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Interdisciplinary Faculty of Economic and Administrative Sciences

RESEARCH

A study of water Supply in the Municipality of Hidalgo del Parral, Chihuahua

Un estudio del agua en el Municipio de Hidalgo del Parral, Chihuahua

Date received: May 5th, 2025 Date of approval: July 07th, 2025

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Abstract

The 2030 Agenda and the introduction of the Sustainable Development Goals (SDGs) presented by the United Nations in 2015 include goals aimed at fighting poverty, caring for the planet, and reducing inequalities. Among them is Goal 6: Clean Water and Sanitation. Accordingly, this document aims to analyze statistical information regarding the current water situation in the city of Hidalgo del Parral, Chihuahua. A total of 500 statistically significant household surveys were conducted. Among the most relevant findings, the average monthly payment was approximately $378.00 pesos, while the average consumption was 13.5 cubic meters. Additionally, households are willing to pay, on average, 16% more on their monthly bill in exchange for constant water supply 24 hours a day. Therefore, it is recommended to support scientific research on water-related issues to broaden and deepen the diagnosis of the local water situation from a multidisciplinary perspective, encompassing various aspects related to water management.

Keywords: Water, Sustainable Development Goals, public policy.

JEL Codes: Q25- Water; Q28-Public Policy; R23-Housing Characteristics.

Resumen

La Agenda 2030 y la presentación de los Objetivos de Desarrollo Sostenible presentadas por las Naciones Unidas en 2015 incluye objetivos para la lucha contra la pobreza, el cuidado del planeta y la reducción de las desigualdades. Entre ellos está el Objetivo 6: Agua limpia y saneamiento. Por lo anterior, es que este documento tiene como objetivo analizar información estadística de la actual situación hídrica en la ciudad de Hidalgo del Parral, Chihuahua. Se aplicaron 500 encuestas, estadísticamente significativas, en hogares. En los resultados más relevantes se encontró que el pago promedio mensual oscila alrededor de los $378.00 pesos, mientras que el consumo promedio fue de 13.5 metros cúbicos y, además, los hogares están dispuestos a pagar, en promedio, un 16% más sobre el pago mensual que les permita tener agua constante las 24 horas del día. Por tanto, se recomienda apoyar la investigación científica en el

tema del agua para ampliar y profundizar sobre el diagnóstico de la situación hídrica a nivel local, de manera multidisciplinaria, para abarcar distintos aspectos relacionados con la gestión del agua.

Palabras clave: Agua, Objetivos de Desarrollo Sostenible, políticas públicas.

Código JEL: Q25 – Agua; Q28 – Política Pública; R23 – Características de las viviendas.

1. Introduction

The so-called "Day Zero" is a term coined to describe the moment when access to (fresh and potable) water is exhausted and becomes irreversible. This scenario has become increasingly concerning in recent years, as it appears to be approaching more rapidly, both internationally and nationally. For instance, in the case of Mexico, there is an alarming situation regarding water access in several regions throughout the country, from the north to some areas in the center and south (Coparmex, 2024).

Due to this situation, there is an urgent social need for actions that ensure access to this vital resource and promote the changes and improvements necessary to secure economic and social development and, above all, human survival. According to the National Water Plan 2024–2030, the main objective framed as a human right is to provide water in both quality and quantity in a safe manner, thereby enabling the sustainability of resources through more objective and responsible water management.

Access to clean and safe water leads to improved levels of health and well-being. However, uncontrolled population growth, persistent droughts, and the lack of efficient water collection systems have significantly reduced water availability over the past 60 years. "Clean Water and Sanitation" is one of the Sustainable Development Goals (SDGs) introduced by the United Nations General Assembly in 2015 (Agenda 2030). Numerous countries, including Mexico and specifically the state of Chihuahua have made commitments to achieve these goals, integrating the SDGs with the State Development Plan. According to a recent report, despite the 2030 SDG goals, progress in water management has been limited, with a global SDG index score of 54 out of 100 far from meeting Goal 6.5, which states: "the implementation of integrated water resources management at all levels..." (United Nations, 2023).

According to the Mexican Institute for Competitiveness (IMCO, 2023), the distribution of water consumption is as follows: 76% is used in agriculture, livestock, and aquaculture; 15% is allocated to public supply, which includes businesses, commerce, households, and services connected to the public network; and the remaining percentage is used by thermoelectric plants and self-supplied industries. Given the importance of this vital resource, many studies in recent decades have focused on analyzing the current situation related to network services, storage, distribution, as well as problems and their potential causes and short-term solutions. In fact, López (2017) identified that a large part of Mexico's water problems stem from the fact that settlements and main economic activities are located in the country's most water-scarce regions.

In 2017, the National Institute of Statistics and Geography (INEGI) published the Household and Environment Module (MOHOMA) of the National Household Survey (ENH), representative only at the national level. Notable among the findings are the results on water supply methods and perceptions of the potable water network system. Likewise, the National Survey of Household Income and Expenditure (ENIGH), also published by INEGI (2022), allows for national and state-level analysis of household water availability, especially the supply of potable water. However, in both cases, there is no municipal-level data, making it necessary to assess water supply and household perceptions of water management in the municipality of Hidalgo del Parral.

Therefore, the objective of this study is to gather and analyze statistical information on the current water situation in Hidalgo del Parral, Chihuahua, to provide an overview of cost, consumption, and evaluation of public water service, among other characteristics. This contributes to maintaining an updated descriptive framework of the conditions and perceptions of potable water consumers. Accordingly, this document is divided into four sections. The first contains this introduction; the second presents the contextual and referential framework, which includes the argument of climate change and the water situation in Parral; the third section explains the data and methodology used in the research; the fourth presents the results analysis, and finally, the last section offers the conclusions.

