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# What affects public acceptance of recycled and desalinated water?

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ABSTRACT

This paper identifies factors that are associated with higher levels of public acceptance for recycled and desalinated water. For the first time, a wide range of hypothesized factors, both of socio-demographic and psychographic nature, are included simultaneously. The key results, based on a survey study of about 3000 respondents are that: (1) drivers of the stated likelihood of using desalinated water differ somewhat from drivers of the stated likelihood of using recycled water; (2) positive perceptions of, and knowledge about, the respective water source are key drivers for the stated likelihood of usage; and (3) awareness of water scarcity, as well as prior experience with using water from alternative sources, increases the stated likelihood of use. Practical recommendations for public policy makers, such as key messages to be communicated to the public, are derived.

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## 1. Introduction

Many countries endure water supplies that are insufficient to meet their present and future demands. Escalating pressure from increased population, along with the uncertainty of water supply conditions due to climate change, amounts to a burgeoning water crisis. While technologies are available to alleviate water shortage, many countries have experienced public resistance to the adoption of much needed water augmentation projects. To address the world's water crisis it is essential that engineers and social scientists work together. Engineers can provide the best, safest and most energy-efficient solutions to augment water supplies, whereas social scientists can facilitate better understanding of the reasons for public resistance to the adoption of water from alternative sources. Social scientists can also suggest ways in which public policy makers may be able to increase acceptance of alternative water sources and find solutions which are most acceptable for the community. The present study represents a social science contribution to this field.

To date a significant amount of empirical work has been conducted to investigate the level of stated public acceptance for recycled water – Bruvold and Ward (1970); Bruvold (1972); Kasperson et al. (1974); Sims and Baumann (1974); Stone and Kahle (1974); Olson et al. (1979); Bruvold et al. (1981); Milliken and Lohman (1985); and Po et al. (2004). Recently, similar studies have been conducted in the context of desalinated water: Dolnicar and Schäfer (2006); Dolnicar and Schäfer

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(2009); and Dolnicar and Hurlimann (2010). Each of these studies has provided an interesting snapshot of the public's sentiments toward alternative water sources at the time of survey. Additionally, a number of other studies identified correlates of high acceptance levels – Hanke and Athanasiou (1970); Gallup (1973); Kasperson et al. (1974); Sims and Baumann (1974); Johnson (1979); Olson et al. (1979); Alhumoud et al. (2003); and Hurlimann and McKay (2004). However to date, a limited number of studies have attempted to include a comprehensive set of potential explanatory variables, and to simultaneously test the effect they have on the acceptance levels of water from alternative sources.

The aim of this paper is to fill this gap, both for recycled and desalinated water. Specifically, we investigate which of the hypothesized personal characteristics are in fact associated with higher or lower levels of acceptance of recycled and desalinated water. Testing is conducted simultaneously for a wide range of independent variables, thus avoiding the over-interpretation of single factors. From the empirical findings we derive key insights and recommendations for public policy makers.

## 2. Literature review

Since the 1970s a significant body of knowledge has developed around the topic of public acceptance of recycled water, providing useful information about general acceptance levels for various uses of recycled water. Most studies investigating public acceptance of recycled water come to the same conclusion – that people are very open to using recycled water for uses with low personal contact, such as watering trees and shrubs in their garden, but are reluctant to adopt recycled water for uses with high personal contact, such as drinking or bathing one's baby. Although it could be argued that recycled water has now been used for many decades, recent studies have shown that the same pattern is still valid – Marks et al. (2006); Dolnicar and Schäfer (2006); Hurlimann (2006); and Hurlimann (2007a,b,c). For example, Dolnicar and Hurlimann (2010) found that 92% of Australian respondents would use recycled water for garden watering, but only 36% for drinking.

Despite the significant research attention that public acceptance of recycled water has attracted, very little social science research has focused on water from other alternative sources. Only recently have comparative studies of acceptance across different kinds of water been undertaken, such as Dolnicar and Schäfer (2006), and Dolnicar and Schäfer (2009). Both conclude that people – in this case the Australian population – clearly discriminate between recycled and desalinated water. Desalinated water was preferred over recycled water for close-to-body uses such as drinking (49% compared to 20% acceptance respectively). Recycled water was preferred over desalinated water, however, for some uses with little body contact, for example, for watering gardens (89% compared to 68% acceptance respectively). Respondents understood that water recycling is more environmentally friendly than desalination which, in turn, was perceived by respondents as less risky from a public health perspective.

