water

MDPI

Article

Willingness to Pay for Rainwater Tank Features: A Post-Drought Analysis of Sydney Water Users

Sorada Tapsuwan [1,2,*], Stephen Cook [3] and Magnus Moglia [3]

1 CSIRO Land & Water, GPO Box 1700, Canberra, ACT 2601, Australia
2 School of Agriculture and Environment, University of Western Australia, M089, Perth, WA 6009, Australia
3 CSIRO Land & Water, Ian Wark Building (B203), Clayton South, VIC 3169, Australia; stephen.cook@csiro.au (S.C.); magnus.moglia@csiro.au (M.M.)
* Correspondence: sorada.tapsuwan@csiro.au

Received: 1 August 2018; Accepted: 5 September 2018; Published: 6 September 2018

Abstract: The Millennium Drought across Australia during the 2000s placed cities under pressure in providing urban water security. In Sydney, Australia's largest city, a comprehensive water demand programme triggered a significant reduction in per capita water consumption. The water demand programme included incentives for the installation of rainwater tanks. This paper explores the willingness to pay (WTP) for rainwater tank features in the post-drought context. Rainwater tanks have been demonstrated as an effective measure to reduce mains water demand, but they also provide broader environmental and economic benefits, such as the reduction of urban runoff to waterways and deferred capital investment in augmenting capacity of water supply system. Therefore, there is the need to better understand WTP for rainwater tank features across the community. An online survey was administered to a sample of Sydney households, with 127 respondents completing a rainwater tank choice experiment that explored their WTP for different rainwater tank features and the socio-psychological constructs that might influence their tendency to adopt rainwater tanks. The results demonstrated that householders surveyed valued slimline rainwater tanks, as they are likely to be less obstructive, particularly given the trend for smaller lot sizes and increased building size. Householders also placed greater value on connecting the rainwater tank to outdoor demands, which may be influenced by perceived vulnerability of outdoor uses to water restrictions relative to indoor uses. The survey analysis also identified that the householders most receptive to installing a rainwater tank are likely to be conformists, who compare themselves to peers, and spend significant effort when making decisions, and are already taking actions to conserve water. The findings are of significance when targeting future education programmes and designing financial incentives to encourage rainwater tank adoption.

Keywords: choice experiment; water conservation; drought; residential; rainwater harvesting

1. Introduction

Pressure on urban water supply during the Millennium Drought triggered a significant reduction in residential water demand in Sydney through the implementation of a comprehensive water conservation programme. In the early 2000s, per capita water demand was around 425 L per day. However, by 2008 the per capita daily water demand in Sydney had fallen to around 300 L. Since the Millennium Drought ceased around 2010, per capita consumption has not returned to pre-Millennium Drought levels. This reduction in residential water demand was the combined result from a range of programmes that included: rebates for installation of more efficient water fittings and appliances, rebates for the installation of rainwater tanks in existing homes, building sustainability assessment that encouraged adoption of rainwater tanks and efficient appliances in new homes, customer awareness and education programmes, and improved water efficiency standards and labelling for new appliances.

Currently Sydney's per capita water demand is markedly lower when compared to demand during early 2000s. However, in comparison to other Australian cities, Sydney has the second highest per capita consumption, with only Perth using more water per person (see Figure 1). Looking at other parts of the world, per capita consumption ranges from 28 to 631 L per capita per day [1], hence, there is potential for Sydney residents to achieve a lower per capita water use target. We take note that extremely low per capita water consumption values are not realistic for Sydney given climate and economic differences.

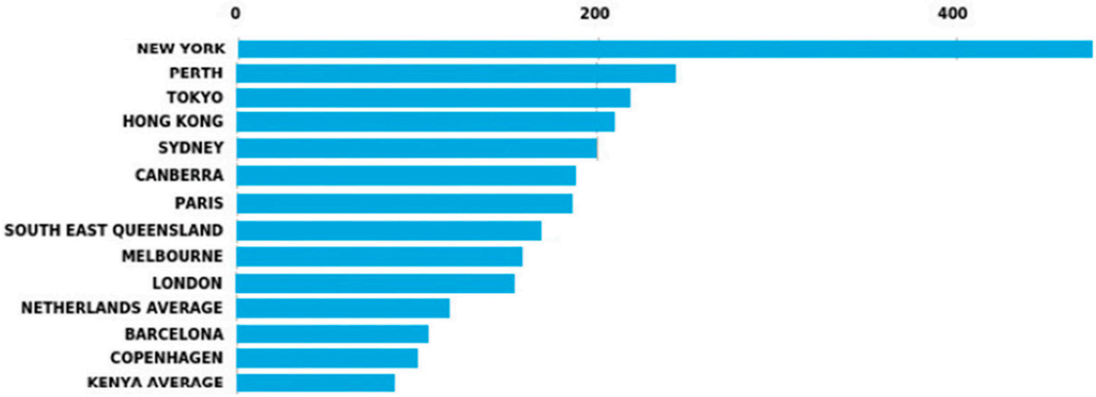

Figure 1. Water consumption (litres/capita/day) in 2014 of selected locations in the world [1].

Water conservation is an important way by which cities can improve water supply resilience, improve resource efficiency, delay infrastructure investment and thus reduce cost of service delivery, and sometimes help improve environmental water flows. Water conservation can take many forms. Inman and Jeffrey [2] stated that campaigns to reduce water use usually involve a coordinated use of five types of demand management tools: technological, financial, legislative, operation and maintenance, and educational. Household adoption of water conservation technology is one of many demand-side management measures that water utilities could potentially promote to reduce household water use.

