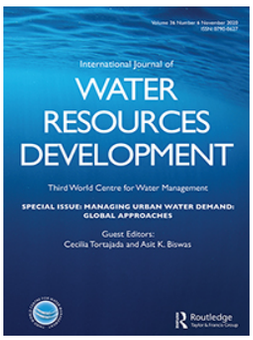

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Exploring the psychosocial and behavioural determinants of household water conservation and intention

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ABSTRACT

Securing urban freshwater supplies is a major challenge for policy makers globally. This study investigated the determinants of household water conservation to identify the relative contribution of psychosocial and behavioural determinants. Using a survey of 1196 households across the UK, we found that attitudes, norms and habits play an important role in determining intention to conserve water, and that habits were the single most important predictor of water conservation intentions and self-reported water bills. Changing ingrained water conservation habits is therefore an important component of managing urban water demand.

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Water conservation; water demand; conservation intention; pro-environmental behaviour; routines; psychology; water-efficient infrastructure

Introduction

Domestic demand for freshwater resources accounts for approximately 15% of current global water demand, ranging anywhere from 7% in India to 35% in South Africa, and this is expected to increase across all emerging economies. Demand is also increasing from industrial and agricultural practices, setting up competition between water-use sectors (Addams, Boccaletti, Kerlin, & Stuchtey, 2009). At the same time, there is evidence of pressure on supply from environmental damage and climate change (Intergovernmental Panel on Climate Change, 2018). Water security is therefore a substantial challenge for policy makers, who need to meet increasing demand while managing decreasing supply. Demand-side management has emerged as an essential complement to more traditional supply-side approaches (Brooks, 2006; Jeffrey & Gearey, 2006). Indeed, the Intergovernmental Panel on Climate Change has labelled demand management a 'no regrets option' to help cope with the vulnerability of water supplies in the face of climate change impacts (Bates, Kundzewicz, Wu, & Palutikof, 2008).

In the recent literature there has been increasing recognition of the relationship between water-use behaviour and water-use technologies and the need for a greater understanding of the underlying psychological process that help determine water-use behaviour (Russell & Fielding, 2010). Research that helps identify the underlying psychological processes and social drivers of water use can inform policy to create more conservation behaviour (Fielding, McDonald, & Louis, 2008; Russell & Fielding, 2010).

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There is a growing body of research examining the determinants of water use and conservation. Factors that have been investigated include household and social demographic characteristics such as number of occupants in a household (Aitken, Duncan, & McMahon, 1991), water-use practices (Aitken et al., 1991; Aitken, McMahon, Wearing, & Finlayson, 1994; Fielding, Russell, Spinks, & Mankad, 2012; Gregory & Di Leo, 2003), attitudes and values (Aitken et al., 1994; Gregory & Di Leo, 2003; Syme, Seligman, & Thomas, 1991), water pricing, (Kenney, Goemans, Klein, Lowrey, & Reidy, 2008), and the installation of water-efficient appliances (Kenney et al., 2008; Stewart, Willis, Panuwatwanich, & Sahin, 2013).

The study presented here aims to advance understanding of the determinants of household water use by including sociodemographic, contextual, psychosocial, behavioural and infrastructure variables. Most research to date has focused on only one category of determinants, with little consideration of the relative contribution of each determinant (for an exception, see Fielding et al., 2012). The current study investigates the relative contribution of key predictors of household water use that have been identified in past research.

A stream of research is starting to build up in this area, including studies in Australia (Fielding et al., 2012), China (Zhang & Brown, 2005), Greece and Poland (Shan, Yang, Perren, & Zhang, 2015) the United States (Wolters, 2014), Italy (Aprile & Fiorillo, 2017), and Mexico (Ojeda de la Cruz, Alvarez-Chavez, Ramos-Corella, & Soto-Hernandez, 2017). It is important to further develop this research across multiple contexts. The current study investigates the determinants of water conservation in the UK.

In the following sections the theoretical framework of this study is introduced and the key determinants of water use are identified. By using a comprehensive model of environmental behaviour (Klöckner, 2013) and combining this with demographic and contextual determinants, this research offers a systemic and multidisciplinary perspective on household water use. This study thereby answers calls in the literature for taking into consideration a wider range of determinants of water conservation behaviour (Fielding et al., 2012; Jorgensen, Graymore, & O'Toole, 2009; Russell & Fielding, 2010).

