothing has been done. According to the analyses, high levels of arsenic are found in drinking water for the people, five plants were installed, but none of those plants work.

The Endhó dam is a big sewer of the Valley of Mexico and its metropolitan area, it is a real source of infection for the Mezquital Valley Area, but also a source of irrigation for agricultural production. Here you will find everything from bad smells to excess garbage.

The obstruction, that is, the silting of the dam, has slowly caused the decrease in the storage capacity of the dam, however, it does not cancel the effects of this dam to the groundwater in the area.

According to the samples taken, "it was detected that in some wells the level of arsenic, sulfates, fluorides, sodium and total dissolved solids are above the maximum permissible limit contemplated in the Official Mexican Standard (NOM) 127-SSA1-2021 on the use of water and human consumption." (Villeda, F. 2024).

Precisely, this torrent of water faces an environmental crisis of great proportions, due to the hydrological pollution that damages its waters, the discharges of wastewater "from the deep drainage system of Mexico City... These discharges contain a complex mixture of pollutants, including heavy metals such as lead (Pb), arsenic (As), mercury (hg) and cadmium (Cd), as well as nutrients and organic compounds." (Vega, Larios, Reyes, Badillo, & Kuri, 2024).

In relation to the "Endhó dam was built in 1951 and is supplied by the Organismo de la Cuenca de Aguas del Valle de México (OCAVM), it is located in the basin of the Mocterzuma River and in the sub-basin of the Tula River... It has a storage capacity at NAMO (Maximum Ordinary Water Level) of 182.90 million cubic meters, it is a free spillway with a maximum capacity per spillway of 1,700m3/s and the intake work is 60m3/s. The area of the basin contributing to the Endhó dam is 2,038km2 and has an availability of 1.63Mm3". (Environment and CONAGUA, 2024: p. 4).

In the area of the upper basin of the Tula River up to the Endhó dam, according to CONAGUA, the quality of the water was classified as contaminated and heavily contaminated due to the non-observance of the indicator parameters of Biochemical Oxygen Demand, Chemical Oxygen Demand, Fecal Coliforms, Escherichia Coli, Toxicity and Percentage of Dissolved Oxygen Saturation, which demonstrate contamination by organic matter. Pathogenic microorganisms and toxic substances in water, which could be related to discharges of wastewater of domestic and industrial origin.

According to the results of Biochemical Oxygen Demand (BOD), during the period from 2012 to 2023, of the 12 sites where they were monitored located on the Tula River and the Endhó dam, 6 sites are classified as contaminated water, as acceptable and 2 as good quality. (Environment and CONAGUA, 2024).

In fact, the "Tula River and the Endhó dam is the identified area of greatest contamination is located in the upper basin of the Tula River till up to the Endhó dam (3 sites of the Tula River and 3 of the Endhó dam in red traffic light) in the municipalities of Tula de Allende and Tepetitlán in the state of Hidalgo. It can be inferred that the contamination could be related to the discharges of wastewater mainly from the Valley of Mexico, through the Central and East Emitter Tunnels, which are not treated in the Atotonilco Wastewater Treatment Plant (WWTP) and that arrive through the Salto River, in addition to the discharges from... especially from the urban area of the city of Tula, and the contributions from the Tepeji, Salado, Jilotepec and Rosas rivers." (Environment and CONAGUA, 2024: p. 104).

The municipality of Tula de Allende is a geographical area of the state of Hidalgo with greater development and has an important weight in the industrial area. The Tula River is one of the most important streams in the municipality, however, it transports wastewater from Mexico City, from the government of Luis Echeverría and also receives contaminated water from the industrial area of Tula, which makes it one of the most polluted rivers in the country. The National Water Commission (CONAGUA) carried out a project to cover the riverbank, with the argument of ensuring the flow of rainwater, with this argument the agency carried out the felling of more than 800 trees, which were located on the banks of the river with an age of more than 50 years. They were mainly species of ahuehuete and pirul. (Machuca, Saavedra, & Velázquez, 2018).

