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Priorities in Residential Water Use: A Trade-Off Analysis

Edward Sadalla[1], Anna Berlin[1], Rebecca Neel[1], and Susan Ledlow[1]

Abstract

A trade-off paradigm was used to examine priorities in residential water use. A total of 426 participants allocated either a small or large budget to various household water uses. A comparison of allocations across budget conditions revealed which water uses were regarded as most important, as well as the amount of water regarded as sufficient for each use. Further analyses focused on the perceived importance of outdoor water use, which accounts for the majority of the water used in residences. Data indicated that indoor uses, especially those related to health and sanitation, were consistently higher priorities for participants in this study. The finding that residents are more willing to curtail outdoor water use than indoor water use has important implications for behavior change campaigns. Individual difference variables of environmental orientation and duration of residence in the desert accounted for some of the variance in water choices.

Keywords

water use, residential water, sustainability psychology, conservation psychology, water trade-offs

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Fresh water supplies are becoming increasingly scarce worldwide as the result of a number of factors, including population growth and climate change. Climate models suggest that many regions face impending water shortages, leading to an increased focus on conservation (Gleick, 2010; Jackson et al., 2001; Oki & Kanae, 2006; Vörösmarty, Green, Salisbury, & Lammers, 2000). Water consumption in residential environments is a significant component of overall water use, and many local governments and water utilities have initiated campaigns to promote water conservation by residential users (e.g., Together We Conserve, 2011; Water—Use it Wisely, 2011). These campaigns, however, are not typically informed by either theory or empirical findings. Individuals' behaviors and preferences related to everyday water use are generally underresearched (Hurlimann, Dolincar, & Meyer, 2009). Psychological determinants of conservation, in particular, have been understudied despite the potential for such knowledge to inform effective interventions to reduce consumption (Russell & Fielding, 2010). The current study explores aspects of the psychology of residential water consumption. The aims are twofold: to distinguish priorities among the many different uses water serves in the home and to identify those that may be most amenable to behavioral change campaigns.

Study Location: Phoenix, Arizona

The current research examined the water priorities of residential users in a region experiencing drought, and with projected future water shortages (Martin, 2008). Located in the Sonoran desert, Phoenix has an arid climate with limited water sources, and long-term water management is a particular concern. The rapid growth of the region has depended on the availability of inexpensive water drawn from a mix of surface and underground sources (Bolin, Seetharam, & Pompeii, 2010). Both these sources are currently being depleted at rates that exceed their ability to be replenished, and water supply for the greater Phoenix area is expected to fall short in less than 50 years (Bolin et al., 2010; Eden & Megdal, 2006). At the same time, population projections for Phoenix predict that by 2030, the metropolitan region will contain 8.5 million people and will consume all of the 2.4 million acre feet of water currently available to the area (Holway, 2006, cited in Martin, 2008). The combination of population growth and the current unsustainable use pattern suggests that effective reduction of residential water consumption will become essential for maintaining the region's economy and residents' quality of life.

Table 1. Mean Daily per Capita Water Use in 12 Cities Across North America

	Volume used		Percentage used	
Fixture or end use	Gallons	Liters	Indoor only	Overall
Indoor				
Toilet	18.5	70.0	0.31	0.11
Clothes washer	15.0	56.8	0.25	0.09
Shower	11.6	43.9	0.19	0.07
Faucet	10.9	41.3	0.18	0.06
Other domestic	1.6	6.1	0.03	0.01
Bath	1.2	4.5	0.02	0.01
Dishwasher	1.0	3.8	0.02	0.01
Indoor total	59.8	226.3	1.00	0.35
Outdoor total	100.8	381.5	NA	0.59
Other (leak or unknown) total	11.2	42.4	NA	0.07
Total	171.8	650.3	NA	1.00

Identifying Targets of Change

A systematic study involving 12 cities across North America (American Water Works Association, 2011) examined indoor and outdoor residential water use. Precise end use data from 100 single-family residences in each city were collected with the goal of identifying where water was used in the residential setting. Table 1 displays a summary of the results.

Two notable results emerged from this study. Most notably, the bulk of residential water is used outside the residence. Even if leaks are assumed to occur primarily indoors, more than half of residential water is directed outdoors. Second, the bathroom is responsible for the majority of indoor water use. The toilet, shower, and bath account for more than half of the approximately 60 gallons per capita per day of indoor water use. This study suggests that two clear targets for reducing residential water consumption would be to reduce outdoor water use and to reduce water use in the bathroom.

Priorities in Water Use

Although systematic studies of actual water use in residential settings have been carried out, little is known about how users *value* different water uses in and around the home. Nancarrow, Smith, and Syme (1997) have a very

useful analysis of the way that people think about water. Their analysis, however, did not specifically focus on the distinct water usages within a home. It is not necessarily the case that residential water use reflects residential water priorities. From a consumer's point of view, water is used for multiple purposes in the home—cooking, washing laundry, flushing toilets, watering lawns, filling swimming pools, and so on. Each of these purposes may be valued differently. Certain water uses may be considered to be more necessary, whereas other uses may be perceived to be less important "luxury" items that would be purchased only when extra funds are available. The distinction between more essential and less essential goods originated in the field of economics and has been applied to several domains of psychological research (Cottrell, Neuberg, & Li, 2002; Li, Bailey, Kenrick, & Linsenmeier, 2002; Li & Kenrick, 2006).

