



Evaluating the efficacy of an information-based residential outdoor water conservation program

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ABSTRACT

Information-based policy instruments are some of the most commonly used tools for influencing consumers' water use in the residential sector. However, their ability to change behavior remains an area in need of further research. This study describes the evaluation of an information-based demand management program, rooted in normative comparison, designed to increase the efficiency of households' residential outdoor water use. Results indicate that the program had an impact on water use among households that received persuasive messages regarding their past consumption, compared to estimates of lawn water requirements and the water use of neighbors. Additionally, the results demonstrate that the treatment effect gets stronger over time and varies among message recipients as a function of baseline water use. Unanticipated effects of the administration of the messages show an increase in water use among the lowest consuming households. Top users reduced their water use significantly as a function of the persuasive message. The findings suggest that utilities seeking to augment users' water consumption through persuasion must be cognizant of the way that messages are framed, and who receives them, or potentially face unanticipated side effects, and that message repetition may have some additionality.

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1. Introduction

Conservation programs that encourage water savings through the provision of education, information, and persuasion are some of the most commonly used policy instruments in the residential sector (Russell and Fielding, 2010). In many cases these instruments are the only ones available to water managers as the political climate precludes the use of pecuniary strategies or market-based instruments to manage demand (Katz et al., 2016). However, the efficacy of information-based instruments in bringing about a change in water use remains an area in need of further study (Landon et al., 2016). Some scholars maintain that in the long-term "... conservation needs will always lack salience or immediacy for consumers, and consequently, voluntary conservation is impossible to motivate" (Syme et al., 2000 pp. 540). Others, however, contend that feedback information, and persuasive messages that employ specific behavioral principles, can have an immediate impact on

water use (Schultz et al., 2014; Seyranian et al., 2015). Relatively little research has been directed toward understanding the impacts of persuasion, education, and feedback information on water use over longer periods of time while drawing on individual level household data in the field (Otaki et al., 2017; Katz et al., 2016). Obtaining reliable data and drawing inferences from counterfactual changes in water consumption as a function of the administration of information-based conservation campaigns can be problematic at the field-scale (Syme et al., 2000). However, given the ubiquity of implementation of information-based instruments in demand management programs, developing a better understanding of the ability of these instruments to bring about a change in water use, and sustain that change over time, is critical if utilities are to meet rising demands for increasingly scarce and contested freshwater supplies (Fielding et al., 2013). In this study the efficacy of one such information-based residential demand management program in affecting a change in household water use was evaluated.

1.1. The current study

Water managers in College Station, Texas, have engaged in a

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campaign to improve the efficiency of outdoor water use among a subset of the utility's most prolific water customers. Households residing in the top 14 water using neighborhoods in the service area represent roughly 15% of the residential accounts, yet are responsible for as much as 40% of the city's water consumption. Consistent with much of the southern and western United States, the majority of water consumption for these households is done outdoors for lawn and landscaping irrigation. Past research has documented high levels of waste in outdoor water use stemming from leaking irrigation systems, incorrectly programmed automatic controllers, and misdirected and broken sprayers among many other sources (Endter-Wada et al., 2008). Consequently, improving the efficiency of irrigation water application can yield substantial water savings, especially among high consuming households (Landon et al., 2016).

Households in the 14 neighborhoods targeted in the study ($n = 5565$) were provided with feedback information on their outdoor water use, including a comparison of their water use to an "efficient" standard, and the average outdoor water use of their neighborhood. Messages were delivered at the beginning of the major irrigation season running from April to October each year over the period 2012–2014. Collectively, the information provided to residents was referred to as a "water budget". In reference to the water budget, efficiency was defined as the amount of water that the household would need to have applied over a given area of lawn, over a given time frame, under a given set of climate conditions, in order to keep it healthy (White et al., 2004). By providing customers with the messages, the program intended to motivate water use in-line with what is considered appropriate in terms of efficiency as defined by the utility, and what is normal in terms of the water use behavior of the households' peers.

