

## The high cost of water for Mexico's poorest households

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### ABSTRACT

This study was aimed at analyzing how access to piped and other sources of water is related to the costs incurred by households to access water sources, while also considering income deciles in the analysis. The analysis shows a significant difference in access to water between low-income and high-income households, as well as the impact that this can have in terms of low-income households spending more to gain access to different sources of water. This microlevel analysis demonstrates that the design of public policies for the provision of public services, in this case, access to water, should include a diversified socio-economic component.

**Key words:** Access, Cost, Poverty, Public policies, Water

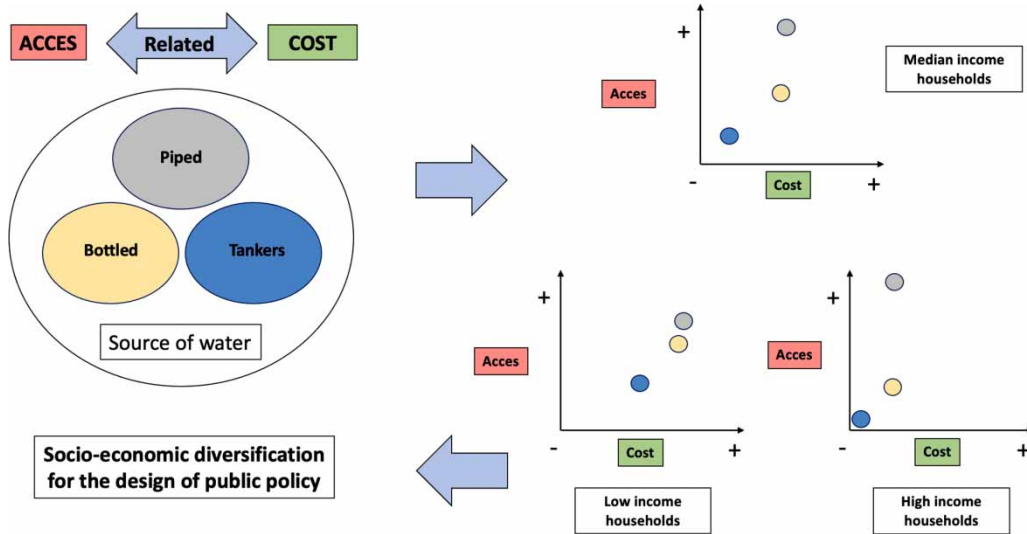
### HIGHLIGHTS

- Although the information at the macrolevel can show high access to water, this is not necessarily reflected at the microlevel.
- Households with higher levels of poverty have lower levels of access to water and higher costs for its access.
- Public policy on the provision of public services should take greater account of issues of equity and socio-economic diversification.

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## GRAPHICAL ABSTRACT



## 1. INTRODUCTION

Water scarcity poses a problem that is caused by a set of environmental, natural, socio-economic and cultural factors. The human right to safe drinking water and sanitation was explicitly recognized in July 2010 by United Nations General Assembly Resolution No. 64/292 (Kooy *et al.*, 2018). The legal content of the right to water and sanitation should be determined by its availability, quality, accessibility and affordability (Cook *et al.*, 2016). These criteria are key to expanding water and sanitation services, and to ensuring that everyone can benefit regardless of income, age, gender or race, among other characteristics (Mack & Wrase, 2017). In fact, affordability – understood as the percentage of income that any household in a population spends on a particular service, such as access to piped water – has been recognized over the last few years by several global and regional declarations on water. Its adoption was also considered and included in the formulation of Millennium Development Goal 7 regarding access to water and sanitation (García-Valiñas *et al.*, 2010a, 2010b). Having a connection to piped water is not sufficient, but rather, daily supply must also be considered. The quality and cost of this service should not be disproportionately high for any particular household income (Kessides *et al.*, 2009).

