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Household water use behavior: An integrated model

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ABSTRACT

Water authorities are dealing with the challenge of ensuring that there is enough water to meet demand in the face of drought, population growth and predictions of reduced supply due to climate change. In order to develop effective household demand management programs, water managers need to understand the factors that influence household water use. Following an examination and re-analysis of current water consumption behavioral models we propose a new model for understanding household water consumption. We argue that trust plays a role in household water consumption, since people will not save water if they feel others are not minimizing their water use (inter-personal trust). Furthermore, people are less likely to save water if they do not trust the water authority (institutional trust). This paper proposes that to fully understand the factors involved in determining household water use the impact of trust on water consumption needs investigation.

1. Introduction

Population increases, water pollution, urban development, agricultural irrigation, climate change and drought have contributed to significant disparities between the availability of quality water sources and demand for consumption. The main water issue for many regions is the diminishing and uncertain water security in the face of increasing consumption. While water authorities attempt to secure future water supplies they also recognize the need to manage water demand.

Governments and water providers are planning to, or already have, introduced a range of demand management strategies (Chen et al., 2005; Marsden and Pickering, 2006; Kenney et al., 2008). While water pricing features large in the future of water resources management, non-pricing policies, such as water use restrictions and incentives for water saving device use have also received attention and discussion (Jackson, 2005; National Water Commission and Water Services Association of Australia, 2007; Clark and Finley, 2008; Iglesias and Blanco, 2008). Many water providers are seeking to expand existing supplies (for example through pipeline extensions, alteration to dam storage capacity, new dams, desalination plants and recycling). Inevitably, both the supply and demands sides of water management have significant economic and social components. On the demand side there are issues of fairness and equity particularly around pricing, and on the supply side community opposition to the costs of measures to expand water supplies.

Reducing demand by improving the efficiency of water use necessitates an understanding of how water is used and in what ways water savings can be realized. Stumbling blocks to achieving this goal are apparent in the social and economic research on water demand management and water consumption (see for example Barta, 2004). First, the greater bulk of relevant research takes the form of non-peer reviewed technical reports, case studies and consultancy reports (Gregory and Di Leo, 2003). Second, research concerning the economic drivers and characteristics of water demand has received more attention than the social psychological determinants of water use behaviors and water conservation (Corral-Verdugo et al., 2002; Gregory and Di Leo, 2003). Rarer still, are models that seek to integrate economic and social viewpoints, not least because of problems of locating available data at appropriate scales (Campbell et al., 2004). Third, the implementation and outcomes of water conservation measures have tended to be context specific such that generalizations are difficult to draw (Atwood et al., 2007). Fourth, while applications and evaluations of water conservation strategies have been constrained by site and issue specific factors, their theoretical underpinnings are derived from general theories of environmental and consumer behavior developed in non-water contexts (e.g., household recycling, household energy conservation, private goods consumption, etc.). Therefore, the

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development of integrated socio-economic models of water conservation is sorely needed (Land & Water Australia, 2006).

The aim of this paper is to develop a theoretical integrated social and economic water use model for understanding household water consumption through the examination of current water use behavioral models and previous water use behavior studies. The paper begins with a review of the types of demand management and some of the issues caused by not fully understanding how people use water and make decisions about water use. Next the paper provides a description of the drivers of water use that have been identified in previous studies. Following this is a section that examines the findings of water use behavioral models that leads to the development of a new integrated social and economic water use model. A significant component of this integrated model is the role of trust in determining water use behavior. As such, the paper concludes with a discussion about the importance of trust in water use decisions, suggesting that this is an area for further research, which is needed to develop a clearer understanding of the drivers of water use behavior to help in the development of effective demand management strategies that result in reduced demand.

2. Issues with water demand management

The success of household water demand management strategies is dependent on how well we understand how people think about water and water use. There is evidence to suggest that (mandatory) water restrictions reduce consumption over the short term when *motivations to comply* exist among consumers (e.g., acceptance of responsibility for the problem, perceptions of institutional trust, environmental values, etc.). Water conservation is more apparent when individuals believe that water is scarce and when they perceive that other consumers are also conserving water (e.g., perceptions of inter-personal trust) (Corral-Verdugo et al., 2002). But there are still questions about the interactions between water pricing strategies, water restrictions, expansions in water supply and individual motivations to conserve water.

Similarly, the price of water can affect demand in the short run (Campbell et al., 2004). Although, it is not clear whether *awareness* of the marginal price is the main driver (Carter and Milon, 2005) rather than the pricing structure (e.g., increasing block tariff), and/or the frequency of *behavioral feedback* mechanisms, such as the frequency of water billing (Olmstead et al., 2003). In addition, it is unclear whether pricing effects on water consumption over time operate directly or through changes in awareness of the seriousness of water scarcity and/or individual motivations (both conservation motivations and perceptions of trust in the water provider). If price is to be an effective means of managing demand, water providers need to know how price information is incorporated into the water use decision-making of their customers and in what ways it interacts with other factors (e.g., water restrictions) in the decision process (Syme et al., 1990–1991; Howe and Goemans, 2002; Barta, 2004). And finally, while pricing and water restrictions may operate to regulate household water consumption in times of perceived water scarcity, little is known about how effective these strategies might prove to be when water supply is expanded. There are still questions about whether water conservation motivations and behaviors become less apparent over time in households when consumers perceive that water is being effectively managed through pricing, restrictions and the development of new water sources.

