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The effect of information on public acceptance - The case of water from alternative sources

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The effect of information on public acceptance - The case of water from alternative sources

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Abstract

This study aims to provide conclusive evidence that information about water from alternative sources increases public acceptance. We conducted an experiment with 1000 Australian respondents asking them about their acceptance of recycled and desalinated water for a range of purposes under two conditions: 1) no information provided and 2) information about the production process provided. Results indicate that – both for desalinated and recycled water – the stated likelihood of use increases significantly if people are provided with information about the production process. This has major implications for public policy makers indicating that providing factual information (as opposed to persuasive campaigns) will increase public support of water augmentation projects.

Keywords: Recycled water, desalinated water, public attitudes/resistance, public acceptance, alternative water sources.

1. Introduction

Technology to augment water on a large scale has been available for a long time (Asano and Tchobanoglous, 1991; Elimelech, 2006). Yet, public knowledge about water, especially water from alternative sources such as recycled and desalinated water, is relatively low among the general population (Dolnicar & Schäfer, 2009). This may be why, historically, proposals for large scale water augmentation have triggered strong negative reactions from the public, and sometimes organised community resistance (such as CADS - Citizens Against Drinking Sewage, and SCUD - Sydney Community United against Desalination in Australia).

History has shown that community resistance can prevent augmentation projects from being developed. Twenty years ago Dishman *et al.* (1989) concluded that technical aspects of potable water reuse can be resolved, but "the issue of public acceptance could kill the proposal" (p. 158). Indeed in Australia, public opposition to Towoomba Council's potable reuse plans contributed to the community voting against the proposal in a referendum (Hurlimann and Dolnicar 2010). Public opposition has also delayed projects including Sydney's desalination plant, and in the USA, San Diego's indirect potable reuse plan of the 1990s.

Although some researchers have postulated that knowledge/information about water augmentation schemes increases public acceptance (Hills *et al.*, 2002; Jeffrey and Jefferson, 2003; Hurlimann, 2007) limited empirical proof for the effect of information on acceptance levels has been provided. Our study aims to fill this gap. More specifically we will investigate the hypothesis that providing information about how recycled (H1) and desalinated water (H2) is produced will increase public acceptance of recycled/desalinated water.

2. Literature review

2.1 Recycled and desalinated water

There is growing demand for water and increasing uncertainty surrounding the supply of natural water resources due to changing and irregular weather patterns. Water authorities around the world are thus forced to adopt non-traditional sources, such as domestic wastewater effluent and seawater (Elimelech, 2006), to secure their water supply. Although considered ‘alternatives’ to natural surface or ground water sources, both wastewater reclamation and seawater desalination have been practiced for many decades. The first example of planned, potable water recycling dates back to 1969, when a conventional water treatment plant in Windhoek (Namibia) was upgraded to treat a combination of surface water and secondary effluent (du Pisani, 2006). The first seawater desalination in the world was commissioned in Kuwait in 1951 (Hamoda, 2001).

With constant advancement in water treatment technologies, domestic wastewater has become a viable source from which to produce water of any desired quality (Elimelech, 2006). Many water reclamation plants for indirect potable water recycling are now operational, most prominently the Water Factory 21 in Orange County (USA) and the NEWater Factory in Singapore. These more recent water recycling schemes are all ‘indirect’ and are based on the very prudent concept of a multiple barrier system. These barriers – designed to eliminate microbial pathogens, and adequately remove harmful substances to protect public health – are comprehensive incorporating both treatment and non-treatment barriers.

In a typical indirect potable water recycling scheme, domestic wastewater is first treated to a secondary effluent standard in a conventional wastewater treatment plant. The effluent is further purified with an array of advanced treatment processes including microfiltration, low pressure reverse osmosis and UV treatment to remove a range of micropollutants that can survive the conventional wastewater treatment process (Bixio and Wintgens, 2006). The high quality reclaimed water is then stored for an extended retention time in a reservoir, where it is blended with other sources. This blended water is treated once more, usually by a conventional water treatment plant consisting of coagulation/flocculation, rapid sand filtration and chlorination before it can be delivered for domestic consumption. In addition, non-treatment barriers include the diversion of industrial effluent away from domestic wastewater, extensive monitoring and blending reclaimed water with other water (Bixio and Wintgens, 2006).

