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RESEARCH ARTICLE

Beyond awareness: the persuasion stage of decision-making explains urban residents' compliance with landscape irrigation restrictions

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ABSTRACT
Inadequate compliance with landscape irrigation restrictions poses a significant challenge for policymakers, environmental educators, and communicators working in urban water conservation as these policies are only effective if compliance is achieved. This study examined perceptions among Florida, USA residents to whom these policies apply using the Diffusion of Innovations Theory. Among the approximately half of these residents who were aware of these restrictions and had an opportunity to develop perceptions about them, perceptions were moderately positive with compatibility, observability, relative advantage, trialability, and complexity falling between 0.0 and 1.0 on a scale ranging from −2 to + 2. Hierarchical linear regression revealed complexity, compatibility, and relative advantage were significant predictors of intention to comply. Perceived complexity was found to be the biggest barrier to individuals' intent to comply. Policymakers and others working in urban water conservation need to simplify both irrigation restrictions and education about them.

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Diffusion of innovations; formative audience research; irrigation restrictions; policy compliance; water conservation

Introduction

Water consumption has been identified as a seminal issue both generally (Aprile and Fiorillo 2017; Ma et al. 2020; World Economic Forum 2019; Yazdanpanah et al. 2015; Zucchinelli et al. 2021) and specifically in the context of urban sustainability (Dadvar, Mahapatra, and Forss 2021; Morain and Anandhi 2022). Factors including urbanization, urban development, population growth, and climate change have and will continue to exacerbate water shortages (Boazar, Abdeshahi, and Yazdanpanah 2020; Greve et al. 2018; Ren et al. 2016; Tajeri Moghadam et al. 2020). More than half the world's population is currently exposed to inadequate water accessibility (Jensen and Wu 2018), and despite predictions that the global population will expand up to 10.2 billion by 2050, water withdrawals are already near peak levels (Boretti and Rosa 2019) in both developing and developed countries (Hurlimann, Dolnicar, and Meyer 2009).

Urban areas in both arid regions and water-rich countries are major water consumers and are especially vulnerable to water shortages (Addo, Thoms, and Parsons 2018; Eslamian, Li, and Haghighat 2016; Ren et al. 2016; Stavenhagen, Buurman, and Tortajada 2018). With human activities centered in urban areas, water security is of particular importance in urban spaces (Eslamian, Li, and Haghighat 2016; Nazemi and Madani 2018) as urban water demand is expected to increase 80% by 2050 (Flörke, Schneider, and McDonald 2018). Thus, water shortages in urban areas are a real and growing concern from environmental, social, and economic perspectives (Lee, Tansel, and Balbin 2011; Mekonnen and Hoekstra 2016), challenging decision makers and urban water management professionals (Hurlimann and Wilson 2018; Rodriguez-Sanchez and Sarabia-Sanchez 2020; Shahangian et al. 2022). The state of Florida, USA, is no exception. With 104 urban areas and 21 million people, the state's growth has outpaced the rest of the country (Urban Area Criteria for the 2010 Census; U.S. Census Bureau 2021a, 2021b) and the state's withdrawal of groundwater is currently at the maximum for sustainable limits (Maliva, Manahan, and Missimer 2021). By 2070, Florida is expected to house more than 33 million residents (Carr and Zwick 2016). Florida's residences are required by law to include installed landscapes (Dukes 2022) and they are typically dominated by turfgrass and irrigated using automatic, in-ground irrigation systems (Clem et al. 2021) which are watered substantially more than yards without such systems (Bremer et al. 2012). Residents tend to apply more water than needed by their landscape (Hayden et al. 2015), creating a condition where there is substantial conservation potential in targeting reduced landscape irrigation (Morain and Anandhi 2022).

In contrast to a focus on supply management policies (Galán, López-Paredes, and Del Olmo 2009), which aim to create new sources of water supply (Tsegaye and Vairavamoorthy 2009), urban water demand management (Stavenhagen, Buurman, and Tortajada 2018) and specifically the reduction of water use among residents (Eslamian, Li, and Haghighat 2016) is important to preventing water shortages (Dadvar, Mahapatra, and Forss 2021). Water demand management incorporates the development and practical application of policies expected to reduce demand (Willis et al. 2011) to reduce urban water consumption

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(Athanasiadis et al. 2005; Willis et al. 2011). Thus, behavioral changes are important to promote long-term, sustainable water conservation in urban areas (Fielding et al. 2013; Saurí 2013; Willis et al. 2011; Yazdanpanah et al. 2015). Although technological development and political interventions at large geographic scales play an important role in addressing environmental challenges, policies that influence individual behavior changes are critically important (Klöckner 2013) and there is great promise in managing urban water demand by implementing measures aimed at aligning consumer behaviors with best practices for conserving water (Lee and Tansel 2013; Shahangian, Tabesh, and Yazdanpanah 2021).

