Household water consumption in Algiers facing population growth

Meriem Naimi-Ait-Aoudia, Ewa Berezowska-Azzag

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Meriem NAIMI-AIT-AOUDIA[1,2], Ewa BEREZOWSKA-AZZAG[2]
[1]USDB, Université Saad Dahleb Blida, Route de Soumaa, BP 270, Blida, Algeria
[2]EPAU, Ecole Polytechnique d'Architecture et d'Urbanisme, El-Harrach, BP N°177, Algiers, Algeria

Abstract

Since independence in 1962, Algiers capital of Algeria has experienced a massive influx of people from other parts of the country. The unrestrained population growth did not take long to induce serious socio-economic and urban issues. Household water supply was one of the problems that arose with acuity. Pressure on water resources was such that the supply could not meet the growing demand. In the mid 90s water shortages were a prevailing phenomenon and the situation worsened with cyclical droughts and continuous population growth. Since 2002, Algerian government has launched major infrastructure projects consisting of dams and desalination plants to expand the water supply system and consequently overcome this deficit. Over the past two years, Algiers household water supply reaches a satisfactory level ensuring 24 hours a day distribution. Nevertheless, such a policy focusing solely on offer may not be sustainable. The demand-side management should be an integral part of a water management policy for the purpose of optimal use of resources. In this paper, we will focus on the analysis of domestic water consumption related to population growth and the means implemented to meet the needs of households since independence to present day. We will then outline the limitations of the pursued supply-oriented policy. We address thereafter the determinants that influence domestic consumption and the levers aiming at reducing Algiers household water demand.

Keywords: Algiers household water consumption, supply system, water management.

1 Introduction

One of the main indicators of well-being and human development is incontestably adequate fresh water access. In the second edition of the World Water Development Report, "Managing Water under Uncertainty and Risk" (UNESCO, 2012), UN-Water stressed that water underpins all aspects of human development, and that a coordinated approach to managing and allocating water is critical. The major water concern in many regions is insecurity about the adequate water supply in the face of rising population demand. According to the United Nations Organization FAO (2007), by 2025, 1800 million people will be living in countries or regions with absolute water scarcity and two-thirds of the world population could be under conditions of water stress.

Algiers, political and economic capital of Algeria, has experienced the problem of acute water shortage due to rampant population growth. The capital has exercised and still exercises a power of attraction for countryside people. Consequently, water demands were constantly increasing inducing pressure on water resources. The supply from available water resources could not meet appropriate consumption. This situation has been exacerbated by cyclical droughts.

In order to overcome water shortages, Algerian government has launched major infrastructure projects consisting of new dams and desalination plants. Nevertheless, the

current water supply system shows vulnerability vis-à-vis several factors. Threats to groundwater table and climatic hazards are the main elements undermining the system. But the paradox in a reputed arid country, water is not used optimally. Algerian authorities have focused on a policy of supply. Few actions were conducted to influence the evolution of the water demand.

Any strategy aiming to improve the efficiency of water use requires, in addition to a policy of improving supply, an understanding of how the water is used and how the water saving can be achieved. Several studies have been conducted worldwide to determine the major drivers of urban water use and consumption. The objective is to reduce freshwater demand.

Household water consumption is influenced by many determinants related to economic, social and environmental factors (Alcamo et al., 2003 ; Zhang and Brown, 2005 ; Schleich and Hillenbrand, 2009 ; Corbella & Pujol, 2009 ; Suzuki et al., 2010 ; Rathnayaka et al., 2011 ; Rockaway et al., 2001 ; Ouyang et al., 2013 ; Stoker and Rothfeder, 2014). Managing the demand side of household water consumption in Algiers should be undertaken in order to achieve an efficient use of water resources.

The remainder of the paper is organized as follows. We give in section 2 an overview of the spatial expansion of Algiers and the related population growth. In section 3, we address on the one hand the successive institutional reforms undertaken by the Algerian government to promote more efficient water resources management and on the other hand the hydraulic infrastructures implemented to meet the growing demand of water. The evolution of per capita per day water consumption across the municipalities of Algiers from independence to present day is highlighted. Section 4 is devoted to the limitations of the pursued supply oriented-policy. We outline in section 5, the determinants of household water use in Algiers. Section 6 concludes the paper.

