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Water Demand Management strategies in fast-growing cities. The case of Arequipa, Perú

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ABSTRACT

Using a socioenvironmental perspective, this paper analyses strategies of water demand management (WDM) in Arequipa, Peru, and their perception by residents through a survey of six city districts (three in the core and three on the periphery) complemented with interviews with key stakeholders. The results show significant differences in WDM. Strategies to reduce demand through pricing are dominant. Domestic water-saving technologies are uncommon, and awareness campaigns are limited to periods of water stress. Despite differences in water access, improvements in water networks (leak repair, adequate water pressure and continuous supply) are the most demanded actions by residents.

KEYWORDS: Water demand management, fast growing cities, Urban formal and informal areas, public perception, Latin America.

1. Introduction

Access to reliable and safe water supplies represents one of the fundamental backbones of the urbanization process. Historically, this access has been made possible through the construction of infrastructures to bring and distribute clean water and eliminate polluted flows (Grigg, 2019). The demand for water supply and sanitation infrastructures continues today in many urban areas of the world fuelled by population growth and economic development amidst growing concerns about future availability (Tortajada & Biswas, 2017; UNESCO, 2015).

However, many factors intervene to question the current infrastructural approach to water supply and sanitation. Increasing economic costs, including the much-needed renovation of urban water networks, the social opposition to large water supply projects, and environmental impacts have raised interest towards alternative sources (desalination and reclaimed water, for example) and water demand management (WDM) (Butler & Memon, 2006). WDM represents a fundamental pillar of sustainable water management (Brooks, 2006; Sauri, 2003). Broadly, it rests on three main types of instruments: economic (prices and taxes), technological (efficient water-saving devices) and awareness strategies (campaigns to limit water use).

WDM can be considered part of the ecological modernization (EM) approach originating within the affluent and relatively equitable societies of Central and Western Europe in the early 1980s (Spaargaren & Mol, 1992). Essentially EM argued for the application of technological and market instruments to environmental problems without compromising the operation of the market economy (Jänicke, 2008). Proponents of EM developed instruments such as the ‘polluter pays’ principle, the precautionary approach or the obligation of conducting environmental impact assessments of policies, plans and programmes. In the water field, the influence of EM through WDM measures, such as the application of the principle of 'full-cost recovery', can be noticed in, for instance, the European Water Framework Directive of 2000 (Kaika, 2003). Interest in WDM, especially its economic dimensions, also coincided with the Dublin declaration of 1992 emphasizing the consideration of water as an economic good (International Conference on Water and the Environment (ICWE), 1992), and with changes in urban water governance towards a greater role for private companies (Araral, 2009). WDM has made headway in Europe, Australia and North America, improving although not solving entirely problems in the domestic water supply. WDM has also attracted the attention of water managers in Africa (Crow-Miller et al., 2017; Gumbo, 2004; Mwakalila, 2007), Asia (Araral & Wang, 2013; Tortajada, 2006) and, perhaps to a lesser extent, Latin America (Adler, 2011).

Given this interest, one important question is whether WDM has any role to play in improving water services in fast-growing cities with uneven water supply (Horne et al., 2018). Prices, changing tariff structures, the promotion of water-saving technologies or the increase in water awareness among consumers implicitly assume a socially and spatially homogeneous city. However, the contemporary socio-spatial diversity of many urban areas indicates otherwise, and the reality of 'splintering urbanism', with some neighbourhoods having access to networked water and others lacking this access, remains common despite the important advances made in extending water supply networks (Graham & Marvin, 2001; Kooy & Bakker, 2008; Mitlin et al., 2019).

WDM strategies in consolidated urban areas with universal water access might differ from those strategies applied to fast-growing cities with uneven water access. More significantly, WDM strategies may differ considerably between formally planned urban areas and informal, unplanned settlements (Sharma & Vairavamoorthy, 2009), but studies considering the full range of WDM initiatives in fast-growing cities with uneven water access are still scarce.

The objective of this paper is to shed light on WDM strategies and their perception by citizens of central and peripheral areas of fast-growing cities in Latin America through the case of the city of Arequipa, Peru. Arequipa is the second-largest city in Peru, and one of the fastest growing cities in South America in both population and economic terms (The Business Year, 2015). Arequipa also represents an example of polarized urban growth between planned, core areas having access to water networks, and unplanned, peripheral areas where the networked water supply is insufficient or absent and must be complemented with more uncertain and comparatively more expensive sources. It is important to note that in this paper we use the binary core/planned and peripheral/unplanned areas as a heuristic device to reveal the different realities of water supply in Arequipa. However, we acknowledge that these categories, and especially the notion of peripheral/unplanned area, are not monolithic and may encompass different and uneven socioeconomic conditions, in turn influencing the intersection of WDM with these conditions.

The paper is organized as follows. We next review briefly the recent academic contributions to WDM strategies in their triple dimensions of economic, technological and awareness instruments, and explore their possible effectiveness for fast-growing cities characterized by uneven access to water. This is followed by a presentation of Arequipa focusing on recent population and urban development and the characteristics of water supply and consumption in the city. The fourth section describes the methodology of the study, which is primarily based on the analysis of a number of surveys to citizens (N = 721), complemented by interviews with key stakeholders in the city water sector in order to characterize water supply practices and their perception by residents in three districts located in the formal urban core and three districts located in the informal settlements of the periphery. The fifth section presents and discusses the results and is divided in two subsections. The first includes an overview of WDM measures in Arequipa, while in the second the survey results are presented and discussed in the light of socio-spatial differences in the city. Finally, in the conclusions, findings for Arequipa are discussed in terms of the lessons learnt of possible interest for other fast-growing cities lacking homogenous universal levels of water provision.

2. Strategies of WDM in urban areas

WDM aims at providing efficient resource use and conservation through technology and market principles (Huber, 2000; Rogers et al., 2002; Savenije & Van der Zaag, 2002). Prices can stimulate users to be more prudent in consuming water, and, at the same time, fulfil cost-recovery requirements. Likewise, technology-driven water conservation and campaigns to educate the population on proper water behaviours help in the efforts to reduce water consumption (Tortajada et al., 2019). The combination of these strategies is seen as one important reason behind the observed decline of water consumption in certain cities of North America, Europe and Australia (Sauri, 2019).

WDM assumes homogeneous areas with universal levels of service provision. While this may be the case in most cities of North America, Australia and Europe (although not always), the situation in the fast-growing cities of Latin America, Asia and Africa is rather different. In the latter, there is significant polarization between, in general terms, the formal, legal and planned city, and the informal, alegal and unplanned city (Kooy & Bakker, 2008; Pflieger & Matthieussent, 2008).

According to the United Nations (2018), 20% of the urban population in developing countries lives in informal settlements. The achievement of sustainability objectives such as universal water supply and sanitation in these areas remains a daunting task (Dovey, 2015; Montoya et al., 2020; Soyinka et al., 2018), and access to water and energy is usually problematic. It is estimated that by 2050 the demand for water in cities will increase by up to 33% (UNESCO, 2015), possibly aggravating and widening unequal access between formal and informal urban settlements. Moreover, the sprawled nature of many informal settlements does not facilitate the enlargement of water supply networks due to costs, the uncertain nature of legal titles to land ownership or, simply, little political will. Faced with this reality, households tend to rely on a set of supply systems with different characteristics and levels of provision and that are selected according to price, type of source, distance from the source or quality of service (Ahlers et al., 2014). All these alternatives fail to ensure a steady supply of water, resulting in water consumptions in informal settlements that tend to be lower than in the formal city (Adams, 2018; Kooy & Bakker, 2008). Moreover, water quality from these may be worse than water from the public networks (Rusca et al., 2017).