While information-based education strategies might increase awareness of water issues, they have met with mixed success in altering conservation behaviors (Nancarrow et al., 1995; Syme et al., 2000; Winter, 2000; Gregory and Di Leo, 2003; e.g. Barta, 2004; Campbell et al., 2004). This is due to the lack of a direct link between attitude and behavior, resulting in individuals believing water saving is important, but for a number of different reasons this attitude is not reflected in their water use behavior. Although, when individuals are made aware of this difference between their behavior and attitude, their water use decreases (Aitken et al., 1994).

While a large body of econometric research has addressed the impact of price and non-price water policies on aggregate and household water consumption, the reason for the success and failure of specific initiatives are often ad-hoc (for a review see Campbell et al., 1996). This is perhaps partly due to the lack of social psychological data at the household level. For example, off-setting behaviors (e.g., increasing shower length after installing a low flow showerhead) are thought to account for the ineffectiveness of household water saving technologies, such as low flow showerheads (Campbell et al., 2004), without the benefit of data concerning the dynamics of water use behavior at the household level. Further, while water providers attempt to achieve water conservation in an equitable manner, the definition of equity and fairness across different consumers and communities is usually not known (Atwood et al., 2007). And, despite clear indications of the importance of spatial context, explanations of neighborhood effects and regional variability in water consumption tends to be limited by the relative availability of census data (e.g., housing density) instead of individual household characteristics linked to actual consumption.

The examples above highlight deficiencies in our understanding of how people think about water shortages and the range of policy tools that might be deployed to manage water availability. While attributions to 'natural' causes (e.g., drought, low rainfall, etc.) might be expected, so might behavioral issues such as inappropriate use of water in households, and/or mismanagement and poor planning on the part of relevant authorities and service providers (e.g., Atwood et al., 2007). It is in this social environment in which demand management strategies are introduced. Accordingly, it is important that water demand management strategies are informed by an understanding of the factors impacting on water use, including the drivers of household water use behavior to have a chance of reducing water demand.

3. Drivers of household water use behavior

A number of studies have identified a range of direct and indirect drivers of water behaviors (see Table 1). The exact drivers appear to be contextual and behavior dependent particularly when comparing indoor (e.g., cooking, drinking, showering, laundry, toilets, etc.) to outdoor uses (e.g., garden irrigation, cleaning, swimming pool, etc.). Outdoor use is thought to be more discretionary when compared to indoor use and thus, it is often the first target for regulations through water use restrictions. Some of the drivers for indoor use include household composition, presence of water saving devices and a range of socio-economic factors. The main drivers for outdoor use include garden type and importance, regulations, social norms and lot size. However the impact that these drivers have on household water consumption and which are the most important for household use, in terms of developing effective water demand strategies, and how they interact with other factors that may block behavior change, are in question. Many studies have attempted to model the range of factors influencing household water use, described in the following section.

4. Social and economic models of household water use behavior

4.1. Social models

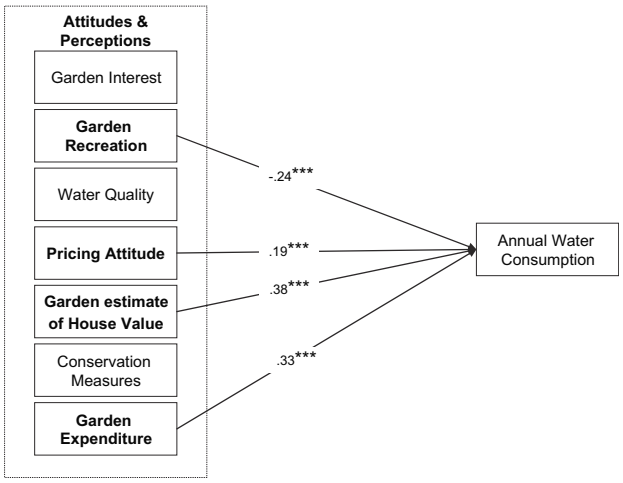
Social models of household water use behavior emerged from studies that attempted to predict household water consumption.

Table 1
The direct and in-direct drivers of water saving behaviors.

Direct drivers	In-direct drivers
• Climate/seasonal variability (Berk et al., 1980; Campbell et al., 2004; Klein et al., 2006) • Incentives/disincentives (e.g., tariff structure and pricing, rebates on water saving technologies, etc.) (Berk et al., 1980; Campbell et al., 2004; Dandy et al., 1997; Lyman, 1992; Martin et al., 1984; Nieswiadomy, 1992; Renwick and Archibald, 1998; Renwick and Green, 2000) • Regulations and ordinances (e.g., water restrictions, local government planning regulations) (Klein et al., 2006; Lee, 1981; Renwick and Green, 2000) • Property characteristics (e.g., lot size, pool, bore, tank, house size, house age, etc.) (Campbell et al., 2004; Cavanagh et al., 2002; Lyman, 1992; Olmstead et al., 2003; Renwick and Archibald, 1998; Renwick and Green, 2000; Syme et al., 2004) • Household characteristics (e.g., household composition, household income, water saving technology, water supply technology) (Campbell et al., 2004; Gilg et al., 2005; Loh and Coghlan, 2003; Mayer et al., 1999; Nancarrow et al., 2004; Renwick and Archibald, 1998; Syme et al., 2004; Tognacci et al., 1972) • Person characteristics (e.g., intention to conserve water, knowledge of how to conserve water) (Corral-Verdugo et al., 2002; De Young, 1996; St Hilaire et al., 2003; Syme et al., 1990–1991; Syme et al., 2004)	• Person characteristics (e.g., subjective norm, behavioral control, attitude toward the behavior) (Beedell and Rehman, 1999; Hines et al., 1986; Leviston et al., 2005) • Institutional trust (i.e., trust in the water provider) (Lee, 1981; Lee and Warren, 1981) • Inter-personal trust (i.e., trust in other consumers) (Lee, 1981; Lee and Warren, 1981) • Fairness (i.e., in decision-making processes, water restrictions, tariffs, new pipelines) • Environmental values & conservation attitudes (Corral-Verdugo et al., 2002; De Young, 1996; Syme et al., 1990–1991; Syme et al., 2004) • Intergenerational equity • Socio-economic factors (e.g., income, household composition, age, gender, education, etc.) (Agthe and Billings, 1997; Campbell et al., 2004; Loh and Coghlan, 2003; Nancarrow et al., 2004)