An implication of this distinction is that high priority uses will be relatively impervious to behavioral change campaigns. For example, if regular toilet flushing is perceived to be a high priority item, then encouraging people to flush after every other use will likely be in vain, and alternative interventions such as technological innovations may be better strategies for changing actual gallon consumption in toilet flushing. Lower priority items, however, may be more pliable targets for changing water-consumption habits. Identifying water priorities will thus help to identify realistic targets for behavioral versus technological interventions to reduce demand for water in residential contexts.

Study Overview

The current research used a trade-off paradigm in which participants were asked to allocate a budget of a given size to various water uses in and around the home. Two different budget conditions were used: a small budget and a large budget. The smaller budget required participants to choose carefully between different water uses, whereas the larger budget allowed participants more leeway to choose lower priority uses. We examined residents' allocations of water to 10 possible uses: toilet flushing, showering, water pressure (via faucets and showerheads), dishwasher use, washing machine use, baths, landscaping (including the choice of high or low water-consumption foliage), outdoor watering (including irrigation and car washing), swimming pools, and native plant and animal protection (i.e., "your water provider offers an option for you to get your water in a way that has less impact on natural streams and springs"). The indoor uses were chosen because they are the primary water uses in a typical single-family residence in the United

States (American Water Works Association, 2011). Outdoor uses such water-intensive landscapes, car washing, and swimming pools have been found to take up 60% to 75% of residential water use in Phoenix (cited by Balling, Gober, & Jones, 2008). Because of this, items related to landscaping, watering, and swimming pools were included.

We also explored the effects of gender, environmental orientation, and of duration of residence in the Phoenix area.

Research Questions and Hypotheses

Water priorities and sufficiencies. A central focus of this study is the assessment of residential water priorities. We assume that different water uses are differently valued and that by comparing high and low budget conditions, we can establish which water uses are priorities for residents. Data resulting from this study will allow us to compare priorities in water use with previously observed patterns of water use. We are particularly interested in whether outdoor water use, which accounts for the majority of the water used in residences, is actually perceived to be a priority.

We are also concerned with the level of water use that is *sufficient* to meet residents' satisfaction levels. For example, if a 10-min shower per day is regarded as a high priority water use, is it also sufficient? If provided a larger budget, will residents spend it on even longer showers, or, if their needs are sufficiently met by a 10-min shower, will they allocate any extra funds to something else? The trade-off paradigm allows us to explore this question. By including high and low budget conditions, we can evaluate both priorities and sufficiencies.

Health and sanitation. We hypothesized that water used on indoor items related to personal hygiene would be given a higher priority than water allocated to recreation and aesthetics (primarily a function of outdoor water use). This hypothesis is based in part on the Darwinian concepts of natural selection and sexual selection, which predict that humans, like other animals, will have evolved behavioral and emotional mechanisms that promote health and sexual attractiveness.

Empirical literature supports the idea that humans have evolved a "disgust" response that leads to germ avoidance and reduces exposure to disease (see Rozin, Haidt, & McCauley, 2000). Disgust is considered to be a culturally universal emotion (cf. Ekman, 1993; Plutchik, 1980) and is experienced as a feeling of revulsion, sometimes accompanied by nausea, and a desire to move away from the source of the emotion. It is believed that the emotion of disgust originally evolved as a response to offensive foods that may cause

harm to the organism (Wicker et al., 2003) and bodily fluids that that are the source of pathogens (Curtis & Biran, 2001). Although mediated by cultural conditioning, body odors can elicit a disgust reaction. This in turn can influence an individual's sexual attractiveness and sexual success (Buss & Schmidt, 1993). Therefore, water uses involved in maintaining sanitary conditions in the home and mitigating odors that elicit disgust reactions (i.e., toilets, showers, etc.) are predicted to be higher priorities than other water uses. Water used to minimize bathroom odors, offensive kitchen odors, and personal hygiene odors should take priority over other water uses.

Individual differences in water priorities. Previous research suggests that gender, environmental orientation, and duration of residence in the desert should account for individual differences in water priorities.

Gender. Several studies have identified gender differences in landscape preferences. Lyons (1983) found that women preferred more vegetation in landscapes than did men. Ruso, Atzwanger, Buber, Gadner, and Gruber (2004) found that women preferred landscapes with higher "refuge" values (more vegetation) than did men. Women in Phoenix have been shown prefer wet to dry landscapes for their own yards (Yabiku, Casagrande, & Farley-Metzger, 2008). These aesthetic considerations suggest that women might place a higher priority on outdoor water use than would men.

Sociological studies, however, might predict that men would regard outdoor water use as a higher priority than women. Data on the domestic division of labor indicate substantial sex differences in indoor versus outdoor activities. Although women spend substantially more time on domestic chores than do men, most of that labor is done inside the home (including such activities as cooking, cleaning, and laundry). Surveys indicate that men contribute a greater percentage of their time, and more time overall, to external home maintenance, including such things as car washing, lawn watering, and lawn maintenance (Gunter & Gunter, 1990). Blair (1991), for example, found that husbands spend 3.5 times more hours per week doing outdoor chores than do their wives. Such tasks typically involve water use, leading to the prediction that men should place a higher priority than women on outdoor water use, whereas women should place a higher priority on indoor water uses. Although the literature does not lead to a clear prediction about gender, there is sufficient justification for exploring sex differences in water priorities.