More recently, Dolnicar and Hurlimann (2010) conducted a similar comparison, finding that Australians now generally prefer desalinated water: 53% were willing to drink it (as compared to only 36% who were willing to drink recycled water) and 84% were willing to water their garden with it (compared to 86% who were willing to water their garden with recycled water). It is likely that developments since the 2006 study have significantly impacted people's perceptions. Most importantly, Australians in a Queensland country town, Toowoomba, voted against the development of a water recycling plant. Public opposition led by the community group 'Citizens Against Drinking Sewage' dominated national media (for a detailed case study see Hurlimann and Dolnicar, 2010). Possibly as a consequence of the Toowoomba case, many Australian state governments have chosen desalination as the preferred path, thus communicating to the public the benefits of this alternative method of securing Australia's water for the future. It is likely that these developments have led to the shift in public perception observed between the 2006 and the 2009 studies.

While a significant amount of survey research has been conducted to ask respondents directly about their willingness to use different kinds of water from alternative sources, only a small amount of work has attempted to identify which personal characteristics are associated with a high or low level of acceptance towards alternative water sources. An overview of these studies is provided in Table 1. As can be seen, key explanatory factors include trust (in the water provider or public policy makers); knowledge and information; past experience with alternative water sources; and perception of risk. Demographic variables have been explored, but consensus on the nature of the association is low, particularly for age.

The main limitation of this body of work is that most studies investigate factors hypothesized to be associated with acceptance of water from alternative sources in isolation from one another, thus risking that the association is over-interpreted. The possible interaction effects of multiple factors have mostly been ignored to date. To the authors' knowledge only one study, Po et al. (2005), attempted this in the context of the general public's acceptance of indirect potable reuse of wastewater. Statements of intended use were found to be significantly related to positive attitudes towards indirect potable reuse, which, in turn, were influenced by a number of factors: subjective norms, emotions, trust in the authorities, risk perceptions, sense of obligation to protect the environment, and their perceived control over the source of their drinking water. However, this study focused mainly on complex psychological constructs which are hard to assess and are thus of limited value to public policy makers who need to be able to easily target certain segments of the population with educational messages about water from alternative sources.

## 3. Methodology

### 3.1. *Fieldwork administration*

Data was collected online in January 2009 using an Australian permission-based research-only internet panel. 13,884 invitations were sent out to panel members. The final total sample size amounted to 3094 respondents (a 22% response rate); 1495

**Table 1 – Factors found to influence community acceptance of recycled water.**

| Factor positively influencing attitudes to recycled water | Study |
|---|---|
| **Attitudes and experiences** | |
| Trust in authorities associated with recycled water use | Lohman and Milliken (1985)<br>Jeffrey and Jefferson (2003)<br>Hurlimann and McKay (2004)<br>Po et al. (2005)<br>Hurlimann (2007b)<br>Hurlimann (2007c) |
| Knowledge/information | Lohman and Milliken (1985)<br>Flack and Greenberg (1987)<br>Jeffrey and Jefferson (2003)<br>Tsagarakis and Georgantzis (2003)<br>Hurlimann et al. (2008) |
| Risk perception (negative) | Po et al. (2005)<br>Hurlimann (2008)<br>Hurlimann et al. (2008) |
| Past experience with alternative water source | Sims and Baumann (1974)<br>Olson et al. (1979)<br>Lohman and Milliken (1985)<br>Flack and Greenberg (1987)<br>Dishman et al. (1989)<br>Hurlimann (2007a) |
| Health concern (negative) | Olson et al. (1979)<br>Dishman et al. (1989)<br>Marks et al. (2006)<br>Baggett et al. (2006) |
| Perception of good water quality | Higgins et al. (2002)<br>Po et al. (2005)<br>Baggett et al. (2006)<br>Hurlimann et al. (2008) |
| **Demographic variables** | |
| Age – older | Hurlimann (2007a)<br>Dolnicar and Schäfer (2009) |
| Age – younger | Stone and Kahle (1974)<br>Lohman and Milliken (1985)<br>McKay and Hurlimann (2003) |
| Gender – being male | Baumann and Kasperson (1974)<br>Lohman and Milliken (1985)<br>Tsagarakis et al. (2007)<br>Hurlimann (2007a)<br>Nancarrow et al. (2008)<br>Dolnicar and Schäfer (2009) |
| Education level – having a higher education degree | Bruvold (1972)<br>Stone and Kahle (1974)<br>Flack and Greenberg (1987)<br>Lohman and Milliken (1985)<br>Alhumoud et al. (2003)<br>Menegaki et al. (2006)<br>Hurlimann (2007a)<br>Dolnicar and Schäfer (2009)<br>Robinson et al. (2005) |

of the respondents were representative of the Australian public. Representativeness was ensured by using a quota sampling procedure. This is achieved by online fieldwork companies who send out invitations to a large group of panel members representative of the population and then monitoring, for all quota criteria, frequency of responses. Toward the end of the process it may be that some respondents wanting to participate in the survey are rejected because they do not qualify as the kind of respondents still required to ensure representativeness. Quotas were set for gender, age, state and education level. Census data from the Australian Bureau of Statistics was used to specify the quota requirements numerically.