Background and literature review

The aim of this research was to identify the most important factors affecting water conservation behaviour by integrating existing knowledge of the determinants of water conservation behaviour with advances in understanding of the psychosocial determinants of conservation behaviour more broadly. A comprehensive model of environmental behaviour (Klöckner, 2013) is used as the theoretical framework, supplemented by the framework presented by Russell and Fielding (2010), which effectively combines psychological literature with knowledge of the sociodemographic and contextual determinants of water-use behaviour.

Comprehensive model of environmental behaviour

The Comprehensive Action Determination Model (CADM, Klöckner, 2013) of environmental behaviour draws together the two of the most frequently cited theoretical frameworks in conservation literature, the theory of planned behaviour (Ajzen, 1991) and value-belief-norm theory (Stern, 2000), to derive an integrative framework to classify the drivers of conservation

behaviour. CADM predicts that behaviour is directly determined by the psychosocial determinants of intention, which acts as an integrative variable in joining the impact of attitudes, social norms, perceived behavioural control and personal norms. CADM further includes habits and routines as a powerful determinant of behaviour, and this differentiates the model from previous psychological models, which have largely assumed that behaviour is rational and reasoned. Using CADM as an organizing framework and drawing on the work of Russell and Fielding (2010), a conceptual model was developed (Figure 1). This model draws together the psychosocial and behavioural determinants as outlined in CADM, along with the sociodemographic and contextual factors that have been shown to be important in predicting water use (Russell & Fielding, 2010). Thus, the model in Figure 1 represents an integrative and multidisciplinary framework on which the hypotheses for this research are based. The following sections provide a review of extant research on household water use in each of the four categories of determinants (psychosocial, behaviour, sociodemographic and contextual), and identify the study hypotheses.

Psychosocial determinants

CADM suggests that the core psychosocial determinants of water conservation behaviour intentions are attitudes, social norms, perceived behavioural control and personal norms. Attitudes can be understood as overall measures of the favourability of particular behaviours. Subjective norms are made up of the perceived expectations of relevant other people who are important to the subject, or the felt social pressure to engage in particular behaviour. Perceived behavioural control is the extent to which people feel they have the opportunity and ability to perform a particular behaviour (Ajzen, 1991). Finally, personal norms are an individual's value system in a given situation, and they can be defined as the extent of moral obligation felt to engage in the behaviour (Klöckner, 2013; Stern, 2000).

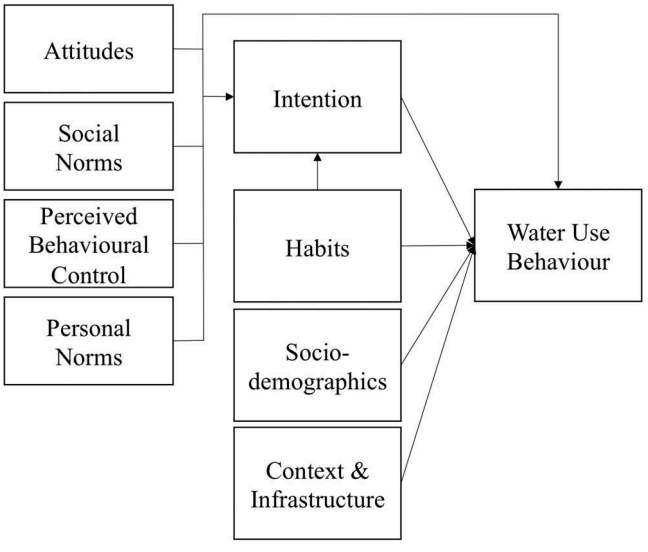

Figure 1. Conceptual model of the determinants of water-use behaviour.

There is evidence that all of these variables are important predictors of water conservation behaviour (Clark & Finley, 2007; Kantola, Syme, & Campbell, 1983; Lam, 1999, 2006; Russell & Fielding, 2010). Thus, it is hypothesised that attitudes, social norms, perceived behavioural control and personal norms will be positively related to water conservation intentions and behaviours.