2 Spatial expansion and demographic growth

After independence in 1962, Algiers has experienced a massive influx of population within the country looking for better living standards. This trend continues to the present day. The city has gradually spread to support the ever increasing population. Table 1 shows the number of inhabitants given by the successive general national censuses (ONS, 2009).

General Census	1966	1977	1987	1998	2008
Population	989,526	1,436,141	2,015,374	2,561,992	2,988,145

Table 1: Algiers Population Growth.

In the beginning, following the COMEDOR (1968) committee recommendations and thereafter POG plan (COMEDOR, 1975), the expansion was towards the east for reasons related to the topography of the site. These measures attracted more population: workforce and their families. The urban master plan referred to as PUD (CNERU, 1983) elaborated between 1981 and 1983, has made a sudden change of the expansion direction. The city has to extend to the southwest on the hills of Algiers Sahel. A policy of individual housing was encouraged leading to urban sprawl. With interruption of the electoral process in 1992, Algeria has entered a period of political turbulence. The urban plan referred to as PDAU initiated in 1991 was adopted in 1995 (CNERU, 1995) without any consultation. Urban development was no longer a priority. The development of the city was made in all directions

without a clear strategy. The spatial extent of Algiers has progressively expanded until 1997 to include 57 municipalities. The main changes in administrative boundaries of Algiers are shown in Figure 1. This urban growth has led to a significant pressure on available natural resources.

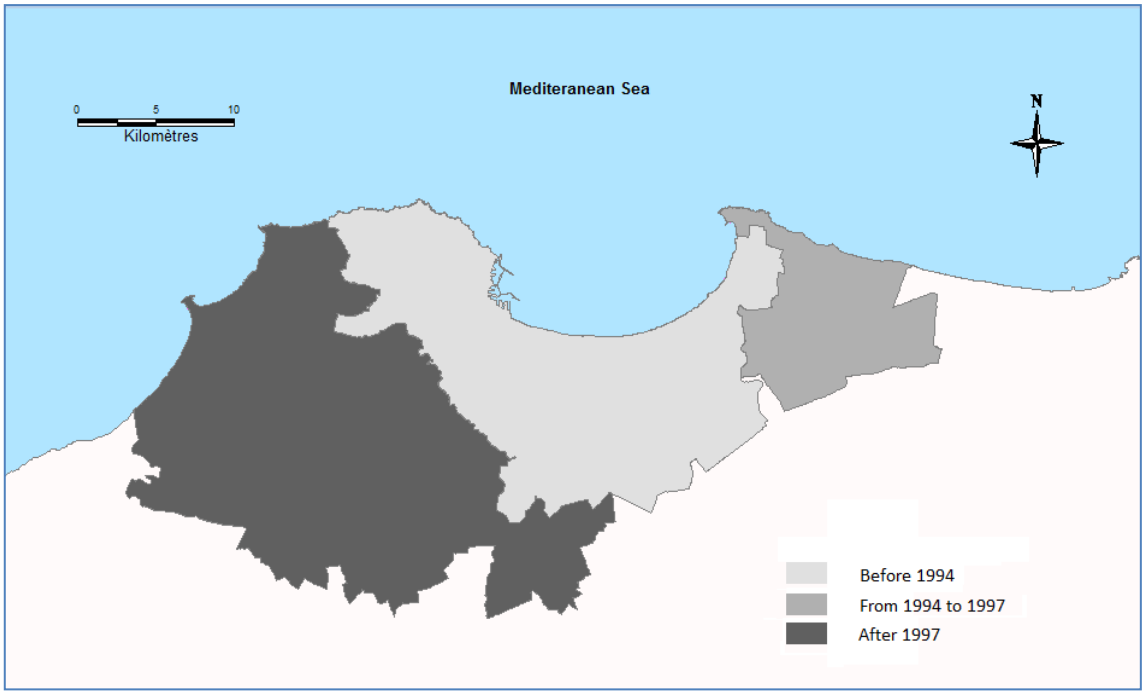

Figure 1. Changes in administrative boundaries

3 Household water issues: from independence to present day

3.1 From independence to 1976: an era of recklessness

During this period, there was no water policy. Algiers was supplied with water from Mitidja and Sahel underground aquifers (see figure 4). The millennium water resource was sufficient to meet the needs of the population. The lack of a water policy induced wasteful behaviours. Use of water meters was not systematic and water was ceded at symbolic prices. This situation was not long before producing adverse effects on water resources. During this period, there was no hydraulic strategy for surface water mobilization. It should also be noted that the urban planning instruments did not take into account the water supply issues.