Economic strategies for WDM have gained significant leverage over technological or awareness strategies on two assumptions. The first is that price increases would lead to lower consumption. The second is that higher prices may act as a stimulus for water companies to invest in the enlargement of water networks in growing urban areas (Rogers et al., 2002). However, these assumptions often do not materialize because higher water prices may have unfavourable effects on low-income households. The limited capacity to pay of households located especially in the informal city discourages investment by water companies and may lead even to the termination of concessions (Bakker, 2003, 2007).

According to some authors (Fernández, 2015; Molinos-Senante & Donoso, 2016), water prices in Latin America are relatively low, but have registered high increases in recent years (Brichetti, 2019). In most cities, water prices follow the principle of increasing block tariffs, whereas unitary pricing, regardless of consumption, is rapidly declining. A total of 88.6% of water companies have adopted the increasing block structure, while only 11.6% use uniform rates (Brichetti, 2019). Block pricing is seen by its proponents as an appropriate alternative to control demand, improve affordability and equity in access, and contribute to expanding supply networks (Baerenklau et al., 2014; Mayer et al., 2008). Other views, however, are highly critical (Boland & Whittington, 2000). One of the most controversial issues concerns distributional impacts. In Latin America, block pricing only appears to work reasonably well for middle-income groups, while it may affect disproportionately low-income groups, especially large households, and may not induce behavioural change in high-income groups (see Barde & Lehmann, 2014, for the case of Lima).

In general terms, the use of water-saving fixtures (e.g. low-flush toilets, low-flow showers and faucet aerators) can reduce the demand for water to between 30% and 50% for indoor uses and to between 5% and 10% for outdoor uses (Sauri, 2013). However, the limited purchase capacity of many low-income households may explain the difficulties in accessing efficient technologies in fast-growing urban areas.

More efficient technologies may bring substantial savings not only to final users but also to water operators. Although probably impossible to know in exact terms, some authors estimate that water losses from distribution networks, or 'non-revenue water', amount to 126 billion cubic metres/year worldwide (Liemberger & Wyatt, 2019). In developing countries, this figure may represent between 30% and 60% of distributed volumes (Mutikanga et al., 2009). Part of this water is lost through leaks owing to ageing and deteriorating system components, while other losses may be due to inadequate operational management (McKenzie, 2018). Additionally, unregistered connections may represent between 10% and 15% of the water distributed in the networks (Kingdom et al., 2006).

Awareness campaigns are addressed to change behaviours by encouraging or making mandatory water conservation practices among the public usually involving the transmission of messages to conserve water through popular media, especially during periods of water stress. In fast-growing cities with social and spatial uneven access to water, awareness campaigns might not be effective for households lacking reliable access or consuming little water. For example, in Jordan, while awareness campaigns could have increased people's attitudes towards conservation, this change did not occur because water available was already very limited (Kingdom et al., 2006). In Salta (Argentina), awareness campaigns have included, among other items, advertisements, educational programmes or information for the installation of water meters. However, total consumption has not diminished due to the significant losses of water in the public network (Iribarnegaray et al., 2014). Also, during the drought in Sao Paulo (Brazil) in 2014–15, awareness campaigns were part of measures implemented to reduce water consumption. According to Braga and Kelman (2020), these campaigns reduced consumption by 25%. However, other authors point to the severe restrictions on water availability as the most likely cause of the decline (McKenzie, 2018). Awareness campaigns tend to be designed in very general terms and may ignore differential consumption patterns within urban areas, failing to address the specific needs of some citizens. In times of drought the message is to save water with most messages targeting indoor uses and especially habits of personal hygiene.

In Latin America, some decreases in consumption have been documented between 2000 and 2014–15. For example, water consumption in Chilean cities fell from 22.7 to 18.6 m3/household/month between 2000 and 2014 (Donoso, 2015). In Buenos Aires, consumption decreased from 383 to 327.5 litres per capita/day (lpcd) between 2005 and 2014. Likewise, in Brasilia, consumption declined from 166 to 152 lpcd between 2006 and 2015. Finally, in Lima, consumption decreased slightly from 155 to 152 lpcd between 2005 and 2014. According to some studies, declines can be attributed to the application of WDM instruments, especially pricing (Donoso, 2015). However, other factors, including the incidence of drought episodes, which may reduce the availability of water, may be present as well (March & Sauri, 2017). In addition, frequent interruptions in supply and loss of pressure in the network affect consumption (Lee & Schwab, 2005). Hence, precarious and often unreliable water distribution systems may also become a manifestation of uneven access to the resource (Mitlin et al., 2019; Ojeda De La Cruz et al., 2017).

3. The case of Arequipa

Arequipa (1.3 million people) is the second largest city of Peru after Lima (CAF, 2018). It is located in the southern region, bordering the Atacama Desert at some 2300 masl. The city has an arid climate with annual precipitation of only 19 mm, and water availability depends on river flows originating in the Andes.

The recent historical trajectory of Arequipa follows the pattern of many cities in the developing world in terms of fast urbanization fuelled by immigration processes (Cohen, 2006). Until 1940, the city experienced moderated growth, but since 1940 it began to gain population in increasing numbers. From 155,000 inhabitants in 1940, Arequipa grew to 421,000 in 1960, with an annual growth rate of 4.8% (Van Garden, 1989). In the early 2000s, the city passed the 1 million mark, and in 2017 it reached 1.3 million people (INEI, 2017). Population growth in Arequipa has followed a typical spatial pattern of cities in the developing world. While core districts, historically concentrating most of the population, have experienced moderate increases, the urban peripheries have progressed faster, especially in the 1990s. Local migration (rural–urban) and migration from other Peruvian regions, above all from the Andean areas of Cuzco and Puno, attracted by agro-industrial, energy and transportation activities (Bayer et al., 2009), have both contributed significantly to the growth of Arequipa. Unable to absorb immigration within the limits of the planned city, Arequipa has witnessed the increase of urbanization in the non-planned peripheries known locally as Barrios Urbanos Marginales (BUM) (Calderon-Cockburn, 2017; Muñoz, 2018). BUMs have developed out of the planning system and under the driving force of the market (legal and illegal, including land trafficking as in the Cono Norte part of the city). Thus, vast spaces located in the outskirts of the urban area are occupied and built upon, usually in the form of single-family houses, according to the occupants' economic possibilities. Essential services (water, sanitation and electricity) may be provided eventually depending on two factors: collective action under organized community groups demanding the legalization of the new urban land or initiatives of 'land formalization' adopted by the local government (Castro & Riofrio, 1996). According to Sin Fronteras (2018), the urban periphery of Arequipa has more than 200 informal housing associations. The informal status means the denial of access to basic services such as water, sanitation or electricity, resulting in harsh living conditions. Inhabitants of these urban sectors organize and mobilize in front of state agencies to demand the recognition of their establishment, usually through a 'certificate of possession'. This certificate of recognition (which is a prerequisite before formalization) is requested by utility companies (Castro & Riofrio, 1996). However, despite social mobilizations, public entities do not always provide these certificates, in part because informal housing may be located in areas considered to be at risk (IMPLA, 2016). Formalized housing associations have access to basic services (water and sanitation), although affordability and reliability issues may remain, while 'uncertified' housing associations end up excluded from all the basic services and must recur to other alternative sources of water not only more expensive but are also more costly to store.

It is important also to acknowledge that peripheral areas in Arequipa show important internal differences. Table 1 provides information on the origin of the population, average income, and population in poverty conditions for the six districts included in the study. Table 1 shows notorious differences in terms of income and poverty between the core and the periphery (e.g. the average income in the core districts of Arequipa and Yanahuara almost doubles that of the periphery districts), but internal differences within the periphery can be discerned as well. For example, almost 50% of the population of Yura district on the periphery was not born in the city, coming especially from the Andean highlands, which on the other hand provide most of the immigrants to the city. Yura also observes the highest percentage of population in poverty (more than 20% of the total).