Water savings from rainwater tanks could be substantial. Rahman et al. [3] found that the average annual water savings from rainwater tanks are strongly correlated with average annual rainfall. Due to the rainfall pattern throughout the year, a rainwater tank in Sydney is more likely to be empty during July to September, and more likely to be full during January to March [3]. Hence, most of the water savings would occur during the summer months. In any case, Rahman et al. [3] estimated that if a 5000 L tank is connected to the toilet and laundry, households could potential save on average 32.8–34.7 kilolitres of water per year. If the tank is connected only for outdoor irrigation, then the potential water savings could be between 43–57 kilolitres per year. Assuming an average per capita consumption of 155 kilolitres per year (based on early 2000 per capita Sydney water consumption of 425 L per day), water savings from rainwater tanks could be between 21–37%.

In comparison to other water technologies, rainwater tank has significant potential to reduce water demand. Table 1 provides a review of the literature on water conservation technologies, and how much water each technology can save. Burns et al. [4] posited that rainwater tanks' effectiveness in saving water is between 10% and 100%, while the maximum effectiveness that other water technologies can achieve is 25%—from installing revenue-neutral meters (European Environment Agency, 2001).

The effectiveness of rainwater tanks at water conservation can be translated into significant cost savings to tank owners. Subsequently, Rahman et al. [3] estimated the cost benefit of rainwater tank sizes 2000, 3000 and 5000 L, specifically for Sydney households. They concluded that rainwater tanks should be connected to toilet, laundry and outdoor irrigation to achieve the best financial outcome for the home owners. However, they also concluded that the benefit cost ratio for the rainwater tanks is smaller than 1.00 without government rebate, hence, policy makers in Sydney should maintain or possibly increase the rebate for rainwater tanks to enhance its acceptance. Similar suggestions around rebates for rainwater tanks were echoed by Tapsuwan et al. [5], although with evidence from South East Queensland, rather than Sydney. Tapsuwan and colleagues conducted a choice experiment (CE) survey to ascertain how much SEQ households were willing to pay for a rainwater tank. Their willingness to pay (WTP) estimation, from surveying 590 households, was between $800 and $7400 for a rainwater tank sizes between 5000 and 25,000 L. Comparing their WTP estimation to current market price at the time, Tapsuwan and colleagues concluded that WTP was substantially lower than market price, and subsidies would be required to encourage adoption.

Table 1. Effectiveness of water conservation technology.

Programme/Activity	Source	Effectiveness	Time Period	Location
Rainwater harvesting	Campisano et al. [6]	8% system-wide reduction in potable use; with 34% adoption rate among feasible households	2013–2014	Australian cities
Rainwater harvesting	Burns et al. [4]	10–100%	2010–2012	Melbourne, Australia
Rainwater harvesting	Moglia et al. [7]	6–45%	2013–2014	Melbourne, Australia
Revenue-neutral metering	European Environment Agency [8]	25%	1997	Seville, Spain
Smart metering	Petersen et al. [9]	3%	2005–2006	Ohio, US
Metering coupled with pricing	Inman and Jeffrey [2]	14%	1993–1999	UK
	Inman and Jeffrey [2]	8.9–18% reduction in residential water demand	1997–1998	California, US
Smart metering	Liu et al. [10]	8%	2013–2014	Sydney, Australia
Smart metering	Doolan [11]	7–10%	2010–2011	Sydney, Australia
Retrofitted water efficient appliances		9–12% reduction in residential water consumption	1984–2004	Multiple studies from US
Low-flow showerheads	Olmstead and Stavins [12]	9%	1998	United States
Water efficient appliances and rainwater harvesting combined	Muthukumaran et al. [13]	77%	2006–2007	Melbourne, Australia
Water efficient appliance retrofit programme	Turner et al. [14]	8–12%	2000–2002	Sydney, Australia
More water efficient toilets	Mayer et al. [15]; Mayer et al. [16]; Mayer et al. [17]	10–17%	1999–2004	Seattle, San Francisco, Tampa Bay
Fixing leaks	Mayer et al. [15]; Mayer et al. [16]; Mayer et al. [17]	7–20%	1999–2004	Seattle, San Francisco, Tampa Bay

Certain behavioural aspects may explain why the effectiveness of rainwater tanks are not fully realised and translated into significant cost savings. The rebound effect [18]—where people end up using more water as a direct effect of installing water conservation technology—may be one of the explanations. As a consequence of new technology adoption, in this particular case, water meters in California, Maddaus [19], as cited in Inman and Jeffrey [2], found that that in the first year of installation, metering led to an 18.9% reduction in residential water demand between 1997 and 1998, but only an 8.7% reduction between 1997 and 1999 indicating that water demand rebounded after the initial impact of metering. Another possible explanation is lack of rainwater tank system maintenance, which has been shown to influence performance [20]. Moglia et al. [21] reported that Brisbane residents are not sure how to maintain their rainwater tanks, and there is typically no mechanism in place for making sure that the household rainwater collection systems are maintained and in a good condition, as evidenced through surveys (see e.g., [20,22,23]).

There are also attitudinal variables that come into play, whether people are aware of it or not, when making a rainwater tank purchasing decision. Perception of how severe the next drought is going to be, and how concerned people are about how water shortages could affect their well-being has been found to have an effect on WTP (see e.g., [5]) and the acceptance and adoption of rainwater tanks (see e.g., [24,25]). Social normative influences also play an important role, as people who want to conform with others are more likely to 'do the right thing' and conserve more water (see e.g., [26–28]). The level of difficulty in making an informed choice influences the strategies for making a choice, either by delaying a choice, by simplifying choice and use heuristics, Broniarczyk and Griffin [29] or even by people having a greater preference for options that are easier to analyse [30]. Furthermore, the now well-established theory of social comparison [31] states that, depending on personality, people to a lesser or greater degree compare themselves against others on an ongoing basis, for a number of reasons such as seeking social status or to seek self enhancement by being competitive [32]. All these factors can be explored using various instruments and survey questions (see e.g., [33,34]).