Precisely, the "Tula River suffers alarming pollution, due to the waste that emanates from the Miguel Hidalgo Refinery, The Francisco Pérez Ríos Thermoelectric Plant and some factories that are within the jurisdiction of the municipality... the felling of trees had a considerable impact on the flora and fauna of the region on the banks of the Tula River. This impact was devastating that caused the emigration of. the animals that lived there." (Machuca, Saavedra and Velázquez. 7).

The main body of water of the Tula River is born with the black waters of the capital of our country, it converges with the waters of the Churubusco, Los Remedios and La Piedad rivers, forming a large channel that reaches the State of Mexico; Its drained basin comprises an area of 6,551 square kilometers.

According to the studies that have been carried out on the pollution of this river, it was found that the "metalloid As was the most abundant of the three elements in the water column, with values ranging between 0.3 and 4.8 µg/L, followed by Pb and then Cd. Copper and zinc were also detected in the ... sediments". (Vega, Larios, Reyes, Badillo, & Kuri, 2024: p. 215).

The inhabitants of the municipalities affected by the pollution of this tributary affirm that since the last century cement plants, refineries, chemical factories, a coal-fired power plant and lime kilns have arrived in Tula.

"With the support of all levels of government, these industries have destroyed the ecological balance of the area and ruined the health of its population, poisoned the water,

air and soil with toxic waste... On the banks of this river, hundreds of trees were cut down on November 10, 2017 was an ecocide, the response by the construction companies was for the construction of a mega project, where it was decided to convert the natural course of the Tula River into a mega channel of open air sewage ...es the East Emitter Tunnel (TEO), drainage of Mexico City... from the arrival of the emitters from Mexico City at the portals of the Atotonilco Wastewater Treatment Plant, to the Endhò Dam (the largest sewer in the world), passing through several communities…

Later with this tunnel the population of the affected municipalities was aware that more black water would arrive, more diseases and the risk of flooding, which arrived in September 2021, the families had to suffer the consequences, there were many victims, damage to their property and sources of work, today they still cannot recover all their belongings…

In this region, 498 companies have been identified as generators of hazardous waste, including 14 that produce hydrocarbons". (Coalition for Human Rights in Development, 2025).

CONAGUA (National Water Commission), presented projects to amend and protect this river, however, this attempt to rebuild the river was suspended, something very difficult to achieve.

Against this backdrop, one can consider the destruction of the ecosystem of the Tula River, the most polluted área. The Treatment Plant only treats 35% of the total flow.

"This area has been declared by the current government as an Ecological Restoration Zone." (Coalition for Human Rights in Development 2025).

DISCUSSION

Raising an in-depth discussion of the contamination of this lake is a serious problem with many phases, caused by the discharge of wastewater and rainwater from Mexico City and industry, which has caused dangers to the health of the inhabitants of the municipalities that live near this river, due to the use of contaminated water in agriculture and the penetration of pollutants in the subsoil. it also causes the ruin of the ecosystem. There is no government coordination, there is no attention to wastewater treatment.

The population that lives near this tributary presents health problems due to the use of wastewater in the irrigation of crops, which causes contamination of heavy metals in food, in fact, in the case of pumpkin cultivation viruses are transferred, bacteria and heavy metals creating foci of infection; Therefore, ecological imbalances concur with this highly polluted water that irreversibly ruin the quality of life of the inhabitants.

It is important to mention in this discussion the position of farmers who consider the use of this wastewater in their crops as very positive factors, obtaining higher yields in the crops, that is why there is resistance and opposition to the treatment of these contaminated waters, so the intervention of the authorities at all levels is essential to solve this problem of environmental degradation and the suffering of the population.

