Drop by Drop: Scarcity as the Severance Between Intentions to Save Water and Actual Water-Saving

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Abstract

Water scarcity is an escalating global issue. Since 2015, Cape Town has experienced the worst drought in the city's recorded history. There is an increasing need to encourage sustainable behavioural changes to conserve available water. Decreasing water demand may be improved by predicting water usage. This study used the Theory of Planned Behaviour (TPB), was used to investigate the social and psychological determinants of Cape Town residents' intention to adhere to water restrictions during the drought. This study aimed to create a model of prediction for intention to adhere to the daily limit, and to test this model's predictive utility by comparing water-saving intentions to actual water usage. This was accomplished by creating and distributing a TPB-based questionnaire over two studies. Study 1, an online elicitation study ($N = 28$), provided insight into Capetonian's beliefs about their water usage. These beliefs were used to create an 88-item TPB-questionnaire administered in Study 2 ($N = 74$). Path analysis revealed that attitude and perceived behavioural control significantly predicted intention, but subjective norms did not. Unexpectedly, behaviour was not significantly predicted by intention, but was predicted by self-perceived knowledge of water usage. The model explained 31% of the variance in intention, and 6% of the variance in behaviour. The proposed influence of scarcity on these results were discussed. The study concluded that TPB has minimal predictive utility when applied to water-use behaviour in the context of water scarcity. Future research should consider other methods to identify determinants of water-use behaviour.

Keywords: Cape Town; drought; predicting water usage; Theory of Planned Behaviour; water-use behaviour; water scarcity.

Drop by Drop: Scarcity as the Severance Between Intentions to Save Water and Actual Water-Saving

Since 2015, Cape Town, South Africa, has experienced the worst drought in its recorded history (Meissner & Jacobs-Mata, 2016). The city's water supply has become progressively scarcer due to increases in population size, a lack of infrastructure to support the increase in demand, and changing weather patterns causing droughts (Lindsay, Dean, & Supski, 2017). However, such issues are not limited to Cape Town, as water scarcity is an escalating global issue (Kummu et al., 2016). There are two possible solutions for this problem: (1) to increase water supply (e.g., by means of desalination plants), or (2) to decrease demand (e.g., by means of water demand management strategies [WDMS]; Hurlimann, Dolnicar, & Meyer, 2009). This study will focus on the latter solution, as improving water-saving behaviours to conserve existing resources is more likely to facilitate a sustainable management strategy. In South Africa, municipalities have implemented WDMS in the form of water restrictions. This strategy has been found to have limited success in changing water-use behaviours (Jacobs-Mata et al., 2018). In instances where WDMS did effectively decrease water use, the behavioural changes were not sustained beyond the context of water scarcity. Thus, to design and implement successful interventions that facilitate maintainable water-saving, it is important to study the drivers of water-use behaviour. Such research is vital, as water conservation practises are necessary to ensure that similar water crises do not reoccur, either in Cape Town or elsewhere.

In response to increasing instances of water scarcity, researchers have investigated scarcity's effect on behaviour. Scarcity induces a change in perception wherein an item's value increases simply due to the fact that it has become scarce (Zhao & Tomm, 2018). Thus, the context of scarcity causes one's judgement to deviate. This can be adaptive, as research has shown that this increased perception of value can cause resource efficiency. However, at the same time, scarcity has also been shown to cause impulsive behaviour (Mittone & Savadori, 2009). This is known as the scarcity heuristic; an unwitting bias in decision-making. The adaptive effects of scarcity were demonstrated by Zhao and Luo (2015) who asked participants to wash dishes in a sink that was directly under a clear water tank. As they did, participants could see the tank's water level decrease from either half full at the start (condition one) or from being a quarter full at the start (condition 2). Participants randomly placed in the quarter-full tank condition used 38% less water than participants in the half-full tank condition, despite both groups being informed that the water tank would be refilled if it ran empty. The participants' behaviour suggested that, even though they knew that more water was available if necessary, seeing that they only had a small amount left strongly influenced their water-use behaviour. This study exhibited that the context of scarcity affects the way we perceive a resource. Therefore, scarcity disturbs typical decision-making processes.

Few studies on water scarcity have been conducted in ecologically authentic contexts. Such contexts would include periods such as the 1997-2009 Millennium drought in Australia. During this period, researchers focused on how individual, rather than contextual, factors influence water-saving (e.g. sociodemographic factors such as annual household income, household size, age, and gender; Makki, Stewart, Beal, & Panuwatwanich, 2015). Interventions such as daily water consumption feedback, provided by smart water meters, were also studied in such contexts (Davies, Doolan, van den Honert, & Shi, 2014). These studies found that feedback decreased usage by reconciling disparities between perceived and actual water usage (Beal, Stewart, & Fielding, 2013). Self-regulation of water usage improved after particpants' knowledge of how much they used was enhanced. However, Russell and Fielding (2010) found that, 12 months after identifying an improvement in usage using smart water meters, the intervention group's decreased water use had returned to pre-intervention levels. These results suggested that behavioural change was only facilitated by such interventions whilst they occured.

There has been a shift in the focus of research on water-saving from technological interventions to the psychological underpinnings that drive water consumption. The key to decreasing water demand is predicting water usage (Hurlimann et al., 2009). A seminal theory of behaviour prediction is the theory of planned behaviour (TPB; Ajzen, 1991). This theory posits that behaviour, such as keeping within water restrictions, is predicted by the strength of one's intention to save water (Ajzen, 1991). This intention is guided by three factors: (1) one's personal evaluation of water-saving (attitude), (2) the strength of social pressure from prominent referents that one perceives regarding engaging in water-saving behaviour (subjective norms; SN), and (3) the perceived difficulty or ease of saving water, based on experience and anticipated obstacles (perceived behavioural control; PBC). This intention to save water is thought to be a direct proxy for the actual adoption of water-saving behaviour (Ajzen, 2002). Research conducted on behaviour prediction of water usage hopes to yield insight into the drivers of water-use behaviour. Such insight aims to improve WDMS to increase the likelihood that behavioural changes might be maintained.

Three notable studies have used the TPB to try to predict water usage (Clark & Finley, 2007; Perren & Yang, 2015; Trumbo & O'Keefe, 2005). All three of these studies have disregarded the suggested sufficiency of the three TPB variables (i.e., attitude, SN, and PBC). Rather, these studies have expanded on the core TPB model to increase its predictive power (Perren & Yang, 2015). The first, conducted following water scarcity in Bulgaria, created a model including self-perceived knowledge of climate change, environmental attitudes, and worry over future shortages in addition to attitude, SN, and PBC. The three core TPB predictors, along with knowledge of climate change, significantly predicted intention to conserve water (Clark & Finley, 2007). However, environmental attitudes and worry over future shortages were significantly, but weakly, correlated with intentions to conserve. The second study, conducted after a drought in Nevada, USA, considered the explanatory power that sociodemographic variables, environmental values, and attention paid to water conservation information, would have in predicting water-saving intention (Trumbo & O'Keefe, 2005). Their extended model accounted for 27% of variance in intention, and the core TPB variables explained 67% of that variance. In a review of psychological influences on water consumption, Russell and Fielding (2010) concluded that the perception of social pressure, feeling in control of water conservation, and positive attitudes toward water conservation were strong predictors of commitment to engage in water-saving behaviours.