3.2 From 1977 to 1992: A fledgling water strategy

With the ever-growing population, the apparent effects of water policy lack began to be felt. Contribution of aquifers has become insufficient to meet the needs of residents. Increases in water consumption drained underground aquifers faster than they can be replenished. Water cuts become the daily of Algiers inhabitants. A program of water rationing was established in 1978. Policymakers have realized the importance of the rational management of water resources. A Ministry of Hydraulics was established in 1977. In the same year, a public company called SEDAL (1977) was responsible for the management of drinking water supply and sanitation in Algiers.

In order to increase the capacity of water supply, it was decided to mobilize the surface water resources located in far off places. In 1981, a hydraulic plan was adopted which provides for the realization of several dams. A law on water code was adopted in 1983 (law n° 83-17, July 16, 1983). The National Agency for Dams and Transfers ANBT was established by executive decree n° 85-163 of 16 July, 1985. The first system to transfer water from dams to the city referred to as SPIK became operational in 1987. The SPIK system involves Keddara, Hamiz, Beni-Amrane and Koudiet-Acerdoune dams (see figure 4).

In 1992, a public company referred to as EPEAL was created to manage Algiers water supply and sanitation. After a clear improvement of the water supply for the population, water shortages have re-emerged after a short period of time (Chikhr-Saidi, 1997). The water supply policy was one step behind. It should be noted that there were disparities in the allocation of water to various municipalities of the capital. Although located on the heights of the city, upscale neighbourhoods benefited a water daily supply over 100 litres per capita per day (see figure 2).

