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Water-conservation policies in perspective: insights from a Q-method study in Salta, Argentina

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Abstract

Narratives and discourses on issues such as water management and other complex social-ecological systems respond partly to people's worldviews or social perspectives. Knowledge of these perspectives might help increase the rate of success of specific initiatives related to water conservation and could be an important tool to improve water governance. A study performed in the city of Salta, Argentina, revealed the existence of four social perspectives on issues related to water management. Perspectives were obtained with Q methodology by interviewing 29 local stakeholders. Participants sorted 68 statements organized around four themes (service provider; water rights; public participation; water availability) according to their degree of agreement or disagreement. The findings support our contention that there are clear links between social perspectives and the rate of success of some water policies implemented by the local water utility in the past 15 years, in particular the promotion and use of household water meters and awareness campaigns launched to reduce water consumption. We show that the limited success of these initiatives was partly due to ignorance or disregard of social perspectives on water management.

Keywords: Q methodology; Salta; Water and sanitation management systems; Water policy

Introduction

Target 7c of the Millennium Development Goals, which aims to reduce by half the proportion of the population without sustainable access to safe drinking-water and basic sanitation by the year 2015, has already been met for drinking water, even if with disparities among regions (World Health Organization [WHO], 2013). At the same time, around 2,500 million people still lack access to basic sanitation. Based on this figure and the current rate of progress, it has been estimated that the world is unlikely to meet the

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target for sanitation, both globally and within most regions. Although in some areas access to drinking water is limited by reasons of physical water scarcity (Oron *et al.*, 2007), most water 'crises' result from management and governance failures (Molle & Mollinga, 2003; Ballabh, 2008; Grigg, 2011). This is not surprising since water and sanitation management systems are extremely complex and usually require the coordinated contribution of multiple actors performing multiple tasks across multiple scales. These systems need to be managed by flexible, dynamic, and trustworthy institutions in which purely technical approaches are insufficient to respond to the demands of increasingly complex decision-making processes (Bertrand-Krajewski *et al.*, 2000; Berger *et al.*, 2007; Jorgensen *et al.*, 2009).

Including more social actors in decision-making processes is not without conflicts, not least because identifying stakeholders is not an easy task (Mitchell *et al.*, 1997). Moreover, different actors come to the negotiating table with potentially divergent ideologies, interests, and understandings of the 'problems' at stake; therefore, conflicts are unavoidable (or frequent) in water governance (Moreyra, 2009; Hoppe, 2010). To manage these conflicts, attention to political, cultural, institutional, and historical issues is essential (Ostrom, 2009). Knowledge of local narratives and discourses of stakeholders may identify social perspectives around the status or management of complex social-ecological systems and facilitate the process of consensus building and social learning, essential to improve the relevance of policy-oriented knowledge generation (Swyngedouw *et al.*, 2002; Folke *et al.*, 2005; Enserink *et al.*, 2007; Pahl-Wostl *et al.*, 2007; Reed *et al.*, 2010). Lack of this knowledge makes it difficult to judge the adequacy of governance processes or policy initiatives, increasing the likelihood that decision makers will repeat past mistakes (Doria, 2010; Hukka *et al.*, 2010; Garnåsjordet *et al.*, 2012).

Empirical research on the relationship between water conservation strategies and environmental beliefs is relatively scarce. The literature on sustainable consumption has usually followed conceptual and normative approaches, and focused primarily on personal characteristics and behavioral intentions (van den Bergh, 2008; Hurlimann *et al.*, 2009). Awareness of the existence of different social perspectives on an issue is important not only to understand people's value priorities but also to assess the adequacy of different economic and technical policy instruments. Additional studies are needed on this issue since the way people understand the relationship between them and their environment can be a predictor of water-conservation behavior (Corral-Verdugo *et al.*, 2003). Exploring behavioral attitudes and social worldviews might be useful during decision-making processes prior to the implementation of a specific environmental policy or initiative (Gilg & Barr, 2006; Jones *et al.*, 2011). Water-conservation campaigns need to raise environmental awareness in order to have some measurable success (Berk *et al.*, 1980; Corral-Verdugo & Frías-Armenta, 2006; Corral-Verdugo & Pinheiro, 2006). Yet increased environmental concern alone does not always translate into detectable changes in specific environmentally-related behaviors such as household water conservation (Bamberg, 2003; Gregory & Di Leo, 2003). Because policies are sometimes synergistic, water utilities could show willingness to save water by, for instance, fixing pipes and therefore reducing 'unaccounted for water' (UFW), and customers might then be more cooperative in water-conservation programs depending on their individual efforts. Needless to say, any measure leading to water savings is also an opportunity to extend the coverage of water services to new areas. The gradual achievement of water consumption reductions would require the implementation of a number of company and government Water Demand Management (WDM) strategies such as subsidizing the use of water-saving devices, refunds to encourage environmentally-friendly behaviors, unit exchange programs for showerheads, toilets, taps, or appliances, formulating specifically-designed awareness campaigns, and installing different kinds of water meters (Lee *et al.*, 2011; Willis *et al.*, 2013).

Q1

In this paper, we describe social perspectives on the efficiency and fairness of water and sanitation management systems in a case study in northern Argentina. We analyze and discuss the links between these perspectives and the degree of success of particular policies implemented in the city of Salta by its water-supply company in the past 15 years. We show that the lack of success of some of these policies can be explained, at least in part, by a systematic (probably involuntary) disregard of the diversity of social perspectives on these issues. Inefficient water managers, lack of investments, and relaxed government controls are surely to blame as well, as explanations for any policy failure are complex and multiple. However, initiatives that ignore people's views and opinions or clash with social beliefs and political standpoints are destined to fail. We will focus our analysis on two initiatives, the installation of household water meters and public awareness campaigns, both launched by Salta's water-supply company with the explicit objective of reducing water consumption and improving the overall technical and economic efficiency of the system. This study can be useful to optimize local WDM and forecasting and has implications for water companies concerned with water conservation.

Materials and methods

Description of the case study and water-conservation initiatives

This study was performed in the city of Salta, in northwestern Argentina (population ca. 550,000). Drinking water consumption is very high in Salta, most likely above 600 liters per person per day (L/p.d). Net consumption is actually much lower because 30 to 40% of the water injected in the grid is lost due to leaks from the outdated distribution system (in particular at the household-grid interface) and ill-maintained household piping (Iribarnegaray *et al*., 2012). Net water consumption is far above international standards (Gleick, 1996; Falkenmark & Rockström, 2004) and exceeds the 250 L/p.d recommended by the local Water Code (Provincial Law 7017). Drinking water coverage in the city is close to 95% but only about 80% of the population is served with a sewerage network connected to a sewage treatment plant.