Irrigation restrictions comprise one of the primary tools to reduce excessive irrigation used worldwide (Dukes 2022; Kong et al. 2023) and like other conservation approaches, the success of such conservation measures depends on people accepting them (Shahangian, Tabesh, and Yazdanpanah 2021). These policies limit lawn watering to a certain number of days per week and typically to specific morning and later afternoon hours to prevent water loss. They can be extremely effective conservation tools (e.g., see Mini, Hogue, and Pincetl 2015), especially when enforced (Borisova, Rawls, and Adams 2013). Many places in the United States use irrigation restrictions to respond to drought, rather than implementing year-round restrictions (AWE 2020). Because water is managed by states in the US (Maliva, Manahan, and Missimer 2021), there may be considerable value in exploring policies at the state level. The state of Florida provides a good case to explore perceptions of irrigation restrictions as four out of its five water districts, which hold regulatory authority to manage water use and conservation (Maliva, Manahan, and Missimer 2021) impose year-round restrictions (SFWMD n.d.; SJRWMD 2022; SRWMD n.d.; SWFWMD 2018). The research presented here was undertaken with Florida as a case study because the state's year-round water restrictions could be an example of what is to come as water availability becomes more and more capricious.

It is important for policy makers to understand what factors, including public perceptions, that facilitate or inhibit behavior change to help to inform more impactful policy development. Social science research continues to uncover insights into the factors that influence consumer water demand, which is fundamental to designing effective interventions (Alvarado Espejo et al. 2021; Rahimi-Feyzabad et al. 2020; Shahangian et al. 2022; Willis et al. 2011). However, less attention has been paid to public perceptions of related policies, mechanisms that affect policy-related behavior changes, and these factors' relationship to the policy development process, all of which are important for policymakers (Cooper 2017; Jones et al. 2011). Therefore, some of the main challenges faced by policymakers to encourage household water conservation includes understanding what drives or prevents households' water consumption and conservation activities and how to encourage households to participate in reducing their water consumption. Policy research has 'given insufficient attention to the role that characteristics of the policies themselves play in determining the speed of policy diffusion' (Makse and Volden 2011, 108), and the research presented here examined people's perceptions of such policy characteristics to explain compliance with irrigation restrictions.

Theoretical framework

Social marketing offers a potential approach to eliciting behavior change (e.g., improving policy compliance) as it can help persuade people to act in ways that benefit society and the individual (McKenzie-Mohr and Schultz 2014). A crucial component of social marketing is choosing a theory-based strategy with which to conduct formative audience research used to develop an intervention (Evans 2016). This research was carried out as preliminary audience research to guide efforts that encourage residents' compliance with landscape irrigation restrictions. The concepts of Diffusion of Innovations (DOI) and specifically the Innovation – Decision process (Rogers 2003) served as the framework for the study. DOI explains how innovations are adopted as people advance through five stages of an innovation-decision process (see Figure 1): knowledge, persuasion, decision, implementation, and confirmation (Rogers 2003). The knowledge stage is when a person learns about an innovation and becomes familiar with how it works. Persuasion occurs when an individual develops a positive or negative attitude toward innovation. Decision happens when a person takes actions that result in accepting or rejecting the technology or idea. At the implementation stage, an individual puts the idea into practice, and finally, confirmation happens when individuals seek confirmation for

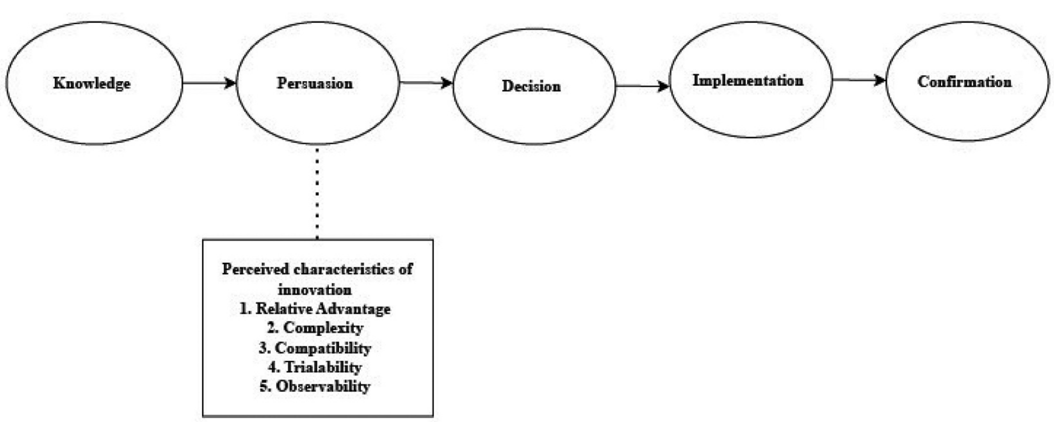

Figure 1. The innovation-decision process. Adapted from (Rogers 2003).

their decision, but they can always change their minds given further information (Rogers 2003).