Environmental orientation. We measured respondents' environmental orientation with the revised New Environmental Paradigm (NEP) Scale (Dunlap, Van Liere, Mertig, & Jones, 2000) and examined whether differences on this scale predicted water priorities. The NEP measures the degree to which a person holds proenvironmental attitudes and engages in proenvironmental behaviors. High NEP scores may describe a person who is sensitive to

sustainability issues and who is more likely to conserve water in residential settings. We hypothesize that NEP scores will predict total expenditures for water in the high and low budget conditions, with those scoring high on NEP spending less of their available budgets. We also expect scores on the NEP to predict the amount of money allocated to native plant and animal protection.

Environmental orientation may also influence the preference for high-water-use landscapes. Prior research has found environmental concerns influence choice of yard landscaping (Larson, Casagrande, Harlan, & Yabiku, 2009; Sevenant & Antrop, 2009). Participants with greater environmental orientation may thus be more sensitive to incipient water shortages in the Phoenix region, and be more likely to accept low over high water use landscaping.

These questions are relevant because previous research indicates that general environmental beliefs, such as those measured with the NEP, relate to conservation behavior only to the extent that those general beliefs lead to more specific beliefs about availability of resources (Kaiser, Wölfing, & Fuhrer, 1999). For instance, Corral-Verdugo, Bechtel, and Fraijo-Sing (2003) tested whether NEP predicts specific beliefs about water availability, and found that specific beliefs about water availability were a more powerful, direct predictor of behavior than was NEP alone. We thus also measured residents' beliefs about future water availability in the region and examined whether these beliefs moderate water priorities.

Duration of residence in the desert. It might be expected that recent arrivals to the desert from less arid climates would bring with them preferences for the lusher landscapes that characterized their former residences. Several survey studies have, however, shown the opposite effect: The longer their residence in the area, the more Phoenicians are likely to prefer and actually own water-intensive, nonnative landscapes (Larson et al., 2009; Martin, Peterson, & Stabler, 2003). This "desert oasis mentality" is thought to be a part of Phoenix culture, and thus the longer residents have lived in Phoenix, the more likely they are to espouse these views and, ironically, use more water than shorter-term residents (Harlan, Yabiku, Larsen, & Brazel, 2009). We expected that, in the current study, duration of residence in the Phoenix metro area to predict allocation of resources to water-intensive landscaping.

Method

Participants

The experiment conducted as an online survey was administered to a random sample of the approximately 6,200 staff members of Arizona State University,

excluding faculty. The participants represented a variety of incomes and professions, ranging from groundskeepers to highly paid technical or administrative positions. Participation was voluntary and lasted approximately 30 min. A total 426 respondents responded to an email invitation and logged into the survey website.

Participants who skipped 1 or 2 of the water usage items were given a value of zero dollars for those responses. Those participants ($n = 4$) who did not provide responses for 3 or more of the 10 water usage items were dropped from the sample. Two participants in the low budget condition were dropped because they allocated more than they were allowed to spend. Finally, 1 participant was dropped because budget condition was not recorded. The final sample consists of 419 respondents.

Materials

Participants were randomly assigned to the low budget (US$24) or high budget (US$36) condition. They were then presented with the following scenario:

> The study you are going to participate in today requires that you make choices regarding your water consumption. Imagine that you will be moving into a new house that you just bought and you are in the process of preparing your monthly budget. The budget you have prepared will allow you to spend US$24 (or US$36) a month for all your water-related activities. Before moving in, the developer requires you to make a final selection on various build options like low flow versus high flow faucets and landscaping that will affect your water consumption. To make sure you stay on budget, you will need to factor in all possible water consumption choices. In this survey, you will be asked to choose which options you would like that keep you within your US$24 (or US$36) budget. Please spend as close to US$24 (or US$36) as you can without going over that amount.

Working within their monthly budget of either US$24 or US$36, participants then had to decide how much money to allocate to the 10 options, some of which are structural (e.g., faucets) and some of which are behavioral (e.g., limiting length of showers) depicted in Figure 1.

The following is a list of choices you can make about how you will use water in your new house. Each choice has a particular cost. You are on a budget, so choose options that will not total more than US$24 per month.

Showering	$ Per Month
No showers	$0.00
One 5-minute shower per day	$2.00
One 10-minute shower per day	$4.00
Unlimited showers	$6.00
Baths	**$ Per Month**
No baths	$0.00
1 bath per week	$2.00
3 baths per week	$4.00
Unlimited baths	$6.00
Dishwasher Use	**$ Per Month**
Once a Week	$0.00
Three times per week	$2.00
Five times per week	$4.00
Unlimited use	$6.00
Washing Machine Use	**$ Per Month**
Once a week	$0.00
Three times per week	$2.00
Once a day	$4.00
Unlimited use	$6.00
Faucets and showerheads	**$ Per Month**
1 gallon per minute (very low flow)	$0.00
2 gallon per minute (low flow)	$2.00
3 gallons per minute (moderate flow)	$4.00
Unrestricted flow	$6.00
Toilet Flushing	**$ Per Month**
Flush every third time	$0.00
Flush every other time	$2.00
Flush every other time for liquids, every time for solids	$4.00
Unlimited flushing	$6.00
Landscaping	**$ Per Month**
All desert front and back/only native trees	$0.00
All desert plus non-native trees and shrubs	$2.00

(continued)

Figure 1. (continued)

