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Análisis del agua potable en el barrio San Luis, Distrito de Escobar, Buenos Aires, Argentina. Una aproximación para el estudio integral de la calidad del agua y la vida

Potable water analysis in San Luis Neighborhood, Escobar District, Buenos Aires, Argentina. An Approximation for the integral study of water and life quality

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Resumen: El acceso al agua está vinculado a la calidad de vida, a la noción de riesgos ambientales y para la salud. El estudio de la calidad del agua constituye una observación para analizar los procesos de los determinantes sociales de la salud. Nuestro objetivo fue realizar un análisis exploratorio del agua en un barrio de Buenos Aires, Argentina, como un enfoque para estudiar la calidad del agua y la calidad de vida de manera integrada. El muestreo de agua abarcó 45 puntos de toda la superficie del barrio. Se realizaron análisis de pH, conductividad, concentración de nitritos, escherichia coli y coliformes totales. Los resultados obtenidos sugieren una contaminación fisicoquímica que podría contribuir a la inadecuación del agua para el consumo en el barrio. La experiencia constituyó un puente para aproximarse, con datos empíricos, a las condiciones de vulnerabilidad a las que están expuestas las personas que viven en la zona.

Palabras clave: Acceso al agua, acceso a los servicios de salud, interacción con el medio ambiente, vulnerabilidad, calidad del agua.

Abstract: Access to water is linked to the quality of life, to the notion of environmental and health risks. The study of water quality constitutes an observation to analyze processes of the social determinants of health. Our objective was to carry out an exploratory analysis of water in a neighborhood of Buenos Aires, Argentina, as an approach to studying water quality and quality of life in an integrated manner. Water sampling covered 45 points of entire surface of the neighborhood. Analyses of pH, conductivity, nitrite concentration, Escherichia coli and total coliforms were carried out. The results obtained suggest physical-chemical contamination that could contribute to the unfitness of the water for consumption in the neighborhood. The experience constituted a bridge to approximate, with empirical data, the conditions of vulnerability to which people living in the area are exposed.

Key words: Water access, health care access, environmental interaction, vulnerability, water quality.

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Introduction

Access to water is intimately linked to the quality of life, with the notion of environmental and sanitary risk when studying a given territory. The constitution of the Republic of Argentina, amended in 1994, in article 41 explicitly states the right of all inhabitants to a healthy environment, within this environment, water is an essential resource for life and therefore, the right to health and the water right cannot be conceived separately (Verzeñassi & Vallini, 2019).

The study of water quality constitutes an observation to analyze processes of the social determinants of health (Breilh, 2020), especially when considering study territories in which a) there is a lack of both running water and sewage networks, b) the intensive use of plots and the proximity between water boreholes and cesspits is evident, and c) flooding and blockages of the drainage of water from the stream occur. All these factors, which combine environmental and social factors, generate conditions that hurt the health of the population.

The concept of safe water refers not only to water that is fit for consumption, of good quality, and does not generate diseases, but also takes into account access in sufficient quantities, unrestricted access, continuous availability, and low cost, and therefore accessible to the entire community (Córdoba *et al*., 2010). According to Jagals 2006, the concept of safe water is defined by 3 principles: (1) health-related microbiological quality must be adequate for the intended use; (2) the supply/source must be accessible; and (3) water must be constantly available in sufficient quantities for domestic use. Thus, providing safe

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drinking water implies meeting all 3 requirements for the service to be improved (Jagals, 2006). It should be noted that water can be a vehicle for the proliferation and transport of diseases (pathogens, vectors, etc.), so increasing resources for drinking water does not necessarily mean safe water. In line with this, skin infections can be mentioned, which are highly influenced by water, and are always related to overcrowding and low economic conditions (Howard Guy & Bartram Jamie, 2003). Domestic water supply is one of the fundamental requirements for human life. Drinking water is understood as any water that when used for human consumption does not cause harm to health and complies with the provisions of recommended values or aesthetic, physical, chemical, biological, and microbiological quality standards issued by local and international authorities (Cruz Roja Ecuatoriana, 2010). The importance of an adequate quantity of drinking water for human health has been recognized for many years and there has been extensive debate about the relative importance of water quantity and quality, sanitation, and hygiene in producing and improving health (World Health Organization., 2006).