Syme et al.'s (1990–1991) study of households in Perth, Australia measured homeowner's attitudes against their actual water consumption for a year (see Fig. 1). They found that attitudes pertaining to garden importance as a house investment and a source of recreation, expenditure on garden, and attitude toward water price were all significant predictors of household water use (Syme et al., 1990–1991). As a result, the study suggests that effective demand management strategies should focus on changing garden water use behaviors among households in which the garden is highly valued in combination with increasing price.

Corral-Verdugo et al. (2002), investigating the factors influencing Mexican citizens' water use (Fig. 2) found that conservation motives significantly reduced annual water consumption. Conservation motives included reducing the amount of money spent on water, social norms (i.e., neighbors try to conserve water) and wanting to comply with conservation campaigns. Conversely they found that a perception that others were wasting water decreased conservation motives and resulted in increased water consumption. They also found a disparity between perceived and actual



*** $p < .001$

Fig. 1. Syme et al.'s (1990–1991) social model of household water consumption (*R*-square is about 0.30).

sector consumption, with participants feeling city dwellers were using a higher percent of water than they actually do (31% compared to 8.5%) and farmers using less than they actually do (24% compared to 83.3%) (Corral-Verdugo et al., 2002). This demonstrates that people's perceptions of how others use water are not in line with reality. Furthermore their perceptions of how others use water can impact on their own water use. That is, when individuals did not trust others to save water, they felt no obligation to save water themselves. What this model suggests is that actual water use is influenced by perceptions of how others use water, both wasting and conserving. Like Hardin's (1968) Tragedy of the Commons, the shared resource is depleted through motives of self-interest.

Another social model developed by Gregory and Di Leo (2003) emphasized environmental behavior where awareness (i.e., issues, knowledge and opportunities) affects unreasoned (habits and reflexes), and reasoned (i.e., involvement, attitudes, intentions, perceived self-efficacy) influences. They argue that issues, knowledge and opportunities all directly impact on behavior, which in turn impacts on reasoned and unreasoned influences. Furthermore, behavior is also affected by situational influences (e.g., socio-economic, household and physical environmental variables). By testing this model with residents of Shoalhaven, Australia, they found that environmental awareness, personal involvement, habits and demographic characteristics (such as income, age, education and household size) have some predictive ability for household water consumption (Fig. 3). Thus, Gregory and Di Leo's model suggests that annual water consumption is influenced by local awareness of water conservation which influences water use habits (particularly washing machine loads, full clothes loads and shower use habits) through involvement in decisions about water use.

Loh and Coghlan (2003) study of water use in Perth, Australia, found that inside water use is relatively stable across seasons, socio-economic groups and housing types. The only differences seen were dependent on household size and appliance ownership. This finding, and the fact that 56% of Perth's household water use is for purposes outside the dwelling, means that outside use behaviors are important to target for changes in water consumption (Loh and Coghlan, 2003). Syme et al. (2004) specifically investigated outdoor water use and discovered that lifestyle (e.g., importance to lifestyle of large garden, large lawn, green home environment, etc.), recreation in the garden and enjoyment of gardening are all interrelated and contribute to higher water use. In contrast to Gregory and

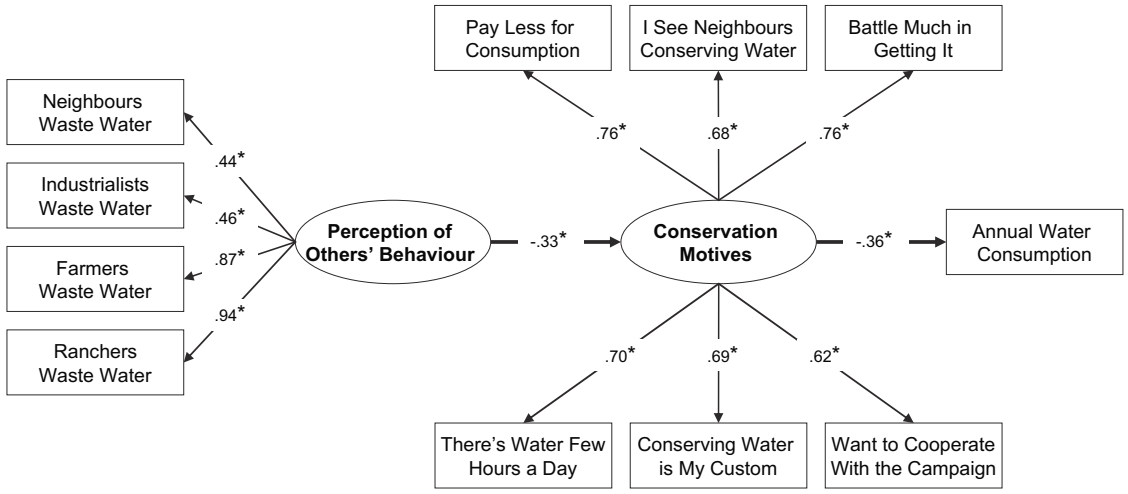


Fig. 2. Corral-Verdugo et al.'s (2002) social model of household water consumption (*R*-square is about 0.13).

