Official Journal of the World Water Council
Water Policy

Water Policy Vol 00 No 0, 1 doi: 10.2166/wp.2025.190

Progress in access to water in homes in Bolivia: special attention to inequality issues

Daniel Revollo-Fernández [a,*], Jean Paul Benavides[b], Fernanda Wanderley[b] and Lilia Rodríguez-Tapia[c]

[a] SECIHTI-UAM, Departamento de Economía, Universidad Autónoma Metropolitana, Unidad Azcapotzalco. Av. San Pablo No. 180, Col. Reynosa Tamaulipas, Del. Azcapotzalco, Ciudad de México, México
[b] Universidad Católica Boliviana San Pablo, Instituto de Investigaciones Socio-Económicas (IISEc), La Paz, Bolivia
[c] Deparment of Economics, Metropolitan Autonomus University, Campus Azcapotzalco. Av. San Pablo No. 420, Col. Nueva El Rosario, Alcaldia Azcapotzalco, Ciudad de México, México
*Corresponding author. E-mail: darevollof@secihti.mx; darf@azc.uam.mx

DR, 0000-0001-6350-0924

ABSTRACT

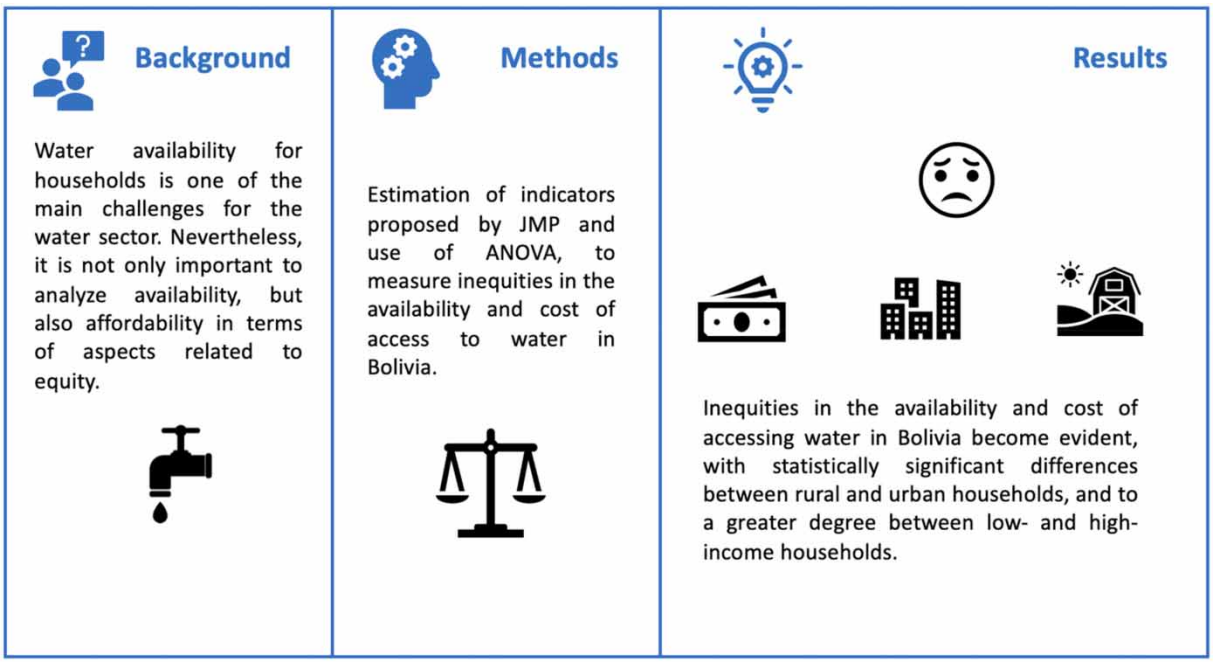
One of the main challenges facing the water sector worldwide relates to the availability of water for households. However, it is not only important to analyze availability but also affordability, taking into account equity aspects. In this regard, by estimating indicators proposed by the Joint Monitoring Program for Water Supply, Sanitation, and Hygiene (JMP) and using statistical tests of means (ANOVA), it is evident that, in the case of Bolivia, for 2021, basic access to water service was 90.3% nationwide, 98.1% in the urban sector, and 73.0% in the rural sector, demonstrating a statistically significant difference between the two geographic areas. And if considered by income decile, for example, at the national level, the difference between the first and tenth deciles is almost 22.5%. In this sense, although water policy in Bolivia has advanced in recent years, it is important to consider actions to reduce this inequality and thus achieve greater social well-being, especially for the most vulnerable households. Consideration should be given to designing policies that provide assistance, primarily to the most vulnerable sectors, for example, by prioritizing investments in the sector to expand or improve the water network or distribution systems.

Key words: Access, Inequality, Water

HIGHLIGHTS

- Household access to water is essential for greater social well-being.
- However, it is not only important to analyze access, in quality and quantity, but also affordability considering aspects of equity.
- In the case of Bolivia, inequality in access and the cost of accessing this resource is statistically significant between rural and urban households, but to a greater extent between low- and high-income households.