There is, however, some inconsistency in findings. Fielding et al. (2012), for example, found that perceived behavioural control was an important predictor of water conservation behaviour. But in their Australian sample, attitudes and subjective norms did not help explain variation in household water use. This might be explained by the inclusion of contextual variables in the study, and indeed, they showed that contextual variables explained a significant proportion of household water use. This is further evidence of the need for comprehensive and systematic studies that combine a broad range of determinants and not just one category. It may be, for example, that contextual variables strongly contribute to the predictive power of these psychosocial determinants and that therefore it is necessary to combine both contextual and psychosocial variables in a single study.

Behavioural determinants

To date, the dominant perspective in water management and psychology research has been that individuals make rational and reasoned choices (Bamberg & Möser, 2007; Burness, Chermak, & Krause, 2005; Espey, Espey, & Shaw, 1997; Russell & Fielding, 2010). Yet more and more evidence is showing the importance of automatic processes that require less cognitive effort, such as habits or routines (Fielding et al., 2012; Russell & Fielding, 2010). CADM integrates habits as an important predictor of intentions and behaviours and suggests that habits become increasingly important for behaviours that are repeated frequently. Thus, in this study habits are included as a determinant of water conservation intentions and behaviour.

Habits can be defined as 'relatively stable behavioural patterns, which have been reinforced in the past … [and] are executed without deliberate consideration, and result from automatic processes, as opposed to controlled processes like consciously made decisions' (Verplanken & Holland, 2002, p. 287). Automatic processes, rather than deliberative reasoning, thereby guide habitual behaviours. In the water conservation literature, there is evidence to suggest that habits have a positive relationship to water conservation intentions and behaviour (Aitken et al., 1991, 1994; Fielding et al., 2012; Gregory & Di Leo, 2003). Thus, we hypothesize that water conservation habits are positively related to water conservation intentions and behaviour.

Sociodemographic

In the water conservation literature, there has been a tendency to examine the determinants of water conservation within disciplinary silos, with many studies examining psychosocial determinants *or* sociodemographic and contextual factors (Russell & Fielding, 2010). For a more systemic perspective, this study takes an interdisciplinary approach, including both sociodemographic and contextual factors as determinants of household water-use behaviour.

Research has shown that sociodemographic and contextual factors play an important role in explaining water use because these factors can constrain or facilitate behaviour

(Russell & Fielding, 2010). Unsurprisingly, households with more residents use more water (Fielding et al., 2012; Gregory & Di Leo, 2003; Jeffrey & Gearey, 2006). Research has generally found that households with more education often have stronger intentions to conserve water (Gilg & Barr, 2006; Lam, 1999). However, this is not always translated into action, with other research finding that more education can also associated with greater water use (De Oliver, 1999; Gregory & Di Leo, 2003). It is important, therefore, to consider education in the context of other variables. Like education, higher income has been associated with stronger intentions to install water-efficient appliances (Lam, 1999) yet also with greater water use (Fielding et al., 2012; Gregory & Di Leo, 2003). In general, older householders consume less water (Clark & Finley, 2007; Gilg & Barr, 2006). Evidence also suggests that households with younger members, particularly households with teenagers (Mayer et al., 1999), use more water than average (Lyman, 1992).

Contextual and infrastructure factors

Contextual factors such as the type of building and the tenure of residents have also been shown to be important in water conservation behaviour (Russell & Fielding, 2010). Past studies have shown that residents of detached houses report greater intention to conserve water (Clark & Finley, 2007; Gilg & Barr, 2006) and homeowners use less water than renters (Randolph & Troy, 2008). The provision of water meters increases water conservation behaviour (Olmstead & Stavins, 2009). In line this research, we hypothesize that more water will be used by larger rather than smaller households; younger rather than older households; those living in detached homes; and those without water meters installed.

Water-efficient infrastructure is another important determinant of household water use. Research has shown that replacing existing household appliances with water-efficient alternatives such as toilet dams, faucet aerators and low-flow shower heads can reduce water use by anywhere from 9% to 50% (Inman & Jeffrey, 2006). But despite these benefits, there is also evidence that behavioural factors can 'rebound' and offset any potential gains. Rebounding frequently occurs when the potential savings are undermined because of a corresponding change in water-use behaviours (Campbell, Johnson, & Larson, 2004; Geller, Erickson, & Buttram, 1983). For example, Stewart et al. (2013) showed that the installation of technologies to reduce water use in showers was effective in reducing water use in the short term, but after four months water use had reverted to the levels before the device installation. Fielding et al. (2012) also showed mixed results in relation to water-efficient appliances, with the installation of some appliances reducing water use (rainwater tanks and water-efficient dishwashers) and others increasing it (pool covers, water-efficient irrigation and water-efficient washing machines). In essence, past studies have had mixed results and suggest that while water-efficient infrastructure may help reduce water use, it is not guaranteed to do so.