In contrast to the previous two studies' findings, the third study, conducted in Greece, found that while SN and PBC predicted intentions to save water, attitudes towards conserving water did not. In addition, prior water saving behaviour and active engagement with material on water conservation predicted intentions to save water (Perren & Yang, 2015). An Australian study produced similar findings, as SN and PBC were positively associated with intention to save water in both Brisbane and Melbourne, whereas attitude towards water-saving was not a predictor of water-saving intentions in Melbourne (Fielding, Thompson, Louis, & Warren, 2010).

The findings of TPB studies on behavioural intentions to save water have not been conclusive. A consistent limitation of previous research has been a failure to address how a study's context may affect intention to save water and actual water-saving. Many studies measure intentions to conserve water to preempt behaviour during an oncoming water-scarce period, or do so retroactively, once the water crisis has passed (Hurlimann et al., 2009). The study of intentions to save water seldom takes place in the midst of water scarcity. As indicated by Zhao & Luo's (2015) water-tank study, the scarcity of a resource we have typically experienced in abundance has important influences over how we behave. Therefore, it is important to conduct the study of influences of water-use behaviour within the water-scarce context in which the scarcity heuristic is elicited. Previous studies have often taken place outside the context in which behavioural intentions would manifest. This disparity between contexts could weaken the predictive strength of the model and, therefore, lead to inconsistent results. In addition, as few TPB studies take scarcity into account, there is a lack of research on how predicted intention may manifest within the context of scarcity (Hurlimann et al., 2009). Thus, there is currently a gap in the research literature between intention to conserve water and actual water-saving.

Rationale, Aims, and Hypotheses

It is common for people to be affected by a scarcity heuristic when four parameters of scarcity are present: (1) increasing rarity, (2) diminishing quantity, (3) restriction, and (4) time sensitivity (Cialdini, 1993). In 2017, Cape Town received 30% of its expected annual rainfall, fulfilling the parameter of rarity (City of Cape Town, 2018a). In 2018, dam levels had decreased to critically low levels, fulfilling the parameter of diminishing quantity. In response, in February 2018, water restrictions of 50 litres per day (lpd) were enforced, fulfilling the parameter of restriction. The City of Cape Town projected ‘Day Zero’ – a time in which access to municipal water would be cut and water rationed to 25 litres per person per day. This day was initially predicted for April 2018, fulfilling the parameter of time sensitivity. With prospect of ‘Day Zero,’ Cape Town was at risk of being the first major city in the world to run out of water (Cassim, 2018).

Cape Town was successful in halving its water consumption: usage dropped from 1.2 billion litres in February 2015 to 511 million litres per day (MLD) in March 2018. However, of this 689MLD decrease over three years, a 400MLD reduction took place between February 2017 and 2018 (City of Cape Town, 2018b). Although numerous intervention strategies were implemented by the City of Cape Town, Department of Water and Sanitation, non-governmental organizations, and media, over the entire course of the drought, the sudden increase in efficient water-saving may be explained by the impending threat, and motivation to save, that water scarcity produced (Jacobs-Mata et al., 2018). If usage was most curbed by the context of water scarcity rather than effective WDMS, water-use behaviour may return to pre-drought levels once Cape Town’s water crisis is over. Thus, water would likely be depleted to critical levels again in the future. There is a need to create behavioural changes that are sustained beyond the context of water scarcity. Although water use in Cape Town was relaxed in October 2018 from 50 litres to 70 litres per person per day, However, readings taken on 15 October 2018 showed that the city's consumption was still 63MLD above the target (City of Cape Town, 2018c).

The current study aimed to investigate social and psychological determinants of Cape Town residents' intentions to save water and their actual water-saving. Research into water usage suggests that it is crucial to understand behavioural intentions if one hopes to meaningfully change water-wasting behaviour (Hurlimann et al., 2009). Thus, this study aimed to create a model which accurately predicts water usage using the TPB. It is theorised that having positive attitudes, perceptions of SN, and perceived control over water-use behaviour would increase the likelihood that Cape Town citizens would intend to keep within the water restrictions. In addition, the current study explored the role of demographic factors on water usage. Given the lack of attention paid to context in previous research, this study aimed investigate the three TPB variables within the context of scarcity (i.e., during Cape Town's water crisis). To address a further weakness in previous studies, this study went a step further to assess the accuracy of its predictive model by comparing citizens' predicted intention to keep within water restrictions to their actual water usage over one year. Comparing water usage in 2017 to 2018 provided insight into how Cape Town citizens' water usage changed over the period in which the water crisis was at its worst. The study, therefore, addressed the current gap in the research literature between intention to save water and actual water-saving.

The hypotheses for this study were that:

1. Behavioural intention would significantly predict actual water usage in 2018.
2. Attitudes relating to adhering to water restrictions would significantly predict intentions to keep within Cape Town's water restrictions.
3. SN relating to adhering to water restrictions would significantly predict intentions to keep within Cape Town's water restrictions.
4. PBC relating to adhering to water restrictions would significantly predict intentions to keep within Cape Town's water restrictions.
5. There would be a significant positive correlation between intention to keep within water restrictions and the amount by which water usage had reduced between 2017 and 2018.