Emerging or developing countries are facing significant problems and challenges in general, and one that particularly cannot be overlooked is water, which involves several problems, including unequal distribution and improper sanitation of this crucial resource, little innovation in water systems and their deficiencies maintenance, overexploitation, contamination of water resources, high water subsidies, as well as waste and daily leaks, among others (Kooy *et al.*, 2018). Drinking water and sanitation are among the most important services, given their strong relationship with health and population growth. These are commonly referred to as public services because in most cases they are supplied by the public administration (Revollo-Fernández *et al.*, 2019a). In Mexico, the geographic distribution of water does not coincide with the geographic distribution of the population. While the average per capita renewable water volume in the country is 4,028 m<sup>3</sup> per inhabitant per year, there are substantial differences between southeastern and northern Mexico. Water is very scarce in some areas while

others experience frequent hydrometeorological events that result in costly floods that affect human settlements and infrastructure. National drinking water coverage is nearly 93% (Revollo-Fernández *et al.*, 2019b), with 97% in urban areas and 84.8% in rural areas (localities with less than 2,500 inhabitants). The lower coverage in rural Mexico is due to population dispersion throughout complex physiographic settings and the technical and financial difficulty of developing drinking water systems in those areas. Although 94% of the population officially has access to public drinking water service, this percentage may be lower when considering the quality of the resource and the frequency with which it reaches the home, situations that drastically affect lower-income households or those with more social marginalization (Revollo-Fernández *et al.*, 2019a). Along with this problem, roughly 40% of water is wasted in cities due to leaks in supply and distribution networks and household connections (Espinosa-García *et al.*, 2015).

In this context, the objective of this work is to analyze access to drinking water and the expenses incurred by households by carrying out an analysis at a microlevel, that is, at the level of income deciles. Its purpose is to offer public policy recommendations that benefit society, particularly the most vulnerable sectors. This document is structured as follows: the second section presents the materials and method, the third section presents the results, and finally, the fourth section presents a discussion and conclusions of this work.

## 2. MATERIALS AND METHODS

### 2.1. Status of piped water in Mexico

In Mexico, water development, supply and sanitation activities are regulated in accordance with the Political Constitution of the United Mexican States, specifically Article 27, which establishes that ‘national waters are the property of the nation’. Article 115 stipulates that ‘the municipal governments are responsible for providing piped water, drainage, sewage, wastewater treatment and disposal services’. In addition, there are state and municipal water regulations. This set of legal instruments establishes the guidelines for the use and conservation of this resource, as well as the rights and obligations pertaining to a water management organization (WMO). A WMO is an economic unit that manages and operates the systems and provides piped water, sewage and sanitation services. The WMOs are diverse in terms of their formation and structure, and they are generally part of municipal governments, with representation in piped water and sanitation departments and commissions, or in decentralized water systems. They also operate as local boards, water user committees and, less frequently, as private concessionary companies.

In Mexico, the level of coverage and the number of inhabitants with access to piped water service has been increasing over recent decades. In 1990, the total national water coverage was 75.4% (61.2 million people), with 87.0% of the urban population (50.5 million people) and 46.5% of the rural population (10.8 million people) supplied. By 2020, national coverage reached 93.3% (115.5 million people), with 97.2% coverage in urban areas (91.3 million people) and 85% in rural areas (24.2 million people). Although there has been a considerable increase in the level of coverage over the years, this datum masks the problems with continuity of service and the quality of water delivered to households.

With regard to continuity, according to the National Survey of Household Income and Expenditures (INEGI, 2020), in the year 2020 approximately 70% of households that had access to piped water at the national level received water daily. The rest only received water once, twice or three times a week. In terms of water quality, there are no data or studies at the national or state level that have been substantiated by any government or private institution, but assertions or observations have been made in the field by recognized researchers on this subject matter (Espinosa-García *et al.*, 2015; Revollo-Fernández *et al.*, 2019a). Furthermore, surveys such as

the 2017 Households and Environment Module, which is part of the National Household Survey (INEGI, 2017) conducted by the National Institute of Statistics, Geography and Informatics (INEGI in Spanish), have shown that nearly 51% of households in Mexico express a perception that the taste, smell and clarity of the water that is supplied are poor or fair, and that 53% of those households do not have confidence in the water supplied to their homes in terms of health.