Within the persuasion stage, perceptions develop that will ultimately inform future adoption decisions. These perceptions are comprised of people's perceived characteristics of an innovation which includes relative advantage, complexity, compatibility, observability and trialability (Rogers 2003). When discussing the diffusion of policies among state governments, Clark (2008) encouraged researchers to focus on attributes of policies themselves rather than adopters to understand adoption, and the present study assessed residents' perceptions developed during the persuasion stage of the innovation-decision process. In the context of the current study, irrigation restrictions were considered the innovation, and a resident's decision to comply with landscape irrigation restrictions (i.e., adopt the innovation) was dependent on their perceptions of five innovation characteristics.

Relative advantage is the perception that an innovation outperforms or is otherwise better than the concept or technology it replaces (Rogers 2003). For instance, complying with irrigation restrictions could be seen as having economic advantages compared to noncompliance as following irrigation restrictions could result in water bill savings as well as the avoidance of fines associated with violations. Similarly, a recent study on the potential acceptability of reclaimed water use in the United States reported that reduced monthly water costs increased respondents' likelihood of participating in the reclaimed water program (Garcia-Cuerva, Berglund, and Binder 2016). While not described explicitly as relative advantage, this finding demonstrates seeing an advantage (i.e., expecting to save money) resulted in increased likelihood of engaging in a behavior. Other advantages to compliance could be social in nature, where adhering to irrigation restrictions could be perceived as doing the right thing for the environment and community at large, as well as avoiding potential embarrassment associated with violations. Mandates for adoption are a mechanism by which an entity requires a specific behavior change (e.g., compliance with irrigation restrictions), which can be done by implementing either positive or negative incentives to increase perceived relative advantage and ultimately boost adoption rate (Rogers 2003). Along with an innovation's five basic attributes described here, the nature of an innovation – decision as voluntary or mandatory also plays a role in adoption and further reveal their likelihood of complying with these policies.

Compatibility is the degree to which an innovation aligns with residents' values, needs, habits, and past experiences (Rogers 2003). If residents value water conservation or have experienced water scarcity in the past, then they may be more likely to perceive irrigation restrictions as compatible with their needs. Furthermore, past experiences with irrigation restrictions (e.g., experiencing decreased lawn health or receiving citations imposed due to non-compliance) may either slow down or speed up the adoption rate. In their study on diffusion of water-saving irrigation innovations in Florida's urban residential landscapes, Warner et al. (2020) reported that compatibility was the most important predictor of a person's adoption of water conservation technologies and activities (which included irrigation restriction compliance) followed by trialability and relative advantage. Kong et al. (2023) reported longer time frames between allowed irrigation events led to impatience among residents and greater water use, hinting at a lack of perceived incompatibility associated with these policies and consequent non-compliance.

Complexity measures how difficult it is to use or understand an idea or technology (Rogers 2003). As it applies to policy, complexity could mean difficulty in understanding as well as following the specifics of a policy (Makse and Volden 2011). Complying with landscape irrigation restrictions could be perceived as complex because residents may not know the technical reason for imposing irrigation restrictions. Or, they may not understand the details of when irrigation is allowed and how they can adjust their irrigation technologies to comply. Complying with irrigation restrictions may require careful planning, which could consume a lot of time and may influence the adoption rate. Warner et al. (2020) reported that complexity was an important predictor of the rate of adoption of several residential landscape water conservation technologies and activities (which included irrigation restriction compliance). If residents perceive complying with irrigation restriction policies is not overly complex the likelihood of adoption may increase.

Observability refers to the extent to which an innovation's results can be seen by others (Rogers 2003). Individuals who have witnessed others adopt irrigation restrictions and experience positive outcomes may perceive compliance as beneficial. In their study on different stakeholders' perceptions of renewable energy initiatives, Silk et al. (2014) reported that providing visible examples of successful innovations in adjacent towns and allowing direct observability may influence the public to adopt alternative energy sources. For residents, opportunities to see the results of compliance in other communities can help them recognize the outcomes of adopting an innovation. Potential observable outcomes might include healthier lawns with fewer weeds.

Trialability is the ability of prospective adopters to test an innovation on a small scale before making an adoption decision (Rogers 2003). In this study, the trialability of complying with irrigation restrictions before fully committing may help the residents understand its impact and increase the chances of adoption. Trialability may be perceived as high because residents do not need to make major changes or purchases to test out this innovation. In their study on the adoption of drip irrigation technology in one of the more water–scarce irrigation communities in Spain, Alcon et al. (2011) reported that trialability accelerated adoption, demonstrating the value of familiarizing oneself with the technology and developing comprehension via the use. In another study, Warner et al. (2020) reported that trialability was a predictor of the adoption of a suite of 18 water conservation innovations in residential landscapes which included adhering to irrigation restrictions.