Early seawater desalination plants were primarily based on thermal distillation and were restricted to oil rich countries of the Middle East (Fritzmann *et al.*, 2007). However, with recent progress in the development of reverse osmosis technology, particularly in membrane materials and energy recovery, reverse osmosis has become the norm of modern seawater desalination (Fritzmann *et al.*, 2007; Zander *et al.*, 2008). Because seawater is considered to be less contaminated than domestic wastewater, the treatment process of seawater is relatively simple. A typical state of the art seawater desalination plant using reverse osmosis technology consists of only three major components: pre-treatment usually by rapid sand filtration or pre-filter, high pressure reverse osmosis, and post-treatment. While seawater desalination is highly reliable and is considered to be insensitive to natural hydrologic variability, high energy consumption is a major drawback (Zander *et al.*, 2008).

2.2 Public acceptance of recycled and desalinated water

The majority of work on public attitudes towards alternative water sources has been conducted in the context of recycled water and overwhelmingly concluded that acceptance is higher for uses with low human contact (e.g. toilet flushing, garden watering) and lower for high human contact (e.g. drinking, Bruvold and Ongerth, 1974; Marks *et al.* 2006; Dolnicar and Schaefer, 2009). One of the few studies investigating acceptance of desalinated water was conducted by Dolnicar and Schaefer (2009) in Australia, concluding that acceptance of desalinated water followed the same high contact/low contact pattern observed for recycled water. Also, the public was found to clearly discriminate between the two alternative water sources, with a higher willingness to use recycled water than desalinated water for low human contact uses, but lower willingness to use recycled water than desalinated water for high human contact uses.

Little is known about the effect of knowledge and information on acceptance of alternative water sources. Recent research in Australia (Dolnicar and Hurlimann 2009) found the public do not feel well informed about recycled water. Jeffrey and Jefferson (2003) investigated whether people who know more about water treatment are more likely to accept water recycling. Their study of 300 people representative of England and Wales suggest a high correlation between knowledge of water treatment and acceptance. Hills *et al.* (2002) surveyed 1055 visitors to the Millennium Dome in England regarding water recycling and conservation initiatives. They concluded that acceptance of reclaimed water was higher in individuals who had seen signage in the washrooms (where recycled water was used) or the Watercycle exhibit, in comparison with a control group having seen no signage. Their results suggest that exposure to reclaimed water systems further increases acceptance.

Hurlimann *et al.* (2008) conducted a study of consumer satisfaction with non-potable recycled water use at Mawson Lakes (Australia) concluding that people who felt well informed about recycled water trusted the water authority more; this in turn led to greater satisfaction with the use of recycled water. In further research with the Mawson Lakes community, Hurlimann (2007) found that perception of risk related to recycled water use was negatively related to perception of feeling well informed.

An extensive literature review revealed only one study which directly investigated the effect of providing information on acceptance: a study conducted in the USA by Lohman and Milliken (1985) for the Bureau of Reclamation. They measured public awareness (in the Denver Water Department area) of potable water reuse and analysed the effect of information/education measures on public understanding and acceptance of potable water reuse. In total, 72 people participated and were exposed to various forms of educational treatment. Treatment 1 (n=11) provided reading material and a tour of a potable water reuse demonstration plant. Treatment 2 (n=25) provided reading material only. A third group (n=35) acted as a control. All respondents were interviewed about their attitudes to water and acceptance of various types of reuse before and after the 'educational treatments.' It was found that (1) knowledge increased willingness to accept the use of recycled water, (2) on-site tours are the best method of informing people, (3) all methods should be used to educate about reuse, (4) it is critical that professional members of the agency understand and support the project, (5) reliance cannot be placed on the regular system of news reporting to achieve public education, and finally, (6) the degree of public acceptance is closely related to faith in the water agency and understanding of potable reuse.