The local water-supply company, CoSAySa (Compañía Salteña de Agua y Saneamiento S.A., also known as 'Aguas del Norte'), has undergone significant governance changes. In 1998, the water and sanitation system of the entire province (approximately 150,000 km^2) was given by the provincial government in concession to only one private company (Saltiel, 2003). During this private period, the company consistently failed to provide services to the poorest areas of the city, as also reported for other Argentinean provinces or for other countries where water services had been privatized (Azpiazu *et al*., 2005; Hall & Lobina, 2006; Castro, 2007; Araral, 2010). In part due to these problems, but also responding to local political changes, the provincial government rescinded the contract in 2009 and the service reverted to a state-owned company (CoSAySa).

The installation of household water meters was one of the prime strategies of the water company during both its private and public periods[1,2]. When the company was privatized, this practice was explicitly recommended in the concession contract. The company and the government presented this policy as a step towards a more equitable system since free riders would be punished with more expensive

[1] Newspaper 'Nuevo Diario de Salta', July 8, 2009.
[2] Newspaper 'El Intransigente', August 19, 2009.

water bills and each household would be charged according to its own consumption. The company's justification was that this policy would preserve a scarce resource. In spite of these arguments, the water company faced severe difficulties to gain widespread acceptance for water meters. Critics pointed out that the true intention of this initiative was more related to improving the financial feasibility of the company than to saving drinking water or achieving a fair billing system[3]. The accuracy of the meters used by the company was also questioned[4]. The company claimed that, if well implemented, household water meters (also known as micro-meters), coupled with an overall estimation of the water injected in the grid by means of macro-meters, would eventually lead to an overall reduction of water consumption. However, users continued to oppose water (micro-) meters, especially since they had to bear installation costs. These costs were later assumed by the water company with a subsidy from the provincial government, but suspicions over the real purpose of water meters remain to February 2014, five years after the company was taken over by the state in 2009[5]. In fact, according to data provided by CoSAySa, after more than 15 years since the initiative was launched, the coverage with the metered system is only about 35% in the city of Salta and 20% in the entire province. This issue has many ideological undertones since the use of water meters and differential tariffs as means to curb excessive water consumption is rooted on the assumption that economic instruments (such as incentives or deterrents) are a good way to change user behaviors (Corral-Verdugo *et al*., 2002). These economic policies face opposition from rights-based advocates and environmental activists who support the idea that water is a fundamental human right and that it cannot be turned into a commodity destined to make profit (Cahill, 2005).

The need to save water is not without reason since, as indicated above, drinking water consumption in the city of Salta is very high. Yet savings induced only by water meters do not seem enough to reach desirable consumption values, as can be deduced from a pilot study conducted in Salta by CoSAySa. Water consumption was measured during an entire year after the installation of household water meters in 10 neighborhoods (more than 10,000 households; roughly 45,000 inhabitants). Baseline water consumption had been previously determined during a few months. Before actually charging households with a consumption-based tariff, they were informed during 3 months about their water consumption and prospective water bills. During this transitional period, consumers were encouraged to fix leaks and replace dripping taps and other defective appliances in order to distinguish real consumption from water wastage. As shown in Table 1, water consumption in these neighborhoods significantly decreased by an average of 26.3% ($P < 0.01$) after one year under the new billing system, a reduction equivalent to 95 L/p.d. However, if calculated after the three-month transitional period, the reduction was only 21.6% (340–266 = 73 L/p.d) ($P < 0.05$), with 13.8% (340–293 = 47 L/p.d) achieved during the first three months of the new billing system. Reductions in water consumption were no longer statistically significant beyond the third month after the variable fee started.

These data help put in perspective the idea that water metering should be the only strategy to reduce water consumption. In drinking water systems, a varying amount of water is lost in distribution pipelines. The amount of UFW depends on the age of the distribution system, pipe corrosion, operation and maintenance of valves and other structures, and mechanical damage. A 10 to 20% UFW is considered acceptable (Lahlou, 2001). Table 1 shows that UFW in Salta is almost 40% (assuming that,

[3] Newspaper 'El Intransigente', July 10, 2009.
[4] Newspaper 'Nuevo Diario de Salta', August 28, 2009.
[5] Newspaper 'El Tribuno', February 13, 2014.

Table 1. Average household water consumption in 10 neighborhoods of Salta before and after the installation of water meters.

Neighborhoods		Household water consumption (L/p.d)				
		No meters	With meters			
			Fixed fee	Variable fee		
				Month 3	Month 6	Month 12
1	Ferroviario	373	341	325	302	278
2	Mariano Moreno	365	341	286	278	262
3	Tres Cerritos	397	381	310	317	333
4	Gendarmería	405	381	190	198	175
5	San Cayetano	365	341	341	333	286
6	El Carmen	349	317	302	294	278
7	Santa Victoria	389	373	333	310	302
8	Villa Chartas	413	397	373	349	333
9 & 10	San Benito & Siglo XXI	198	183	175	159	151
Average		362	340	293	282	266
Reduction (L/p.d)			22	69	79	95
Reduction (%)			6.1	19.0	22.0	26.3

Based on data provided by Salta's water company CoSAySa (Compañía Salteña de Agua y Saneamiento S.A.).

as indicated above, gross consumption is around 600 L/p.d and net consumption is 362 L/p.d). Taking UFW to a reasonable level (15%) would reduce water consumption by 24.7%, or 148 L/p.d (from 600 to 452 L/p.d). If, in addition, household leaks could be reduced to the extent indicated in Table 1 (22 L/p.d), water consumption would go down from 600 to 430 L/p.d, representing an overall reduction of 28.4%. Conversely, if leaks are not detected and controlled, the reduction in water consumption attributed to a change in consumer behavior would amount to only 12.2% of the total water consumed (73 out of 600 L/p.d), which is less than half the potential savings achievable by leak detection, control, and prevention.