Given the recent changes in rainfall patterns since the end of the Millennium Drought, to what extent are water customers still prepared to pay for a rainwater tank? The objective of this WTP study is to ascertain how much Sydney Water Customers are willing to pay for various attributes of a rainwater tank, particular in the post-Millennium Drought context. Findings from this study can shed light on the perceived benefits residents place on rainwater tanks as measures to help conserve water and become more resilient to the drought in the future. This can be used to design future water demand management programmes that ensure interventions (e.g., advertising, financial incentives, etc.) are structured to encourage adoption, given that the threat of the drought is no longer salient in people's minds.

2. Method

The study applies the CE method. The CE method is a type of stated preference method using a survey instrument to ascertain how much people are willing to pay for attributes of a good. In this case, the good of interest is a rainwater tank. Empirical literature in the environment and health domains have provided evidence that CE surveys show external validity, in other words, results can be generalised to other populations, settings and circumstances (see e.g., [35,36]).

In a CE survey, goods are described in terms of their attributes, and the attributes have varying levels. In the case of WTP for interventions that may help customers reduce their water demand, CE allowed for a flexible approach to structuring the evaluation of a rainwater tank that included a range of attributes with different levels. Table 2 presents a list of attributes and levels of the rainwater tank CE survey.

Table 2. List of attributes and levels.

Attributes	Levels
Storage volume (litres)	2000 5000 10,000
Tank material	Corrugated galvanized steel Polyethylene (plastic) Fibreglass
Tank use	Outdoor only Toilet only Washing machine only Toilet and washing machine
Tank design	Round Slimline
Cost (purchase and installation)	$1000 $1500 $2000 $2500

There, a 'stated preference' method was deemed most appropriate to ascertain these WTP levels.

2.1. Utility Function

The utility (i.e., benefit) from choosing a particular option (here comprising a bundle of AWM programme attributes and a cost) is determined by the characteristics of the attributes and individual or farm specific characteristics. The assumed functional forms for the utility (V_{ij}) for individual i of option j is specified as:

$$V_{ij} = \beta_{sq}(\mathrm{SQ}) + \beta_T(\mathrm{Tank}_j) + \beta_P(\mathrm{Price}_j) + \beta_A(AttBeh_i) + \beta_W(\mathrm{WCI}_i) + \beta_S(SocEcon_i) \quad (1)$$

where: SQ is the status quo dummy variable (SQ = 1 for the opt-out option, and SQ = 0 for Options I and II)

Tank_j is a vector of attributes of a rainwater tank in option j
Price_j is the cost of purchase and installation of a rainwater tank (in $)
$AttBeh_i$ is a vector of attitudinal and behavioural variables of individual i
WCI_i is the water conservation index of individual i
$SocEcon_i$ is the socio-economic characteristics of individual i
β_{sq} is the coefficient of the SQ dummy variable
$\beta_T, \beta_A, \beta_W, \beta_S$ are the vectors of parameters, and
β_P is the coefficient on the price variable.

It is hypothesised that WTP will increase as tank size increases. We also expect that people are willing to pay more for a slimline tank and a tank that is made from plastic and fibreglass. It is difficult to anticipate how demographics and household characteristics will have an effect on WTP, except for income where theoretically WTP should be positively correlated with income. It is anticipated that respondents with high WCI_i score are more willing to pay for rainwater tanks. Respondents with strong feelings to conform and compare themselves with others are also expected to be willing to pay more; likewise for participants who believe that the threat of the next drought is going to be severe.

2.2. Water Conservation Index

To account for differences in current water conservation behaviour, and how water conservation behaviour could impact WTP for rainwater tanks, we developed a Water Conservation Index (WCI_i)

that for each survey respondent indicated their level of water conservation motivation based on reported behaviour and presence of water saving technologies. The WCI follows a similar approach to Berk et al. [37] who developed a water conservation index based on the combination of water conservation behaviour reported by households. In this study, we assume that households are currently practicing water conservation activities (e.g., taking shorter showers), or have adopted water conservation technology), as a result of the prolonged experience to water shortages from the Millennium Drought. However, we expect significant heterogeneity among households in terms of how much effort and investment is being put towards water conservation.

The WCI applied to both indoor and outdoor water uses:

$$\text{WCI indoor score for person } i = Y_i = \sum_{j=1}^{N} X_{i,j} \cdot w_j \tag{2}$$

where:

$X_{i,j}$ is a function with value 0 or 1, indicating whether householder i carries out the behaviour j or not; e.g., only uses washing machine when full, mostly uses half flush button, etc.
w_j is the weight that indicates relative importance of behaviour j, where all weights sum to 1

$$\text{WCI outdoor score for person } i = Q_i = \sum_{j=1}^{N} X_{i,j} \cdot O_j \tag{3}$$

where

$X_{i,j}$ is a function with value 0 or 1 depending on whether person i carries out outdoor water conservation behaviour j.
O_j is the weight that indicates relative importance for outdoor water conservation behaviour j, where all weights sum to 1.

The WCI for both indoor and outdoor water use are measured on a scale of 0–100, where 0 is no water conservation behaviour, and 100 is maximum water conservation behaviour. It is hypothesized that WCI is positively correlated with WTP.

2.3. Factor Analysis

To capture the attitudinal and behavioural aspect of individuals ($AttBeh_i$) relating to water conservation behaviour, and adoption of new water technology, we employed psychosocial constructs and statements from the psychology literature. Table 3 presents the attitudinal and behavioural variables that are expected to have an effect on the WTP for rainwater tanks. Statements in Table 3 were presented to respondents, and respondents were asked to respond on a 5-point Likert scale how strongly they agree or disagree with the statements (1 = strongly disagree; 5 = strongly agree).

Table 3. Attitudinal and behavioural variables and associated observed indicators.

