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ORIGINAL PAPER

Water conservation campaigns and citizen perceptions: the drought of 2007–2008 in the Metropolitan Area of Barcelona

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Abstract Droughts are expected to become more common in Mediterranean urban contexts during the next decades. Water conservation campaigns are a crucial part of drought management actions but doubts remain regarding their effectiveness once the drought period has finished. In this paper and taking the example of the Metropolitan Area of Barcelona, we present the results of a survey on drought perception and behaviour undertaken for 437 households of this area. Conservation messages were compared with household perception and conservation behaviours. Results indicate that conservation campaigns were successful in raising awareness about the drought, but messages failed to target specific uses (indoor/outdoor). Against a backdrop of decreasing consumption per capita in the compact urban areas, future conservation campaigns must be aware of these factors if the conservation burden is not to fall on those already consuming very little water.

Keywords Drought · Metropolitan Area of Barcelona · Awareness campaigns · Citizen perception · Urban model

1 Introduction: Drought perceptions in urban settings

Droughts constitute common phenomena in Mediterranean areas and their occurrence and impacts are likely to worsen with climate change (IPCC 2007). However, droughts are also increasingly recognized as hybrid events in which natural but also social causes intertwine to produce situations of water stress for the human and non-human worlds. In this vein,

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some authors such as Kallis (2008) define droughts as the temporal lack of water caused necessarily but not exclusively by an abnormal climatic situation that may affect negatively the population, economic activities and the environment. While agricultural droughts have remained the principal subject of attention, also in the developed world (see, for instance, Taylor et al. 1988; Wilhite 1993), the analysis of drought perceptions, human responses and awareness campaigns, with an important applied component, appears to have shifted towards urban contexts probably because of the much larger social and political clout of cities when compared with rural areas (Kallis 2008).

Perception and responses to drought and to water shortages in general has been an important subject of enquiry for the social sciences since the pioneering study by Saarinen (1966) in the High Plains of the United States. More recently, contributions have expanded to cover water conservation and related topics (see, for instance, Berk et al. 1980; Wilhite 1993; Aitken et al. 1994; De Oliver, 1999; Syme et al. 2000; Gilg and Barr 2006; Mondéjar-Jiménez et al. 2011; Willis et al. 2011). An important characteristic of drought perception and water conservation studies is their common reliance on North American and Australian cases instead of other urban settings (but see Mondéjar-Jiménez et al. 2011). Moreover, according to the review of water conservation campaigns in Syme et al. (2000), most studies have focused on assessing the immediate effects of water conservation campaigns on consumption, but not those effects on a longer term. These authors admit that studies on identifying citizen's attitudes towards water conservation are much less abundant despite their relevance for improving the long-term effects of conservation messages. Other authors have sought to relate the performance of these campaigns according to whether water was supplied by a public or by a private contractor with no clear indication of the outcome in either case (Kallis et al. 2010). Acknowledging that these are important considerations, we think that other questions in other contexts than the Anglo-American world may be relevant as well. First, it may be important to examine drought perceptions and responses not in the context of suburban environments but in the context of urban areas presenting already moderate water consumption figures. Conservation campaigns often assume that consumptions may be extravagant which may not be the case in compact urban areas where outdoor uses are minimal. Second, in these contexts of moderate consumptions, it is also relevant to ascertain to what extent conservation messages by the water authorities and actual behaviours of citizens do coincide and whether or not these messages recognize different urban residential models and therefore different habits of water consumption. Third, public perception of new technologies addressed to increase the resilience of urban water supply against future crises may provide important clues to policy makers regarding the likely social acceptance of these technologies in the face of recurrent droughts.

In this paper and taking as an example the case of the drought of 2007–2008 in the Metropolitan Area of Barcelona (henceforth MAB), we plan to examine some of the questions outlined above. More specifically, we are interested in: (a) societal perception of the seriousness of the drought problem and of its causes; (b) societal perception of the responses to the drought and to what extent these responses followed conservation messages issued by the authorities and (c) societal perception of alternatives presented by the water administration to reduce the impact of future droughts.

The paper is organized as follows. First, we provide some context on the area and on the drought episode of 2007–2008. Second, we introduce the most relevant characteristics of a survey on drought perception, water conservation behaviour and other issues undertaken for 437 households in the MAB. After presenting the survey results, we discuss them in the context of the research questions presented in this section. Finally, we conclude with the key findings of the research.

2 Water crisis in Metropolitan Barcelona: the episode of 2007–2008

In Metropolitan Barcelona, precipitation deficits and subsequent reductions on surface water and groundwater availability have shaped water politics through the twentieth century, and especially through the first decade of the twenty-first century. As a clear example of the seriousness of the situation, in the past 10 years, eight drought warnings have been issued by Catalan authorities. In 2007–2008, the MAB suffered one of the severest droughts of the last decades. The precipitation deficit was the worst since the mid 1940s (Pastor 2008). After some 20 months with little or no rain, in late March 2008, reservoirs supplying Barcelona had fallen to 20 % of their capacity and emergency actions, such as transporting water to the city by sea tankers or building pipes to distant rivers, such as the Ebro river, had to be put into force. The gravity of the situation forced the authorities to ban some uses such as public fountains and Public Park watering, and also the use of water for private gardens and swimming pools. Beyond the structural actions to increase the supply, and the bans on some outdoor uses, awareness campaigns aiming to voluntary reductions in consumption were launched. As a matter of fact, water pricing was not modified during this period, although, later on, the costs of the drought were used as one of the justification for raising water prices and taxes.

