THE DECLINE OF WATER CONSUMPTION IN SPANISH CITIES: STRUCTURAL AND CONTINGENT FACTORS

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Abstract

As cities will concentrate most of the world population and economic activities, urban water demand will absorb a large proportion of global water demand in the future. In contrast, recent empirical evidence indicates that water consumption in many cities of the developed world is declining. In this paper, this decline in consumption is studied for the major Spanish cities and some of the drivers of this decline (economic, technological and behavioral) are explored. The paper also argues that contingent events such as droughts and economic crises may intensify the decline in consumption as shown for the case of Barcelona.

Key Words: Water, cities, declining consumptions, impacts, Spain, Barcelona

Introduction

Past trends and future projections on worldwide water demand and consumption coincide in pointing towards a continued expansion that, despite regional variations, may intensify in the next decades due to population growth and economic development (Alcamo et al 2007; Flörke et al 2013; Wada et al 2016). A significant amount of this growth will occur in cities and especially in the mega capitals of the developing world (United Nations 2018a). Even though irrigation will still be by far the highest driver of global water demand, manufacturing (including energy) and urban uses will experience the fastest growth rates (Hejazi et al 2013).

Because of the increase in water demand, world freshwater supplies are projected to come under mounting pressures. In some world regions, water stress will probably be exacerbated by climate change and related hazards, especially beyond the 1.5 °C scenario (IPCC 2018). Thus water scarcity conditions, either temporal or permanent, are foreseen for some of the most populated areas of the world including the booming cities of the Global South.

The combination between increasing demand and dwindling supplies poses an enormous challenge to urban and water planners and decision makers worldwide with drastic changes needed if goals of safe and reliable water supply and sanitation for all are to be met (Tortajada and Biswas, 2017). Domestic water supply and consumption is already at the top of the agenda of many international organizations and programs such as the Sustainable Development Goals (United Nations 2018b). Differences between cities of the Global North and of the Global South regarding access to water supply must be considered along with internal differences in these

cities. In some urban areas of the Global North, for instance, access to water may not be limited by lack of infrastructure but by lack of capacity to afford costs while in cities of the Global South stark differences in access can be found between the so called “formal city” and the “informal city” with water comparatively more expensive in the latter than in the former (Swyngedouw 2004).

This global picture of increasing consumption, decreasing supplies, struggles for access and grim scenarios of water scarcity for many of the world cities needs to be contrasted with empirical evidence on current trends in consumption as well as in access and affordability of water. In this sense, the paper attempts to explore two hypotheses. First, that domestic consumption does not follow an increasing trend everywhere. Rather, and at least for many urban areas of the developed world, evidence points at reductions in consumption (Hotlos et al 2012; DeOreo and Mayer 2012; Donnelly and Cooley, 2015; March and Sauri, 2015 ; Baldino and Sauri, 2018; Rockaway 2011; Cahill and Lund, 2013; Stavenhagen et al 2018). Second, in this process of declining consumption inequities may appear through, for instance, higher economic costs for vulnerable consumers (Aqua Publica Europea, 2016 ; Mack and Wrase 2017; Morote et al 2016).

The hypotheses stated above will be examined by looking at the case of water consumption trends in the eight largest Spanish cities for the period 2003- 2016. This period has been selected according to data availability and to the fact that the year 2003 recorded a peak in water consumption for many Spanish cities. In examining water consumption decline, the paper will differentiate between structural causes or long term factors eliciting purposeful and non-purposeful actions, and contingent factors such as severe droughts or periods of economic and social hardship. Next and focusing on the Spanish case, the specific impacts of structural trends in economic and financial aspects, technology and behavior, and also the impact of contingent natural and social events in domestic water consumption will be examined. The paper will make a special reference to the case of the Metropolitan Area of Barcelona which suffered two almost consecutive events with strong impacts on water consumption: the drought of 2007-2008 and the economic crisis beginning in 2008 and extending during the following decade. Methods used included a review of existing literature on the subject of factors behind water consumption decline and data compilation and analysis on recent water consumption for the main Spanish cities. In the context of this paper consumption in cities refers to domestic consumption and not to industrial, commercial or municipal consumption. Typically, in Spain domestic consumption represents about 65 per cent of total urban consumption.

The paper is organized as follows. First, a brief contextual account on water in Spain, emphasizing the high exposure to current and future climatic extremes and present trends in domestic water consumption for the eight largest Spanish cities is provided. Second, the paper introduces the main drivers of domestic water consumption decline and characterizes them for the Spanish case. Third, and in order to illustrate the relevance of structural and contingent factors in domestic water decline, a special reference to the Metropolitan Area of Barcelona, suffering consecutively a major drought and a long period of economic crisis, is made. Fourth, in the conclusions, the paper attempts to cast lights (growing citizen awareness for water conservation, for instance) and shadows (affordability issues for vulnerable populations) on this decline.