Variable/Construct	Statements of Observed Indicators
Conformity	It is expected of me that I should install a rainwater tank on my property.
	It is expected of me that I should install water efficient/saving devices around the home.
	I feel pressured by others (for example, friends, family, neighbours) to install a rainwater tank.
	I feel pressured by others (for example, friends, family, neighbours) to install water efficient/saving devices around the home.
Vulnerability	I am concerned that Sydney will experience water shortages in the future.
	I worry about how water shortages will affect my way of life.
	I worry about how water shortages will affect my water bill.
	I am worried about how water shortages will affect others in my community.
	My friends and family are worried about future water shortages.
	I do not think other people in my community are concerned about future water shortages.
Cognitive	I spend the time required to choose an alternative that is satisfactory for me.
	I spend the time required to choose solutions that meet my needs.
	Whenever I am faced with a choice, I try to imagine what all the other possibilities are, even ones that are not present at the moment.
	I tend to choose solutions that guarantee satisfactory results for me.
Compare	I often compare myself with others with respect to what I have accomplished in life.
	I always pay a lot of attention to how I do things compared with how others do things.
	I always like to know what others in a similar situation would do.
	I am not the type of person who compares often with others.
	I often try to find out what others think who face similar problems as I face.
	I never consider my situation in life relative to that of other people.
	I often compare how I am doing socially (e.g., social skills, popularity) with other people.

To analyse the constructs shown in Table 3, confirmatory factor analysis was used as a data reduction technique to generate a single composite variable for coping behaviour. The current study utilises the method specified in Equation (9) to calculate the composite score for coping behaviour. The composite score is specified as:

$$\widehat{AttBeh}_a = \omega_1 X_{1a} + \omega_2 X_{2a} + \ldots + \omega_n X_{na} \quad (4)$$

where $\widehat{AttBeh}_a$ is the estimated composite score for selected attitudinal and behavioural variables of each individual, ω_n are the factor score regression weights and X_{na} are the observed score for each indicator of each attitudinal and behavioural variable.

2.4. Parameter Estimation

When the data consist of choice-specific attributes instead of individual-specific characteristics, the appropriate model is the conditional logit model, which is specified as

$$\text{Prob}(Y_i) = \exp^{\lambda V_i} \bigg/ \sum_{j=1}^{J} \exp^{\lambda V_j} \quad (5)$$

where V_i is the indirect utility function which represents the utility of the different options specified in (1) and (2) and λ is a scale parameter.

Estimation of the conditional logit model is simplest by Newton's method or the method of scoring. The log-likelihood is

$$\log L = \sum_{i=1}^{n} \sum_{j=1}^{J} d_{ij} \log \text{Prob}(Y_i = j), \qquad \text{where } d_{ij} = 1 \text{ if } Y_i = j \text{ and 0 otherwise.} \tag{6}$$

This approach allowed for an efficient approach getting respondents to evaluate a large number of combinations within the one survey [38]. By including the price (cost) as one of the attributes, WTP for each attribute separately and as a package can be indirectly recovered from the people's choices (see [39] for a more comprehensive explanation). Figure 2 shows example screen shots of the rainwater tank choice cards.

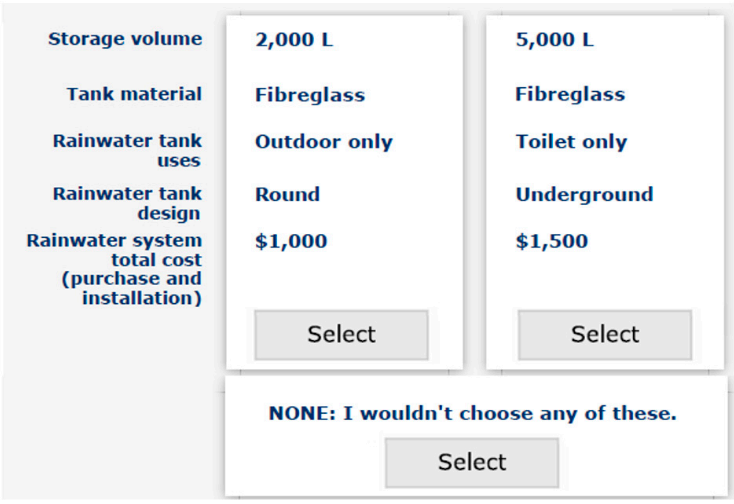

Figure 2. Example of a choice card to ascertain the willingness to pay for features of a rainwater tank.

A variable deletion test (i.e., a stepwise regression with backward elimination) is used to arrive at the final parsimonious model. Highly collinear variables (correlation coefficient > 0.5) were dropped to avoid any multicollinearity issues.

2.5. Willingness to Pay Estimation

The coefficients estimated under the conditional logit model can be used to estimate the part-worth, or the maximum amount the respondent would be willing to pay to achieve a change in an attribute. The presence of the SQ effect in the model means that the amount an individual would be willing to pay for the introduction of a particular innovation is given by:

$$\text{Part} - \text{worth} = -\left(\frac{-\beta_{sq} + \beta_k}{\beta_{pr}}\right) \tag{7}$$

where β_k is a vector of the coefficient of the AWM attributes (i.e., AWM programme components) and SIT variable. A part-worth without the SQ effect is simply an equation where $-\beta_{sq}$ is dropped.

2.6. Survey Design

Respondents were directed to the rainwater tank WTP survey if they stated that they do not currently own a rainwater tank, and were directed to the rest of the survey otherwise (i.e., if they stated that they already own a rainwater tank). To capture preference heterogeneity, the surveys also collected information on various socio-economic variables, household characteristics, water use behaviour, and attitude towards water conservation.

As part of the experiment design to ascertain the level of WTP, a respondent was presented with six choice cards, each containing three options (two rainwater tank option plus an opt-out option). The rainwater tank options varied slightly in terms of the attributes of a rainwater tank across all six choice cards. Respondents were then asked to choose the option they most prefer, or choose neither one of the options presented to them. We utilized the statistical functionality of Lighthouse Studio 9.3.1 (Sawtooth Software [40]) to perform and test our experimental design, to maximize the statistical significance of the parameter estimates from a sample size of around 100 respondents.

