ACCESS TO AN IMPROVED WATER SOURCE AND ITS MEASUREMENT: THE CASE OF MISIONES (ARGENTINA)

ACESSO A UMA FONTE MELHOR DE ÁGUA TRATADA E SUA MEDIÇÃO: O CASO DA PROVÍNCIA DE MISIONES (ARGENTINA)

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Abstract

This aim of this work is to analyze the situation of the Province of Misiones (Argentina) in terms of the access to improved water of its inhabitants, while discussing different existing theoretical proposals to quantify the phenomenon. Data from the Permanent Household Survey, Annual Survey of Urban Households, National Household Expenditure Survey and Research Project on Contemporary Argentine Society are used. It is observed that Misiones has a higher percentage of people who do not have access to an improved water source, between 2011-2018. Worst indicators are also observed in terms of affordability, even though there are no significant differences in quality of supply. High levels of inequality are observed among those who manage to access improved water and those who do not.
Keywords: Improved water; Misiones; Sustainable development goals.

Resumo

O objetivo deste trabalho é analisar a situação da Província de Misiones (Argentina) em termos de acesso à água tratada de seus habitantes, discutindo diferentes propostas teóricas existentes para quantificar o fenômeno. Dados do Inquérito Permanente Domiciliar, Pesquisa Anual de Domicílios Urbanos, Pesquisa Nacional de Despesas Domésticas e Projeto de Pesquisa sobre a Sociedade Contemporânea Argentina são usados como fontes de pesquisa. Observa-se que a Província de Misiones tem uma porcentagem maior de pessoas que não têm acesso a uma fonte de água tratada, entre 2011-2018. Os piores indicadores também são observados em termos de acessibilidade, embora não existam diferenças significativas na qualidade da oferta. Altos níveis de desigualdade são observados entre aqueles que conseguem acessar água tratada e aqueles que não conseguem.
Palavras-chave: Água tratada; Misiones; Metas de desenvolvimento sustentável.

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1 Introduction

A safe, accessible and affordable water supply is essential for human health (Hunter *et al*., 2010). The Sustainable Development Goals (SDG), recognizing its importance, admit that ensuring availability and sustainable management of water and sanitation is one of the fundamental aspects to be achieved by all countries by 2030 (SDG 6, United Nations, 2015).

At present, however, about 2.1 billion people worldwide can not access to a source of drinking water (free of contamination) within the household, which deepens in rural areas, (World Health Organization [WHO], 2017a). At the same time, it is recognized that in Latin America and the Caribbean, in 2015, 35% of people can not manage to access a water service managed without risks, understanding it as water provided from an improved source[2], accessible at home, available when required and free of fecal and chemical contamination (United Nations [UN], 2018). This situation is associated with higher levels of infant mortality, gastrointestinal infections, hepatitis and cholera (Haseena et al., 2017), as well as a higher prevalence of low weight, short stature and rickets (Fenn, 2012; Arnold et al., 2009; Langford, 2011). In the same way, the adverse effects of malnutrition will be deepened in children, especially in the first 3-5 years of life, given the persistence of these even when adequate nutrition can be accessed in later stages of development (Charmarbagwala et al., 2004).

In this sense, the empirical evidence suggests that malnutrition in children is mainly explained by an insufficient intake of nutrients and infectious diseases such as diarrhea or cholera (Dangour et al., 2013). Regarding this, access to safe water contributes to improving the nutritional status from a reduction in the prevalence of diseases (Ngure et al., 2014). In turn, the WHO (2005) recognizes that improved water consumption in household is associated with increases in adult productivity and higher rates of school attendance in children. Accordingly, Sachs (2001) points out that, within a large group of developing countries, those with higher levels of access to improved water experience higher gross domestic product (GDP) growth rates, even when controlled by the level of GDP per capita.

The case of Argentina, in particular, stands out in the Latin American context due to its high proportion of urban population, 91%, according to the National Population, Household and Housing Census carried out in 2010 (NPHHC, 2010), accompanied by a high proportion of people, 84 %, which accesses to <ñpan improved water source, such as piped water in household (NPHHC, 2010). The foregoing, however, hides broad existing territorial disparities. The Province of Misiones, located in the Northeast region (NEA), gives an example of this: in 2010, 71% of its population accessed the same source of improved water (NPHHC, 2010), making it the jurisdiction with the lowest coverage of the service in the country. This situation, where Misiones presents the lowest access levels, is repeated when examining the previous censuses -60% in 2001, 41% in 1991 and 23% in 1980- (National Institute of Estatistics and Censuses [NIEC], 2016).