(Table 1 around here)

Urban water services in Peru are provided by public service entities called EPS, which are supervised by the Superintendencia de Servicios de Saneamiento (SUNASS, the National Supervising Agency for Water and Sanitation) (Figure 1). In the Arequipa region, the municipal service EPS Servicio de Agua Potable y Alcantarillado de Arequipa (SEDAPAR the Water and Sewer Services of Arequipa) treats and supplies the water. Although SEDAPAR together with the regional government and municipalities have invested significantly in infrastructure, especially for the expansion of the public drinking water network, rapid urbanization is outpacing infrastructure development.

(Figure 1 around here)

The Chilli and Socabaya rivers provide water for Arequipa as well as for the irrigation of some 10,000 ha of agricultural land in nearby areas, and for the generation of electricity (Andersen, 2016; CAF, 2018). Surface water flows are seasonal and depend on rainfall and snow in the Andes. Given the increase in water demand due to rapid population growth and economic activities (SEDAPAR, 2018), river flows have experienced an unprecedented decrease in recent decades, exacerbated by variations in rainfall and the reduction of snow packs in the Andes (Vuille et al., 2018). The response to ensure future water availability has been the planning and construction, since 1961, of several dams to regulate flows (AQUASTAT-FAO, 2015). While the hydraulic system has enhanced the water supply for the city, it has also affected ecological and social uses and redistributed water volumes and rights (Zapana et al., In press).

The hydraulic complex known as 'Regulated Chili' can store, on average, some 177 cubic hectometres (Hm) of water/year (Autoridad Nacional del Agua, 2019), increasing the water flow in the Chilli River from the original 5 to 13 cubic metres/second. Hydraulic regulation has made it possible to improve the supply of water by 18.5 Hm3 between 2006 and 2017, but it has not solved water scarcity in the urban periphery. A small proportion of the water supply, especially in the informal settlements of the periphery, comes from groundwater sources (Table 2).

(Table 2 and 3 around here)

Nevertheless, the increase in supply has been unable to compensate for the increase in demand, partly because some 23.2 Hm3/year, or about one-third of the water supplied, is lost in the distribution network (INEI, 2019; Superintendencia Nacional de Servicios de Saneamiento (SUNASS), 2018b). Imbalances between supply and consumption reached a critical moment in 2016 when a strong decrease in rainfall possibly related to climate change (Vuille et al., 2018) affected the upper Chilli River basin. For SEDAPAR, this episode showed the need for increasing water use licensing. SEDAPAR had a permit of 1960 litres/second for drinking water production, but managers noted that demand was over 2315 litres/second. Hence, and after a water emergency was declared in the city (RPP, 2016), water managers and city community groups asked the Peruvian government to increase the hydraulic capacity of the Chilli river system by building new reservoirs. At the same time, they also called for a more significant role for water conservation to reduce consumption.

As other rapidly growing cities in the developing world, Arequipa is characterized by its internal disparity in access to essential services. Water supply in the city combines conventional (public water networks) and alternative supply systems (pipe trucks, public fountains, wells). The latter facilitate the distribution of water in sectors without access to the public network (Bakker, 2003).

In Arequipa, the conventional supply system operated by SEDAPAR is widely present in the urban core. In contrast, informal systems usually managed by private actors are more common on the periphery, with different degrees of intensity depending on specific areas. Here the purchase of non-network water is usually done in groupings to negotiate better prices and reduce waiting times in transportation.

According to the most recent annual report of SEDAPAR (2018), the supply of water through public networks in the city of Arequipa increased from 89.7% to 92.0% of the urban area between 2008 and 2018, reflecting an effort to make water coverage universal. However, household water coverage also includes supply from public water tankers and pylons (especially in the urban periphery recently 'formalized'). In addition, access to water through networks is ridden with problems related to water losses, supply interruptions or low pressure of the system (La Repúbica, 2019). Water losses may be smaller than in other Latin American cities (Ojeda De La Cruz et al., 2017; SUNASS, 2018b), but remain significant for Arequipa, which suffers from recurring droughts. In the urban peripheries, the presence of non-conventional supply systems may involve access to one or more water sources in highly variable proportions (Constantine et al., 2017; Misra, 2014), including public pylons or fountains, private wells or water transported by privately operated water trucks. The latter is comparatively more expensive than network water and of an uncertain quality in some cases.

In 2019, average water consumption in Arequipa attained 140 lpcd (SEDAPAR, 2019). This figure obscures important differences of consumption between core and periphery districts, but also within the same periphery districts, as some have a larger presence of the network than others. Accordingly, differences in water consumption between the core and the periphery of Arequipa are primarily related to access to the public water network (Figure 2).

The average consumption per capita in the three districts of the urban core included in the study (Arequipa DC, Yanahuara and JL Bustamante) was 169 lpcd. In comparison, the water consumption in three districts of the peripheral area included in our study (Yura, Sabandía and Tiabaya) was 109 lpcd for the 48% of the population with access to the public water network (Figure 2). Large disparities in income and situations of poverty, which modulate the capacity to pay for the resources, might be a central element in understanding uneven patterns of water consumption. According to the income threshold for poverty established in the country (less than half the minimum wage), in the urban core of Arequipa only 2% of the population is considered poor, while in the peripheral area poverty reaches 16% of the total (BCR, 2016) (Table 1).

Figure 2 around here

4. Methodology

To assess whether WDM strategies differ between the urban core and the urban periphery of Arequipa, as well as to investigate the perception by citizens of WDM measures, we used WDM-related variables from a database built from household surveys (N = 721) conducted between September and November 2018 by a trained team of six people led and coordinated by the first author. Following statistical sampling methods, surveys were carried out in six of the 20 districts of Arequipa as mentioned above: three districts from the urban core (n = 354) and three districts from the urban periphery (n = 367) (Figure 3). The districts of the urban core had higher incomes and almost all households were supplied by the city public water network, while the districts of the urban periphery had lower economic incomes and households were supplied partly by the city water network, but also from other sources (Table 1 shows the sociodemographic data of the six districts).

Figure 3 around here

The household survey included a set of 29 closed questions on the perception of users on water availability, accessibility and quality; satisfaction with the service; prices; domestic water-saving technologies and water awareness. In accordance with the objectives of this paper, we focused on the set of variables from the database related to the three components of WDM (economic instruments, efficient technologies and water awareness measures) as well as data on the perception of water provision (accessibility, availability and quality of water service).

The selected variables from our database were first subject to a descriptive analysis for each district (Table 1). Second, a non-parametric Chi-square analysis (X2), after the tests of normality and homogeneity of values, was performed in order to examine comparatively how the adoption of WDM measures, their perception and water service delivery factors (accessibility, availability and quality of water service) varied between households in the core and periphery districts (Table 3).

In addition to the analysis of the database developed from the survey, interviews were conducted with representatives of SEDAPAR, SUNASS and AUTODEMA (Autonomous Authority of the Majes-Siguas Water Supply Project), and with representatives and members of two housing associations in the urban periphery. Interviews took place between September and November 2018 and were conducted face to face with the exception of one by telephone. Topics covered in the interviews with water managers included, among other aspects, the challenges for the water sector in Arequipa, water pricing systems, distribution technologies and water awareness strategies. On the other hand, the interviews with the representatives and members of the housing associations referred mainly to the provision of water services, water access tariffs and domestic water-saving technology. Ancillary sources included annual urban water management reports and drinking water production data, provided by SEDAPAR as well as miscellaneous economic and sociodemographic statistical information (Instituto Nacional de Estadística e Informática (INEI), 2017; SEDAPAR, 2017b, 2018, 2019).