Desert front, lawn in back	$4.00
Grass and trees of choice front and back	$6.00
Outdoor Watering	$ Per Month
No outdoor watering	$0.00
Alternate day landscape watering, no washing cars or sidewalks	$2.00
Every day landscape watering, no washing cars or sidewalks	$4.00
Unlimited, can wash cars, sidewalks, etc	$6.00
Swimming pools	$ Per Month
No access to a pool	$0.00
Access to a public pool	$2.00
Membership in a neighborhood, HOA, or gym pool	$4.00
Your own pool	$6.00
Native Plant and Animal Protection Option (your water provider offers an option for you to get your water in a way that has less impact on natural streams and springs)	$ Per Month
Same amount of water as they currently have (standard plan)	$0.00
5% more water for native plants and animals	$2.00
10% More water for native plants and animals	$4.00
25% more water for native plants and animals	$6.00

Figure 1. Residential water consumption trade-offs

After completing their budget allocation, participants indicated how difficult their choices were (1 = *not at all difficult*, 7 = *extremely difficult*) and how satisfied they were with the options they selected (1 = *not at all satisfied*, 7 = *extremely satisfied*). Finally, participants completed the revised NEP Scale (Dunlap, et al., 2000), which measures "environmentalism." They also answered several items assessing beliefs about current and future water availability in the Phoenix area (e.g., "Do you believe Phoenix will have a water shortage in the next 5, 25, 50, or 100 years"), and provided demographic information.

Table 2. Within-Subjects Contrasts of the Dollars Allotted to Each Water Usage Item, in the Low Budget Condition

Comparison of usage A to B			
Usage A	Usage B	*F*	*p*
Toilet flushing	Showers	15.920	.000
Showers	Water flow	59.421	.000
Water flow	Pool	9.060	.003
Pool	Landscaping	0.279	.598
Landscaping	Outdoor watering	3.457	.064
Outdoor watering	Washing machine	4.282	.040
Washing machine	Dish washer	0.094	.760
Dish washer	Protecting nature	0.817	.367
Protecting nature	Bath	7.124	.008

Note: Degrees of freedom for all contrasts are (1, 201).

Results

Participant Characteristics

Of the 419 participants in the final sample, 326 self-identified as White (77%); 36 identified as Spanish, Hispanic, or Latino (8.6%); and 31 as Asian (7.4%). Less than 2% of the sample fell into another racial category, and about 8% of the sample declined to answer or responded "other." The mean age of participants was 42.4, and age ranged from 20 to 67 years. There were 142 males and 260 females; 17 participants declined to report their gender. In all, 87 participants had less than a college degree, 167 had a college degree, 161 held an advanced degree, and 4 declined to answer. Approximately 40% of the sample reported their political affiliation as Democrat, 20% as Republican, and 28% as independent. A majority of the sample (74%) were homeowners. The modal household size was 2 people and less than 5% of the sample reported a household size of 5 or greater. On average, participants reported living in the Phoenix area for 17.8 years.

Manipulations Checks

Three different manipulation check questions were assessed to better understand the effectiveness of the budget manipulation: perceived task difficulty, satisfaction with choices, and dollars remaining. For all three questions, *t* tests were run to compare the means of the low and high budget groups. Levene's test for equality of variances was violated for

difficulty, $F(1, 417) = 15.067$, $p < .001$, and dollars remaining, $F(1, 417) = 178.25$, $p < .001$. Consequently, all three tests are reported with equal variances not assumed.

Difficulty. Participants in the low budget condition ($M = 3.06$, $SD = 1.71$) reported the task to be more difficult than did participants in the high budget condition ($M = 2.41$, $SD = 1.43$), $t(390.94) = 4.23$, $p < .001$.

Satisfaction. There was a significant difference between the two budget conditions on satisfaction, $t(411.80) = 2.34$, $p = .020$, with participants in the low budget condition ($M = 5.17$, $SD = 1.63$) reporting less satisfaction with their choices than high budget participants ($M = 5.54$, $SD = 1.57$).

Dollars remaining. Participants in the low budget condition ($M = 1.80$, $SD = 3.25$) had fewer dollars remaining than did individuals in the high budget condition ($M = 8.57$, $SD = 7.74$), $t(294.19) = -11.82$, $p < .001$. On average, participants in the high budget condition spent more money than was available to participants in the low budget condition.

These results indicated that the budget manipulation was successful in influencing the participants' decision processes, and that the lower budget condition was significantly more challenging than the high budget condition.

Priorities and Sufficiencies

Our first research question concerns the value that residents place on different kinds of water use. We assumed that more money and a higher proportion of a low budget would be spent on uses that are perceived to be higher priority water uses. We hypothesized that water used for health and sanitation would have a high priority, whereas outdoor uses (which actually account for the most residential water use) would be lower priorities.

Priorities. Following Li and colleagues (2002), allocations under a low budget were examined as a first look at priorities. Under a restricted budget, participants should allocate funds to those household uses deemed the most essential, so allocations in this condition should reflect the higher priorities for water use. A repeated measures ANOVA on the 10 water usages was conducted on the 202 participants in the low budget condition. Due to sphericity in the data, Mauchley's $W = .29$, $\chi^2(44) = 253.08$, $p < .001$, a Greenhouse–Geisser adjustment of .77 was applied to the degrees of freedom for the ANOVA. The results suggested that participants did, in fact, allot different amounts to each water usage, $F(6.9, 1393.2) = 96.733$, $p < .001$. The effect size was large, $\eta_p^2 = .33$.

To determine which differences between items were significant (i.e., if the #1 water use was allotted significantly more money, on average, than the #2 water use, etc.), repeated within-subjects contrasts were performed on the 10 items, comparing the item with the highest proportion to the one with the next highest proportion (see Table 2).