Note, however, that the present study does not require the sample to be representative because we are interested in assessing which factors affect public acceptance of recycled and desalinated water. It is more important to ensure that there is sufficient variety in those variables which are hypothesized to play a role. This is ensured by the way the sample was drawn.

The remaining 1599 were collected from specific locations which differ in their local water situations (Adelaide, Sydney, Brisbane, Melbourne, Perth, Darwin, The Mallee and Toowoomba).

The online data collection allowed controlling for non-response. The questionnaire administration ensured that respondents could not proceed without having completed all questions on a page. As a consequence, missing values due to oversight or unwillingness to answer, as experienced in paper-and-pencil data collections, were not a factor.

### 3.2. *Questionnaire*

Respondents were asked to answer a number of questions which are related to their behaviour, attitudes and socio-demographic characteristics. They are discussed below under the headings of *Dependent variables and Independent variables*, reflecting the hypothesized relationship in the model.

#### 3.2.1. *Dependent variables*

*Stated likelihood of using recycled/desalinated water* is the dependent variable in this model. One such variable was computed for recycled water, one for desalinated water. The variables aim to measure the attitude of the respondents towards recycled and desalinated water by determining the likelihood of using this kind of water for different purposes. The final value of the stated likelihood of using recycled/desalinated water is computed as the sum of 10 items, each of which represents one particular water use. The 10 alternative uses were: watering the garden (flowers, trees, shrubs), washing clothes/doing laundry, cooking, showering/taking a bath, drinking, brushing teeth, toilet flushing, cleaning (the house, windows, driveways), watering the garden (vegetables, herbs to be eaten raw), and washing the car.

In order to ensure that the data would not be biased by respondents who differed in their understanding of what recycled/desalinated water meant, each were provided with the following definitions before they were asked to state the likelihood of use: *"For the following questions we will use the term 'recycled water' to describe 'purified wastewater or sewage,' and we will use the term 'desalinated water' to describe 'purified seawater,' and we will assume that both recycled and desalinated water are treated to the same level of water quality."*

For each item the respondents had to place a cross on a line. The endpoints were assigned the values 1 and 100 and all intermediate values were equidistantly determined. Respondents also had the option not to answer a question by ticking

a box labelled *not applicable*. However, since no information was available for such items, the summated score cannot be determined. For each item of the *likelihood to use recycled water* variable, between 0.7% and 5.9% of the questions were answered *not applicable*. The average of *not applicable* answers for each item was 2.3%, with 11.6% of respondents answering *not applicable* to at least one of the items measuring this variable. For the *likelihood to use desalinated water* variable the situation was similar, with between 0.8% and 5.7% of the answers being *not applicable*, with an average of 2.2% for each item. Respondents who had chosen *not applicable* in any part of the survey were removed, leading to an exclusion of 12.9% of the respondents, a method which was preferred to that of coding each answer as zero. Substituting zero for these answers would suggest that the respondents do not use any kind of water for certain purposes, however, this would distort the data to suggest a negative attitude towards recycled and/or desalinated water. The final sample size therefore was 2694 which lead to a precision level under the worst care scenario (for binary questions with maximum variance and a confidence level of 95%) of 2%. A comparison of the state distribution as well as the size of the city distribution between the retained and excluded respondents indicated no significant differences (state: $\chi^2 = 11.3$, df $= 7$, $p$-value $= 0.13$; size: $\chi^2 = 8.7$, df $= 10$, $p$-value $= 0.56$). Thus the composition of the sample with respect to location and size of city was not significantly altered by the omission.

#### 3.2.2. *Independent variables*

The following independent variables were included in the model:

*Environmental attitudes* were measured using the New Ecological Paradigm (NEP) scale designed by Dunlap et al. (2000), which – according to Bragg (1996) – is the most widely used instrument for measuring environmental attitudes. The scale consists of 15 items covering five dimensions: reality of limits to growth, anti-anthropocentrism, fragility of nature's balance, rejection of exemptionalism, and possibility of ecocrisis. Respondents were offered five answer options to indicate their level of agreement. The item labels with corresponding scores were *Strongly agree* (2), *Mildly agree* (1), *Unsure* (0), *Mildly disagree* (−1) and *Strongly disagree* (−2). Item-level responses were added to the total NEP score.

*Environmental concern* was measured using the items developed by Berenguer et al. (2005) for general environmental concern. A sample item is: *To what extent are you concerned about the situation of the environment in general?* Respondents were asked to record their answer using a five-point agreement scale identical to the scale used for the environmental attitudes. The values of the six concern items were added to form the overall value for environmental concern.

*Altruism* was measured using Clark et al.'s (2003) nine item altruism scale, which is based on Schwartz's (1970,1977) norm-activation model. Three items measure personal norms, three measure awareness of consequences, and three measure ascription of responsibility. Respondents expressed their beliefs on a five-point agreement scale identical to the scale used for the environmental attitudes. The total altruism value was computed as the sum over all nine altruism items.

