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Socio-economic and psychological predictors of domestic greywater and rainwater collection: Evidence from Australia

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SUMMARY

The importance of securing water supply necessitates that all options be explored. Research has indicated that demand on water catchments can be substantially decreased when a large proportion of households reuse greywater and/or install rainwater tanks. This paper reports on an internet survey completed by 354 households residing in the Australian Capital Territory and surrounding regions. Statistical analyses examined the relationship between socio-economic and psychological variables and the likelihood of the garden being irrigated with greywater and/or rainwater. The results show income, gender, age and education could not differentiate residents who were irrigating their garden with water from a tank from residents who were not. Residents who used tank water on their gardens had a higher self-reported understanding of a range of water supply options. Female participants and lower income residents were more likely to use greywater on their garden. Participants who irrigated the garden with greywater were more likely to judge various other water collection and recycling proposals as being appropriate. General concerns about water collection and reuse risks were not found to predict which households used tank water and/or greywater on their garden.

Introduction

Australia is the driest inhabited continent with its population primarily distributed around freshwater river systems. A number of well-respected organizations suggest a high likelihood that south-eastern Australia will be facing escalating pressures on its water resources due to climate change, economic development and population growth (ACT Government, 2003; Allen Consulting Group, 2005; Australian Greenhouse Office, 2003; CSIRO, 2001; Farmhand For Drought Relief Foundation, 2004; Hadley Centre, 2004; Victorian Government White Paper, 2004; Western Australian Greenhouse Task Force, 2003; World Water Assessment Programme, 2003). In the last decade all Australian capital cities, except Darwin and Hobart, have imposed water restrictions to curtail demand and protect supplies. Current water consumption practises are widely recognised to be unsustainable (Chartres and Williams, 2006; Dillon, 2000; Quiggin, 2006; Syme and Hatfield-Dodds, 2007). Freshwater is a valuable resource with benefits extending beyond "just keeping us alive" by "quenching our thirst" (Syme, 2002). Agriculture, industry and the population at large are able to generate many different types of economic and social benefits from freshwater supplies (Roberts et al., 2006). A lack of water can impact society in different ways; for example, limiting both population and economic growth, impacting wildlife, reducing the potential for well-being from domestic gardening and home-grown food.

Australian communities are attempting to develop strategies to protect existing water supplies while maintaining their quality of life. Water policy tends to focus on increasing supply via large-scale centralised public projects e.g. building a dam across the Mary River, Queensland and enlarging the Cotter Reservoir, Australian Capital Territory (ACT), constructing desalination plants in Melbourne, Sydney and Perth. Capture and storage of stormwater is another large-scale water supply option available to urban centres. All of these options involve large financial investments to build infrastructure. Dams and desalinations plants can also have serious negative environmental consequences (Einav et al., 2003; Hoepner and Lattemann, 2002; Ibrahim, 2004; Malmqvist and Rundle, 2002). Several proposals for large scale and centralised water schemes to recycle water back into the mains water supply have generated intense political debate and polarised communities, primarily because of concerns about drinking the reclaimed water (Marks, 2004, 2006; Marks et al., 2008; Po et al., 2003; Stenekes et al., 2006).

The Australian Bureau of Statistics (2001) found urban residents to be highly significant users of a number of important water catchments, e.g., 54% of the water consumed from the ACT catchments. There is in such cases the potential for small scale and

