

Short Communication

Motivators for treated wastewater acceptance across developed and developing contexts

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ABSTRACT

As water scarcity increases, we must turn to underutilized sources such as treated wastewater. While work has been done on barriers to public acceptance, less work has been undertaken to explore motivations that may incentivize adoption of this potential water source. Using data collected from respondents in four global sites (in Guatemala, Fiji, New Zealand, and Spain), we (1) analyzed how four motivators (cost, current and future water shortages, and ecological conservation) influenced respondents' willingness to use treated wastewater and (2) examined if respondents' willingness varied across contexts based on the level of wastewater treatment available. Despite a focus in previous research on the role of reducing cost and providing economic incentives for wastewater reuse adoption, cost was broadly the least motivating factor while ecological conservation and future water shortages were the two strongest motivators across all sites. Additionally, respondents in sites with low levels of wastewater technology were more likely to express a willingness to use treated wastewater given any motivator.

Key words | acceptability, motivation, treated wastewater, water reuse, willingness to use

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INTRODUCTION

Central challenges of safe and reliable water resources are at the forefront of public health concerns. The use of treated wastewater to augment surface and groundwater resources can help to meet increasing global demand (Gleick 2000). It is estimated that two million tons of untreated wastewater (municipal, industrial, and agricultural) are discharged into the world's waterways every day (Corcoran *et al.* 2010). For many developing countries, expanding the water resource portfolio to include treated wastewater will also improve public health outcomes by enhancing wastewater management practices (Qadir *et al.* 2010).

There are a variety of wastewater treatment technologies available to achieve recycled water of acceptable quality

(National Research Council 2012). However, implementation of wastewater reuse schemes is often met with public resistance (e.g., Hurlimann & Dolničar 2010). A large number of studies have examined the role that factors such as water source (e.g., Nancarrow *et al.* 2002), intended use (e.g., Bruvold 1988; Buyukkamaci & Alkan 2013; Bagha-pour *et al.* 2017), risk perception (e.g., Baggett *et al.* 2006; Massoud *et al.* 2018), disgust (e.g., Haddad *et al.* 2009; Wester *et al.* 2016), trust (e.g., Ormerod & Scott 2012), and economic incentives (e.g., Dupont 2013) can have in hindering or facilitating public perception and acceptance of wastewater reuse. Across these studies, several important findings have emerged: (a) public perception and

acceptance of treated wastewater reuse is primarily hampered by feelings of disgust and concern over public health risks, (b) people are generally more willing to accept treated wastewater reuse for non-potable purposes only, and (c) public acceptance of treated wastewater reuse is highly dependent on the respondents' level of trust in water managers, researchers, and government officials.

To date, most studies of wastewater reuse acceptance have been performed in a single setting within a developed context. Existing comparative studies largely focus on comparing sites within a single country (e.g., Haddad et al. 2009; Garcia-Cuerva et al. 2016) or across developed countries (e.g., Marks 2006). However, there is a recognized need for comparative studies and research in other parts of the world in order to increase our understanding and structure a more generalized theory around perceptions of wastewater reuse (Dolničar & Saunders 2006). In addition, relatively few studies have examined motivations for supporting or opposing water reuse. Bruvold's (1979) study found that respondents in California preferred uses of reclaimed wastewater that they perceived to conserve water, enhance the environment, protect health, and keep down treatment and distribution costs. Of the five factors that Bruvold identified only cost has received significant study.

Research on financial incentives has shown that environmental behavior is not always economically rational (Kollmuss & Agyeman 2002). Some research has indicated that pro-environmental behavior may stop if there is an economic motive that disappears (Pardini & Katzev 1984) and in a literature review on the effectiveness of incentives, Stern (1999) determined that there are multiple motives affecting pro-environmental behavior and that monetary incentives are really only effective when people are inspired by other motives to seek out information that tells them that the incentive is available.

This research expands the literature on motivations for wastewater reuse by examining the role that *cost*, as well as three other motivators (*current water shortages*, *future water shortages*, and *ecological conservation*), play in peoples' willingness to adopt treated wastewater as a viable alternative source. Specifically, we analyze close-ended interview data across four economically developed (2) and developing (2) sites to answer the following questions: (a) are there cross-cultural motivations for willingness to use wastewater, and (b) how do respondents' willingness to use scores vary with differences in wastewater technology (low vs. high) given each motivator?