The decline of domestic water consumption in Spain

The climate of Spain can be generally defined as Mediterranean except from the Northern and Northwestern areas where patterns are more Atlantic. Average precipitation attains some 630 mm annually with strong differences between the rainy North (Cantabria coast, 1700mm per year) and the arid Southeast (less than 200 mm a year). Climate change projections point at a reduction of precipitation values towards the middle of the 21st century and beyond accompanied by an intensification of hydrological extremes (Moreno-Rodriguez, 2005). Droughts, in particular, are recurrent phenomena in the Iberian Peninsula and, as it is common in Mediterranean climates, may last several years (Olcina 2001) During the last decades the most important droughts, affecting different parts of Spain, were those of 1980-83; 1991-95; 2005-2005-2008, and 2014-2017 (Tejedor et al 2016; Villarreal et al 2017). Dryland agriculture in Central and Southern Spain; irrigated agriculture in Eastern and Southeastern Spain and cities also in Central, Southern and Eastern Spain as well as the Balearic Islands are especially exposed. Many cities including Seville, Palma de Mallorca, Tarragona or Cadiz have suffered domestic cuts (Seville only had water 10 hours a day in 1993-94) and some, such as Mallorca or Barcelona had to be supplied by trucks or even by tankers during drought crises (March et al 2013).

Urban water supply barely represents some 15 percent of total water use in Spain which is overwhelmingly dominated by irrigation. Data for the period 2000-2014 shows how water distributed and metered in Spanish municipalities has decreased by 17% (INE, 2016). Most of this decrease has concentrated in municipal and commercial/industrial uses (36 percent reduction for the former and 18.5 percent reduction for the later), reflecting a variety of causes such as the effects of economic restructuring and the shutdown of manufacturing activities; budgetary

deficits in many municipalities as well as gains in efficiency and use of alternative resources. Domestic consumption increased its proportion over the total (from 65 to almost 70 percent) decreasing less (11 percent) than productive sectors or municipal uses. Overall, average domestic consumption per capita fell 27 percent during the period, from 168 liters/person/day (lpd) to 132 lpd. Per capita consumptions tend to be higher in medium and smaller municipalities and below the average in larger municipalities (INE, 2016).

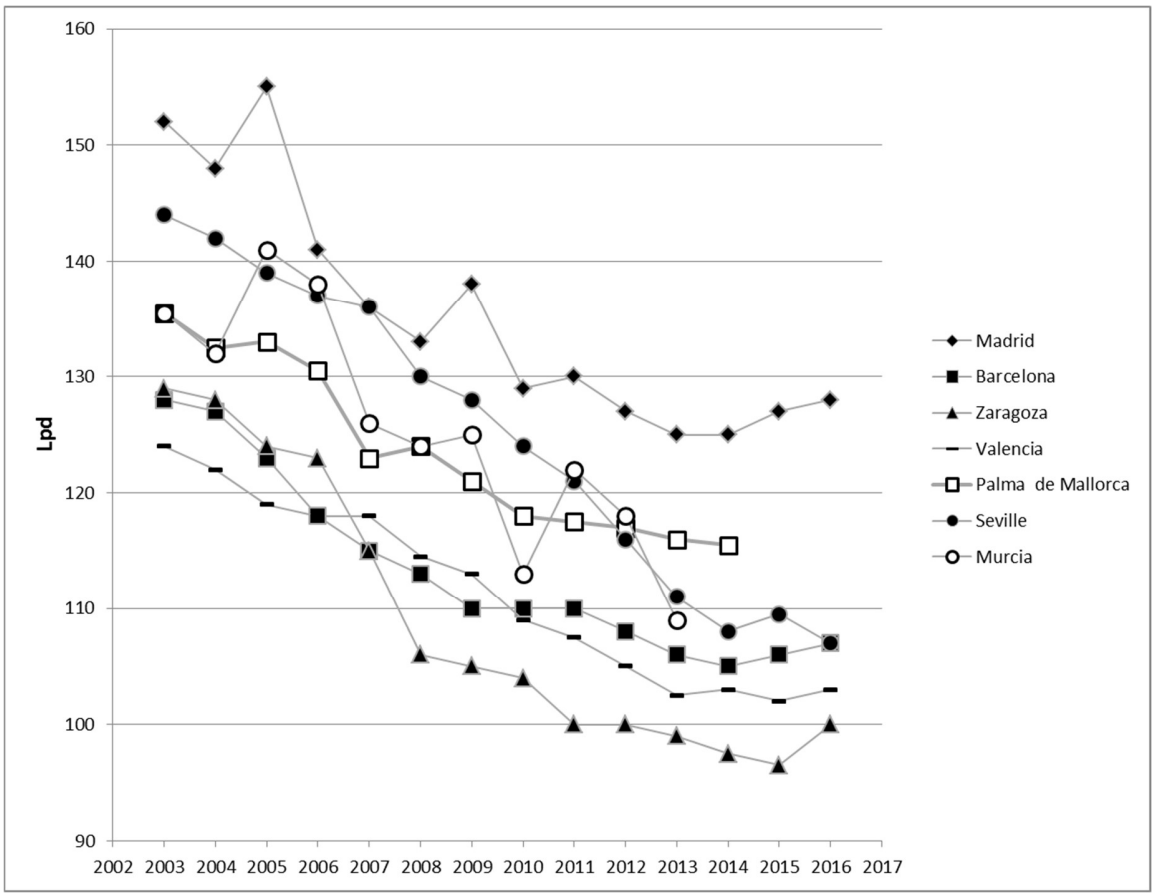
The decrease in domestic water consumption is especially significant in large cities. Table 1 and Figure 1 show the change in domestic water consumption (in lpd) for the seven largest Spanish cities (population above 400,000 people) between 2003 and 2016.