GRAPHICAL ABSTRACT



1. INTRODUCTION

One of the main challenges for the water and sanitation sector in the Latin America and Caribbean (LAC) region is the availability and quality of the drinking Water, Sanitation and Hygiene (WASH) services received by households in both urban and rural areas of the region (Ezbakhe & Pérez-Foguet 2019; Rakotomanana *et al.* 2020).

The 2030 Agenda for Sustainable Development (SD), approved in September 2015 at a United Nations summit, is an action plan that officially became effective on January 1, 2016, to benefit people, the planet, and prosperity. It consists of 17 Sustainable Development Goals (SDGs) and 169 targets for the global community (Ezbakhe & Pérez-Foguet 2019; Rakotomanana *et al.* 2020). Specifically in terms of clean water and sanitation, Goal 6 of this agenda is aimed at ensuring water availability, sustainable water management, and sanitation for all. This goal includes the following eight targets: drinking WASH services; wastewater treatment; water quality; water use; water resources management; transboundary cooperation; water-related ecosystems; official assistance for development and the participation of local communities (Girma *et al.* 2021; Daniels *et al.* 2023).

SDG targets 6.1 and 6.2 are a call to society for universal access to WASH services by 2030. They set ambitious indicators that go beyond the types of installations used by households by introducing additional criteria related to the level of service provided (Dickin & Gabrielsson 2023). Furthermore, the 2030 Agenda aims to progressively reduce inequalities within and among countries, and specifies that, whenever relevant and possible, SDG indicators should be applied according to economic income level, gender, age, race, ethnicity, migration status, disability, and geographic location, among others (Nayebare *et al.* 2019; Quispe-Coica & Pérez-Foguet, 2022; Saroj *et al.* 2020; Dickin & Gabrielsson 2023).

In this regard, a couple of years ago the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) established the Joint Monitoring Program for Water Supply, Sanitation and Hygiene (JMP) to

monitor the progress that countries are making on SDG targets 6.1 and 6.2, as well as to standardize comparisons among countries by using a set of WASH indicators that are mainly related to access to water and its quality (Rakotomanana *et al.* 2020). The Joint Monitoring Program also helps to track indicators for SDG targets on ending poverty (1.4), health and well-being (3.9), quality education (4.a), and reducing inequalities (10.3) (WHO and UNICEF JMP 2022).

As a natural resource, the relative scarcity of water is problematic and is caused by a set of environmental, natural, socioeconomic, and cultural factors (Bartram *et al.* 2014). The human right to safe drinking water and sanitation was explicitly recognized at the United Nations General Assembly in July 2010, through Resolution No. 64/292 (Kooy *et al.* 2018). The normative content of the rights to water and sanitation should be determined not only according to its availability and quality but also affordability (Cook *et al.* 2016). These criteria are key to expanding water and sanitation services and ensuring that everyone can benefit regardless of income, age, gender, or race, among other factors (García-Valiñas *et al.* 2010a, b; Khadka *et al*. 2023; Mack & Wrase 2017). It is not enough to be able to be connected to piped water, but daily frequency and quality must also be considered, and the cost of that should not be disproportionately high with respect to how much income a household can earn (Kessides *et al.* 2009).

In general, emerging or developing countries are currently experiencing significant problems and challenges, and one that particularly cannot be disregarded is the future of water. This problem includes the unequal distribution of water, inadequate treatment, limited innovation in water systems and insufficient maintenance of these systems, overexploitation and contamination of water resources, high water subsidies, and daily waste and leaks, among others (Kooy *et al.* 2018; Revollo-Fernández 2023). Given how closely they are related with health and population growth, drinking water and sanitation are among the most important services, which are commonly referred to as public services because they are provided by the public administration. Bolivia has progressively reformed the regulatory and institutional framework for the provision of drinking water and sanitation services, in line with the political philosophy of the Government in power (Hines 2021). In the last three decades, four important milestones can be argued that have marked this regulatory framework: (i) the cancelation of concessions to private companies that provided drinking water services to the cities of La Paz and El Alto; the presence of the 'water war' in the city of Cochabamba, which culminated in the completion of the private concession in said city (Hines 2021); Bolivia's international leadership for the approval of the Human Right to Water by the United Nations; and the issuance of the new Political Constitution of the State, approved in 2009, which specifies that the water resource is a human right and that it must be a public service under the responsibility of the State. In other words, we are moving from a period where the provision of drinking water services is concentrated in the State; subsequently, access is granted to private companies through concessions; and finally, it returns to the State. All this has led to the implementation of a series of programs and projects in recent years aimed at achieving a profound reform in the water and sanitation sector, which has led to sustainable growth in access to drinking water (Andersen *et al*. 2016). According to the JMP (WHO and UNICEF JMP 2022), the proportion of the national population with access to water at the basic level increased from 72.8% in 2001 to 94.1% in 2021. The data show that this growth has been more rapid in rural areas than in urban areas, thereby contributing to narrowing the gaps between these regions. However, inequalities persist despite these important advances, and to a greater extent when taking into account socioeconomic variables such as income (Botton & Urquiera 2020). While officially over 90% of the population has access to water services, this percentage could decrease when considering the quality of the resource and/or the frequency with which it reaches the home, factors that drastically and more significantly affect lower-income and more socially marginalized households (Revollo-Fernández *et al*. 2019). At the international level, the literature shows a series of studies on the measurement of access to water and inequality metrics, among which we can mention, for example, the use of the Gini

index and the Lorenz curve (Morales-Novelo *et al*. 2018, 2024), the use of geospatial techniques (Medina-Rivas *et al*. 2022, 2024), performance indicators and concentration coefficients (Revollo-Fernández *et al*. 2019) and multidimensional poverty indices (Cheng *et al*. 2024; Mekonnen 2024).