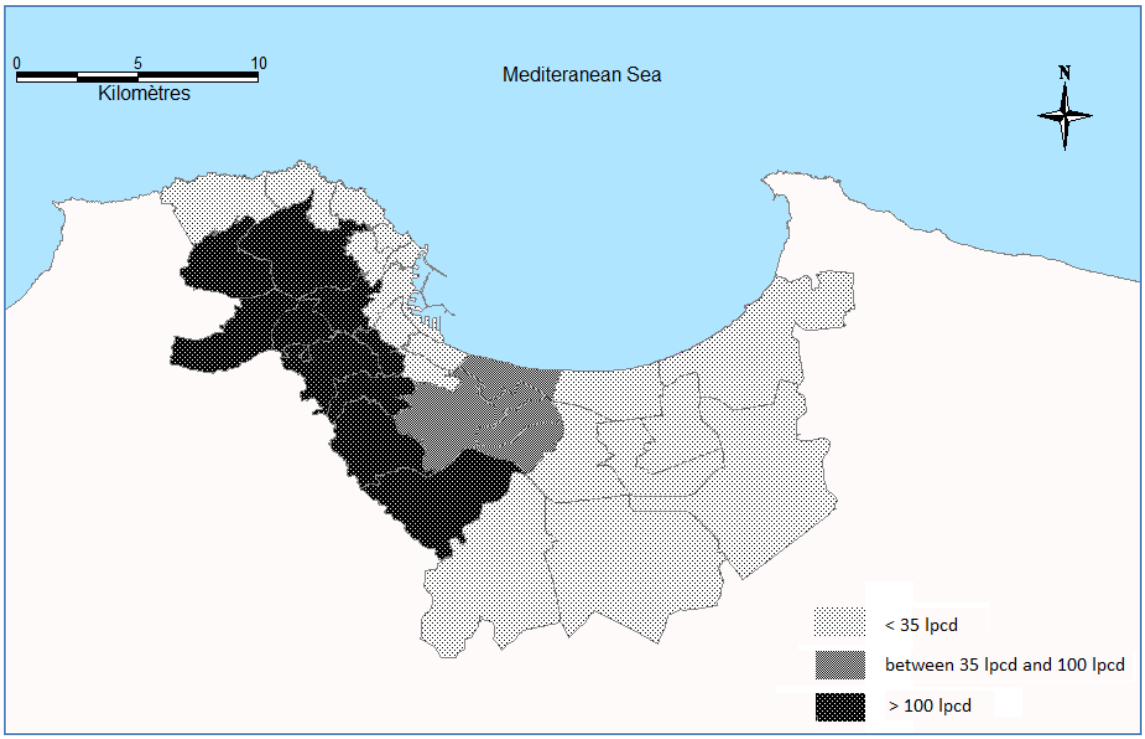

Figure 2. Household consumption in 1992

3.3 From 1993 to 1999: A downturn era

With the entry into a period of political instability, water supply of residents has worsened. The financial crisis experienced by the country during that period did not help matters. All infrastructure programs were interrupted. The use of jerry-cans and tanks took on enormous proportions. Filling jerry-cans and tanks became a national sport. A song written by Salah Ougrout, a famous humorist, whose lyrics describe the daily has become very popular: "*water flows through the taps in the middle of the night, wake up and fill …*". Water supply took a lot of time and effort to households. In 1999, many neighbourhoods of Algiers were still supplied every two days (see figure 3).

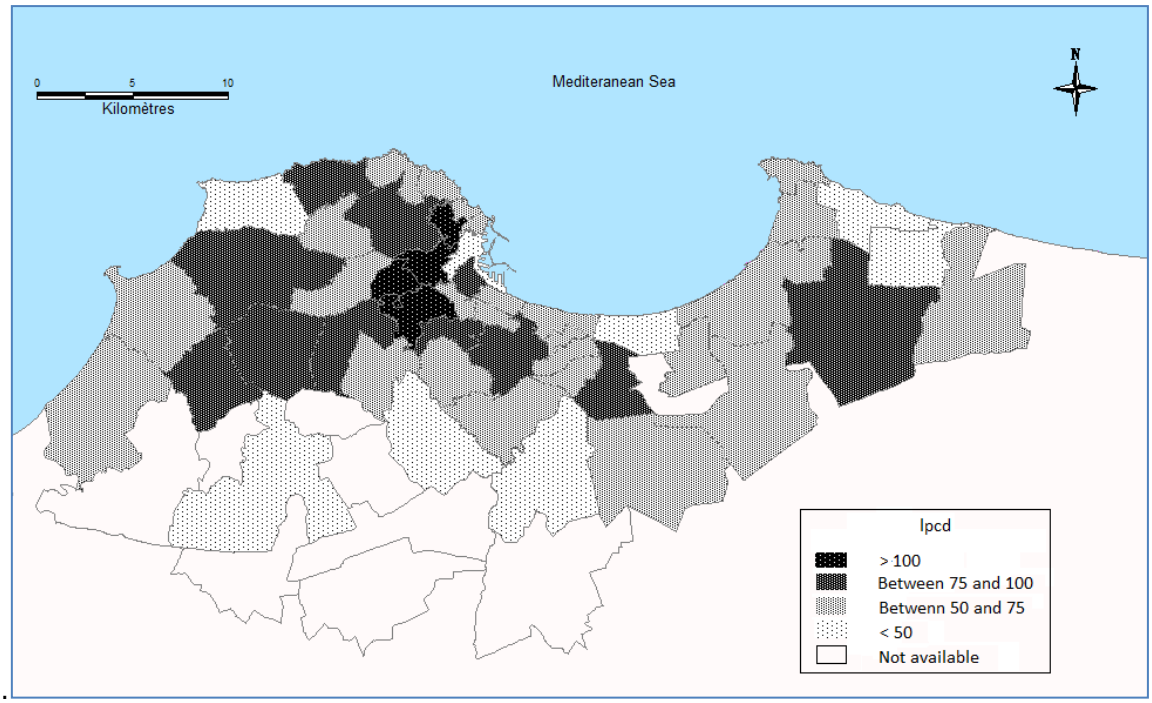

Figure 3. Household consumption in 1999.

3.4 From 2000 to present: Increasing supply at all costs

With the end of political turbulences, the water policy has become a central focus of the government. A specific ministry of water resources, that gathers all water issues, was created in 2000 (executive decree n° 2000-325, October 25, 2000). Its mission is to structure the sector in a comprehensive manner by supervising all matters relating to water: drinking water supply and wastewater elimination. Two bodies referred to as ADE and ONA, are respectively in charge of water supply and sanitation. The creation of these two structures restores some order in water management. With a newfound financial health, infrastructure projects have been revived. The SAA transfer system involving Boukedane, Bouroumi and Ghrib dams (see figure 4) had been put into service in 2002.