Di Leo's model (2003) attitude to water conservation predicted external consumption. Syme et al. (2004) attribute this to excluding internal water use, which is often dependent on household size, and to being more targeted than previous studies. Income, block size, home ownership, type of garden irrigation system and the presence of a swimming pool all had a significant impact on external water use. These factors, along with garden quality and the role the garden plays in lifestyle, are significant contributors to external water consumption (Fig. 4).

Other studies have found that a different mix of factors impact on water use, often dependent on those factors that were the focus of the study. Clarke and Brown (2006) who investigated the receptivity of the community to using alternative water sources and technologies found that demographic influence was weak, but that the ability and capacity of individuals to acquire and apply household water saving and reuse measures is required for behavior change. This finding was also reflected in Berk et al.'s (1993) study where they found people with a higher income, more education and a higher status job were more likely to engage in water saving practices. Upon further investigation, it was discovered that this could be linked to the use of water saving technologies rather than behaviors per se; simply a matter of having the

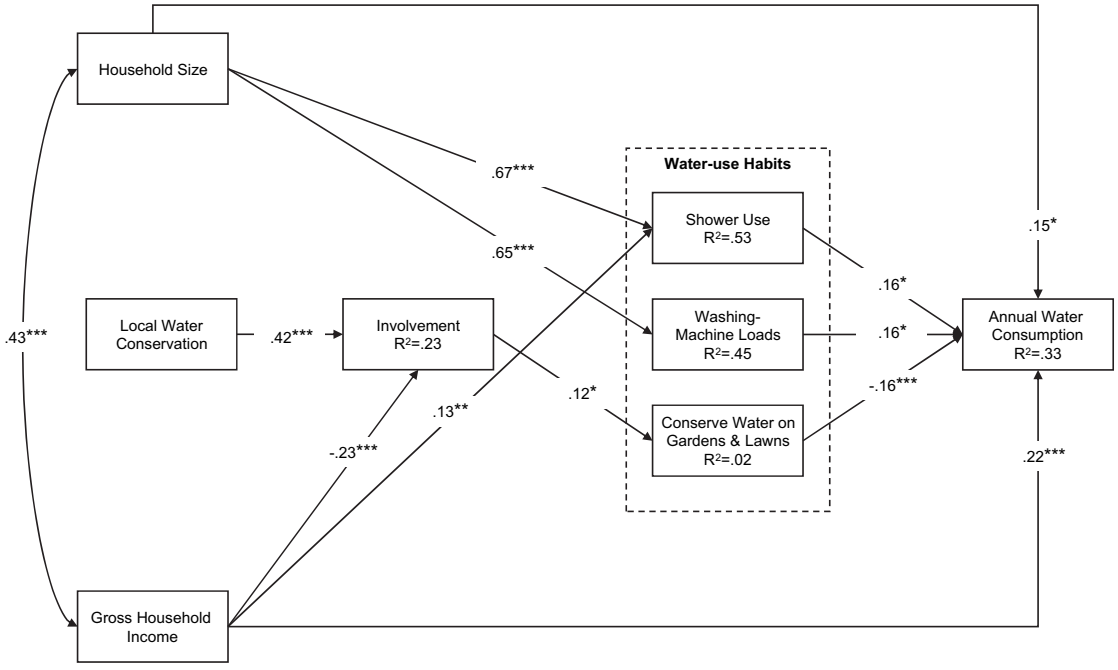


Fig. 3. Gregory and Di Leo (2003) social model of household water consumption.