5. Results and discussion

5.1 Documenting WDM measures in Arequipa

Water administrators, regulators and providers in Arequipa disagree about the effective approaches to water management (Filippi et al., 2014). While the Arequipa regional government and the Peruvian ANA (Autoridad Nacional del Agua), among others, prefer strategies focused on increasing the water supply (the construction of dams and micro-dams at the headwaters of the Andean river basins), the public water and sanitation company SEDAPAR appears to be more committed to WDM. SEDAPAR has two main concerns. First, to supply drinking water in ‘efficient’ ways; and second, to solve what it considers a ‘lack of education’ among the public regarding the use of basic services (Filippi et al., 2014). However, the water network suffers from recurrent technical problems (leaks, insufficient water pressure in the pipes, etc.). Moreover, other actors intervening in the Arequipa water cycle have their own agendas. The Cerro Verde mining company, a private actor and member of the Multisectoral Committee of the Chilli River Basin, has funded infrastructures such as dams, canals, and water and wastewater treatment plants in the city. However, these actions also favour extractive activities by the company. For example, the mining company has pursued several expansion projects based on copper extraction, requiring additional water rights, but, in turn, generating massive citizen protests as well.

Given the increasing difficulties in financing new water supply infrastructures for Arequipa, SEDAPAR has implemented a series of measures focused on managing water demand. Economic and awareness measures are the most used. In contrast, the installation of water-efficient technologies, although favoured by water managers, is limited mostly due to the lack of government subsidies.

Economic measures

In Arequipa, the use of economic instruments differs according to the water source. In the urban core and peripheral areas where water is served from the public network, increasing block rates (IBR) are the most widely used strategy for managing water demand. A fixed rate per litre is common in peripheral areas with limited or no access to the public network as citizens need to resort to alternative water providers.

In the urban areas serviced by the public network, the water bill is composed of a fixed charge (equivalent to US$0.84/month), and three consumption blocks (with volumetric ranges of 0–10, 11–30 and ≥ 31 m3/month), with different rates for each block. The water rate is US$0.14/m3 higher between the first and second blocks and US$0.45/m3 higher between the second and third blocks. The tariff for these blocks increases annually after the application of the 'principle of tariff regulation' addressed to provide for the recovery of investment costs, the costs of exploring new water sources, the efficiency of water consumption and the criteria of equitable distribution (SUNASS, 2014a, 2014b). In total, SEDAPAR clients can expect to pay between US$8.30 and 9.69/month, equivalent to 3.7% of the minimum wage.

The domestic water tariff has increased continuously since 2000. Between 2001 and 2018, the average water rate rose from 0.34 to US$0.69/m3 (SEDAPAR, 2018). Local water administrators argued that the increasing block rate structure improved equity and provided benefits to poor households who consumed less than 10 m3/household/month (SUNASS, 2014b). However, in Arequipa, this consumption level only occurred in Yura district, the poorest of all. In contrast, in other low-income districts with larger households, such as Tiabaya, average consumption could rise to 16 m3/household/month.

In areas where basic water needs are not principally (or solely) served by the public water supplier but by private operators, a fixed rate per litre is widely used. This fixed rate does not aim at water conservation or to distributive equity, but simply responds to a process of cost recovery (e.g., water transport) plus fees for private operators (Water and Sanitation Program, 2008). These tariffs are established outside the legal framework of tariff determination characteristic of the formal sector, and tend to stress the economic capacity of customers, limiting the purchase of water to essential uses only. Rates oscillate between 2.76 and US$3.97/m3 (interviews with the presidents of the Salud Del Sur and Villa Tambo housing associations, respectively, November 2018). Peripheral areas supplied with different water sources are subject to different pricing schemes according to the water source.

Technological measures

Public programmes for the use of water-efficient technologies are rare in Arequipa. Water fixtures are not always replaced by more efficient devices and conventional devices (toilets, etc.) are still widely found in Arequipa households, especially in peripheral areas. Households there may not modernize their facilities because water consumption is already low and the costs of water-saving devices could absorb an important part of the family income.

A good technical condition of the public water network system (stable supply and adequate pressure) is essential to implement WDM strategies. In Arequipa, it has been estimated that about one-third of the system's pipes have not been renovated in more than 40 years (El Buho, 2019a; SEDAPAR, 2017a). Much of this aged system is in the urban core, where water supply is less problematic. Although important investment programmes for the maintenance and renovation of ageing pipes (usually in some districts of the urban core) have been carried out 2017 and 2018, investment figures are often smaller in contrast to the cost of the expansion of water supply systems in the growing urban periphery (SEDAPAR, 2017b, 2018). Massive investments on expanding networks also have political motivations and are avidly sought by representatives seeking to increase the number of votes.

Awareness campaigns

In Arequipa, SUNASS and SEDAPAR have issued educational and public programmes to promote water conservation. Educational programmes at the local level include talks at schools, while public information includes public lectures, advertisements in the local media and leaflets distributed with the bills. After the water emergency declared in 2016, water managers intensified awareness campaigns. For example, SUNASS started the education programme ‘Good practices for saving drinking water’ aimed at students from schools in both the core and the peripheries of the city (SUNASS, 2018a). Similarly, the local water utility SEDAPAR has launched numerous educational and public information programmes, for example, ‘Every drop counts’ and ‘the Culture of water’, targeted schools in the different districts with different consumptions of water. Educational programmes are oriented towards promoting more ‘responsible’ behaviours. Through presentations and advertisements in the most popular newspapers, SEDAPAR encourages users to conserve and reduce water consumption, repair leaks, and replace faulty faucets and other fixtures. In interviews given to local media, the SUNASS coordinator states that the water consumption in Arequipa should be around 100 lpcd (referring to the recommendations by the World Health Organization (WHO)) (El Buho, 2019b; Prensa Regional, 2019). In sum, awareness campaigns can increase positive attitudes towards water conservation. However, these attitudes may not translate into conservation practices because many households, especially in the peripheral areas, already consume little water. Additionally and related to the above, awareness campaigns appear to be oblivious to the sociodemographic conditions of certain districts populated by poor immigrants from other regions of Peru.

5.2 Differences in WDM strategies between core and periphery districts

Table 3 presents the overall survey results on the perception of WDM strategies disaggregated by area (urban core and periphery) and districts. Before discussing responses related to WDM, it is worth noting that near 50% of respondents declared having difficulties in accessing water, although most (72%) had water available at their homes. Moreover, nine out of 10 respondents reported interruptions in the service.

A more detailed analysis by urban area and district reveals statistically significant differences in accessibility, availability and quality of service. As to accessibility, only 10% of respondents in the urban core manifested having difficulties in accessing water, while in the informal districts of the periphery this figure rose to almost 75%. All respondents in the core, but only 55% on the periphery, declared to have water available at their homes (in two of the three informal districts, the proportion was less than 50%). Continuous supply was almost universal in the core but much more reduced on the periphery where only 40% of respondents enjoyed water 24 hours day (25.3% in Yura district). Interruptions in the service were widespread in both areas, although in two of the three districts of the periphery the percentage of households declaring these interruptions was smaller (78.4% in Characato and 84.2% in Sabandia) than in the three districts of the urban core (Table 3).