In April 2008, rains came back signalling the beginning of a wet spell that left reservoirs at 80–90 % of their capacity while replenishing aquifers used during the emergency period of 2007–2008. At the same time, rains almost left idle a 230 million Euro desalination facility finished in 2009. All in all, the aftermath of the drought included 490 million Euro in economic costs of emergency measures and a fierce debate between the new water supply solutions proposed by the Catalan Water Agency (CWA), revolving around desalination, and the old "hydraulic paradigm" of inter-basin transfers proposed by the professional associations of engineers and the economic elites.

Above all, however, the drought episode left a decline in water consumption per capita in Metropolitan Barcelona. According to the CWA, water demand during the last week of June 2008 had dropped by 21 % with respect to the previous year. Moreover, some municipalities had reduced per capita water consumption figures to 110 l/person/day (henceforth lpd) or less (AMB 2009). Comparatively and as expected, reductions in consumption were higher in municipalities with larger outdoor uses but, overall, per capita water consumption had declined everywhere. Metropolitan authorities and the CWA acknowledged the responsible behaviour of citizens and emphasized the success of awareness campaigns during the recurrent drought episodes of the 2000s. In Table 1, we have compiled the main messages presented in water conservation campaigns by the CWA in Barcelona since 2005.

As it can be observed, messages are mostly addressed to indoor uses and range from the very general (e.g. water is priceless) to the specific (turn taps off while brushing the teeth, etc.).

High-rise apartment blocks resulting in very high population densities (over 5,000 people/km^2) characterize the urban landscape of the MAB, which had a population of 3.22 million people in 2011 (AMB 2011). Despite that the MAB, in general terms, presents high population densities, the fringes of the area tend to follow the more sprawled model of Anglo-Saxon suburban areas. Accordingly, the distribution of water consumption per capita follows urban density. Within the MAB average consumptions range from barely 100 lpd in the high-density cities surrounding Barcelona, to some 200 lpd in some suburban locations in the fringes of the area, where gardens and swimming pools are common features of the landscape (March and Saurí 2010a; Parés et al. in press).

Table 1 Messages in water conservation campaigns targeting the domestic sector

Years	Main issues	Main motto	Other messages
2009	Inauguration of the desalination plant (more water than ever and of good quality) + individual actions (more savings than ever).	The revolution of small gestures has started.	We have built a desalination plant to avoid depending on the rain and thus have more and better quality water.
2008	The government is acting against the drought with all possible means.	Together we can deal with drought.	The enemy is big, but we are sparing no effort to fight it; can we continue to rely on your help?
Early 2008	Distribution and installation of 650,000 retrofitting kits.	Install me!!!	
2007	Reduction in water consumption (targeted mostly to indoor uses).	To have water turn off the tap.	Turn off the tap when soaping or brushing your teeth. To save water stop using your bath.
2005	Need of reduction in water consumption (very focused on indoor uses).	Water is priceless. Save it!!	Love water. Each drop counts!!

Source: own translation from Catalan Water Agency (various years)

Thus, while indoor uses are dominant in the MAB, recent urban sprawl has contributed to the expansion of potentially high-demanding outdoor uses (lawns, pools) relatively ignored in drought awareness campaigns. At the other end of the consumption spectrum, most housing units in the denser cities of the MAB have showers but no baths. In this respect, advertisements along streets recommending showers instead of baths in neighbourhoods where flats have only tiny bathrooms showed a certain lack of familiarity and sensitivity with these target areas.

3 Understanding how people perceive drought in Metropolitan Barcelona

3.1 Methodology

In order to answer the questions outlined in the introductory section, 437 households of the Metropolitan Area of Barcelona (MAB) were selected in November 2009 (about 1 year after the critical period of the drought) for a survey on drought perception and behaviour. The sample was stratified according to predominant housing types in the MAB, where, as mentioned before, a high-density compact fabric predominates. Thus, 89 % of households surveyed were in apartments (389 cases), 5 % were in apartments with a shared garden area (22 cases) and 5.9 % were in single houses (26 cases).

The survey was carried out by telephone, and respondents representing each household were asked to give their views on the seriousness of the drought episode; the causes and future scenarios regarding water availability in the MAB; their knowledge and opinion about the measures adopted by the administration and their perception of their behaviour during the drought. We also asked them about desalination and water pricing as possible measures to manage scarcity. The survey had a fixed structure following a list of 17 questions; most of them being yes/no questions or Likert scale questions (values 1–5). Nonetheless, some of the questions were open or multiple choice and some of the yes/no questions had subquestions. For instance, when asked if respondents undertook measures to

Table 2 Examples of questions of the survey

During the drought of 2008, did you adopt any action to reduce household water consumption? (yes/no)
If so, which of the following measures did you undertake? (a) Installing retrofit kits in the taps; (b) Reducing the time of water running in the bath; (c) Buy water-efficient appliances; etc.
From 1 to 5, where 1 is not serious and 5 very serious, how do you appraise the gravity of the drought of 2008? (Likert scale, 1–5)
Could you estimate approximately the percentage of water savings due to the measures you undertook? (Multiple choice; in this case "<5%", "5–20%", ">20%").
Which are the reasons that led you to argue that Catalonia will not have its water necessities covered within 10 years? (open question)

face the drought, if the response was affirmative, we also asked for the specific measures undertaken. Table 2 presents an example of each type of question.

Socio-economic variables such as gender, age, income, education and type of building were also included in the survey in order to establish correlations with citizens' perceptions. Data about water consumption obtained from the secondary sources have been also analysed in order to contrast water consumption with some of the findings of the survey.