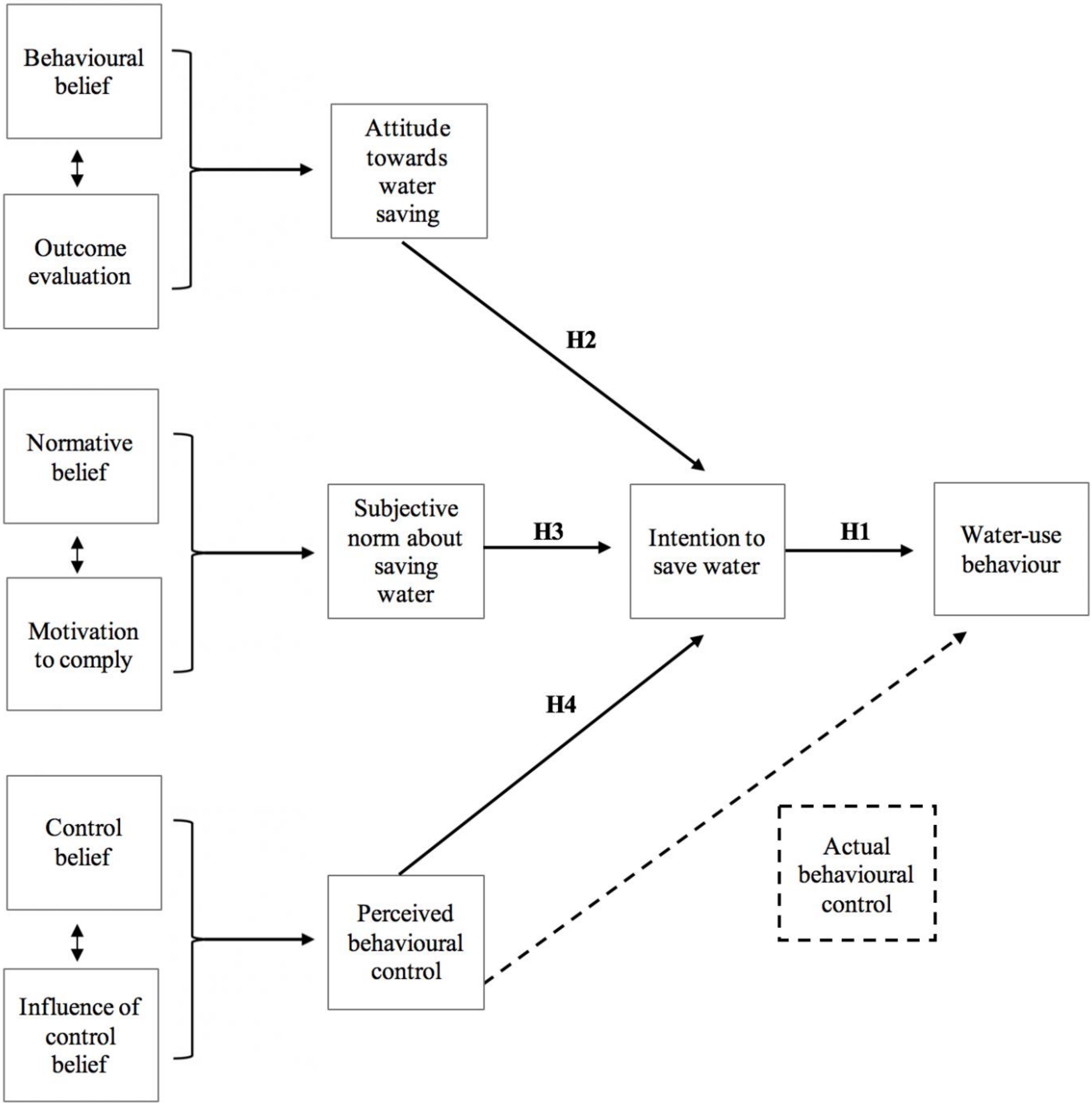

Figure 1. The theory of planned behaviour model including the first four hypotheses.

The TPB's core constructs are informed by three corresponding pairs of salient beliefs, as illustrated in Figure 1 (Fielding, 2010). First, attitude towards a behaviour is constructed from an 'expectancy-value analysis' (Francis et al., 2004). The 'expectancy' component to this analysis refers to the expectation of a positive or negative outcome of a behaviour, known as a behavioural belief. The 'value' component of the analysis refers to the fact that the behavioural belief is weighted by an appraisal of the expected outcome, known as the outcome evaluation. Attitudes are, therefore, determined by a combination of the accessible beliefs and the subjective values underlying the expected outcomes (Ajzen, 2002). For example, if we equate saving water with saving money, and one of our aims is to save money, then we are more likely to have a positive attitude about saving water. Second, SN about water-saving are theorised to be based on beliefs about societal expectations around the behaviour (normative beliefs) and the desire to align with these expectations (motivation to comply). Third, PBC is informed by an assessment of factors that either assist or impede the behaviour (control beliefs) weighted by the anticipated influence such factors would have if they were present (influence of control belief).

As one of the three main predictors, PBC is a measure of confidence in one's capacity to conduct a certain behaviour. In addition to the psychological perception that one might not have the capacity to conduct a behaviour is a measure of our perception of actual, 'non-psychological' impediments to behaviour. For example, if one has a strong intention to conserve water, but a household pipe suddenly springs a leak, one may use more water not because of an intention to, but because of a structural obstacle which would be present until the leak is fixed. Thus, the TPB notes that a strong behavioural intention may be overridden by actual barriers to performing the behaviour. This is known as lacking 'actual behavioural control'(Francis et al., 2004). As PBC may offer insight into impediments to carrying out behavioural intention, the line joining PBC and action (Figure 1) is dashed rather than solid.

Methods

There were two components to this study. In Study 1, I collected qualitative data about the salient behavioural, normative, and control beliefs about keeping within water restrictions of Cape Town citizens (N = 28). Using a tailored design method in accordance with previous TPB research, this qualitative information was used to create items for a quantitative questionnaire, which was developed to measure Cape Town citizens' intentions to keep within the water restrictions (Study 2). Creating a measure of intention which could be quantified allowed data on water-saving intentions to be collected and compared. These data were used to create a predictive model of intention. Both Study 1 and 2 were conducted online via the SurveyMonkey platform (www.surveymonkey.com).

Methods: Study 1 (Qualitative Survey)

Design and Setting

Study 1 aimed to elicit participants' experiences of, and feelings about, using water in Cape Town during the water crisis to create items for the TPB questionnaire. Thus, a phenomenological approach was used. This qualitative study formed part of a larger, mixed-methods design. The study was set in Cape Town, South Africa, during the water crisis (August) and took place online.

Participants

I obtained a sample of $N = 28$ (17 women and 11 men). This sample size is in accordance with TPB research guidelines, which have reported 25 participants as sufficient for ensuring adequate representation of the target population's most salient beliefs (Ajzen, 2002; Flowers, Freeman, & Gladwell, 2017). The sample, created via voluntary participation, comprised household residents across several communities in Cape Town (viz., the: Atlantic Seaboard, Cape Town City Bowl, Southern Suburbs, Cape Flats, Northern Suburbs, West Coast, and Southern Peninsula). Participant recruitment took place online via multiple Facebook community pages (see Appendix A for the community pages; see Appendix B for the electronic invitation). The current study adhered to the University of Cape Town's Code for Research Involving Human Subjects. Ethical approval was received from the Department of Psychology's Research Ethics Committee (reference: PSY2018-051; see Appendix C for the ethical approval letter).

Eligibility criteria. Participants had to have lived in Cape Town for at least 3 years prior to the study, as this would ensure that they had experienced the full effect of the drought, which officially began in 2015 (Africa Check, 2016). Furthermore, to ensure independent observations, only one member per household was allowed to participate in this study (Grawitch & Munz, 2004). All participants had to be older than 18 years of age.

Measures

A survey (Appendix D) was created using two guidelines by Ajzen (2002) and Francis et al. (2004). The survey was developed, based on the TPB, to elicit the underlying salient beliefs of attitude, SN, and PBC about adhering to Cape Town's water restrictions.

Format. Section 1 included 18 open-ended questions on behavioural, normative and control beliefs. Section 2, which was voluntary, asked participants to upload their water usage readings. The response rate of this section was used to assess the feasibility of including a measure of water usage in Study 2.

Procedure

Participants first completed an electronic consent form (Appendix E), followed by the elicitation survey, which took approximately 15 minutes. The final page contained a debriefing form (Appendix F). The participants were thanked and encouraged to email the researcher with any questions.

Data Analysis

I analysed responses using content analysis. To increase the validity of the analysis, I, the primary researcher, and a research assistant that I appointed completed the analysis independently (Bengtsson, 2016). The results were then compared and 75% of the most frequently mentioned themes were used in the TPB questionnaire. According to TPB literature, this percentage of agreement was sufficient to adequately represent the population's dominant beliefs (Francis et al., 2004).

Methods: Study 2 (Quantitative Questionnaire)

Design and Setting

This study was an ex post facto quasi-experimental design. The independent variables of the study were attitude, SN, PBC, and intention. The three TPB constructs had two levels: a direct and indirect measure of each construct. Intention was only measured directly. The dependent variable was actual water-saving behaviour, measured by 2018 water usage. Data collection took place online during Cape Town's water crisis (September –October).

Participants

I obtained a sample of N = 92 (65 women, 25 men, and 2 participants who preferred not to specify their gender; age: M_{age} = 49.85 ± 11.83 years). As in Study 1, I invited Cape Town residents from various Facebook community groups to participate achieve a diverse cohort (see Appendix A for these groups; see Appendix G for the invitation). In addition, the study was advertised on a local radio station (Smile Radio, 90.4FM). The eligibility criteria for this study was the same as for Study 1. Participants were entered into a raffle to win one of three cash prizes: R750, R500, and R250.