A major limitation of this study is the small sample size which is not representative of the Denver Water Department area, and does not allow confidence in the changes observed before and after the experimental treatments. Also, the study is 25 years old. Back then, the issue of emerging trace organic contaminants in wastewater had attracted only limited attention.

3. Methodology

We conducted a survey in January 2009 with 1000 respondents over two survey waves using an Australian permission-based research-only internet panel. The chosen panel maintains a database of respondents which enables representative samples to be drawn, based on the Australian Bureau of Statistics' (ABS) census information. A total of 13,884 respondents were randomly selected and invited to participate in the study. 1495 participated in the first wave (response rate of 11%, note however that people were rejected if their quota was full to ensure representativity of the final sample), 1000 completed both the first and second wave questionnaire (final response rate of 7% for longitudinal design). Respondents were paid a compensation payment at standard rates used by the permission-based online panel which is based on the questionnaire length.

The final sample is nationally representative with respect to gender, age, state of residence, and education level. Note however, that representativity is not required for this study because no statements about the proportions of the population are made. All respondents completed a survey which contained a range of questions about pro-environmental behaviour and water. After 13 days the same respondents were asked to complete a second, shorter, survey which also included schematic diagrams (see Figures 1 and 2) illustrating how recycled and desalinated water are produced. These diagrams were developed to ensure that they could realistically be used in a public information campaign. Specifically, they were visually appealing, could be processed by people relatively quickly (as opposed to a guided tour through a recycling plant or reading a multi-page information brochure or webpage about treatment processes) and therefore did not place undue burden on people.

---- Insert Figure 1 here ----

---- Insert Figure 2 here ----

The independent variable was exposure to the information contained in Figures 1 and 2. Respondents were not exposed at the first measurement and were exposed at the second measurement. Two dependent variables were used to test the postulated hypothesis: (1) separate items asking respondents to indicate on a visual analogue scale their likelihood of using recycled and desalinated water, respectively, for each of 14 different purposes (see Table 1 in section 4.1 for a list of all purposes), and (2) an average value across all 14 purposes.

The visual analogue scale appeared in the questionnaire as a horizontal, movable line. Respondents were asked to indicate how likely they were to use recycled/desalinated water for each of the purposes by placing a cross on the horizontal line. The endpoints of the line were labelled as “very likely” and “very unlikely”. Data was exported in to a data set by dividing the horizontal line into 100 sections. Resulting values of both dependent variables therefore lie between 0 and 100 and are treated as metric in nature.

A number of additional questions were included in the questionnaire. This ensured that the aim of the study was not obvious to respondents. Other constructs measured included altruism, environmental concern and environment-related attitudes. Respondents were also asked to provide basic socio-demographics. Data was analysed using Paired Sample T-tests. The data complies with the assumptions underlying this test: the dependent variable is measured on a metric scale, the population distribution of differences is normal based on histograms and superimposed normal curves and the observations within each treatment are independent.

In addition we conducted a binary logistic regression to assess whether socio-demographic variables would discriminate between groups of people who react to the information about recycled/desalinated water in different ways. For this purpose we computed the sum of differences in the stated likelihood to use separately for recycled and desalinated water per person. We then split respondents along quartiles and compared, by means of binary logistic regression, the two extreme groups: the 25% who demonstrated the overall most positive change and the 25% who demonstrated the overall most negative change as a consequence of being exposed to information. The following variables were included in the regression: age, education, income, occupation, newspaper reading, and state of residence.

4. Results and discussion

4.1 Recycled water

The results for recycled water, using the item-level dependent variables, are provided in Table 1. The first column in this table lists all water uses which were included in the questionnaire. The second column lists the average stated likelihood to use recycled water when no additional information (survey one) was provided on a 100 point scale. This is followed by the average stated likelihood to use recycled water when additional information about how recycled water is produced (survey two) was provided. In the last column the p-value for the Paired Sample t-tests is provided, rounded to three decimal points.