In this context, the research aims to analyze the evolution of access to improved water in the Province of Misiones during the period following the last population census, 2011-

[2] Improved sources include: piped water, boreholes or tubewells, protected dug wells, protected springs, rainwater, and packaged or delivered wáter (UN, 2018). However, WHO asserts that bottled or delivered water constitutes unimproved sources (WHO, 2012) although this is not applicable in the context of the SDGs.

2018. At the same time, an attempt is made to provide a theoretical discussion on the different measures proposed in the literature about which indicators to use in measuring access to improved water. Therefore, section 2 presents a comparative analysis of the different indicators detected for the measurement of access to improved water. Section 3 covers a brief contextualization of Misiones and main results. Finally, section 4 includes main conclusions.

2 Access to improved water

Numerous metrics have been used in the measurement, monitoring and planning of water service at household level. Recently, the classification proposed by UN, which considers the source from which the water comes (improved-unimproved), has been widely disseminated. Such clasification is based on the type of service, according to Kayser et al. (2013), considering the underlying infrastructure. Deepening, indicator 6.1.1 of the SDGs is defined as the proportion of the population that uses safe water supply services managed without risks (UN, 2018), that is, an indicator that combines the source of water (improved-unimproved) with aspects of availability (accessible on premises when needed) and quality (free of fecal and chemical contamination) (WHO, 2017a).

Related to the above, the issue of the availability of water in households has been studied considering 2 major aspects: time needed to reach the water source and return home (Sorenson, et al., 2011; WHO, 2017a) and the number of hours per day -or days per year- in which access to water is effectively available (Lloyd and Bratram, 1991). Deepening the time spent in the search of the resource, UN (2018) sets a threshold of 30 minutes per trip in the collection of water, to distinguish between a basic service (up to 30 minutes per trip) and limited (more than 30 minutes), in both cases when it comes from an improved source. In terms of the number of hours or days with effective water availability, which is especially relevant because of the possibility of using contaminated sources due to the lack of regular supply (Subbaraman et al., 2013), Lloyd and Batram (1991) propose a classification of the service, considering a period of one year: without interruptions, annual availability with daily interruptions, seasonal interruptions, and compound discontinuity (daily and seasonal). In this sense, estimates have found that 55% of urban households in Kenya have water all the time (Central Bureau of Statistics of Kenya, 2004) or that 74.8% of all households with access to improved water report always having the resource in India (Johns Hopkins University, 2019).

At the same time, linked to the quality of water in households, which has extensive implications on health status in children and adults (Langford, 2011, Haseena et al., 2017), some indicators have been proposed to assess the presence of fecal matter, especially E. coli, or chemical contamination, particularly with arsenic or fluoride (UN, 2018). In this sense, the WHO (2017b) defined a relative risk scale depending on the amount of E. coli detected -in number of colony forming units per 100 ml-: low risk (<1), intermediate (1-10), high (11-100), very high (> 100). Alternatively, it is suggested to consider the count of thermotolerant coliform bacteria that, like E. coli, should present undetectable amounts in 100 ml samples to present a low risk. Finally, in terms of chemical contamination WHO (2017b) suggests establishing tests to detect the presence of particular pollutants according to each case and establishing tolerable thresholds of these, distinguishing between those that pose a risk to

health due to their continuous intake in long periods and those that involve risk even in occasional intakes.

On the other hand, one aspect detected as relevant in the analysis of access to an improved water source is the daily amount available in household for each person. In this way, the WHO (2017b) states that 7.5 liters per person per day are sufficient, in most environments, to provide adequate hydration and cooking of food. Alternative estimates suggest other magnitudes: 20 liters (Well, 1998) or 50 liters (Gleick, 1996). In this way, scales of service level are defined according to the quantity, average, consumed daily per person: without access (<5 liters), basic access (20 liters), intermediate (50 liters) and optimal (more than 100) liters) (Howard and Bartram, 2003; WHO, 2017b).