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decentralised household supply initiatives to reduce the need for large scale investments e.g. rainwater substituting for mains supply in Germany (see Herrmann and Schmida, 1999). Urban centres reducing their use of mains water by 20% or more is equivalent to the water supplied by major projects such as desalination of seawater (Marsden and Pickering, 2006). The ACT Government (2003) has estimated that increasing water efficiency by 3% equates to deferral of a new $100 million (AUS) dam by about 3 years, with every year of deferral saving about $1 million (AUS). While increasing water efficiency represents a cost shifting exercise (e.g. rainwater costs around $6/kl via household rainwater tank), there are benefits to increasing water supplies at a household level. There is strong evidence that Australian communities will accept water recycling (Marks et al., 2006a) and stored rainwater for gardens (Marks et al., 2008) for non-potable purposes. However, what remains unclear is what differentiates households that water the garden with alternative water sources from households that do not. Households can augment their water supply by installing water tanks and/or recycling household 'greywater'. Water tanks capture and store rainwater that falls on the roof of a house or outbuilding and have been argued to be an important supply option for many Australian communities (Coombes and Kuczera, 2003; Coombes et al., 2002). Household greywater is defined as being the wastewater from the hand basin, shower, bath, spa bath, washing machine, laundry tub, kitchen sink or dishwasher. Due to prolonged drought conditions and water restrictions many households currently irrigate their gardens and lawns with tank water and/or greywater, and many new housing developments require the installation of greywater or rainwater tank infrastructure. The simplest greywater systems involve diverting water from the laundry and/or bathroom directly to the garden or lawn for immediate use by a bucket or siphon. There are also more sophisticated greywater systems (Jefferson et al., 1999), but as they are expensive very few have been installed in Australian households. Recycling household greywater has the potential to exceed supply from rainwater tanks (Karpiscak et al., 2001). For example, the typical Canberra household has been estimated to generate between 200–350 litres per day in greywater (ACT Government, 2007; Australian Bureau of Statistics, 2001). A community in Casa del Agua, Tuscon, Arizona was retrofitted with rainwater and greywater infrastructure and low-water-use appliances. Over a 13 year period this achieved a 24% reduction in total water used and a 47% reduction relative to other Tuscon residents. Marks et al. (2006c) summarised a water management plan that include the compulsory use of rainwater tanks combined with other supply options such as stormwater and reusing sewage effluent that can allow for the population of the town of Meadows in South Australia to grow from 800 to 2400. While there is less controversy surrounding water supplies designated for non-potable purposes (Marks et al., 2006a), more studies are required to understand what drives people to actively participate in non-potable recycling options.

Household supply initiatives can protect residential gardens in times of drought and severe water restrictions. Syme et al. (2001) conclude that home gardens are a major contributor to quality of life, provide both active and passive recreation and a personal food source. A number of psychological benefits have been noted including provision of an individually created aesthetic, an important social statement and connecting people with nature (Browne et al., 2007; Clayton, 2007; Head and Muir, 2006). As Randolph and Troy (2008) note, many residents are attracted to the suburbs by a verdant environment in which houses are set amongst trees, shrubs, flowers and vegetable beds; an environment enabled by assured water supplies during long dry summers. The biophilia hypothesis claims this to be the result of evolution, where people are deeply attracted to living in garden environments (Kellert and Wilson, 1995). While such claims appear speculative, there is little doubt that many western cultures place a particularly high value on "green" gardens. Assured water supplies are needed if communities such as Canberra and Melbourne are to maintain their garden capital status with the associated psychological and cultural benefits that entails.

Clearly there are a variety of potential motives for households to create alternative sources of water. In this paper we report results for socio-economic and psychological variables aiming to predict (i) whether an individual recycles household greywater on their garden/lawns or (ii) whether an individual collects rainwater for their garden/lawns. In "Predictors of water consumption behaviour" we propose a relationship between these behaviours and the role of psychological perceptions. "Method" describes the approach taken for the case study design and implementation. "Results" reports the statistical analysis and results. "Discussion" concludes with a discussion and interpretation outlining implications for policy with some suggestions for future research.