In this context, the objective of this work is to analyze access to drinking water and the expenses incurred by Bolivian households through the indicators proposed by the JMP and using a variance analysis, but performing an analysis at the micro level; that is, at the level of income deciles both at the national level and by rural and urban area. The purpose of all this is to propose public policies that benefit society, and especially the most vulnerable sectors. This document is structured as follows. The second section presents the materials and methods, the third section presents the results, and finally, the fourth section presents the discussions and conclusions of this work.

2. MATERIALS AND METHODS

2.1. Water situation in Bolivia

Bolivia is among the top 20 countries in available freshwater resources (Montes de Oca 2005; Urquidi 2012). The national water supply is approximately 500,000 mm^3/year while the demand is only 2,000 mm^3/year (Urquidi 2012). Agricultural irrigation is the sector that consumes the most water, between 80 and 94% of total demand (Van Damme 2002; Urquidi 2012). The 2009 New Political Constitution of the State established water as a universal, non-tradable right to which 100% of the population should have access. Since then, there has been a notable increase in public investments in the sector. Between 2006 and 2016, approximately USD 148 million was invested per year on average, which is a 200% increase over the yearly average that was spent during the prior decade (Bernabé Lang 2021). However, this investment has been decreasing over recent years due to the drop in hydrocarbon prices, the government's main source of income, as well as because of access to and the decline in international loans and the presence of COVID-19, among other factors. Thus, the average investment over the past three years was approximately USD 50 million annually. It is also important to mention that the Political Constitution of the State prohibited the privatization of water supply and sanitation services, thereby creating a market that is controlled solely by the government.

In Bolivia, the level of coverage and the number of inhabitants with access to water services have been increasing in recent decades. In 2001, the total national water coverage was 72.8% (6.3 million people), with 93.3% for the urban population (5.1 million people) and 56.9% for the rural population (1.8 million people). By 2021, the national coverage reached 94.1% (11.5 million people), with 98% coverage in urban areas (8.5 million people) and 73% rural areas (2.6 million people). Nevertheless, while the level of service coverage has increased considerably over the years, this data could mask the problems with the continuity of the service and the quality of the water that is delivered to households for their use.

With regard to continuity, according to the Household Survey (Instituto Nacional de Estadística 2021), by 2021 approximately 92.5% of the households nationwide that had access to piped water received it every day and 76.1% had water 24 h per day. In urban areas, 92.9% of households had access to piped water every day and 77.8% had 24-h/day access. Also, in the case of rural households, 92.4% had access every day and 68.5% had 24-h access. In other words, the percentage of urban and rural households with frequent access to piped water was very similar but there was an important difference in the number of hours of service. Finally, regarding quality, there are no data or studies at the national level that have been validated by any government or private institution to show how this has evolved. Some studies of natural surface waters have found that they exceed chemical limits for human use, as in the case of Lake Poopó. Also, the water in the

Desaguadero River, which comes from Lake Titicaca, is not suitable for irrigation due to the risk of salinization (Van Damme 2002).

2.2. Methods

The JMP indicators for household WASH services were estimated at the national, urban, and rural levels, and taking into account income deciles (Table 1). These indicators are associated with five levels of access to water service. The first level is the safely managed service (SM). This refers to the percentage of households that receive water for consumption from an improved water source located in the dwelling or on the property, and which is available when needed and is free of fecal contamination and contamination from priority chemicals. The second level is the basic service (B), which refers to the percentage of households that receive water for consumption from an improved water source and for which it takes no more than 30 min to go to the water source, wait to obtain it, and return. The third level is limited service (L). This is the percentage of households that receive drinking water from an improved water source with a round trip time of more than 30 min. The fourth level is the unimproved service (U), which is the percentage of households that receive drinking water from an unprotected dug well or an unprotected spring. Finally, the fifth level is the surface water service (SW), which is the percentage of households that receive drinking water from rivers, dams, lakes, ponds, streams, channels, or irrigation canals. It is also important to mention that, according to the JMP, improved sources include piped water, boreholes or tube wells, protected boreholes, protected springs, rainwater, and packaged or distributed water.

Table 1 | Water access service levels as proposed by the JMP.

SERVICE LEVEL	DEFINITION
SAFELY MANAGED (SM)	Drinking water from an improved water source that is located on premises, available when needed and free from fecal and priority chemical contamination.
BASIC (B)	Drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip, including queuing.
SERVICE LEVEL	**DEFINITION**
LIMITED (L)	Drinking water from an improved source for which collection time exceeds 30 minutes for a round trip. Including queuing.
UNIMPROVED (U)	Drinking water from an unprotected dug well or unprotected spring.
SURFACE WATER (SW)	Drinking water directly from a river, dam, lake, pond, stream, canal or irrigation canal.
Note: Improved sources include: piped water, boreholes or tube wells, protected dug wells, protected springs, rainwater, and packaged or delivered water.	