*Moral obligation* to behave in an environmentally friendly way has been shown to be a good predictor of pro-environmental behaviour. For example, Berenguer et al. (2005) find moral obligation to be the best predictor of pro-environmental behaviour. Dolnicar and Leisch (2008) found moral obligation to be a useful segmentation base to identify subgroups of the population with distinctively different levels of pro-environmental behaviour. We used the following wording for the single item measure: *Do you consider yourself morally obliged to carry out environmentally friendly behaviours?* Respondents had to respond by ticking either *Yes* (1) or *No* (0).

*Pro-environmental behaviour* was a summated value across respondents' answers to the following question: You will now see a list of behaviours. Please indicate how frequently you carried out each of these behaviours at home in the last year. Response options were *Always* (4), *Often* (3), *Rarely* (1) and *Never* (0) and *Not applicable* (0). A total of thirty behaviours were included.

*Active involvement in searching for information about water* was measured using a single item measure by asking respondents: How much effort have you made this year to look for information on water-related issues (water recycling, desalination, water conservation, rain water etc.)? Respondents had four response options: *Absolutely no effort* (0), *A small effort* (1), *A big effort* (2) and *A huge effort* (3).

*Previous use of recycled/desalinated water* was measured using a single item measure, worded as follows: *Have you ever used recycled water/desalinated water?* Answer options were *Yes* (1) and *No* (0).

*Experience with water restrictions* was measured by asking respondents *Have you ever experienced water restrictions?* Answer options were *Yes* (1) and *No* (0).

*Perception of being limited by water restrictions* was measured asking *To what extent do you feel limited by water restrictions?* Answer options were *Not at all* (0), *Slightly* (1) and *Strongly* (2). For analysis we used a collapsed variable with the categories *Not at all* (0) and *Slightly/Strongly* (1).

*Attitude towards water conservation* consisted of the sum over nine items about water conservation which were developed specifically for this study based on results from the qualitative fieldwork stage. One example is: *Water conservation is necessary because of water scarcity*. Response options were *I agree* (1) and *I disagree* (−1).

*Water conservation behaviour* was also computed as a sum over 17 items indicating different means of water conservation behaviour, such as *I make sure that taps do not drip*. Answer options were *Yes* (1) and *No* (0).

*Extent of influence of other people on people's water-related behaviour and attitudes* was computed as the sum over 14 items which listed different social sources of influence, for example, friends, partner, the media. Answer options were *Yes* (1) and *No* (0) for each listed social source.

*Knowledge about recycled and desalinated water*, as well as *perceptions of recycled and desalinated water*, respectively, were measured with knowledge and perception items developed by Dolnicar and Schäfer (2006). The sum across all items was used to arrive at separate overall measures of knowledge about recycled and desalinated water. Note that the knowledge and perception questions were asked before the definition of recycled and desalinated water was provided and respondents were asked to state their likelihood of use. Once respondents were provided with the definition and the

statement that both recycled and desalinated water were treated to the same level of water quality, respondents were not able to click back anymore. This was done to ensure they would not retrospectively change their answers to the perceptions and knowledge questions.

Finally, a number of socio-demographic questions were asked covering age, gender, education, size of city, feeling of belonging to the region, importance of religion, media use and whether or not respondents had read something about recycled or desalinated water recently.

These variables were chosen because they emerged as predictive in a number of studies trying to explain pro-environmental behaviour of different kinds, namely pro-environmental behaviour in general (Berenguer et al., 2005), intentions to undertake pro-environmental behaviour (Cordano et al., 2003) as well as specific kinds of pro-environmental behaviour such as subscribing to green electricity programs (Clark et al., 2003), willingness to pay for species protection (Kotchen and Reiling, 2000), for environmentally sound products (Laroche et al., 2001) and environmental protection in general (Stern et al., 1993). We deliberately included a wide range of criteria which were found to be associated with pro-environmental behaviour more generally because we felt that limiting our selection of variables to those studied in water-related research may lead to the omission of key factors.

## 4. Analysis

The numeric independent variables (such as environmental attitudes, environmental concern or altruism) were standardized to have comparable coefficient estimates. For variables with answers *Yes* or *No* the baseline category are the *No* answers, which are therefore included in the intercept, and the estimated coefficient indicates the change in likelihood if this question was answered with *Yes*.

All of the proposed independent variables are assumed to be correlated with the likelihood of using recycled or desalinated water and hence, might be used to predict this likelihood. Separate multivariate linear regression models were fitted for the two dependent variables. Variables which are specific to recycling water – such as experience with recycling water or the perception of recycled water – were only employed in the regression, using the likelihood to use recycled water as the dependent variable; the same approach was taken for desalinated water. Variable selection was made using stepwise forward selection by adding the variable with the smallest $p$-value and utilising the $F$-test to compare the model with this variable added against the model without this variable added. Candidates for terms which could be added in the model were all variables and all pairwise interactions between the variables already included in the model. The selection process was stopped when all $p$-values were larger than 0.05. Variables which are not included in the final model therefore do not significantly increase the explained variance if added to the model. The final model is analysed with respect to: (1) the variables included; and (2) the estimated coefficients for each of the variables.