Predictors of water consumption behaviour

The traditional approach used to predict water consumption behaviour assumes that water usage can be explained by individual attributes such as education, income and age. Socio-demographic variables are therefore construed as indicators or proxies for personal capabilities (Stern, 2000). For example, a high income may increase the likelihood of installing a rainwater tank due to ease of funding the investment and lack of concern over the financial return. In a meta-analysis, Hines et al. (1987) suggest that pro-environmental behaviours are more likely to be performed by younger females who are well-educated and from a wealthy nuclear family. Yet the extent to which such findings can be transferred is questionable. For example, no published results specifically analyse the relationship between socio-economic variables and whether or not residents irrigate their garden with tank water and/or household greywater. Whether socio-economic variables (such as income, gender, age or education) increase or decrease the likelihood of households using alternative water supplies remains unclear. For example, an educated household may use greywater for the garden because they know how to reuse water safely, while an uneducated household may use greywater supplies because they are unaware of any risks associated with such behaviour. Empirical studies are required to understand the profile of households who are currently using alternative water supplies.

A number of studies have investigated the socio-economic profile of general household water usage. Gregory and Di Leo (2003) measured water consumption for a year in Shoalhaven, New South Wales, and found, contrary to their expectations, that the households proactively using less water had lower income and educational levels and were older. They note that many residents were raised in an era when awareness and conservation of dam or tank water was a part of everyday life. Porter et al. (2005) report that younger people are more likely to rate a water conservation proposal positively, while no significant differences were found across education categories. Po et al. (2003) cite a 2003 study by McKay and Hurlimann predicting the greatest opposition to water reuse schemes from people aged 50 years and over, but also noted that a 2002 study conducted by Jeffrey found no significant variation across gender, age or socio-economic groups. In a summary of ten empirical studies, Dolničar and Saunders (2005) conclude acceptance of recycled water is correlated with a high level of education, followed by being in the younger age category, while income and gender appeared significant in only one third of the studies. Thus, generalising about the influence of socio-economic variables is mitigated by the specific context with respect to costs and benefits, and population characteristics.

A comparison of psychological perceptions, unlike socio-economic variables, cannot be assumed indicative of a causal process. While particular perceptions may encourage use of alternative water supplies, regularly performing such behaviours can also alter an individual's perceptions. Rather than trying to ascertain whether perception causes the behaviour, or the behaviour causes perceptions, this study simply compares perceptual differences between households engaging in supply diversification compared to those not doing so. Three psychological variables are then addressed: (i) general concerns about water reuse, (ii) perceived appropriateness of collecting and reusing water and (iii) perceived understanding of water reuse options.

General concerns about water collection and water reuse include various economic, health and environmental issues (Bruvold, 1988; Dillon, 2000; Higgins et al., 2002; Marks et al., 2006b). Household greywater may contain disease causing organisms or pollute garden soils with fats, oils, detergents, soaps, salt, nutrients, food and hair derived from household and personal cleaning activities. The quality of greywater depends upon the water activities performed inside the house (Eriksson et al., 2002; Jefferson et al., 1999). Some chemicals and salts in greywater are capable of causing serious long-term soil damage. Soils and plants are able to process many such contaminates only within certain bounds and improper use can lead to local environmental damage. Official government assessments regard the risk of transmission of disease through the use of domestic greywater on lawns and gardens as being low—subject to precautions such as not storing the water for more than 24 h (ACT Government, 2007; EPA Victoria, 2008; NSW Government, 2007). Stored rainwater can contain specific pathogens (Brodribb et al., 1995; Crabtree et al., 1996) or breed mosquitoes. Roof catchment systems which are poorly maintained allow a build-up of leaf litter in the tank which can acidify the stored water. Many of the concerns surrounding water from rainwater tanks are avoided by appropriate practice and design. Marks et al. (2008) concluded that rainwater is probably seen as a clean and pure water source that is not perceived as being risky or reliant upon expertise for safe usage. This belief is backed up by Australian studies that have found rainwater tanks to provide an acceptable quality for outdoor water usage (Coombes et al., 2000, 2003).