Despite these efforts, water supply was not keeping pace with consumption, drought exacerbating this gap. The option of desalination has emerged. The government has launched several projects of desalination plants in order to support the water supply of the agglomeration of Algiers. A new law on water was established in 2005 (law n° 05-12, August 04, 2005). The main principles of sustainable development are the guideline of that law. The opening to private management was consecrated. Since 2006, urban water supply is managed by a public company SEAAL in cooperation with a private partner SUEZ environment. In 2008, a new transfer from Taksebt dam was put into service. From 2008, desalinated water has been a non-negligible part of the water supply of the capital. Desalinated water mainly comes from two plants located in Hamma (in service in 2008) and Fouka (in service in 2011). An additive supply comes from SDEM system (mono-bloc stations).

Different sources of the current water supply system are shown in figure 4. The government has succeeded to supply water to the city 24 hours a day. Since 2011, Consumption per capita per day has exceeded 130 litres in Algiers (Naimi-Ait-Aoudia & Berezowska-Azzag, 2014).

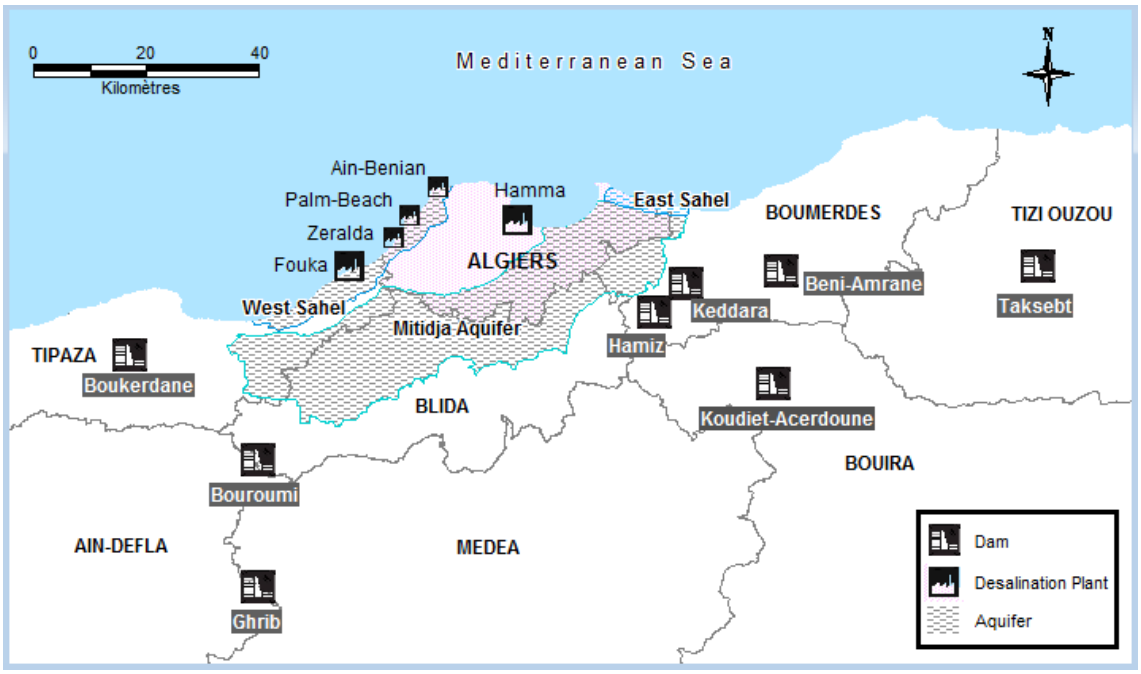

Figure 4. Water supply system

3.5 Water supply evolution related to consumption standards

Right after independence, adequate water supply for residents of the capital did not arise as the historical artesian resource was fully sufficient. With the increase of the population, water shortages have begun to be felt. Daily consumption of the inhabitants was below generally admitted standards. Water could only be provided once every two days and even once every three days in some neighborhoods. A strategy has been implemented by the Algerian government to overcome shortages problems. However, due to the lack of sufficient financial means, the projects planned were unable to be completed. Algiers was still thirsty. With the return of stability combined with financial ease due to oil revenues, all projects were carried out. New hydraulic infrastructures were completed. This has significantly improved the level of daily water consumption of Algiers inhabitants which has now become comparable to those in cities of developed countries as shown in figure 5.