Likewise, this problem of lack of access to piped water and lack of continuity is greater mainly in municipalities where there are more households living in poverty and marginalization. Due to a lack of access to water services, discontinuity or low quality, households in Mexico seek other sources of water, such as rainwater collectors, wells, rivers, streams, cisterns, bottled water and soda. In several localities or municipalities, people rely on cisterns or bottled water for drinking due to concerns about access and quality, which can add a considerable additional financial burden for those often living in the poorest areas and who have the lowest incomes. The fact that Mexico has the highest per capita consumption of bottled water in the world (350–450 l per year) is an indication of the population's distrust of piped water services, lack of access to it and/or taste preferences for this beverage.

## 2.2. Data

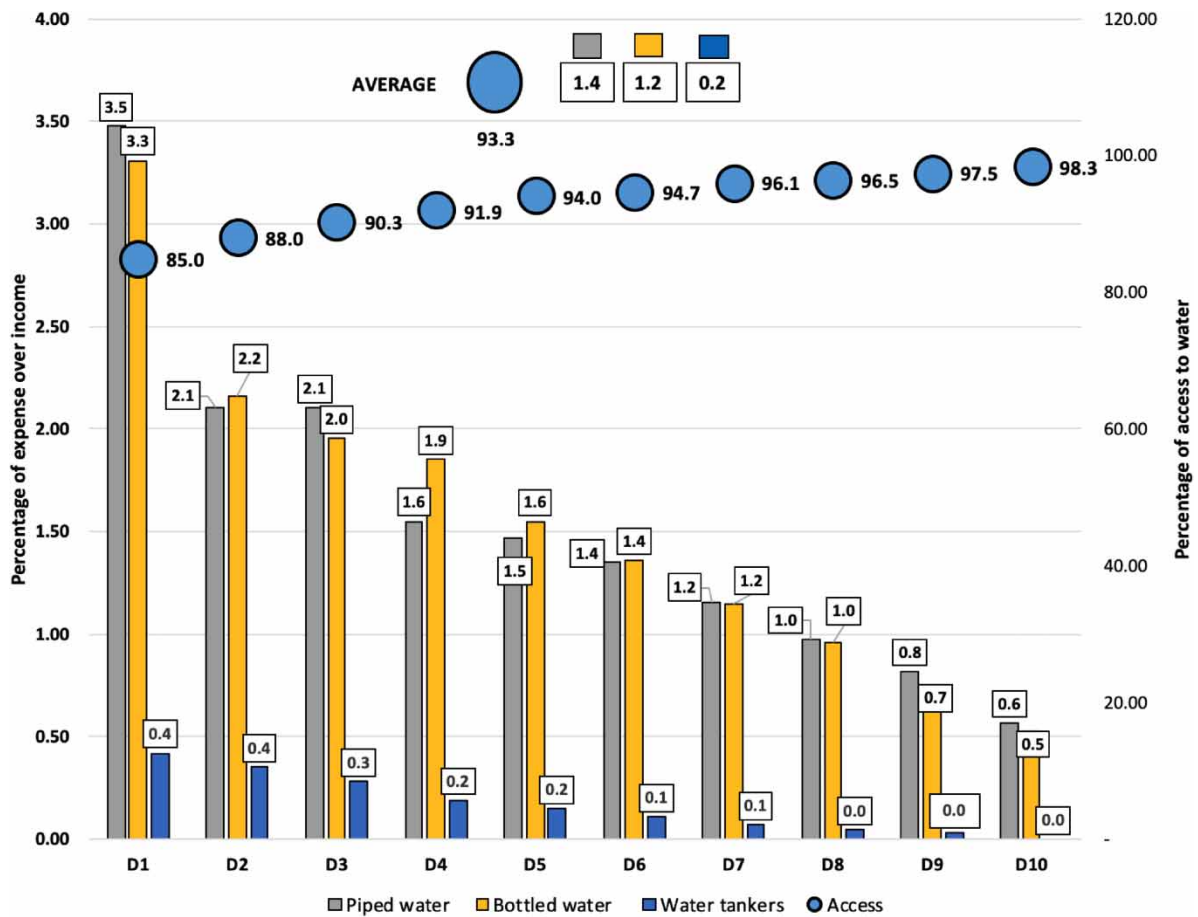
The data were obtained from the National Survey of Household Income and Expenditures (ENIGH in Spanish) for the year 2020, generated by the National Institute of Statistics and Geography (INEGI in Spanish). This survey was aimed at providing a statistical overview of the behavior of household income and expenditures in Mexico in terms of amounts, sources and distribution. It also provides information about the occupational and socio-demographic characteristics of household members and their access to food, as well as characteristics related to housing and household equipment. The survey has national- and state-level coverage. This research used national household data about water sources, expenditures and income.