Table 1. Domestic water consumption for selected Spanish cities [2003-2016] (liters/person/day, lpd)

Year	Madrid	Barcelona	Zaragoza	Valencia	Palma de Mallorca	Seville	Murcia
2003	152	128	129	124	135,5	144	135,5
2004	148	127	128	122	132,5	142	132
2005	155	123	124	119	133	139	141
2006	141	118	123	118	130,5	137	138
2007	136	115	115	118	123	136	126
2008	133	113	106	114,5	124	130	124
2009	138	110	105	113	121	128	125
2010	129	110	104	109	118	124	113
2011	130	110	100	107,5	117,5	121	122
2012	127	108	100	105	117	116	118
2013	125	106	99	102,5	116	111	109
2014	125	105	97,5	103	115,5	108	
2015	127	106	96,5	102		109,5	
2016	128	107	100	103		107	

Source: Compiled from information by City Councils and municipal or metropolitan water companies.

Figure 1. Domestic water consumption (liters/person/day) for selected Spanish cities. 2003-2016



Source: Elaborated from data in Table 1

On average, for the seven cities domestic water consumption declined from 135 lpd in 2003 to 110 lpd in 2016; that is a reduction of almost 23 percent. The highest decline occurred in Seville (34.5 percent) while the lowest was registered in Palma de Mallorca (15 percent). In both years the highest per capita consumption was recorded in Madrid while the lowest value was found in Valencia for 2003 and in Zaragoza for 2016.

Regarding population, some cities such as Seville lost population (probably to their metropolitan areas). Others increased their numbers but relatively little (Madrid, Barcelona, and Valencia) while others expanded more vigorously (Zaragoza, and especially Palma de Mallorca and Murcia). The evolution of population figures in all cities does not follow a steady pattern during the period considered. Rather, there are periods of population growth (up to 2009-2011 in most cases) followed by periods of population decline. Average domestic water consumption; however, does

not seem to be affected by population trends and consistently declines in both, periods of population growth and in periods of population decline (Table 2). What is remarkable is that cities experiencing important population expansion, such as Murcia or Palma de Mallorca, continue reducing their per capita water consumption.

Table 2. Change in water consumption (lpd) and change in population. Selected Spanish cities 2003-2016

City	Change in water Consumption	Change in population
Madrid	-15.79	2.35
Barcelona	-16.4	1.64
Valencia	-16.94	1.22
Seville	-25.69	-2.73
Zaragoza	-22.48	5.59
Murcia (*)	-19.47	12
Palma Mallorca (**)	-14.76	8.7

(*) 2003- 2013

(**) 2003-2014

Source: Own elaboration

Next, these changes in domestic water consumption are assessed in the light of the three main factors outlined above: economic, technological, and behavioral, and their specific role in water demand management in Spain (Tortajada et al, 2019).

Economic factors

The effects of economic instruments such as prices and taxes on domestic water demand have been long studied in urban water management. Economic instruments remain widely favored in water policy, for example in OECD documents (OECD 1999) or in the European Water Framework Directive of 2000 (Bithas 2008). The argument is that, in many cases, water conservation cannot advance because water prices and taxes are too low and far from covering the full costs of the water cycle. Therefore, rises in prices and taxation would lead to more responsible consumption (Howe, 1982; Rogers et al 2002; Reynaud and Romano 2018). However, since water is a fundamental, non-substitutable component of human life, in economic terms it tends to be more responsive to prices for non-essential uses than for essential uses so that the demand of the latter

is inelastic (Dalhuisen et al. 2003). Policies addressed to curb consumption therefore need to be attentive to balance equity and efficiency and not translate the conservation burden to essential uses (Billings and Aghte, 1980 ; Nieswiadomy and Cobb, 1993; Renwick and Archibald, 1998; Garcia Valiñas 2005; Raynaud, 2016). .

In Spain, water prices show an enormous disparity (Bagué et al 2013). Generally water is more expensive in the Mediterranean coast and in the islands and less expensive in the interior and in the Northern regions. In 2016, Murcia and Barcelona, with water bills above 500 euros per year for a consumption of 175 m^3 (average consumption of a 4 member household), topped the ranking of Spanish cities, followed by Palma de Mallorca (441 euros), Seville (394 euros) and Valencia (376 euros). At the other extreme, the cost for a similar consumption in Madrid was of 271 euros and in Zaragoza of 269 euros (OCU 2016). Water companies and public agencies with responsibilities in the water cycle resorted to rising prices and taxes to equilibrate their budgets during the worst years of the economic crisis (March ad Sauri, 2013). According to OCU (2016), water bills in Spanish cities rose 29 percent on average between 2009 and 2016, period which coincided with the hardest years of the economic crisis. For example, between 2009 and 2013 unemployment had risen to 25 percent of the working population. Moreover, in 2013, 17 percent of households declared "a lot of difficulty in arriving at the end of the month" up from 10.7 percent in 2007 (INE, 2013).