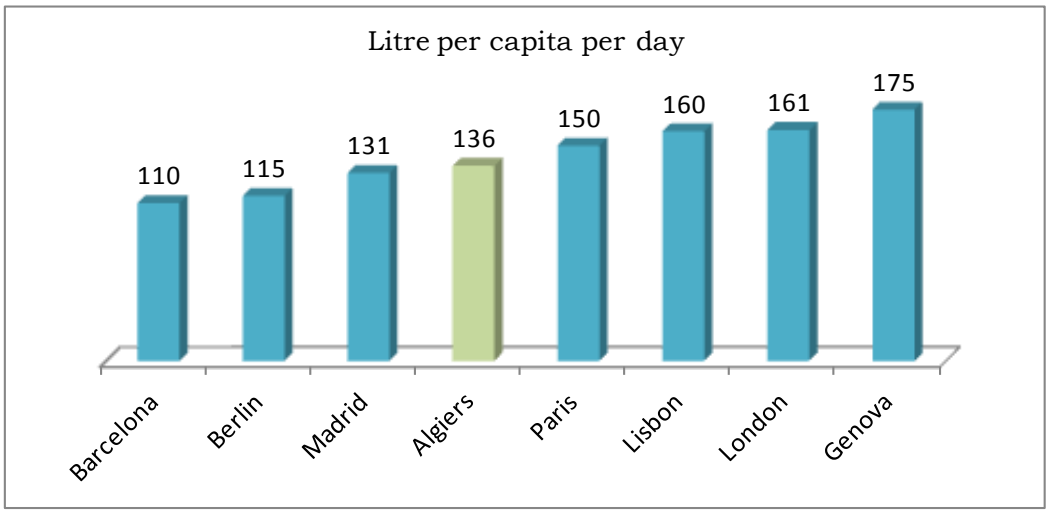

Figure 5. Household water consumption in Algiers and some European cities

4 The limitations of a supply-oriented policy

The Algerian government has exclusively focused on water supply-side management, investing largely in new infrastructure, to meet the water needs of residents. Such a policy is not exempt from several flaws.

4.1 Balance between water supply and demand

According to UN demographic projections (UNDESA, 2012) shown in Table 2, Algiers population will be around 4,000,000 in 2025. This population growth will inevitably cause an important increase in water demand. Household water needs for different service levels are shown in figure 5. The choice of service levels 100, 150 and 200 lpcd (litres per capita per day) is based on the recommendations of the World Health Organization (WHO, 2011), which sets the interval from 100 to 200 litres per capita per day as an adequate consumption to minimize the health risk. It turns out that the related water needs vary considerably.

The amounts of water delivered by the supply system in place, which can be considerably reduced in times of drought, couldn't satisfy the ever-growing demand (Naimi-Ait-Aoudia et al., 2014). A policy focusing only on offer will lead to heavy investments in new water mobilization infrastructures.

Population growth combined with the threat of global warming have led water managers and planners to think critically about current and future household water needs and how best to meet them. It is therefore necessary to analyze thoroughly patterns of domestic consumption with a view to an overall reduction of demand through optimal use of water.

Year	2015	2020	2025
Population	3,303,000	3,608,000	3,977,000

Table 2: Algiers Population Forecast.