## 2.3. Method

Based on the economic income variable, income deciles were constructed to classify the different households in Mexico from D1 to D10, where D1 corresponds to households with the lowest income and D10 represents those with the highest income. This variable was then used in the estimate of household access to piped water, the identification of the different sources of water obtained by the households and the estimation of the average expenditures on those different sources. Finally, a test of means (ANOVA) was performed with these variables.

## 3. RESULTS AND DISCUSSION

Access to piped water at the national level was 93.3% of households in 2020. Nevertheless, when this access was analyzed by decile level, a large difference was found between the highest and lowest deciles. For example, 98.3% (3.9 million households) of households had access to piped water in decile 10, the highest-income decile, while only 85.0% (2.8 million households) of households had access in the first decile, the lowest-income decile. This inequality in access to piped water goes hand in hand with the fact that 81.6% of households in D10 had daily access to water compared to only 57.1% in D1. In other words, the percentage of households with access to piped water was lower for the first decile than for the tenth decile (Figure 1).



**Fig. 1** | Households nationwide with access to piped water, by deciles for the year 2020.

This situation results in households in different deciles, particularly in the first decile, seeking different sources of water and spending different percentages of their income on this resource. On average, in the year 2020, a household in Mexico spent 1.4% of its income on piped water, 1.2% on bottled water and 0.2% on water from water tankers. However, when this information is analyzed by household income decile, the situation changes radically. For example, on average, a household in the first decile spent 3.5% of its income on piped water, 3.3% on bottled water and 0.4% on water from a water tanker, while a household in the tenth decile spent only 0.6% on piped water and 0.5% on bottled water, and none on water tankers since it did not use that source.

These differences among the deciles in the degree of access to piped water and in household expenditures on the consumption of piped water (Table 1), bottled water and water from tankers (Table 2) are statistically more significant between the first and tenth deciles. For example, a difference of roughly 13.3% was found between D1 (85%) and D10 (98.3%) in the number of households with access to piped water, while the difference in spending on piped water between these deciles was 1.4%, and in both cases, the test of means presented a clear statistical significance of 99%.

**Table 1** | Percentage differences among household income deciles for access to piped water and expenditure on pipe water.

| Variable                                | Access to piped water (% of households) |         |         |         |         |        |         |          |           |           |           |
|---|---|---------|---------|---------|---------|--------|---------|----------|-----------|-----------|-----------|
|   | Decile                                  | 1       | 2       | 3       | 4       | 5      | 6       | 7        | 8         | 9         | 10        |
| Expenditure on pipe water (% of income) | 1                                       |         | -3.01*  | -5.37*  | -6.93*  | -9.08* | -9.75** | -11.15** | -11.53*** | -12.55*** | -13.34*** |
|   | 2                                       | 0.58*** |         | -2.35   | -3.91   | -6.06* | -6.73*  | -8.13**  | -8.51**   | -9.53***  | -10.32*** |
|   | 3                                       | 0.52*** | 0.00    |         | -1.55   | -3.71  | -4.37   | -5.78*   | -6.15**   | -7.18***  | -7.97***  |
|   | 4                                       | 0.85*** | 0.27    | 0.33    |         | -2.15  | -2.81*  | -4.22*   | -4.60*    | -5.62***  | -6.41***  |
|   | 5                                       | 0.89*** | 0.30*   | 0.36    | 0.03    |        | -0.66   | -2.07    | -2.44**   | -3.47**   | -4.26***  |
|   | 6                                       | 0.94*** | 0.35*   | 0.41*** | 0.08    | 0.04   |         | -1.4     | -1.78*    | -2.80**   | -3.59**   |
|   | 7                                       | 1.04*** | 0.45*** | 0.51**  | 0.18    | 0.15   | 0.10    |          | -0.37     | -1.40*    | -2.19**   |
|   | 8                                       | 1.16*** | 0.57**  | 0.64**  | 0.30**  | 0.27   | 0.10    | 0.12     |           | -1.02     | -1.81*    |
|   | 9                                       | 1.26*** | 0.67*** | 0.74**  | 0.40**  | 0.37   | 0.32    | 0.22     | 0.10      |           | -0.79     |
|   | 10                                      | 1.45*** | 0.86*** | 0.92*** | 0.59*** | 0.56*  | 0.51*   | 0.41*    | 0.28*     | 0.18      |           |

Statistical significance: \*\*\*99.0%, \*\*95.0%, \*90%.