Consequently, the provision of safe water is considered a measure capable of improving the health of the population since there are diseases associated with water quality such as infectious diarrhea, chronic arsenic, selenium and other intoxications, viral hepatitis type A and E, viral meningitis, typhoid fever, a variety of intestinal parasitosis, among others (Maceira et al., 2007). These diseases derived from the contamination of water resources can have a chemical and/or biological origin (viral, bacterial, and parasitic diseases). In the case of microbiological contamination,

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a frequent vehicle is through excreta, and it is to be expected that cesspools in precarious waterproofing conditions contaminate water intakes when these are at shallow depths (Córdoba et al., 2010). On the other hand, chemical contamination can cause illness through both acute and chronic exposure at low doses. It can trigger more dangerous complications than exposure to microbiological contamination, especially when metals and other carcinogenic organic substances are involved.

In 2003, the United Nations (UN) agreed on an interpretation of the Human Rights-Based Approach that provided a conceptual and methodological framework based on international human rights standards and its promotion has now been extended to other issues such as health and water (López et al., 2014). The importance of addressing these issues led the UN to set as one of its millennium goals for 2015 the reduction of half of the population without sustainable access to safe drinking water and basic sanitation (Maceira et al., 2007). Approximately 768 million people are estimated to be without access to quality water according to the United Nations Children's Fund 2014. The perception of safe water is an important determinant of community acceptance of public water service (Tshepiso Ramolefhe *et al.*, 2017). One of the sustainable development goals is to provide access to safe and affordable drinking water for all (Rani, 2022). In Argentina, the Metropolitan Region of Buenos Aires (RMBA) responds to a territory that, as a result of the expansion from the center to the peripheries, developed in a disorganized and unplanned manner following the route of the different railway lines that connected the port of Buenos Aires (center) with the interior of the country.

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In this way, different cities found their place through processes that involved social, political, and economic developments that took place from 1930 onwards and demanded the expansion towards peripheral areas, a fact that intensified by 1990 on land near the motorways (Goldwaser & Balazote, 2013). Due to this particular form of growth, over time small or medium-sized areas have been generated which, due to their characteristics and those of adjoining areas, make them highly vulnerable. In particular, Barrio San Luis has a relatively small area and is surrounded by a gated community and a highway, which makes it a candidate for being a very vulnerable area. For all these reasons, our objective was to carry out an exploratory analysis of drinking water in the San Luis neighborhood, Escobar district, Province of Buenos Aires, Argentina, as an approach to studying water quality and quality of life in an integrated manner.

Materials and methods

Study area

The San Luis neighborhood is located in the municipality of Escobar, Province of Buenos Aires (Figure 1), and is part of the Buenos Aires Metropolitan Region (RMBA). According to projections made by the Statistics Department of the Province of Buenos Aires, the Escobar District has an area of 304 km2 and a population of 255,000 inhabitants. The district of Escobar has experienced significant population growth over the last 30 years, and there have been many real estate developments in the district, especially gated communities, which highlight the differentiation between areas with appropriate infrastructure

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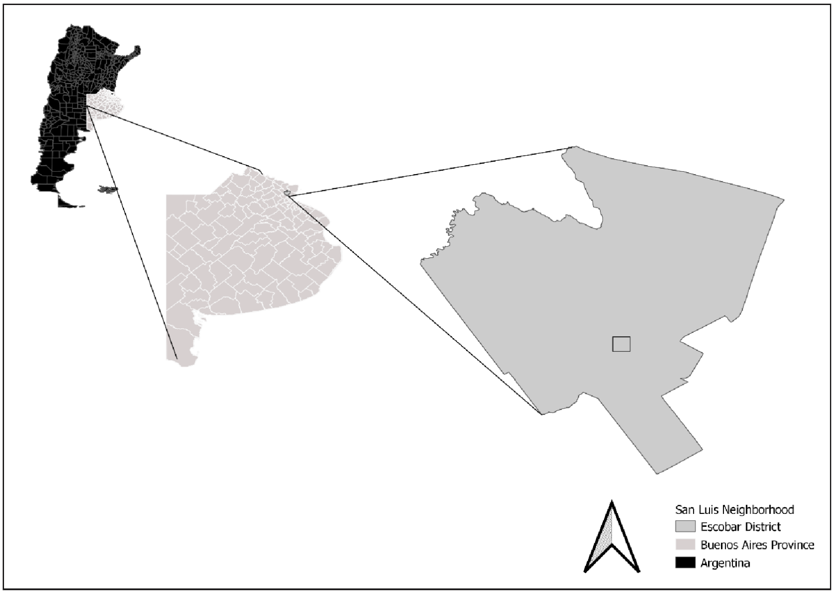
Figure 1.