2. Contextual and referential framework

In recent years, studies on the global water situation have focused on analyzing possible short- and medium-term scenarios related to water availability and access. However, according to Toledo (2002), after conducting a planetary water balance, he identified that less than 1% of freshwater is actually available for human consumption. This finding aligns with Simonovic (2000), who, through various international organizations, projected that by the year 2025, two-thirds of the global population would experience direct consequences and stress related to water scarcity. A 2023 study by IMCO also revealed that from 1960 to 2020, water availability has decreased significantly, dropping from an average of 10,000 cubic meters to just 3,200 cubic meters. This problem has been worsened by population growth, increased droughts, and more frequent extreme weather events.

According to Pacheco (2014), the governance of common goods such as water has been studied based on the work of Elinor Ostrom (1990), which has inspired research from various disciplines and perspectives, helping to build a multidisciplinary reference framework enriched by case studies and theoretical foundations. In Mexico, the issue of water has been examined from general perspectives (Ávila, 2003; Peña, 2006; Ávila, 2008), as well as through studies focused on community management and social participation in decision-making within a sustainability framework, such as the work of Guerrero-De León et al. (2010) and Sandoval and Günther (2013).

The study by García et al. (2013) analyzes the perception of scarcity risk and awareness among individuals regarding the potential shortage of water resources. Meanwhile, the analysis of institutional capacity or water governance through public policies has been addressed by authors such as Domínguez (2010), in the case of Veracruz, and Salcido et al. (2010), for the state of Jalisco, emphasizing the importance of citizen participation in decision-making.

Overview of the water situation in the context of climate change

The state of Chihuahua is the largest state in Mexico, accounting for 12.6% of the national territory, with a significant economic activity. According to the 2023 annual report on Science and Technology for Mexican Agriculture by the National Institute of Forestry, Agricultural, and Livestock Research (INIFAP, 2023), the agro-industrial GDP contributed approximately 11% to the total, with a cultivated area of 1.12 million hectares, 51% of which was irrigated. Chihuahua ranks nationally in the production of apples, yellow corn, cotton, pecans, jalapeño peppers, alfalfa, forage oats, beans, onions, and peanuts. This information on cultivated area is relevant in relation to water availability, which depends on both surface and groundwater sources.

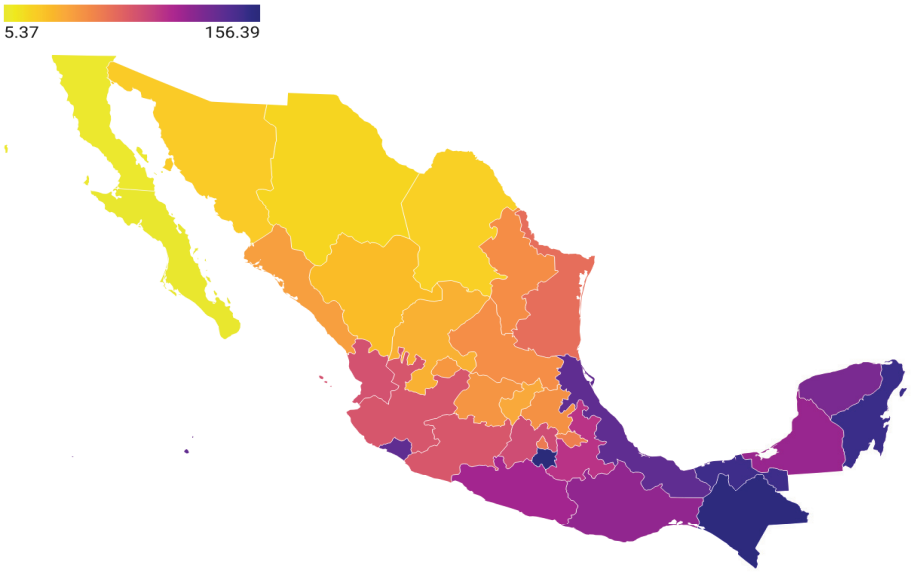
The water situation in the state is marked by sharp contrasts; it records the lowest average annual precipitation.According to data published by the National Meteorological Service, in 2024, Chihuahua was the third state with the lowest rainfall, following Baja California Sur and Baja California, with an average annual precipitation of just 20.4 mm. Figure 1 visually illustrates the average precipitation levels for the year 2024.

According to Cervantes (2019), the state of Chihuahua has committed to addressing the challenges of climate change through the 2030 Agenda for Sustainable Development by modifying its legislation to align with the Sustainable Development Goals (SDGs) established by the United Nations since 2015. The State Climate Change Program (PECC) presents a general descriptive analysis of the state's characteristics, a detailed quantification of greenhouse gas emissions, mitigation scenarios, and a vulnerability and adaptation analysis to climate change. It includes data on extreme weather events, droughts, and wildfires. The PECC (2019) provides a detailed summary of the state's hydrological regions and the watersheds that supply its water resources.

Water study in Hidalgo del Parral

Hidalgo del Parral is a municipality located in the southern part of the state of Chihuahua, which, according to the Population and Housing Census, had a total of 34,570 households and a population of 116,662 inhabitants as of 2020. This made it the fifth most populated municipality, following Ciudad Juárez, Chihuahua City, Cuauhtémoc, and Delicias, respectively. Additionally, it has been characterized as the economic leader among the municipalities of southern Chihuahua, including the region of Valle de Ignacio de Allende, Matamoros, Santa Bárbara, San Francisco del Oro, among others.