Awareness campaigns and mass-media advertisements encouraging reductions in water consumption and promoting the use of water meters started shortly after the water company was privatized in 1998 and continued into 2013, years after the company reverted to state control in 2007. These campaigns included radio and television ads, brochures, activities in schools, a Facebook account, and billboards on the streets, among other activities (Figure 1). According to the company, *per capita* water consumption remains high (and even 'irrational')[6] in spite of these campaigns. This is not surprising because most of the waste results from leaks in the distribution system. Moreover, when leaks are large it becomes difficult to detect, let alone assess, reductions in water consumption in households unless the latter are extraordinarily high.

Q methodology

Social perspectives have been studied empirically and systematically with Q methodology, a technique originally developed and used by psychologists that has expanded its area of application to a

[6] Newspaper 'Nuevo Diario de Salta', February 2, 2010.

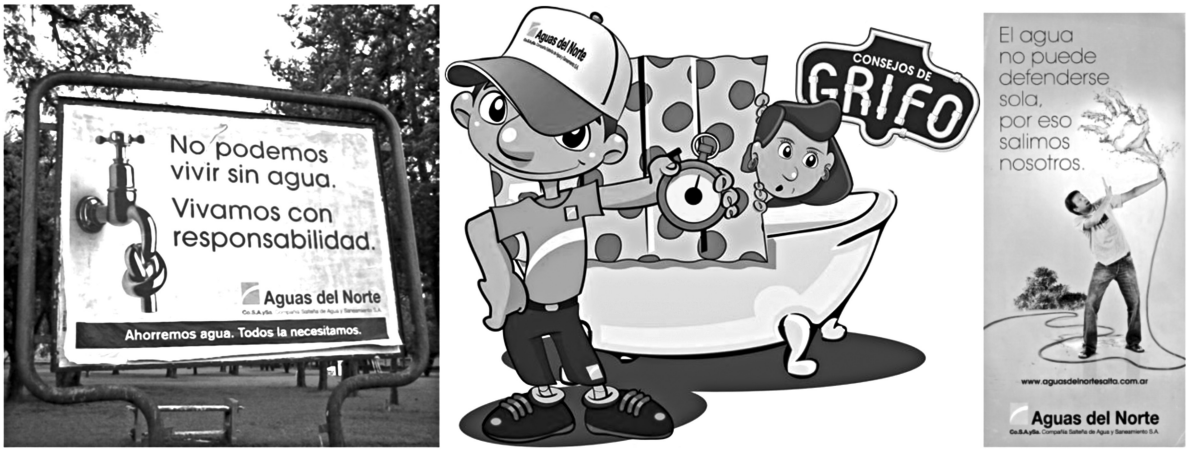

Fig. 1. Awareness campaigns launched by Salta's water company to foster water conservation. Main message in the billboard on the left: 'We can't live without water. Let's live with responsibility' (source: own photograph). Center: character called 'Grifo' (Tap) used to encourage responsible water behavior, especially among children (source: https://www.facebook.com/pages/Grifo-Aguas-del-Norte/317318505038207 Accessed 23 August 2013). Right: brochure distributed among customers when they get a fine due to alleged water wastage. The message reads: 'Water can't defend itself, that's why we take action'.

wide range of issues in the social and environmental sciences (Addams & Proops, 2000; Eden *et al.*, 2005; Robbins, 2006; Vugteveen *et al.*, 2010; Brannstrom, 2011; Ray, 2011; Lansing, 2013). Q methodology combines qualitative methods with the statistical rigor of quantitative analysis and can be useful in the generation of socially-sensitive environmental policies (Brown, 1980, 1996; Barry & Proops, 1999). It can be defined as a 'set of psychometric and operational principles that, when conjoined with specialized statistical applications such as factor-analytical techniques, provides researchers a systematic and rigorously quantitative means for examining human subjectivity' (McKeown & Thomas, 1988, p.7). Q methodology assumes that subjectivity on a specific issue is: (a) communicable, since it is self-reflexive and conscious; and (b) operant, because it gives shape to discourses and behaviors expressed by people with respect to a given issue in a given context (Barry & Proops, 1999; Robbins, 2005). Subjectivity is comprised of finite ideas that can be measured and organized, through factor analysis, into distinctive worldviews or 'social perspectives'. These perspectives reflect 'the sum of behavioural activity that constitutes a person's current point of view' (Watts & Stenner, 2012, p. 26).

In Q methodology, social perspectives can be identified by analyzing how participants sort a set of statements (or photographs, videos, etc.) in a specific grid. For the sake of simplicity, this grid is usually assumed to be normally distributed. Participants have to accommodate the set of statements in the grid according to their degree of agreement or disagreement. When the ratings of various participants have high correlation with each other, it means that they hold similar views and therefore belong to the same social perspective. For the application of Q methodology, data collection units are individuals who are highly engaged with the particular object of analysis. Participants are selected purposively to represent the range of views of the target population, and need not be related to the proportion of people within each potential group of stakeholders. The outcome of a Q study is a group of factors (social perspectives) that represent common views that exist in a group of people about a particular subject (Stephenson, 1965). Each factor is summarized in a model Q-sort, namely a weighted average sort

that represents the opinions of all those participants whose sorts 'loaded' (correlated) with this social perspective. Factors are generalizations of the attitudes that people have with respect to a given issue, allowing comparisons to be made between them based on the results of the statistical analysis. Mathematically, the analysis offers different possible solutions, so knowledge of the local context is paramount. We analyzed our data with PQMethod 2.20, a free software developed by Peter Schmolck at the Federal University of Munich[7]. This program performs three basic statistical processes: calculation of the correlation matrix, extraction and rotation of significant factors by principal components analysis, and definition of a set of scores for each factor. Our study was performed following the methodological sequence described in Webler *et al*. (2009). A number of issues deserving special clarifications will be touched upon below, since they depend on the circumstances of our case study.