In terms of deciles, the income variable was used to classify the different households in Bolivia from decile D1 to D10, where D1 represents households with the lowest incomes and D10 represents those with the highest. Based on this variable, the five JMP levels for classifying household access to water were calculated, and this was complemented by estimating the average that households spent on access to piped water with respect to their monthly income. Finally, a test of means (ANOVA) was performed to determine whether there were statistical differences in WASH levels between upper and lower household income deciles (D10 versus D1 and D9 versus D2). In the case of ANOVA, first, a normality test is performed for each of the five WASH levels; second, the average value of each WASH level is estimated, at the national, rural and urban levels, for the different ten decile groups (D1 to D10); and finally, through ANOVA, a comparison is made of whether or not there is a significant difference in the WASH levels. The entire process and analysis of the information was carried out in the StataSE18 program.

2.3. Data

The data were obtained from the 2021 Household Survey generated by the National Statistics Institute (INE). The purpose of that survey was to provide general statistics on the behavior of household income and expenditures in Bolivia in terms of their amount, sources, and distribution. It also provides information on occupational and sociodemographic characteristics, access to food by household members, and characteristics related to housing and household appliances, all at the national, urban, and rural levels. In the EH, the study population is households and members in private homes; the effective sample size is 12,948 homes, representing 12.8 million inhabitants. The research herein used the data on sources and frequency of household access to water, related expenditures, and household income level, all at the national, urban, and rural levels.

3. RESULTS

The results show that, in the case of Bolivia for the year 2021, approximately 90.3% of households nationally had the basic service (B) level of access to water, with 98.1% in the urban sector and 73.0% in the rural sector, for a statistical difference of nearly 25% between the two geographic areas ($p < 0.01$) (Table 2). Access to the limited service (L) was 0.7% at the national level, 0.8% in the urban area, and 0.4% in the rural area, with no statistically significant difference ($p > 0.10$). For the unimproved service (U), 3.9% had access to this level of service at the national level, with 1.0% in the urban area and 10.2% in the rural area, demonstrating a significant difference of nearly 9.0% ($p < 0.01$). For the surface water service (SW), 5.1% had access to this level nationally, with 0.1% in the urban area and 16.4% in the rural area, for a significant difference between these areas of 16.3% ($p < 0.01$). Finally, the safely managed service (SM) resulted in 49.2% at the national level, 64.5% in the urban area, and 14.9% in the rural area, reflecting a significant difference of roughly 50% ($p < 0.01$). In other words, of the five indicators estimated at the urban and rural levels, four show a significant difference between these two regions.

The results also show a significant difference when analyzing household income at the national, urban, and rural levels. That is, in the case of the B at the national level, 97.2% of households in the tenth decile had access to water while 75.2% in the first decile had access, for a significant difference of roughly 22% ($p < 0.01$). In the urban area, the difference between these deciles was minimal and not significant ($p > 0.10$), while it was significant for rural households ($p < 0.01$). In the case of the L, there was no significant difference between urban and rural households or among households in different deciles ($p > 0.10$). In the case of the U, a significant difference among deciles was found, mainly for households at the national level and the rural sector. For example, at the national level, 1.3% of D10 households accessed water from an unprotected dug well or an unprotected spring while 7.9% of D1 households obtained water from these sources. Similarly, significant differences in the SW were found between the first and last deciles both nationally and for the rural sector. Finally, the

Table 2 | Percentage of households at the national, urban, and rural level by income deciles with various sources of access to water for the year 2021.

	AMBIT	TOTAL	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1
SM	National	49.2%	65.0%	59.6%	58.8%	59.0%	54.7%	52.2%	48.1%	43.9%	32.3%	19.2%
	Urban	64.5%	69.2%	67.5%	66.6%	65.8%	64.2%	65.0%	63.0%	57.5%	60.6%	57.4%
	Rural	14.9%	32.2%	22.2%	27.4%	29.9%	15.9%	16.6%	15.5%	18.9%	7.9%	6.5%
B	National	90.3%	97.2%	93.6%	96.3%	94.3%	93.9%	93.1%	91.2%	87.6%	81.4%	75.2%
	Urban	98.1%	99.2%	97.3%	98.6%	97.5%	98.5%	97.2%	98.2%	96.8%	98.8%	99.4%
	Rural	73.0%	81.6%	76.0%	86.7%	76.7%	75.3%	81.5%	75.6%	70.5%	66.5%	67.2%
L	National	0.7%	0.4%	1.8%	0.5%	0.4%	0.4%	1.6%	0.3%	0.4%	0.2%	0.5%
	Urban	0.8%	0.3%	2.2%	0.6%	0.5%	0.3%	2.0%	0.2%	0.6%	0.2%	0.3%
	Rural	0.4%	0.9%	0.0%	0.5%	0.2%	0.8%	0.7%	0.7%	0.2%	0.1%	0.5%
U	National	3.9%	1.3%	1.4%	1.0%	2.7%	2.7%	2.6%	4.4%	6.2%	8.6%	7.9%
	Urban	1.0%	0.5%	0.4%	0.6%	1.9%	1.1%	0.6%	1.5%	2.2%	0.8%	0.3%
	Rural	10.2%	7.6%	6.1%	2.5%	6.7%	9.1%	8.0%	10.8%	13.4%	15.2%	10.4%
SW	National	5.1%	1.1%	3.2%	2.2%	2.7%	3.0%	2.7%	4.1%	5.8%	9.8%	16.4%
	Urban	0.1%	0.0%	0.0%	0.2%	0.0%	0.1%	0.2%	0.1%	0.4%	0.1%	0.0%
	Rural	16.4%	9.9%	17.9%	10.3%	16.4%	14.8%	9.8%	13.0%	15.9%	18.2%	21.9%