This study was motivated by three specific research questions related to the effectiveness of the program: RQ1: Has there been a reduction in water use among message recipients as a function of receiving the messages? RQ2: If there has been a reduction in water use, how has this reduction persisted over time? and RQ3: Did the effects of the messages vary among recipients as a function of their water use during the period before they were administered? Evaluating the efficacy of the water budget program adds to a growing body of literature in information-based residential water conservation program evaluation, and helps to establish a baseline against which to judge future management actions (Landon et al., 2016). Additionally, determining variability in consumer responses to information-based instruments can aid policy makers in directing scarce resources toward the most responsive consumers in order to bring about the greatest change in water use possible (Ferraro and Miranda, 2013).

1.2. Literature review

Feedback refers to providing consumers with information about their past or current behavior with the intent to influence that behavior in the future (Abrahamse et al., 2005). In the residential water conservation literature, many studies have examined the impacts of feedback information on subsequent water use. These studies have taken on two dominant forms. The first has focused on providing near real-time information on water use through so-called "smart meters". Smart meter studies are predicated on the assumption that the more salient water consumption information can be made, the more users will be motivated to conserve (Nguyen et al., 2018; Boyle et al., 2013). Results from this literature are mixed as research has shown that descriptive information is not necessarily incorporated into the decisions of consumers (Schultz, 2002), and that associated gains in conservation with information-based interventions are relatively ephemeral (Fielding et al., 2013).

The second is rooted in social comparison. Normative

approaches to behavior change like the Focus Theory of Normative Conduct (Cialdini et al., 1990) and Community Based Social Marketing (McKenzie-Mohr, 2000) have gained increasing attention as management tools in natural resource conservation (Abrahamse et al., 2005). Drawing on Festinger's (1954) social comparison theory this approach is based on the notion that individuals behave in a way that is consistent with their peers (Ferraro et al., 2011). Research has consistently shown that when individuals are given information that describes their behavior in relation to that of their peers, or peers expectations, aligned with a message concerning the appropriateness of that behavior, they will adjust their behavior to be more closely in-line with the social group (Cialdini et al., 1990, 1991; 2006). Critics of the so-called information-deficit model see the normative benchmark provided through social comparison as a critical mechanism for behavior change that is rooted in theory. That is, information alone is often not sufficient to achieve a change in individual behavior; information must be presented in a way that activates specific motivational processes and aligned with a statement concerning its appropriateness in the social arena (Schultz et al., 2007; Cialdini et al., 1990).

It should be noted, however, that the two approaches are not mutually exclusive. Researchers have found that feedback information containing descriptive normative messages can affect a change in household water consumption (e.g., Fielding et al., 2013), and that high resolution information obtained from smart meters may be useful in social comparison studies (Liu et al., 2016). Beal et al. (2013), for instance, found that users' perceived and actual water consumption are not necessarily aligned, and that high using households underestimate their use. Information of this nature, revealed through smart meter end use studies and surveys, can be used to better design behavior change instruments.

Using the social comparison framework, Schultz et al. (2007) found that the administration of normative messages that compared individual and neighborhood water use yielded a significant reduction in consumption during a period of drought above and beyond technical advice or appeals for conservation when the message was aligned with a statement that approved or disapproved of their level of consumption. These results were replicated in a later study (Schultz et al., 2014) and extended to show that the extent to which individuals feel a moral obligation to conserve moderates the impact of social influence on behavior change. Further, Ferraro et al. (2011), in one of only a few long-term investigations of the impacts of social norms interventions on residential water use, were able to show that a single message resulted in a policy relevant level of behavior change six years after it was administered. However, the strength of the treatment effect declined over time. This finding stands in contrast to Fielding et al. (2013), who found a relatively fast return to baseline consumption (~12 months) following a feedback experiment that provided descriptive normative and real-time consumption information to Australian homeowners.

Feedback experiments rooted in social comparison have been implemented in a number of other contexts as well (Cialdini et al., 2006; Goldstein et al., 2008). For instance, similar studies in the energy sector have shown that norms-based messages can affect residential consumption (Ayres et al., 2009; Costa and Kahn, 2013; Schultz et al., 2007). Alcott and Rodgers (2012) summarize the results of a number of large scale field experiments in energy conservation finding support for the utility of norms-based messages in applied resource conservation.

Social influence, however, can emanate from a variety of relationships (Fishbein and Ajzen, 2010). French and Raven (1959) hypothesize that social influence is a function of the perceived power of social agents – i.e. water managers, neighbors etc. – to administer rewards and coercive punishments; legitimate power of

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