Figure 1. Annual precipitation by Federal Entity, 2024

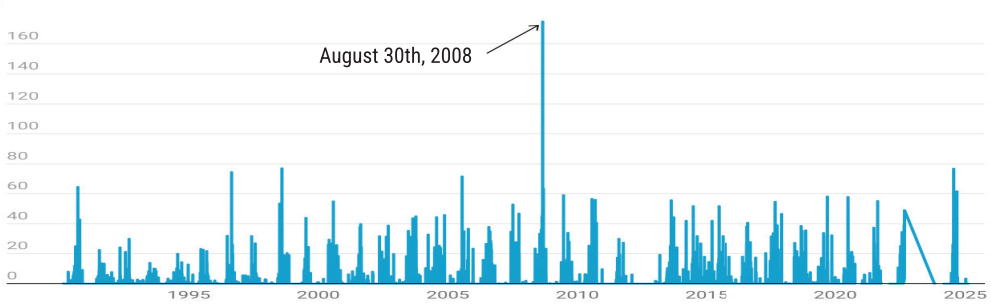


Source: Own elaboration based on data from the National Meteorological Service, National Water Commission

On the other hand, according to 2018 data published by the Government of the State of Chihuahua, the municipality of Hidalgo del Parral sources its potable water from 21 underground sources and 1 surface source. However, the overexploitation of aquifers and persistent droughts in the state have caused significant challenges in accessing potable water for the residents of Parral, leading to supply issues for the city.

According to the 2023 Annual Report from the National Institute of Forestry, Agricultural, and Livestock Research (INIFAP), the year 2023 was marked by a significant decrease in precipitation, severely affecting the state of Chihuahua and, in particular, Hidalgo del Parral. Graph 1 presents the historical record of daily rainfall for station 8305. An increase in rainfall volume can be observed, but with more widely spaced occurrences, which negatively impacts aquifer recharge. However, the available data published by this administrative unit does not allow for a comparison with the Climatological Normal for Hidalgo del Parral, hindering thorough analysis and decision-making. In addition, Cervantes and Dévora (2019) argue that in Hidalgo del Parral, water use is distributed among agriculture, livestock, commerce, and services. Although water rates are among the lowest in the country, only 43% of the cost of extracting water from aquifers is recovered.

Graph 1. Daily precipitation, Station 8305, Parral, Chihuahua



Note: Precipitation in millimeters (mm).
Source: Own elaboration based on data from the National Water Commission, General Directorate of the National Meteorological Service. Historical daily records. Station 8305, Name: Parral, Municipality: Hidalgo del Parral, Chihuahua.

3. Methodology

Data collection

This section explains how the data were collected to analyze statistics related to the current water situation in households within the municipality of Hidalgo del Parral, Chihuahua. First, a survey was developed that included sociodemographic and economic aspects of the households. Additionally, questions were incorporated based on the National Household Survey (2017), specifically from the Household and Environment Module (MOHOMA) by INEGI. Second, for the sampling process, the total number of occupied private dwellings reported in the 2020 Population and Housing Census was used as a reference specifically in the urban area, totaling 34,570 households. Subsequently, Equation 1 was applied to ensure population inferences:

$$n = \frac{z^2 qDEFF}{r^2 p(1-tnr)} \quad (1)$$

Where:

n = sample size

p = estimated proportion of interest

q = 1 – p

r = maximum expected relative error

z = z-value from statistical tables that ensures the desired confidence level

DEFF = design effect, defined as the ratio of the variance in the estimation using the employed sampling design to the variance obtained with simple random sampling for the same sample size

tnr = expected non-response rate

For the calculation of Equation 1, the following values were used:

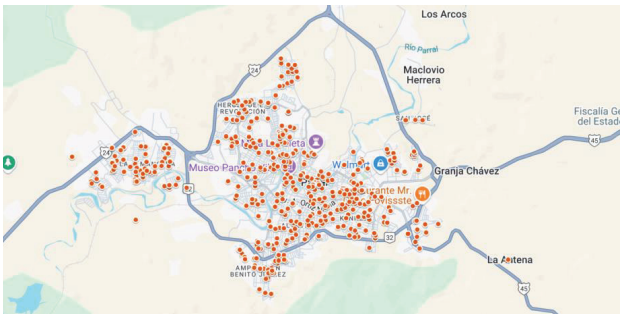
p = 0.5, a maximum relative error of 0.11, a z-value corresponding to 95% confidence; when the DEFF value is unknown, a value of 1.44 is used, based on the methodology of the 2020 Population and Housing Census. A 5% non-response rate was applied.After inserting these values into the formula, a total of 481 surveys was obtained, which was rounded up to 500. This represented 1.44% of the total number of households. Finally, a weighted stratification was applied based on the Basic Geo-statistical Area (AGEB), which was obtained from the National Institute of Statistics and Geography (INEGI). It is important to note that each AGEB includes data on the number of occupied private dwellings, total population classified by age, among other relevant features for decision-making. Map 1 shows the distribution of the AGEBs considered for the sampling, while Map 2 displays how the surveys were implemented across the city of Hidalgo del Parral, weighted by AGEB.

Finally, each household was randomly selected by blocks and streets within each AGEB. The interviews were conducted face-to-face in each of the 500 selected households. In each household, individuals aged 18 or older who were knowledgeable about the questions were considered. To verify both water payments and consumption, respondents were asked to have their water bill on hand during the interview.