**Table 2** | Percentage differences among household income deciles for spending on bottled water and water tanks.

| Variable                              | Spending on bottled water (% of income) |         |         |        |        |         |         |         |         |         |         |
|---------------------------------------|---|---------|---------|--------|--------|---------|---------|---------|---------|---------|---------|
|                                       | Decile                                  | 1       | 2       | 3      | 4      | 5       | 6       | 7       | 8       | 9       | 10      |
| Spending on water tanks (% of income) | 1                                       |         | 1.14**  | 1.35** | 1.46** | 1.76*** | 1.95*** | 2.16*** | 2.35*** | 2.59*** | 2.78*** |
|                                       | 2                                       | 0.07    |         | 0.20*  | 0.31** | 0.61**  | 0.80**  | 1.01**  | 1.20*** | 1.44*** | 1.63*** |
|                                       | 3                                       | 0.14    | 0.07    |        | 0.10   | 0.40    | 0.59*   | 0.80*   | 0.99**  | 1.23**  | 1.42*** |
|                                       | 4                                       | 0.23    | 0.16    | 0.09   |        | 0.30    | 0.49*   | 0.70*   | 0.89**  | 1.13**  | 1.32*** |
|                                       | 5                                       | 0.27**  | 0.2     | 0.13   | 0.04   |         | 0.19    | 0.40    | 0.59    | 0.83**  | 1.02**  |
|                                       | 6                                       | 0.31**  | 0.24    | 0.17   | 0.08   | 0.04    |         | 0.21    | 0.40    | 0.64**  | 0.83**  |
|                                       | 7                                       | 0.35**  | 0.28**  | 0.21   | 0.12   | 0.08    | 0.04    |         | 0.19    | 0.43    | 0.62**  |
|                                       | 8                                       | 0.37**  | 0.30**  | 0.23** | 0.14   | 0.1     | 0.06    | 0.02    |         | 0.24    | 0.43    |
|                                       | 9                                       | 0.39**  | 0.32**  | 0.25** | 0.16** | 0.12    | 0.08    | 0.04    | 0.01    |         | 0.19    |
|                                       | 10                                      | 0.42*** | 0.35*** | 0.28** | 0.19** | 0.15    | 0.11    | 0.07    | 0.04    | 0.03    |         |

Statistical significance: \*\*\*99.0%, \*\*95.0%, \*90%.

#### 4. CONCLUSIONS

This analysis made it possible to measure the significant differences that exist between low-income and high-income households with respect to access to piped water, as well as the impact that this can have in terms of the former allocating more income to different sources of water. Therefore, it is important to note that while the rate of access to piped water in the domestic sector has increased significantly at the general level in Mexico, this masks the problems faced by lower-income households in terms of accessing this resource.

Therefore, water policies in Mexico and in other countries with similar situations should seek to improve access for the most vulnerable households. These policies should not only focus on access but also on daily access to quality water, and on household spending on water that is affordable based on income levels. Currently, in Mexico, the quality of piped water is regulated through the 1994 Official Mexican Standard 'Environmental health, water for human use and consumption – permissible limits for quality and treatment to which water must be subjected for its purification,' revised in 2000 (NOM-127 SSA1-1994/2000). The distribution and control of this resource are regulated through the National Water Law which was enacted in 1992 and revised in March

2016. Nonetheless, these laws are outdated, and there is virtually no compliance with the former. In this sense, new legislation on current and modern water issues is needed both at the national and state levels, to reduce or eliminate the problems that currently exist not only for the benefit of the entire society but especially for the most vulnerable groups, which are generally invisible when analyzing data at the macrolevel.

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## DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

## CONFLICT OF INTEREST

The authors declare there is no conflict.

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