2.7. Data Collection

Households were recruited via an online research panel. Participants on the panel who live within the list of postcodes of our study region (i.e., Sydney Water service area) were sent an email from the online research company with an invitation to complete the online survey. In compliance with the CSIRO Research Ethics Guideline, participants were required to provide their consent to take part in the survey by checking the consent box before proceeding further with the survey. A follow-up email reminder was sent out to respondents who did not respond to the first invitation, to ensure that anyone who wished to participate had the chance to do so. Participants who complete the survey have their respondent's ID entered into a draw to win a prize, as an incentive to complete the survey. This research study received ethical clearance from the relevant Human Research Ethics committee (Approval Reference 120/17 Water Conservation Modelling). Informed consent was obtained from the participants prior to the study.

3. Results

The survey was conducted in November 2017. A total of 278 participants completed the survey, approximately 45% of respondents (n = 127) currently do not own a rainwater tank, and were redirected to complete the rainwater tank choice cards. The following results are based on the analysis of the 127 respondents. An actual response rate was difficult to determine via an online survey because there maybe respondents who wanted to complete the survey after it has been closed.

3.1. Descriptive Statistics

Table 4 presents a statistical summary of variables that are significant in the conditional logit model only. Non-significant variables were dropped to maintain a parsimonious model. Hence, a number of demographic variables were dropped, and the only two remaining are income and whether the respondent works full-time or not. Nearly 45% of respondents surveyed work full-time. This is a slightly lower figure than the 2016 census where full-time employment rate for Sydney was 61% [41]. The difference may stem from the fact that our survey excludes people who already own a rainwater tank, which may consistent a large proportion of full-time employees. According the Australian Bureau of Statistics [41], average household income in Sydney is $91,000 a year.

Note that the majority of respondents in the survey have the capacity to own a rainwater tank in that nearly 95% of space on their property for a tank, nearly 80% live in a house rather than a multi-unit dwelling, and almost 82% own their own home. Hence, they have the space to put a rainwater tank and are in the position to make an autonomous decision about installing a rainwater tank.

The WCI for outdoor water use appears to be low, showing an average of around 39 (out of 100). The normalized scores for the four attitudinal and behaviour variables (Cognitive, Compare, Conform, and Threat Vulnerability) are sitting around the average of between 0.43 and 0.66, with a standard deviation of between 0.18 and 0.23. Hence, the normalized score of these constructs are relatively normally distributed as expected.

Table 4. Descriptive statistics.

Variable	Percentage	Mean	STD. DEV.	MIN	MAX
Outdoor willingness to pay (WCI)		38.93	19.43	0	100
Cognitive		0.66	0.18	0	1
Compare		0.51	0.22	0	1
Conform		0.43	0.23	0	1
Threat vulnerability		0.61	0.2	0	1
Has space for tank on property	94.49%				
Own washing machine	96.85%				
Live in a house	79.53%				
Own the home	81.89%				
Work full-time	44.88%				
Income					
Less than $25,000	2.36%				
$25,000–$50,000	20.47%				
$51,000–$85,000	26.77%				
$86,000–$130,000	21.26%				
$131,000–$260,000	23.62%				
More than $260,000	5.51%				

3.2. Conditional Logit Parameters

Regression parameters from the conditional logit analysis of the WTP survey results are presented in Table 5. The likelihood chi-square test statistic is 220.41. The model is statistically significant because the p-value is less than 0.000. The SQ variable is not significantly different from zero, indicating that respondents are somewhat ambivalent about whether they want to buy a rainwater tank or not. A positive SQ coefficient would imply a strong aversion to buying rainwater tanks, and a negative coefficient would imply a strong desire. As expected, the coefficient for tank volume is positive, suggesting that respondents are willing to pay more for a larger tank. On the other hand, respondents appear to be indifferent about tank material, as the coefficients for fibreglass and galvanised tanks are both not significantly different from zero (note that plastic is the baseline). There is a significant WTP for rainwater tanks that are connected for outdoor water use, and toilet + washing machine use, as compared to toilet use only, as indicated by the significant and positive coefficient for these two variables. Lastly, respondents are willing to pay more for slimline tanks than round tanks, as the coefficient of a slimline tank is positive and significantly different from zero.

Table 5. Parameter estimates from the conditional logit analysis of willingness to pay (WTP) for rainwater tanks.

Conditional (fixed-effects) logistic regression; Log likelihood = −726.93588; Number of observations = 127 | LR chi2(20) =220.41; Prob > chi2 = 0.0000; Pseudo R2 = 0.1316