As to WDM measures, current prices did not represent a problem for 43.1% of the respondents, but more than 75% declared that increases in price would affect the economy of their households. Only 16% of all respondents declared to use water-saving devices at home. Regarding water awareness, most respondents argued that water consumption should not decrease, and that water conservation should be a responsibility of the state and not of individual users. Finally, over 70% of all respondents manifested to reuse water. The results from Chi-square tests showed significant differences between the urban core and periphery. For example, the current water rate represented a problem for 48% of respondents in the urban core and for almost 64% of respondents from the peripheral areas. On the other hand, regarding an eventual increase in the rate, there was no significant difference (core and urban periphery), since an eventual increase in the tariff could negatively affect the family income of 74% of respondents in the core and of 81% on the periphery. The results showed that the option of increasing the water rates to control consumption might cause substantial difficulties in family economies, especially but not only those of the peripheral areas.

The water administrators of Arequipa indicated that, contrary to that perception, the increase in tariffs through IBR was fair, since IBR sets a relatively moderate price for the first consumption block and higher prices for the second and third blocks (interviews with representatives of SEDAPAR and SUNASS and with the executive manager of AUTODEMA, 2018). Water managers claimed that poor inhabitants consuming less water paid less than wealthy inhabitants consuming larger volumes. In this sense, a representative of SUNASS argued that: ‘The population must understand that behind tap water there is a very big cost. In this sense, the block tariff structure makes possible the recovery of investments by the water utility’ (interview with a representative of SUNASS, November 2018). Along the same line, it was also mentioned that:

> The block tariff structure makes it easy for users to pay a different price. For example, the first consumer block has a special rate and is aimed at low-income citizens. Likewise, the

> rate structure will also allow the incorporation of payment for ecosystem services. (interview with a representative of SEDAPAR, October 2018)

Authors such as Griffin and Mjelde (2011) and Liu et al. (2003) point out that the use of the IBR without considering the size of the household may deepen inequities. In Arequipa, the size of households in the urban core (districts of Arequipa DC, Yanahuara and JL Bustamante) is relatively small for a water consumption of 22 m3/household/month. In contrast, the sizes of households in the peripheral area (Yura, Characato and Sabandia) are relatively large for water consumptions that can attain an average of 13 m3/household/month (SEDAPAR, 2019). According to these data, water consumption in both areas falls in the second block (10–30 m3), but the economic impact is much higher for poorer households of the peripheral areas. This would explain the dissatisfaction of the poorer inhabitants of the periphery neighbourhoods with the current tariff structure. From Griffin and Mjelde (2011) and Liu et al. (2003), as well as from previous research on the distributional effects of WDM measures (Duke et al., 2002; Renwick & Archibald, 1998), it could be argued that the recovering of investment costs, and the objectives of efficiency and financial security in Arequipa through higher prices sought by the water utility may be met at least in part at the expense of poor households. On the other hand, block pricing does not apply to households in peripheral areas not connected to the network who pay more for their water consumption, up to, on average, US$3.36/m3 (interviews with the presidents of Salud del Sur and Villa Tambo Housing Associations, 5 November 2018). Moreover, there were also complaints about the quality of non-network water:

> We are abandoned by public institutions that manage water […] this water is not only more expensive than the water supplied in the urban core, but is of poor quality. The water we buy is sometimes dirty, but we are told that it can be drunk. (interviews with members of Salud del Sur and Villa Tambo Housing Associations, 5 November 2018)

Regarding technology, the survey asked whether households used improved technological devices to save water. The results reported significant differences between the urban core and the periphery (Table 3). A total of 23% of respondents in the core district used these devices. In comparison, in the peripheral areas, this was only 10.9%. In sum, an overwhelming proportion of households in both areas did not pursue this strategy. The reasons for the limited use of water-efficient domestic technology may be related to the lack of subsidies or interest-free loans for the purchase of water-saving devices. For example, 40.4% (urban core) and 48.3% of respondents stated that they did not use these devices due to their high cost. Likewise, users on the periphery were sceptical about water-saving technology because their main concern was the improvement of the quantity and quality of water supplied to them (interviews with members of Salud del Sur and Villa Tambo Housing Associations, November 2018).

These answers may reflect the numerous limitations that water supply suffers in both the core and the urban periphery. This means that the need for technological improvements in the public water network was perceived as far more critical than the need for technological improvements at the household scale. In the urban core, 9.9% of households had experienced occasional difficulties accessing network water, and 92.4% indicated that the water service suffered interruptions. Meanwhile, in the peripheral area, 74.5% of households stated that they had difficulties in accessing water, 44.7% that they did not have potable water in their homes, 59.3% that they did not have water service 24 hours a day and 93% that the service was affected by interruptions (Table 3). These interruptions were frequent due to physical causes such as broken pipes (El Comercio, 2019). In this sense, a representative from SUNASS noted that:

> The difficulties of access to water have to do with rapid urbanization. There is an urban population that has settled above the level of the origin of the drinking water plant. This situation not only increases supply costs, but also makes it difficult to supply water. However, the population continues to grow in these sectors. (interview with a representative of SUNASS, November 2018)

According to the results, the implementation of water-saving measures may be hampered by the costs of technological devices that can exceed family income and the interruptions in water supply that can difficult the performance of these devices. Likewise, results show that technological measures to reduce water consumption were seen as a responsibility of the water utility and not of individual households because of the deficient operation of the public network. In general, although water managers encourage users to instal water-saving devices, it is likely that these efforts, although probably increasing the motivation of users, fail to materialize due to the various constraints discussed above. In this respect, Iribarnegaray et al. (2014) in Salta (Argentina) and Araral and Wang (2013) and Lavee et al. (2013) in other fast-growing cities show how technological measures alone cannot achieve the objectives of reducing water consumption. More attention to service interruptions, starting with the renovation of ageing pipes and subsidies for purchasing water-saving equipment, may be attractive for the inhabitants of the urban core. For the urban periphery, promoting access to water-saving equipment for the poor was less relevant than reducing interruptions in water supply, recognizing informal supply practices, or encouraging the improvement of existing traditional water-saving and reuse practices. Water reuse in homes was a common practice with no significant differences between the urban core and the periphery (Table 3). In Arequipa, 70.1% (urban core) and 63.9% (peripheral areas) of respondents stated that they reused water in their homes. The final purpose of reused water varied between the urban core and the peripheries. In the urban core, the cleaning of floors and of entrances to buildings was the most frequent use, followed by garden irrigation. In the peripheries, general house cleaning and, above all, toilet flushing were the most mentioned.

Regarding awareness measures, the survey asked whether residents should reduce their water consumption since this was the main objective of awareness campaigns promoted by water managers in Arequipa (SEDAPAR, SUNASS and AUTODEMA), especially after the drought episode of 2016 (RPP, 2016). As the executive manager of AUTODEMA argued:

> Although the water consumption figure in Arequipa is lower than the average of 250 lpcd in Tacna, with the awareness campaigns it is desired to reduce consumption from 136 lpcd (average population use) to 110 lpcd in Arequipa. This figure would be optimal for population use. (interview with the executive manager of AUTODEMA, 5 October 2018)

In this respect, the responses showed significant differences between urban core and periphery (Table 3). For example, 57.3% of those surveyed in the urban core felt that water consumption by citizens of Arequipa should decrease, but only 20.5% of those surveyed in the peripheral area believed the same. However, although awareness campaigns seem to increase the interest of the inhabitants, especially of the urban core towards reducing water consumption, these initiatives could also face significant public resistance as observed in other locations ranging from Salta, Argentina (Iribarnegaray et al., 2014), to Blagoevgrad, Bulgaria (Clark & Finley, 2007), among other examples (Kingdom et al., 2006).