The gender of respondents was almost balanced: 200 respondents were men (45.8 %) and 237 were women (54.2 %). According to the data for the whole MAB (INE 2012), men represent 48.65 % of population while women represent 51.35 %. Concerning income, 170 respondents stated that their annual gross household income was below 18,000 Euros, 109 answered that it was between 18,000 and 30,000 Euros, 50 said that it was comprised between 30,000 and 42,000 Euros and only 12 stated that it was over 60,000 Euros. Seventy-three respondents declined to provide information about their income level. The Catalan Statistical Office estimates that the gross annual income per households of the city of Barcelona and neighbouring municipalities (constituting the *comarca* of Barcelonès) was around 18,300 Euros in 2011, while for the Baix Llobregat was around 17,000 Euros. Both the *comarca* of Barcelonès and Baix Llobregat form most of the MAB. Although other suburban municipalities which do not belong to those *comarcas* but to the MAB, such as Tiana or Sant Cugat del Vallès, observe much higher levels of income, their number is very small. Hence, we suggest that our results on income seem to be consistent with official data.

The average household size of the sample is 2.93 persons. As it happened with income, we do not generally have the average household size of the MAB and where we do, it is more than 10 years old. Thus, the Barcelonès *comarca* in 2001 had an average household size of 2.7 persons, while the Baix Llobregat had 2.86 people (IDESCAT 2012). The important arrival of immigrants during the 2000s have probably increased these figures (migrant households are larger because of economic reasons), thus possibly approaching the average found in our sample.

Slight differences notwithstanding, we can argue therefore that the gender balance, household size and income distribution of our sample is representative for the MAB.

Results of this perception survey are organized and presented next according to the three topics presented in the introductory section: citizen awareness of the drought, citizen responses (and their perception) and citizen perception of new water supply alternatives.

3.2 Citizen awareness of the drought

Most people interviewed (91.5 %) were aware of the critical situation of water supply in the Metropolitan Area of Barcelona in 2008. In addition, most people felt well informed

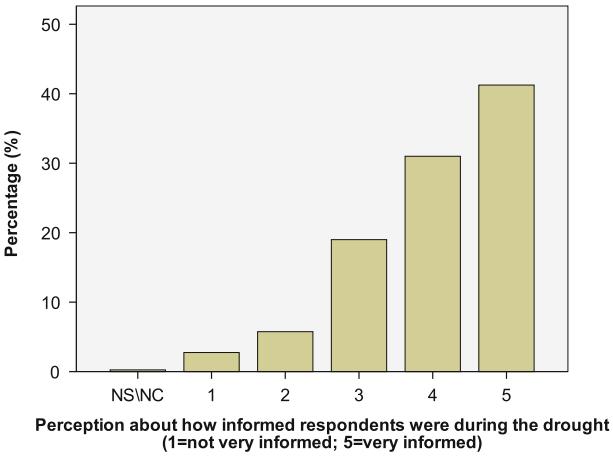

Fig. 1 Perception about how informed respondents were during the drought (from 1 = not very informed to 5 = very informed; NSNC means "no answer")

about the drought situation (Fig. 1). Both results are consistent with the impact that the drought generated in the media and accordingly, with the large volume of information available to citizens regarding this event.

The appreciation of the seriousness of the drought translated into a high degree of social concern, to the point that water escalated to the first position in the worries of Catalans in early 2008. Most citizens interviewed considered that the drought had been either very serious (44.2 %) or serious (31.5 %). As could be observed in Fig. 2, women perceived the drought as more acute than men did ($p < 0.01$, Mann–Whitney), which is consistent with studies stating that, in general, women are more aware to environmental risks and issues than men (Slovic 2000) and have stronger beliefs concerning their impacts (Stern et al. 1993). The high social awareness detected is surely related to the very high level of media attention towards the issue but also perhaps to certain historical facts reflecting the importance given to water by Mediterranean societies (Maass and Anderson 1978; Holst-Warhaft and Steenhuis 2010).

Regarding citizen perception about the difficulties to meet the water needs of Catalonia in future, opinion was quite divided between those who believed that there would not be any difficulties to meet the water needs of the next 10 years (37.1 %) and those who argued that difficulties would exist (32 %). The remainder considered future water supply too uncertain to emit any judgement (27.7 %). Again, women showed a significant higher level of concern ($p < 0.01$, Mann–Whitney) in consonance with the higher seriousness attributed to the drought by this group mentioned before. Educational levels also appeared to affect the perception of future water availability. Thus, higher educational levels were associated with more negative visions of the water situation [Chi-square $p < 0.05$ (0.013)], which concurs with the literature (see for instance Liberty and Hongjuan 2010). Interestingly, young people (between 18 and 35) appeared more pessimistic concerning water futures [Chi-square $p < 0.05$ (0.00)].

The analysis of the reasons given by respondents to justify their views on future water demand and of the difficulties in meeting this demand provides interesting insights (Fig. 3). Most respondents attributed future difficulties to climate change and the ensuing reduction in precipitation which is consistent with the relevance and publicity given to climate change and related impacts in the Mediterranean (see for instance IPCC 2007). On the other hand, population growth and high water consumption are cast as the main causes

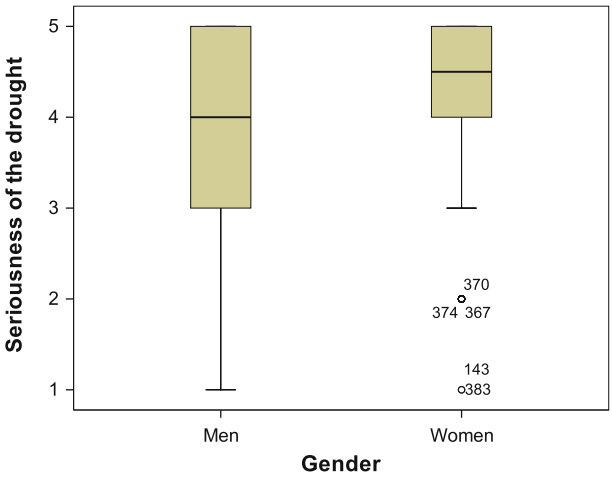

Fig. 2 Perception of the drought by gender (from 1 = not serious to 5 = very serious)