Materials and methods

Participants and procedure

Participants were UK residents recruited via an online panel. Panel members were individuals who had signed up to complete surveys on a wide array of research topics in return for a small

financial incentive (about £3) for each survey completed. The research was part of a larger study on water and energy behaviour in the UK and was presented as such to participants.

The study sample was stratified according to the UK tenure split. In the UK, owner-occupiers account for two-thirds of households, while private and social renters each make up 17%. At the beginning of the survey, participants were presented with information about the survey, and ethical considerations, and asked to indicate if they agreed to participate. 'Water conservation behaviours' was defined for participants as 'engaging in everyday actions to save water around the house' at the beginning of the survey. Because the target behaviour was about reducing water use, 'water conservation behaviour' was used rather than simply 'water-use behaviour'.

Measures

Most of the survey items used a Likert-scale response format. Unless otherwise indicated, responses were measured on a five-point scale. All multiple-item scales were computed by taking the mean of the scale items, and in all cases higher values represented more of the construct. All the scales had good reliability (Table 1).

Attitudinal beliefs were measured with four semantic differential items. Respondents were presented with the list of behaviours and asked to rate each behaviour as bad/good, harmful/beneficial, unpleasant/pleasant, and unsatisfying/satisfying.

Subjective norms were assessed in terms of four items: role beliefs, approval, desirability and expectation, worded as follows. Role beliefs: For someone with my education, employment, age and income (social status) the following behaviour is 'very inappropriate' (1) to 'very appropriate' (5). Approval: If I engage in this behaviour people most important to me would 'completely disapprove' (1) to 'completely approve' (5). Desirability: People most important to me think it is 'very undesirable' (1) to 'very desirable' (5) to engage in this behaviour. Expectation: People most important to me think I 'definitely should not' (1) to 'definitely should' (5) engage in this behaviour.

Personal normative beliefs were measured using four items with responses from strongly disagree (1) to strongly agree (5). They included measures of moral obligation (I have a moral

Table 1. Means, standard deviations, and bivariate correlations among continuous variables.

	Mean	S.D.	1	2	3	4	5	6	7	8	9
1. Age	48.77	15.99									
2. No. of people in household	2.59	1.29	−.37**								
3. Household income[b]	6.32	2.66	−.14**	.23**							
4. Attitudes	3.84	.60	.14**	.00	−.05	(.89)					
5. Subjective norms	3.58	.66	.07**	.04	.02	.67**	(.92)				
5. Perceived normative beliefs	3.38	.77	.02	.04	.01	.60**	.63**	(.95)			
6. Perceived behavioural control	3.50	1.01	.19**	.01	.16**	.24**	.22**	.21**	(.96)		
7. Water conservation habits	3.44	.80	.17**	−.14**	−.04	.50**	.44**	.47**	.13**	(.63)	
9. Water conservation intentions	3.53	.85	.05*	.03	.01	.63**	.64**	.71**	.23**	.66**	(.83)
10. Monthly water bill (£)	1.85	.65	−.18**	.35**	.22**	−.03	.04	.02	.02	−.20**	.00

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Note: Cronbach's alphas for computed scales are in parentheses on the diagonal.

[b]Household income per month was coded as 1 = less than £216, 2 = £217–432, 3 = £433–866, 4 = £867–1299, 5 = £1300–1732, 6 = £1733–2166, 7 = £2167–2599, 8 = £2600–3032, 9 = £3033–3466, 10 = £3467–3899, 11 = £3900–4332, 12 = £4333 or more.

obligation to do the following behaviours…), guilt (I would feel guilty if I did not do the following behaviours…), principles (Not doing the following behaviours would be against my principles), and self-concept (I consider myself as someone who should do the following behaviour).

Perceived behavioural control in relation to efficiency behaviours was measured using four items. Degree of control over behaviours was measured by asking, 'How much control do you have over the behaviour?' Responses ranged from (1) very little control to (5) a great deal of control. The second item measured efficacy: 'It is up to me whether I install the following appliances', with responses from (1) strongly disagree to (5) strongly agree. Difficulty was measured by asking how difficult it was to install water-efficient appliances, from (1) very difficult to (5) very easy. Finally, likelihood was measured by asking how likely participants were to install water-efficient appliances in the next six months, from (1) very unlikely to (5) very likely.