Risk perception can play an important role in public acceptance of water projects. Large scale potable water projects have been rejected on the basis of public risk perception. For example, a "toilet to tap" campaign derailed a proposed water recycling plant in Toowoomba, Queensland (Stenekes et al., 2006). As there are generally high levels of community support for non-potable projects (Marks, 2004), the relationship between risk perception and non-potable water reuse is unclear. Research suggests greater acceptance of risks if they are perceived as familiar, voluntary and of negligible catastrophic potential (Renn et al., 1992; Smithson, 1993). Many large scale projects violate these conditions and many such water reuse schemes recycle water back into the mains supply and are accompanied by concerns over health impacts especially on children. Small scale household projects may avoid these problems, being familiar and controllable, even though in some cases the actual risks of using grey or tank water are higher. Studies have found that the 'use history' of water affects the concerns that people have about recycling (Jeffrey, 2002; Nancarrow et al., 2002). Grey or treated waste water from one's own household tends to be more acceptable than that from others or secondary sources. When recycling water from the house people can control which water sources are reused (e.g. laundry or shower water) and the location where the greywater is used (e.g. in the garden for lawn, flowers or vegetables). Rainwater harvesting from one's own roof has been found to outrank greywater reuse in terms of acceptability, which in turn outranks treated wastewater (Marks et al., 2008; Nancarrow et al., 2002). The current study assesses whether household residents who are currently irrigating their garden with household greywater and/or tank water have fewer concerns about the collection and reuse of water.

The second psychological issue is the perceived appropriateness of water collection and recycling. People generally support water options that promote water conservation, provide environmental protection benefits, protect human health and cost-effectively treat and distribute water to those with a need (Bruvold, 1988; Hartley, 2006). There is a conceptual difference between being concerned about water options and assessing a given option as being appropriate. An individual may be concerned about an impact but, given the current situation in Australia, judge such schemes to be appropriate because of a pressing need to increase water supplies. Previous studies have concluded that many household residents find greywater an appropriate water source for the garden, while regarding use of recycled water as inappropriate for other activities. Marks et al. (2006b, 2008) reported that over 90% of people felt greywater should be used on the garden. Po et al. (2003) summarised eight studies and found only 6% of respondents viewed recycled water inappropriate for the garden, while a majority were against water reuse inside the home. They note the proportion of people actually using greywater on the garden is much smaller than those approving of such use. We investigate whether people who currently water their garden with grey or tank water are more likely to perceive other water collection and recycling options as appropriate.

The third psychological aspect is the individual's self reported knowledge. At the heart of government policymaking is the notion that increasing objective knowledge of an issue will alter behaviour for the better (Hartley, 2006). A qualitative study by Browne et al. (2007) concluded that education and marketing information influenced water usage. However, a number of limitations of knowledge campaigns are also recognised (Barr, 2003; Syme et al., 2000) which means careful targeting and design are required for successful communication (Reisch et al., 2008). While the focus of marketing and education is to increase actual knowledge, perceived knowledge can also influence behaviour. An individual's actual and perceived knowledge may be unrelated, e.g. see Knight (2005) on agricultural biotechnology options. People are capable of thinking that they know more or less than they do (Alba and Hutchinson, 2000). For example, a relatively uninformed individual may believe they know a lot, while a very educated individual may feel that their knowledge base is inadequate. Selnes and Gronhaug (1986) suggest that objective measures of knowledge should be used when the research objective is related to a consumer's ability to choose the best alternative course of action, while subjective measures of knowledge should be used when the research focuses on a consumer's motivation to conduct choice-related behaviours. An individual who feels that their knowledge about a particular domain is inadequate may hesitate to take action within that domain.

Method

This study examines socio-economic and psychological predictors of alternative water supply use on the garden. We analyse the relationship between greywater and rainwater tank use and the socio-economic variables of age, gender, income and education. The study probes whether people who are currently using alternative water sources on the garden feel that they know more about a range of water supply options. This requires looking at the relationship between perceived knowledge of water options (e.g. greywater reuse in the laundry and shower, reusing treated sewage for irrigating parks, collecting and using stormwater) and the use of greywater and/or tank water on the garden. The relationship between general concerns about water collection and reuse and the use of greywater and/or tank water on the garden are also assessed, along with the relationship between perceived appropriateness of water collection and reuse and the irrigation of domestic gardens with greywater and/or tank water.