Map 1. Distribution of AGEBs in the city of Hidalgo del Parral, Chihuahua

Source: Own elaboration based on GOOGLE Earth and the AGEB classification by CONEVAL (2020).

Map 2. Distribution of surveys weighted by AGEB.



Source: Own elaboration based on Google My Maps and the survey results database.

4. Results

Among the most relevant results, it stands out that of the 500 households surveyed, 52.3% of respondents identified themselves as the head of the household, of which 59.8% were women. The average age was 51.5 years, and the average years of schooling reached 11.5 years, approximately equivalent to the second year of high school.

For the analysis of the water situation, Table 1 presents variables of monthly payment, consumption, and willingness to pay based on income classification by deciles; that is, decile I includes households with the lowest income levels, while decile X comprises those with the highest incomes. It was found that monthly payment does not show a clear positive relationship with income deciles for example, households in decile I pay about 49.00 pesos more than households in decile V. However, there is a clear trend between monthly payment and water consumption: as water consumption increases by decile, the monthly water payment also increases. Regarding willingness to pay which measures the percentage change between what households currently pay and what they are willing to pay above the bill it shows that, regardless of household income level, they are willing to pay an average of 16% more for having constant water supply 24 hours a day. For example, households in decile VIII would pay up to 46% more, while decile IX only 6.3%.

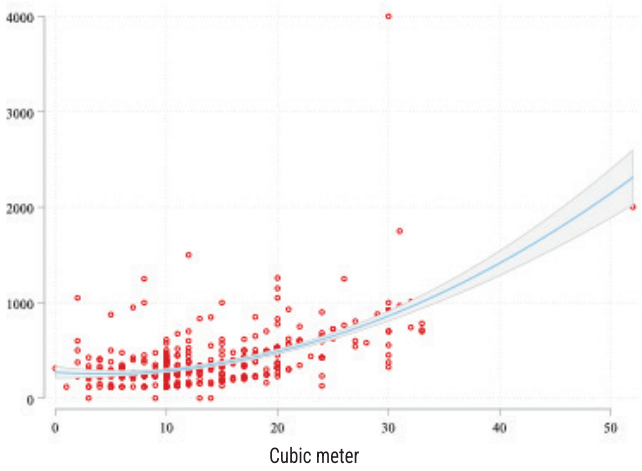
A more detailed analysis of the dispersion between water payment and consumption is shown in Graph 2, which implies that there is a more exponential than linear trend between these two variables. This means that water payment is not proportional to consumption, resulting in a form of consumption restriction.

Table 1. Classification of water payment and consumption by decile

Decile	Monthly payment (in pesos)	Consumption m^3	Willingness to pay (%)
I	$369.08	11.01	16.4
II	$354.45	13.88	12.6
III	$451.42	13.91	17.5
IV	$336.65	11.63	13.2
V	$320.41	11.07	13.4
VI	$434.00	14.65	10.0
VII	$384.45	14.17	15.0
VIII	$325.63	13.81	46.0
IX	$345.30	11.10	6.3
X	$433.02	26.09	28.0
Total	***$378.15***	***13.50***	**16.0**

Source: Own elaboration based on the survey results on water supply and consumption in households in the city of Hidalgo del Parral, 2024.

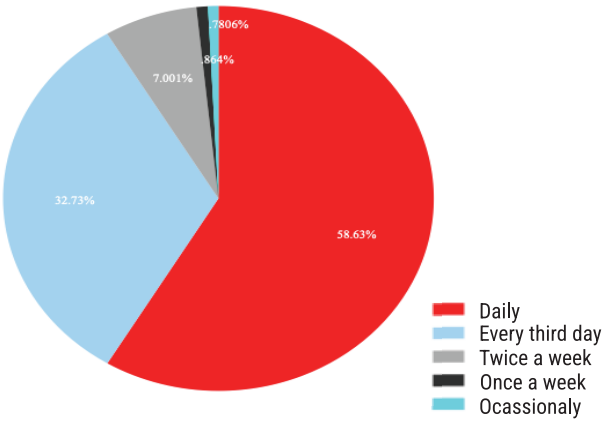
Graph 2. Monthly household payment vs. monthly consumption



Note: The trend curve was estimated with a 95% confidence interval using STATA 17.1 software.
Source: Own elaboration based on results from the survey on water supply and consumption in households of the city of Hidalgo del Parral, 2024.

On the other hand, the main source of water supply within households comes from the public network (99.1%), a statistically similar result to that reported by the Population and Housing Census sampling by INEGI (2020). Regarding water billing, 87.3% is measured through a meter, 12% by a fixed fee, and about 1% do not pay for water. Graph 3 shows the frequency of water delivery to homes. These results are similar to those published by various local media outlets referring to "tandeo" (scheduled water rationing), which affects approximately 28 neighborhoods (Murillo, 2025).

Graph 3. Water delivery to households.



Source: Own elaboration based on results from the survey on water supply and consumption in households of the city of Hidalgo del Parral, 2024.

Table 2 represents the percentage ratings of aspects of the public water service, except for the last column, which shows the average rating of the service aspects (where 1 is the lowest rating poor and 5 is the highest excellent). The data show that the highest percentage concentration was for customer service at 48.6%, followed by supply pressure at 40.7%, both in the "good" category. Meanwhile, the "poor" rating was most frequent for leak repairs at 22.5%, followed by trust regarding health at 20.2%. However, when considering the lowest ratings (poor and deficient), trust regarding health accumulated a total of 38.2% of households, which is higher than that of leak repairs.

from the tap, and the remainder use other methods. Among those who consume bottled water, 68% responded that they do so because it is healthier. On the other hand, the average monthly expenditure on bottled water was 320.00 pesos; however, when classified by income levels (deciles), the amount ranges from 249.00 to 433.00 pesos in the lowest and highest deciles, respectively.