Concourse of statements. The thematic universe or 'concourse' of Q statements was obtained from an analysis of the local media, conference proceedings, scientific articles, background interviews, and our own experience on water and sanitation in the region (Seghezzo, 2004; Iribarnegaray *et al*., 2012; Iribarnegaray & Seghezzo, 2012; Seghezzo *et al*., 2013). Following common practice in the literature, we organized Q statements around four *foci* or themes:

1. *Service provider*: This theme intended to identify different perspectives related to three possible types of service providers, namely: (a) state agencies; (b) public or semi-public companies; and (c) private companies.
2. *Water rights*: We were interested in identifying social perspectives on the idea that access to water is a fundamental human right. Extreme positions in this debate can be summarized as follows: (a) access to an affordable amount of clean water constitutes a specific human right and should be directly or indirectly secured by the state; and (b) water is considered a commodity and access to it should be regulated by the market.
3. *Public participation*: Participation of different actors in water-related decision-making processes can be: (a) active, with companies, end users, and the state engaged in participatory decision making; (b) passive, in which participation is generally limited to answering occasional top-down consultations; or (c) indifferent, with participation reduced to bottom-up claims or sporadic requests of information only relevant to affected customers.
4. *Water availability*: Different views are possible on this issue, namely: (a) water is naturally scarce and only rational use (basically by end users) can guarantee availability of water to all; and (b) water is relatively abundant and the water company is ultimately responsible for providing enough and safe water to all citizens, who might or might not save water according to their willingness to pay a fair price for it.

From an initial concourse of more than 150 potential statements we selected between 13 and 20 statements per theme, with a total of 68 final statements (see complete list in the Appendix). Statements were sorted by participants on a relative scale from −5 (most strongly disagree) to +5 (most strongly agree) using the sorting grid in Table 2. Being a relative scale, it is assumed that participants can rank statements in a relative order even if they happen to agree (or disagree) with all of them.

[7] Available at http://schmolck.org/qmethod/ (Accessed 23 August 2013).

Table 2. Sorting grid used in our study.

	Most disagree ←					→ Neutrality ←					→ Most agree
Scores	−5	−4	−3	−2	−1	0	+1	+2	+3	+4	+5
Number of statements	2	3	5	8	10	12	10	8	5	3	2

Statements were assessed according to a ranking scale with scores from −5 (most strongly disagree) to +5 (most strongly agree). A total of 68 statements were distributed in the grid according to the number of statements indicated for each score. Arrows indicate the direction of agreement or disagreement.

Selection of participants. Participants were selected using purposive sampling from six groups with potentially distinctive perspectives on the water system of Salta: (1) water company managers, technical staff, and public relations representatives; (2) government officials from the state office in charge of controlling the water service (Ente Regulador de los Servicios Públicos), the Secretary of Energy (Secretaría de Recursos Energéticos), and the National Institute of Agricultural Research (INTA); (3) members of social and environmental non-governmental organizations (NGOs) active in water-related issues; (4) general water users and water customers belonging to citizens organizations in areas of the city with water provision or sanitation problems; (5) scholars and scientific researchers working on water treatment, cleaner production, and the sociology of water issues; and (6) environmental engineers and students of environmental sciences with particular interest in water issues. As indicated in Webler *et al*. (2009), participants in a Q study are intentionally selected because they have distinctive opinions on the subject under study. Four to six individuals per social perspective is usually enough, although some studies might involve more people to ensure a certain degree of redundancy in the answers. In our study, a total of 29 persons were identified and interviewed at the end of 2011 during sessions that lasted between 30 min and 2 hours. None of the individuals approached refused to participate. During the interviews, participants were not informed about the four themes selected to avoid any influence on their answers. Follow-up post-Q semistructured interviews were conducted in mid-2013 with the most representative participants of each social perspective in order to assess their satisfaction with model perspectives identified during our analysis and to collect additional comments on the study.

Results

Social perspectives

Six factors (or potential social perspectives) obtained eigenvalues above 1, a precondition to consider them independent (Addams & Proops, 2000). A contextual analysis of the results suggested that a simpler, four-factor solution was more meaningful under local circumstances. Factors five and six, with eigen values barely above 1, seemed relatively artificial and their actual meaning was difficult to ascertain. The number of defining sorts dropped considerably when selecting five factors. On the other hand, selecting only three factors implied losing what was found to be a very distinctive fourth factor. The four factors selected collectively represented an accumulated variance of 62%. Factors were interpreted based on the contents of the different sorts and the conceptual relationships among statements. In the analysis that follows, numbers between brackets preceded by the number sign (#) refer to statement number (see Appendix). Table 3 shows the factor array and rank statement scores, with distinguishing statements indicated for $p < 0.05$ and $p < 0.01$. Each factor will be described according to: (i) its statistically

Table 3. Factor array and rank statement scores. Description of factors provided in the text.

Statements		Factors							
		A		B		C		D	
No	Brief description	*Z*	Rank	*Z*	Rank	*Z*	Rank	*Z*	Rank
1	State ensure right to water	2.38	5	2.41	5	1.38	3	1.90	5
2	Inefficient state companies	0.03*	0	−1.78**	−4	−0.62	−1	−0.70	−2
3	Co-management of water	−0.24	−1	0.12	0	−0.22	0	1.26**	3
4	Public policy of subsidies	−0.12	0	0.12	0	−1.19	−3	−0.60	−1
5	State not transparent/efficient	0.60	2	−0.57	−1	0.63	1	−0.12	−1
6	Political aspects important	−0.90**	−2	0.96	2	0.33	1	0.73	2
7	Public water and sanitation	−0.11	0	0.43	1	−0.56	−1	1.84**	4
8	Private water and sanitation	−0.51**	−1	−1.65	−4	−1.69	−4	−2.06	−4
9	Active private companies	0.14**	0	−1.31	−3	−0.79	−2	−2.09*	−5
10	Insensitive private companies	1.17*	3	−0.15	0	0.08	0	0.48	1
11	Adaptive management	−0.03	0	0.17	1	1.44**	4	0.00	0
12	No water scarcity	1.01**	2	−1.61**	−4	−0.59	−1	0.12	0
13	Always save water	0.80	2	0.80	2	0.78	2	0.19	0
14	Tariffs affordable for users	−1.01	−2	1.05**	2	−1.78	−5	−1.07	−3
15	Pricing minimizes wastage	−1.41	−3	−0.19	−1	−0.57	−1	−0.83	−2
16	Protection of watersheds	0.47	1	0.95	2	1.86	5	1.14	3
17	Public private partnerships	0.31	1	−0.54	−1	−0.09	0	−0.66	−1
18	Right to water universal	1.36	4	1.24	4	1.26	2	2.53**	5
19	Water injustice violates rights	0.33	1	0.34	1	0.75	2	0.26	1
20	Water, health, development	1.28	3	2.36	5	0.70	1	1.71	4
21	Restrictions violate rights	0.90	2	−1.28	−3	−0.73	−2	1.26	3
22	Water and sanitation as rights	0.82	2	0.31	1	0.43	1	0.25	0
23	Public private cooperation	0.43	1	−0.01	0	0.38	1	−0.42	−1
24	Water injustice also political	0.49	1	1.05	3	0.51	1	1.05	3
25	Protect water by not using it	−1.88**	−4	−0.75	−2	−0.69	−2	0.48**	1
26	Consider impacts on nature	0.31	1	0.82	2	1.26	3	0.70	2
27	Treat and reuse water	0.31	1	−0.03	0	0.17	0	0.82	2
28	Declare water public good	0.83	2	1.18	3	0.32	0	0.16	0
29	Scarcity affects the poor	1.21	3	0.73	2	0.31	0	0.54	1
30	Citizens main stakeholders	0.80	2	−0.58*	−1	0.19	0	1.33	3
31	Right to pay and consume	−0.48**	−1	−1.56	−3	−1.73	−4	−1.39	−3
32	Water use unsustainable	−0.52	−2	−0.24	−1	0.47	1	0.67	2
33	Ban on large-scale projects	−0.83	−2	−0.33	−1	1.44**	4	0.16	0
34	Water markets are equitable	−1.68	−4	−0.09**	0	−0.97*	−2	−2.25	−5
35	Water markets are efficient	0.38	−1	−1.02	−3	−0.44	−1	−1.61	−4