Water conservation habits were operationalized as past behaviour; respondents were asked how much they engaged in curtailment behaviour in a typical week in the last 6 months (1 = almost never, 5 = almost always). Behaviours included turning off the tap when brushing teeth, taking shorter showers (four minutes or less), taking showers instead of baths, using reduced-flow taps appropriately, and using single flushes when appropriate.

Sociodemographic variables included respondents' ages, education (dummy, with 1 indicating high school or above), household income (from less than £216 to £4333 or more per month) and number of people in the household. Contextual variables included whether the home was owned or rented (1 = owned), whether a water meter was installed at the property (1 = metered), and whether the house was a flat or other type of property (1 = flat, 0 = other, including detached, semi-detached, terrace, or bungalow).

The presence of water-efficient infrastructure was captured by asking respondents whether they had installed each of five water-efficient appliances in their home: low-flow showerheads, flow restrictors in taps, dual-flush toilets, rainwater capture systems, and greywater reuse systems.

Water conservation intentions were measured using two items. We asked, How likely are you to do the following activities in the next week? Responses ranged from very unlikely (1) to very likely (5). We also asked about the strength of their intention, from very weak (1) to very strong (5).

Household water use was measured using the proxy of self-reported water bills. Respondents were asked to indicate whether they knew how much water they used annually or monthly and were asked to provide this information. Calculations were done to ensure that all data were reported for monthly water bills. Consistent with past research, household water use, as measured by self-reported water bills, was positively skewed and was therefore log transformed (Campbell et al., 2004; Fielding et al., 2012). Two outliers (i.e. more than three standard deviations from the mean) were identified in the log-transformed water use, and they were excluded from subsequent analysis.

Overview of analyses

Following the checking of assumptions and the removal of two cases with outlying responses for water bills, the final sample was made up of 1196 households in the analysis of water conservation intentions and 191 households in the analysis of self-reported water

bills. Means, standard deviations, and correlations among continuous variables are shown in Table 1. As illustrated in this table, none of the variables have correlations above 0.9, indicating that our analysis met the assumption for regression analysis that there is an absence of multicollinearity (Tabachnick & Fidell, 2001).

Block-wise hierarchical linear regression was used to test the hypotheses. The order of blocks was determined by following convention in past research (Fielding et al., 2012; Russell & Fielding, 2010). The demographic determinants of age, education, income and number of people in the household were entered at the first step of the analysis, along with the contextual variables (private or public housing, flat or other dwelling type, and water meter or no). The psychological variables (attitudes, subjective norms, perceived behavioural control, and personal normative beliefs) were entered in the second step, and water curtailment habits in the third step. In the final step the procedure used by Fielding et al. (2012) was followed, and water-efficient appliances were entered separately (rather than creating an index), as there is evidence that water-efficient appliances are not always related to lower water usage. In line with past research it was expected that each block of variables (demographic and contextual determinants, psychosocial variables, water curtailment habits, and infrastructure) would account for significant variance in intentions to conserve water and water use (Fielding et al., 2012).

Results

In this section, the results of the two analyses are presented. The first subsection includes water conservation intentions as the dependent variable; the second includes self-reported water bills as the dependent variable.

Predicting water conservation intentions

At the first step of the regression, demographic and contextual variables did not account for a significant amount of variance in water conservation intentions (Table 2).

The addition of psychological variables increased the variance explained in intentions to conserve water, with 59% of variance explained. Attitudes, subjective norms and personal normative beliefs all significantly contributed to explaining water conservation intentions. Households who reported having a more positive attitude, a greater sense of social pressure, and a stronger sense of personal obligation to conserve water responded that they also had greater intentions to conserve water. This is consistent with expectations and demonstrates the importance of these psychological variables in explaining conservation intentions. The presence of a water meter also significantly predicted stronger water conservation intentions.

In the next step of the analysis habitual water conservation behaviours significantly increased the explanatory power of the model. Those respondents who reported greater habitual actions were also more likely to report greater intentions to engage in those actions in the future. The addition of habitual behaviour to the model reduced the effect of water metering to non-significance, suggesting that the effect of water metering is mediated through habitual behaviour. The Sobel test for mediation was significant ($z = 5.16$, $p < .0001$), supporting this conclusion.