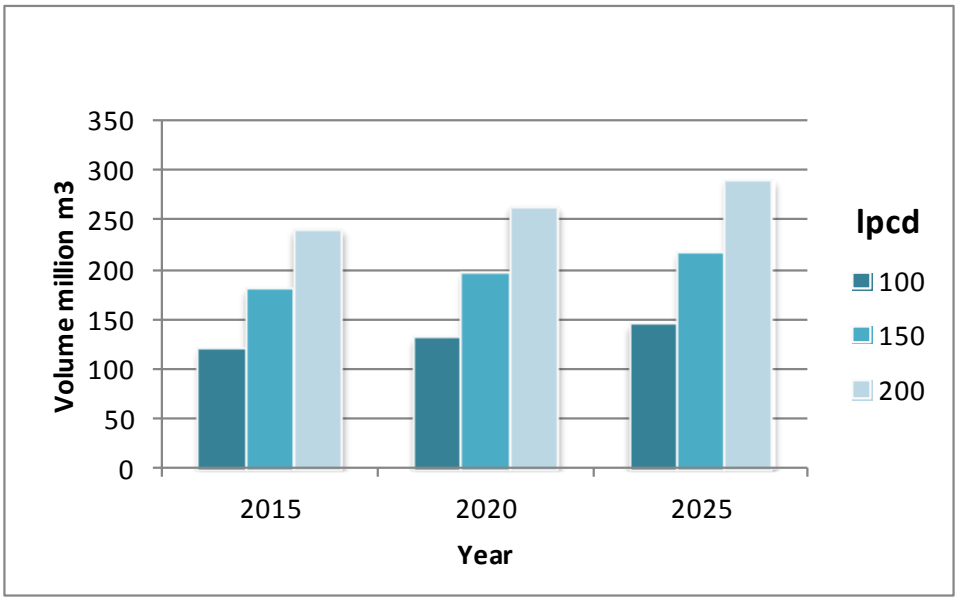

Figure 6. Domestic water needs.

4.2 Water costs

The means used for the mobilization of water generate environmental, social and economic costs. Due to groundwater overexploitation, Mitidja and Sahel aquifers are threatened with depletion. Even worse, their proximity to the sea makes them prone to the phenomenon of seawater intrusion that will make them definitely unusable.

Surface water mobilized to meet the needs of Algiers inhabitants, which comes from remote areas, requires high costs. Moreover, water availability for Algiers citizens is achieved at the expense of their neighbours.

As regards unconventional water sources, although large-scale desalination has at least 50 years of existence, there are still many knowledge gaps and uncertainties regarding environmental, socioeconomic, and human health impacts of this water product process (Cotruvo et al., 2011). In addition, costs of desalinated water remain relatively high, compared with those associated with groundwater and surface water withdrawals.

Water prices are government-subsidized. The overall cost concerning the mobilization and distribution of water is borne at 70% by the Government. The retail rates set by the Government do not allow the sector companies to cover their operating costs. Subsidized water pricing has a negative effect on efficient water use because it encourages wastefulness but the dilemma is that if the Government withdraws its subsidy, the price of water will soar and low-income citizens will no longer afford adequate consumption.

5 Demand reduction: henceforth a preoccupation in water management

Historically, water managers have focused on supply-side management and means of water resources mobilizing. However, a new orientation points to managing the demand side of household water consumption. The goal is an optimal use of water resources to meet the needs of people without recourse to new large-scale infrastructure and thus avoid adverse environmental effects that may result. Water demand reduction would henceforth be a matter of concern.

5.1 Household water use determinants

Several studies have identified many determinants that greatly affect domestic consumption. Arbuès et al. (2003), Grafton et al. (2011) and Kertous (2012) have focused on the price of water as a factor in reducing demand. Other studies have highlighted equally important determinants which are either, economic, social, climatic, policy or behavioural. Cooley & Gleick (2009) identified as the most significant determinants of domestic consumption, population growth, climate change and the type of urban development. House-Peters et al. (2010) have investigated the effects of urban spatial structure, socio-demographics, and climate on residential water consumption. Jorgensen et al. (2009) have focused on household water use behaviour. Slavíková et al. (2013) studied Impacts of climate variables on residential water consumption. De Maria André et al. (2014) focused on spatial determinants of urban residential water demand.

In sum, determinants of household use can be classified in six major categories: water supply, demographics, climate variables, policy variables, built environment and socio-economic variables as shown in figure 6. Each category involves several variables.