The research was part of a social assessment project commissioned by the ACT Government to inform a major water planning program aiming to reduce the demand on the Canberra water supply by 3 Gigalitres per annum (Maheepala, 2008; Schandl et al., 2009). Participants were recruited from the ACT in 2008, during level 3 water restrictions i.e., preventing sprinkler watering of lawns and gardens. Residents could use drippers, buckets and hand-held hoses with a trigger nozzle at specified times only. Participants were recruited via media advertising in local newspapers and on radio. Four community focus groups were run where participants were asked to recruit their friends by word of mouth. Recruited participants were provided with access to an internet website that administered an online survey investigating water recycling options in the ACT. The online survey was completed by 460 participants who were resident in or adjacent to the ACT. The research presented in this paper specifically concentrates on those residing in a detached house ($n = 354$)—rather than apartments, town houses or retirement villages—because of their control over installing rainwater tanks and greywater infrastructure. Table 1 compares the sample demographics with those for the ACT 2006 census. This suggests that the gender and age is representative while income and education are higher than the average ACT citizen. Recruitment methods may have caused a self-selection bias, although being a resident in a detached house also implies a higher income and education.

The internet webpage stated that the purpose of the study was to "explore options such as stormwater collection, wastewater recycling and groundwater storage and retrieval to supplement Canberra's water supply". The survey was stated to be "part of the social assessment of water management options, and complements other research conducted by CSIRO on physical and economic aspects of water management". Participants were then directed through eight web-pages.

The three psychological aspects were probed as follows. First, participants were asked "How concerned are you about the following aspects of water collection and water recycling?" and were then asked to assess (i) water quality; (ii) injury risk; (iii) odours; (iv) aesthetic impact; (v) economic viability; (vi) mosquitoes. Responses were on a three-point scale (1 = not concerned; 2 = somewhat concerned; 3 = very concerned). Second, participants were presented with six options and were asked "Do you agree that the following are appropriate forms of water collection and recycling in Canberra?". The items they assessed were (i) roof water harvesting; (ii) recycling household water; (iii) collecting and using stormwater; (iv) wetlands projects; (v) reusing treated sewage for irrigating parks; (vi) ground water recharge. These items were answered on a five-point response scale (1 = strongly agree; 2 = agree; 3 = undecided; 4 = disagree; 5 = strongly disagree) and participants were also given the option of "don't know". Third, participants were asked "How well do you understand the following water collection and recycling approaches?" and then asked to assess the same set of six options. Participants answered on a five-point scale (1 = very high understanding; 2 = high understanding; 3 = moderate understanding; 4 = low understanding; 5 = very low understanding).

Table 1
Demographic for survey and ACT based on 2006 census.

Survey demographics	ACT demographics
Gender	
52% Female	51% Female
48% Male	49% Male
Age	
71% < 55 years	75% < 55 years
29% ⩾ 55 years	25% ⩾ 55 years
Education	
51% no post-grad degree	88% no post-grad degree
49% post-grad degree	12% post-grad degree
Income	
Personal Income	Median household income
54.8% < $75,000	
45.2 ⩾ $75,000	$78,463

Results

Exploratory analysis of psychological scales was undertaken for each of the three psychological questions. A principal axis factor analysis was run to assess the response patterns to the six items assessing concern about water collection and water recycling. A one-factor solution explained 45.20% of the variance, suggesting that all of the items had a similar response pattern. The general public assessment of different concerns (e.g., water quality, economic viability, mosquitoes and aesthetics) may be based upon a general underlying concern rather than participants assessing each separate concern in isolation. The many unknowns associated with water reuse may increase the likelihood that people express a general concern rather than being able to isolate their specific concerns. Many of the concerns that participants were asked to assess are also related, and the general population may be aware of this. Poor water quality can lead to odours, unacceptable aesthetics, breed mosquitoes and reduce economic viability. Forty-four participants answered "not applicable" to one of the "concern" items, with 27 participants choosing this response for the "injury risk" item. Due to a poor response rate on this item, a decision was made to drop the injury risk item from the scale. The remaining five items were combined into a "concern" scale which reported a Cronbach's α of .78.