There is a significant difference between D10 and D1 ($p<0.01$) (ANOVA)

There is a significant difference between D9 and D2 ($p<0.01$) (ANOVA)

	AMBIT	TOTAL	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1

There is a significant difference between D8 and D3 ($p<0.01$) (ANOVA)

There is a significant difference between D7 and D4 ($p<0.01$) (ANOVA)

There is a significant difference between urban and rural ($p<0.01$) (ANOVA)

SM was found to have the largest differences in all respects: between urban and rural households and among income deciles. That is, when analyzing access to water from an improved water source located in the dwelling or on the property and that was available when needed and free of contamination, 65.0% of D10 households versus only 19.2% of D1 households had this type of access at the national level ($p < 0.01$).

The differences that were found for the various JMP indicators in access to water between rural and urban households in Bolivia and among income levels were substantiated when analyzing spending on access to piped water for households that paid for that service. On average, a household in Bolivia that had access to piped water either inside the dwelling or outside on their property paid approximately USD 7.2 per month for its consumption, while urban households paid USD 7.7 and rural households paid USD 3.1 (Figure 1). The affordability of accessing piped water can also be expressed as a percentage of monthly household income. Thus, it was found that a household in Bolivia that had access to piped water spent 1.4% of its monthly income on this service, with urban households spending 1.4% and rural households 0.9%. Although this difference between urban and rural households is not statistically significant ($p > 0.1$), it is considerable when analyzed by decile levels, whether at the national, urban, or rural level. That is, a high-income D10 household that had access to piped water at the national level spent only 0.6% of its monthly income on water consumption while a low-income D1 household spent approximately 3.5% ($p < 0.01$). At the urban level, a D10 household spent 0.6% of its income while a D1 household spent 4.5% ($p < 0.01$). In the rural case, a household in the tenth decile spent only 0.2% and a household in the first decile spent 2.6% (Figure 1).

4. DISCUSSION

Despite the significant progress that has been made in recent years with public investments in access to water in Bolivia, the problem with unequal access continues to exist. The test of means analysis shows significant

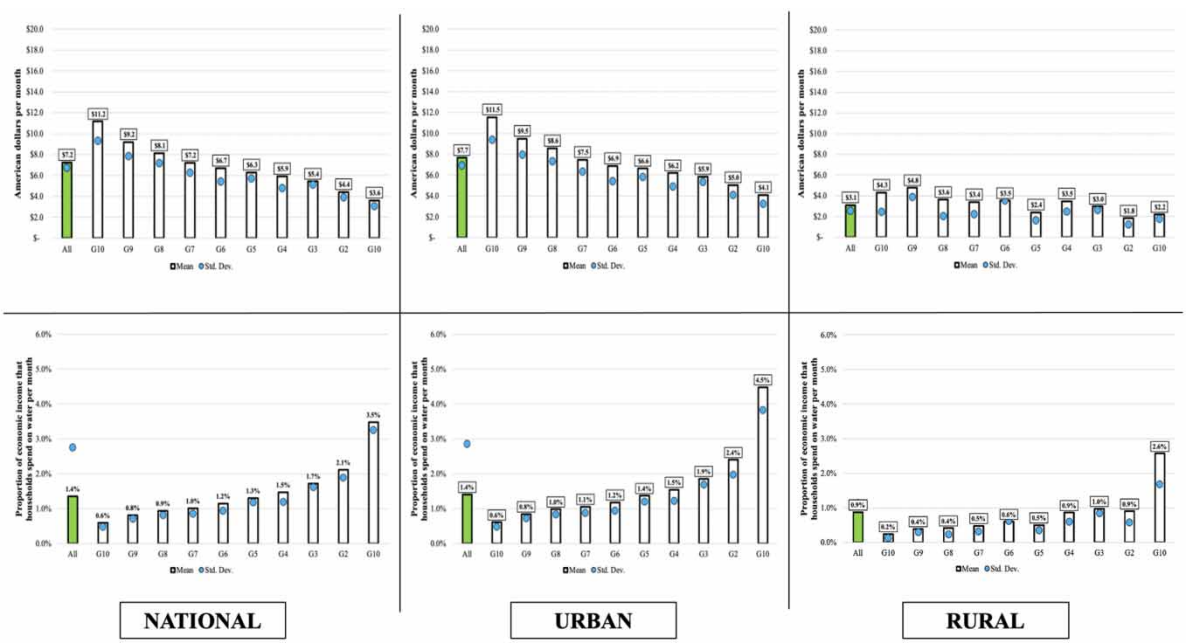


Fig. 1 | Expenditure per month spent by households in Bolivia on the consumption of piped water.