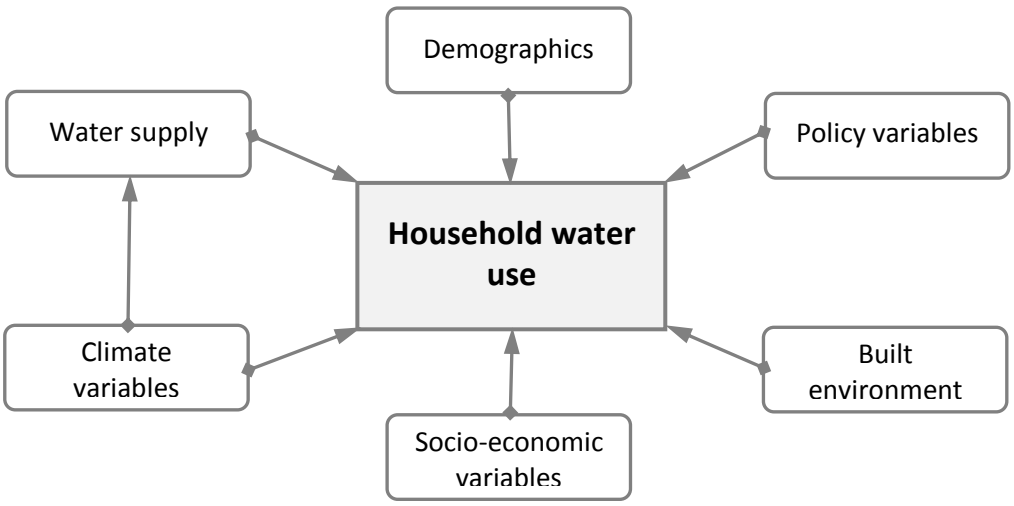

Figure 7. Determinants of household water use.

The main variables related to the determinants of domestic consumption are given below. For Water supply, these variables are summarized in natural supply potential and mobilization infrastructure. The Demographics variables are population growth and household size. Temperature and rainfall are the main climate variables affecting both supply and household consumption patterns. Policy variables such as water price and incentives are levers to regulate consumption. Dwelling characteristics and urban structure are built environment variables. Income and behaviour are socio-economic variables playing a key role in water consumption.

5.2 Levers for reducing Algiers household water demand

For an optimal management of water resources, a thorough analysis of the determinants of domestic consumption is necessary with a view to defining action levers ultimately aiming at water demand reduction. This strategy is based on two major axes consisting in encouraging water conservation and combating wastage in all its forms.

The network losses, which are of the order of 30%, are fairly important in a country with limited water resources. These losses are due to poor connections, leaks, ruptures, and theft. The water distribution system in the centre of Algiers is obsolete and generates considerable loss of water. The hunt for leaks by the renovation of defective pipes is necessary. Theft, by bypassing meters, is a scourge to be strongly fought because in addition to revenue losses, it generates wasteful behaviour.

Usage of household water saving equipments such as low-flow toilets, shut-off valves, low-water washing machines and dishwashers must be encouraged to minimize water use. Current house-cleaning habits use excessive amounts of water that can be significantly reduced. Installation of modern rainwater harvesting systems should also be encouraged through incentives. Rainwater thus collected can be used for domestic purposes like flushing toilets, laundry, gardening, and washing cars. This can significantly reduce home water demand.

In a country facing fresh water scarcity, recourse to alternative water resources turns out to be indispensable. Throughout the world, water reuse has emerged as a key element of sustainable integrated water resources management. Part of fresh water for agricultural and industrial uses could be replaced by reclaimed water with the appropriate level of treatment

and thereby increasing the available volume of water for domestic use. A substantial investment in wastewater treatment plants must be undertaken so as to support this strategy.

Water pricing plays a non-negligible role in the regulation of water demand. It is from this perspective that progressive pricing was introduced in 2005 (table 3), but this measure had no impact on water consumption in Algeria (Kertous, 2013). This is partly explained by the small difference between the third and the fourth ranges of the fee schedule. An upward revaluation of the fourth range is essential to encourage consumers to show restraint.

	m^3 / trimester	Tariff per m^3
Range 1	[0-25 m^3]	6.30 DA (0.06 EUR)
Range 2	[25-55 m^3]	20.48 DA (0.19 EUR)
Range 3	[55-82 m^3]	34.65 DA (0.32 EUR)
Range 4	> 82 m^3	40.95 DA (0.38 EUR)

Table 3: Tiered pricing structure applicable in Algeria

In general, residents adopt saving behaviours if they are motivated to do so. Education, public awareness and government incentives are the main motivations that play a key role in long-term change in water consumption patterns.

6 Conclusion

It is undeniable that huge efforts have been made to secure the water supply of Algiers. During the last two years, water flowed 24 hours a day into taps. The level of household consumption has become comparable to that of countries of the northern shore of the Mediterranean. Nevertheless, focusing solely on a supply-oriented policy can be costly in economic and environmental terms. Water recycling, which is at an embryonic stage in Algeria, should be privileged in order to reduce consumption of fresh water. The efficient and effective integrated management of water resources must be a priority.

The management of water demand as much as on supply is of critical importance in a country with limited fresh water resources. Reducing water demand must be a major long-term challenge for the management of water resources that integrates sustainability issues in terms of environmental and economic dimensions. The ultimate aim is to consume less by consuming better.

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