Regarding water-saving mechanisms, 34.7% save water by using toilets with water-saving tanks, and 9% use a device designed to conserve water; 28.1% used water-saving showerheads or faucets, and only 3.6% used other water-saving mechanisms.

Table 2. Rating of aspects of the public water service

	Poor	Deficent	Regular	Good	Excellent	Mean
Taste, odor, clarity of water	12.30%	12.70%	33.70%	30.40%	10.90%	3.15
Trust regarding health	20.20%	18%	26.50%	31.10%	4.20%	2.81
Supply pressure	7.50%	14.60%	26.10%	40.70%	11.10%	3.33
Continuity of supply	14.40%	20%	22.50%	30%	13.10%	3.07
Amount charged	12.80%	16.80%	30.40%	29.50%	10.50%	3.08
Measurement of water consumption	10.40%	20.80%	27.80%	30.50%	10.40%	3.09
Customer service at offices	11.80%	12%	21.80%	48.60%	5.80%	3.24
Leak repair	22.50%	13.30%	27.35	32.50%	4.40%	2.83

Source: Own calculations based on results of the Water Survey in Parral, 2024.

In fact, in the case of continuity of supply (see Table 2), 34.4% of households rated it as poor or deficient, and 22.5% rated it as regular; that is, about 58% disapproved of the service. These results confirm that water is not available every day or is supplied only through rationing ("tandeo"). For example, 24 neighborhoods suffer from interrupted supply, with some lacking water for up to 15 days. For a more specific analysis, results were analyzed by AGEB (see Table 3), calculating average ratings for each service (where 1 = poor and 5 = excellent), and AGEBs were ordered from lowest to highest rating. It was found that water service ratings were much lower in those AGEBs (the first 13 in total) that include neighborhoods where water is supplied by rationing (every third or fourth day, or even every 15 days). Similarly, the continuity of supply service had failing ratings in these same AGEBs.

Continuing with the survey results, regarding the sources of drinking water (potable water), 87.4% purchase bottled or jug water, 11% consume directly

Finally, the rest of the water-saving practices within households are shown in Graph 4.

5. Discussion and conclusions

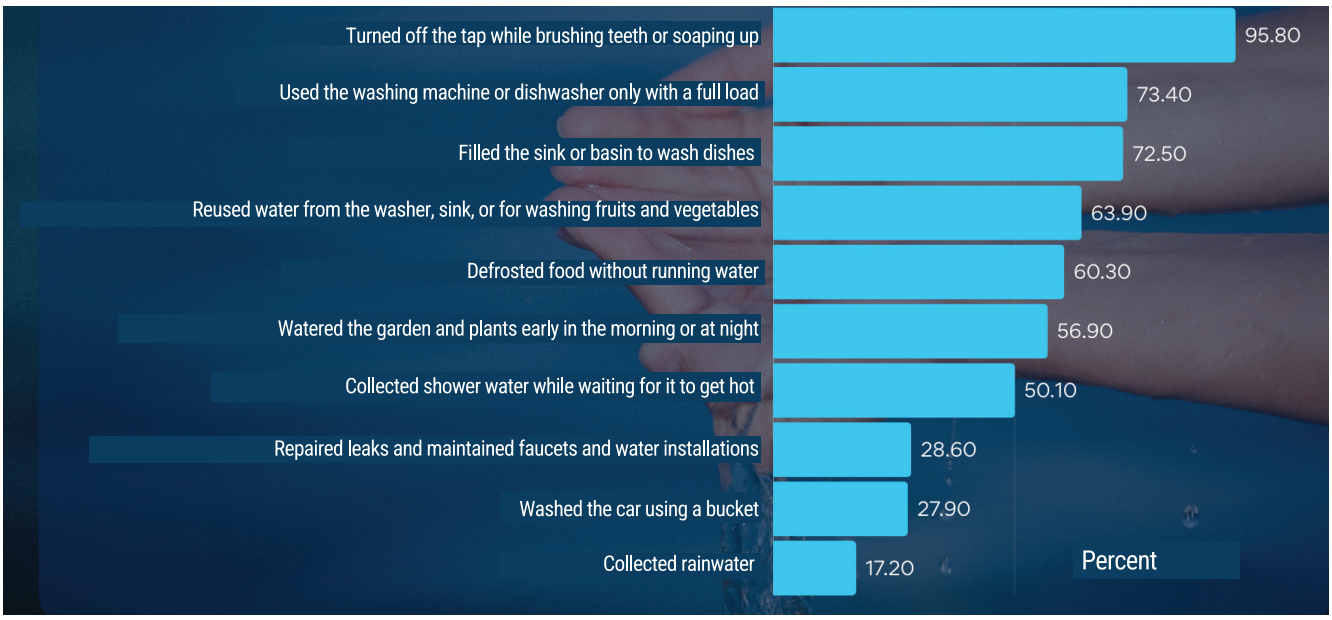
In Mexico, the issue of water has become a priority considered even a matter of national security as it is seen as a key element within social and economic development policies. Access to water ensures development across various regions of the country and, fundamentally, its quality supports health conditions that improve the general well-being of the population (CONAGUA, 2006). According to the United Nations Sustainable Development Goals Progress Report (2023), there has been global improvement in water quality and sanitation. However, guaranteed access to water remains conditioned by external factors such as recurring droughts, aquifer overexploitation, and the state of local infrastructure.