Location of the study neighborhood, Escobar District, Buenos Aires Argentina.



and those with practically no infrastructure at all (Pizarro, 2010). Gated communities currently cover some 50,000 hectares in the Buenos Aires Metropolitan Area (AMBA) and are home to 300,000 people (Pablo Venturini *et al.*, 2021). In the municipality of Escobar, the development of gated communities for permanent housing, with different extensions, degrees of inbreeding and internal complexity, has expanded to 15.6% of the total area of the municipality (Narodowski, 2011). Barrio San Luis is surrounded by such gated communities. At the end of the 1950s, a process of reconversion began in terms of uses and appropriation, both of productive areas and wetlands and flood valleys in the reference área (Farberoff *et al*., 2019). Because of the characteristics of the land, particularly due to the recurrence of floods, the lots were mostly acquired by low-income working families. The San Luis neighborhood is located on the banks of the Escobar stream relief channel, running the risk of flooding whenever the channel is obstructed by rubbish or branches and leaves (Goldwaser & Balazote, 2013).

Sampling

The water sampling covered 45 points covering the entire surface of the San Luis neighborhood. To make a general diagnosis of the living conditions of the neighbors in the study area, basic water sampling was carried out considering some variables that were possible to analyze in the laboratory. Sampling was deployed in three crews and a total of 45 samples were collected. Sampling was carried out taking into account the Protocol for Sampling, Transport, and Conservation of Water Samples for Multiple Purposes (Instituto Nacional de Tecnología Agropecuaria (INTA), 2011). Where possible, the sample was taken directly from the water pumping system and, where this was not possible, the sample was collected at the intake closest to the water tank or reservoir. Samples were kept refrigerated until ex-situ processing. Once sampling was completed, the material was immediately transported to the Ecology Laboratory of the University of General Sarmiento (UNGS) where analyses of pH, conductivity, nitrite concentration and microbiological tests (*Escherichia coli* and total *coliforms*) were carried out.

 DOI: https://doi.org/10.29105/transdisciplinar5.10.119

Experimental design

The microbiological assay was carried out using 3M™Petrifilm™ *E. coli* and *Coliform* Count Plates kits, and incubated in an oven at 37ºC for 48 hours, after which the colonies were counted on each plate. For nitrite analysis, a Tetra Test NO_2 colorimetric analysis kit was used, with a range of 0.3-3.3 mg/L NO_2^-. In the case of pH and conductivity analysis, pH test strips and the Hanna Instruments HI 98311 sensor were used, respectively.

Samples were collected mostly from water tanks or reservoirs and, to a lesser extent, directly from the pumping installation. The depth of the wells or boreholes according to the testimony of the neighbors was less than 20 meters.

Results

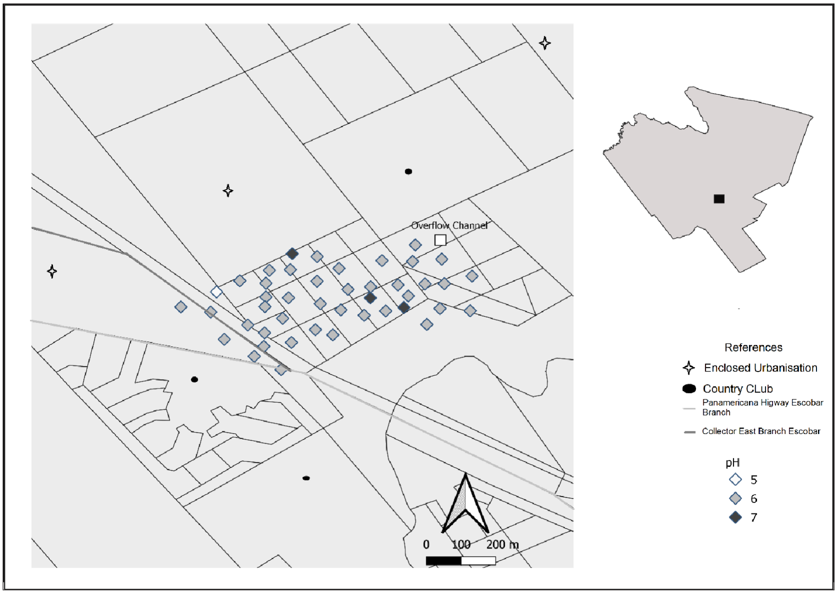
Interaction with neighbors during the sampling revealed that all the houses visited obtained water from boreholes of varying depths, which in many cases was unknown to them. Although tap water is used for everyday activities such as washing clothes and bathing, the household survey revealed three significant facts: some of the residents prioritize the consumption of bottled water - with the consequent burden on the household economy. For washing clothes, cleaning the house, and even cooking, the majority use water from the borehole. Among those who consume water from their borehole, slightly more than half of the households reported using it without any purification process, while the remaining 50% were divided between those who purify by chlorination or boiling. When asked what these methods were for and how they differed from each other,