differences in the majority of the JMP indicators of access to water (SM, B, L, U, and SW) as well as in affordability, between urban and rural households and among household deciles. In general, high-income decile households (e.g., D10, D9, D8), especially urban and to a lesser extent rural households, have more access to basic and safely managed services than lower-decile households (D1, D2, D3). Furthermore, higher-income urban and rural households spend a smaller percentage of their income on water than lower-income households.

For example, approximately 1.2 million out of roughly 12 million people in Bolivia still access water from sources that require a round trip time of over 30 min, or draw water from a dug well, an unprotected spring, or from rivers, dams, lakes, or ponds. Of these 1.2 million people, roughly 32,000 are D10 households, 55% of which are rural, while roughly 310,000 are D1 households, approximately 75% of which are rural. It is also important to note that around 10.9 million people nationwide have access through a basic service and nearly 5.9 million people have access through a safely managed service. This difference (4.9 million people) between these two ways of measuring access to services demonstrates that a considerable number of people are transitioning to a better service. This situation should improve over the years by developing suitable public policies aimed at increasing household access to water from sources in the home or on the property, with availability at the time at which it is needed, and by making low-income rural households a priority.

To attempt to reduce this inequality, not only for Bolivia, the following efforts should be undertaken. (i) Decrease historical and ongoing patterns of systemic inequality, since historically, households that are rural, with low incomes, education, and health levels, and greater levels of poverty, also have the poorest access to water, both in quality and quantity. (ii) Increase investments and adequate infrastructure. In general, semi-urban and rural households lack access to adequate infrastructure that provides at least a limited service, let alone a safely managed service. In this regard, investments should be increased or prioritized for sectors that do not have access to water, either in quality or quantity, and alternative sources such as rainwater harvesting should be sought in areas where the cost of obtaining water is very high. (iii) Strengthen community water and sanitation organizations that are created within the social structure of communities, especially in rural areas. (iv) Regulate the contamination of water sources. Marginalized households are generally located in regions that have more industry, agriculture, or livestock activities, which can contaminate water supply sources. (v) Regulate competition among economic sectors for the use of water as an input in the production process. (vi) Look for solutions to reduce leaks in the network, especially in urban areas. (vii) Design water policies with fees that reflect the value of water. Not taking into account socioeconomic criteria in their design is an incentive to users to improperly use the resources. (viii) Further the development of water quality monitoring and safety in both urban and rural areas. Also, finally, (ix) water policies should consider external factors that affect water availability as an indirect consequence of human activity, such as climate change. If the design of water policies does not take into account these issues, then there could continue to be an impact on: (i) health, with an increase in gastrointestinal diseases, skin irritation, cancer, an COVID-19 cases, among other illnesses; (ii) economics, with households spending more to access water in their homes or to purchase filters to get quality water, as well as lost work days or missed school days as a result of illnesses caused by ingesting contaminated water, among other consequences; and (iii) social, such as unrest and conflicts among communities, ethnic groups, and economic sectors, among others, which can exacerbate existing inequalities.

Therefore, it is important to note that, although the rate of access to water in the domestic sector has increased in Bolivia, these data mask the problems with accessing water that are experienced by lower-income households and/or those in rural areas. Therefore, water policies in this country and others with similar situations should seek to improve the conditions related to access for the most vulnerable households, with a focus not only on access but also on daily access, water quality, and affordability with respect to household income. Thus, there is a need to generate new, current, and modern water legislation and/or projects both at the national and

municipal levels, to reduce or eliminate existing problems for the benefit of the whole society, and especially for the most vulnerable groups, which are generally invisible when analyzing information at the macro level.