METHODS

Site selection and description

For this study, four sites were selected to represent varying levels of wastewater treatment and indirect reuse (Table 1), which is, to some extent, a product of socio-economic status and political development: Acatenango, Guatemala; Viti Levu, Fiji; Wellington, New Zealand; Madrid, Spain. Data from Guatemala were collected in Acatenango, an indigenous Mayan community in the Central Highlands of Guatemala. Piped water quality and supply is inadequate and, as a result, many residents buy treated bottled water. Fijian data were collected in an indigenous village on the Coral Coast of the main island of Viti Levu. Between 2006 and 2010, local villagers worked with outside experts to build a piped water system, including a wastewater treatment system. All houses in the village have been joined to sewage lines; grey water is treated using three levels of filtration (coconut husk, soil, and sand) and black water is held in septic tanks before being pumped to

Table 1 | Study site characteristics

	Acatenango, Guatemala	Viti Levu, Fiji	Wellington, New Zealand	Madrid, Spain
Population (approx. rounded)	18,000	300	500,000	3,200,000
Research site rurality	Semi-rural	Semi-rural	Urban	Urban
Wastewater reuse purpose	None	Village gardens	None	Irrigation of public green spaces
Wastewater treatment	None	Ecological treatment	Secondary treatment	Secondary and tertiary treatment

a constructed wetland. Data from New Zealand were collected in the capital city of Wellington. In Wellington, water is managed by local city governments. The area is served by four wastewater treatment plants that practice secondary level treatment (Wellington Water 2015). Spanish data were collected in the capital city of Madrid where water is primarily managed by the public limited company, Canal de Isabel II Gestión. Canal Gestión operates 154 wastewater treatment plants, 23 of which provide tertiary treatment (Canal de Isabel II Gestión 2012).

Sampling

Using a non-probabilistic, purposive sampling strategy (Bernard *et al.* 2016), we targeted permanent adult residents at each field site with the goal of having a sample that was well representative of broader population demographics. This design was based on the rationale that if there exists a shared cultural understanding of water issues, it should be detectable through sampling of local residents in public spaces (Handwerker & Wozniak 1997). We set the minimum number of respondents needed at each field site at 60 based on the highest necessary sample size according to the most rigorous guidelines for ethnographic research (Bernard *et al.* 2016). In total, we conducted 283 interviews: 63 in Guatemala, 77 in Fiji, 64 in New Zealand, and 79 in Spain. Data were collected through face-to-face, semi-structured interviews from June 2013 to September 2013.

Data collection

The survey protocol was written in English and pre-tested with native English-speakers to ensure comprehensibility. The protocol was translated and back-translated by two bilingual English/Spanish speakers and approved under Arizona State University IRB #0804002902. Interviews were conducted in the respondents' language. The protocol included open- and close-ended questions about wastewater reuse and basic demographics. The data analyzed here were elicited through a close-ended question asking respondents to mark their willingness, on a seven-point Likert scale from 'Totally Unwilling' (-3) to 'Totally Willing' (3), to accept treated wastewater as an alternative water source if it was certified safe and (a) for *cost*: 'The cost was half of

what you currently pay for water,' (b) for *current water shortages*: 'It would prevent water shortages in your community now,' (c) for *future water shortages*: 'It would prevent water shortages for future generations,' and (d) for *ecological conservation*: 'It would help save rivers, lakes, and wildlife.' These motivators were chosen to represent hypothetical extrinsic incentives (cost) and intrinsic incentives (ecological conservation and preventing current and future water shortages) (Hornik *et al.* 1995) based on three of the motivations Bruvold (1979) previously identified: conservation, environment, and cost.

Data analysis

We analyze the Likert-type data for each motivator to assess (a) whether cross-cultural motivations for willingness to use wastewater exist and (b) how respondents' willingness to use scores vary with differences in wastewater technology (low vs. high) given each motivator. First, we calculated the percentage of respondents at each site who indicated that the motivator positively affected their stated willingness to accept treated wastewater. Second, we conducted cross-site analyses to determine the association between wastewater technology level, and the average stated willingness to use treated wastewater given a particular motivator. In lieu of a non-normal distribution, Mann-Whitney U tests were utilized as the non-parametric alternative to the t-test for independent samples, allowing us to determine whether there is a difference in the distribution of willingness to use scores between respondents in developing and low technology sites (Guatemala and Fiji) and respondents in developed and high technology sites (New Zealand and Spain). The results of the exact Mann-Whitney U tests can be found in Table 2.