DOI: https://doi.org/10.29105/transdisciplinar5.10.119

or whether they could be counterproductive under certain circumstances (type of contaminant in the water or improperly performed procedure), all respondents were unable to answer. Concerning sewage effluents, they are discharged into cesspits, of which many neighbors do not know the location on the lot, so there is a potential risk that the boreholes are close to their cesspits or those of neighbors, which could lead to leaks and consequently to microbiological contamination of the water intake wells. Almost all respondents identified the quality of the water available to them as a problem and associated it with illnesses and/or symptoms recorded in some or all members of the household. The most frequently identified were skin reactions/allergies and digestive complaints.

Figure 2.

ph. spatial distribution.



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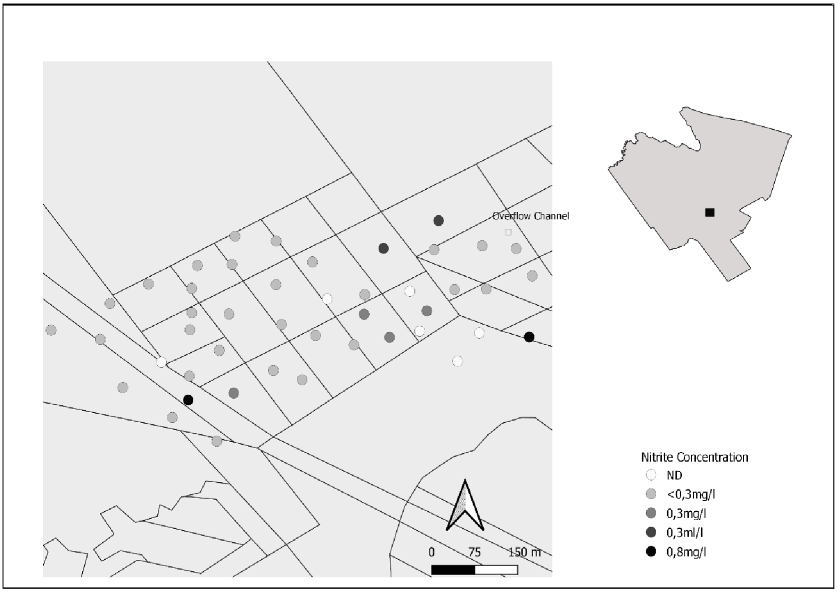
To have a first look at the general state of drinking water in the San Luis neighborhood, conductivity, and pH measurements were made for the different samples collected. Regarding conductivity analysis, 31.1% of the samples showed values between 2000 µS/cm and 3000 µS/cm, and 13.3% above 3000 µS/cm. It is interesting to note the spatial distribution with a slight tendency to register higher values in the area near the spillway channel of the Escobar stream, the lower conductivity values tended to be registered at the other end of the neighborhood. On the other hand, the pH results were mostly in the pH 6 range (Figure 2), and no spatial trend was observed.

Figure 3.

Nitrites analysis. Spatial distribution.



Regarding the nitrite concentration results, 68.9% of the samples showed concentrations below 0.3 mg/L while

4.5% exceeded 0.8 mg/L. The Argentinean Food Code (CAA) establishes a limit for drinking water of 0.10 mg/L NO_2^- so that all the samples taken would not comply with the regulations. When observing the spatial distribution (figure 3), a slight tendency can be detected, as with the conductivity results, of elevated values towards the vicinity of the overflow channel.

Integrating the results of conductivity and nitrites, a zone with a tendency to high values can be observed. It is considered that this distribution should be specially observed to extend water studies to determine whether there is the presence of other compounds harmful to health. It is important to recognize that this trend delimits a zone of vulnerability. In the case of the microbiological analysis, the results were inconclusive as they were below the detection limit set by the Petrifilm technique, so it is recommended to increase the number of samples and contrast with another methodology of greater sensitivity.