A total of 67.2% of the inhabitants of the core and 90.1% of the inhabitants of peripheral areas believed that water conservation should be the responsibility of the state. In comparison, only 2.8% of the inhabitants of the urban core and 1.0% of peripheral areas believed that water conservation should be the responsibility of the citizens. Again, this appears to imply the general state of dissatisfaction with the public network and the need to improve city water infrastructures and practices in conserving water before asking for similar efforts to the citizens.

Although a large proportion of inhabitants (63.1%) of the Arequipa district (urban core) seemed enthusiastic about reducing water consumption, there are doubts about to whether the inhabitants of these sectors can effectively curb their consumption (Table 3). This action requires significant efforts at the household level, for example, replacing conventional water-saving devices with more efficient ones when 78.5% (of Arequipa DC) does not use these devices. Likewise, awareness campaigns do not seem to have significantly affected the districts of the peripheral areas where only 20% of respondents believed that they should use less water. Although respondents from Characato (35.1%) and Sabandía (37.5%) were optimistic about reducing water consumption, these districts faced significant challenges in accessing water (CAF, 2018).

Awareness campaigns usually assume that water consumption is homogeneous, without considering the significant differences in consumption within cities (March & Sauri, 2017; Sauri,

2019) and the fact that especially in the informal, low-income settlements that rely on non-networked sources, water consumption is already low (Kooy & Bakker, 2008). Awareness campaigns may be more effective in urban cores, since according to Martínez-Espiñeira and García-Valiñas (2012), households with higher incomes may incorporate water-conservation practices, while low-income households tend to have already stronger water conservation habits. In any case, in order to achieve their objectives, it will be necessary for the water utility to guarantee quality service without interruptions in the service.

Finally, in the survey, responders from both core and periphery neighbourhoods call for greater efforts by the water company to solve the numerous deficiencies associated with the networked water service while the company insists on mandatory (pricing) and voluntary (awareness campaigns) to stimulate water savings. Neighbours hold the company responsible for not attending efficiently demands by consumers about improvements in the provision of water. On its part, the company tends to transfer to citizens the bulk of the responsibility to reduce water consumption given the continuous problems in ensuring sufficient, reliable and secure supplies of network water.

6. Conclusions

WDM has been praised as a tool to curb excessive water consumption. It uses economic, technological and awareness instruments to achieve reductions in consumption, increase efficiency and, according to its proponents, promote intra- and intergenerational equity. However, when WDM strategies are to be applied in cities with strong urban disparities between planned and formal areas and unplanned and informal areas, they should consider the socioeconomic conditions of the populations targeted, and specially the uneven urban socio-spatial configurations.

One important question is to discern whether and to what extent patterns of water consumption per capita vary according to the urban layout (planned and unplanned) of the city mostly because access to water from the public network will be determined by the location of households either in the planned, legal, formal city or in the unplanned, alegal and informal city. A critical difference between the core and the peripheral areas is that in the planned and high-density urban core water supply is safe and universal. Contrarily, in the unplanned, low-density peripheries, access to public networks is not universal, and the sources of water supply are more heterogeneous, more limited, less reliable and comparatively more expensive. As mentioned in the introduction, we have used in this paper the binary core/planned and peripheral/unplanned areas as a heuristic device to highlight the dramatic different realities of water supply in cities of the Global South. But this option should not be interpreted as understanding informal areas as undifferentiated and monolithic realities. Rather, we must acknowledge that informal areas may involve different socioeconomic structures and different materialities of everyday life, including different degrees of dependence towards non-networked water source. Hence, WDM strategies should be aware of such differences to work towards reducing the uneven patterns of water access in informal areas.

In Arequipa, WDM strategies (economic, technological and awareness strategies) have important limitations. For example, although not always, the economic measures that are preferred by local water managers are based on the IBR with differentiated prices for each block. This is supposed to foster efficiency, reduce consumption and improve equity, assuming that more affluent households would pay more because they consume more water than poorer households. However, in the case of the six districts of Arequipa included in the survey, households of the more prosperous urban core and households of the more impoverished peripheries connected to the public network fall in the same consumption blocks because the latter have more members. Hence, and paradoxically, the objectives of efficiency and financial security sought by the water utility may be met at least in part at the expense of the poorer households.

Likewise, in the six districts of Arequipa studied, technological measures that promote water consumption efficiency are used only by a small group of urban core households. Leaving aside the lack of public subsidies to instal water-saving devices at home, most households in the core and the periphery believe that before domestic water-saving technology, an effort must be made by SEDAPAR to repair leaks, limit the frequent interruptions of the service and provide a sufficient water pressure, especially in peripheral areas.

Last, awareness campaigns, such as that launched on the occasion of the water crisis of 2016 in the city, seem to have a more considerable influence in the urban core where the water supply is more universal. In the peripheral area where the water supply is more heterogeneous (network, pylons for public use, water trucks, wells), awareness campaigns lose relevance since water consumption per capita is already low. Moreover, messages may be insensitive to the reality of water use by poor, immigrant populations.

In sum, results for the case of Arequipa appear to indicate that WDM shows limitations as a feasible policy option given the difficulties in having access to safe and reliable water from public networks. As in other cities fast-growing cities with a strong duality of formal and informal areas, it is fair to acknowledge the progress made in the universalization of water supply and sanitation, but, as the case of Arequipa shows, the universalization of water services may be plagued with difficulties requiring substantial investments while certain districts must rely on other, more problematic, sources. Finally, water reuse is not generally included in WDM strategies, at least explicitly. The fact that water conservation is practiced may imply that the most important objective of WDM is already met without a need to increase prices to make people more water responsible.

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Interviews

Representative of SEDAPAR (Drinking Water and Sewerage Service of Arequipa), date of interview 30 October 2018

Representative of SUNASS (National Superintendence of Sanitation Services), date of interview 26 November 2018

Executive Manager, AUTODEMA (Autonomous Authority of the Majes-Siguas water supply project), date of interview 5 October 2018

President of Salud del Sur Housing Association from Yura district, date of interview 5 November 2018

President of Villa Tambo Housing Association from Yura district, date of interview 5 November 2018

Table 1. Population by origin, income and poverty status in Arequipa districts

Districts		Social composition by origin						Ave in
		Local population (%)	Regional migration		National migration			
			Coast (%)	Highlands (%)	Coast (%)	Highlands (%)	Rainforest (%)	
High income	Arequipa	67,01	3,51	3,39	10,33	14,82	0,62	Mor
	Yanahuara	69,92	3,73	3,31	11,61	10,38	0,47	Mor
	J.L. Bustamante	67,83	3,51	3,41	8,76	15,19	0,41	Ave
Low income	Characato	64,5	1,61	3,95	8,12	21,15	0,52	Less
	Tiabaya	76,24	1,29	1,55	3,33	17,1	0,31	Ave
	Yura	51,04	0,9	13,4	2,19	32,12	0,27	Less

Table 2. Water supplied and water billed in Arequipa. 2006-2017

Years	Water supplied (Hm3)		Water billed (Hm3)				
	Surface	Underground	Social	Domestic	Public	Commercial	Industrial
2006	35,7	8,5	·	·	·	·	·
2007	39,2	8,9	·	·	·	·	·
2008	38,9	8,7	·	·	·	·	·
2009	41,5	7,8	·	·	·	·	·
2010	42,2	7,8	·	·	·	·	·
2011	41,3	7,4	0,1	26,1	2,8	4,0	1,5
2012	42,2	8,2	0,1	27,2	2,9	4,4	1,6
2013	49,8	8,3	0,2	29,5	2,1	5,6	1,6
2014	52,8	8,6	0,3	31,7	2,2	5,7	1,5
2015	55,3	8,1	0,3	33,6	2,1	5,8	1,1
2016	57,8	8,2	0,6	34,5	2,2	5,4	0,9
2017	54,2	8,2	0,9	34,0	2,1	5,2	0,8