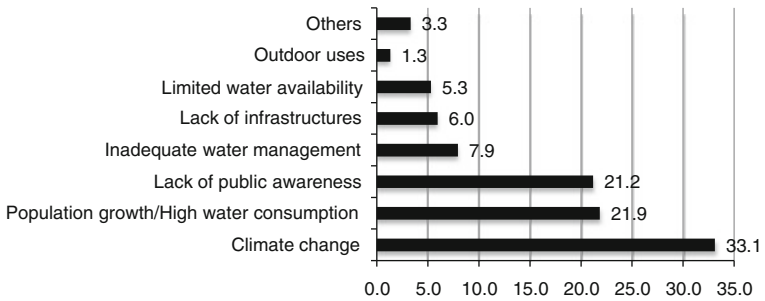

Fig. 3 Main causes of future water scarcity crisis in Metropolitan Barcelona as stated by respondents

of vulnerability to droughts in the region by over one-fifth of the respondents. This is not surprising as much of the literature attributes to these two drivers a critical role in increasing societal vulnerability to drought (see for instance Wilhite 1993). With a similar preponderance, lack of public awareness (wasteful behaviours) and inadequate water management were pointed as potential causes of the water crisis. A smaller group of respondents saw in the lack of infrastructures such as water transfers or the insufficient water supply the main reasons behind possible future difficulties to meet water demand. Last but not least, a few respondents blamed outdoor uses as the triggers of future crisis.

The causes advanced to explain possible difficulties in meeting future water demand range from the very generic and also probably media induced (i.e. climate change or high water consumption) to the internalizations of certain conservation messages such as low public awareness. It is interesting to note that the lack of adequate water supply infrastructures was mentioned by a small percentage of respondents, notwithstanding the fact that this question was at the forefront of the political debate during the drought.

3.3 Perception of the responses to the drought episode of 2007–2008

During the most critical period of the drought, mass media broadcasted daily figures of water stored in reservoirs supplying the MAB, converting drought into a dramatic

spectacle. The nude, quartered soil of water reservoirs supplying Metropolitan Barcelona combined with the images of the iconic fountains of the city running dry became often part of television screens and were also common in other media sources.

Beyond the mediatisation of the crisis, public calls instigating water savings appeared regularly on television, radio, press, the Internet and in massive advertisements along streets. Other than the role of socio-demographic drivers, such as ageing population or immigration, leading to a decrease in consumption (March et al. 2012), water conservation messages might be a key factor to understand reductions in average consumption during the drought, possibly much more than bans on private outdoor uses since these were comparatively small in Metropolitan Barcelona. In comparison with 2007, domestic water consumption in 2008 fell 3.3 % on average and attained a record figure below 110 lpd. This may be seen also as the continuation of a declining trend in water consumption and that may be related to previous droughts and the ensuing conservation campaigns (Table 3). Along these lines, in the municipalities representing best the predominant urban model of Barcelona (high-rise block apartments) water consumption decreased around 10 % in the period 2006–2011. In the more sprawled areas of the periphery, reduction in consumption was even higher since the effect of bans on outdoor uses was added to the voluntary reductions.

Beyond these general data, our survey attempted to shed some light on how citizens faced the water crisis. About two-thirds of the residents (65.8 %) affirmed to have adopted measures to reduce water consumption during the drought, which fits well with the perception of the drought as serious or very serious. Thus, residents adopting one or more measures considered that the seriousness of the drought was high ($p < 0.01$, Mann–Whitney). Furthermore, the engagement of those who took action was important as most of them (67 %) affirmed to have adopted more than three measures to reduce consumption. It is interesting to note that before the drought episodes of 2007–2008 (and also to that of 2005) a study on water habits carried out in the Metropolitan Region of Barcelona (MRB) (Domene et al. 2004), found that one of the indoor uses with a higher water saving potential was the shower: in 2004 only 48.1 % of users mentioned to close the shower tap while soaping and most users (67.7 %) affirmed to spend more than 5 min in the shower (implying an average consumption of more than 60 l). Interestingly, as it can be seen in Table 4, the reduction in the time spent in the shower was the most mentioned measure

Table 3 Water consumption (lpd) in different municipalities of the MAB before, during and after the drought of 2007–2008

Predominant urban model	Locality	Before crisis 2006	Early crisis 2007	Critical situation 2008	After the crisis			Reduction 2006–2011 (%)
					2009	2010	2011	
Compact (high rise)	Barcelona	116.44	112.81	111.37	108.51	108.3	108	−7.25
	Hospitalet de Llobregat	104.59	102.21	98.42	95.98	94.3	94.8	−9.36
Compact and semi-detached	Castelldefels	152.9	147.73	135.6	135.04	132.4	128.7	−15.83
	Pallejà	157.08	149.15	129.63	134.35	140	126.4	−19.53
Detached and semi-detached	Sant Cugat del Vallès	180.7	173.39	149.13	160.83	154.4	151.1	−16.38
	Begues	182.68	174.19	141.99	152.04	143.7	141	−22.82
Average MAB		116.63	113.79	109.96	108.32	107.5	107.1	−8.17