More recently, the use of inequality measures in the analysis of access to improved water has been proposed (Hoekstra, 2014, Mekonnen et al., 2015). This was driven by the recognition of access to improved water as a human right, something that, in turn, implies non-discrimination and equitable access to the resource (UN, 2010). Equity can be analyzed by comparing between countries, or within each of them, between regions or population subgroups (WHO, 2017a). In this sense, some works propose comparing the proportion of people with access to water in household, discriminating by socioeconomic level of households in the same region (Aleixo et al., 2016), contrasting between income deciles and urban/rural spheres (Pan American Health Organization, 2001), compare the water footprint between regions and countries (Mekonnen et al., 2015), use the Erreygers concentration index (Mulenga et al., 2017), among others.

Finally, another aspect analyzed in access to an improved water source is affordability. The goal 6.1 of the SDGs establishes "By 2030, achieve universal and equitable access to safe and affordable drinking water for all" (UN, 2018). At the same time, WHO (2017b) argues that the affordability of water service is relevant due to the possibility that households choosing unimproved water sources, with a lower cost. Even more, a high cost could cause a reduction in quantities consumed below the minimum thresholds considered acceptable. At this point, the lack of consensus in the definition of a critical threshold or an universally accepted indicator to quantify affordability is recognized (Kayser et al., 2013), although it is accepted that payment for the service should not constitute a barrier to access to water supply or to deprive the household of satisfying other basic needs (UN, 2018). Hutton (2012) argues that a widely used indicator is the proportion that, over the monthly or annual household income, represents the payment for the water supply. In this sense, the World Bank (2008) suggests a threshold of 5% of disposable income to assess affordability, while Smets (2012) uses a threshold of 3% of income when evaluating the same phenomenon in Argentina.

In summary, when evaluating access to water supply at household level, there have been considered measures such as: water source (improved-not improved), availability (time consumed in arriving at the source and returning home or hours/days of effective supply availability), quality (fecal or chemical contamination), quantity, equity (between countries / regions or population subgroups) and affordability. This classification does not intend to achieve completeness, although it does provide an overview of frequently used measures.

3 The Province of Misiones

Located in the NEA region, the Province of Misiones has a population of 1,101,593 inhabitants and an area of 29,801 km2 (NPHHC, 2010). The city of Posadas - its capital - concentrates 29% of the people. The rural population, amounts to 26% of the provincial total and represents 8% of the rural population of Argentina, which is higher than its contribution to the national urban population, which amounts to 2%.

At the same time, Misiones presents a subtropical climate with high temperatures (20° C on average) and abundant rainfall throughout the year (annual average of 1700 mm) (Perez Chilavert, 2016). In this way, Misiones holds the highest levels of annual rainfall in Argentina (National Institute of Agricultural Technology, 2015). Accordingly, it has abundant surface water resources that cover more than 800 water courses -between streams and rivers- (Ministry of Agriculture, Livestock and Fisheries, 2009). The Paraná River, which defines the border between the province and the Republic of Paraguay; the Uruguay River, which delimits the border with the Federative Republic of Brazil and; the Iguazú River that houses the Iguazú Falls and flows into the Paraná river. Together, they represent nearly 1,000 km of international borders bounded by rivers. Finally, the territory of Misiones is located entirely on the surface that runs through the Guaraní Aquifer, which covers a space of 1,200,000 km2 between Brazil, Argentina, Paraguay and Uruguay and involves a reserve of fresh water of 40,000 km3, which is found at an average depth of 250 meters (World Bank, 2006). This makes the Guaraní Aquifer the second largest reservoir of fresh water in the world.

In spite of the above, Misiones has historically presented the lowest levels of access to improved water in household, among all argentine provinces. This situation can be observed when analyzing the 1980, 1991, 2001 or 2010 population censuses (NIEC, 2016).

Table 1: Proportion of people with access to piped water

Region	1980 Census	1991 Census	2001 Census	2010 Census
Misiones	23,10%	41,70%	60%	71,70%
Argentina	60,90%	72,20%	80,30%	84,10%

Source: own elaboration based on NIEC (2016)

It is detected that, on average, Misiones has a 20-year lag in the coverage of water supply in households: by 2001 it managed to reach the levels of coverage that Argentina had in 1980. The same happens in 2010 when comparing Argentina's coverage in 1991. In this context, knowing what happened since the completion of the last population census (2010) is relevant and it is possible when analyzing other data sources, which will be described below.