Technological factors

Technology and its application at multiple scales is also a major player in the reduction of water consumption. In urban areas, technology has been used to improve the efficiency of the supply network by detecting and repairing leaks and other causes of water losses and by ensuring more precise methods for recording consumption including meters and more recently "smart" meters (Boyle et al 2013). Water saving technology has entered households, especially in bathrooms and kitchens prompting multiple studies on the relationships between these technologies and behavior by consumers (Makki et al 2011; Richter and Stamminger 2012; Lee et al 2013) . Fixtures such as low flow toilets or pressure reductors in taps are now much more common than in the past. Likewise, dishwashers and washing machines have achieved considerable reductions in the amount of water they use. However, one important caveat regarding domestic water saving technologies is that these technologies may be costly and therefore only accessible to well off

households (Millock and Nauges, 2010). Hence, those more in need to save water in order to lower their water bills may not be able to afford these more efficient technologies.

In 2006, Spain passed The Technical Code for Buildings according to which taps, showers and WCs in new apartment and commercial blocks had to be equipped with water saving devices. However, campaigns for subsidized retrofitting as in California or Australia have been limited to the occasional distribution of small devices to regulate flows in taps and showers. Some water companies such as the *Canal de Isabel Segunda* of Madrid have been active in promoting home conservation fixtures (Cubillo et al , 2008). On the other hand, some municipalities, most notably in the Barcelona area, have passed legislation requiring mandatory use of indoor fixtures but also of alternative resources such as greywater or rainwater (Vallès-Casas et al 2016). Hotels, especially in large tourist destinations, have been keen on adopting water conservation fixtures in rooms and common areas (Gabarda-Mallorquí, 2016; Rico et al, 2019).

Behavioral factors

Changes in consumer behavior towards more responsible uses of water are also major factors in the reduction of consumption (Seelen et al 2019). Many cities and not necessarily those located in water stressed areas have implemented public communication programs advising citizens to consume less water and some sectors such as the hotel industry routinely ask customers to be more responsible in their water consumption behavior (Gossling et al 2015). Most messages target indoor uses, especially in the bathroom, while messages targeted at outdoor uses focus especially on the species composition of gardens and garden irrigation systems. Schoolchildren are a group of particular interest under the belief that, if properly educated, they may influence their parents behavior (Damerell et al 2013). The effectiveness of these campaigns, at least for cases such as that of Barcelona or of Californian and Australian cities, appears to be related to the presence or not of drought conditions and especially to the intensity of media attention (March and Sauri 2013; Quesnel and Ajami 2017).

Water conservation campaigns have been constantly present as one of the most important strategies to save water in Spanish cities since at least the droughts of the early 1980s (Del Moral and Giansante, 2000) with cities such as Zaragoza having a long and active history of water awareness actions (Staenhagen et al 2018). These campaigns are usually promoted by city councils or by water supply companies, although in some cases, provincial and regional

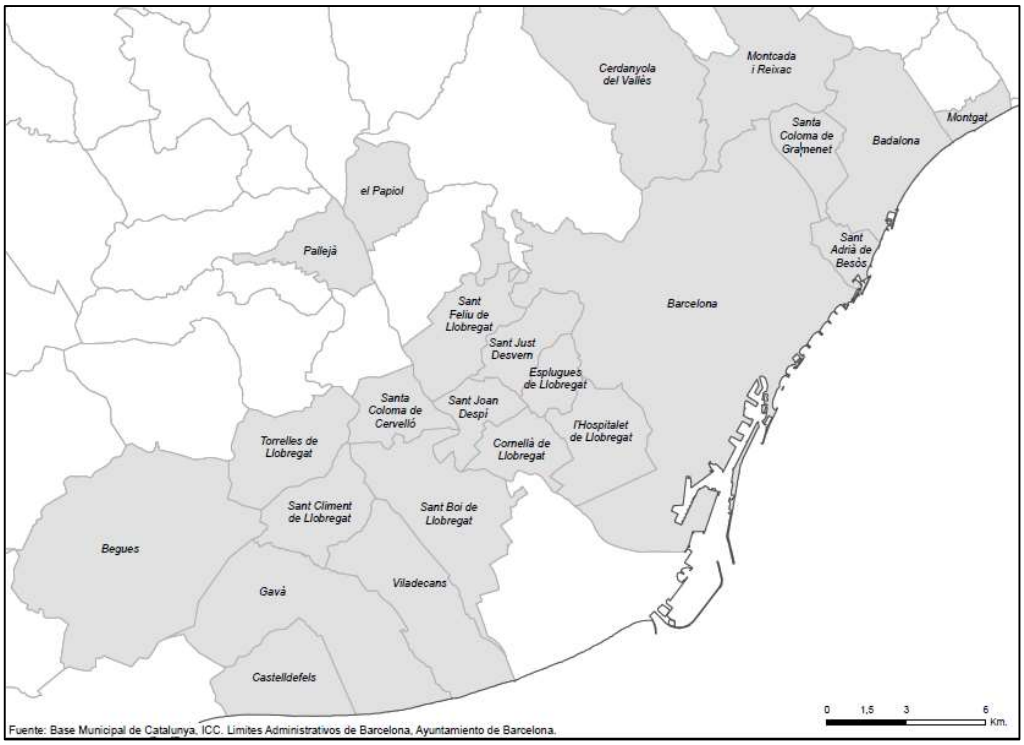
governments take also an active stance (March et al, 2013). The most common strategy is to provide extensive but easy to understand information to citizens regarding changes in consumption habits (March et al, 2015). The usual media (street advertising, radio and TV announcements, and more recently internet social networks) are profusely used. As said before, particular targets are schools and schoolchildren for whom specific tools (animated cartoons, stories, and even theater plays) are prepared (EMASA, 2019). In cities with a strong presence of international tourism such as Palma de Mallorca, campaigns are undertaken in several languages especially addressed to citizens with little or no experience in water conservation (Ibeconomía, 2016). Some campaigns may even distribute freely kits to be installed in taps or showers (March et al 2013).