Table 4 Water conservation measures adopted by the residents of the MAB who took actions regarding the drought ($n = 263$ residents, 65.8 % of the sample)

Measure	Percentage (%) ($n = 263$)
Reduction in the time spent in the shower or the bath	73.8
To close the tap while brushing teeth	67.3
To close the tap while soaping	65.8
Reduction in time in washing hands	60.5
To use the washing machine at full capacity	49
To use the dishwasher at full capacity	33.8
Installation of aerators in the taps	33.5
Mechanisms to control water consumption for toilet flushing	30.4
To purchase more water-efficient home appliances	24.3
To store in a bucket the cold water that is wasted in the shower until hot water comes out and its reuse for toilet flushing or irrigation	22.8
To reuse water employed for washing vegetables to water the plants	18.3
To stop watering the plants	16.3
Other	12.5

during the drought of 2007–2008, followed by other bathroom-related habits such as closing the tap while brushing the teeth and soaping up or reducing the time in washing hands. Other actions such as using washing machines and/or dishwashers at full capacity ranked also high. Hence, measures involving change of habits, especially those related with daily hygiene, occupied clearly the first positions among all measures taken to conserve water.

More structural measures such as installing diffusers in the taps or devices in the toilet were adopted by about a third of the households taking actions against the drought. Other measures that demanded additional efforts by residents were also put into practice although to a lesser extent. For instance using a bucket in the shower in order to store water until the hot water came out; reusing clean water for watering the plants, or even stopping watering the plants altogether.

It is worth mentioning that the percentage of households that adopted at least one water conservation measure was higher in single-family houses (76 %) than in apartment buildings (65.3 %), as the former register higher consumptions of water and therefore there is more scope for water savings. However, we cannot know whether these actions were taken before or after the declaration of the second level of exceptionality of the Drought Warning Decree that banned the irrigation of private and public gardens.

It is also interesting to comment on how residents perceived the effectiveness of conservation measures they undertook. Most of them believed that these measures resulted in water savings, though not all of them saw these measures equally effective (see Fig. 4).

Nine out of ten residents undertaking actions against the drought stated to have maintained the water conservation measures adopted. This behaviour could partially explain the steady reduction in water consumption achieved in the Metropolitan Area of Barcelona (MAB) since 2008. In 2010, for instance, average per capita consumption in the MAB fell to 107.5 l/day (Table 3); that is, some 25 l less than in the previous decade (El Periódico, 16 March 2011).

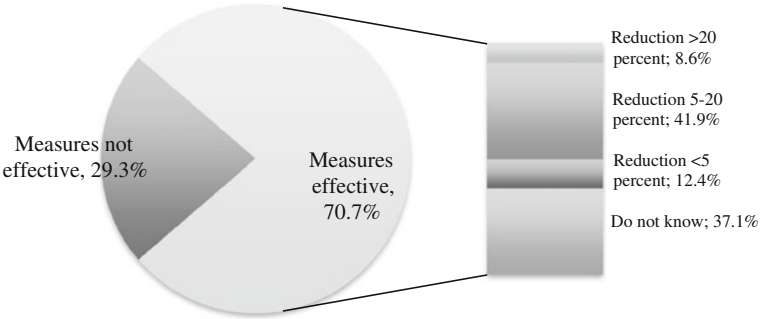

Fig. 4 Perceived effectiveness of the measures to reduce water consumption

Residents not adopting any additional measure during the drought (one-third of citizens surveyed) argued either that they were already conserving water before the drought or that they already consumed very little water. In this sense, the extremely compact urban form of certain neighbourhoods and towns in the MAB, with small to very small flats now partially occupied by large immigrant families, may have pushed water consumption to very low figures per capita. Some of these neighbourhoods observe per capita consumptions below the 100 l/day, which is the standard limit, fixed by the World Health Organization. Therefore, the scope for domestic water savings seemed small in these cases.

3.4 Citizen perception of the measures promoted by the CWA and the Catalan and Spanish governments

A wide range of actions with different character and scope were adopted by the CWA and the Catalan and Spanish governments in order either to increase the volume of water available or to reduce water consumption. The most important package included temporary emergency measures such as the increase in supply through the transportation of water by sea tankers, or the controversial transfers from distant rivers such as the Segre and the Ebro (finally cancelled). Beyond awareness campaigns, these options were largely publicized in the media and, subsequently, spurred heated debates among defenders and critics of water transfers. Despite the ample echoing of these measures, more than half of the total respondents to our survey did not remember any measure proposed or adopted by public authorities (Table 5). Among the measures most recalled by citizens, awareness campaigns (summarized in Table 1) and the shipping of water from other areas of Spain and France ranked first and second, respectively. In the later case, the widely reported images of tankers arriving in the Barcelona harbour might have significantly contributed to strengthen the citizen memories of the drought. In the third position, we came across the ban on using water in public fountains. Given that one of the main tourist attractions in Barcelona is the public fountain of Montjuïc, it is hardly surprising that the cancellation of the shows during the drought became a well-known matter in the city. The highly controversial and echoed proposal to bring water from the Ebro River in the South was the fourth most recalled measure. Far behind were other measures such as various water transfers, and, curiously enough, the desalination plant in the Barcelona harbour, still under construction during the drought and in operation since August 2009.