---- Insert Table 1 here ----

The provision of information increased the stated likelihood of using recycled water (Table 1). Stated likelihood increased significantly for all uses except toilet flushing and watering the garden. One possible reason for the insignificant difference for these items is the fact that both items had very high base levels of stated likelihood of use, and as mentioned in section 2.2 are not perceived to be a particular concern by the public in terms of health. The highest differences appear to have occurred in the context of uses with moderate human contact, although no linear patterns of this kind can be detected. In terms of the two uses which have emerged as the having the highest public resistance to adopting water from alternative sources (drinking and bathing the baby, as shown in Dolnicar & Schaefer 2009), providing information increased the stated likelihood of use from 36 to 43 and from 39 to 45, respectively.

These results are confirmed by the second analysis which uses the summated scale across all uses as a dependent variable. On average, the stated likelihood to use recycled water increased from 63 to 69 (p=0.000).

Based on these results H1 cannot be rejected: providing information about how waste water is treated has generally increased people's stated likelihood of use.

4.2 Desalinated water

The results for desalinated water are provided in Table 2, containing similar information as Table 1, but for desalinated water. Differences in stated likelihood for desalinated water are significant for all uses (Table 2). Interestingly, the largest increase in stated likelihood when information was provided occurred for the two uses typically perceived as most sensitive: drinking (from 54 to 62) and bathing the baby (from 56 to 65). The smallest change occurred for toilet flushing, the use which has a high starting level of acceptance.

---- *Insert Table 2 here* ----

These results are confirmed by the second analysis which uses the summated scale across all uses as a dependent variable. On average the stated likelihood to use desalinate water increased from 73 to 79 (p=0.000). Based on these results H2 cannot be rejected: providing information about how seawater is treated has generally increased people's stated likelihood of use.

4.3 Recycled versus Desalinated water

When comparing the changes that occurred for the two kinds of water from alternative sources, we can conclude that they are generally quite similar. Difference exists with respect to feeding pets and filling the swimming pool. For these two uses, the increase of stated likelihood of use was much higher for recycled water than it was for desalinated water. On the other hand, the increase was higher for desalinated water regarding watering the garden (flowers, trees, shrubs), drinking, and bathing the baby. For some of these differences explanations can be provided. For example, watering the garden is a typical concern in relation to using desalinated water because people may fear that some amount of salt residue may have negative effects on their plants. Clearly, for such uses, providing information about how the water has been treated can make a difference – increasing stated likelihood of use. The same holds for feeding pets and filling up the swimming pool in relation to recycled water.

Results reported in this study suggest that public hesitance to embrace water from alternative sources is primarily driven by water quality concern. The public clearly differentiate between recycled and desalinated water as reflected by a higher overall acceptance level for the latter. Nevertheless, they seem to have a similar level of concern about both of these alternative water sources. Although recycled water had notably lower base levels of stated likelihood of use than desalinated water, increases in the level of acceptance of both recycled and desalinated water after the provision of additional information regarding treatment technologies were quite similar (Figure 3). The average increase in stated likelihood of use of recycled and desalinated water after intervention were 5.3 and 5.7 percentage points, respectively. In this study, water quality concern appears to overwhelm other factors, including economic and environmental consideration, as a primary basis of the public decision to accept or reject water from alternative sources. Indeed, considerable increases in the stated likelihood of use of desalinated water for a range of non-potable purposes could be observed as a result of additional treatment information (Figure 3). This is despite the fact that seawater desalination is energy intensive and that water usage in these contexts would only result in secondary exposure (i.e. human contact via water flashing or other forms of accidental exposure). However, it is noteworthy that information about energy usage and cost were not explicitly provided to the respondents in the intervention phase of this study. In future research, the provision of such information would be beneficial to measure the sensibility of economic and environmental factors on public acceptance of alternative water sources.