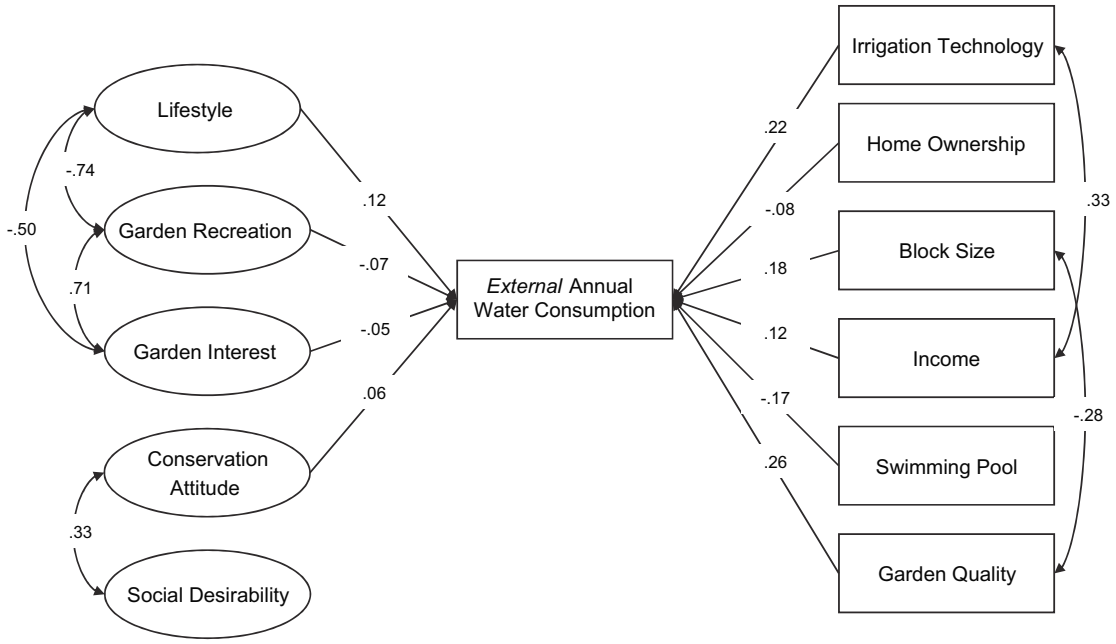


Fig. 4. Syme et al.'s (2004) social model of household outdoor water consumption (*R*-square is about 0.22). Note: Significance levels for the model parameters were not provided in Syme et al. (2004).

ability to purchase more water saving devices unlike the findings of Corral-Verdugo et al. (2003), that linked peoples' tolerance to anti-social behavior and wasteful water behaviors.

4.2. Economic models

Econometric models, such as Renwick and Archibald (1998) (see Fig. 5), indicate that price, price structuring and use restrictions have a direct influence on household water use. These factors also figure in a number of the social models developed (i.e., Corral-Verdugo et al., 2002 and Syme et al., 1990–1991). However, water use is often found to be unresponsive to pricing and income (e.g., Hoffmann et al., 2006), although elasticity (i.e., the responsiveness of demand to changes in price) is higher in home owners compared to renters and to low income households (Renwick and Archibald, 1998; Hoffmann et al., 2006). Renwick and Archibald's model suggests that household characteristics, such as density, household size, location and number of faucets (proxy for house size), play a large role in determining water use, as well as the impact of price and water restrictions. The location of the house also influences the amount of water used, suggesting that some water use behaviors are specific to locations, indicating that demand management needs to be informed by local information about how the community uses water.

The impact of housing density on water use is linked to the size of garden and thus, the amount of outdoor water use. In Renwick and Archibald's study, low density housing was defined as a lot size of greater than 0.55 of an acre, while high density was less than 0.08 of an acre. In this case, low density housing is influenced slightly more by pricing and non-pricing programs, compared to high density housing, as low density housing tends to have larger areas of landscaping compared to higher density housing and use more water outside for gardening, even though both types of housing had both low and high income households (Renwick and Archibald, 1998). The affect of housing density on water use was also observed in Barcelona where low density housing had a much higher water use compared to medium density housing (Domene and Sauri, 2006). The Barcelona study also found that along with housing density, the amount of water used on the garden, household size and the presence of a pool were the largest factors impacting on water use, with consumer behavior index (related to the number of conservation measures used), income and house and garden size having a comparatively small to limited impact. It is evident then that low density housing uses more water for outside uses, making them more sensitive to outdoor water use restrictions to reduce demand.

Renwick and Archibald (1998) found that water use restrictions had the largest impact on water consumption with a larger impact on low density housing, which was probably linked to a greater ability to reduce water used in the garden. The presence of water saving devices impacted on water consumption, particularly low flow showerheads, toilets and water efficient irrigation. This finding suggests that household characteristics, particularly density, number of people and faucets, have more of an influence than either price or income. Income only marginally impacted on water use directly, but it did impact on water pricing influence with low income households reducing their water use with higher prices compared to moderate and high income households. This indicates that pricing is a more effective water demand strategy for low income households and restrictions on use and quantity are more effective for low density households. Interestingly, Syme et al. (1990–1991 p. 164) found that '…respondents who agreed that price affects their water use had a higher price elasticity than the rest of the sample'.

In Aurora, Colorado, Kenney et al. (2008) found that residential demand was largely a function of a number of factors: price, the impact of non-price demand management programs, such as restrictions, rebates and water smart readers, weather and climate. They also found that the influence of price and restrictions interacted with each other, but caused no additive effect, with consumers less responsive to price when under restrictions. They also found that the effect of pricing and restrictions varied among different classes of water users (i.e., low, medium and high) and between drought and non-drought areas. This suggests that the impact of price and non-price demand management strategies will depend on