Source: Own elaboration from SEDAPAR

Table 3. Perception of WDM strategies in Arequipa. Urban Core and Urban Periphery districts

Variables	Questions	Answers	Urban core					Peripheries				Comparison
			N	**1 (%)**	**2 (%)**	**3 (%)**	**%**	**4 (%)**	**5 (%)**	**6 (%)**	**%**	***p*-value**
Accessibility	Do you have difficulty accessing drinking water?	Yes	**323**	10,8	9,4	9,3	**9,9**	75,7	40	85,4	**74,5**	
		No	**398**	89,2	90,6	90,7	**90,1**	24,3	60	14,6	**25,5**	**0,001**
Availability	Do you have drinking water at home?	Yes	**525**	100,0	100,0	100,0	**100**	44,6	85	41,1	**55,3**	
		No	**196**	0,0	0,0	0,0	**0**	55,4	15	58,9	**44,7**	**0,001**
	Do you have drinking water available 24 hours a day?	Yes	**470**	95,4	97,8	97,7	**96,9**	40,5	82,5	25,3	**40,7**	
		No	**251**	4,6	2,2	2,3	**3,1**	59,5	17,5	74,7	**59,3**	**0,001**
Quality of the Water Service	Have you had any interruptions in the water service?	Yes	**608**	88,5	95,0	93,0	**92,4**	78,4	84,2	96,9	**93,0**	
		No	**48**	15,0	9,0	3,0	**7,6**	21,6	15,8	3,1	**7,0**	**0,052**
Economic Measures: Affordability and Price	Does the price represent a problem for you?	Yes	**244**	23,8	14,9	7,0	**17,2**	36,5	17,5	58,9	**49,9**	
		No	**317**	59,2	48,6	44,2	**52,0**	62,2	62,5	24,5	**36,2**	
		Likely	**160**	16,9	36,5	48,8	**30,8**	1,4	20	16,6	**13,9**	**0,001**
	Would you be affected by an eventual price increase?	Yes	**553**	70,0	76,8	74,4	**74,0**	75,7	62,5	83	**80,8**	
		No	**114**	22,3	13,8	20,9	**17,8**	21,6	30	9,1	**12,9**	
		Likely	**54**	7,7	9,4	4,7	**8,2**	2,7	7,5	7,9	**6,3**	**0,241**
Technological Instruments	Do you have and use water saving devices at home?	Yes	**121**	21,5	23,8	27,9	**23,4**	6,8	22,5	9,5	**10,9**	
		No	**328**	38,5	42,5	37,2	**40,4**	58,1	47,5	48,6	**48,3**	
		Don't know	**272**	40,0	33,7	34,9	**36,2**	35,1	30,0	41,9	**40,7**	**0,001**
Measures Related to Water Awareness	Do you think that the consumption of water should decrease?	Yes	**279**	63,1	53,6	55,8	**57,3**	35,1	37,5	13,8	**20,5**	
		No	**321**	27,7	12,7	11,6	**18,1**	62,2	37,5	77,5	**69,2**	
		Sometimes	**121**	9,2	33,7	32,6	**24,6**	2,7	25,0	8,7	**10,3**	**0,001**
	Do you reuse water at home?	Yes	**495**	66,9	73,5	65,1	**70,1**	74,3	65,0	65,6	**63,9**	
		No	**211**	30,0	24,3	30,2	**27,1**	24,3	35,0	32,8	**34,4**	
		Sometimes	**15**	3,1	2,2	4,7	**2,8**	1,4		1,6	**1,7**	**0,207**
	Who should be responsible for water conservation?	State	**569**	68,5	65,7	69,8	**67,2**	89,2	62,5	94,9	**90,1**	
		Private company	**74**	13,8	17,7	7	**15,0**	6,8	27,5	2	**5,3**	
		Citizen	**14**	7,7	0	0	**2,8**	4,1	0	0,3	**1,0**	
		NGO	**64**	10	16,6	23,3	**15,0**	0	10	2,8	**3,6**	**0,001**

N=number of surveys (N=721); 1=Arequipa D.C.; 2=J.L. Bustamante; 3=Yanahuara; 4=Characato; 5=Sabandía; 6=Yura; (%)=percentage; %=average percentage; *p*-value=significance level of the comparison between urban core and periphery; Source: Own elaboration from surveys, 2018

Figure 1. Organization of the urban water sector in Peru.