Participants allocated a greater proportion to toilet flushing than to showering, $F(1, 201) = 15.92$, $p < .001$, $\eta_p^2 = .07$; more on showering than on water flow, $F(1, 201) = 59.42$, $p < .001$, $\eta_{p2}^2 = .23$; and more on water flow than on pools, $F(1, 201) = 9.06$, $p = .003$, $\eta_{p2}^2 = .04$. Pools, landscaping, and outdoor watering constituted the fourth through sixth greatest proportions of the budget, but none of these items was significantly larger than the next largest item. Outdoor watering was significantly higher than washing machine usage, $F(1, 201) = 4.28$, $p = .040$, $\eta_p^2 = .02$. Dishwashers, and the plant and animal protection options also were not significantly different from the next largest item. Baths took up the smallest proportion of the budget, and significantly less than donations to native plant and animal protection, $F(1, 201) = 7.12$, $p < .008$, $\eta_p^2 = .03$.

These analyses support the hypothesis that indoor uses related to health and sanitation are the highest priorities for water use. The two water uses most relevant to personal health and hygiene ("toilet flushing" and "showering") were allotted the most funds. Water flow, which is also related to health and hygiene, accounted for the third highest allocation.

Sufficiencies. We are also concerned with the level of water use that residents deem to be sufficient in each usage category. Later, we examine the level of each type of water use in the high budget condition, beginning with indoor expenditures and ending with outdoor expenditures. Participants in our high budget condition had 50% more money in their initial budget than did participants in the low budget condition. The average participant in this condition left US$8.57 unspent (enough to buy four more levels of various water uses), indicating that choices in this condition were relatively unconstrained by budget limitations. The level of water use purchased in this condition should thus reflect what residents regard as sufficient for their purposes. It is worth noting that, by design, the mean expenditures for a usage were always greater in the high than the low budget conditions. One might expect, then, to observe significant differences between the means due to the study design. Consequently, effect sizes are reported to enable the reader to compare the magnitudes of the mean differences. As before, the assumption of equality of variances was violated for 3 of the 10 usages, consequently degrees of freedom were adjusted for all tests.

Results by Water Usage

Toilet flushing. Toilet flushing accounts for the largest expenditures in the low and high budget conditions. These results are consistent with the notion that a high level of toilet flushing is a very high priority. In the low and high budget conditions, participants spent an average of US$4.53 and US$4.95, where US$4 corresponded to "flushing every other time for liquids, every time for solids" and US$6 to "unlimited flushing." When budget constraints were relaxed, participants allocated more money to more flushing than in the low budget condition, $t(396.20) = 2.69$, $p < .007$. The effect size, Cohen's $d = .27$, for this difference was small and indicated that the mean of the low and high budget groups differed by only a quarter of a standard deviation. Nearly half the sample (58% of the high, and 46% of the low budget participants) opted to pay the maximum allowed (US$6) for unlimited flushing. Taken together, the results indicate that unlimited toilet flushing is preferred. Under budget constraints, flushing every time for solids and every other time for liquids may be sufficient for some water users.

Showering. Showers were the second largest expenditures in the low and high budget conditions. Participants in the high budget condition spent significantly more money on showering, $t(416.43) = 2.16$, $p < .03$, than their low budget counterparts, Cohen's $d = .21$. In the low and high budget conditions, participants spent an average of US$3.93 and US$4.28, respectively, where US$4 corresponded to one 10-min shower per day. A 10-min shower was a high priority in both budget conditions, and appeared to be sufficient for participants in the high budget condition. Less than one third of each condition (32.3% low, 27.6% high) opted to limit showering to 5 min per day or less. Those in the low budget condition were more likely to pay US$4 for 10-min showers daily (38.1% of the condition) than pay US$6 for unlimited showers (29.7% of the condition). Unlimited showering was thus not seen as necessary for either those in the high or low budget conditions, but a 10-min shower was sufficient in both conditions.

Water flow. Water flow accounted for the third highest level of expenditures in low and high budget conditions. In low and high budget conditions, participants spent an average of US$2.77 and US$3.64, respectively, where US$2 corresponded to "2 gallon per minute (low flow)" and US$4 to "3 gallons per minute (moderate flow)." Expenditures in the two budget conditions were significantly different, $t(415.79) = 5.61$, $p < .001$, and Cohen's $d = .55$ was large. Participants in the high budget condition spent more on water flow. In the low budget condition, only 7.9% of the participants opted for unlimited flow, whereas 19.8% of the high budget participants went with that option.

The majority of low budget participants (58.4%) chose one of the two lowest water flow options, whereas only a third (33.2%) of high budget participants did so. In sum, it seems that a low/moderate water flow was sufficient for participants; water flow may be one of the areas in which residents would be willing to make compromises when faced with a low budget.

Clothes washing. In the low and high budget conditions, participants spent an average of US$1.49 and US$2.18 on clothes washing where US$0 corresponded to "once a week" and US$2 to "three times per week." There was a significant difference between budget conditions, $t(375.68) = 4.40$, $p < .001$, Cohen's $d = .42$, with participants in the high budget condition spending on average US$2.18 on clothes washing, and low budget participants spending US$1.49 on average. The majority of people in both conditions selected the "three times per week" (US$2) option for clothes washing. One or two loads of laundry per week were deemed sufficient for most participants.