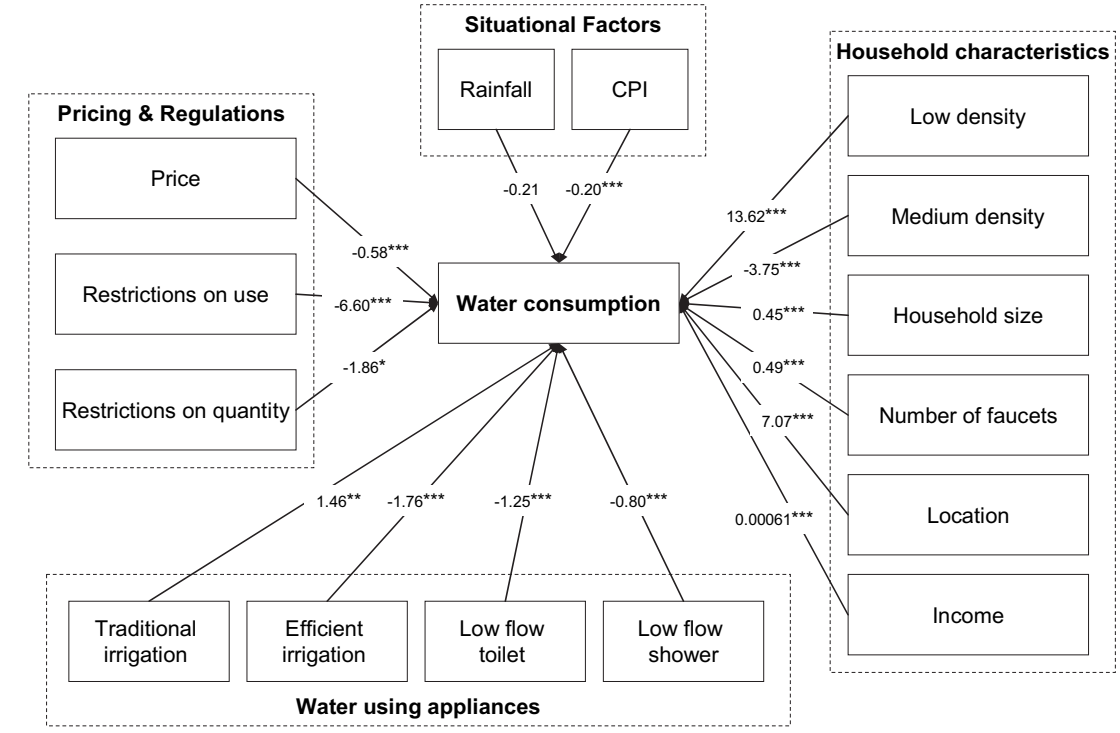


Fig. 5. Econometric models of household water consumption (Renwick and Archibald, 1998) (*R*-square is about 0.31).

the context in which they are used. The area being investigated in the Colorado case was in drought when the restrictions and pricing changes were implemented. Consequently, the changes in water use may have been due to changes in awareness of the value of water since it was in short supply, and thus, changes in behavior and water use, were not directly related to the demand management programs. Changes in awareness, attitude or behavior were not investigated in this study, only demographic, economic and weather related factors were examined.

All of these examples demonstrate that each of these studies on household water use have found different variables that are affecting water use behavior. The factors found include (italics refer to those factors found in multiple studies): *garden recreation*, garden value, how much people spent on their garden and *attitude to pricing* (Syme et al., 1990–1991); perceptions of how others behaved and *individual conservation motives*, such as *compliance with conservation campaigns* and conserving being a custom (Corral-Verdugo et al., 2002); *income*, involvement in water use decisions, awareness of water conservation and *household size* (Gregory and Di Leo, 2003); *household size*, *income*, *irrigation technology*, *block size*, lifestyle, *garden use* and interest and *conservation attitude* (Syme et al., 2004); *income*, *block size* (housing density), *household size*, *pricing*, *restrictions*, *irrigation technology* and other types of water using appliances, rainfall, consumer price index and location (Renwick and Archibald, 1998). Even when these studies were looking at the impact of the same factor, the influence of these factors was found to vary widely. For example, household size was found to act directly on water use by Renwick and Archibald, but both directly and indirectly through income and water use habits by Gregory and Di Leo, and different levels of variation were attributed to this factor in each study. Furthermore, the explanatory power of the models is modest more often than not, with R^2 values of no more than 0.30. Therefore, the discrepancies found in the factors impacting on water use between these studies and the low explanatory power of the models indicates that there is much to learn about the underlying factors impacting on water use that are yet to be discovered. With this in mind, we propose a new, but not exhaustive, integrated social and economic model of household water use to inform future research in this field.

5. Integrated social and economic model of household water consumption

A general implication of the review of other studies is that we don't know all the factors that impact on household water consumption and that much is missing from these models. We need to know much more about water use behaviors (inside and outside the home), water use motivations, barriers to water conservation (e.g., distrust), inside versus outside water consumption figures, and many other factors. Some of the problems with previous studies is that they investigate a limited number of water use habits, there is a lack of individual household consumption data and there are many factors influencing water use that are not included (often due to the difficulty in quantifying or obtaining information on them). For example, past water use history, habits versus reasoned behaviors, exposure to restrictions or water shortages, trust in water authorities and others to do the right thing, knowledge of water saving behaviors, perceptions of water supply abundance or shortage, and many others we may not have considered.

Of particular interest is the issue of the linkage of people's perceptions of the water wastage of other users to water conservation

motives in Corral-Verdugo et al.'s (2002) model. According to their model, if people don't *trust* others to conserve water, they will use this to justify their lack of motivation to conserve water resulting in their higher water consumption. There is also an element of trust involved with the 'want to cooperate with campaign' variable in Corral-Verdugo's model. This involves institutional trust, or trust that the water authority is doing all it can to provide enough water. Moreover, Heiman (2002) found that institutional trust is required to encourage people to save water where willingness to save water increased with governmental conservation efforts and supply augmentation. This suggests that people are more willing to save water when they believe the water authority and government are also doing their bit to ensure supplies. The possible role of trust is further discussed below. With, this in mind, trust is one of a number of factors impacting on water use we have included in the new integrated social and economic model of household water use to inform future research in this field.