## 5. Results

The empirical distributions for both dependent variables are provided in Fig. 1. Both dependent variables range from 10 to 1000, because each respondent provided responses for 10 items, each of which was assessed on a 100-point scale. Overall, public acceptance for desalinated water is higher, supporting the results of previous studies as discussed in Section 2.

### 5.1. *Explaining the likelihood of use of recycled water*

Results for recycled water are provided in Table 2. The table gives the parameter estimates together with the standard errors and the $p$-values of the corresponding $t$-tests. For numeric variables, negative estimates indicate that an increase

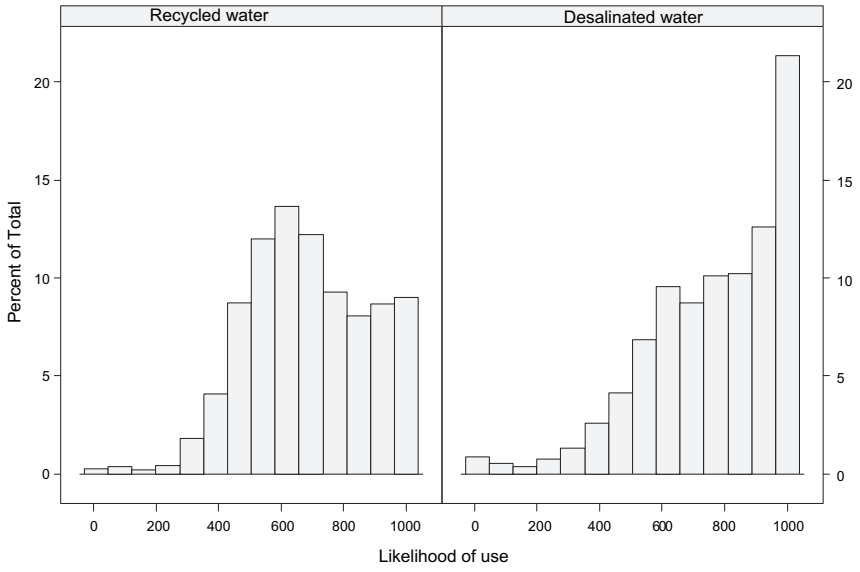


**Fig. 1 – Empirical distribution of the dependent variables (stated likelihood of using recycled/desalinated water).**

**Table 2 – Regression coefficients – recycled water.**

| | Estimate | Std. Error | *p*-value |
|---|---|---|---|
| Intercept | 666.81 | 10.53 | <0.001 |
| Perception of recycled water (positive) | 102.05 | 3.07 | <0.001 |
| Knowledge (more) | 18.57 | 3.06 | <0.001 |
| Age (older) | 20.13 | 3.11 | <0.001 |
| Extent of influence of others (higher) | 10.90 | 3.54 | 0.002 |
| Environmental attitudes (positive) | 5.89 | 3.53 | 0.095 |
| Experience with water restrictions | | | |
| – Yes | 39.22 | 11.85 | <0.001 |
| Feeling limited by water restrictions | | | |
| – Slightly or strongly | −17.18 | 7.24. | 0.018 |
| TV (commercial) | | | |
| – State | 20.22 | 7.25 | 0.005 |
| – Don't watch | 5.18 | 29.98 | 0.863 |
| Religious | | | |
| – Yes | −14.48 | 6.88 | 0.035 |
| – Not sure or did not say | −17.53 | 8.13 | 0.031 |
| Interactions | | | |
| Knowledge (more): extent of influence of others (higher) | −8.28 | 2.84 | 0.004 |
| Perception (positive): extent of influence of others (higher) | −9.00 | 3.12 | 0.004 |
| Extent of influence of others (higher): TV (commercial) | | | |
| – State | 17.86 | 7.20 | 0.013 |
| – Don't watch | 36.43 | 32.53 | 0.263 |
| Environmental attitudes (positive): TV (commercial) | | | |
| – State | 5.25 | 6.89 | 0.447 |
| – Don't watch | 61.92 | 24.06 | 0.010 |

$R^2 = 0.398$.

in the variable leads to a decrease in the likelihood of using recycled water; for categorical variables, the likelihood of using recycled water is decreased compared to the base level of the variable which is accounted for in the intercept. The order of estimates is in the sequence each entered the model. The $R^2$ value of 0.398 indicates that the model was able to account for a substantial amount of the variance. Nine factors hypothesized to increase the level of likelihood that respondents would use recycled water are significant: (1) previous experience with water restrictions; (2) not feeling limited by water restrictions; (3) greater knowledge about recycled water; (4) more positive perceptions of recycled water; (5) a high extent of other people influencing one's water-related behaviours; (6) pro-environmental attitudes; (7) older age (note that the underlying model is assuming a linear relationship, so the regression results indicate that higher age is associated significantly with a higher stated likelihood of using recycled water); (8) religion not being an important life factor; and (9) watching State (non-commercial) TV channels. This information contained in the Estimate column in Table 2 provides information about how sensitive the dependent variable (likelihood of use of recycled water) is to each of the factors in the regression model. This number is interpreted as follows: if the independent variable is increased by one unit the dependent variable increases with Estimate units, i.e., if the Estimate is negative the dependent variable decreases. The Standard Error indicates the precision of the Estimate, i.e., the 95% confidence interval for the estimate is approximately given by Estimate ± 2 Standard Error.