We were also interested in the citizen's view of drought management measures (see Table 5). Among the most favoured measures, we can cite the recuperation of abandoned

Table 5 Main measures adopted by the public authorities remembered by respondents

Measure	Percentage (%) ($n = 188$)	Opinion (1 = very much disagree, 5 = very much agree)
Transportation of water by boat	23.4	2.64
Awareness campaigns	23.4	3.86
Closure of public fountains	20.7	n.a
Ebro transfer	19.7	3.11
Water reutilisation from a wastewater treatment plant for secondary uses	16.0	4.3
Rhône transfer	10.1	3.37
Recuperation of abandoned wells	8.0	4.27
Renovation of the distribution network in order to avoid leakages	7.4	3.57
Segre transfer	6.9	2.77
Desalination plant	4.8	3.92, see Fig. 5
Reduction in street cleaning	3.7	n.a.

wells, water reuse (the most appreciated) and awareness campaigns. Less support was obtained by the several projects of transferring water from other sources (and among these projects, the Rhone transfer from France appeared to reach a better social consideration than the Ebro or Segre projects), and by the transportation of water by tankers. On the other hand, and because it was the alternative championed by the CWA in front of other such as inter-basin transfers, we were especially intrigued about how respondents valued desalination and this specific question was asked to the entire sample. Most respondents supported the idea of supplying desalinated water to the MRB (Fig. 5) while only less than 10 % were reluctant to this alternative. In sum, this may indicate the penetration of alternative water technologies in the collective imaginary of citizenry and the potential of these measures to revert the deep-rooted prevailing water paradigms based on reservoirs and transfers (Domènech et al. 2013).

We were also interested in the perception of water pricing, as this measure is central in many demand-side management strategies. Over half of the respondents considered that the price they paid for water was relatively high (56 % of the sample), while 31 % considered that the price of water was neither low nor high, and only 6.8 % stated that the price was low. In comparison, in 2000, 74.2 % of citizens of the MAB stated that water was too expensive, while 23.6 % considered water was fairly priced, the remainder arguing it was too cheap or not having a clear idea on the matter (La Vanguardia, 27/4/2001). Interestingly, the perception of water as too expensive has somewhat declined after recurrent drought crises but citizens still perceive that they pay too much. From our survey, it appears that citizens may appear reluctant to finance large infrastructures to confront future droughts, although, on the other hand, they seem to be willing to use revenues from water pricing to improve water quality, both for river ecosystems and for human consumption. Hence, and against the financial crisis suffered by the water administration, forecasted dramatic increases in water price will have to be transparently presented and

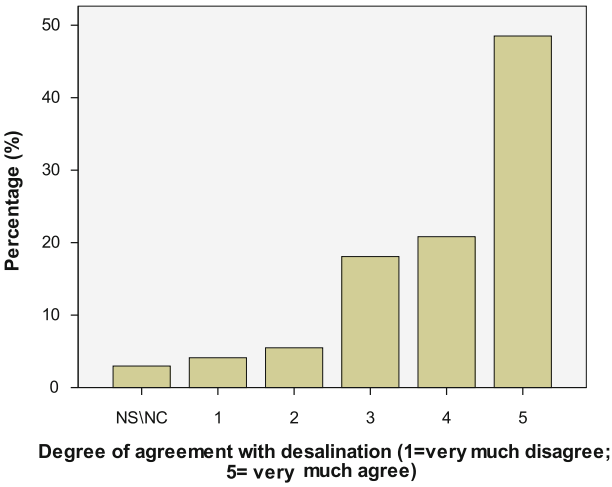

Fig. 5 Degree of agreement with desalination (from 1 = very much disagree to 5 = very much agree)

discussed. Above all, who will bear the conservation burden (Renwick and Archibald 1998) in future water crisis remains a critical issue.

4 Urban droughts and citizen perception: discussion

Droughts are expected to affect Mediterranean cities more and more during the next decades. Therefore, it is important to investigate institutional and citizen perception and responses to this increasing hazard. This paper has presented the results of a survey of 437 households in the Metropolitan Area of Barcelona addressed to investigate the perception of the drought episode of 2007–2008 and the role of water conservation campaigns undertaken in this area. Conservation messages were compared with household perception and conservation behaviours, and public policies to confront the worst effects of the drought were also put to the opinion of respondents.

According to the survey, the water crisis raised important concerns among the citizens of the MAB. On the one hand, this opinion may reflect the weight of the awareness campaigns and the images offered by the media of exhausted reservoirs with the threat of domestic water cuts looming in the horizon. On the other hand, the persistence of these images, already shown profusely during the previous drought episodes of 2002 and 2005, appears to influence perception as shown in many studies (for instance, Taylor et al. 1988).

Regarding awareness campaigns, it is interesting to compare some of the messages for water conservation included in these campaigns and the actual behaviour of the public (Table 1). Some messages such as "avoid baths and take showers instead" did not seem to acknowledge that most people already followed this habit (see Domene et al. 2004) not the least because a substantial portion of the housing stock in the MAB does not have baths. In our survey, some of the measures taken by citizens to reduce water consumption were suggested in the awareness campaigns (i.e. turning off the tap when brushing the teeth or using washing machines at their full capacity) but others (i.e. reducing the time spent in the shower) were not or at least not explicitly. Moreover, awareness campaigns also failed to a large extent to tailor more precisely different type of audiences, especially citizens living in the compact cores and citizens living in the more sprawled peripheries. Thus, the overwhelming majority of messages were addressed to indoor uses and not explicitly to the

growing segments of the MAB population living in houses with gardens and swimming pools. The latter were forced to stop irrigating their gardens or filling their pools when the drought crisis entered the phase of exceptionality but only received specific advice in the awareness campaigns very late (and not everywhere) in the drought period. Moreover, and according to another survey in a suburban area most people ceased to irrigate their lawns but more long-term actions such as changing the species composition of the garden were taken by relatively few households (Domènech and Saurí 2010).