Table 2. Hierarchical regression analysis predicting water conservation intentions.

Predictor variables	Step 1 Adj. R^2 = .01, $F(1181)$ = 3.47, p = .001	Step 2 Adj. R^2 = .59, ΔR^2 = .57***, $F(1177)$ = 156.01, p < .001	Step 3 Adj. R^2 = .68, ΔR^2 = .09***, $F(1176)$ = 211.43 p < .001	Step 4 Adj. R^2 = .68, ΔR^2 = .00, $F(1171)$ = 149.99, p < .001
Age	0.04	−0.03	−0.05*	−0.05*
Educational qualification	0.01	0.01	0.00	0.00
No. of people in household	0.06	−0.01	0.04*	0.04
Household income	−0.02	−0.01	−0.01	−0.01
House ownership	0.04	0.02	0.02	0.02
Water meter installed	0.10**	0.05**	0.01	0.01
Dwelling type: Flat	−0.04	−0.04	−0.03	−0.03
Attitudes		0.22***	0.11***	0.12***
Subjective norms		0.21***	0.17***	0.17***
Personal normative beliefs		0.44***	0.35***	0.35***
Perceived behavioural control		0.03	0.04	0.03
Water conservation habits			0.37***	0.36***
Greywater system				0.03
Rainwater capture				−0.01
Low-flow showerhead				−0.01
Low-flow tap				0.02
Dual-flush toilet				0.01

*p < 0.05; **p < 0.01; ***p < 0.001.

The addition of habits also resulted in increasing the effect of age and occupancy to significance, suggesting that age and occupancy were also moderated by habitual behaviour. Sobel tests for mediation were also significant for age (z = 2.96, p < .001) and occupancy (z = −4.55, p < .0001). That is, in the presence of strong water conservation habits, older participants had weaker conservation intentions and larger households had stronger conservation intentions.

In the final step of the analysis, the addition of infrastructure variables did not significantly increase the power of the model to explain variance in water conservation intentions. Looking at these results further shows that the installation of a greywater system was approaching significance (p = .07), suggesting that having a greywater system may be associated with greater intentions for water conservation behaviour; but the effect was minimal, and further research is warranted. In summary, the model variables accounted for 68% of the variance in water conservation intention, with psychological and behavioural determinants being particularly important.

Predicting water bills

To investigate further, the block-wise hierarchical regression analysis was repeated for the subset of the sample that reported their monthly water bills (n = 191). The combination of all determinants explained 15% of the variance in household water bills for those who reported this information (Table 3). Step one of the analysis shows that those households with greater income, more people in a household, and living in houses rather than flats had larger water bills. This is perhaps unsurprising in the UK, where water bills are largely based on fixed tariffs based on number of occupants and type of house. Those with lower incomes are also likely to receive discounts on water

Table 3. Hierarchical regression analysis predicting self-reported water bills.

	Step 1	Step 2	Step 3	Step 4
	Adj. R^2 = .15, $F(205) = 6.29$, $p < .001$	Adj. R^2 = .13, ΔR^2 = .00, $F(201) = 3.98$ $p < .001$	Adj. R^2 = .16, ΔR^2 = .03, $F(200) = 4.37$ $p < .001$	Adj. R^2 = .15, ΔR^2 = .01, $F(195) = 3.25$, $p < .001$
		.00	.03	.01
Age	−0.07	−0.07	−0.06	−0.05
Educational qualification	−0.07	−0.07	−0.07	−0.08
No. of people in household	0.24***	0.24***	0.22**	0.22**
Household income	0.16*	0.16*	0.16*	0.16*
House ownership	−0.04	−0.03	−0.04	−0.04
Water meter installed	−0.10	−0.10	−0.07	−0.07
Dwelling type: Flat	−0.15*	−0.15*	−0.15*	−0.16*
Attitudes		−0.05	0.01	0.01
Subjective norms		0.06	0.08	0.09
Personal normative beliefs		0.01	0.06	0.06
Perceived behavioural control		−0.01	−0.01	−0.01
Water conservation habits			−0.21**	−0.23**
Grey water system				−0.03
Rainwater capture				0.10
Low-flow showerhead				0.00
Low-flow tap				−0.08
Dual-flush toilet				0.02

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

bills, so this is an imperfect measure of water use. Yet, in the absence of actual water-use data, it is argued that this approximation can still provide useful information.

