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Effects of feedback about community water consumption on residential water conservation

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ABSTRACT

This study was designed to investigate methods of promoting water conservation through feedback about the level of water consumption in the long term. Most previous studies have been conducted in areas where water resources are under stress, whereas as this study was conducted in the Tokyo commuting area, where there is little worry about a water shortage. Three types of feedback about the level of water consumption in their community were provided to water users. These included actual mean consumption, consumption rank, and emoticons with written information. Feedback was sent once every two weeks during a 24-week period. Two hundreds and forty-six participants were randomly sampled from survey monitors in the Tokyo commuting area. The results indicated that effective feedback information differed for high and low water consumers. Water use in high consumers decreased when they received emoticons, whereas that in low consumers decreased when they saw that their use had decreased. Consumption in low water users did not increase even when they were notified that their consumption was relatively small. In addition, information about mean water consumption is only effective under conditions of water scarcity. In the future, the amount of regional water resources should be considered in selecting the survey area.

1. Introduction

The instability of water resources is increasing, not only in areas that have typically experienced water stress, but also in many new areas because of the uneven distribution of rainfall caused by climate change. For sustainable use of water resources, the importance of water conservation has been increasing, not only from supply-side water management but also from demand-side (Bates et al., 2008). In many industrialized countries, however, the price of water has long been very low, and domestic consumers have tended to waste water (Nauges and Thomas, 2003). Using social and econometric models, a number of studies have identified a range of direct and indirect influences on water consumption that may be applied to change consumers' water use behavior and achieve residential water conservation (Jorgensen et al., 2009).

In particular, water price is the most significant factor in decreasing residential water consumption (Espey et al., 1997; Grafton et al., 2011). However, it takes a great deal of time for households to adapt their water use behavior to price changes (Dalhusein et al., 2000; Nauges and Thomas, 2003; Arbues et al., 2004). Further, there is a limit on price increases that can be imposed to regulate water consumption, because water is indispensable for life. Finally, as the price elasticity of higher income households is significantly smaller than that of lower income households (Renwick and Archibald, 1998), only lower income households decrease their water consumption in response to a price increase.

The introduction of water-saving devices has also been considered (Randolph and Troy, 2008). Empirical evidence of water saving by use of low-flow showerheads is mixed (Olmstead and Stavins, 2009), and of all water-saving devices, only a low volume/dual-flush toilet has been reported to have a statistically significant effect on water saving (Grafton et al., 2011). The replacement of a device occurs so infrequently that we do not typically consider its effects in the long run (Nauges and Thomas, 2003), and rebates for water-saving devices have had no significant impact (Renwick and Green, 2000).

There is a growing body of literature on the relationship

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between water consumption and attitudes as well as behavior related to household water use. Awareness of local water conservation efforts was found to influence water use habits, particularly washing machine loads and showers (Gregory and Leo, 2003). Water consumption was significantly associated with consumer attitudes towards conservation practices (Domene and Sauri, 2006) and was affected by trust in the water authority and community (Jorgensen et al., 2009). However, water consumption is related to specific beliefs about water, rather than general environmental concerns (Corral-Verdugo et al., 2003). The majority of these studies only measured water conservation intentions or used self-reported measures of water conservation. Because self-reports of water conservation behavior are often not linked to actual water consumption (De Oliver, 1999; Beal et al., 2013), research needs to move toward measuring both water conservation intentions and actual water use (Russell and Fielding, 2010).

A number of approaches have been used to change behavior to be more environmentally responsible. De Young (2000) makes a distinction between antecedent and consequence approaches to behavioral change. The antecedent approach means a change of attitude about the determinants of behavior and conservation, for example, by environmental campaigns or providing information. Kurz et al. (2005) found that including information detailing the importance of conserving water in their homes and describing ways to reduce usage led to a 23% reduction in residential water consumption. The consequence approach changes behavior by influencing determinants after the enactment of the behavior, for example, providing rebates for water saving to reinforce water conservation practice or giving households feedback about the level of water consumption in their community (Russell and Fielding, 2010).