4 Data sources used

Household surveys carried out, and periodically published, by the National Institute of Statistics and Censuses (NIEC) are used. In first place, the Permanent Household Survey (PHS), published on a quarterly basis, provides information on the type of water source in urban households in 31 urban agglomerates of Argentina. In the case of Misiones, the city of

Posadas is included. Disadvantageously, the PHS does not allow obtaining information from small urban areas or rural areas. Therefore, the analysis is complemented with the Annual Survey of Urban Households (ASUH) published by NIEC between 2010-2014 with an annual frequency and that collects information from urban areas of Misiones of more than 2000 inhabitants. In this way, the geographic coverage is extended, from Posadas, to encompass urban areas of the provincial interior.

In turn, data on household expenditures are collected from the National Household Expenditure Survey (NHES) conducted between 2012/2013 by NIEC and which had a national geographic coverage. On the other hand, data on the quality of water source are provided by the Research Project on Contemporary Argentine Society (RPCAS)[3].

5 Results

First, when considering access to an improved water source, the following results are observed:

Table 2: Lack of access to improved water in Posadas and Argentina, 2011-2017

Year	Posadas	Argentina
2011	2,37	0,79
2012	2,65	0,55
2013	1,55	0,45
2014	1,18	0,58
2015	1,33	0,46
2016	2	0,46
2017	0,55	0,52

Source: own elaboration based on PHS

It is detected that, in general, the Argentine population has a high access to an improved water source considering widely accepted international standards. At the same time, between 2011-2017, the proportion of people without access to improved water tends to decrease. However, Posadas presents a worse situation in relation to all the urban agglomerates of Argentina: between 2011-2017, the percentage of people without access in Posadas triples the national average, reaching a difference of 5 times in 2012. Interestingly, towards 2017, similar levels of lack of access are detected - around 0.5% - and that represents, for Posadas, that some 1964 people can not access an improved water source.

Related to the above, when using the ASUH and including the urban localities of the interior of Misiones and Argentina, the following is detected.

[3] Databases published by NIEC can be consulted in: https://www.indec.gob.ar/bases-de-datos.asp. While RPCAS data are in: http://pisac.mincyt.gob.ar/

Table 3: Lack of access to improved water in Misiones and Argentina, 2010-2014[4]

Año	Misiones	Argentina
2010	5,8	1,93
2011	4,66	1,1
2012	5,86	1,22
2013	5,41	0,89
2014	5,58	1,01

Source: own elaboration based on ASUH

By expanding the geographical coverage, higher levels of lack of access to improved wáter are detected. At the same time, the gap between Misiones and Argentina remains more stable, where, between 2010-2014, Misiones presents a proportion of people without access 4.4 times higher than the Argentine average.

On the other hand, when considering the affordability of access to improved water and using the NHES, which was carried out in 2012-2013, the following is observed:

Table N ° 4: Average amount spent on water supply at household level, 2012-2013

Region	Lack of access to improved water	Expenditure in $[a]	Average income[b]	Threshold 3%[c]	Expenditure/Income[d]
Misiones	5,21	65,8	3060	36,9	2,15
Argentina	0,14	34,6	4090	13,5	0,84

Source: own elaboration based on NHES

[a]Average expenditure on water supply, expressed in current 2013 pesos

[b]Average declared income, expressed in current 2013 pesos

[c]Percentage of people who allocate to the payment of water a proportion greater than or equal to 3% of their declared income

[d]Average percentage that, over declared income, represents the expenditure on household water supply

In this way, the fact that Misiones has a greater proportion of people without access to an improved water supply at household level is maintained. In turn, the average spending in Misiones is higher than the argentine average (90% higher) and the income is significantly lower. This leads to a greater proportion of people who, according to the 3% threshold suggested by Smets (2012), does not have, in theory, conditions of affordability of the water supply (36.9%). This proportion is almost 3 times that observed at the national level. Moreover, in recent years (2016-2017) there has been a process of updating public utility rates - electricity, water and gas (Ministry of Energy and Mining of the Nation, 2017), which could have contributed to increase the relative expenditure in the water supply.

On the other hand, when analyzing the quality of water supply in households, no estimates of public use have been detected for the case of Misiones. Advantageously, the

[4] In 2014, the publication of the ASUH was discontinued by NIEC.

RPCAS survey allows, superficially, to address the issue. In this sense, one of the questions in the questionnaire inquires about the turbidity or low pressure / cut of the water supply.