Power Analysis. In accordance with SEM guidelines, the sample size was calculated using a ratio of observations to the number of model parameters. This study's model had 12 parameters (Figure 1). Using Kline's (2005) measure of 5-10 participants per parameter, the minimum acceptable sample size would have been 60 participants. As this study recruited 74 participants, the sample was sufficient.

Measures

Sociodemographic questionnaire. A 12-item sociodemographic questionnaire (Appendix H) was administered to explore the possible influence of particular sample characteristics on water usage. These demographic variables included: age, gender, relationship status, level of employment, number of years living in Cape Town, location, and monthly household income (MHI). Standard response scales were used for each variable, except for MHI, which came from the City of Cape Town's (2016) socio-economic profile.

In addition, three items which measured perceived knowledge of water usage (PKWU) were included as a control measure to ensure that single participants could adequately represent the water usage practices of their household. This was given the accepted threshold of an above-neutral rating (>4).

Table 1

Item Breakdown for the TPB Questionnaire

Direct measures		Item	Scoring	No. of items
Attitude		Overall, I think that keeping within Cape Town's water restrictions is *good*/*bad*	+1 - +7	6
Subjective norm		Most people who are important to me keep within Cape Town's water restrictions.	+1 - +7	5
Perceived behavioural control		I am confident that I can keep within Cape Town's water restrictions if I want to.	+1 - +7	7
Indirect measures		**Item**	**Scoring**	
Attitude belief components:	Behavioural beliefs x	If I keep within Cape Town's restrictions, I will save more water than if I hadn't otherwise.	+1 - +7	8
	Outcome evaluation	Saving water is *extremely desirable*/*extremely undesirable*	-3 - +3	8
Subjective norm components:	Normative beliefs x	My family thinks I *should*/*should not* keep within Cape Town's water restrictions	-3 - +3	5
	Motivation to comply	My family's approval of my water usage is important to me.	+1 - +7	5
Perceived behavioural control components:	Control beliefs x	I expect that I will reuse water around my household in the next month	+1 - +7	9
	Influence of control	I am *less likely*/*more likely* to keep within Cape Town's water restrictions if I re-use water around my household.	-3 - +3	9

TPB Questionnaire. As illustrated in Table 1, 70-items were created on two numerical scales with ranging anchor values. The behavioural, normative, and control beliefs elicited in Study 1 were used to create 'indirect' items which implicitly measured attitude, SN, and PBC. 'Direct' items were created, according to the recommendations from Ajzen (2002) and Francis et al. (2004), which explicitly measured these three TPB variables. In addition, one item was included which directly measured behaviour, and five items which directly measured behavioural intention to keep within Cape Town's water restrictions (both scales had a scoring of +1 to -7).

A draft questionnaire was distributed online to 10 participants using convenience sampling to troubleshoot and assess the clarity of questions. Revisions were made based on participants' feedback regarding unclear items and instructions.

Water accounts. The final section of the questionnaire asked participants to upload their water bill readings to provide empirical indication of their water-use behaviour. Participants provided accounts from (a) one month prior to the study (August 2018) to compare intention to actual behaviour; and (b) one year prior to the study (August 2017) to investigate changes in actual behavior.

Procedure

For ethical reasons, before beginning the questionnaire, participants ticked a box to indicate their consent to take part in the study (Appendix I). Participants then completed the sociodemographic questionnaire, followed by the TPB questionnaire. Finally, participants provided their water usage for August 2017 and 2018. A debriefing form was displayed upon completion of the questionnaire which stressed that the data would be kept confidential, and thanked participants for their time (Appendix J).

Data Management and Statistical Analyses

Data were analysed using SPSS (version 25.0; 2017) and the lavaan package in R Studio (2014), with $\alpha = .05$.

Filtering data. Outliers for the questionnaire responses were defined as any z-score values greater than 2.24 or less than -2.24 (n = 2; Aguinis, Gottfredson, & Joo, 2013)[1]. The data reflecting water usage were set to filter out all cases in which 2018 daily water usage was >100 lpd, and 2017 daily water usage was >200 ($n = 6$). Missing data was treated with listwise deletion ($n = 10$). Thus, the final sample was $N = 74$.

Scoring data. The direct and indirect scales in the TPB questionnaire were scored using the standard procedures outlined by recommendations of Ajzen (2002) and Francis et al. (2004). Direct items were scored by calculating the mean of all item answers. The indirect items were scored by computing a 'multiplicative composite score' for each predictor variable by multiplying the expectancy measure and the value measure (e.g. behavioural belief x outcome evaluation; see Appendix K for further details of the scoring procedure; Hankins, French, & Horne, 2000).

[1] As this data is based on personal opinions, each outlying observation was reviewed on a case-by-case basis.

TPB measures. I conducted bivariate correlations between the direct-and-indirect total scores. The indirect multiplicative composite scores for attitudes, SN, and PBC each had a statistically significant relationship with the direct scores of attitudes, SN, and PBC. All Pearson's r correlation coefficients were acceptable ($r > 0.3$). The direct and indirect scales were combined to form three overall TPB scores which were used in the path analysis (Francis et al., 2004).

Water usage. Daily water usage was calculated for each participant by dividing the 2018 household water usage by the number of household residents, and dividing this by 31 for a daily reading. This was repeated for 2017 water usage. The annual difference in usage was calculated by subtracting the 2018 reading from the 2017 reading.

Validity and reliability analysis. Convergent validity measures whether constructs that should, theoretically, be related are related (Carlson & Herdman, 2010). Convergent validity is assessed by calculating (1) standardized factor loading, (2) composite reliability (CR) and, (3) average variance extracted (ARE; see Fang, Ng, Wang & Hsu, 2017). First, standardised factor loading was conducted using factor analysis (FA) to assess construct validity (Fang, Brown, Florence, & Mercy, 2012). FA was used to assess whether items of individual scales all loaded onto their singular corresponding factor (i.e. attitude, SN, and PBC). Second, a CR score of ≥ 0.6 was used to indicate that the model measured the construct well. Third, an ARE value of ≥ 0.5 was used to indicate high validity for both the construct and individual variables (Bagozzi & Yi, 1988; Raines-Eudy, 2000).

Cronbach's alpha reliability analysis was used to assess the correlation between direct items in the questionnaire. A Cronbach's alpha of >0.60 was deemed an acceptable correlation. However, this measure of internal consistency is not appropriate for indirect measures, as they are a formative model of measurement rather than reflective (e.g., one might be motivated to comply with the friends' expectations, but not motivated to comply with neighbours' expectations; Russo et al., 2015). Thus, low or negative correlations between such items cannot be interpreted as grounds for removing these items in the same way that they would for direct items.

Statistical analyses. The assumptions of all statistical analyses were checked, and were met unless otherwise stated.

First, bivariate Pearson's correlations were conducted to explore the collected data. The influence of sample characteristics, which included (1) sociodemographic factors, and (2) a measure of PKWU, on usage was investigated. Second, a paired-samples t-test was used to compare the daily water usage in 2018 to 2017.