Despite relationships being reported between DOI characteristics and conservation behaviors as described above, potential connections have not been explored specific to compliance with irrigation restrictions. Fichter and Clausen (2021) reported that most diffusion research on policies has been conducted in the energy sector and that it was impossible to make comparisons to other sectors, emphasizing the need to explore characteristics of innovations, including policies, on adoption.

Lastly, in addition to DOI characteristics, it is possible the perceived likelihood of water scarcity occurrence would influence people's willingness to comply. Although this perceived likelihood may emerge in the characteristic of compatibility, it may also denote a sense of urgency to act on the problem. In the coming decades, it is anticipated that up to two-thirds of the world's population will experience water scarcity (Mancosu et al. 2015). Of the 4.3 billion people who experience moderate-to-severe water scarcity for at least 1 month of the year, 130 million live in the western and southern states of the United States (e.g. Texas and Florida) (Mekonnen and Hoekstra 2016).

Methods

Purpose and approach

The purpose of this research was to explore perceptions of landscape irrigation restrictions, as developed in the persuasion stage of decision-making, to better understand residents' decisions to comply so better policies and education can be developed in the future. Specific objectives were to 1) Identify participants' stage in the Innovation-Decision Process; 2) Quantify participants' perceptions using the five characteristics of innovations pertaining to irrigation restrictions; 3a) Assess the relationship between characteristics of innovations and intent to comply with irrigation restrictions; and 3b) Determine whether voluntariness or experience with water shortages improves the predictions of residents' intent to comply with irrigation restrictions.

Population and sample

The cross-sectional survey employed in this study was part of a larger project undertaken to understand Floridians' water conservation perceptions and practices. The target population for the survey was Florida residents at least 18 years of age who use automated landscape irrigation. Non-probability sampling was used because there is no sampling frame, or list, of residents who use this type of landscape irrigation from which to draw a random sample. To minimize error associated with a non-probability approach, we employed quota sampling to target a representative statewide sample of 2,101 residents in Florida, USA in terms of age, sex, race, and ethnicity (Baker et al. 2013; Lamm and Lamm 2019; Taherdoost 2016). A professional survey sampling company (Centiment; Denver, Colorado, USA) contacted potential participants through email (Dillman, Smyth, and Christian 2009) with a link to the study details and approved informed consent information. The instrument was formatted in such a way that it could be easily accessible across mobile and desktop devices. Participants who completed the survey were compensated and their personal information was kept anonymous by researchers. The Institutional Review Board at the University of Florida reviewed and approved the research protocol as exempt (IRB202202337).

Screening and quality control

Based on the study's objectives, we screened participants in multiple steps to make sure our sample was comprised of those individuals to whom irrigation restrictions applied, given many exemptions throughout the state (e.g. for those who hand-water or use well- rather than city water) (see Table 1). We first confirmed participants were engaged in decision-making related to their lawn and/or landscape (n = 1432), and then screened those decision-makers to identify those that had automatic (in-ground) sprinklers in their landscape (n = 789). Third, we selected participants who indicated their irrigation water source was city (municipal) or county (n = 444). Out of the five-water

Table 1. Screening questions employed to identify survey participants to whom irrigation restrictions applied.

Screening instruments and responses	%	*n*
Do you have a lawn and/or landscape that you make decisions about or personally care for? (*N* = 2101)		
Yes	68.2	1432
No	31.8	669
Do you use automatic (i.e., sprinklers) on your lawn and/or landscape? (n = 1432)		
Yes	55.1	789
No	42.8	613
Unsure	2.1	30
Where does that water for your irrigation (i.e., sprinklers) system primarily comes from? (n = 789)		
City (municipal)/county	56.3	444
Irrigation well	18.1	143
Reclaimed water (publicly supplied reclaimed water/purple pipe)	13.4	106
Water bodies	7.2	57
Rain barrels	1.1	9
Other	0.5	4
I don't know	3.3	26
Participants with city (municipal)/county water and their corresponding water management districts (n = 444)[a]		
South Florida WMD	43.4	191
Southwest Florida WMD	21.8	96
St. Johns River WMD	26.6	117
Suwannee River WMD	2.5	11
Northwest Florida WMD	5.7	25

Note. [a]WMD responses total 440 because 4 individuals provided incorrect ZIP codes and were removed from study.

management districts in Florida, the Northwest Florida water management district did not have irrigation restrictions in place, so participants belonging to that specific district (n = 25) were excluded, resulting in 415 individuals in the sample used for data analysis. Through this screening process, we ensured the resulting sample was comprised of individuals who were subject to mandatory irrigation restrictions.