5. CONCLUSIONS

Access to safe and clean piped water is a fundamental human right. Yet despite significant progress, this right remains unattainable for many people around the world and in Bolivia. The results show that, in the case of Bolivia for the year 2021, the basic service (B) of access to water at the national level is approximately equal to 90.3% of households, for the urban sector 98.1% and for the rural sector 73.0%, evidencing the statistical difference of almost 25% between the two geographic areas. Also, if it is considered at the level of income deciles, for example, at the national level the difference between the first and tenth deciles is almost 22.5%; that is, households with higher economic income have greater access than households with lower income. In this sense, disparities in access to water perpetuate systemic inequalities and widen the gap between privileged and marginalized communities, amplifying the urgency of addressing this pressing problem through public water policies. Marginalized populations, such as rural and low-income communities, are in many cases disproportionately affected by water scarcity and contamination, which results in a series of negative impacts on health and society. For example, not having access to water, whether of quality or quantity, can lead to a greater likelihood of contracting a disease, increase household expenses to gain access to water resources, among others. In the case of Bolivia, a household spends approximately 1.4% of its monthly income on average to pay for its consumption of piped water, a percentage that can be considered reasonable when comparing this indicator at a global level; however, the situation becomes critical when observing that a household that belongs to the tenth decile, a household with high economic income, spends only 0.6% of its monthly income on piped water consumption; while a household that belongs to the first decile, a household with low economic income, spends approximately 3.5%. The intersection of water access and inequality is an increasingly important topic of discussion, as it highlights how access to clean water is related to broader issues of equity, equal access, and human rights. Therefore, consideration should be given to designing policy schemes to offer assistance primarily to these low-income sectors. For example, assistance provided to households may be in the form of direct aid to individuals (for example, a water voucher or check) or a reduction in tariffs (reduction in the bill). Public authorities at central, district or municipal level can guarantee financial assistance to low-income groups through social policies (subsidies covered by taxpayers), but they can also be covered by users in the context of solidarity policies (cross-subsidies) through large users, companies or deciles of households with high incomes. Also, mainly prioritize investments in the sector for the expansion or improvement of the network or means of water distribution for the most vulnerable sectors.

FUNDING

The article was prepared with the technical and financial support of the SECIHTI, Mexico Chairs Program No. 1812: 'Economic and Water Model Project for the Valley of Mexico Basin'. Likewise, thanks to the Instituto de Investigaciones Socio-Económicas (IISEc) – Universidad Católica Boliviana (UCB) for the time and availability during the sabbatical research stay.

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.

REFERENCES

Andersen, L. E., Cardona, C., del Granado, S., Doyle, A. S., Valdivia, M., (2016) Agua Potable en Bolivia. In: En Andersen, L. E., Branisa, B. & Canelas, S. (eds.) *El ABC del desarrollo en Bolivia*, 01edn.. Bolivia: Fundación INESAD, pp. 17–26.

Bartram, J., Brocklehurst, C., Fisher, M. B., Luyendijk, R., Hossain, R., Wardlaw, T. & Gordon, B. (2014) Global monitoring of water supply and sanitation: history, methods and future challenges, *International Journal of Environmental Research and Public Health*, *11* (8), 8137–8165. https://doi.org/10.3390/ijerph110808137.

Bernabé Lang, J. (2021) *El Mercado de agua potable y saneamiento en Bolivia*. Bolivia: ICEX España Exportación e Inversiones, E.P.E. La Paz.

Botton, S. & Urquiera, P. (2020) *An Overview of Inequalities in Urban Water Services in Bolivia*. AFD Research Papers.

Cheng, X., Liu, Y., Yu, Z., Gao, J., Dai, Y., Chen, J., Liu, Y., Wang, C., Shuai, C., Li, W. & Xie, Z. (2024) Adding a basis for sustainable poverty monitoring: the indicator systems and multi-source data of multi-dimensional poverty measurement, *Environmental Development*, *49*, 100966. https://doi.org/10.1016/j.envdev.2024.100966.

Cook, J., Kimuyu, P. & Whittington, D. (2016) The cost of coping with poo water supply in rural Kenya, *Water Resources Research*, *52*, 841–859.

Daniels, M. E., Pradhan, A., Odagiri, M. & Jenkins, M. W. (2023) Waterborne exposure during non-consumptive domestic use of surface water: a population study across WASH service levels in rural India, *Journal of Water & Health*, *21* (6), 751–762. https://doi.org/10.2166/wh.2023.309.

Dickin, S. & Gabrielsson, S. (2023) Inequalities in water, sanitation and hygiene: challenges and opportunities for measurement and monitoring, *Water Security*, *20*, 100143. https://doi.org/10.1016/j.wasec.2023.100143.

Ezbakhe, F. & Pérez-Foguet, A. (2019) Estimating access to drinking water and sanitation: the need to account for uncertainty in trend analysis, *Science of The Total Environment*, *696*, 133830. https://doi.org/10.1016/j.scitotenv.2019.133830.

García-Valiñas, M., Martínez-Espiñeira, R. & González-Gómez, F. (2010a) Affordability of residential water tariffs: alternative measurement and explanatory factors in southern Spain, *Journal Environmental Management*, *91* (12), 2696–2706.

García-Valiñas, M., Martínez-Espiñeira, R. & González-Gómez, F. (2010b) Measuring water affordability: a proposal for urban centres in developed countries, *International Journal of Water Resources Development*, *26* (3), 441–458.

Girma, M., Hussein, A., Norris, T., Genye, T., Tessema, M., Bossuyt, A., Hadis, M., van Zyl, C., Goyol, K. & Samuel, A. (2021) Progress in Water, Sanitation and Hygiene (WASH) coverage and potential contribution to the decline in diarrhea and stunting in Ethiopia, *Maternal & Child Nutrition*, *20*, e13280. https://doi.org/10.1111/mcn.13280.

Hines, S. T. (2021) *Water for All: Community, Property, and Revolution in Modern Bolivia*. Oakland, CA: University of California Press.

Instituto Nacional de Estadística (2021) *Bolivia – Encuesta de Hogares 2021 (EH-2021)*. La Paz, Bolivia. Instituto Nacional de Estadística.