The model we are proposing (Fig. 6) suggests that demographics, dwelling characteristics (including house size, water using appliances and type) and household composition (number of people and ages) impact directly on consumption, conservation intention, trust and perceived behavioral control and on the range of attitudes, perceptions and habits. This is in keeping with other studies findings where housing type and size has been found to have the largest influence on water use, along with the direct impact of climate and seasonal factors. We have also included the Theory of Planned Behavior model with the impact of conservation attitude, subjective norm and perceived behavior control on conservation intention. There are two things we want to stress about this model: 1) different factors will have varying effects on indoor and outdoor water use, and 2) past water use behavior, outdoor area interest and use, institutional trust and fairness (trust others are also conserving water), attitudes to restrictions and pricing and perceived risk of shortages will all impact on consumption through conservation intention, but may also impact on consumption directly. We are not attempting to present an exhaustive list of possible variables, but just point out some of those that appear to be influencing water use, from other studies. Trust is one variable of particular interest, since its impact on household water use has not been fully investigated, yet it appears to have an influence on water use (Corral-Verdugo et al., 2002; Heiman, 2002).

6. Trust and its role in household water use behavior

Trust has been identified in the water and natural resources literature as a key institutional issue in understanding natural resource dilemmas, public good allocation and collective action. For example, Lee (1981) and Lee and Warren (1981) suggest that compliance with water restrictions might be greatest when customers trust the water provider's assessment regarding the need to conserve water, when they fear the consequences of depleting water supplies, and when a prevailing community spirit and sense of social responsibility exists such that individuals recognize a shared interest and trust that their neighbors are also conserving water (see also Atwood et al., 2007).

Trust comprises of two related facets (Rousseau et al., 1998): 1) a willingness to be vulnerable to the actions of another party (i.e., water authority); and, 2) positive expectations of another's conduct (i.e., others are saving water too). The first facet concerns the strength of an individual's behavioral intention to cede power to another party. While the second facet concerns the intensity of the beliefs that another party will act in accordance with the commonly accepted norm of water saving behavior.

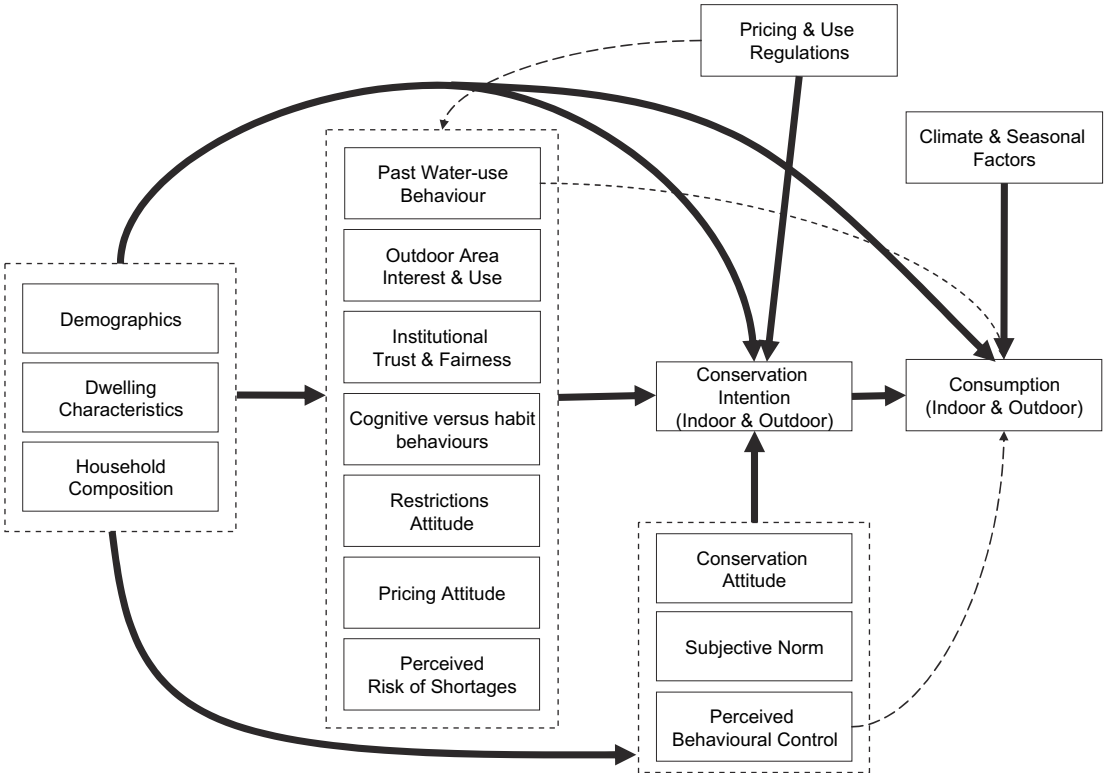


Fig. 6. Integrated social and economic household water consumption model.

Perceptions of institutional trust must be a key variable in any water consumption model that seeks to inform management options and/or behavior change interventions (Syme and Jorgensen, 1999). If the public regard water agencies as untrustworthy, they may be unreceptive to initiatives that managers propose as a means of conserving water and securing supply. Furthermore, trust impacts on the level of accountability required of water agencies by the public. If authorities are frequently required to explain their decisions, there is a risk that it might adversely affect their ability to manage effectively (Tyler and Lind, 1992). It is important, therefore, that water corporations develop a climate of trust in order to improve voluntary acceptance of their decisions by the public (Tyler and Degoey, 1996). In this sense, communication between water providers and consumers could be considered an 'umbrella' type of demand management strategy under which all other strategies might be implemented. While, effective public communication about water saving initiatives is recognized as important to the success of demand management strategies in general, it has tended to be seen within an educational framework of information dissemination rather than a relational framework that seeks to engender cooperation and build trust.