(*Continued.*)

Table 3. (*Continued.*)

Statements		Factors							
		A		B		C		D	
No	Brief description	*Z*	Rank	*Z*	Rank	*Z*	Rank	*Z*	Rank
36	Water is an economic good	−2.32	−5	−1.33	−3	−1.70	−4	−1.91	−4
37	Water better than gold	0.28**	0	−0.89	−2	−0.59	−1	−0.75	−2
38	Water and development	1.70	4	2.34*	4	0.63*	1	1.36	4
39	Citizens responsible for water	−1.59**	−3	−0.68	−2	−0.69	−2	−0.67	−1
40	Water metering essential	0.19	0	1.35*	4	0.59	1	−0.70**	−2
41	Citizens as partners	0.12	0	−0.91	−2	−0.52	−1	0.09	0
42	Decisions not only companies	−0.17	−1	−0.98**	−2	−0.16	0	0.04	0
43	Citizens as decision makers	0.45	1	−0.25	−1	1.13*	2	0.03	0
44	Citizens and governance	−0.38	−1	−0.63	−2	0.92	2	0.57	2
45	Participation is sustainability	0.42	1	−0.59**	−1	1.39	3	0.70	2
46	Water meters reduce wastage	−0.24	−1	0.27	1	0.19	0	−1.30**	−3
47	Citizens are not needed	−1.15	−3	−0.37*	−1	−1.28	−3	−1.18	−3
48	Pricing implies conservation	−0.97	−2	0.60**	1	−0.44	−1	−1.33	−3
49	Institutions only responsible	0.52	1	0.21	1	−0.52	−1	−0.01	0
50	Users do not need to plan	−1.72**	−4	0.05	0	−0.80	−2	−0.61	−1
51	Participation as a weakness	−1.93*	−5	−0.67	−2	−1.27	−3	−0.88	−2
52	Water is no longer abundant	0.11**	0	1.05	2	0.96	2	−0.82**	−2
53	Need equitable distribution	1.09	2	0.60	1	1.06	2	0.38	1
54	Rational consumption key	−0.14	−1	0.44*	1	1.43**	3	−0.28	−1
55	Education is essential	1.33	4	1.22	3	1.71	5	0.51*	1
56	Rights linked to obligations	2.07*	5	1.08	3	1.30	3	0.89	2
57	Infrastructure is a priority	1.15	3	1.15	3	0.43	1	0.54	2
58	Ban some activities	−1.43*	−3	0.75*	2	0.11*	0	−0.63*	−1
59	Users not responsible	−0.09	0	0.06	0	−1.00**	−2	0.44	1
60	Use in gardens and pools	−1.26	−3	−2.19	−5	−2.00	−5	−0.70	−2
61	Pricing policies and rights	−0.49	−1	0.04	0	−0.90	−2	−0.04	−1
62	Savings at home irrelevant	1.16*	3	−0.01	0	−0.92**	−2	0.44	1
63	Privileged use more water	−1.02	−2	0.28	1	−0.10	0	−0.79	−2
64	Water scarcity is a strategy	−1.05	−2	−1.88	−5	−1.55	−3	0.25**	0
65	Wastage unrelated to income	−0.43	−1	−0.13	0	−0.04	0	0.47	1
66	Water governance is key	0.17	0	−0.15	0	1.46**	4	0.23	0
67	Participation needed	0.31	0	−0.50*	−1	0.73	2	0.38	1
68	Water providers as protectors	−0.57	−2	−0.67	−2	−1.63**	−3	−0.51	−1

Statements were assessed according to a ranking scale with scores from −5 (most strongly disagree) to +5 (most strongly agree). A total of 68 statements were distributed in the grid according to the number of statements indicated for each score. Arrows indicate the direction of agreement or disagreement. Distinguishing or significant statements are indicated for $p < 0.05$ (*) and $p < 0.01$ (**). *Z*: z-scores (in standard deviations).

significant or 'distinguishing' statements (see statements with one or two asterisks in Table 3); (ii) the type of respondents who loaded on that factor (marked with *x* in Table 4); and (iii) supporting qualitative data from interviews conducted after the Q analysis with defining respondents for each factor.

Factor A: Rights-based consumption advocate. This perspective was built with the Q sorts of six participants (four customers, one scientific researcher, and one representative of the regulatory office; see Table 4). Respondents under this perspective exhibited a rights-based, consumption-oriented approach. They seem convinced that the problem of inadequate water and sanitation services is related to lack of management capacity on the part of profit-oriented water companies and inadequate control by the state (#10, #12). They see water management as a predominantly technical issue and believe that political aspects should not affect the efficiency of the service (#6). They think that access to an adequate amount of drinking water is a human right that should be linked to some obligations from users (#56), but they also think that end users are not as responsible as the state or the water company for

Table 4. Factor loadings obtained by extraction and rotation of significant factors by principal components analysis (Varimax) in the free software PQMethod 2.20.