Kessides, I., Miniaci, C. & Valbonesi, P. (2009) *Toward defining and measuring the affordability of public utility services*. *Policy Research Working Paper* 4915, The World Bank, Development Research Group, Environment and Energy Team.

Khadka, M., Joshi, D., Uprety, L. & Shrestha, G. (2023) Gender and socially inclusive WASH in Nepal: moving beyond 'technical fixes', *Frontiers in Human Dynamics*, *5*, 1181734. https://doi.org/10.3389/fhumd.2023.1181734.

Kooy, M., Tina, C. & Prabaharyaka, I. (2018) Inclusive development of urban water services in Jakarta: the role of groundwater, *Habitat International*, *73*, 109–118.

Mack, E. A. & Wrase, S. (2017) A burgeoning crisis? A nationwide assessment of the geografy of water affordability in the United States, *PLoS ONE*, *12* (1), e0169488.

Medina-Rivas, C. M., Rodríguez-Tapia, L., Morales-Novelo, J. A. & Revollo-Fernández, D. A. (2022). Spatial inequality of domestic water consumption in Mexico city, *Water Resources and Economics*, *40*, 100210.

Medina-Rivas, C. M., Morales-Novelo, J. A., Rodríguez-Tapia, L. & Revollo-Fernández, D. A. (2024) Mexico city's decline in per capita domestic water use: a comprehensive spatial-temporal study. *Urban Water Journal*, *22* (1), 1–15.

Mekonnen, A. G. (2024) Estimating multidimensional poverty: a new methodological approach, *Journal of Poverty*, *29* (2), 110–128. https://doi.org/10.1080/10875549.2023.2301620.

Montes de Oca, P. (2005) *Geografía Y Recursos Naturales de Bolivia*. La Paz, Bolivia: Editorial Offset Boliviana Ltda.

Morales-Novelo, J. A., Rodríguez-Tapia, L. & Revollo-Fernández, D. A. (2018) Inequality in access to drinking water and subsidies between low and high income households in Mexico City, *Water*, *10* (28), 1023. https://doi.org/10.3390/w10081023.

Morales-Novelo, J. A., Rodríguez-Tapia, L., Medina-Rivas, C. M. & Revollo-Fernández, D. A. (2024) Waterborne gastrointestinal diseases and child mortality: a study of socioeconomic inequality in Mexico, *International Journal of Environmental Research and Public Health*, *21* (11), 1399. https://doi.org/10.3390/ijerph21111399.

Nayebare, J. G., Owor, M. M., Kulabako, R., Campos, L. C., Fottrell, E. & Taylor, R. G. (2019) WASH conditions in a small town in Uganda: how safe are on-site facilities?, *Water, Sanitation & Hygiene for Development*, *10* (1), 96–110. https://doi.org/10.2166/washdev.2019.070.

Quispe-Coica, A. & Pérez-Foguet, A. (2022) From the global to the subnational scale: Landing the compositional monitoring of drinking water and sanitation services, *Science of The Total Environment*, *838*, 156005.

Rakotomanana, H., Komakech, J. J., Walters, C. N. & Stoecker, B. J. (2020) The WHO and UNICEF Joint Monitoring Programme (JMP) indicadors for water supply, *sanitation and hygiene and their association with linear growth in children* 6 to 23 months in East Africa, *International Journal of Environmental Research and Public Health*, *17* (7), 6262. https://doi.org/10.3390/ijerph17176262.

Revollo-Fernández, D. A. (2023) New development: the high cost of the free rider in public water services in developing and emerging economies, *Public Money & Management*, *43* (8), 858–861. https://doi.org/10.1080/09540962.2023.2210777.

Revollo-Fernández, D. A., Rodríguez-Tapia, L. & Morales-Novelo, J. A. (2019) Impactos de los subsidios al agua en los hogares pobres de la Ciudad de México, *Revista Gestión y Política Pública*, *28* (1), 39–67.

Saroj, S. K., Goli, S., Rana, J. & Choudhary, B. K. (2020) Availability, accessibility, and inequalities of water, sanitation, and hygiene (WASH) services in Indian metro cities, *Sustainable Cities and Society*, *54*, 101878. https://doi.org/10.1016/j.scs.2019.101878.

Urquidi, F. (2012) *Los recursos hídricos en Bolivia. Un punto de vista estratégico sobre la problemática de las aguas transfronterizas*. En B. Cisneros y Galizia Tundisi, J. (Ed.), Diagnóstico del Agua en las Américas, 01ed., pp. 75–96. Foro Consultivo Científico y Tecnológico, AC. México.

Van Damme, P. (2002) *Disponibilidad, uso y calidad de los recursos hídricos en Bolivia*. La Paz, Bolivia: CONIAG – CGIAB.

WHO and UNICEF JMP (2019) *Progress on Household Drinking Water, Sanitation and Hygiene 2000–2017. Special Focus on Inequalities*. Geneva: WHO/UNICEF.

WHO and UNICEF JMP (2022) *Annual Report*. Geneva: WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP).

First received 22 July 2024; accepted in revised form 26 February 2025. Available online 17 March 2025