Table 5: Problems related to water supply, foodplanis and contamination, 2015

Region	Lack of access to improved water	% Households turbidity problems[a]	Foodplains[b]	Contaminated rivers/streams[c]
Misiones	2,84	1,56	1,6	1,82
Argentina	1,4	1,67	1,68	1,86

Source: own elaboration based on RPCAS

[a] Percentage of households that report experiencing problems of turbidity or low pressure / cut in the water supply, in the 12 months prior to the survey.

[b] Percentage of households that report experiencing problems of flooded land or streets, in the 12 months prior to the survey.

[c] Percentage of households that declare experiencing contamination problems of rivers or streams in their neighborhood, in the 12 months prior to the survey.

In this case, again, levels of lack of access to an improved water source are higher in Misiones than the national average. However, when analyzing problems related to water supply, the results do not differ significantly: a fraction between 1.5-1.9% of the population declares to have experienced problems of turbidity, flooding or contamination.

Finally, when analyzing the equity in access to improved water it is possible to delimit some indicators that account for the nature of the existing disparities. Based on the household surveys used previously- PHS and ASUH- and considering the educational level attained by the head of household, average income and location of the household in an emergency villa or precarious settlement, the inequalities present among those households who access an improved water source and those who do not are exploratoryly analyzed.

Table N ° 6: Inequality in access to improved water, year 2014

Condition	Head of household with complete high school[a]		Average income[b]		Location on precarious settlement	
	PHS	ASUH	PHS	ASUH	PHS	ASUH
Improved water access	52,49	47,18	10683	10902	0,98	0,90
Without access	20,56	15,98	6738	5998	10,83	14,04

Source: own elaboration based on PHS and ASUH

[a] Percentage of households with head of household that has full secondary school or more

[b] Average declared income in the household, expressed in current 2014 pesos

Both household surveys tend to produce concordant results: those households that do not manage to access an improved water source, simultaneously experience other deficiencies - and to a greater extent than those that do - such as a lower educational level, lower household income and they are more likely to be located in emergency villas. The proportion

of heads of household with, at least, full secondary school is 2 to 3 times higher among those who have improved water in their homes, while their income is between 58-81% higher.

6 Discussions and Conclusions

It was noted that access to an improved water source has broad implications for health, especially in children, economic growth and productivity. In turn, in recent years, the international community has manifested a growing consensus on the importance of ensuring availability and sustainable management of water. The Sustainable Development Goals (SDG) ratify it.

At the same time, the measurement of access to an improved water source has been addressed from multiple dimensions in the literature analyzed. Repeatedly, the type of service, defined from the underlying infrastructure, was considered, determining if the water came from an improved or unimproved source. The United Nations and the World Health Organization adhere to this classification (UN, 2018; WHO, 2017a), which has the advantage of allowing global comparisons given its wide availability in databases. However, other factors evaluated in the access to an improved water source were detected: availability (in hours per day or time needed to reach the water source), quantity, quality (presence of fecal or chemical contamination in water), equity (between regions or population subgroups) and affordability (cost of service in relation to household income).

In particular, the Province of Misiones presented, in the last 40 years, lower levels of access to water at household level (1980, 1991, 2001 and 2010 Census). In each moment of time, Misiones achieved the current levels of coverage in Argentina with a lag of 20 years. Then, from the completion of the last census (2010) - 2011 to 2018- Misiones continued to show higher levels of lack of access to an improved water source. The Permanent Household Survey (PHS), however, suggests a certain reduction in disparities in access in 2017. The foregoing should be contrasted with the fact that only data from Posadas (capital of the province) are included. By extending the geographical coverage to urban agglomerations in the interior of Misiones, using the Annual Survey of Urban Households (ASUH), greater disparities were found in access, especially in last years of the series.

On the other hand, when examining other indicators, it was observed that Misiones presents worse conditions of affordability in the water supply, considering a threshold of 3% of the household income. However, no significant differences were detected in the quality of water supply, episodes of flooding or contamination of surface water courses. In terms of equity, wide educational, income and location disparities were found between those who access an improved water source and those who do not.

Finally, it should be highlighted that more information is needed on the subject: expanding coverage, including rural areas, is essential for proper public policy planning regarding water. At the same time, the survey of urban areas in the interior is important. In the future, and in accordance with the Sustainable Development Goals, policy actions should be addressed in order to achieve greater territorial equity in access to basic services.

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