Dishwasher use. In the low and high budget conditions, participants spent an average of US$1.45 and US$1.78, respectively, where US$0 corresponded to "once a week" and US$2 to "three times per week." There was a significant difference between budget conditions, $t(416.86) = 2.16$, $p < .03$, Cohen's $d = .21$, with participants in the high budget condition allocating 19% more dollars to dishwashing. The majority of participants in both conditions selected the "three times per week" option for dishwasher use; however, 18% of the participants in the high budget conditions bought the "five times per week" option. Although using the dishwasher infrequently was sufficient, more water allocation was more desirable.

Baths. Baths were the lowest priority for water use in our sample. In the low and high budget conditions, participants spent an average of US$0.86 and US$1.43, respectively, where US$0 corresponded to "no baths" and US$2 to "one bath per week." High budget participants spent significantly more on baths than did low budget participants, $t(408.96) = 3.33$, $p = .001$, Cohen's $d = .32$. Seventy percent of low budget participants and 57% of high budget participants selected "no baths" per week. Baths are clearly not a priority, and a very low level of use for this activity is sufficient.

Swimming pools. Private swimming pools were not a high priority among our participants, but some *access* to a swimming pool was a priority. In the low and high budget conditions, participants spent an average of US$2.12 and US$2.40, where US$2 corresponded to "access to a public pool" and US$4 to "membership in a neighborhood homeowners association (HOA), or gym pool." The difference between low and high budget groups was not significant, indicating that having access to a pool was sufficient to meet participants' needs.

Landscaping. Desert landscaping was sufficient for the majority of participants in both experimental groups. For low and high budget conditions, participants spent an average of US$2.00, and US$2.81, respectively, where US$2 corresponded to "all desert plus nonnative trees and shrubs" and US$4 to "desert front, lawn in back." High budget participants spent significantly more, $t(416.96) = 4.10$, $p < .001$, Cohen's $d = .40$. Sixty-six percent of the low budget group and 51% of the high budget group opted for all desert landscaping with no lawns. Only 7% of the low budget group and 17.5% of the high budget group selected the "grass and trees of choice" option.

Outdoor watering. In the low and high budget conditions, participants spent an average of US$1.75 and US$2.06, respectively, where US$0 corresponded to "no outdoor water usage," US$2 to "alternate day landscape watering, no washing cars or sidewalks," and US$4 to "every day landscape watering, no washing cars or sidewalks." High budget participants spent significantly more on outdoor watering than did low budget participants, $t(414.42) = 2.50$, $p = .013$, Cohen's $d = .24$. The majority of participants (68.8% low, 69.6% high) opted to spend US$2 for "alternate day landscape watering, no washing cars or sidewalks." These findings suggest relatively low quantities of water for outdoor use is sufficient.

Native plant and animal protection. Native plant and animal protection was the second lowest priority of all items. In low and high budget conditions, participants spent an average of US$1.30 and US$1.91, respectively, and this difference was significant, $t(413.83) = 3.66$, $p < .001$, Cohen's $d = .36$. The item was listed as "native plant and animal protection option" and described as "your water provider offers an option for you to get your water in a way that has less impact on natural streams and springs." The option of US$0 corresponded to "same amount of water as they currently have (standard plan)" and US$2 to "5% more water for native plants and animals." Expenditures were low on this item with only 13.4% of the low budget participants selecting the US$4 or US$6 options. Almost any allocation for this use would be sufficient for most participants.

Individual Differences

We measured three between-subject variables that were hypothesized to influence decisions about the allocation of residential water: gender, environmental orientation, and duration of residence in Phoenix.

Gender. Previous studies of gender differences in household activities and aesthetic preferences led to the exploration of gender differences in priorities for indoor versus outdoor water use. To test for this pattern in the current data,

we computed a set of two variables reflecting the means for the six indoor items (showers, baths, dishwasher, washing machine, water flow, and toilet flushing) and the three outdoor items (landscaping, outdoor watering, and swimming pools) separately. Then we compared the means of water used indoors, $t(401) = 1.721$, $p = .086$, and outdoors, $t(401) = .416$, $p = .69$, and found that males and females did not differ in the extent to which they budgeted for indoor or outdoor water usage. Our data do not indicate gender differences in indoor versus outdoor water priorities.

Environmental orientation. We expected scores on the NEP to predict the total budget spent on water, the amount of money allocated to landscaping, and the amount of money allocated to native plant and animal protection. The data generally supported these expectations. To test relationship between NEP and water use while accounting for differences in budget, hierarchical regression analyses were run with budget entered as a dummy coded variable in the first step, NEP centered at the mean on the second step. Finally, in a third step, the NEP × Budget interaction was added; however, the interaction term did not account for a significant amount of variance in any of the three outcomes (all ps > .7 for the test of r^2 change), so results of the third step of the models are not reported. Results are reported separately for the three outcomes.

Total spent. As expected, in the first step of the analysis, budget accounted for a significant proportion of total dollars spent, $F(1, 415) = 78.31$, $p < .001$, $r^2 = .157$. Being in the high budget condition was associated with a US$5.22 increase in total spent, $B = 5.22$, $SE = .59$, $t(415) = 8.85$, $p < .001$. In the second step, NEP did not predict total spent over and above the effects of budget, F change$(1, 414) = 3.00$, $p = .084$, r^2 change = .006. Finally, in the third step, the Budget × NEP interaction did not predict total spent over and above the effects of budget and NEP F change$(1, 413) < 1.0$, $p = .72$, r^2 change < .001.