Path model. Path analysis was used to examine the utility of the TPB for predicting intention to keep water-use within Cape Town's restricted daily limit . The included variables were hypothesised to relate to each other as specified in Figure 1. Consistent with previous research, I assessed model fit by ensuring that the (1) goodness-of-fit was > 0.9, (2) comparative fit index (CFI) was > 0.95, and (3) the root mean square error of approximation (RMSEA) was ≤ 0.08 (Brown, 2015; Hu & Bentler, 1999; Perren & Yang, 2015).

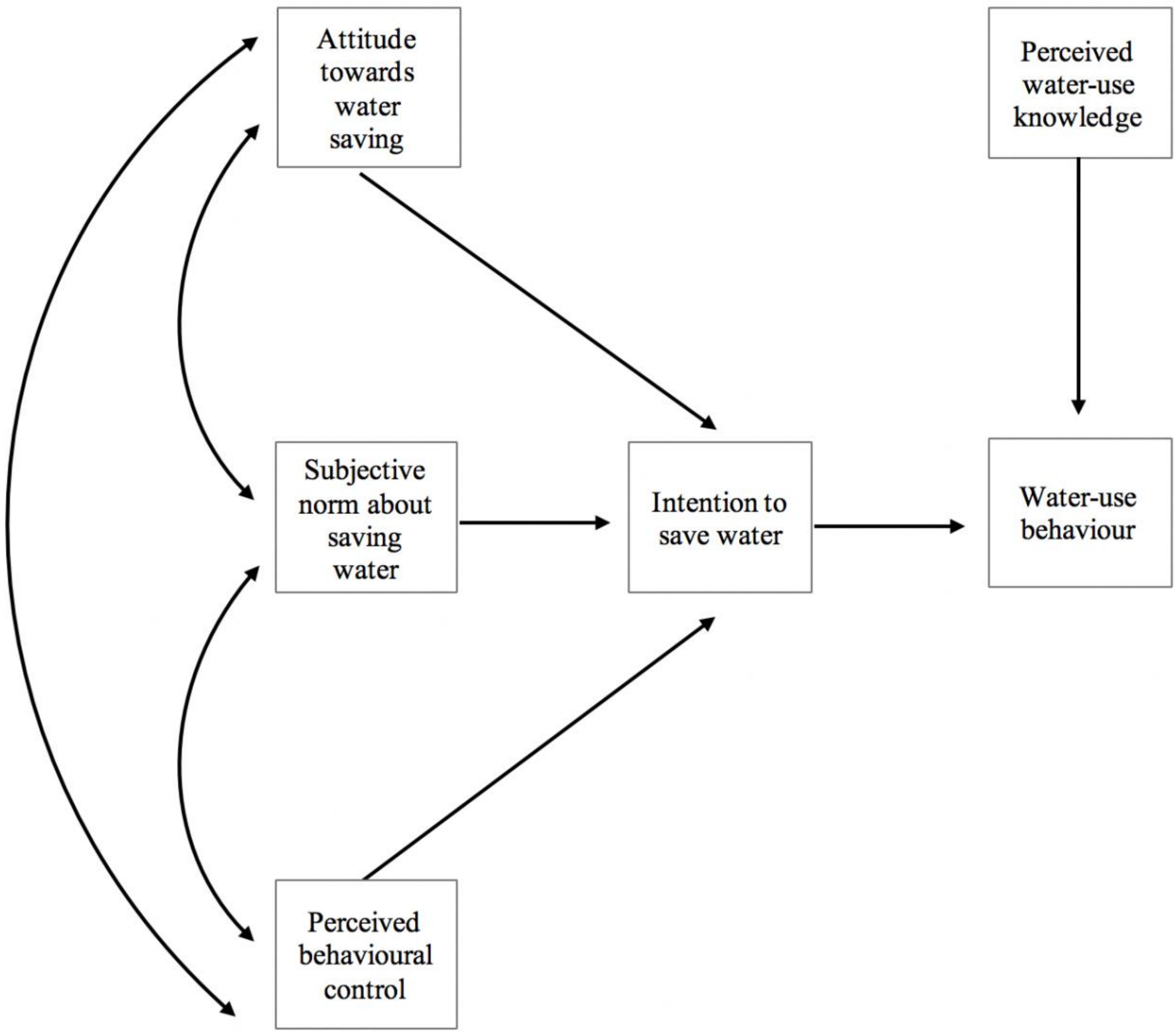

Figure 1. The hypothesized path analysis model including the TPB constructs and PKWU.

Results

Sample Characteristics

The sociodemographic characteristics of the sample are presented in Appendix L. More women (67.7%) than men completed this questionnaire and were mostly in the middle-to-high income category. The sample varied substantially in terms of certain demographic characteristics (e.g., residential location, time living in Cape Town), which ensured the sample was representative of people living in Cape Town.

Table 2

Descriptive Statistics for the Direct and Indirect Predictors of Water Usage (N = 74)

	N	Possible range	Minimum	Maximum	*M*	*SD*
Attitude	74	-100-100	13.69	99.40	62.01	17.19
SN	74	-100-100	-5.71	74.29	27.45	16.85
PBC	74	-100-100	-3.17	77.78	49.81	18.38
Intention to save water	74	0-100	24	100	90.02	15.53
PKWU	74	0-100	57.14	100	87.77	12.44
Water usage[a]	74	0-100	0.00	96.77	38.96	22.69

Note. PBC = perceived behavioural control. PKWU = perceived knowledge of water usage. SN = subjective norms. For comparability, the results of the attitude, SN, and PBC items have been scaled to provide an overall score ranging from -100 to 100. The unscaled score range was -168.00-168.00 for attitude, -105.00-105.00 for SN, and -189.00-189.00 for PBC. [a] Water usage provided in litres per person per day.

The participants' average responses regarding the three TPB predictors, intention, PKWU, and actual water usage, are summarised in Table 2. Although the average water usage for Cape Town citizens during August 2018 was below the 50 litre limit, there was a large variance in daily water usage amounts. Attitude had the highest average score of the three TPB predictors, indicating a strong positive attitude towards water-saving. The second highest mean of the TPB variables was the PBC score. The mean score of SN was the lowest, and suggested that most participants perceive moderate social pressure to adhere to water restrictions. Finally, PKWU had a high mean with the smallest range, indicating that the majority of the sample rated their knowledge highly. The overall positive scores for attitudes, PBC, and PKWU meant that all three variables were slightly negatively skewed, as indicated in Figure 2 below[2].

[2]Log transformations were conducted to attempt to solve this skewness. However, this did not improve the distribution of data, so the original data was used in analyses.

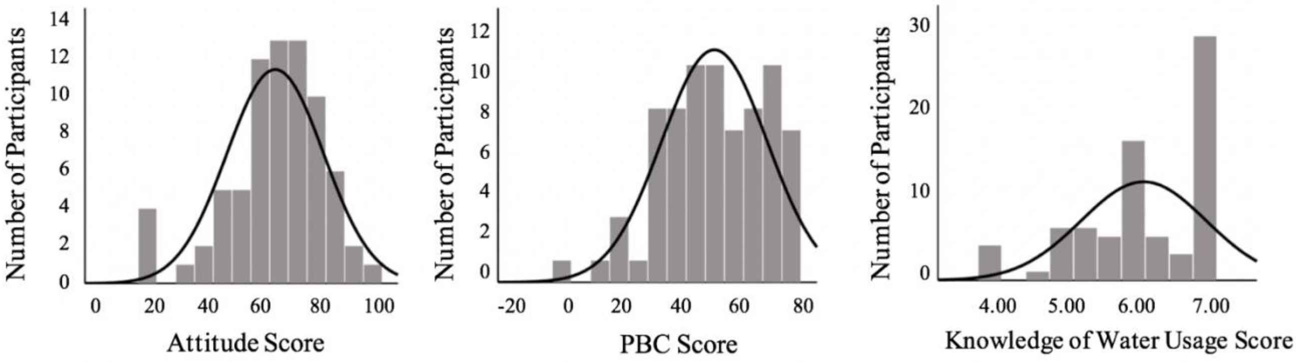

Figure 2. From left to right: distributions of the overall scores of attitudes, perceived behavioural control, and knowledge of water usage, which are all negatively skewed.