The effectiveness of these campaigns is open to discussion and some of the messages passed on to consumers may not be entirely attentive to the social and urban context. For example, in Spain messages may be issued asking the public to take showers instead of baths in areas where the presence of baths in apartments is relatively small (March et al, 2015). As one would expect, campaigns work better during periods of drought mostly because of the intensification of communication efforts. For example, during the drought of Barcelona of 2008, daily news in radio, TV and the press almost always opened with news about the drought insisting time and again on the critical importance of saving water The media campaign was so intense that in a poll about the problems that raised more concern for Barcelona citizens, water appeared for the first time at the top of preoccupations and above unemployment, security and other public worries (March et al 2013).

The perfect storm. Drought and economic crisis in the Metropolitan Area of Barcelona

Contingent factors in domestic water reduction may be defined as factors or drivers that are not the product of more or less conscious decisions to save water. Rather, they tend to come in the form of relatively unexpected events that may produce important impacts on water consumption (Gil-Olcina et al, 2015) . In the case of the Metropolitan Area of Barcelona See Figure 2), two consecutive contingent factors, first, the most severe drought in more than 60 years and second, the worst economic crisis since the 1970s, had a deep and lasting effect on domestic water consumption. While the drought was unique to this area and short in duration, the economic crisis affected and still affects the rest of Spain as well producing important effects on the affordability of water (March and Sauri, 2016).

Figure 2. Municipalities of the AMB served by Aigües de Barcelona (in grey)



Source: Own elaboration. For the purposes of this paper, the Metropolitan Area of Barcelona (AMB) is constituted the 23 municipalities served by the company "Aigües de Barcelona" (Barcelona Water). Four municipalities that administratively belong to the AMB are served by different water companies and are not considered here

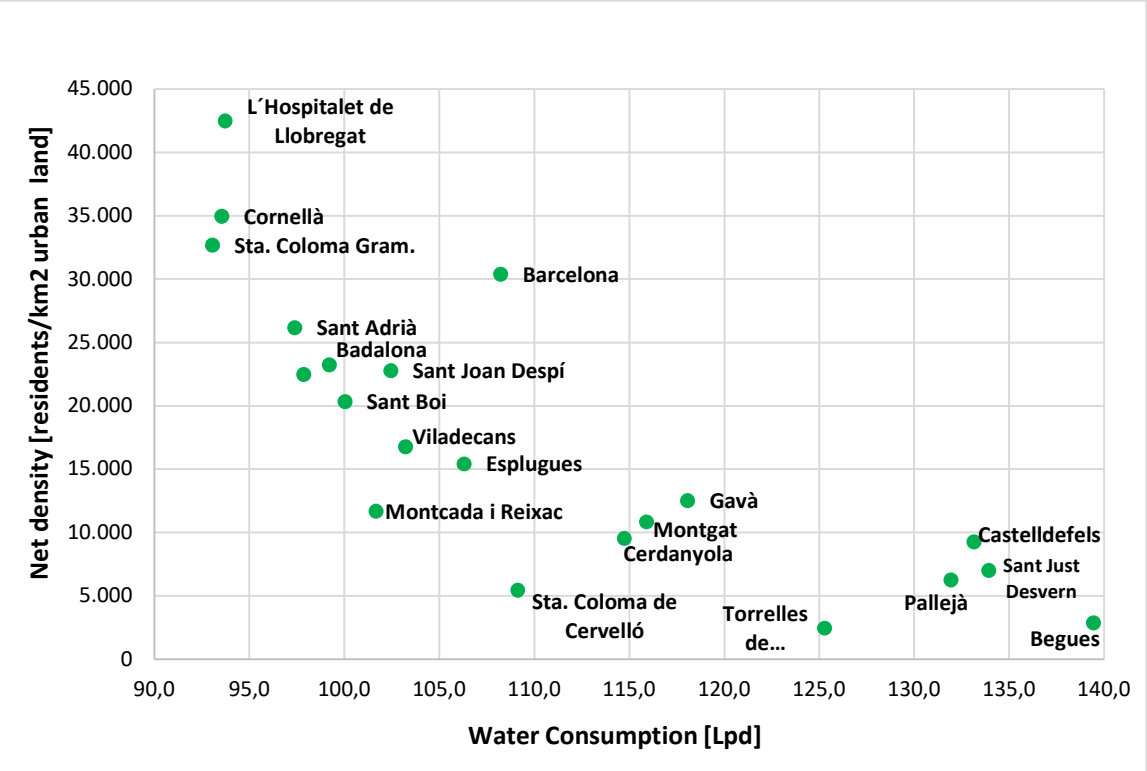
In 2008, water supply in the Metropolitan Area of Barcelona was based on surface water provided by the reservoirs of the Ter-LLobregat river system complemented with groundwater from the lower Llobregat river valley. All these sources contributed annually with some 611 Hm^3 (85 percent surface water and 15 percent groundwater) while demand was 592 Hm^3 in 2007 (ACA, 2008). These figures indicate that security margins were relatively tight, increasing the frequency of drought periods defined according to the amount of water stored in reservoirs. The worst case scenario is represented by periods with below average rainfall lasting more than a year. This is precisely what happened in 2008, when, after a rainless year, reservoirs fell to 20 percent of their capacity, requiring emergency actions such as the shipment of water with tankers from Tarragona