All the items assessing the appropriateness of water collection and recycling had a high response rate except ground water recharge, which had 58 participants select the "don't know" option. This suggests that many participants were not confident in their ability to assess groundwater recharge, although they were able to assess the other options. The groundwater recharge item was dropped from further analyses. A principal axis factor analysis was run to assess the response patterns to the five remaining items. This found a one-factor solution which explained 41.39% of the variance, suggesting that participants tend to demonstrate a similar response pattern to all five items. This indicates that there may be a general assessment of the appropriateness of water collection and recycling that underlies judgements concerning the appropriateness of specific options. If a participant assessed one of the water options as being appropriate, they were likely to assess all the options as being appropriate. For subsequent analyses the five items were combined into a scale. In order to do this all the items were reverse scored, so that a high score represents a high assessment of the appropriateness of water reuse. The "appropriateness" scale was found to be reliable, reporting a Cronbach's α of .77.

A principal axis factor analysis assessed the response patterns to the 6 items on understanding of water collection and recycling approaches. Once again a one-factor solution was found, this time explaining 56.76% of the variance. This suggests that an individual who believes they are knowledgeable about one water option has a tendency to believe they are knowledgeable about all the options. While there are some major differences between water options, many of the principles of how to use water wisely are the same.

For example, there are strong similarities between collecting stormwater and roof water harvesting, as both are harnessing rainwater. For subsequent analyses a scale was created without the groundwater recharge items, because the "appropriateness" scale (as discussed above) dropped this item. The remaining five items were reversed scored so that a high score represents a high level of understanding. This scale demonstrated excellent reliability, reporting a Cronbach's α of .87.

Next we analyse the relationship between socio-economic and psychological variables and propensity for participants to collect and use rainwater or greywater for their garden. Participants were asked whether they "collect and use rainwater for gardens/lawns" (155 indicated yes; 199 indicated no) and whether they "recycle greywater for gardens/lawns" (233 indicated yes; 121 indicated no). Table 2 shows the correlations between socio-economic and psychological variables. As expected a higher level of education was associated with having a higher income. Higher income groups also had a poor assessment of the appropriateness of various water collection and recycling schemes. Females were more likely to perceive water collection and recycling schemes as appropriate, but were less likely to feel that they understood these schemes. Consistent with the literature, younger respondents were more likely to assess various water schemes as being appropriate and were also less likely to be generally concerned about water collection and reuse.

The final analyses investigate the relationship between socio-economic/psychological variables and use of greywater and/or tank water on the garden. The socio-economic and psychological motives were treated separately because: (i) policy based on psychological perceptions often has a different focus and (ii) there is a clearer causal relationship between socio-economic variables and behaviour than psychological variables and behaviour.

Logistic regression analyses assessed the influence of socio-economic variables on whether (i) rainwater is collected and used for gardens; and (ii) greywater is recycled on the garden. The socio-economic variables employed were income, education, gender and age. Table 3 defines each of these variables for the logistic regression and displays the number of responses in each category. Table 4 displays the logistic regression assessing the relationship between socio-economic indicators and tendency to collect rainwater. This model was not found to be significant $X^2(4) = 5.14$, $p > .05$. Furthermore, none of the socio-economic indicators were found to have a significant relationship with tendency to collect and use rainwater on the garden. Table 4 also displays the logistic regression assessing the relationship between tendency to recycle greywater and socio-economic indicators. This model was found to be significant $X^2(4) = 23.18$, $p < .05$. A significant relationship was found between gender and tendency to recycle greywater, with females being more than twice as likely to recycle. A significant relationship was found between income and tendency to recycle with higher income participants being almost half as likely to recycle as lower income participants.