Landscaping. We predicted that environmental orientation would also account for some of the variance in money spent on landscaping, with high NEP participants spending less on landscaping. The data supported this prediction. As expected, in the first step of the analysis, budget accounted for a significant proportion of allocations to landscaping, $F(1, 415) = 16.98$, $p < .001$, $r^2 = .04$. In the second step, NEP accounted for a significant proportion of the variance in allocations to landscaping over and above budget, F change$(1, 414) = 4.70$, $p = .031$, r^2 *change* = .011. In the second model, for individual at the mean level of NEP, being in the high budget group was associated with an 8-cent increase on landscaping allocations, $B = .81$, $SE = .20$, $t(414) = 4.13$, $p < .001$. For every 1-unit increase in NEP, participants spent approximately 33 cents less on landscaping, $B = -.33$, $SE = .15$, $t(414) = 2.19$, $p = .031$.

Plant and animal protection option. Finally, just as before, in the first step of the analysis, budget accounted for a significant proportion of allocations to plant and animal protection, $F(1, 415) = 13.68$, $p < .001$, $r^2 = .03$. In the second step, NEP accounted for a significant proportion of the variance in allocations to plant and animal protection over and above budget, F change $(1, 414) = 14.86$, $p < .001$, r^2 change = .034. In the second model, for participants at the mean level of NEP, being in the high budget group was associated with a 63-cent increase in allocations to the plant and animal protection option, $B = .63$, $SE = .17$, $t(414) = 3.79$, $p < .001$. Each 1-unit increase in NEP was associated with allocating an additional 50-cents to plant and animal protection, $B = .50$, $SE = .13$, $t(414) = 3.86$, $p < .001$.

Beliefs. We also found that participants who scored higher on the NEP scale were more likely to believe that the world would soon experience an ecological catastrophe ($r = .703$, $p < .001$), more likely be believe that Arizona was currently in a drought ($r = .184$, $p < .001$), and more likely to believe that Phoenix currently has a water shortage ($r = .252$, $p < .001$). We tested whether those specific beliefs about the environment were a better prediction of water priorities than NEP scores alone. Contrary to previous research, however (e.g., Corral-Verdugo et al., 2003), these specific beliefs did not predict water priorities better than did NEP scores alone.

Residence duration and landscaping. We expected that participants with longer durations of residence in the Phoenix metro area would allocate more resources to water-intensive landscaping. Duration of residence data was available on 408 participants. To examine the effect of duration of residence in the valley on allocations to landscaping, the budget condition was dummy coded (with the low budget as the reference group) and entered into the first step in a set of hierarchical regressions. Budget accounted for a significant proportion of variance in allocations to landscaping, $F(1, 406) = 54.46$, $p < .001$, $r^2 = .03$. Residence duration was entered in the second step and explained a significant amount of additional variance for landscaping over and above budget, $F(1, 405) = 13.297$, $p < .001$, r^2 change = .031. The final model accounted for approximately 6.2% of the total variance in landscaping budgets.

For each additional year of residence in the valley, participants allocated an estimated 3 cents to landscaping, which was significant, $B = .027$, $SE = .007$, $t(405) = 3.65$, $p < .001$. Although 3 cents per year was relatively small, the residence duration ranged from several people having lived in the area for a year or less and eight who had lived in the area 50 years or more. The average residence duration was 17.8 years, which indicates that the average area resident was predicted to allocate approximately 48-cents more to landscaping than a person who was new to the area.

Discussion

A major focus of this investigation is to determine whether observed patterns of residential water use match residents' priorities as assessed by a trade-off task. Given that water prices are currently low in the Phoenix region, residents typically do not carefully consider how to apportion their water use, and may use considerable water on what are actually low priority uses. We hypothesized that priorities would predictably differ from established use patterns. This hypothesis was supported by the data.

Although the bulk of residential water is actually used outside the home, indoor uses were found to be generally higher priorities for participants in this study. Some degree of outside water use was regarded as a priority, but participants largely chose low water use landscapes, and tended to restrict outdoor watering. In previous studies, most Phoenix residents have expressed strong preference for *mesic* (grass and trees) landscaping for aesthetic, self-presentational, and recreational reasons (see Larson et al., 2009). The present study would indicate that under a restricted budget, residents would be willing to forgo a significant amount of high-water-use landscaping.

It was also surprising that although access to a swimming pool was a high priority, owning a *private* pool was not. A study of residential water consumption by Wentz and Gober (2007) found that 25% of Phoenix residents own pools, with as many as 86% of homeowners in some neighborhood having private pools. Homes with pools have been shown to use the double the amount of water as homes without pools (Mayer et al., 1999). Therefore, although pool ownership is common, it also represents a significant opportunity for water savings in future construction, should water become more expensive, or should water restrictions be enacted in the future.

Our results imply that campaigns to reduce outdoor water use would not meet with as much user resistance as would campaigns to reduce indoor water use. Surveys have shown that the majority of water used indoors is used in the bathroom. Our data suggest that this does, in fact, constitute the highest priority for residents. These indoor priorities are more likely to reflect health and sanitation concerns (see Gleick, 2003). Behavioral change campaigns designed to reduce water use in the bathroom (such as flushing every other time, or taking shorter showers) are likely to meet significant user resistance. Campaigns to urge users to buy technological innovations that reduce water use inside the home are likely to be the more successful interventions.

Few gender effects were observed in this study. Given that men spend more time washing cars and tending landscaping than do women, it could be expected

that men would allot a greater proportion of their budget outdoor uses than would women. Given that women tend to prefer landscapes with more vegetation than do men, it might be expected that women would allot more of their budget to landscaping and outdoor watering, yet there was no evidence for this in this study. Perhaps these opposing tendencies neutralize each other and account for the lack of gender effects observed in water budgeting.