There are various ways of achieving efficient water use, such as equipment and facilities replacement, as well as the structural change of water utility fees. This study focuses on the idea that feedback on water consumption would facilitate changes in users' behaviors. For example, it has been reported that real-time feedback about energy consumption reduced consumption by 5–20% (Sonderlund et al., 2014). However, there are relatively few studies of the effects of such feedback on water consumption. For example, Stewart et al. (2012) developed visual monitors for water use in showers. These not only indicated the actual water consumption in real time but also set off alarms when excessive water was consumed. Their results of an empirical study on the Gold Coast of Australia indicated that use of water decreased in the short term, but this reduction was not maintained in the long term.

Some researchers have provided feedback about water consumption combined with other information. Fielding et al. (2013) examined the types of communication that were effective for promoting water conservation in South East Queensland, Australia. They compared the effects of four types of communication: control (no communication), information only, information plus descriptive norm, information plus feedback about water end use. Information was provided by means of postcards showing ways to save water. Descriptive norms showed the percentages of households with similar family structures that were engaged in water-saving behaviors. Feedback provided the overall levels of water consumption in their community and the percentage break-down across water using activities (e.g. toilet, cooking, bathing, gardening, and so on) on three occasions. The results indicated that water consumption decreased in the all experimental groups relative to the control group. However, it is unclear which of the factors, i.e. information, descriptive norms, or feedback, was effective in reducing consumption. Furthermore, after 12 months, changes in water-saving resulting from transition in behavior of participants in the experimental groups disappeared. The area where the survey was conducted had experienced a serious drought, and water resources in this area were therefore uncharacteristic. Thus investigations need to be conducted under general water resource condition.

Erickson et al. (2012) conducted a 15-week empirical study using an Internet portal site for 303 households in Dubuque, Iowa. Near real-time feedback on water consumption was provided on this website, along with social comparisons with “Neighbors Like Me”, games, news, and chat. A water saving of 6.6% was achieved during the first nine weeks. Because there were different types of information on the website, it is unclear which information was effective in the reduction of consumption. On the other hand, providing different types of information could have been effective because the information that motivates water saving may differ for different people. Moreover, since participants in the survey were volunteers, they may have been interested in water use from the start. Therefore, future studies need to choose ordinary citizens as participants. Furthermore, the survey was conducted for just fifteen weeks, and it is thus unclear whether water conservation is maintained over several months.

Based on the outcomes of the above survey, this study was designed to investigate methods of promoting water conservation through feedback about the level of water consumption in their community over several months in an area having sufficient water resources. It was considered that most previous studies were unrepresentative in five respects. Firstly, they have focused on areas where water resources were under stress. Secondly, they drew upon volunteer samples who were particularly water conservation-minded (Sonderlund et al., 2014). Thirdly, they were conducted in areas where a large portion of residential water was used outdoors. Fourthly, there are few studies with an intervention period of more than several months. Lastly, the factors for feedback were insufficiently controlled. This survey of residents in the commuting area of Tokyo was designed to overcome these five limitations as far as possible. Firstly, this survey extended research into areas little affected by water shortage. Secondly, participants were sampled from the general population and included those who were not always water conservation minded. Thirdly, more than 94% of residential water was used indoors (Bureau of Waterworks Tokyo Metropolitan Government, 2012). Fourthly, the intervention period was as long as six months. Finally, feedback information was developed to identify information that was effective for reducing water consumption.

2. Materials and methods

2.1. Overview of research procedure

Participants were residents in the Tokyo commuting area who were randomly sampled from a roster of survey registrants with a research company. As they were not volunteers, people who were not always water conservation-minded were included in the sample. The survey was conducted from October to March which is the period between autumn and spring in Japan, when fluctuations in water consumption are known to be relatively small (Sumi et al., 1996). Participants were required to read the value shown on their water meters and report it once every two weeks for a 24-week period (i.e., 12 observations). Feedback about the level of water consumption in their community was sent by fax to each participant within 2–3 days of each observation. Participants were asked to display the fax in their homes so that all family members could see it and information could be shared among them. In order to control for the effects of seasonal factors, a control group just read and reported the reading on the water meter once every two weeks and received no feedback. The feedback and control groups

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