A logistic regression analyses was employed to assess the relationship between water reuse on the garden and the three psychological factors: (i) concern about water collection and recycling; (ii) perceived appropriateness of water option and (iii) perceived knowledge of water options. Table 5 describes the descriptive sta-

Table 4
Logistic regression for rainwater and greywater.

	B	SE B	e^B
Rainwater			
Constant	−.17	.23	.85
Income	−.26	.23	.78
Education	−.18	.23	.84
Gender	.33	.25	1.39
Age	−.14	.25	.87
Number of obs = 337			
Nagelkerke R^2 = .02			
Greywater			
Constant	.56*	.24	1.75
Income	−.64*	.25	.53
Education	.15	.25	1.16
Gender	.83**	.24	2.29
Age	−.33	.26	1.75
Number of obs = 337			
Nagelkerke R^2 = .09			

* Significant at the .05 level (2-tailed).
** Significant at the .01 level (2-tailed).

Table 5
Summary statistics for psychological variables.

	N	Mean	Standard deviation	Min	Max
Appropriateness	335	4.48	.62	1	5
Concern	354	1.99	.53	1	3
Understanding	351	3.81	.75	2	5

Table 2
Correlations for demographic variables and psychological variables.

	Income	Education	Gender	Age	Concern	Appropriateness
Education	.28**					
Gender	−.09	.09				
Age	−.08	−.04	−.10			
Concern	.09	−.03	.02	.09		
Appropriateness	−.11*	−.07	.11*	−.21**	−.18**	
Understanding	.03	.07	−.17**	.07	−.10	.12*

* Significant at the .05 level (2-tailed).
** Significant at the .01 level (2-tailed).

Table 3
Summary statistics for socio-economic categories.

Variable	Definition	Number of No responses (coded "0")	Number of Yes responses (coded "1")
Income	Greater or equal to $75,000	187	154
Education	Post-graduate level	181	173
Gender	Female	169	183
Age	55 years or older	250	101

Table 6
Logistic regression for rainwater and greywater.

	B	SE B	e^B
Rainwater			
Constant	−3.48**	1.18	
Appropriateness	.23	.19	1.25
Concern	−.13	.22	.88
Understanding	.65**	.16	1.91
Number of obs = 333			
Nagelkerke R^2 = .08			
Greywater			
Constant	−4.09	1.28	
Appropriateness	.86**	.21	2.36
Concern	.29	.24	1.33
Understanding	.10	.17	1.10
Number of obs = 333			
Nagelkerke R^2 = .08			

* Significant at the .05 level (2-tailed).
** Significant at the .01 level (2-tailed).

tistics for the three scales used in this analysis. Table 6 displays the results of the logistic regression predicting tendency to collect and use rainwater on the garden from the psychological scales. This model was found to be significant, $X^2(3) = 20.98$, $p < .01$. The only significant predictor of tendency to collect and use rainwater was perceived understanding, with each additional score on the perceived understanding scale resulting in a 91% chance of collecting and using rainwater. Table 6 also displays the results of the logistic regression predicting tendency to recycle greywater on the garden. This model was found to be significant, $X^2(3) = 19.81$, $p < .01$. The only significant predictor of tendency to recycle greywater was perceived appropriateness, with each additional score on the perceived appropriateness scale more than doubling the chance that an individual recycles greywater.

Discussion

Our analysis found that participants do not consider any aspect of the possible future water supply systems in isolation, but took a more holistic approach. The results of a principal axis factor analysis provided support to the notion that participants assess water options with a holistic approach, as respondent's demonstrated consistency when expressing (i) their concerns about water recycling and reuse options, (ii) their assessment of the appropriateness of water options and (iii) their perceived knowledge of various water options. The exception was assessments of groundwater recharge, where a large portion of respondents indicated that they did not know how to assess the appropriateness of groundwater recharge.