VARIABLES	COEFFICIENT		STANDARD ERROR	95% CONFIDENCE INTERVAL	
Status quo inertia (no inertia < 0)	0.3073		1.1723	−1.9903	2.6049
Rainwater tank attributes					
- Tank volume	7.23×10^{-5}	***	1.56×10^{-5}	4.17×10^{-5}	0.0001
- Tank material—fibreglass	0.1667		0.1302	−0.0885	0.4219
- Tank material—galvanized steel	0.0086		0.1276	−0.2415	0.2587
- Tank use—outdoor only	0.4490	***	0.1527	0.1497	0.7483
- Tank use—washing machine only	0.2201		0.1557	−0.085	0.5252
- Tank use—toilet and washing machine	0.2833	*	0.1543	−0.019	0.5857
- Tank shape—slim line	0.5148	***	0.0993	0.3202	0.7094
Proposed tank price	−0.0007	***	9.79×10^{-5}	−0.0009	−0.0005
Measures of preference heterogeneity					
Space for tank (yes = 1, no = 0)	−0.9499	**	0.3711	−1.6773	−0.2224
Employment (full-time = 1, otherwise = 0)	0.8618	***	0.2251	0.4206	1.3031
Income ($/year)	−0.2177	**	0.0884	−0.3909	−0.0445
Own a home (outright of pay mortgage = 1, otherwise = 0)	0.7549	***	0.2723	0.2211	1.2886
Live in house (yes = 1, no = 0)	−0.9218	***	0.2335	−1.3793	−0.4642
Have washing machine (yes = 1, no = 0)	2.6334	**	1.0576	0.5606	4.7062
Index of outdoor water conservation behaviour (low = 0 to high = 100)	−0.0114	**	0.0052	−0.0216	−0.0011
Spend effort at making decisions (normalized score low = 0 to high = 1)	−2.3993	***	0.7054	−3.782	−1.0167
Likely to conform with others (normalized score low = 0 to high = 1)	−1.4822	**	0.5808	−2.6205	−0.3438
Likely to compare themselves with others (normalized score low = 0 to high = 1)	−1.6217	***	0.5481	−2.6958	−0.5475
Concerned about future drought (normalized score low = 0 to high = 1)	2.1214	***	0.6839	0.781	3.4618

***, **, * Significant at $p < 0.01$, $p < 0.05$, $p < 0.1$, respectively.

3.3. Willingness to Pay

Based on the significant variables in the conditional logit model, we can estimate the average WTP for rainwater tanks and each feature. On average households are willing to pay $2300 for a round polyethylene tank with an average volume 4400 L. Compared with Tapsuwan et al. [5], who reported that the WTP of South East Queensland residents was between $2100 and $5000 for a 5000 litre tank, findings from our analysis appear to fit within this range. Additionally, households are willing to pay an extra 11 cents for every additional litre of tank volume they gain. Households also show a strong preference for a slimline tank over a round tank. On average, they are willing to pay $770 more to obtain a slimline tank over a round tank. There is also a strong WTP to use tank water for outdoor water use rather than for toilet flushing or for washing clothes. Households are somewhat indifferent to the material used to make the tank (i.e., households are indifferent whether the tank is made from fibreglass, galvanized steel or polyethylene). Table 6 provides a summary of the WTP levels on average (and the 95% confidence interval around the average WTP value) for a rainwater tank and its features.

Table 6. Willingness to pay for rainwater tank and its features.

Willingness to Pay	Mean	95% Confidence Interval
For a tank	2361.81 *	(759.36, 3964.25)
For an additional litre (above 4400 L)	0.11 *	(0.06, 0.16)
For a fibreglass tank (as compared to polyethylene)	252.14	(−137.73, 642.01)
For a galvanized tank (as compared to polyethylene)	12.99	(−365.35, 391.34)
For outdoor water use (as compared to toilet use only)	679.24 *	(199.58, 1158.90)
For washing machine use (as compared to toilet use only)	332.99	(−131.34, 797.31)
For washing machine and toilet use (as compared to toilet use only)	428.64	(−33.86, 891.13)
For a slimline tank (as compared to a round tank)	778.78 *	(432.22, 1125.34)

* Statistically different from 0.

4. Discussion

The strong preference demonstrated for slimline rainwater tanks indicates the importance of the aesthetics for homeowners. The preference for less obtrusive slimline tanks may continue to strengthen with the increasing trend for smaller lot sizes with larger homes and increased medium density development (townhouses and units). Meanwhile, the greater WTP for a rainwater tank connected to outdoor uses compared to indoor uses may be related to perceptions that outdoor water uses, such as garden watering, are more sensitive to the impacts of water restrictions. Water restrictions during the Millennium Drought were mostly targeted on outdoor uses as these were seen as more discretionary, with less risk to public health, than limiting supply to indoor uses. People who highly value their garden or washing their car at home might be more willing to pay for a rainwater tank during a drought.

In addition to technological attributes of rainwater tanks, various socio-economic and household characteristic variables (e.g., household size, household water use behaviour) were modelled to test for their correlation with WTP. A number of variables were significant, which suggests a degree of preference heterogeneity among households.

Consistent with economic theory, households with higher income are willing to pay more for a rainwater tank than households with lower income. Respondents who live in a house, state that they have space on their property for a rainwater tank, or are actively conserving outdoor water use are willing to pay more for rainwater tanks than other respondents. Respondents who stated that they have a full-time job are willing to pay less for a rainwater tank. This could be explained by the time involved in maintaining a tank, which those with full-time jobs may have less time to do.

Those who own their own homes (outright or paying a mortgage) are not as enthusiastic about paying for a rainwater tank as compared to those who do not own their home. The latter group (primarily renters) are less likely to pay for the installation, while still reaping the benefits. This may explain why only 30% of homeowners currently own a rainwater tank.

Households with a washing machine are less willing to pay for a rainwater tank than households without one. This is also echoed in the zero WTP for a connection from the rainwater tank for washing machine use. One possible explanation is that households with a washing machine have a more reliable greywater source during a drought for their garden so may be less interested in a rainwater tank. In any case, we suggest further investigation on this matter.

Respondents who have a tendency to compare themselves with others, who like to conform, and who spend effort at making decisions are willing to pay more for a rainwater tank than respondents who rate lower on each of these three attitudinal and behavioural tendencies. However, respondents who are more concerned about water shortages in the future are less likely to pay for rainwater tanks. This could reflect a sense of hopelessness in any effort to conserve water.

5. Conclusions

This paper provides insights from the survey of Sydney Water residents on households that currently do not have a rainwater tank what features they most value, and the household types that would be most receptive to incentives to install a rainwater tank. The results show encouraging evidence for adoption of rainwater tanks among households who currently do not own one. Given insights from this study around preference heterogeneity, specific attention could be given to particular groups of customers for targeting rainwater tank adoption messages. These people have a tendency to compare themselves with others, like to conform, spend effort at making decisions when buying products, and are already actively conserving water outdoor. Space for a rainwater tank is also important.