In step two of the analysis the addition of psychological variables showed no significant increase in the predictive power of the model. The addition of water conservation habits at step three of the analysis significantly increased the predictive power of the model. Those respondents who reported greater water conservation habits also reported smaller household water bills. The addition of water-efficient infrastructure variables in step four did not increase the predictive power of the analysis.

What is most interesting from this analysis is that those who reported stronger habitual water conservation behaviours also reported smaller household water bills. This finding is particularly important because it demonstrates the importance of water conservation habits. The measure of self-reported water bills used in this study is a crude indicator of water use. In the UK, even for those households who are on water meters, a large amount of the bill can be attributed to contextual variables. However, the analysis presented here clearly shows that even after accounting for a large amount of variance from occupancy, income and dwelling type, there was still substantial variance in water bills that was explained by water conservation habits. Thus, the importance of behavioural determinants of water use cannot be overstated. In total, the demographic and contextual and behavioural variables accounted for 16% of the variance in self-reported water bills.

Discussion and conclusions

The current study aimed to test the importance of psychosocial, behavioural, demographic, context, and water-efficient infrastructure predictors of water conservation intentions and self-reported water bills. Results regarding water conservation intentions are considered first, followed by the results in relation to self-reported water bills.

Water conservation intentions

For the respondents in this study, water conservation habits were the single strongest predictor of water conservation intentions. Thus, this study concurs with past findings to suggest that habits have a positive relationship to water conservation intentions (Aitken et al., 1991, 1994; Gregory & Di Leo, 2003). Our results extend past research by demonstrating the strength of the effect of habits in the context of other categories of determinants. Indeed, the effect of habits was strong enough to mediate the relationship between the presence of water metering and water-use intention. It is reasonable to expect that those households that have a water meter will also report greater intentions to conserve water. However, in the presence of strong water conservation habits the presence of a water meter was not a significant predictor of water conservation intentions.

Age and occupancy were also significant, with younger and larger households reporting greater intentions to conserve water. The psychological variables of attitudes, subjective norms and personal normative beliefs were also significant predictors of water conservation attitudes. Specifically, where there were more positive attitudes, stronger social pressure and a stronger sense of personal moral responsibility, there was also evidence of stronger intentions to conserve water.

In contrast to previous research (Fielding et al., 2012), we see no relationship between the installation of water-efficient appliances and water conservation intentions. Previous research has shown mixed results in relation to water-efficient infrastructure (Fielding et al., 2012; Stewart et al., 2013), and the results here underscore the context-specificity of such research.

Self-reported water bills

All participants in this study were asked to estimate their water use by providing information about their water bills. A small subset (approximately 16%) of the study sample reported this information. Using this subsample, the analyses were run again using estimated water bills as the dependent variable. In the UK water bills are generally provided quarterly, and they are usually based on a household's size and residence type, and these variables could there be expected to be strong predictors of water use. As expected, smaller households and those in flats reported smaller water bills. Higher incomes were also related to higher water bills, which is consistent with past research (De Oliver, 1999; Gregory & Di Leo, 2003).

What was somewhat unexpected in these results was the strength of water conservation habits as a predictor of reported water bills. Despite water bills being self-reported, and based on historic data, habits were a strong predictor of water bills – stronger than household size (Table 3). Households that reported stronger water conservation habits also reported significantly smaller household water bills. These findings underscore the importance of behavioural determinants of water use and clearly show that habits have a very important role to play in determining household water use.

Implications

The findings of this study have implications for both policy makers and academicians. They highlight the importance of psychosocial and behavioural determinants of water

conservation intentions and water-use behaviour. It is clear that in any interventions designed to affect household water use, habits need to be considered. Habits were the single most important predictor of water conservation intentions and of water bills. Therefore, interventions that aim to disrupt habitual water-wasting behaviour and reform water conservation habits would be of benefit in affecting household water use.