Participants		Factor loadings for 4 factors identified							
		A		B		C		D	
1	Representative of a professional association	0.4741		0.2213		0.5355		0.3551	
2	Local environmental NGO representative	0.1841		0.1414		0.5936		0.5759	
3	Local environmental NGO representative	0.4727		0.2015		0.5106		0.3688	
4	Local social-environmental NGO representative	0.5654		0.2004		0.4812		0.3352	
5	Environmental engineer	0.3420		0.2931		0.4633		0.4918	
6	Environmental sciences student	0.3578		0.3137		0.7502	*x*	0.0449	
7	Environmental sciences student	0.4485		0.1205		0.4537		0.3495	
8	Environmental engineer	0.2529		0.1961		0.6506	*x*	0.5261	
9	Water user and customer	0.5290		0.2992		0.5517		−0.0559	
10	Water user and customer	0.6873	*x*	0.0966		0.1375		0.1227	
11	Water user and customer	0.4594		0.0491		0.2790		0.4238	
12	Water user and customer	0.6623	*x*	0.1396		−0.0390		0.1083	
13	Water user and customer	0.6742	*x*	0.0563		0.2955		0.2201	
14	Water user and customer	0.4416	*x*	0.2949		0.2464		0.1423	
15	Water user and customer	0.4801		0.1620		0.4640		0.2196	
16	Scientific researcher on water issues	0.4239		0.3424		0.4426		0.4070	
17	Scientific researcher on water issues	0.5697	*x*	0.1098		0.2780		0.4303	
18	University professor and water researcher	0.3911		0.2732		0.2139		0.6513	*x*
19	Philosopher and water NGO representative	0.1098		0.0697		0.3121		0.7774	*x*
20	University professor and social researcher	0.3681		0.2985		−0.0612		0.7019	*x*
21	State energy sector official	0.1284		0.1873		0.6738	*x*	0.1979	
22	Water company director	−0.0224		0.7697	*x*	0.4377		0.0488	
23	Water company technical manager	0.1893		0.6513	*x*	0.2849		0.1109	
24	Water company public relations official	0.1857		0.7790	*x*	0.3065		−0.0138	
25	Water company engineer	0.0383		0.1103		0.5683	*x*	0.1208	
26	State agricultural and water resources researcher	0.4171		0.6264	*x*	0.2377		0.2274	
27	Regulatory office representative	0.1751		0.7017	*x*	0.1694		0.2216	
28	Regulatory office representative	0.7182	*x*	0.2296		0.1312		0.2261	
29	Regulatory office representative	0.1168		0.7279	*x*	−0.1819		0.2688	

NGO: Non-Governmental Organization; *x*: indicates defining sort.

protecting water resources (#39). This is probably linked to their idea that inefficient companies are to blame for water problems, not physical water scarcity (#12). In fact, respondents within this perspective strongly believe that water savings by customers are irrelevant in a city with significant leakages in the distribution system (#62). The salient feature of this factor is the idea that customers have the right to consume water, which is seen as a natural resource to satisfy human needs. Leaving water in its natural environment and minimizing its consumption by humans is not acceptable for this factor, demonstrating a strong utilitarian attitude towards water resources (#25). Not surprisingly, they do not support bans on water consumption activities (#58). Probably guided by a self-centered motivation to protect their alleged rights over water consumption, they manifest a strong desire to play a more active role in water planning and management (#51).

Factor B: Proponent of market-based and technical water management. Six participants defined this perspective (three members of the water company, a water resources researcher, and one official with the regulatory office; see Table 4). Common to these participants was a market-based, technical approach to water management. They believe current water management in the city of Salta is technically adequate and economically affordable (#2, #12, #14). This factor is particularly inclined to use market instruments and water metering to foster more rational water management (#40). As indicated above, the idea of water metering has been constantly promoted by local water companies as one of the best ways of reducing water consumption and raising awareness over the cost of water and the need to protect water sources. This factor also seems in favor of relatively centralized, technocentric water management in charge of public or private water companies, with reduced participation of other stakeholders (#42). In line with the idea that market instruments are efficient, respondents in this factor believe that water consumption should be reduced by inducing (allegedly irresponsible) consumers to avoid wasting water (#54). Moreover, this factor is the only one to openly support the idea of banning some activities such as watering gardens and filling swimming pools (#58). They see physical water scarcity as a problem (#12) that might jeopardize local development (#38). Unlike Factor A, Factor B strongly disagrees with statements critical of the current water administration (#2, #5, #9, #10) and statements supporting the need to involve customers in water management (#12, #30).

Factor C: Participatory governance advocate. Four respondents (one environmental sciences student, one environmental engineer, a representative of the energy public sector, and one engineer from the water company) loaded highly on this perspective (see Table 4). This factor is characterized by its support of more participatory, environmentally-friendly water governance, as strongly evidenced by statements #11 and #66. They favor active public participation as a means to achieve more integrated and environmentally-friendly management systems (#43). Other perspectives were also positive about public involvement in water-related decision making processes, but it is possible that the type of participation desired is different for different actors, since the 'ladder of participation' has rungs varying from consumer manipulation to citizen control (Arnstein, 1969). This perspective is particularly skeptical about the commitment of local authorities and water companies to the protection of water resources (#68) and opposes the use of market instruments in the water sector (#33, #34). They believe end users should consume water in a careful and rational way despite leaks in the system since users are also responsible for water conservation (#54, #59, #62). In this point, they seem to particularly disagree with Factor A (maximum differences for statement #62). Respondents in this factor consider themselves important actors in water-saving schemes, irrespective of the quality of local water management

practices or the efficiency of private or public water companies. Environmental awareness seems to play an important role in defining water-related behaviors within this factor. Respondents in Factor C strongly disagree with those in Factor B with respect to the fairness of water tariffs in Salta (highest difference between factors for statement #14).

Factor D: State-led governance supporter. This perspective, a very stable factor in both the principal component analysis and the different manual rotations performed during the factor analysis, was defined by three participants (two university professors and a philosopher who doubles as NGO representative; see Table 4). No state employees loaded highly on this perspective probably because the water utility, even though it is now controlled by the government, has a relatively long history in private hands. A salient feature of this perspective is the advocacy for relatively hierarchical, state-led, needs-oriented governance. Respondents are rights-based advocates when it comes to access to water and sanitation services (#18) and believe that the state is the only entity that can efficiently provide these services, with little room for autonomous private companies (#7, #9). However, they also support the idea of a certain degree of co-management of water services by public institutions and private companies (#3). They are against water meters as a tool for more rational water management (#40, #46). In fact, they do not believe water scarcity is critical in the Salta region and are therefore against restrictions in consumption (#52). Factor D disagrees with Factor A on the potential role of private companies in water management (high differences for statements #9, #8), with Factor B on the idea that water can be freely traded on the market (#34), and with Factor C about the reasons behind local water scarcity and the ways to protect water resources (#52, #54).