For ease of interpretation we also provide a graph with standardized estimates in Fig. 2. In this graph all factors that positively affect the likelihood of use plot to the right of the vertical axis and all factors with negative effects plot to the left. The length of each bar indicates the extent of the effect.

In addition to the individual effects, there are significant interaction effects between variables. Between two numeric variables this indicates that their combined effect is different from their separate effects. For example, the interaction effect between higher knowledge and the greater influence of others is negative, indicating that while these two variables separately have a positive effect on the likelihood of using recycled water, the effect levels off if both are increased. This observation also holds for the combination of more positive perception and the greater influence of others. For the combination of a numeric and a categorical variable, this can be interpreted as different slopes for the different levels of the categorical variable. The fitted model implies that the higher the influence of others, and the more positive the attitudes towards the environment, the better is the attitude towards recycled water. However, this effect is strongest for those who do not watch TV, followed by respondents preferring State TV channels.

The fact that not feeling limited by water restrictions increases the stated likelihood of using recycled water appears counter-intuitive at first. A proposed explanation is that people with higher pro-environmental attitudes have more understanding for the need for water restrictions and are therefore more tolerant of them. Consequently, this would lead them to express less frustration about water restrictions.

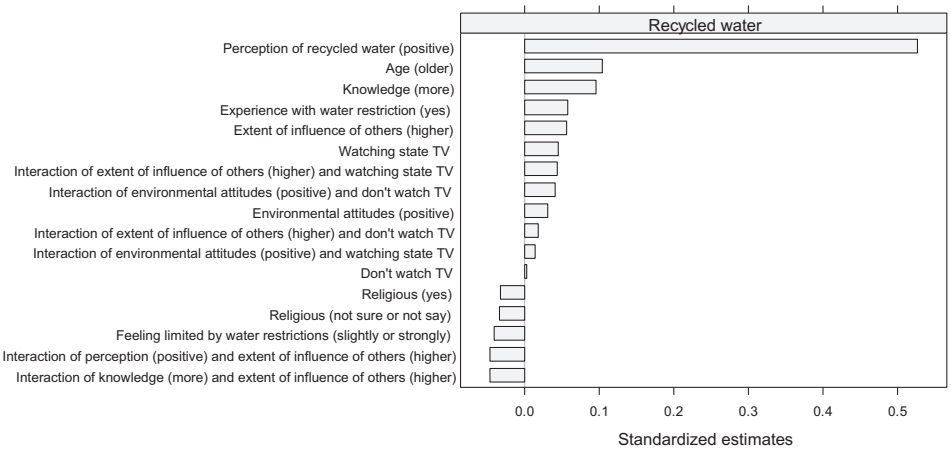


**Fig. 2 – Standardized regression coefficients for recycled water.**

### 5.2. *Explaining the likelihood of use of desalinated water*

Results for desalinated water are presented in Table 3 and in Fig. 3. The number of variables contributing significantly to the stated likelihood of using desalinated water across a range of household uses is higher than it is for recycled water, with ten explanatory variables being significant. The explained variance of the model, which is equal to 31.2%, is slightly lower than that for the recycled water model.

The overlap between the results for recycled water and desalinated water is great, with eight explanatory variables having the same significant influence for the likelihood of using either water source. Watching TV is the only explanatory variable which is significant for the likelihood of using recycled water, but not significant for desalinated water use.

Additional variables which significantly influence the likelihood of using desalinated water are the previous use of desalinated water and the respondent's attitude towards