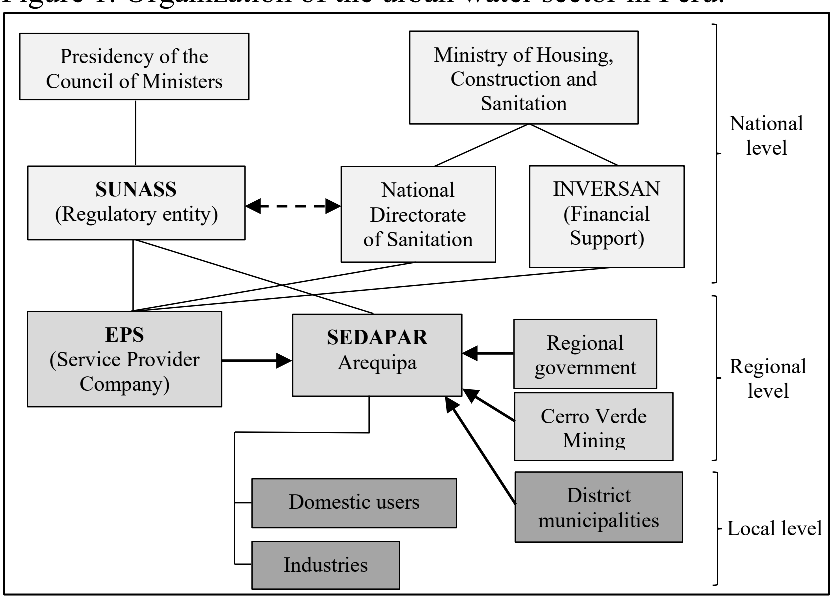
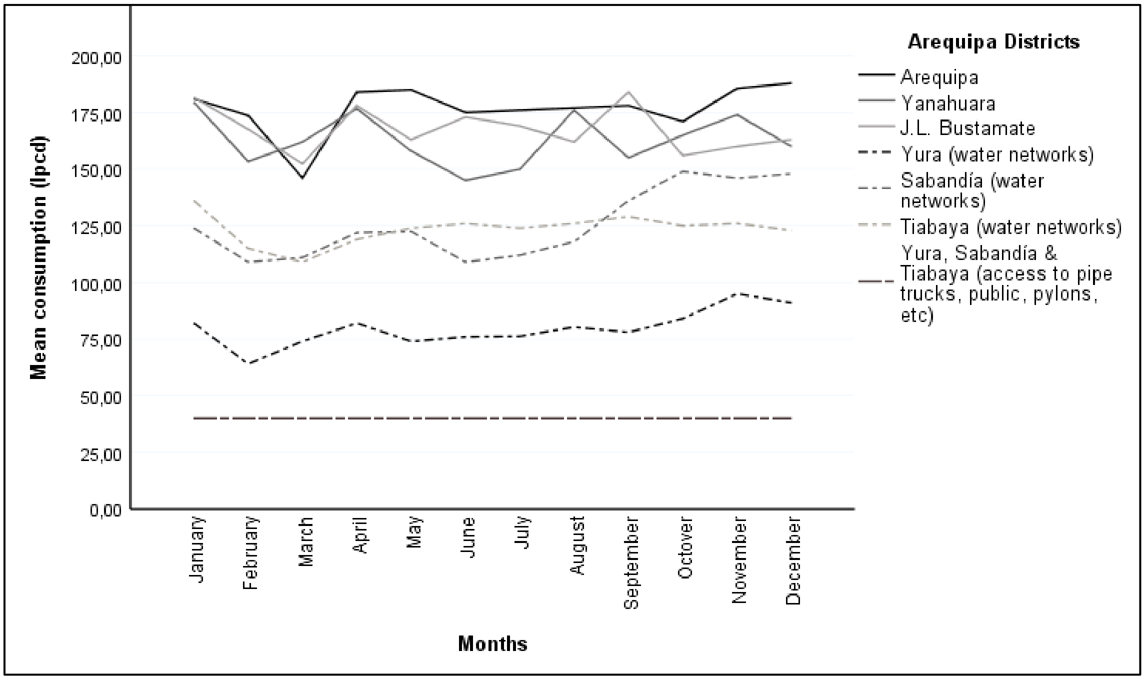
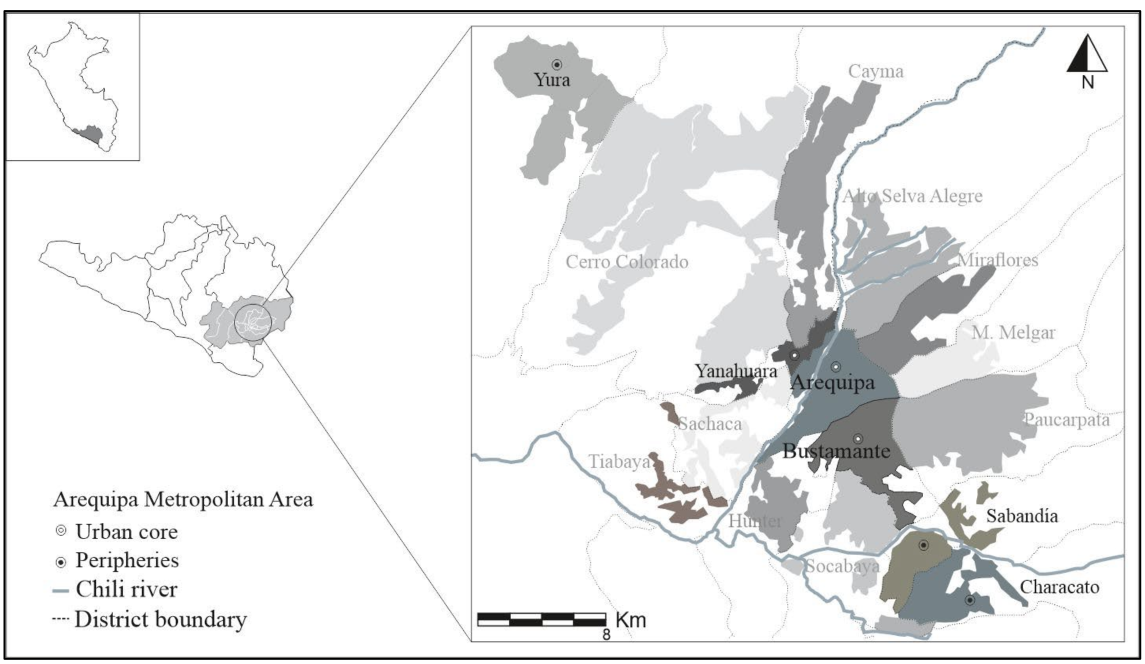


Figure 2. Mean monthly water consumption (lpcd) in Arequipa districts



Source: Own elaboration from SEDAPAR

Figure 4. Location of surveyed districts



Source: Own elaboration

Variables	Questions	Answers	Urban Core Districts					Peripheries Districts				Comparison
			N	1 (%)	2 (%)	3 (%)	%	4 (%)	5 (%)	6 (%)	%	*p*-value
Accessibility	Do you have difficulty accessing drinking water?	Yes	**323**	10,8	9,4	9,3	**9,9**	75,7	40	85,4	**74,5**	**0,001**
		No	**398**	89,2	90,6	90,7	**90,1**	24,3	60	14,6	**25,5**	
Availability	Do you have drinking water at home?	Yes	**525**	100,0	100,0	100,0	**100**	44,6	85	41,1	**55,3**	**0,001**
		No	**196**	0,0	0,0	0,0	**0**	55,4	15	58,9	**44,7**	
	Do you have drinking water available 24 hours a day?	Yes	**470**	95,4	97,8	97,7	**96,9**	40,5	82,5	25,3	**40,7**	**0,001**
		No	**251**	4,6	2,2	2,3	**3,1**	59,5	17,5	74,7	**59,3**	
Quality of the Water Service	Have you had any interruptions in the water service?	Yes	**608**	88,5	95,0	93,0	**92,4**	78,4	84,2	96,9	**93,0**	**0,052**
		No	**48**	15,0	9,0	3,0	**7,6**	21,6	15,8	3,1	**7,0**	
Economic Measures: Affordability and Price	Does the price represent a problem for you?	Yes	**244**	23,8	14,9	7,0	**17,2**	36,5	17,5	58,9	**49,9**	**0,001**
		No	**317**	59,2	48,6	44,2	**52,0**	62,2	62,5	24,5	**36,2**	
		Likely	**160**	16,9	36,5	48,8	**30,8**	1,4	20	16,6	**13,9**	
	Would you be affected by an eventual price increase?	Yes	**553**	70,0	76,8	74,4	**74,0**	75,7	62,5	83	**80,8**	**0,241**
		No	**114**	22,3	13,8	20,9	**17,8**	21,6	30	9,1	**12,9**	
		Likely	**54**	7,7	9,4	4,7	**8,2**	2,7	7,5	7,9	**6,3**	
Technological Instruments	Do you have and use water saving devices at home?	Yes	**121**	21,5	23,8	27,9	**23,4**	6,8	22,5	9,5	**10,9**	**0,001**
		No	**328**	38,5	42,5	37,2	**40,4**	58,1	47,5	48,6	**48,3**	
		Don't know	**272**	40,0	33,7	34,9	**36,2**	35,1	30,0	41,9	**40,7**	
Measures Related to Water Awareness	Do you think that the consumption of water should decrease?	Yes	**279**	63,1	53,6	55,8	**57,3**	35,1	37,5	13,8	**20,5**	**0,001**
		No	**321**	27,7	12,7	11,6	**18,1**	62,2	37,5	77,5	**69,2**	
		Sometimes	**121**	9,2	33,7	32,6	**24,6**	2,7	25,0	8,7	**10,3**	
	Do you reuse water at home?	Yes	**495**	66,9	73,5	65,1	**70,1**	74,3	65,0	65,6	**63,9**	**0,207**
		No	**211**	30,0	24,3	30,2	**27,1**	24,3	35,0	32,8	**34,4**	
		Sometimes	**15**	3,1	2,2	4,7	**2,8**	1,4		1,6	**1,7**	
	Who should be responsible for water conservation?	State	**569**	68,5	65,7	69,8	**67,2**	89,2	62,5	94,9	**90,1**	**0,001**
		Private company	**74**	13,8	17,7	7	**15,0**	6,8	27,5	2	**5,3**	
		Citizen	**14**	7,7	0	0	**2,8**	4,1	0	0,3	**1,0**	
		NGO	**64**	10	16,6	23,3	**15,0**	0	10	2,8	**3,6**	

N=number of surveys (N=721); 1=Arequipa D.C.; 2=J.L. Bustamante; 3=Yanahuara; 4=Characato; 5=Sabandía; 6=Yura; (%)=percentage; %=average percentage; *p*-value from Chi-Square=significance level of the comparison between urban core and periphery.
Source: Own elaboration from surveys, 2018.