The potential for significant further reductions in household water demand through more efficient technology may be limited as there has already been widespread adoption during the drought. It is likely that future water conservation efforts will need to be targeted at motivating household behavioural change.

There might need to be more effort expended in raising customer awareness of the benefits of other water saving technologies, such as smart meters, that extend beyond reducing their direct costs associated with water use. Also, to enable initial adoption there might need to be incentives, such as rebates, which allow for early adopters to influence uptake in the broader community as the benefits and risks are normalised. Targeting of future water conservation programmes will ensure the most efficient approach to further reductions in water demand, and improve water security resilience to future drought episodes.

Author Contributions: Conceptualization, S.T., S.C. and M.M.; Methodology, S.T. and S.C.; Survey design, S.C., S.T. and M.M.; Validation, S.C., S.T. and M.M.; Formal Analysis, S.T. and S.C.; S.C., S.T. and M.M.; Resources, S.C. and M.M.; Writing-Original Draft Preparation, S.T., S.C. and M.M.; Writing-Review & Editing, S.T., S.C. and M.M.; Project Administration, M.M.; Funding Acquisition, M.M. and S.C.

Funding: This research is funded by the CRC for Low Carbon Living Ltd. grant number [RP3035], supported by the Cooperative Research Centres programme, an Australian Government initiative. It is also co-funded by CSIRO and Sydney Water Check carefully that the details given are accurate and use the standard spelling of funding agency names at https://search.crossref.org/funding, any errors may affect your future funding.

Acknowledgments: We acknowledge those in CSIRO, and Sydney Water who have contributed to this research. This includes Stephen White and Luke Reedman of CSIRO, and from Sydney Water: Marcia Dawson, Bronwyn Cameron, Jonathan Dixon and Andre Boerema.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. IWA. International Statistics for Water Services. 2016. Available online: http://www.iwa-network.org/wp-content/uploads/2016/10/Water_Statistics_SCREEN.pdf (accessed on 15 July 2018).
2. Inman, D.; Jeffrey, P. A review of residential water conservation tool performance and influences on implementation effectiveness. *Urban Water J.* **2006**, *3*, 127–143. [CrossRef]

3. Rahman, A.; Keane, J.; Imteaz, M.A. Rainwater harvesting in Greater Sydney: Water savings, reliability and economic benefits. *Res. Conserv. Recycl.* **2012**, *61*, 16–21. [CrossRef]
4. Burns, M.J.; Fletcher, T.D.; Duncan, H.P.; Hatt, B.E.; Ladson, A.R.; Walsh, C.J. The performance of rainwater tanks for stormwater retention and water supply at the household scale: An empirical study. *Hydrol. Process.* **2015**, *29*, 152–160. [CrossRef]
5. Tapsuwan, S.; Burton, M.; Mankad, A.; Tucker, D.; Greenhill, M. Adapting to Less Water: Household Willingness to Pay for Decentralised Water Systems in Urban Australia. *Water Res. Manag.* **2014**, *28*, 1111–1125. [CrossRef]
6. Campisano, A.; Butler, D.; Ward, S.; Burns, M.J.; Friedler, E.; DeBusk, K.; Fisher-Jeffes, L.N.; Ghisi, E.; Rahman, A.; Furumai, H.; et al. Urban rainwater harvesting systems: Research, implementation and future perspectives. *Water Res.* **2017**, *115*, 195–209. [CrossRef] [PubMed]
7. Moglia, M.; Tjandraatmadja, G.; Delbridge, N.; Gulizia, E.; Sharma, A.; Butler, R.; Gan, K. *Survey of Savings and Conditions of Rainwater Tanks*; 10TR4-001: Final Report; Smart Water Fund: Melbourne, Australia, 2014.
8. European Environment Agency. *Sustainable Water Use in Europe—Part 2: Demand Management*; Technical Report No. 19; European Environment Agency: Copenhagen, Denmark, 2001.
9. Petersen, J.E.; Shunturov, V.; Janda, K.; Platt, G.; Weinberger, K.; Corfas, R.; Dennis, L.; Derry, R.; Epstein, C.; Grossman, J. Dormitory residents reduce electricity consumption when exposed to real-time visual feedback and incentives. *Int. J. Sustain. High. Educ.* **2007**, *8*, e33. [CrossRef]
10. Liu, A.; Giurco, D.; Mukheibir, P. Urban water conservation through customised water and end-use information. *J. Clean. Prod.* **2016**, *112*, 3164–3175. [CrossRef]
11. Doolan, C. Sydney Water's smart metering residential project: An insight into the benefits, costs and challenges of smart metering. *Water* **2011**, *38*, 77–80.
12. Olmstead, S.M.; Stavins, R.N. *Comparing Price and Non-Price Approaches to Urban Water Conservation*; The Fondazione Eni Enrico Mattei: Milano, Italy, 2008.
13. Muthukumaran, S.; Baskaran, K.; Sexton, N. Quantification of potable water savings by residential water conservation and reuse—A case study. *Res. Conserv. Recycl.* **2011**, *55*, 945–952. [CrossRef]
14. Turner, A.; White, S.; Beatty, K.; Gregory, A. *Results of the Largest Residential Demand Management Program in Australia*; Study Report; Sydney Institute for Sustainable Futures & Sydney Water Corporation: New South Wales, Australia, 2004.
15. Mayer, P.W.; Deoreo, W.B.; Lewis, D.M. *Seattle Home Water Conservation Study: The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes*; USEPA & Seattle Public Utilities: Boulder, CO, USA, 2000.
16. Mayer, P.W.; Deoreo, W.B.; Towler, E.; Lewis, D.M. *Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in the East Bay Municipal Utility District (EDMUD) Service Area*; USEPA: Denver, CO, USA, 2003.
17. Mayer, P.W.; Deoreo, W.B.; Towler, E.; Martin, L.; Lewis, D.M. *Tampa Water Department Residential Water Conservation Study: The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes*; Seattle Public Utilities and the USEPA: Boulder, CO, USA, 2004.
18. Campbell, H.E.; Johnson, R.M.; Larson, E.H. Prices, Devices, People, or Rules: The Relative Effectiveness of Policy Instruments in Water Conservation1. *Rev. Policy Res.* **2004**, *21*, 637–662. [CrossRef]
19. Maddaus, L.A. Effects of Metering on Residential Water Demand. Master's Thesis, UC Davis, Davis, CA, USA, 2001.
20. Moglia, M.; Gan, K.; Delbridge, N.; Sharma, A.K.; Tjandraatmadja, G. Investigation of pump and pump switch failures in rainwater harvesting systems. *J. Hydrol.* **2016**, *538*, 208–215. [CrossRef]
21. Moglia, M.; Tjandraatmadja, G.; Sharma, A.K. Exploring the need for rainwater tank maintenance: Survey, review and simulations. *Water Sci. Technol. Water Supply* **2013**, *13*, 191–201. [CrossRef]
22. Moglia, M.; Gan, K.; Delbridge, N. Exploring methods to minimize the risk of mosquitoes in rainwater harvesting systems. *J. Hydrol.* **2016**, *543*, 324–329. [CrossRef]
23. Moglia, M.; Gan, K.; Delbridge, N.; Tjandraatmadja, G.; Gulizia, E.; Pollard, C.; Sharma, A.; Cook, S. Condition inspection of rainwater tanks in Melbourne. In Proceedings of the Art and Science of Water—36th Hydrology and Water Resources Symposium, HWRS, Hobart, Australia, 7–10 December 2015; pp. 1413–1417.
24. Tapsuwan, S.; Mankad, A.; Greenhill, M.; Tucker, D. The influence of coping appraisals on the adoption of decentralised water systems in Australia. *Urban Water J.* **2015**, *14*, 45–52. [CrossRef]