Based on an analysis of the mean scores, participants had strong, positive attitudes and PBC, and a moderate positive subjective norm. According to the TPB, these results are an indication that participants would have strong intentions to keep within the water usage restrictions, which was confirmed by the high average score on the intention scale. Despite high scores on intention to save water and remain under the limit of 50 lpd, actual water usage readings had a high maximum value. Fifty-four participants (73%) stated that they either 'agree' or 'strongly agree' that they intend to keep within the water restrictions, however, only twenty participants (40%) used fewer than 50 lpd. Thus, of the participants who indicated that they intended to use fewer than 50 lpd, less than half actually achieved this intention.

Validity and Reliability Analyses

To confirm that the latent variables comprised the manifest variables specified by the TPB, I conducted a factor analysis to investigate the structural conformity of the TPB model and the construct validity of each of the included factors. Intention loaded as one factor and explained 59% of the variance. The factor loading table (Appendix M) showed that, although two factors were extracted for attitude, individual items predominantly loaded onto one factor. Upon further inspection, the item which loaded most onto two factors w the item which loaded most onto two factors was how pleasant participants rated keeping within the water restrictions. These two factors may be reflecting the attitudinal distinction made in the TPB theory between experiential attitudes, (i.e., each participant's affective feeling towards the behaviour), and instrumental attitudes (i.e., participants' evaluation of the utility and possible outcomes of a behaviour; Wan, Shen, & Choi, 2017). However, since the TPB regards such distinctions as still falling under one broader construct of 'attitude', attitude was regarded as one factor. When forcing extraction of one factor for attitude, all items loaded highly onto the one factor, and explained 50% of the total variance. Similarly, two factors were extracted for SN, and they explained 63% of the total variance. However, inspection of the factor loading table (Appendix M) indicate that the factors strongly load on 1 factor. As can be seen by the scree plot, the second factor is just above the 1-cut off line. PBC loaded onto one factor and explained 57% of the total variance (Appendix M). PKWU loaded heavily onto one factor and explained 75% of the total variance.

Table 3

Average Variance Extracted, Composite Reliability, and Cronbach's Alpha for the Direct and Indirect Predictors of Water Usage

Latent Variable	AVE	CR	Cronbach's α
Intention to Save Water	.50	.73	.810
Attitude	.41	.83	.779
SN	.56	.89	.608
PBC	.37	.72	.878
PKWU	.75	.60	.803

Note. SN = subjective norms. PBC = perceived behavioural control. PKWU = perceived knowledge of water use. AVE = average variance extracted. CR = composite reliability.

As illustrated in Table 3, all CR values were above ≥ 0.6, and all Cronbach's alpha scores were ≥ 0.5. These results indicate that the variables used in the path model were factorially consistent. Two ARE values (attitude and PBC) did not meet the accepted threshold. However, Fornell and Larcker (1981) stipulated that, if AVE is <0.5, but CR is >0.6, then the convergent validity of the construct is still adequate. Therefore, these two constructs were retained.

Correlations

Table 4

Bivariate Correlation Matrix for Direct and Indirect Predictors of Water Usage

	Water Usage	Knowledge of Water Usage	Intention to Save Water	Attitude	SN	PBC
Water Usage	1.00					
PKWU	-.23*	1.00				
Intention to Save Water	.13	.19	1.00			
Attitude	-.16	.10	-.53**	1.00		
SN	.07	.19	-.29*	.42**	1.00	
PBC	-.14	.12	-.51**	.50**	.37**	1.00

Note. The data presented are Pearson's *r* correlation coefficients. $*p < .05$. $** p < .01$. $*** p < .001$. PKWU = perceived knowledge of water usage. SN = subjective norms. PBC = perceived behavioural control.

The Pearson's correlation coefficients for the three TPB predictors, intention, water usage, and PKWU are presented in Table 4. In line with the TPB, attitude, SN, and PBC all significantly correlated with intention to save water, *p*s < .01. However, contrary to the TPB, intention did not significantly correlate with water-use behaviour, $p = .290$. In fact, there was a weak correlation between behavioural intention and actual behaviour, as illustrated in Figure 3. In addition, the 3 predictors did not correlate significantly with actual water usage (Table 5). However, the control measure, PKWU, was found so be significantly positively correlated with actual water usage. This indicated that the better participants thought they understood their water usage, the lower their usage was.

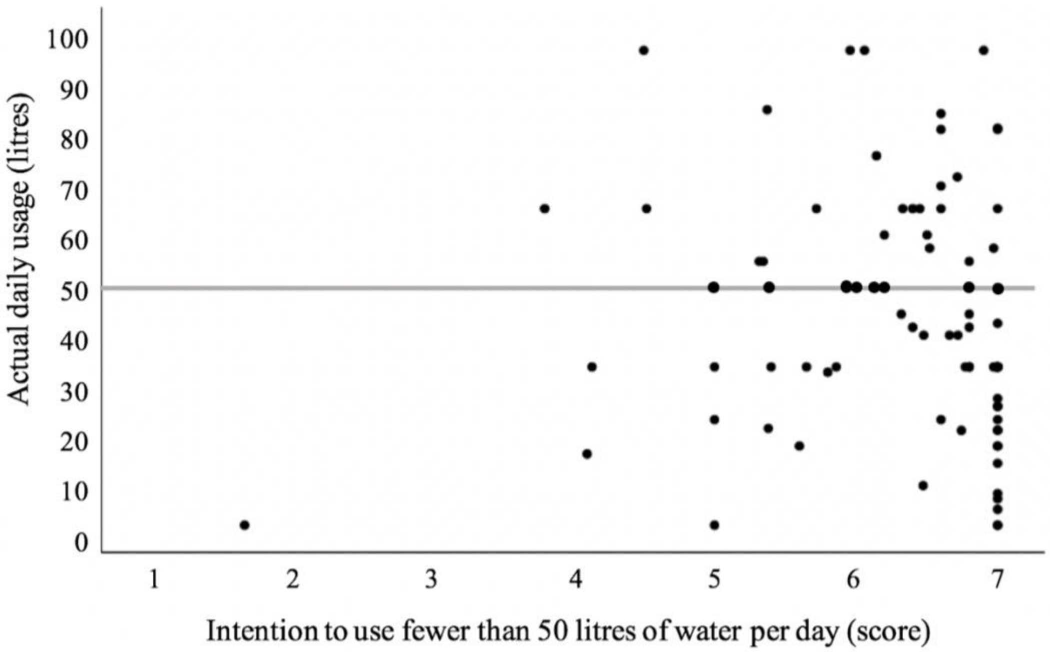

Figure 3. Relationship between intention and actual water usage in 2018.