Consensus points

Perspectives showed no statistically significant differences for ‘consensus’ statements. For example, all perspectives believe that the adoption of water-saving practices is necessary and desirable even in those cases where there is no physical water scarcity (#13). They are sensitive to water injustices (#19) and consider that access to safe water and adequate sanitation should be considered a human right, as enshrined in international legislation since the United Nations General Assembly declaration of July 26, 2010 (#22). Although they differ on the role private companies should play in water management, all perspectives agree that cooperation between public and private sectors is important to adequately manage water resources (#23). The complexity of universal access to drinking water and sanitation, and the need to protect the environment by adequately treating wastewater is acknowledged by all factors (#24, #27). Yet water equity will not be achieved without active, efficient policies (#53). There is also consensus on the idea that local water infrastructure needs to be improved in order to reduce leakages from aging pipes and optimize water consumption (#57).

Although correlation between factors was relatively high (from 0.47 between Factors A and B to 0.61 between Factors A and D), the points of disagreement were enough to determine that they were independent social perspectives. A relatively large number of statements and overlapping meanings between statements may have also contributed to the correlation between factors. As shown in Table 4, some participants could not be clearly associated with any of the factors selected; these are ‘confounders’ (participants who were split between Factors, especially A and C, or C and D) and ‘non-loaders’ (participants who did not distinctively load on any of the four perspectives) (see Webler *et al.*, 2009). These

participants hold hybrid, complex, and sometimes even contradictory views on the issues raised by the statements we tested.

Post-sort interviews

During post-sort interviews, representative participants from all social perspectives expressed a high level of agreement with the descriptions of their respective factors based on model Q sorts. They rated their agreement with 9, 8, 9, and 10 points out of 10 for Factors A, B, C, and D, respectively. During these interviews, respondents also made remarks about the rationale they followed for choosing the statements to rank highly or lowly. These remarks were useful to clarify some answers and better understand the factors. As expected, they also had some slight disagreements and comments on the average scores for some statements. It is worth noting that answers to statements do not always have an unambiguous interpretation. Some answers might even appear contradictory. This is not necessarily erroneous; rather, it is a reflection of the complexity of the issues we tested and the diversity of people's attitudes and discourses about them. Thus, descriptions presented should be considered just approximations of the subjectivity of the people interviewed and their ultimate meaning will always be open to debate.

Discussion

Social perspectives and water-conservation policies

We contend that the identification of social perspectives on water management can be a useful tool to improve local water policies and explain the success or failure of specific initiatives and WDM strategies. In particular, our Q study identified social perspectives that might help understand the relative lack of success of some awareness campaigns launched in Salta in order to reduce water consumption, and could explain why, after years of systematic promotion of household water meters, current coverage in Salta is well below original expectations. Our findings suggest several specific reasons for this policy failure.

To begin with, the tone of some ads used during awareness campaigns was not in line with what some perspectives actually think about who bears the most responsibility for water conservation. Campaigns generally assume that consumers use water irresponsibly, as can be deduced by the tap with a knot and the message contained in the billboard in Figure 1 (left) or the disapproving attitude of the character called 'Grifo' (Tap) who appears with a stopwatch controlling a careless user who was caught taking an excessively long shower (Figure 1, center). Beyond the authoritarian connotations that sensitive customers could detect in these images, calls to be more 'responsible' might also generate negative reactions among those who loaded on Factor A and highly ranked the statement arguing that water savings at home become irrelevant when water losses in the distribution system are significant (#62). The same goes for those who believe that citizens are not the ultimate responsible party for the protection of water resources since saving water is basically a responsibility of the state and other water managers (#39, #68). We do not think that customers only react in extreme conditions, for example, when they get a fine or during politically motivated boycotts against the policies of the water company. Different sectors react in different ways, and there probably are mixtures of indolence, economic interests,

cynicism, disillusion on previous government initiatives, plain distrust of the intentions of the water company, or ideological reasons for this (O'Donnell *et al*., 2000). Yet public attitudes against water meters and the overall reluctance to adopt the behaviors suggested in corporative leaflets and awareness campaigns are congruent with some of the social perspectives we identified and therefore reflect the worldviews of different local actors. Stakeholders, distributed across social perspectives, interpret and value an allegedly 'objective' concept – water scarcity – in different, subjective ways.

This is not to say that consumption behaviors should not change at all. On the contrary, we believe that water-conservation strategies within households are needed and should be encouraged by water companies. Several approaches and complementary policies with different levels of urgency and efficiency are required to achieve this goal. Our contention is that allegedly positive initiatives to save water might face varying degrees of explicit or tacit public resistance and eventually fail to achieve the objectives for which they have been devised, if they are not, at least to some extent, in accordance with prevailing social perspectives (Barry & Proops, 1999). As stated by Norton's 'convergence hypothesis', different policies can be equally efficient in practical terms even if they are founded on different ideological paradigms (i.e. market-oriented versus state-controlled systems) (Norton, 2005, p. 508). However, policies based on different ideological assumptions impose dissimilar responsibilities and financial burdens on different stakeholders. Therefore, stakeholders will tend to reject policies that are interpreted as unfairly demanding or biased against their interests. In any ideological scenario, however, it is generally accepted that water utilities (either public or private) have always the inescapable task of fixing distribution pipes and reducing leaks outside households. Water companies can promote but also ban specific water behaviors. In fact, the use of drinking water to irrigate gardens or wash cars on the street is forbidden in Salta during most of the day, especially in the dry season, and the water company has the power to impose fines when they believe water is being wasted[8] (see also Figure 1, right). This restriction on some water uses is a very contentious issue that was heavily criticized by one respondent who loaded on Factor A.