Instrumentation and data collection

To identify participants' stage in the Innovation-Decision process (Objective 1) participants were asked whether their city/county/water management district currently imposed water restriction that affected the way they watered their lawns. Responses were *Yes*, *No*, and *unsure*. Given that we screened to include only those to whom irrigation restrictions applied, individuals who indicated *yes* to this question were understood to be at least in the persuasion stage and data from these respondents was used for the remaining three objectives. In other words, those who indicated *no* or *unsure* were deemed to be unaware of the irrigation restrictions that applied to them. As per our Objective 2, we quantified relative advantage, compatibility, complexity, observability, and trialability (characteristics of innovations) using the mean score of four to seven statements (see Table 2) measured on a 5-point Likert type scale from −2 to 2, where −2 = *Strongly disagree*, −1 = *Disagree*, 0 = *Neither agree nor disagree*, 1 = *Agree*, 2 = *Strongly disagree*. The variables described here were gathered from all respondents. All DOI variables were coded so a value approaching +2 indicated favorable perceptions (high relative advantage, compatibility, trialability, and observability, and low complexity).

Table 2. Survey items and major constructs used in a study of perceptions of landscape irrigation restrictions.

Instruments and survey items	Cronbach's alpha
Intention	
In the next month, how likely are you to follow applicable irrigation restrictions when making decisions about watering your yard?	0.912
How likely are you to follow applicable irrigation restrictions when making decisions about watering your yard in the next month?	
In the next month, what is the likelihood you will follow applicable irrigation restrictions when making decisions about watering your yard?	
Relative Advantage	
Following applicable irrigation restrictions when making decisions about watering my yard	0.845
. . . is better than how I made decisions in the past.	
. . . is a solution to water scarcity.	
. . . improves the quality of my lawn/landscape.	
. . . is overall beneficial.	
. . . is the right thing to do.	
. . . helps me avoid penalties.	
Compatibility	
Following applicable irrigation restrictions when making decisions about watering my yard	0.873
. . . is compatible with the way I take care of my lawn.	
. . . fits well with my lifestyle.	
. . . can increase the quality of my lawn and landscape.	
. . . fits well with most aspects of my lawn care routine.	
. . . would fit with my neighbors' expectations.	
. . . can decrease the time I spend caring for my yard.	
Complexity	
Following applicable irrigation restrictions when making decisions about watering my yard . . .	0.701
. . . .is easy for me.	
. . . . . .is simple for me to understand.	
. . . . . .is difficult.	
. . . . . .is complicated.	
. . . . . .takes a lot of time for me to get right	
Observability	
I would follow applicable irrigation restrictions when making decisions about watering my yard if.	0.882
. . . I saw others having good results.	
. . . the success of others was visible to me.	
. . . a lot of other people were doing this.	
. . . the results of doing so were apparent to me.	
Trialability	
Following applicable irrigation restrictions when making decisions about watering my yard	0.904
. . . is something I can try before I make a decision about doing so permanently.	
. . . is something I can test before I commit to changing my routine.	
. . . is something I can do on a trial basis.	
. . . is something I can experiment with temporarily.	
Thinking about your irrigation water source, how likely do you think it is that this source will run out in your lifetime?	-
Thinking about your irrigation water source, how likely do you think it is that this source will run out in the next ten years?	-
Thinking about your irrigation water source, how likely do you think it is that this source will run out in the next year?	-
Have you ever experienced a water shortage in your lifetime?	-
Yes	
No	
Unsure	
Irrigation restrictions are:	-
Voluntary	
Mandatory	
Unsure	

To assess the relationship between characteristics of innovations and behavioral intention (Objective 3a), we calculated residents' intent (dependent variable) to comply with the irrigation restrictions using the mean score of three statements (see Table 2) which were each measured on a 5-point Likert-type scale from −2 to 2 where −2 = *Very unlikely*, −1 = *Unlikely*, 0 = *Neither unlikely nor likely*, 1 = *Likely*, 2 = *Very likely*. We measured participants' experience with water shortages and their interpretation of the nature of irrigation restriction (Objective 3b) using a multiple-choice response (*Yes / No / Unsure* and *Mandatory / Voluntary / Unsure*, respectively). To prepare the nominal variables for analysis, we dummy coded water shortage experience as 1 = having experience with water shortage and 0 = unsure or having no experience with water shortage. Similarly, we dummy coded the perceived nature of irrigation restrictions as 1 = irrigation restrictions perceived as being mandatory and 0 = unsure or irrigation restrictions perceived as voluntary. We assessed respondents' opinions of the likelihood of water shortages across three different timeframes (the next year, the next 10 years, and one's lifetime) using a 5-point Likert type scale from −2 to 2 where −2 = *Very unlikely*, −1 = *Unlikely*, 0 = *Neither unlikely nor likely*, 1 = *Likely*, 2 = *Very likely*.

To ensure data quality, we presented participants with a question that required commitment to providing responses carefully throughout the survey. In addition, two quality control questions were integrated in different places in the electronic instrument to prompt a specific response to check if respondents were responding thoughtfully and maintain integrity of the data (Lavrakas 2008). Any respondent who did not respond appropriately to any of the three quality control items was excluded from the study.