In addition, no statistically significant correlations were found between sociodemographic factors and actual water usage (Appendix N). Thus, I hypothesised that the variables that significantly correlated with (a) intention, and (b) behaviour, would relate to each other as depicted in the hypothesised model.

Path Analysis

As illustrated in Table 6, the model fit the data well (CFI = 0.94, RMSEA = 0.08, SRMR = 0.05). The model is significantly different from the baseline model (χ^2= .208, *df* = 9). All goodness of fit indices were deemed acceptable (or close enough to acceptable). Although the CFI did not exceed > 0.95, it was very close, and was therefore interpreted as accepted. The RMSEA score was less than 0.08 and, therefore, considered acceptable. The

SRMR was less than 0.08, and thus acceptable. Although the model does not completely fall within the acceptable parameters, it is very close to doing so.

Prediction of intention. The path coefficients (Figure 4) showed that attitude and PBC significantly predicted intention, $p = 0.002$, $B =$ and $p = 0.027$ respectively. The path coefficient of SN was not significant relevant to intention, $p = .587$. Attitude was the strongest predictor of intention ($b = 0.12$, $SE = 0.04$), followed by PBC ($b = 0.07$, $SE = 0.03$).

Prediction of water usage. There were no significant direct relationship of intention predicting water usage, nor any significant indirect relationships of the 3 TPB predictors significantly predicting water usage. However, PKWU significantly predict water usage, $p = .036$. The measure of water usage explained 5.6% of the variance in intention to keep within Cape Town's water restrictions. The overall model accounted for 31.0% of the variance in intention to keep within Cape Town's water restrictions.

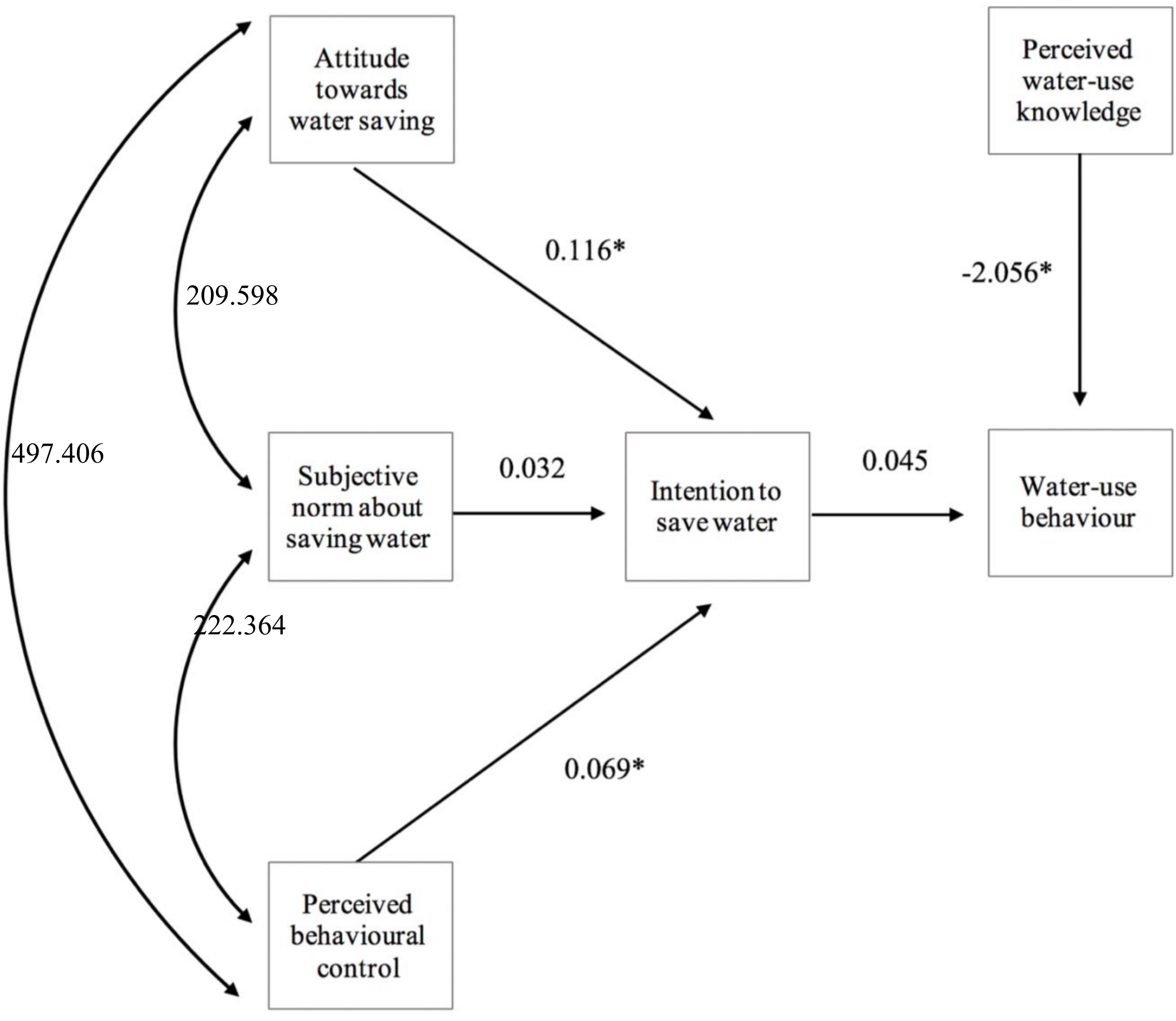

Figure 4. The path analysis model including TPB constructs and PKWU

Additional Analyses

Difference in water usage over one year. 2018 water usage significantly and positively correlated with 2017 usage, $r = .62$, $p < .001$, indicating that those who used more water in 2017 used comparatively more water in 2018. PBC was found to have a significant, negative correlation with the quantity of water reduction between 2017 and 2018, $r = -.28$, $p = .013$, indicating the higher the perception of behavioural control, the greater the reduction in water usage over the year. Attitude and SN did not significantly correlate with water reduction, $r = -.20$, $p = .084$ and $r = -.09$, $p = .432$ respectively. The majority of participants reduced their water usage between the 2017 and 2018. However, the range of reduction was very variable.

A paired-samples *t*-test showed that water usage between 2017 and 2018 differed significantly ($p < .001$). There was a trend of decrease on average, as the *M*-difference was -24.19. The effect size (d=1.71) indicated that the size of the difference was large.

Discussion

The present study had two aims: (1) to identify factors contributing to participants intentions to adhere to Cape Town's water restrictions, and (2) to use these factors as a measure of how successful participants were in meeting their intentions. Evidence indicates that droughts increase intention to save water (Hurlimann et al., 2009). However, such research has tended to take place before or after water crises, not during them. This study is novel as it was conducted during Cape Town's water crisis in mid to late 2018, and thus filled a gap in the current TPB literature on water-use behaviour. This study did not only measure behavioural intentions, but measured them against actual behaviours. Unexpectedly, behavioural intention did not significantly predict water-use behaviour. In fact, intention and behaviour were only weakly correlated. This discussion will provide possible explanations for this main finding, and the other results of this study. In addition, limitations and recommendations for future research, and the study's significance will be discussed.