Environmental orientation accounted for a significant amount of variance in water choices. We found that NEP scores affected budget allocation such that those high in environmental orientation spent a lower proportion of their overall budget, essentially consuming less water overall. In addition, these participants were more likely to choose *xeric* (low water use) landscaping, and allocated more funds to the native plant and animal protection option, thus choosing to use less water and to minimize ecological damage.

Prior research (e.g., Corral-Verdugo et al., 2003) suggested that NEP's direct effect on conservation behaviors is relatively weak, and that more fine-grained, local beliefs about current and impending drought in the Phoenix area would better predict ecologically relevant behavior. We did not find support for this premise; NEP scores were better predictors than were specific beliefs.

It should be noted, however, that allocating water to native plants and animals was a low priority for virtually all study participants. The actual dollar amounts allocated to plant and animal protection were very small, in the high and low budget conditions (US$1.30 and US$1.91, respectively). Respondents in the high budget condition preferred to leave money unspent, rather than spend it on native plant and animal protection. Why participants did not allocate more is not clear, but perhaps could be due to an uncertainty about whether the water utility was actually engaging in environmentally responsible practices or simply "greenwashing." Alternatively, it might suggest the need for programs that enhance awareness of the relationship between residential water use and ecosystem viability.

We hypothesized that longer duration of residence in the desert would correspond with prioritizing high water use (*mesic*) landscaping and more outdoor watering, because of the "oasis mentality" found in previous research in the Phoenix area. This hypothesis was supported: The longer participants had resided in the Phoenix area, the more likely they were to allocate funds to landscaping. Unfortunately, long-term residents of the Phoenix area may be more resistant to campaigns aimed at reducing outdoor water use. More broadly, these data show that examining the local cultural values of landscaping and other outdoor water use may be an important consideration in designing effective campaigns.

Reducing Residential Water Use: Different Interventions for Different Categories of Use

Steg and Vlek (2009) argue that identifying specific behaviors to be changed is an important part of effectively encouraging proenvironmental behavior. When targeting residential household water uses for reducing overall water consumption, possible tactics include informational or other behavior-targeted campaigns, as well as technological advances that reduce water consumption without directly affecting consumption behaviors. These tactics have been shown effective in reducing resource consumption: Informational campaigns—for instance, about quantity of water used or energy consumed relative to neighbors—have led to reduced residential resource use (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). Water-saving technologies can be effective at reducing water consumption as well (Geller, Erickson, & Buttram, 1983; cited in Corral-Verdugo, Bechtel, & Fraijo-Sing, 2003).

Which residential water uses are the best targets for informational versus technological interventions? Our data suggest that technological solutions for reducing water use may be most appropriate for those water uses most closely associated with sanitation and hygiene. Flushing the toilet at each use and showering 5 to 10 min per day are considered minimum necessary levels of use (at least among Phoenix area residents), and even under a constrained budget, these needs are unlikely to be sacrificed. In addition, moderate to high water pressure was seen as a high priority and may be a particularly useful domain for technological interventions due to the availability of high pressure-low flow fixtures on the market. Our data suggest that when campaigns target water needs related to sanitation and hygiene, those promoting behavioral change alone may face a steep uphill battle. In a study of water use in Australia, where half-flushing is a more common option than in the United States, Kurz, Donaghue, and Walker (2005) found that informational attunement labels about water use placed near toilets resulted in 55.8% of participants using the half-flush option more often. Technological solutions may therefore also make behavior changes in toilet use more feasible in the United States.

It is important to note that our analyses speak to relative differences in which water usages are more or less likely to change under restricted budgets. Our data, however, are not intended to assess absolute gallons of water that could be saved. To present participants with options that they understood (e.g., minutes in the shower, not gallons used), each dollar value was associated with an example of a typical use. Although the dollar values

presented to participants always ranged from US$0 to US$6, the gallons used varied from nearly zero to potentially thousands of gallons per month. Although our conclusions indicate likely amenability to behavior change, and not gallons saved, it is noteworthy that domains on which people seemed most likely to change their behaviors also happened to be domains in which the greatest quantity of water is used (i.e., outdoor water usages). This suggests that behavior change has the potential to bring about large savings in actual water quantity.

Our data also suggest that there is great potential for economic incentives and behavioral change campaigns to have an impact on outdoor water use. Higher prices for water should nudge residents to use much less water outdoors. Campaigns that educate residents about conversion to low water use landscaping (or that provide financial support for conversion) could be effective, as could campaigns that educate residents about overwatering existing xeriscaping, a common problem in Phoenix (Martin, 2001). Teaching residents to create low water use outdoor spaces that are aesthetically pleasing and "family friendly" should be particularly effective. Finally, promoting the use of community swimming pools, and increasing access to those pools rather than including pools in future residential construction, could provide water savings in the future.

Our data may also reveal what future consumption in arid regions such as the southwestern United States will look like: Should water become increasing scarce, this would essentially push a greater number of people into a real-life, "low budget" condition (because the same amount of money would buy less water for all uses in the house). In such circumstances, we would expect spending on nonnative landscaping and washing laundry to drop off before toilet flushing, showering, or outdoor watering. Priorities regarding outdoor water use would be expected to be different in nonarid climates, or in places with different norms (e.g., about what acceptable landscaping looks like); however, basic biological tendencies related to health and hygiene should be present in all regions.

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