Even within the same ideological paradigm (say a techno-managerial approach) there can be different strategies to save water, beyond water meters, pipeline replacement, and in-house maintenance. Water can also be saved, for instance, by promoting and using a combination of locally available water-saving devices such as double-flush toilet reservoirs, various tap inserts and accessories, infra-red no-touch sensors, aerators for showerheads, specific washing machines, dishwashers, and high-efficiency toilets, among others. Water consumption could be reduced significantly without affecting user behaviors or previous water consumption patterns (Muthukumarana *et al*., 2011)[9]. This reduction could go even **Q2** further by incorporating additional components such as rain water harvesting and gray water reuse, or by establishing internal housekeeping regulations coupled with programs of environmental awareness or economic incentives. Based on data from a specific building in downtown Salta, we estimated that if only half of the households of the neighborhoods in Table 1 adopted the water-saving techniques indicated above (or if all households adopted 50% of these techniques), water consumption would decrease to 238 L/p.d (fixing in-house plumbing but without installing water meters) or 186 L/p.d (fixing plumbing and installing water meters). These hypothetical targets are arguably difficult to achieve in the short term, but show the potential of gradually replacing current water-wasting appliances and accessories by

[8] Newspaper 'Nuevo Diario de Salta', May 31, 2013; Newspaper 'El Tribuno', July 22, 2013.
[9] See www.niagaraconservation.com (Accessed 29 July 2013).

water-efficient versions. Water consumption of 238 L/p.d, which is below the value suggested in the Water Code, could be achieved without installing household water meters.

Salta's water company is trying to reduce the consumption of drinking water through its awareness campaigns. Our Q-method results suggest that this objective is more likely to be achieved, at least in the short term, by maintenance interventions outside households, rather than introducing a policy of water metering or by encouraging consumers to use less water by means of awareness campaigns. Leak control would be a highly visible and popular measure, since all social perspectives see the government (in our case the state-controlled water company) as responsible for reducing water leaks. Maintenance and supervision costs should be less relevant for a public company than for a private company forced to make profits to survive. The water company would also avoid conflicts with users who oppose policies based on water meters and reject the idea of water as a commodity. This does not necessarily imply that stakeholders have a wasteful attitude since no social perspective ranked highly the statement that water should be used indiscriminately even if it is paid for (#36). In the absence of systematic insight into the views and opinions of social actors, water managers have no way of understanding apparently irrational opposition to their water policies, which they see in a positive light. It is reasonable that, when confronted with these situations, water managers react with frustration and reinforce their view that end users are generally uncooperative, distrustful, and even ignorant squanderers of water.

Q studies identify social perspectives on a particular issue. One of the limitations of the Q method is that it does not permit generalizations about the population (Q-method tests statements, not people); indeed, Q-method findings may inform the content of large-*n* surveys, so that researchers ask appropriate questions, ensuring that valid generalizations are made about a population. However, drawing from the results of this case study and our previous experience in the area, it is possible that Factor A, defined mostly by end users, may be shared by a majority of water customers. On the other hand, water managers and representatives of the regulatory office defined Factor B. They are arguably a minority but they hold most of the decision-making power. As indicated by Hufty (2011), power relationships can be decisive in governance processes, especially in centralized, hierarchical decision-making sectors such as the water system in Salta. Environmental, water, and energy engineers defined Factor C; this likely reflects the opinion of many university professionals with direct or indirect stakes on water management. Their proportion of the population is likely small but their technical background makes them prominent in public debates on water issues. Academics and scholars in environmental and social issues defined Factor D. They are also a minority but are in constant contact with a relatively high number of students and other teachers and, depending on their field of work and public exposure, may have significant influence on public opinion and policy makers.

This study has several implications for environmental policy and urban WDM. As pointed out by Barry & Proops (1999), identifying how individuals think about environmental issues is important because discourses and worldviews determine and condition environmental policies. Recent studies on household water management and conservation almost always acknowledge the relevance of environmental beliefs and social discourses, but usually rely on methods such as high resolution smart metering technology, regression analysis and other statistical techniques, surveys of water using appliances in households, alarming visual display monitors in showers, questionnaires, factor analysis, telephone interviews and other polling techniques, focus groups, econometric studies, and so on (Randolph & Troy, 2008; van den Bergh, 2008; Millock & Nauges, 2010; Willis *et al.*, 2010, 2011, 2013; Muthukumarana *et al.*, 2011; Makki *et al.*, 2013). In this respect, our study shows that **Q3**

the Q method, by helping determine social discourses and perspectives on water conservation, has great potential for ecological economics and environmental policy-making.

Conclusions

A Q-method study performed in the city of Salta, Argentina, revealed the existence of at least four social perspectives about water management. The study involved 29 participants from different interest groups who sorted 68 statements organized around four main topics (service provider, water rights, public participation, and water availability). Factor A was represented mainly by customers and exhibited a rights-based, consumption-oriented approach. Factor B included members of the water company and officials with the regulatory office. This factor presented a market-based, technical approach to water management. Factor C was defined by environment-related professionals who advocate more horizontal, environmentally-friendly water governance. Finally, Factor D (state) was defined by university professors who support hierarchic, state-led, needs-oriented governance.

Empirical determination of social perspectives is important for policy makers. Disregard of people's views may lead to the failure of supposedly positive and environmentally-friendly policies aiming to reducing water consumption. In our case study, we tried to show that the apparent lack of success of water metering and awareness campaigns implemented in Salta by the local water company can be explained, at least in part, by a systematic disregard of social perspectives on these issues. This paper presents evidence indicating that the advertising and use of water meters alone may not achieve the goal of reducing water consumption in the city of Salta.

Water managers ascribed these failures to uncooperative consumers and believed that the solution lay in the strengthening of hierarchical, top-down decision making. However, other respondents (such as environmental engineers) believed that more horizontal water management was necessary to achieve consensus in the identification of water problems and policies. Misunderstandings and even distrust between water managers and customers might result from inadequate public information and the absence of adequate interaction spaces for deliberation and debate around water issues.

The results of our Q study should not be seen as an opinion poll because we do determine the proportion or number of people who hold a particular view. Supplementary studies should be conducted if more quantitative information is needed regarding the population. Overall, Q methodology is a powerful tool to identify and analyze social perspectives on water issues and might contribute to more sustainable water governance.

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Q1 Corral-Verdugo & Frías-Armenta (2006) is not listed in the reference list. Please provide publication details to insert in the list.

Q2 Please confirm the correct spelling of Muthukumarana et al. (2011) as per the reference list.

Q3 Please confirm the change of citation from Makki (2013) to Makki et al. (2013) as per the reference list.