RESULTS AND DISCUSSION

Cost

Across three of the four research sites, reducing the cost of water was, on average, the least motivating factor. The majority of respondents in three of the four sites were either unwilling or not affected by reducing the cost by

Table 2 | Results of the Mann–Whitney U test to compare willingness to use treated wastewater given a particular motivator across respondents in low-technology and high-technology sites

Motivators	Wastewater technology level	N	Median	Rank average	Sum of ranks	U	p
Cost	High	140	0.0	125.57	17,580.0	7,710.0	0.04*
	Low	129	0.0	145.23	18,735.0		
Current water shortages	High	140	1.0	127.66	17,872.5	8,002.5	0.10
	Low	129	1.0	142.97	18,442.5		
Future water shortages	High	140	1.0	122.41	17,138.0	7,268.0	0.00*
	Low	129	3.0	148.66	19,177.0		
Ecological conservation	High	140	1.5	120.47	16,866.0	6,696.0	0.00*
	Low	129	3.0	150.77	19,449.0		

*Significantly different at 95% confidence level.

half to accept treated wastewater (Fiji: 54.9%, New Zealand: 58.7%, Spain: 62.3%). In contrast, in Guatemala, 50% of the respondents indicated that they would be ‘totally willing’ to accept treated wastewater if the cost was half of what they currently pay. The exact Mann–Whitney U test revealed a significant difference between low-technology and high-technology respondents, driven by the Guatemala respondents.

While previous studies have focused solely on economic incentives as a way to motivate people to accept treated wastewater as a viable water source, we found that reducing the cost by half was not a strong motivator for respondents at most of the sites in our study. This finding is consistent with previous studies that have shown that people only expect monetary compensation when wastewater is used to augment the potable water supply (Blamey *et al.* 1999). As cost is generally not a strong motivator across multiple contexts, the need for additional studies of motivations beyond economic incentives is needed.

Current and future water shortages

Most respondents at all sites indicated that they would be willing to accept treated wastewater if it would prevent water shortages now (Guatemala: 60.3%, Fiji: 59.2%, New Zealand: 52.4%, Spain: 52.0%), and in the future (Guatemala: 81.0%, Fiji: 60.6%, New Zealand: 54.0%, Spain: 63.7%). Preventing current water shortages was, on average, the least motivating factor for respondents in Guatemala and the second least motivating factor for respondents at the other sites. Differences between respondents in low-

technology and high-technology sites varied in response to preventing current and future water shortages. In response to current water shortages, there was no significant difference between the respondents in the low-technology and high-technology sites. Alternatively, in response to future water shortages there was a significant difference between low-technology and high-technology sites.

Ecological conservation

The majority of respondents at all sites indicated that they would be willing to accept treated wastewater for ecological conservation (Guatemala: 75.8%, Fiji: 73.3%, New Zealand: 63.4%, Spain: 62.4%). A Mann–Whitney U test revealed a significant difference between low-technology and high-technology sites ($p < 0.05$).

The role of intrinsic motives is an important area for further consideration. Overall, respondents indicated a willingness to adopt treated wastewater for ecological conservation and to prevent water shortages both now and for future generations. Ecological conservation and future water shortages were the two strongest motivators across all four sites. Studies looking at determinants for pro-environmental behavior have long recognized the importance of these motivators (Bamberg 2003).

In addition, it is important to consider the role that the level of wastewater technology, which is a function of development status, may have on respondents’ motivations. For three of the motivators (cost, ecological conservation, and future water shortages), there was a statistically significant difference in the average willingness to use treated

wastewater between respondents in low-technology (developing) and high-technology (developed) sites. In each of these cases, and in the case of current water shortages, respondents in low-technology sites indicated a greater willingness to accept treated wastewater as a viable option. While these findings cannot be used to infer an association outside of the sampled population, they do suggest avenues for future research. Other studies have shown that residents of developing countries have a greater trust in technology (Leiserowitz *et al.* 2005). As such, technological solutions such as wastewater reclamation and reuse options may face less opposition in developing contexts, which are often in the most need of improved wastewater infrastructure.

CONCLUSION

In sum, this research has shown that there are a range of different motivations that can inspire people to adopt treated wastewater as a viable source and that additional research is needed to clarify the role that different motivations play in different contexts. The literature on water conservation suggests that the more motives a person has, the more likely that person will be to engage in conservation. We suggest that future marketing campaigns, which in the past have often failed to change public perceptions of wastewater reuse, need to be oriented around motives that are most relevant for the population of concern. Further, future research needs to identify and rank motives for wastewater reuse, focusing on both individual sites and cross-cultural studies.

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