Table 3. Average rating of aspects of the public water service by AGEB.

AGEB	Taste	Trust	Pressure	Continuity	Amount paid	Water measurement	Custom service	Leak repairs	Mean
1441	1.0	1.0	1.5	1.5	2.0	1.5	1.0	1.0	1.3
725	2.1	1.5	2.5	1.8	2.2	2.2	2.3	1.0	2.0
655	2.3	1.4	2.5	2.0	2.1	2.3	2.5	1.0	2.0
1422	2.3	2.7	3.0	1.2	2.3	1.6	2.0	1.0	2.0
1371	2.0	2.3	1.6	1.8	2.5	2.3	2.8	2.3	2.2
674	1.4	1.6	3.0	2.0	2.2	2.6	2.8	2.3	2.2
975	2.6	2.7	2.0	1.5	1.5	2.3	3.6	.	2.3
098A	2.2	1.8	2.4	2.2	2.2	2.4	3.8	2.3	2.4
1297	3.0	3.0	2.5	1.5	2.0	2.5	2.5	2.3	2.4
689	2.0	1.8	3.2	1.5	1.5	3.0	3.4	3.0	2.4
1206	2.7	1.7	2.7	2.7	3.3	3.3	1.0	.	2.5
1070	2.6	2.0	2.7	2.7	2.0	2.1	3.0	3.0	2.5
693	2.2	1.8	3.4	2.1	3.0	2.8	3.0	1.8	2.5
1189	2.0	2.2	2.9	2.5	2.4	2.5	2.9	2.8	2.5
640	2.5	2.4	2.8	2.3	2.9	2.7	2.9	1.7	2.5
1282	2.4	2.6	3.7	1.4	2.0	2.0	3.3	3.1	2.6
066A	2.1	1.8	3.2	2.0	2.4	2.6	3.7	3.0	2.6
636	2.2	1.4	2.7	2.5	3.4	3.5	.	.	2.6
041A	2.4	1.6	3.7	3.7	2.8	2.6	2.4	3.0	2.8
763	2.3	2.4	2.7	3.0	2.7	2.2	3.6	3.5	2.8
710	2.7	2.5	3.1	2.2	2.9	2.8	3.9	.	2.9
073A	2.4	2.1	3.6	3.5	2.8	2.9	2.7	3.0	2.9
778	2.5	2.7	2.8	3.4	2.9	2.1	3.6	3.1	2.9
1085	3.0	3.1	3.4	1.8	2.6	3.7	3.7	2.2	2.9
994	3.0	2.6	3.0	3.3	3.1	2.2	3.0	3.3	2.9
528	3.2	2.8	3.8	3.5	3.2	2.8	3.1	1.6	3.0
513	2.6	2.6	3.8	3.0	3.2	2.8	3.0	3.3	3.0
392	3.6	3.5	3.0	3.6	3.0	2.4	2.6	2.8	3.1
405	2.7	2.7	3.2	3.2	2.8	3.2	3.5	3.4	3.1
1348	3.3	3.1	3.1	2.1	3.4	3.3	3.3	3.0	3.1
509	3.6	3.6	3.3	3.8	3.1	2.7	2.8	2.2	3.1
547	4.3	4.0	4.0	3.3	3.3	4.5	1.0	1.5	3.2
1047	3.9	3.5	3.0	3.2	2.8	2.6	3.7	3.7	3.3
744	3.6	3.6	3.6	3.0	3.0	3.2	3.2	3.2	3.3
602	3.8	3.1	3.8	3.9	3.4	3.0	3.3	2.3	3.3
759	2.8	3.1	3.6	2.4	3.3	3.9	4.2	3.3	3.3
1193	3.0	3.0	3.7	3.3	3.0	3.3	4.0	.	3.3
373	2.8	3.2	2.8	4.6	3.4	3.4	3.3	3.3	3.3
1028	3.8	2.6	3.8	4.2	4.1	4.0	1.0	.	3.4
1066	3.7	3.2	3.5	3.4	3.4	3.6	3.6	2.6	3.4
458	4.3	1.4	3.4	3.9	3.2	3.5	4.0	.	3.4
1174	3.9	1.8	3.1	3.0	3.9	4.1	2.5	5.0	3.4
1136	3.8	3.8	3.0	2.5	3.5	3.5	3.8	3.8	3.4
116A	4.1	3.2	3.9	3.5	3.3	3.6	3.0	3.0	3.4
059A	4.1	4.0	3.9	2.9	3.7	3.5	3.0	2.9	3.5
424	3.4	3.6	3.8	4.0	3.7	3.2	3.8	3.0	3.6
388	3.8	3.6	3.4	4.0	3.8	3.6	4.0	2.6	3.6
551	3.8	3.8	3.8	3.7	3.5	3.5	3.6	3.5	3.6
1051	4.3	4.2	4.3	3.8	3.4	3.1	3.1	3.0	3.6
1013	4.0	4.3	3.8	4.1	3.2	3.6	3.3	3.2	3.7
532	3.4	3.2	4.0	4.0	3.8	3.8	3.6	3.6	3.7
782	4.0	4.0	3.9	3.9	3.7	3.7	3.2	3.2	3.7
1032	4.0	4.0	4.3	4.0	3.5	3.5	3.3	3.3	3.7
1009	3.5	3.9	3.3	4.0	3.8	3.5	4.0	4.0	3.8
1352	4.0	4.0	4.0	2.0	4.0	4.0	5.0	4.0	3.9
462	4.1	2.9	4.0	3.9	3.5	3.8	5.0	4.0	3.9
443	4.6	3.5	4.5	4.6	4.1	4.3	2.0	.	3.9
570	4.1	3.3	3.7	4.3	4.2	4.4	.	.	4.0
1437	4.7	2.7	4.3	4.7	4.7	4.7	.	.	4.3
Total	**3.1**	**2.8**	**3.3**	**3.1**	**3.1**	**3.1**	**3.2**	**2.8**	3.1

Source: Own elaboration based on the results of the Water Survey in Parral, 2024.