In this same sense, the Tula River in its course is damaged the environment by carrying out discharges of many agricultural, industrial activities and the inhabitants of urban areas, of the serious pollution has been detected, it is

> *"In the sediments... Polycyclic Aromatic Hydrocarbon and Phthalates have the highest concentrations, with values of 30 and up to 500 nanograms (ng), which can pose significant risks to food chains in aquatic environments because these compounds are known to be persistent with potentially toxic, mutagenic and carcinogenic properties... The presence of concentrations of organic compounds in sediments indicates clear evidence of dumping of agricultural materials (pesticide application) and recent industrial activities. Exposure to organic compounds poses significant health risks to nearby farmers and villages, including chronic diseases such as cancer, heart disease, reproductive problems, and neurological disorders." (1).*

CONCLUSIONS

The state of Hidalgo where the Tula River is located is not important in the population mass compared to the other entities of the Central Region where this aquifer is located, likewise its participation in economic aspects such as the generation of total GDP, manufacturing and the service sector, its growth rate for the period 2010-2023, is not significant. taking as a base 2018=100 is 94.4, in this situation there is no regional development. The Tula River, which is the most important in this state, is severely polluted, because it receives large volumes of sewage that come from Mexico City and the City of Tula.

The Tula River as it has been seen is very polluted, it receives discharges from industry, agriculture and human beings from urban areas such as Mexico City, this situation has caused damage to the health of the inhabitants of the municipalities that live near this tributary, in addition contaminated water is used for agriculture. The food that is harvested is very contaminated, in fact, the sediments of this torrent have pesticide and industrial waste contents, which poses significant risks to the health of farmers and nearby villages, where chronic diseases such as cancer, heart disease, reproductive hazards and neurological complications can be observed.

Can not be ignored the presence of farmers who affirm that the use of this contaminated water is very positive because they obtain higher yields in their crops and they oppose to the treatment of this sewage and there is no government coordination, today there is no attention to the treatment of wastewater, in this situation the intervention of the authorities at all levels is essential to solve this problem of the environmental destruction and the suffering of the population.

The city of Tula, which has a population of 115,107 inhabitants, (INEGI. Population and Housing Census 2020) is the community most affected by the pollution of the Tula River, because it receives enormous amounts of wastewater, from the Metropolitan Area of Mexico City, which is made up of 16 mayoralties of Mexico City and 60 municipalities of the Valley of Mexico with a population of more than 21 million people. In such a way that the (UN) described it as the most polluted city on the planet, however, this situation continues.

The discharge of wastewater has caused a very serious deterioration of the quality of the river water, producing health problems for the inhabitants, increasing the risk of infectious and parasitic diseases. The river carries wastewater from industrial sewers or drains, heavy metals, toxins, and other pollutants that are discharged by industrial processes. The Tula River receives 150,000 liters of untreated wastewater every second from Mexico City and the Valley of Mexico

The most important challenge, as mentioned is the continuous discharge of wastewater from Mexico City and the State of Mexico, the population that lives in the city of Tula faces the challenge of the construction of the treatment of these polluted waters, loaded with heavy metals and fats that affect health and of course the environment. Negligence and corruption in water management , and the inadequate culture of waste management by citizens. The situation is aggravated by recurrent flooding and a lack of coordination that has been diminishing between levels of government, which requires comprehensive approaches to ecological restoration and environmental justice.

PROPOSALS

It is essential to build water treatment plants and promote a culture in the population of the conservation of this type of aquifers, because in pollution the population is severely affected in its health, in addition with the overflows of this River the garbage that is found from wrappers of various products to the refinery and the thermoelectric plant are very harmful to the health of human beings.

From my point of view, the intervention of the government, all the authorities and the inhabitants of the municipalities near this river is essential to try to solve this very serious problem of the pollution of this tributary, in addition the affected citizens should not be ignored in their health and quality of life. The inhabitants must be heard, it is essential to try to remedy this situation immediately, resources must be allocated to try to solve this serious problem of contamination of the Tula River.

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