The CWA and other authorities responsible for the campaigns claimed the success of these campaigns after the reductions in per capita consumption recorded in 2008 but also in 2009, 2010 and 2011 with respect to previous years (Table 3). This would contradict somehow the conclusion reached by Syme et al. (2000) as to the effectiveness of conservation campaigns beyond drought duration. However, we suspect that other factors could be relevant in explaining this decline in consumption per capita. For instance, the changing composition of the population of the MAB, including the increase in the number of immigrants from developing countries and in the elderly, may be relevant factors as well. Those two collectives are thought to have in average lower consumptions of water per capita due to economic (lower income per capita) or cultural reasons (water scarcity memories in past times or in the place of origin) (see for instance March et al. 2012). As a consequence of previous drought episodes, it is also likely that part of this reduction can be attributable to improvements in the distribution networks. In addition, awareness campaigns could have promoted the uptake of water-efficient appliances, whose effects remain after the duration of the drought. It is important to remark that this decreasing trend in domestic water consumption is not only specific to Barcelona, but also has been observed in other urban centres, such as Seville (Del Moral and Giansante 2000), Madrid (Naredo et al. 2008; March and Saurí 2010b; Instituto de Estadistica de la Comunidad de Madrid 2011), Paris (Barraqué 2010, personal communication) or some cities of Germany (Lux 2008).

When asked about future water crises and their causes, our respondents tended to blame the "usual suspects", most especially climate change (Palutikof et al. 2004). Some of the respondents argued that future water crisis would be caused by "excessive consumption" of water. However, this perception does not correspond to the current figures of water consumption in the MAB, which remain below European averages and well below North American or Australian cities with similar climatic conditions. This mismatch is probably inherent to the awareness campaigns since citizens may deduce that appeals to reduce consumption convey the message that consumption is excessive. In comparison, causes related to insufficient water supplies, which would have been expected after the heated political controversies between the different options of water transfers discussed, were barely mentioned.

Finally, awareness campaigns failed in our opinion to address the specific situation of households with gardens and swimming pools. Although these households represent a small fraction of the total housing stock in the MAB, their comparatively large water consumptions make them an important target for conservation efforts. Most of these outdoor uses were effectively reduced with the second phase of the exceptionality state implemented in late March when the reservoirs were at their lowest but not before, under, for instance, specific conservation messages to these users. Moreover, the few messages issued by some local governments, advised to change species, that is, to eliminate high water-demanding lawns. However, what most households appeared to do was to stop irrigating their gardens altogether and wait perhaps for better times to go back to plant Atlantic grasses.

5 Conclusions

For some authors (see for example Syme et al. 2000), water conservation campaigns are a crucial part of drought management actions but doubts remain regarding their effectiveness once the drought period has finished. In other words, campaigns may be moderately beneficial to raise awareness but more limited in reducing consumption in the long term. However, in the MAB not only domestic water use per capita declined in a context of already moderate consumption levels but also this consumption continued to fall 3 years after the drought and in a situation characterized by full reservoirs (after years of abundant rainfall), a desalination plant and modern wastewater systems able to produce pre-potable water. However, and as said before, it is not clear whether these campaigns inducing changes of habits were responsible alone for reductions in consumption. One possible answer to this would be an increase in citizen environmental awareness in the area, although some authors argue that attitudes, habits and values are poor predictors of water consumption (Aitken et al. 1994; Harlan et al. 2009). In fact and according to Robbins (2007), certain households may have high environmental awareness and, at the same time, for instance, spend water and chemicals in abundance to maintain their lawns. In our case and as said before, structural factors such as changing socio-demographic and territorial conditions could be relevant, as well as improvements of the distribution networks and the uptake of water-efficient appliances. In sum, awareness campaigns may prove effective in changing behaviours and daily habits during drought periods and afterwards as the Barcelona case seems to suggest but we do not know for sure to what extent their effectiveness must be evaluated also in the context of other important factors influencing water consumption.

In addition, we have to acknowledge that our survey was carried out 1 year after the drought finished. Therefore, the accuracy of respondents' answers may deviate from what respondents really did during the drought period. We stress thus rather than behaviour in front of the drought, what the paper deals with is with the perception and the memories of the citizens concerning the drought, the measures the CWA undertook and the actions they deployed to reduce consumption.

At the date of revising the paper (August 2012), the phantom of drought seems to hang over the collective memory of Barcelonans again due to very dry winter and spring, and a hot and dry summer. If drought reappears, it is likely that conservation campaigns would be launched again but this time targeting water consumption levels much lower than in the previous episode. This scenario deserves a reconsideration of awareness campaigns since many of the messages appear to have been already assimilated by the citizenry which, at least in certain areas, may have pushed consumption levels back a few decades and certainly below the 100 l/person/day recommended by the World Health Organization. Therefore, it would be advisable for the CWA and other authorities to lift the burden of drought management from the shoulders of citizens who had done already tremendous efforts in water conservation. They should start thinking in combining awareness campaigns (aimed to reduced water demand in suburban Barcelona, especially beyond the MAB) with other actions such as the use of alternative water resources (greywater, rainwater in periods of rainfall, etc.) in the way already followed in certain municipalities of the Metropolitan Area.