and Marseilles (March et al 2013). Drought protocols issued by the Catalan Water Agency mandated the prohibition of non-essential uses such as garden irrigation in cases of emergency which was made effective in the winter and early spring of 2008. Awareness campaigns already in motion intensified to include not only more messages urging to save water but also the distribution of a kit to reduce water flow in taps in the Sunday edition of the main newspapers (March et al 2013).

After a rainy period in late spring 2008 that filled the reservoirs again and just before the desalination plant of El Prat began to operate in mid-2009, the world economic crisis struck Spain very hard. Growth rates recorded negative figures and unemployment rose rapidly towards double digits. The crisis also shut down the possibility of borrowing money by public administrations and public debt soared bringing to a standstill many water related projects (March and Sauri , 2013). Response by companies and regulatory bodies was to increase water prices and taxes in a moment when incomes, especially for the poor and unemployed, fell drastically. One of the most immediate consequences of diminished incomes was that many households could not cope with utility expenses including water (Yoon 2018). Hence, the devastating combination of falling revenues and higher prices for many households inevitably led to the multiplication of payment defaults and cutoffs in the service. According to the Spanish Association of Public Companies of Water Supply and Sanitation, some 300,000 water cut-offs occurred in Spain in 2013 (El País, 2014) . Together with the energy poverty, water poverty had begun to be a familiar problem for many Spanish households.

Metropolitan Barcelona has always been characterized by a relatively modest consumption of water. Consumptions per capita tend to be is lower than in other Spanish urban areas and far behind other cities of the world with similar climatic characteristics. To a large extent this is explained by the urban layout characterized by high densities that embraces also the core cities of the metropolitan area (Domene and Sauri, 2006). Therefore, in the Metropolitan Area of Barcelona most of the domestic uses of water are indoor uses, although a few small towns of the peripheries of the Metropolitan Area follow the low density pattern in which with outdoor uses more common, especially gardens and swimming pools. Figure 3 shows the relationship between urban density and relative domestic water consumption in the area.

Figure 3. Urban density and water consumption in the Metropolitan Area of Barcelona



Source: Elaborated with data from Aigües de Barcelona and Corinne Land Cover map (2012)

The evolution of domestic water consumption during the last three decades is characterized by a certain growth from 1994 to 2003 and by a steady decrease since that year (March at al , 2012). The peak of 2003 may be related to the summer heatwave of that year which boosted domestic demand but it is probably an anomaly since consumption may have started to decline already in the 1990s (March et al, 2013; March and Sauri, 2016).

Table 3 shows the evolution of water consumption in the Metropolitan Area of Barcelona for the period 2007-2013, differentiating between total consumption and domestic consumption. Decline in consumption is widespread although more intense for the category “total consumption”, that includes commercial, industrial and municipal as well as domestic uses, than for the category “domestic consumption (11 percent and 6 percent respectively).