---- Insert Figure 3 here ----

4.4 Investigating differences in people's reactions to information

The Chi-square test for the binary logistic regression for recycled water was insignificant ($p = 0.435$), indicating that the model fitted the data well. However, the sociodemographic variables included in the model were not very successful in discriminating between those whose stated likelihood changed in different ways as a consequence of the information intervention: the a priori probability of correct assignment of respondents into the top and bottom group was 50%, the a posteriori probability, taking those sociodemographic variables into account, was 62%. The only variable that emerged as having a significantly positive impact on the likelihood of a positive change was the frequency of newspaper readership ($p=0.45$, Exp (B) = 1.124). This indicates that the cause for heterogeneity in reactions to information may lie in the experience of processing information rather than basic sociodemographics. No variables among the sociodemographics included in this model emerged as significant predictors of changes in stated likelihood of using desalinated water after having been provided with information.

4.5 Policy Implications

Our results indicate that providing people with simple visual information about recycled water and desalinated water increased their stated likelihood of using these alternative water sources. For water policy makers, this indicates that providing simple, visual, factual information to the public, could help garner public support for policies seeking to introduce alternative water use. This is an important and positive implication given past policy failures as discussed in section 1 of this paper (such as Toowoomba and Sydney in Australia and San Diego in the USA). The results also indicate that a ‘DAD’ (decide announce defend) approach to the introduction of such schemes should be abandoned. Further research regarding the effectiveness of other communication means will be beneficial to further inform policy makers.

5. Conclusions

This study is significant in a number of ways. Internationally, it is the first time such a large scale study has been undertaken to assess how information may influence acceptance of alternative water sources. Our study tested whether providing people with visual information about recycled water and desalinated water increased their stated likelihood of using these water sources for 14 purposes. The stimuli used were developed specifically to be realistic in terms of public policy implications that can be derived from the study. Therefore we ensured that the information could be processed relatively quickly, could be presented on one page and was visually appealing.

Our results indicate that providing information about treatment processes significantly increases stated likelihood to use for 12 (of 14) recycled water uses and all 14 desalinated water uses. These results have significant public policy implications as discussed in section 4.5, indicating that providing visually appealing and easily digestible information about alternative water treatment processes can increase the public's likelihood to use these alternative water sources. This will have significant implications for government and public policy makers considering augmentation of water supply with various water sources.

Further research is recommended, including: having larger time periods between surveys, using additional dependent variables (such as testing factual knowledge about water) and extending the experimental design to include additional forms, and including control groups. Such replications are expected to provide additional confirmation of the results, and help establish the relative value of written and visual material, and possible interaction effects between the two, in increasing public acceptance. Furthermore, it would be of interest to investigate whether differences in respondents' reactions to the information can be explained with personal characteristics other than sociodemographics (e.g. level of pro-environmental behaviour, risk-aversion, information processing styles).

6. Acknowledgements

To be added after blind review.

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Table 1

Changes in stated likelihood to use recycled water (ordered by difference)

RECYCLED WATER	No information	Information	Difference	p-value
Feeding my pets	55	64	9.4	0.000
Refilling/topping up the swimming pool	63	71	8.3	0.000
Cooking	46	54	8.1	0.000
Filling up the fish pond or aquarium	72	80	7.5	0.000
Brushing teeth	41	48	6.9	0.000
Drinking	36	43	6.9	0.000
Bathing the baby	39	45	6.8	0.000
Watering of garden	67	73	6.0	0.000
Showering/taking a bath	60	65	4.3	0.000
Washing clothes, doing laundry	76	80	3.6	0.000
Washing the car	85	89	3.4	0.000
Cleaning the house, windows, driveways	86	89	2.5	0.005
Toilet flushing	92	93	0.6	0.336
Watering the garden (flowers, trees, shrubs)	87	88	0.4	0.678

Table 2

Changes in stated likelihood to use desalinated water (ordered by difference)