25. Mankad, A.; Tapsuwan, S. Review of socio-economic drivers of community acceptance and adoption of decentralised water systems. *J. Environ. Manag.* **2011**, *92*, 380–391. [CrossRef] [PubMed]
26. Corral-Verdugo, V.; Frías-Armenta, M. Personal Normative Beliefs, Antisocial Behavior, and Residential Water Conservation. *Environ. Behav.* **2006**, *38*, 406–421. [CrossRef]
27. Lapinski, M.K.; Rimal, R.N.; DeVries, R.; Lee, E.L. The Role of Group Orientation and Descriptive Norms on Water Conservation Attitudes and Behaviors. *Health Commun.* **2007**, *22*, 133–142. [CrossRef] [PubMed]
28. Bernedo, M.; Ferraro, P.J.; Price, M. The Persistent Impacts of Norm-Based Messaging and Their Implications for Water Conservation. *J. Consum. Policy* **2014**, *37*, 437–452. [CrossRef]
29. Broniarczyk, S.M.; Griffin, J.G. Decision Difficulty in the Age of Consumer Empowerment. *J. Consum. Psychol.* **2014**, *24*, 608–625. [CrossRef]
30. Garbarino, E.C.; Edell, J.A. Cognitive effort, affect, and choice. *J. Consum. Res.* **1997**, *24*, 147–158. [CrossRef]
31. Festinger, L. A theory of social comparision processes. *Hum. Relat.* **1954**, *7*, 117–140. [CrossRef]
32. Corcoran, K.; Crusius, J.; Mussweiler, T. Social comparison: Motives, standards, and mechanisms. In *Theories in Social Psychology*; Chadee, D., Ed.; Wiley-Blackwell: West Sussex, UK, 2011.
33. Tigges, B.B. Psychometric properties of the social comparison motives scale. *J. Nurs. Meas.* **2009**, *17*, 29–44. [CrossRef] [PubMed]
34. Gibbons, F.X.; Buunk, B.P. Individual differences in social comparison: Development of a scale of social comparison orientation. *J. Personal. Soc. Psychol.* **1999**, *76*, 129–142. [CrossRef]
35. Carlsson, F.; Martinsson, P. Do Hypothetical and Actual Marginal Willingness to Pay Differ in Choice Experiments? Application to the Valuation of the Environment. *J. Environ. Econ. Manag.* **2001**, *41*, 179–192. [CrossRef]
36. Telser, H.; Zweifel, P. Validity of discrete-choice experiments evidence for health risk reduction. *Appl. Econ.* **2007**, *39*, 69–78. [CrossRef]
37. Berk, R.A.; Schulman, D.; Mckeever, M.; Freeman, H.E. Measuring the impact of water conservation campaigns in California. *Clim. Chang.* **1993**, *24*, 233–248. [CrossRef]
38. Gordon, J.; Chapman, R.; Blamey, R. Assessing the Options for the Canberra Water Supply: An Application of Choice Modelling. In *The Choice Modelling Approach to Environmental Valuation*; Bennett, J., Blamey, R., Eds.; Edward Elgar: Cheltenham, UK, 2001.
39. Hanley, N.; Mourato, S.; Wright, R.E. Choice Modelling Approaches: A Superior Alternative for Environmental Valuation? *J. Econ. Surv.* **2001**, *15*, 435–462. [CrossRef]
40. Sawtooth Software. Lighthouse Studio: CBC. United States of America: Sawtooth Software. Available online: http://www.sawtoothsoftware.com/products/conjoint-choice-analysis/cbc (accessed on 7 August 2018).
41. Australian Bureau of Statistics. 2016 Census Quickstats: Employment. Available online: http://quickstats.censusdata.abs.gov.au (accessed on 15 July 2018).