Table 3. Total consumption and domestic consumption (in million cubic meters), and relative domestic consumption (in liters/person/day, lpd) for the Metropolitan Area of Barcelona. 2007 and 2013

	Total consumption 2007	Domestic consumption 2007	Total consumption 2013	Domestic consumption 2013	Domestic consumption lpd 2007	Domestic consumption lpd 2013
Barcelona	105 334 384	67 742 317	94 675 794	63 783 528	116.35	108.42
L´Hospitalet Llob	13 282 331	9 431 901	11 313 019	8 680 756	102.60	93.61
Cornellà	4 871 019	3 131 048	4 236 171	2 979 366	101.54	94.16
Gavà	3 091 274	2 105 419	2 636 943	1 944 452	129.11	114.87
Sant Boi Llobregat	4 829 402	3 199 371	4 237 128	3 041 147	108.58	99.89
Sta. Coloma Cerv	491 982	331 244	380 983	315 599	120.87	107.28
Viladecans	3 235 106	2 517 125	3 003 977	2 454 206	111.74	102.74
Castelldefels	4 215 800	3 281 255	3 777 171	2 999 526	152.48	130.28
Torrelles Llob.	322 458	290 571	284 137	250 806	160.05	118.96
Esplugues	2 856 139	1 963 533	2 575 545	1 841 378	116.22	108.10
Sant Feliu	2 382 207	1 672 777	2 081 859	1 579 497	108.41	98.87
Sant Joan Despí	1 989 196	1 282 449	1 815 244	1 214 236	110.94	101.39
Sant Just Desvern	1 514 806	820 844	1 236 609	769 140	146.12	124.99
Badalona	11 196 192	8 647 105	9 809 604	7 982 955	109.58	99.55
Cerdanyola	3 585 318	2 320 770	3 180 484	2 133 829	110.08	101.42
Montcada i Reixac	2 449 703	1 286 610	2 046 565	1 319 653	109.77	103.71
Montgat	546 918	450 990	531 650	465 889	126.36	115.46
Sant Adrià	2 224 623	1 232 457	1 978 664	1 249 801	103.15	98.33
Sta. Coloma Gram	5 875 007	4 438 323	4 830 132	4 088 490	104.14	93.32
Begues	515 564	383 088	378 486	315 457	177.95	131.15
El Papiol	307 086	181 046	235 202	176 522	131.19	119.68
Pallejà	767 486	598 930	647 732	514 676	151.67	125.81
Sant Climent Llob	184 684	148 756	164 612	143 964	112.24	100.62
TOTAL	**176 068 685**	**117 457 929**	**156 057 711**	**110 244 873**	**114.31**	**105.29**

Source: Elaborated with data from Aigües de Barcelona and IDESCAT

Decline affected mostly non domestic uses and low density municipalities with widespread presence of outdoor uses, and, to an important extent, it can be attributed to the ban on public and private garden irrigation. This is corroborated by the strong reductions in consumption during the summer months in some municipalities. Begues, a small town with numerous gardens and swimming pools that registers the highest water consumption per capita of the AMB, reduced its June to September consumption by more than 50 percent between 2007 and 2013. Therefore, the highest reductions in per capita consumption during the drought affected especially the municipalities with highest consumption and were very likely related to mandatory or voluntary restrictions in outdoor uses. Regarding domestic uses, average consumption fell from 114 liters/person/day (lpd) in 2007 to 105 lpd in 2013; that is a reduction of almost 8 percent. Most of the strongest declines occurred in the small low density towns located in the periphery of the Metropolitan Area while reductions in the densest municipalities were smaller.

The expected rebound effect associated with the end of the drought did not occur and consumptions continued to decline after 2008. Given the fact that the purchase of domestic appliances, including washing machines and dishwashers, fell by 50 percent between 2007 and 2015 (El Periódico de la Energía, 2015) and that housing construction collapsed during the same period (Burriel, 2016) the continuous decline in consumption may only be marginally attributed to technological improvements in households. Water awareness campaigns diminished in intensity but did not cease after the drought. However, per capita consumptions in many metropolitan municipalities around or even below 100 lpd could indicate that the margin for achieving further reductions was becoming smaller. To an important extent therefore, economic factors were behind most of the decline post-2008 as households responded to falling incomes and rising prices and taxes by, among other actions, cutting water use (March and Sauri , 2016) . In the Metropolitan Area of Barcelona, prices and taxes follow the block tariff system with three blocks separated by thresholds of 6, 12 and 18 cubic meters per household per month respectively. Between 2007 and 2013 the price of each block rose almost 50% (half of which in a single year, 2011 to 2012). Regarding taxes, tariffs also rose but in this case thresholds were modified adding a fourth block nine times more expensive than the first block and addressed to curb consumptions in outdoor uses. But for block 2 (where most customers are located), the regulatory body (ACA) lowered the threshold from 18 to 15 cubic meters Moreover, VAT increased from 7 to 10 percent during this period. On the other hand, the introduction in 2012 of a fourth and very expensive

block in the water tax may have also induced further reductions in outdoor uses especially garden irrigation (March and Sauri, 2016). Hence, rising prices and taxes coupled with rising unemployment and diminishing ability to pay the water bills may have forced households to maintain and even intensify reductions in water use. Common strategies in this regard were, for example, to shower in municipal sports facilities or in the homes of family or friends (Yoon, 2018). On the other hand, the crisis also impacted hard on other urban uses as a consequence of the decline in economic activity and the closing down of many industrial and commercial facilities. Thus between 2007 and 2012, urban industrial uses in the Metropolitan Area of Barcelona declined almost 20 per cent while urban commercial uses declined 12.5 percent (Gil Olcina et al, 2015).