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References

Aitken CK, McMahon TA,Wearing AJ, Finlayson, BL (1994) Residential water use: predicting and reducing consumption. J App Soc Psychol 24:136–158

AMB (2011) Estadístiques metropolitanes. http://www.amb.cat

Àrea Metropolitana de Barcelona (AMB) (2009) Dades ambientals metropolitanes 2008, Entitat del Medi Ambient, Àrea Metropolitana de Barcelona, Barcelona

Barraqué, B. Directeur de recherche CNRS au CIRED (2010) Personal communication, Paris, 18 November

Berk RA, Cooley TF, La Civita CJ, Parker S, Sredi K, Brewer M (1980) Reducing consumption in periods of acute scarcity: the case of water. Int J Soc Sci Res 9:99–120

De Oliver M (1999) Attitudes and inaction: a case study of the manifest demographics of urban water conservations. Environ Behav 31:372–394

Del Moral L, Giansante C (2000) Constraints to drought contingency planning in Spain: the hydraulic paradigm and the case of Seville. J Conting Crisis Manag 8:93–102

Domene E, Saurí D, Molina J, Garriga N, Martí X, Boada M, Huelin S (2004) Estudi del consum d'aigua als edificis de la Regió Metropolitana de Barcelona. Situació actual i possibilitats d'estalvi. Fundació Abertis, Universitat Autònoma de Barcelona, Departament de Medi Ambient i Habitatge and Fudació Agbar. https://www.fundacioabertis.org/rcs_est/estudi_complet.pdf

Domènech L, Saurí D (2010) Usos i gestió de l'aigua a les llars de Matadepera. Unpublished report, Bellaterra, Universitat Autònoma de Barcelona, Departament de Geografia

Domènech L, March H, Saurí D (2013) Degrowth initiatives in the urban water sector? a social multi-criteria evaluation of non-conventional water alternatives in Metropolitan Barcelona. J Clean Prod 38:44–55

Gilg A, Barr S (2006) Behavioral attitudes towards water saving? evidence from a study of environmental actions. Ecol Econ 57:400–414

Harlan SL, Yabiku SC, Larsen L, Brazel AJ (2009) Household water consumption in an Arid City: affluence, affordance, and attitudes. Soc Nat Resour 22:691–709

Holst-Warhaft G, Steenhuis TS (eds) (2010) Losing Paradise: the water crisis in the Mediterranean. Ashgate Publishing, Farnham

IDESCAT (2012) Anuari estadístic de Catalunya. http://www.idescat.cat

INE (2012) Explotación estadística del Padrón. http://www.ine.es

Instituto de Estadistica de la Comunidad de Madrid (2011). Banco de Datos Territorial. Online: http://www.madrid.org/bdt/Inicio.icm

Intergovernmental Panel on Climate Change (IPCC) (2007) Climate change 2007: the physical science basis. Contribution of Working Group I to the Fourth Assessment. Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge

Kallis G (2008) Droughts. Annu Rev Environ Resour 33:85–118

Kallis G, Ray I, Fulton J, McMahon JE (2010) Public versus private: does it matter for water conservation? insights from California. Environ Manage 4:177–191

Liberty M, Hongjuan W (2010) Greening our future and environmental values: an investigation of perception, attitudes and awareness of environmental issues in Zambia. Environ Values 19:485–516

Lux A (2008) Shrinking cities and water supply. In: Hummel D (ed) Population dynamics and supply systems. Campus, Frankfurt am Main, Germany, pp 161–179

Maass A, Anderson RL (1978) …and the desert shall rejoice: conflict, growth and justice in Arid environments. The MIT Press, Cambridge

March H, Saurí D (2010a) The Suburbanization of water scarcity in the Barcelona Metropolitan region: sociodemographic and Urban changes influencing domestic water consumption. Prof Geogr 62:32–45

March H, Saurí D (2010b) Flujos de agua, flujos de capital: sistemas de abastecimiento y gobernanza del agua en Madrid y Barcelona. Investigaciones Geográficas 51:7–26

March H, Perarnau J, Saurí D (2012) Exploring the links between immigration, ageing and domestic consumption: the case of the Metropolitan Area of Barcelona. Reg Stud 46:229–244

Mondéjar-Jiménez JA, Cordente-Rodríguez M, Meseguer-Santamaría ML, Gázquez-Abad JC (2011) Environmental behavior and water saving in Spanish housing. Int J Environ Res 5:1–10

Naredo JM(coord), Carpintero O, Frías J, Gascó JM, Saa A (2008) El agua virtual y la huella hidrológica en la Comunidad de Madrid. Cuadernos I+D+I N°5, Canal de Isabel II, Madrid

Palutikof JP, Agnew MD, Hoar MR (2004) Public perceptions of unusually warm weather in the UK: impacts, responses and adaptations. Clim Res 26:43–59
Pastor JJ (2008) The drought of 2007–2008 in Catalonia. Unpublished report. Catalan Water Agency, Barcelona
Renwick ME, Archibald SO (1998) Demand side management policies for residential water use: who bears the conservation burden? Land Econ 74:343–359
Robbins P (2007) Lawn people. Tempe University Press, Philadelphia
Saarinen TF (1966) Perception of drought hazard on the great plains. Research Paper No 106, University of Chicago Department of Geography, Chicago
Slovic P (2000) The perception of risk. Earthscan, London
Stern PC, Dietz T, Kalof L (1993) Value orientations, gender, and environmental concern. Environ Behav 25:322–348
Syme GJ, Nancarrow BE, Seligman C (2000) The evaluation of information campaigns to promote voluntary household water conservation. Eval Rev 24:539–578
Taylor JG, Stewart TR, Downton M (1988) Perceptions of drought in the Ogallala Aquifer region. Environ Behav 20:150–175
Wilhite DA (1993) Drought assessment, management, and planning: theory and case studies. Kluwer Academic Publishers, Boston
Willis RM, Stewart RA, Panuwatwanich K, Williams PR, Hollingsworth AL (2011) Quantifying the influence of environmental and water conservation attitudes on household end use water consumption. J Environ Manage 92:1996–2009