Integrating the sampling results with local normative context, it has been observed that although the regulations differ in some units in their values, in some sampling points the data obtained drastically exceed the established limits for water potability, being clear, in the dimensions observed, unfit for human consumption as can be seen in Table 1. The Argentine regulations through the Argentine Food Code (CAA) tabulate the limit values for the parameters measured in this work, as well as the Law 11820: Drinking water and sewage, of the Province of Buenos Aires, where the neighborhood studied is located. On the other hand, it is interesting to draw parallels with international regulations to delimit the strictness with which drinking water parameters are determined. National law 18284 is notably more

 DOI: https://doi.org/10.29105/transdisciplinar5.10.119

rigorous in the maximum nitrite content, being an order of magnitude lower than international standards. Among the four criteria mentioned in Table 1, the nitrite value is the one that differs and is the determining factor when defining, given the parameters studied, the water's suitability for consumption.

Table 1.

Comparison of international, national, and provincial standards for the parameters measured in this study.

Parameter	CAA (National Law 18284)	Buenos Aires Province Law 11820	WHO	EPA
pH	6.5-8.5	6.5-8.5	-	6.5-8.5
Nitrite (mg/L)	Max: 0.10	Max: 3.00	3.00	1
Conductivity	-	-	-	-
Coliform/100 mL	Absence	Absence	Absence	Absence
E. coli /100mL	Absence	Absence	Absence	-

Discussion

This campaign aimed to conduct an exploratory analysis of drinking water in the San Luis neighborhood, Escobar district, Province of Buenos Aires, Argentina, as an approach to studying water quality and quality of life in an integrated manner. The results, in contrast with national and provincial regulations, and even international ones, suggest possible physical-chemical contamination that could contribute to the unfitness of the water for consumption in the neighborhood.

It is interesting to note that the aforementioned legislation does not provide a limit value for conductivity, however, it is known that water conductivity is related to the concentration of salts in solution, and several epidemiological studies have even shown a relationship between hard water and protection against cardiovascular diseases (Solís-Castro et al., 2018), so it would be interesting to associate this measure as it correlates with issues related to the health of the population. There are some related factors, such as the presence of calcium, magnesium, pH, and conductivity, which at some point can be parameters that can make us infer water quality (Rodriguez, 2009).

About the concentration of nitrites found in the sampled points, although values of less than 0.3 mg/L were recorded, i.e. points that complied with the limit of the provincial legislation, a considerable portion of the samples showed values at least one order above the values allowed by the regulations. The recording of nitrites in particular is important when discussing the suitability of drinking water because they together with nitrates dissolved in groundwater cause negative health effects, such as the production of nitrosamines (a cause of cancer) and a decrease in the oxygen-carrying capacity of the blood, known as blue baby síndrome (Galaviz-Villa & Itzel, 2010). Furthermore, these anions are in agreement with the conductivity values and complement the results by overlapping the maximum values of both variables in the territory. It should be noted that, for this particular compound, there are very important differences in terms of the limits set by national and international legislation. It is interesting to note that national legislation sets a lower limit than provincial legislation and even international regulations (**Table 1**).

Surface water bodies, as well as groundwater, normally contain impurities and various micro-organisms, including

 DOI: https://doi.org/10.29105/transdisciplinar5.10.119

pathogens. Well, water may contain various pathogens, including the zoonotic parasites *C. pavrum* and *G. lamblia*, indicating that the water in the aquifer that feeds them is contaminated with feces, which can generally occur from surface water that seeps into the aquifer (Enríquez *et al*., 2013). The main risk of water contamination is fecal contamination through seepage and due to the presence of sediments at the bottom of pipes that favor the colonization of microorganisms (Robert Pullés, 2014). Determining the type of microorganisms present in water and their concentration provides indispensable tools for knowing the quality of the water and for making decisions about the control of discharges, water treatment, and conservation of ecosystems, thus avoiding the risk of contamination of people and the environment. The bacteria most frequently found in water are enteric bacteria that colonize the gastrointestinal tract of humans and are eliminated through fecal matter (Arcos *et al*., 2005). Water quality monitoring is done by looking for indicators of fecal contamination approved by international and national standards (Robert Pullés, 2014). Improved drinking water supply undoubtedly plays an important role in improving the quality of life, especially among rural and poor populations (Jagals, 2006). As already mentioned, in the study area, the lack of networks means that households are supplied by domestic boreholes with automatic or manual pumps, and sanitation is solved by cesspits which, in the best of cases, are connected to septic tanks. The problem increases in areas where effluent tanks and boreholes that collect groundwater for domestic consumption are located only a few meters away from each other. However, the sampling carried out in the area did not reveal, in

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the first instance, microbiological contamination in the water intakes of the houses sampled.