Graph 4. Water-saving practices within households



Source: Own elaboration based on the survey results on household water supply and consumption in the city of Hidalgo del Parral, 2024.

Against this backdrop, the need emerged to analyze the current water situation in one of the most vulnerable areas in northern Mexico the so-called "big state" specifically, the city of Hidalgo del Parral. The data collected provided insight into the water situation in terms of supply, quality, price, and other relevant variables.

Based on the survey results, it was found that monthly payments tend to have a more exponential than linear relationship with water consumption. This suggests that citizens are more careful with their water use due to its cost. Although the weak correlation between consumption and income levels may suggest that water is not excessively expensive, households expressed a willingness to pay an average of 16% more than their current water bill to ensure 24-hour daily water availability. This finding aligns with studies by Vásquez et al. (2009), who concluded that households have a payment capacity between 1.8% and 7.5% of their reported income.

Households' perceptions of public water service suggest an inequitable distribution of water. This is mainly due to the fact that supply sources or wells vary across city zones, meaning each sector depends on different water sources. Consequently, certain AGEBs (Basic Geostatistical Areas) are more affected than others, impacting their service ratings. However, a high percentage rated the flavor, smell, and clarity of the supplied water positively, with about 42% scoring it as good or excellent. Nonetheless, a lack of trust in its safety persists, as reflected in the 87.4% of households that purchase bottled water, spending around $320 pesos per month.

The availability and access to potable water through the public network are fundamental for household well-being. In the case of Hidalgo del Parral, the water issue is becoming more severe. Of the 70 neighborhoods included in the survey, 20% still rely on a rotation-based system to access water every third day or weekly. Corona and Miranda (2024) demonstrated that households with less water availability face limitations in carrying out basic activities, often leading to increased unpaid labor. This confirms that households are negatively impacted by a lack of access, which indirectly affects other aspects of well-being among household members.

Finally, there is still a lack of widespread education and culture around water conservation. However, households have gradually adopted basic practices to protect water, such as using faucets efficiently, reusing water, and following designated watering schedules for gardens. These efforts, though, must be supported by clear directives from the Municipal Water and Sanitation Board of the State of Chihuahua (JMAS).

The results of this research fulfill the objectives outlined at the beginning of the document, which

aimed to describe the current water situation in Hidalgo del Parral, Chihuahua. The findings serve as a reference to issue the following public policy recommendations to support efficient and effective decision-making toward solving the problems identified in the survey.

Policy recommendations

The State Development Plan 2022–2027 includes, under Axis 3: Modern and Sustainable Territorial Planning, a focus on integrated water management. To ensure the right to water, four strategies and their corresponding lines of action are proposed, aimed at increasing water collection, improving infrastructure, and promoting proper water use. However, the plan lacks a clearly defined diagnostic action line to assess the current situation.

Within the action line titled: "Encourage water sector governance and governability at the federal, state, and municipal levels with society's involvement", it is recommended to:

1. Support scientific research on water issues to broaden and deepen the diagnosis of the local water situation from a multidisciplinary perspective, covering various aspects related to water management.

2. Conduct ongoing studies in neighborhoods affected by water scarcity to improve decision-making for more efficient water supply support.

3. Challenge the belief in fixed rates; people are indeed willing to pay variable rates, allowing for more targeted billing proposals.

4. Charge higher rates in neighborhoods with daily water access to help subsidize support for communities facing water shortages.

5. Improve customer service to provide quicker and more objective responses.

6. Streamline the complaints process at the Municipal Water and Sanitation Board (JMAS).

7. Develop awareness programs about water issues to promote water conservation and strengthen JMAS's public image and service among residents of Parral.

References

Ávila, P. (ed.) (2003). Agua, medioambiente y desarrollo en el siglo XXI: México desde una perspectiva global y regional, El Colegio de Michoacán/ SUMA/ SEMARNAT IMTA. México.

Ávila, P (2008). Vulnerabilidad socioambiental, seguridad hídrica y escenarios de crisis por el agua en México. Ciencias, 90, 46-57. https://www.redalyc.org/pdf/644/64411395008.pdf

Cervantes, A. (2019). Revisión del panorama hídrico de los municipios de Cuauhtémoc y Delicias, Chihuahua, relacionado al cambio climático. En: Germán Everardo Dévora Isiordia y Esmeralda Cervantes Rendón (coords). Problemáticas del agua y medidas sustentables en estados desérticos de México, caso Chihuahua. Oficina de publicaciones, Instituto tecnológico de Sonora. https://www.itson.mx/publicaciones/Documents/recnat/Libro%20ChihuahuaFINALconISBN.pdf