In accordance with the core TPB model, the second, third, and fourth hypotheses stated that (2) attitudes, (3) subjective norms, and (4) PBC about adhering to water restrictions would each significantly predict intentions to keep within the limits. The path analysis revealed that while attitudes and PBC significantly predicted intentions to keep within restrictions, subjective norms did not. The second and fourth hypotheses were confirmed. These findings supported the TPB's predictive power of behavioural intention and were in line with previous research that aimed to predict water-saving intentions (Clark &

Finley, 2007; Trumbo & O'Keefe, 2005). However, these studies found that subjective norms significantly predicted intention.

An analysis of the TPB measures revealed a positive attitude to adhering to water restrictions. The positive minimum attitude score suggested that all participants had positive attitudes towards water-saving, which, according to the TPB, indicated that all participants intended to adhere to the water restrictions. The mean PBC score indicated that most participants had a moderately positive perception of behavioural control towards saving water, suggesting that most felt confident they could save water. Such results were supported by strong correlations between direct and indirect scales. These correlations suggested that the beliefs of Cape Town citizens (elicited in Study 1) were adequately represented by the questionnaire items. The mean SN score indicated that this variable had the least influence over water-saving behaviour. Contrary to the first two TPB constructs, SN did not significantly predict intention. Therefore, the third hypothesis was disconfirmed. Interestingly, the non-significance of SN in this predictive model was consistent with the findings of TPB studies across different behaviours (Armitage & Conner, 2001). This finding supported the notion that SN is the weakest explanatory variable of behavioural intention.

According to the TPB, the significant prediction of intention by TPB variables suggest that intention to keep within water restrictions should directly predict actual water-saving (hypothesis 1). Contrary to this, hypothesis 1 was disconfirmed. Although the majority of participants' reported intending to save water, few managed. These findings suggested that intention had little effect on actual water-saving. This finding contradicted the TPB's foundational premise, which posits that behavioural intention can be used as a direct proxy for behaviour. The fifth hypothesis, that there would be a significant positive correlation between intention to keep within water restrictions and the annual reduction of water usage, explored how water-use behaviour changed over time. There was little correlation between participants' intention to keep within the water restrictions in 2018, and how much water they had saved over the year. Participants generally used less water in 2018, however, their reduction did not appear associated with the strength of their intention.

While the disparity between intention and behaviour was unanticipated, there could be many causes. First, participants may have had a poor understanding of how much water they used, as previous studies have demonstrated the that tendency to incorrectly judge one's water usage is common (Beal et al., 2013). Second, participants' responses may have been affected by a social desirability bias. Their answers may have aimed to conform to socially permissible behaviour rather than with their honest opinions. Social desirability bias was anticipated due to water restrictions being governmentally-mandated rather than just socially endorsed (City of Cape Town, 2018c). However, as the findings of SN suggest, most participants did not feel strong social pressure with regards to their water usage behaviour. Therefore, respondents' answers did not fall in line with this suggestion.

Finally, this study posits that the findings may be explained by scarcity. Scarcity tends to change how resources are perceived, and cause irrational, paradoxical changes in behaviour – such as both increasing the efficiency by which some work with a scarce resource, and, in others, increasing the impulse to use this scarce resource. Evidence has shown that the context of scarcity creates change in perception, and therefore in decision-making (Zhao & Tomm, 2018). The step between intention and actual behaviour is deciding to act. A short-coming of the TPB is the assumption that these decisions are rational. Cognitive biases caused by the scarcity heuristic may impact our behavioural decisions. Therefore, scarcity's disruption of typical decision-making may explain the lack of correlation between intention and behaviour.

Rather than intention predicting behaviour, PKWU, initially included as a control measure, significantly predicted water usage. Although the TPB posits that a measure of attitude, SN, and PBC are sufficient to capture all influences on our intentions to engage in certain behaviours, this finding provides evidence to the contrary. The finding of an additional significant predictor supported the utility of using an extended TPB model, as many TPB studies on water-use have before (Clark & Finley, 2007; Trumbo & O'Keefe, 2005). The results indicated that none of the sociodemographic factors in this study significantly predicted water usage. This was inconsistent with the previous research, as these factors have been found to influence variations in patterns of household water consumption (Makki et al., 2015). However, as the current study took place within the context of scarcity, effects of scarcity may have obscured the influence of individual differences. In addition, due to the high financial penalties of surpassing restrictions in Cape Town, the typical impact that household differences have on water usage may have been equalized.

This study has identified that the TPB is not an appropriate model for predicting behaviour in water-scarce contexts. Although using the TPB model may have predicted intention, this is not valuable unless intention can be used as a proxy for behaviour. Although suggestions have been made, any definitive explanation of why intention did not correlate with behaviour remains out of the scope of this study. It is important for future research to investigate possible determinants of behaviour during the context of resource scarcity. This research should seek to explain why behavioural intention differs so radically from behaviour. In addition, further research should aim to delineate whether intention is a stable construct, or whether is it transient. To the best of the researcher's knowledge, prior to this study, actual water-use behaviour had never been measured in conjunction with measures of intention. Therefore, it is difficult to evaluate how measures of intention may fluctuate, and what effect this would have on the measurement of behaviour.

Limitations and Recommendations for Future Research

Despite the researcher's best efforts, only 26% of participants who clicked on the questionnaire link completed both the questionnaire and provided water usage accounts for 2018 and 2017. As potential participants were not invited directly, there is no count of how many people viewed the questionnaire but chose not to respond. It is difficult to determine if respondents systematically differed from non-respondents (e.g., if those who completed the questionnaire did so because of their positive attitudes towards water-saving). Thus, the external validity of this research may have been weakened by volunteer bias. Due to this study was promoted by 'Smile Water Warriors,' a water-saving initiative created by Smile Radio (90.4FM), the sample may have also been subject to selection bias. Despite this, the sample's water usage had a large range, and included multiple readings above the water limit. To offset possible volunteer bias, three cash prize raffles were advertised to include an additional incentive for taking part.

It was beyond the scope of my study to conduct a test-retest reliability analysis on the indirect, belief-based scales. This would have provided an indication of the developed measure's temporal stability. As the TPB's measure of intention is predominantly used to inform behavioural interventions, it is important that the measure of intention stays consistent over time. Thus, administering the developed measure to one's sample for a second time would yield valuable insight into the practical utility of the information it gathered.

Finally, the current study has taken a reading of intention and behaviour during the context of scarcity, which has seldom been done before. This valuable data should be compared to readings from the same population, out of the context of scarcity. This research should investigate whether the disparity between intention and behaviour remains. The prediction for 'Day Zero' has been cancelled for 2019. Thus, Cape Town currently offers an opportune context for study of water-saving behaviour, the factors which drive this behaviour, and how these behaviours are maintained or abandoned in the absence of the impending threat, and motivation to save, that the context of water scarcity provides.

Summary and Conclusion

This study used the TPB to create a predictive model for water usage during Cape Town's water crisis. In line with research in the field, the developed model significantly predicted intention to adhere to water restrictions. There were two unexpected findings. Water-saving was not significantly predicted by intentions to save water. Also, participants' perceived understanding of their water usage significantly predicted their actual usage. This study demonstrated that simply creating an accurate predictive model for behavioural intention is not sufficient to understand behaviour. The disparity between intention and behaviour imply limitations of using the TPB to understand water-saving. Future research should consider other methods to identify determinants of water-use behaviour. This study should be the first of many to create a better understanding of water-usage behaviour during one of the most pressing urban water crises the world has seen.

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