Beyond the above, it is important to note that while most chemicals that may be found in drinking water only pose a hazard with prolonged exposure, some may produce hazardous effects after multiple exposures in a short period (Silva *et al*., 2015). The bacterial composition is of clinical interest, as they may be capable of causing opportunistic infections in the upper and lower respiratory tract, as well as bacteremia, skin and soft tissue infections, acute diarrhoeal disease, and other severe diseases in humans (Arcos *et al*., 2005).

On the other hand, it has been observed that beyond what the neighbors perceive - or know - that the quality of the water they consume from the borehole is not within the parameters of portability, they passively accept the inherent sanitary risk, without considering collective action to demand that local, provincial or national authorities guarantee the basic right to safe water. In line with this, from the visual record during the sampling, the presence of children and young people in direct contact with open wastewater was observed, even when indicators of poor quality and risk for interaction by direct contact are evident to the naked eye, such as the presence of waste, waterlogging and stagnation, bad smell, opacity, presence of larvae, insects, and algae (Observation records, territorial tours in march, april, and september 2019). On this point, the danger of interaction of this type can increase when not only urban solid waste is taken into account, but also when sewage drains are added. Human and veterinary applications are the main sources of pharmaceuticals in the environment given the expression,

 DOI: https://doi.org/10.29105/transdisciplinar5.10.119

and inappropriate disposal, among others and it is important to recognize that all wastewater regardless of its location will contain pharmaceuticals (de Jesus Gaffney *et al*., 2015). In recent years, the study of emerging contaminants of this type in surface water has increased in depth (Castillo-Zacarías et al., 2021; Cheng *et al*., 2021) and, in particular, the public is more focused on the risks to human health associated with inadvertent exposure to pharmaceuticals through drinking water (de Jesus Gaffney et al., 2015), with direct contact interactions being a further problem in addition to the physicochemical and microbiological contamination of drinking water mentioned above.

To complement the study of the physicochemical and microbiological variables, it is important to take into account what Huaquisto Cáceres & Chambilla Flores, (2019) defined regarding the fact that water consumption is determined by different factors, among which the following can be highlighted: climatic (temperature, rainfall, relative humidity), social (inhabitants per dwelling, family composition, level of education, social stratum), economic (family income, water prices, historical consumption) and cultural (people's lifestyle, values, education, social norms and models, beliefs associated with environmental behavior), which according to the context, will have different relevance. Another similar group of variables related to domestic water consumption is socio-demographic, psychological, political-economic, urban pattern, and climatic conditions and customs. The economic factor is a determining factor; as the economic level increases, so does water consumption due in many cases to elements outside the home that consume water (gardens, swimming pools, washing machines, etc.). Climatic variables also

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correlate significantly with per capita water use on most time scales, with mean, minimum, and maximum temperatures and daylight length correlating positively; precipitation, wind speed, relative humidity, and cloudiness show an inverse relationship with water use (Huaquisto Cáceres & Chambilla Flores, 2019).

Access to water is a basic human need that must be met with the necessary quantities that meet minimum health standards. Adequate access is one of the most serious challenges for humanity leading to socioeconomic, psychological, and health problems (Oyeniyi & Oluseyi, 2020). Access and availability of water are generally described as an integrated function indicating that reasonable access means that ideally, all people should have 20 L of water per day accessible within 1 km of the user's dwelling (Jagals, 2006). In line with the above, Jagals 2006 showed that providing a small community using untreated river water as the only source of good quality water through a piped distribution system accessible at community taps did not fall within the parameters of the water availability criteria (Jagals, 2006).

Conclusion

The experience constituted a bridge to approximate, with empirical data on a given resource, the conditions of vulnerability to which the people living in the area are exposed. In addition, it was a practice that complemented concretely the observations and theorizations regarding the conditions of inequality and precariousness experienced by the population of the neighborhood.

The results obtained from the neighborhood water showed worrying values for the resource used by the population.

 DOI: https://doi.org/10.29105/transdisciplinar5.10.119

It is important to remember that the local population uses domestic water supply for different purposes. Although this work constitutes a first approach to the problem, the findings are a trigger to promote further more exhaustive studies in the territory.

An exploratory analysis of water quality was carried out, observing not only tendencies of unsuitability towards the spillway channel, but also an important parallel between this area and the precariousness of housing and water intakes.

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