DESALINATED WATER	No information	Information	Difference	p-value
Drinking	54	62	8.5	0.000
Bathing the baby	56	65	8.3	0.000
Filling up the fish pond or aquarium	76	84	7.8	0.000
Feeding my pets	67	75	7.6	0.000
Cooking	66	73	7.3	0.000
Brushing teeth	60	67	7.3	0.000
Watering of garden (vegetables)	76	82	5.7	0.000
Showering/taking a bath	75	81	5.5	0.000
Refilling/topping up the swimming pool	81	85	4.5	0.000
Washing clothes, doing laundry	83	88	4.4	0.000
Watering the garden (flowers, trees, shrubs)	85	89	3.7	0.000
Washing the car	85	88	3.6	0.000
Cleaning the house, windows, driveways	87	90	3.5	0.000
Toilet flushing	91	93	1.7	0.015

Fig. 1. Schematic diagram illustrating treatment processes involved in a typical in-direct potable water recycling scheme.

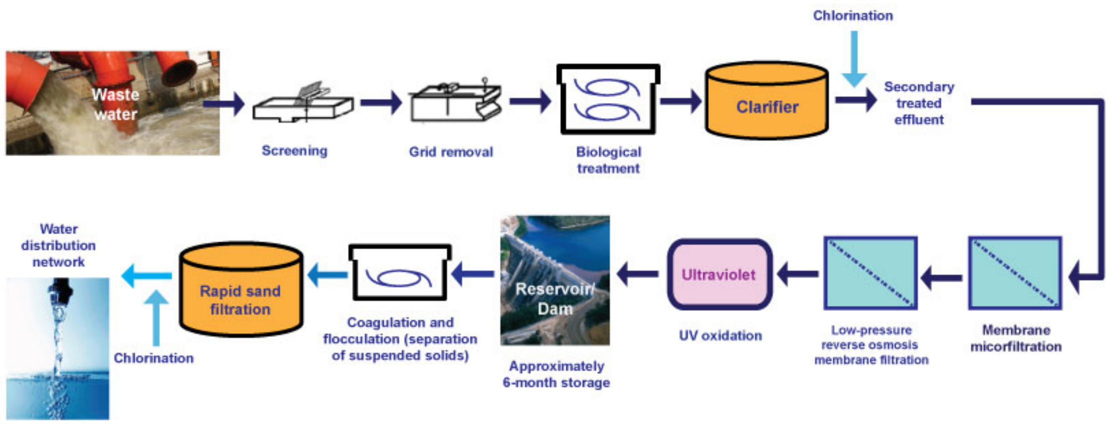

Fig. 2. Schematic diagram illustrating treatment processes involved in a typical seawater desalination scheme using reverse osmosis technology.

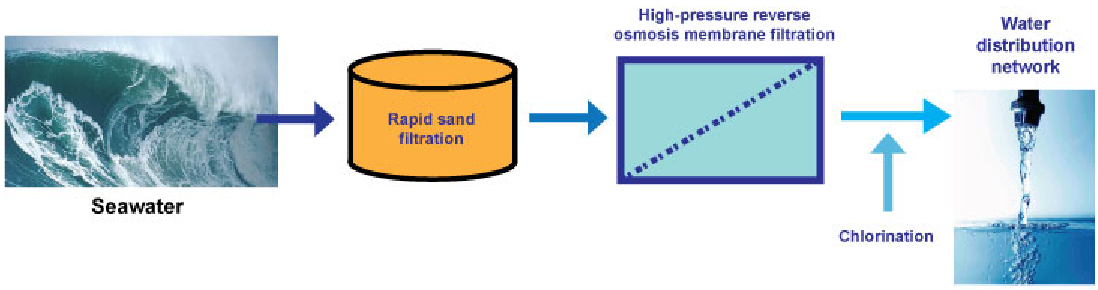

Fig. 3. Increase in stated acceptance of recycled and desalinated water due to the provision of treatment information.