**Table 3 – Regression coefficients – desalinated water.**

| | Estimate | Std. Error | *p*-value |
|---|---|---|---|
| Intercept | 752.39 | 12.55 | <0.001 |
| Perception of desalinated water (positive) | 92.87 | 6.68 | <0.001 |
| Knowledge (more) | 15.18 | 3.53 | <0.001 |
| Attitude towards conservation (positive) | 9.89 | 3.80 | 0.009 |
| Environmental attitudes (positive) | 38.09 | 12.07 | 0.002 |
| Previous use of desalinated water | | | |
| – Yes | 38.67 | 13.12 | 0.003 |
| Age (older) | 10.81 | 3.70 | 0.004 |
| Religious | | | |
| – Yes | −8.60 | 8.72 | 0.324 |
| – Not sure or not say | −26.54 | 10.29 | 0.010 |
| Extent of influence of others (higher) | 9.29 | 3.67 | 0.012 |
| Experience with water restrictions | | | |
| – Yes | 38.85 | 14.08 | 0.006 |
| Feeling limited by water restrictions | | | |
| – Slightly or strongly | −21.07 | 8.50 | 0.013 |
| Interactions | | | |
| Perception (positive): attitude towards conservation (positive) | −10.77 | 3.51 | 0.002 |
| Perception (positive): extent of influence of others (higher) | −9.09 | 3.40 | 0.008 |
| Knowledge (more): attitude towards conservation (positive) | −7.19 | 3.37 | 0.033 |
| Age (older): extent of influence of others (higher) | 9.33 | 3.66 | 0.011 |
| Environmental attitudes (positive): age (older) | −7.02 | 3.56 | 0.049 |
| Previous use of desalinated water (yes): religious | | | |
| – Yes | −60.88 | 22.60 | 0.007 |
| – Not sure or not say | 4.56 | 27.23 | 0.867 |
| Environmental attitudes (positive): previous use of desalinated water (yes) | −21.24 | 9.51 | 0.026 |
| Environmental attitudes (positive): experience with water restrictions (yes) | −26.61 | 12.49 | 0.033 |
| Perception (positive): feeling limited by water restrictions (slightly or strongly) | 16.28 | 7.71 | 0.035 |

$R^2 = 0.312$.

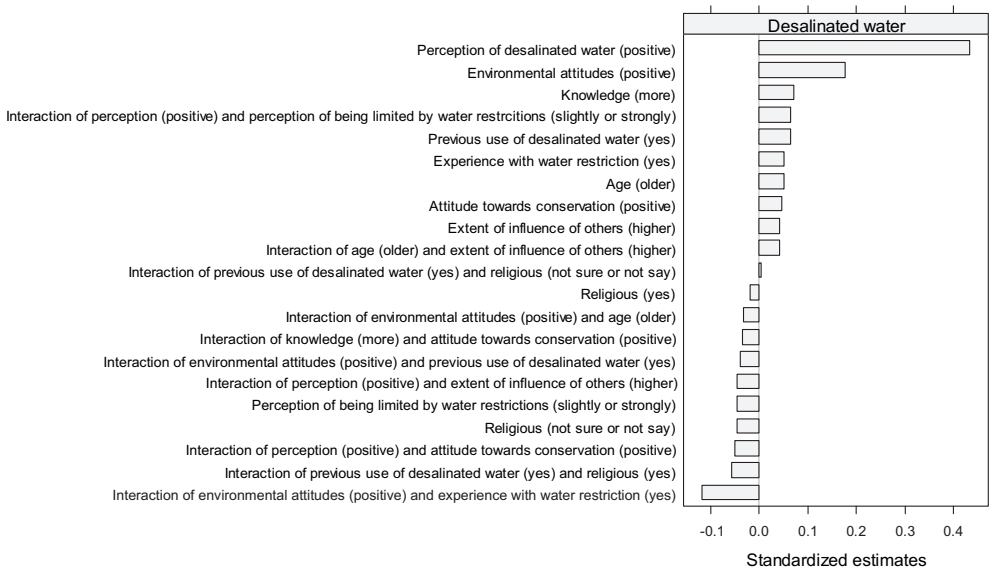


**Fig. 3 – Standardized regression coefficients for desalinated water.**

conservation, where previous use and the higher valuation of conservation both increase the likelihood of use. The interaction effects of two numeric variables compensating their effect are observed for positive perception and attitude towards conservation, positive perception and the influence of others, knowledge and attitude towards conservation, as well as for environmental attitudes and age. By contrast, for age and the influence of others, the combined effect is even more emphasized. The influence of positive attitudes towards the environment on the likelihood of using desalinated water is smaller for respondents who have previously used desalinated water and who have experienced water restrictions in the past. Furthermore, the influence of positive perceptions of desalinated water is enforced if respondents perceive themselves as limited by water restrictions. Religion only impacts on the use of desalinated water if respondents have used this type of water before.

One possible explanation for the finding that positive environmental attitudes increase the likelihood of using desalinated water, is that the knowledge level about desalination within the Australian population is relatively low (Dolnicar and Hurlimann, 2009). The environmental disadvantages of water desalination are not commonly understood, which may lead to (uninformed) support for desalinated water from people generally concerned about the environment. If people have previous experience with the use of desalinated water they are likely to know more about the negative environmental impacts of desalination and therefore become more reluctant to embrace it. These findings and explanation are in line with previous findings that people opposed to desalinated water are often opposed for environmental reasons (Dolnicar and Schäfer, 2009).