In order to treat separately the effects on consumption of the drought and of the economic crisis, Table 4 compares water consumptions for the two periods. The period corresponding to the drought (2007-2008) and the period post-drought, roughly coinciding with the worst years of the economic crisis (2009-2013). From table 4, it can be deduced that municipalities with higher incomes and low density urban layouts appear to have experienced the most important part of the reduction in water consumption during the drought (2007-2008) while municipalities with lower incomes and high density urban layouts tend to concentrate most of the reduction during the period of the crisis (2009-2013). From the table it can be also noticed that the largest reductions in consumption are found in the low density, richer municipalities whereas reductions in the high density, less well-off municipalities are smaller. This is not surprising given the mandatory ban on outdoor uses and especially garden irrigation during the drought period and also given that consumptions per capita in the dense, low income municipalities were already low and further reductions would have been increasingly problematic for users consuming less than 100 lpd.

Table 4. Change in domestic water consumption per capita (lpd) in the Metropolitan Area of Barcelona for the period 2007-2008 and for the period 2009-2013 (in percentage)

Municipalities	2007-08 (drought)	2009-2013 (economic crisis)
Barcelona	-6.4	-2.98
L´Hospitalet de Llobregat	-6.7	-7.27
Cornellà	-10.3	-3.85
Gavà	-7.5	-6.98
Sant Boi	-6.2	-5.59
Sta. Coloma de Cervelló	-19.6	-1.03
Viladecans	-2.1	-4.32
Castelldefels	-8.2	-3.91
Torrelles de Llobregat	-12.9	-4.39
Esplugues	-7.8	-3.06
Sant Feliu	-9.5	-1.61
Sant Joan Despí	-7.6	-3.17
Sant Just Desvern	-13.1	-8.41
Badalona	-4.6	-6.48
Cerdanyola	-10.1	-4.38
Montcada i Reixac	-4.0	-9.25
Montgat	-3.4	0.64
Sant Adrià	-2.1	-7.75
Sta. Coloma Gram.	-5.5	-7.49
Begues	-19.8	-17.76
El Papiol	-2.8	-17.94
Pallejà	-13.3	-10.10
Sant Climent de Llobregat	-4.0	-9.07
TOTAL	**-6.6**	**-4.19**

Source: Elaborated with data from Aigües de Barcelona

In sum, both groups of municipalities (high income and low income) reduced their water consumption during the period of reference. However, while the first group probably cut down non-essential uses such as garden irrigation, the second group, or at least part of it, had to reduce more essential uses related to basic functions in the household in order to lower water bills. In this sense, several municipalities in the Metropolitan Area of Barcelona may be experiencing cases of water poverty defined not in terms of accessibility (as in developing countries) but in terms of affordability (Mack and Wrase, 2017). According to the latest Survey on Living Conditions in the Metropolitan Area of Barcelona some 116,000 households (almost 9 percent of the total) are defined as "water poor" because they dedicate more than 3 percent of their income to pay the water bills (Domene et al, 2018). "Aigües de Barcelona" (Barcelona Water), the company supplying the area, offers a social tariff of 0.4 €/m3 for the first 66 liters/capita/day, and the same company together with local social services and other institutions, offers also discount vouchers contingent upon low consumptions. Therefore, at least for part of the water poor, there are incentives to reduce consumption even further but this objective is hard to achieve given that current consumptions barely meet the minimum requirements regarding hygiene and comfort.

Conclusion

This paper has examined water consumption decline in urban areas taking Spain and, at a finer scale, the Metropolitan Region of Barcelona as examples. Somehow against the current opinion forecasting important increases in global urban water demand for the following decades, the paper argues that recent empirical data for many cities in the developed world would sustain the case for reductions in water consumption at least in many cities of the developed world. Causes behind this tend are multiple and the paper proposes to divide them between structural o those linked to conscious, relatively long term but steady actions taken by individuals or organizations, and contingent or those linked to more specific events (in our case droughts and economic crises) that may accelerate structural trends (Horne, 2018) . Data on water consumption trends for the most important Spanish cities has been presented confirming the declining trend between 2003 and 2016 and discussing the relative importance of economic, technological and behavioral drivers of this decline (Albiol and Agulló, 2014). Reductions in water consumption accompanied by an increasing presence of water resources in principle decoupled of climatic constraints such as desalination and to a certain extent water reuse may provide a response to the challenges posed by both urban growth, droughts, and climate change (Buurman et al , 2017; Rossi and Cancelliere,

2013). Nevertheless, a strong note of caution and an important dose of critical thinking must be added to this line of reasoning. First of all, the challenges of providing reliable and safe water and sanitation to the burgeoning cities of the Global South appear enormous and will imply a massive, unprecedented mobilization of resources (Horne et al, 2018). Second, reductions in water consumption have come at a cost and tend to fall upon the shoulders of low income households which, as the paper has attempted to show for the Metropolitan Area of Barcelona, are becoming water poor. Affordability of water and also of energy will likely be a major challenge for cities of the developed world characterized by growing social and economic inequities. In this sense it is urgent that directions towards sustainable uses of water in cities incorporate fully notions of water justice so that the "conservation burden" does not fall disproportionally on the more vulnerable.

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