Cervantes, A., y Dévora, G. (2019). Problemáticas del agua y medidas sustentables en estados desérticos de México, caso Chihuahua. Oficina de publicaciones, Instituto tecnológico de Sonora.https://www.itson.mx/publicaciones/Documents/recnat/Libro%20ChihuahuaFINALconISBN.pdf

Comisión Nacional del Agua (CONAGUA, 2006). El agua en México. IV Foro Mundial del Agua. https://www.conagua.gob.mx/CONAGUA07/Publicaciones/Publicaciones/EL-AGUA-EN-MEXICO.pdf

Comisión Nacional del Agua (CONAGUA, 2024). Plan Nacional Hídrico 2024-2030. https://agua.org.mx/wp-content/uploads/2024/11/Plan-Nacional-Hidrico-2024-2030.pdf

Confederación Patronal de la República Mexicana (Coparmex, 2024). México en crisis por la falta del agua. https://coparmex.org.mx/mexico-en-crisis-por-falta-de-agua/

Corona, A.I., y Miranda, A. (2024). El uso del tiempo de los mexicanos dada la disponibilidad de agua en sus viviendas. Sobre México, 5(9), 128 – 159. https://doi.org/10.48102/rsm.v1i9.147

Domínguez, J. (2010). El acceso a agua y saneamiento: un problema de capacidad institucional local. Análisis en el estado de Veracruz. Gestión y Política pública, 19(2), 311-350. https://www.scielo.org.mx/pdf/gpp/v19n2/v19n2a4.pdf

García, L,, Cruz, J., Carreón, G., Mecalco, J., Hernández, J., Bautista, M., Méndez, A. (2013). Estructura de las percepciones de riesgo entorno a la escasez y desabasto de agua global y local. Xihmai, 8(15), 95-18. https://dialnet.unirioja.es/servlet/articulo?codigo=4164472

Instituto Mexicano para la Competitividad A.C. (IMCO). (2023). Aguas en México, ¿Escasez o mala gestión? https://imco.org.mx/situacion-del-agua-en-mexico/

Instituto Nacional de Geografía y Estadística (INEGI). (2017). Encuesta Nacional de los Hogares (ENH). https://www.inegi.org.mx/programas/enh/2017/

Instituo Nacional de Geografía y Estadística (INEGI). (2022) Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH). https://www.inegi.org.mx/programas/enigh/nc/2022/

Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (2023). Reporte anual 2023. Ciencia y tecnología para el campo mexicano. Secretaría de Agricultura y Desarrollo Rural. Gobierno de México.

https://www.gob.mx/cms/uploads/attachment/file/920809/REPORTE_ANUAL_2023_Chihuahua.pdf

Guerrero, A. A., Gerritsen, P., Martínez, L.M., Salcido, S., Meza, D., Bustos. H.R. (2010). Gobernanza y participación social en la gestión del agua en la microcuenca El Cangrejo, en el municipio de Autlán de Navarro, Jalisco, México. Economía, Sociedad y Territorio, 10(33), 541-567. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1405842120100002000009

López. Carlos. (2017). El estado del agua en México Retos, oportunidades y perspectivas. En: Carlos Andrés López, Luis Zambrano, Rafael Ortiz, María Alicia Guzmán, Rosario Pérez, Ricardo Sandoval, Gonzalo Hatch, Nicolás Pineda, Raúl Pacheco y Alex Caldera. El agua en México. Actores, sectores y paradigmas para una transformación social-ecológica. Friedrich-Ebert-Stiftung. http://centro.paot.org.mx/documentos/paot/libro/aguaen_mexico.pdf

Murillo, L. (8 de abril de 2025). Llegará agua para nueve colonias que forman parte del tandeo en Parral. El Sol de Parral. https://oem.com.mx/elsoldeparral/local/llegara-agua-para-nueve-colonias-que-forman-parte-del-tandeo-en-parral-22604719

Naciones Unidas (2023). Informe de los Objetivos de Desarrollo Sostenible. Edición especial. Naciones Unidas. https://unstats.un.org/sdgs/report/2023/The-Sustainable-Development-Goals-Report-2023_Spanish.pdf

Ostrom, E. (1990). Governing the commons. The evolution of institutions for collective action. Cambridge University Press.

Pacheco, R. (2014). Ostrom y la gobernanza del agua en México. Revista Mexicana de Sociología, 76, 137-166.

https://revistamexicanadesociologia.unam.mx/index.php/rms/article/view/46485/41758

Salcido, S., Gerritsen, P., Martínez, L.M. (2010). Gobernanza del agua a nivel local: Estudio de caso en el Municipio de Zapotitlán de Vadillo, Jalisco. El Cotidiano, 162, 83-89. https://www.redalyc.org/articulo.oa?id=32513882010

Simonovic S. (2000). "Tools for Water Management One View of the Future". Water International. 25(1): 76-88https://doi.org/10.1080/02508060008686799

Secretaría de Desarrollo Urbano y Ecología (2019). Programa Estatal de Cambio Climático Chihuahua. Universidad Autónoma de Ciudad Juárez. https://lanti.uacj.mx/PECC/web/multimedia/PECC%204%20jun.pdf

Toledo, Alejandro (2002). El agua en México y en el mundo. Revista Gaceta Ecológica. Secretaría de Medio Ambiente y Recursos Naturales. https://www.redalyc.org/pdf/539/53906402.pdf

Vásquez, W., Mozumder, P., Hernández, J., y Berrens, R. (2009). Willingness to pay for safe drinking water: Evidence from Parral, Mexico. Journal of Environmental Managment, 90(2009), 3391 – 3400. https://doi.org/10.1016/j.jenvman.2009.05.009