Results show the predictors of tank water use to be different from those for greywater use. The four socio-economic indicators failed to differentiate participants who were using tank water to irrigate their garden from those who were not. Other socio-economic variables (e.g., property size, roof size and garden type) might have proven more successful. The influence of the four socio-economic indicators used in the current study on the use of rainwater tanks may have been reduced by the fact that many of Canberra's houses were built at a time when installing rainwater tanks was illegal, while other residents may have inherited a rainwater tank from previous owners. Although Marks et al. (2008) concluded that rainwater tanks rely little on expertise to be made entirely safe, residents who used tank water on the garden were found to believe that they have a greater understanding of a range of water options. Residents may purchase a rainwater tank because they believe they are simple to use, and then develop confidence in their knowledge of water recycling and reuse concepts after operating the rainwater tank. An alternative explanation is that residents may purchase a rainwater tank because they believed they have a higher understanding of supply-side options. The perceived appropriateness of various water reuse options was not found to be related to water tank usage. A possible reason for this is that water collected in tanks is often perceived as being higher quality than greywater, stormwater and sewage water, so residents may be less concerned about the quality of tank water.

Female participants and lower income residents were found to be more likely to use greywater on their garden. This may be explained by gender roles in the house where females may be more likely to be the original users of water in the laundry and kitchen. Lower income residents may resort to using greywater because they cannot afford other water saving options or they may be more conscious of wastage and the social need for extra water sources. Psychological indicators showed those who irrigated the garden with greywater were more likely to judge various water collection and recycling proposals as appropriate. Many residents may be reusing household greywater because they are aware that water reuse is appropriate for a range of alternative water options such as wetlands, parks and the garden at home. Conversely, having experience irrigating the garden with greywater may lead many residents to a positive assessment of other alternative water supply options. That perceived knowledge has no influence on greywater usage may be because collecting greywater in a bucket or using a hose to siphon water outside is technically quiet simply. Installing and operating a rainwater tank is technically more difficult than siphoning water from the laundry or taking used household water outside in a bucket. The relevance of perceived knowledge might therefore be higher for those operating more complicated greywater systems.

Citizen concerns have the potential to undermine large scale projects. Concerns about water collection and reuse, however, were not found to predict tank water use or greywater use for household residents. People may be less concerned about water quality, odours and aesthetics because they have direct control over how this water is used. Importantly, households can choose not to drink greywater or tank water. The use of household water and rainwater is voluntary and people are often familiar with the use history of these water sources. While concerns may still be expressed about water collection and reuse, such concerns may not influence behaviour when the household resident has personal control over water use.

The static comparison of variables associated with the use of alternative water supply sources on the garden is able to differentiate the socio-economic profile and perceptions of household residents who are performing particular behaviours. We cannot distinguish whether people adopt an alternative strategy because they have a certain psychological outlook or whether once a strategy is adopted the psychological outlook changes. A longitudinal study could address the question of whether perceptions influence behaviour or behaviour influences perceptions and the effectiveness of interventions such as rebates, marketing or water restrictions.

The dependent variable for the current study asked whether participants use household greywater on the garden. There is, however, great variety in the sophistication of greywater options. Some participants may simply collect greywater in a bucket, others residents could have connected a pipe from the washing machine to outside, while a small minority might have installed a technologically advance purifying device. Future studies could be more specific about what type of greywater is used and how it is transported to the garden.

Policy can be advanced by understanding the demographics and psychological perceptions of household residents who are using alternative water strategies. Conserving water resources is a high priority for Australian communities and small scale voluntary strategies have the potential to offer an alternative solution to large scale public projects. If household use of untreated greywater requires management (e.g. preventing build-up of salts) then having a profile of the type of people who are using such schemes will aid in changing their behaviour. Demand side management and small scale voluntary water supply options should be seriously researched to develop a combination of strategies. This study indicates how research might proceed and offers some initial results addressing the psychological and socio-economic drivers behind domestic water use behaviour.

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