Institutional arrangements, as they relate to trust, have not featured in the published literature dealing with household water consumption. Therefore, little guidance can be obtained about how trust might influence consumers' perception of water management strategies and water use behaviors. Moreover, the broader literature concerning attitude approaches to trust in organizations and public institutions raises a number of questions about the proper definition and measurement of the concept (e.g., Lewis and Weigert, 1985; Bigley and Pearce, 1998). Trust has tended to be defined and measured in cognitive terms as positive expectations and beliefs regarding another's behavior (e.g., Poortinga and Pidgeon, 2003) or behaviorally as a willingness to make oneself vulnerable to another (e.g., Seigrist et al., 2003). This is despite considerable research on the multidimensionality of attitude structure demonstrating that attitudes have empirically distinct affective, cognitive and behavioral components (e.g., Bagozzi et al., 1979; Breckler, 1984; Jorgensen and Stedman, 2001, 2006). Affective responses (i.e., feelings and emotions) have not been empirically studied despite recent developments in attitude research demonstrating that (1) the influence of affect extends to all aspects of cognition and behavior including persuasion (Chen and Bargh, 1998) and judgment and decision-making (Smith and Kirby, 2001); (2) conflict between cognition and affect or from simultaneously conflicting beliefs (e.g. positive expectations of trust versus negative expectations of distrust) complicate attitude-behavior relationships in ways that are not yet fully understood (McGregor et al., 1999) and (3) 'instrumental behaviors' (i.e., behaviors that are a means to an end) have a strong cognitive basis, while 'consummatory behaviors' (i.e., behaviors performed for their own sake, enjoyment or interest) have a stronger emotional basis (Tesser et al., 1995). Understanding how the public conceive of trust in water authorities, how these conceptions might be measured, and their implications for household water management represent distinct gaps in the literature.

Perceptions of trust occupy a central role in attitudinal water models developed in a range of water resource contexts, although not in household consumption (e.g., Nancarrow et al., 1995; Leviston et al., 2005; Po et al., 2005; Porter et al., 2005; Ross, 2005; Jorgensen et al., 2006). Moreover, this research has conceived and measured trust as a general attitude rather than as a multidimensional concept comprising cognitive, affective and behavioral components. Notwithstanding, these models indicate that significant segments of the population believe that water shortages are due to lax planning and management by government and water providers. This is further complicated by the perception among some members of the public of a conflict of interest arising from water providers' roles as both water resources managers and sellers. If segments of the public believe that water is in short supply because of an unrestrained impetus to sell water, management policies that require their consent and compliance might be scrutinized with some suspicion. Similarly, if the public perceives State governments to be using water revenues to cross-subsidize other areas of public expenditure, they may treat proposed price increases with some suspicion. There also needs to be trust within the community that each person is following water restrictions, or making an effort to reduce their water use for the greater good of the community. In other words, if people think others are wasting water, they are less likely to try and save water themselves. Therefore, institutional trust and trust within the community is essential to engender a water saving response from the whole community for water demand programs to be successful. But how can we measure trust?

Research on trust in public authorities has shown that people can share the same meaning about specific, positive expectations (e.g., openness, honest, trustworthy, caring, competent, etc.) (Poortinga and Pidgeon, 2003; Ross, 2005). These attributes all tend to reflect what the literature treats as 'general trust'. Some research has also reported a second dimension of trust – separate to general trust – describing negative expectations of a management authority. The specific, negative expectations tend to be expressed as 'distorts facts', 'has a vested interest' and 'not accountable' (Frewer et al., 1996; Poortinga and Pidgeon, 2003). This measured dimension of trust (or mistrust) has been variously referred to as 'scepticism', 'vested interest' or 'accountability' (Poortinga and Pidgeon, 2003). Thus, it may be by measuring the level of these attributes people in the community feel toward the water authority and toward others in the community that we are able to get some measure of trust and its impact on household water consumption.

As there is a need to better understand the socio-economic drivers of household water consumption and their interactions, there are also opportunities to explore these issues in water resources management. With the presence of water restrictions, and the potential to extend restrictions into the future in some areas, despite what the public might perceive as good rainfall or effective water supply expansion, the conditions are ripe for exploring the interactions among socio-economic drivers of household water consumption.

7. Conclusion

This paper has reviewed a number of the social and economic models of household water consumption. We found that many studies discover different factors acting on water use behavior, dependent on the factors they were investigating. Also, not one study was able to attribute all of the variation in water use to the factors they examined. This indicates that there are other variables impacting on water use that are yet to be described. Thus, we propose a new integrated social and economic model, which describes a number of the factors that we believe are impacting on water use behaviors as well as those that others have found. We suggest that trust may be one an important factor, that has not been fully explored and that may be useful in the development of effective water demand strategies. This is because trust in the water authority and trust in others in the community (including different water using sectors, such as farmers, residents and industry) to take steps to reduce their water consumption will increase the likelihood that people will also take steps to reduce their water use. Further investigation is needed to determine the exact role that trust plays in determining household water use behavior, as well as the importance of the other factors we have included in our model, and those factors yet to be discovered.

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