A panel of experts in social science, survey research methods, urban water conservation, and irrigation restriction policies reviewed the survey instrument to confirm its face and content validity (Cohen, Manion, and Morrison 2007). The survey instrument was then pilot tested with 50 individuals from the target population. The pilot test revealed no need for revisions (e.g. adequate reliability, etc.) and the pilot test responses were therefore included in the full study. Post-hoc reliability was calculated on the final dataset using Cronbach's alpha (a measure of internal consistency) and all constructs exceeded the desired 0.70 threshold (Cohen 1988).

Data analysis

Data cleaning and analysis was conducted using Statistical Package for Social Science (SPSS) (version 29; IBM Corp., Armonk, NY). Frequency and percentages were used to present findings related to Objective 1, whereas central tendency measures (means), and standard deviations, were used to quantify the characteristics of innovations. Hierarchical linear regression was used to assess the effect of characteristics of innovation, mandatory perception of irrigation restrictions, experience with water shortages and future water shortage on participants' intent to comply with irrigation restrictions. We entered theory-based variables which included all five traits of innovations in the first block (model 1) of the hierarchical regression and then added the remaining independent variables (mandatory perception of irrigation restriction, experience with water shortages, and perceived likelihood of future water shortage) to the second block (model 2). Before finalizing our data analysis approach, we tested our data for basic assumption of multiple linear regression. Linearity was tested using a scatterplot which demonstrated a linear relationship between independent and dependent variables. Normality was assessed using a histogram to ensure that errors between observed and predicted values were normally distributed. Multicollinearity was tested using a correlation matrix (to detect whether and correlations exceeded 0.80) and variance inflation factor values (to assess whether and VIF values exceeded 10.0). The correlation coefficients in Pearson's bivariate correlation matrix were all less than .80 and VIF values were all less than 3.0 indicating that there were no multicollinearity issues. To ensure that our data was not homoscedastic, a scatterplot of regression residuals versus predicted values was used and revealed no pattern indicative of this violation.

Table 3. Demographics characteristics of the respondents who were aware of irrigation restriction from their respective county/city/water management districts (N = 218).

Variables and categories	%	*n*
Gender		
Male	52.8	115
Female	47.2	103
Hispanic/Latino/a		
Yes	43.6	95
No	56.4	123
Race		
American Indian or Alaska native	4.6	10
Black or African American	20.6	45
Asian or Pacific Islander	2.8	6
White	70.6	154
Other	4.1	9
Education		
Less than high school	1.8	4
High school/GED	11.5	25
Some college	12.4	27
2-year college degree	11.9	26
4-year college degree	31.7	69
Master's degree	21.1	46
Doctoral degree	3.7	8
Professional degree (J.D., MD)	6.0	13
Family income		
Less than $24,999	5.0	11
$25,000 - $49,999	18.8	41
$50,000 - $74,999	18.8	41
$75,000 - $99,999	19.7	43
$100,000 - $124,999	9.6	21
$125,000 - $149,999	9.6	21
$150,000 - $174,999	4.1	9
$175,000 - $199,999	3.7	8
$200,000 - $224,999	1.8	4
$225,000 - $249, 999	3.7	8
$250,000 or more	5.0	11
Own/Rent home		
Own	79.4	173
Rent	18.3	40
Other	2.3	5
Political Beliefs		
Very Liberal	18.8	41
Liberal	17.4	38
Moderate	38.5	84
Conservative	17.9	39
Very Conservative	7.3	16
Political Affiliation		
Republican	31.2	68
Democrat	45.0	98
Independent	20.2	44
Non-affiliated	3.7	8

Out of 2,101 complete responses, 415 were included in the formal analysis for Objective 1. The target sample for the study (people to whom irrigation restrictions apply and who were aware of these policies, n = 218), were included for the remaining objectives and their demographic information is presented here (see Table 3). Among those who were aware of irrigation restrictions, 52.8% were male and 43.6% identified themselves as Hispanic/Latino/a. The majority (70.6%) of participants were white, followed by Black or African American. Also, most (31.7%) had a four-year college degree followed by master's degree (21.1%). More than half of the respondents reported family income ranges between $25,000 and $99,999. Research has documented that automatic irrigation users do not align with the demographics of the public (e.g. having higher income and education; Huang, Lamm, and Dukes 2016; Monaghan et al. 2013; Warner et al. 2015, 2017), and thus it may be useful to consider respondents' characteristics along with the findings of the study. Our concentration on those on city water presumably weighted the audience further towards Florida's urban areas, as represented in the demographics presented here. For example, Florida's Hispanic/Latino population is 26.8% statewide, but certain urban counties in the state have higher percentages (e.g. Miami-Dade at 69.1%; U.S. Census Bureau 2021c), which resulted in the higher percentage in our target sample. Regarding political beliefs and political affiliation, large segments of participants belonged to moderate and democrat. The majority reported owning their home and 18.3% rented. The average age of the participants who were aware of irrigation restrictions was 42.90 years (*S.D.* = 17.74) and on average participants had lived in Florida for 20.54 years (*S.D.* = 13.85).