When considering interventions to encourage water conservation it is also important to distinguish between discretionary and non-discretionary water uses. Traditionally, non-discretionary water use is defined as water that is required to meet consumption and sanitation needs, e.g., drinking, cooking and cleaning. Discretionary end uses are non-essential water-using activities, e.g., irrigation or leisure) (Willis, Stewart, Panuwatwanich, Williams, & Hollingsworth, 2011). But there is evidence that many essential water-use activities now include a large discretionary component. For example, water is required for showering or bathing, but taking long showers for relaxation could be classified as discretionary. A focus on the discretionary component of water-use behaviours is necessary in the shifting of habits towards water conservation.

In designing interventions to change habits, two potential avenues have been proposed: 'upstream' interventions that aim to target behaviour before it occurs by focusing on the context and structural conditions in which the behaviour occurs; and 'downstream' interventions that provide information at points where habits are vulnerable to change, such as during a house move or renovation (Verplanken & Wood, 2006). An upstream intervention could focus on encouraging public commitments to water conservation and setting of goals (Walton & Hume, 2011), perhaps through school-based education programmes (Fielding et al., 2012). These types of interventions focus on changing behaviour as well as norms, a determinant that was found in this study to be a significant predictor of water conservation intentions. Research has shown that downstream educational campaigns can be effective in changing water conservation habits (Martínez-Espiñeira & García-Valiñas, 2013; Walton & Hume, 2011). Downstream interventions might include providing information (e.g. on bills or through smart metering), in renovation stores, or through tradespeople involved in building, renovation, or servicing water appliances and equipment; thus habits are changed through informing attitudes and personal normative beliefs (Walton & Hume, 2011).

From a theoretical perspective, this study has made an important contribution by examining a broad range of variables and testing their contribution to explaining both water conservation intention and water conservation behaviour (through the proxy of water bills). Thus this study considers both the individual level (by examining water conservation intentions) and the collective behaviour of the household (through the use of water bills). Research has tended to examine variables at either the individual level or the household level, generating a mismatch between levels of analysis (Fielding et al., 2012; Jorgensen, Martin, Pearce, & Willis, 2013). We have attempted to overcome this limitation, and the results clearly show that there are different determinants of intention versus use. A clear and consistent message from these results is the primary importance of habitual behaviour in determining future intentions and behaviour.

Limitations

One of the limitations of the current study is that data were self-reported. It was not possible to take water meter readings or to access water-use history from utility companies for the households in the study, so self-reported data of water bills was used. This is an imperfect measure, subject to participant recall and knowledge of water bills. Furthermore, in the UK context the measurement of water use is limited by a lack of water metering infrastructure. Although this is changing, many of the participants in this study did not have water meters and were not able to (or chose not to) respond to questions about their water bills. Any self-reported measure can be subject to social desirability bias, whereby participants artificially inflate positive behaviours. Social desirability is not always evident in environmentally related behaviours (Milfont, 2009), but our results should be interpreted with caution given that we did not measure social desirability directly. Future research that is able to access observational measures of water use from metered records would be of benefit to verify these results using observational rather than self-reported data.

Another limitation of the current study is that data were correlational, and it was therefore not possible to establish causality. For example, it is not possible to determine the interaction between water conservation intentions and behaviour and water-efficient infrastructure without longitudinal data. The installation of water-efficient infrastructure does not always result in the expected reductions in water use (Stewart et al., 2013). A longitudinal approach that also includes participant interviews would provide a more nuanced understanding of how householders interact with water-efficient infrastructure and the subsequent effect on household water use.

Conclusions

The current research has shown that psychosocial, behavioural, sociodemographic and contextual variables all have a role in determining household water conservation intentions and water use. Household size and income are important determinants of water use and are out of the control of policy makers. However, this study clearly shows that psychosocial and behavioural factors are significant determinants of water conservation intentions and household water use. In particular, habits were the single most important predictor of water conservation intentions and self-reported water bills. The effect of habits can therefore not be overestimated. Thus, there is much scope for policy makers to effect change in interventions targeting these variables. Voluntary and mandatory approaches that encourage ongoing water conservation behaviours may be effective in reducing water demand. The results also suggest a strong relationship between water metering and water conservation, and thus that investment in water metering may be a fruitful avenue to encourage more water conservation behaviour. The current research provides valuable insights into the factors that are important to target in order to manage residential water demand. This information can inform future research that tests interventions to promote household water conservation. The outcomes of this research will thereby inform policy makers in making better decisions about the best way to secure future water supply in urban areas.

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