## 6. Discussion and conclusions

The following key findings emerged from the study: First, some of the factors identified previously as being associated with higher levels of public acceptance of recycled water (e.g., gender and education) do not appear to be the main drivers, but may possibly be correlated with them. Our results provide support for previous research which has found favourable attitudes to recycled water use from:

(1) older respondents (Hurlimann, 2007a; and Dolnicar and Schäfer, 2009); and
(2) knowledge (Lohman and Milliken, 1985; Flack and Greenberg, 1987; Jeffrey and Jefferson, 2003; Tsagarakis and Georgantzis, 2003; and Hurlimann et al., 2008).

Our results also provide evidence for the impact of environmental attitudes, positive perceptions of recycled water, the influence of other people, religion, experience of water restrictions, the perception of being limited by water restrictions, and watching State TV channels, on the stated likelihood of using recycled water. We believe that the predictive value of watching State TV may be due to the fact that State TV (non-commercial) channels have a number of current affairs programs and news shows which provide in-depth analyses on the topics covered. With respect to recycled water, for example, they not only discuss people's fear of health risks, but also provide information about the environmental advantages of recycled water. We think that it is this additional insight which is associated with the increased stated likelihood of use.

Second, drivers of the stated likelihood of using desalinated water were found to be similar to those for recycled water. Only watching State TV channels did not emerge as an influential factor. In addition, respondents who have previously used desalinated water and who indicated a positive attitude towards conservation, were reportedly more likely to use desalinated water than those who have not. The fact that people in Australia know relatively little about desalinated water and how it is produced seems to work in favour of acceptance because the negative environmental effects are not commonly known. But the perception in terms of public

health is more positive than for recycled water (for example, 38% perceive recycled water as "disgusting" but only 25% perceive desalinated water as such; 48% perceive recycled water as not tasting good, whereas only 41% feel the same way towards desalinated water).

These findings have significant practical implications, particularly for public campaigns designed to promote the use of desalinated and/or recycled water. Too much information regarding desalinated water may have the effect of decreasing public acceptance due to the environmental concerns usage might raise. In the case of recycled water it is likely that public campaigns will potentially increase public acceptance and usage since public perceptions play a major role in acceptance.

Key drivers for the acceptance of both water sources are the possession of positive perceptions about alternative water sources, and the extent to which other people might influence a person's decisions about alternative water sources. Positive messages about recycled and/or desalinated water, particularly from personal communication channels such as family, friends and colleagues, are important to the uptake of these water sources. Since knowledge was a significant influencing factor for both water sources, it follows that public information and marketing have a major contribution to make in the context of introducing water from alternative sources. Marketing strategies that make water from alternative sources a positive conversation topic may be particularly valuable.

Finally, previous experience with water restrictions, in addition to previous experience with these water sources, evidently increases the likelihood of use. Again, this is key information for public policy makers as it informs the nature of the communication message that is likely to be effective. In this particular instance it has to be concluded that messages emphasizing the real problem of water scarcity, e.g. by showing examples of current water scarcity in the near geographical proximity of where people live, will have a higher likelihood of positively impacting acceptance.

These findings have important practical implications as they provide guidance to water providers and public policy makers about interventions that are likely to increase public acceptance of water augmentation projects, especially information and communication campaigns:

1. It is essential that people understand that water from alternative sources is not an option, but a necessity; and
2. Suggesting non-threatening ways for people to be able to experience recycled and desalinated water may be a useful strategy to increase public acceptance and usage. Non-threatening ways include voluntary opportunities, such as tasting recycled and desalinated water, filling public swimming pools with recycled and desalinated water. These techniques are likely to be far more effective than public announcements stating that recycled or desalinated water would be added to water supplied to households. Such announcements have proven to be very threatening and have resulted in public rejection of water augmentation schemes in the past (Hurlimann and Dolnicar, 2010).

The above findings support a barely enacted recommendation made more than three decades ago by Baumann and Kasperson (1974), namely, to "put the reclaimed water in an attractive setting and invite the public to look at it, sniff it, picnic around it, fish in it, and swim in it" (p. 670).

This study is limited in three ways, providing opportunities for future researchers to further extend our understanding of why the public rejects or accepts water from alternative sources. First, this study was conducted in Australia only. Although it could be argued that the drivers for resisting acceptance are universal, there is some evidence that critical events in the history of certain Australian locations – such as the Toowoomba referendum – are likely to have an impact on results. Secondly, this study did not include a comprehensive list of every factor that can be expected to affect people's acceptance of water from alternative sources. In future work it would be valuable to include measures for trust, risk perception, health concerns, or perceptions of quality, and include those into the model as independent variables. Finally, respondents were not asked about frequency or volume of water use for different purposes, which could be used to assess the extent to which dam water could easily be substituted with water from augmented sources without raising public health or environmental concerns among the population. Such a study, or studies, would be of great value in future, especially in countries which do not currently use water from augmented sources and where, as a consequence, the population may be reluctant to accept large-scale water augmentation projects.

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