Results

Objective 1: Identify participants' stage in the Innovation-decision process

Out of 415 participants to whom irrigation restrictions applied, 52.5% (n = 218) of respondents indicated they were aware of these policies (see Table 4), indicating they were at least in the persuasion stage of the Innovation-decision process. The remaining 47.5% who were unsure (n = 26) or unaware (n = 171) of these policies were considered as being no further than the knowledge stage of the innovation-decision process and were not included in the next objectives because according to DOI (Rogers 2003) they would not have had a chance to develop perceptions surrounding irrigation restrictions.

Table 4. Participants' awareness of irrigation restriction in their community or water management district.

Does your community or water management district currently impose water restrictions that influence how you water your lawn? (n = 415)	%	*f*
Yes	52.5	218
No	41.2	171
Unsure	6.3	26

Objective 2: Quantify participants' perceptions pertaining to irrigation restrictions using the five characteristics of innovations

Among the 218 individuals who were at least in the persuasion stage, all of the perceived characteristics of innovations were found to be positive, falling between 0 and 1 on a scale from −2 to 2 (see Table 5). Compatibility had the highest mean indicating that following irrigation restrictions was perceived as being compatible in relation to respondents' lifestyles, approach to landscape maintenance, and neighbors' expectations. Observability was similarly positive, implying that the results of complying with irrigation restrictions were apparent to respondents. Relative advantage was positive indicating that on average respondents agreed that compared to not following irrigation restrictions, complying was beneficial to them for different reasons such as avoiding penalties, overcoming water scarcity, being the right thing to do, and improving the quality of their lawn/landscape. Trialability fell below relative advantage but was still positive indicating that participants found irrigation restrictions to be somewhat trialable before implementing them permanently. Complexity, while also positive (on a scale from −2 to 2 where -2 means more complex and +2 means least complex), was the closest to neutral among the five characteristics of innovations indicating the existence of mixed feelings when considering compliance, implying the following irrigation restrictions was perceived as approaching some level of complexity.

Table 5. Indexes for characteristics of innovations used to understand irrigation restrictions perceptions.

Characteristics of innovations	*M*	*S.D.*
Compatibility	.925	.755
Observability	.857	.894
Relative advantage	.737	.551
Trialability	.656	.974
Complexity	.455	.845

Objective 3a: Assess the relationship between characteristics of innovations and intent to comply with irrigation restrictions and Objective 3b: Determine whether voluntariness or experience with water shortages improves the predictions of residents' intent to comply with irrigation restrictions

The dependent variable, the irrigation restriction compliance intent index, was 1.327 (*S.D.* = 0.808) on a scale from −2 to +2. Hierarchical regression showed that both overall models were significant (see Table 6).

Among the five characteristics of innovations, complexity, compatibility, and relative advantage were significant predictors of intention to comply with irrigation restrictions in the first model (see Table 7). These three variables had a positive predictive relationship with behavioral intent, meaning as any of these three variables increase, behavioral intent is expected to increase. Complexity had the largest effect size followed by compatibility and relative advantage. The coefficients indicated

Table 6. Model summary of hierarchical linear regression.

					Change statistics				
Model	R	R square	Adjusted r square	Std. error of the estimate	R square change	F change	df1	df2	Sig. f change
1	.518	.269	.251	.69993	.269	15.350	5	209	<.001
2	.538	.290	.255	.69821	.021	1.207	5	204	.307

Note. Model 1 = Characteristics of Innovation (relative advantage, complexity, compatibility, observability and trialability), Model 2 = Model 1 + water shortage experience, future water shortage (a year, 10 years, and lifetime) and mandatory perception of irrigation restriction.

Table 7. Hierarchical regression analysis of behavioral intent to comply with irrigation as dependent variable and characteristics of innovations as the independent variable.

	Model 1				Model 2			
	B	*β*	*t*	*p*	B	*β*	*t*	*p*
Relative advantage	.219	.149	1.713	.088*	.243	.166	1.886	.061*
Compatibility	.310	.290	3.093	.002**	.244	.228	2.342	.020**
Complexity	.319	.333	5.096	<.001***	.322	.336	4.649	<.001***
Observability	-.043	-.048	-.539	.590	-.030	-.033	-.366	.715
Trialability	.019	.022	.283	.777	.016	.019	.234	.815
Water shortage experience (dummy)					-.063	-.038	-.607	.544
Likelihood of water running out (lifetime)					.098	.157	1.717	.088*
Likelihood of water running out (10 year)					.037	.062	.635	.526
Likelihood of water running out (1 year)					-.057	-.102	-.998	.319
Irrigation restriction mandatory (dummy)					-.037	-.022	-.357	.721

Note. * Statistically significant at p = .10 ** Statistically significant at p = .05 *** statistically significant at p = .001.

that as a person's perceptions of complexity (meaning they believe it is simpler), compatibility, or relative advantage increases, their intent to comply with irrigation restrictions increases as well. Characteristics of innovations accounted for 26.9% (R^2 = 0.269) of the variance in behavioral intent to comply with irrigation restrictions. Conversely, this means about 73% of the variance is not accounted for by the model, meaning other complexities of human behavior are involved in irrigation restriction compliance decisions. This is typical in social science research where R^2 values of less than .50 are expected.

In the second model, we added mean perceived likelihood of future water shortage in a year ($M = -0.37 \pm 1.45$), 10 years ($M = -0.06 \pm 1.35$), and one's lifetime ($M = 0.08 \pm 1.296$). We also added water shortage experience, of which 136 out of the 218 aware individuals indicated they had experienced in their lifetime (experience dummy variable $M = 0.62 \pm 0.486$). Lastly, we added in a perception of whether irrigation restrictions were mandatory, and 132 of the 218 aware individuals indicated they believed they were mandatory (mandatory dummy variable $M = 0.61 \pm 0.488$). When water shortage experience, three future water shortage variables (a year, 10 years, and lifetime), and mandatory perception of irrigation restriction were added to the model, it increased explanation of the variance (R^2) in behavioral intent by 0.021 compared to model 1 (see Table 6), but this increase was not significant F (5,204) = 1.207, $p = 0.307$, meaning the added variables did not improve the model. Only the likelihood of future water shortage in a lifetime was significant (at $p = 0.10$). Overall model 2 (model 1 + water shortage experience + future water shortage + mandatory perception of irrigation restriction) accounted for 29.0% (R^2 = 0.29) of the variance in behavioral intention to comply with irrigation restriction.

In model two, complexity ($p < 0.001$), compatibility ($p = 0.020$), relative advantage ($p = 0.061$) and future water shortage (lifetime) ($p = .088$) were significant predictors of behavioral intent with complexity having the strongest effect size. However, water-shortage experience, future water shortage at one-, and 10-year time frames, and mandatory perception of irrigation restrictions did not contribute significantly.

Conclusions and discussion

Nearly half of our respondents, all of whomo were subjecti to irrigation restrictions, were unaware of these policies, illustrating lack of awareness has critical implications for compliance. Without awareness of irrigation restrictions, residents with in-ground irrigation drawing from public water supply (those who are required to adhere to irrigation restrictions in much of Florida) cannot develop the favorable perceptions about these policies which are needed to actively decide to follow them. Our finding closely mirrors Warner et al.'s (2023) findings from data collected in 2021, who reported 50.0% were unaware of irrigation restrictions, but contradicts the nearly 75% of Floridians who said they follow such policies from an earlier study (Warner, Lamm, and Silvert 2020). Warner et al.'s (2020) findings could be explained by the possible sensitivity of asking someone if they comply with a regulation; perhaps people are concerned to reveal they do not comply whether they are aware of such policies or not. Lack of awareness is clearly a major barrier to compliance that prevents progression beyond the first step in the Innovation-decision process, the knowledge stage. There is also a need for sufficient how-to knowledge to progress in the decision-making process especially when innovations or policies are complex (Kaabachi and Obeid 2016; Rogers 2003). Policymakers, educators, and communicators working in the urban conservation sphere should consider this finding and make provisions for raising awareness among the half of residents who are not aware of these policies.

Of the just over half of respondents who were aware of the irrigation restrictions that applied to their home lawn/

landscape, and who were at least in the persuasion stage of the innovation-decision process, perceptions were moderately favorable. All perceived characteristics of innovations fell between 0 and 1 on variables that could range from −2 to +2, with higher positive numbers indicating favorable perceptions (high relative advantage, compatibility, trialability, observability, and low complexity). Individuals will typically adopt an innovation if they perceive it to be compatible, relatively advantageous, not overly complex, observable, and available to try out before fully implementing (Rogers 2003; Warner, Lamm, and Silvert 2020). These favorable perceptions hint at the social acceptability of irrigation restrictions, which is significantly connected to individual behavior (Jones et al. 2011). Of these perceived characteristics of irrigation restrictions, complexity, compatibility, and relative advantage predicted individuals' intent to comply, while observability and trialability were not significant. This means that people who believe complying with irrigation restrictions is simple and straightforward, better than not complying, and/or compatible with their values and lifestyle, are most likely to comply. Conversely, overly complex irrigation restrictions, or lack of recognition of relative advantage or compatibility can serve as barriers to the public's compliance.

Warner et al. (2023) discussed a lack of how-to knowledge (Rogers 2003) which emerged as poor understanding of irrigation restrictions in locations where policy specifics change throughout the year, thus rendering them more complex. Building on their findings, it appears complexity remains critical at and beyond the persuasion stage given complexity was the strongest predictor of complying with irrigation restrictions among those who were aware of irrigation restrictions. The importance of complexity suggests a number of potential realities. First, perceived complexity may be occurring due to residents' difficulty is understanding the specifics of the policies themselves. Warner et al. (2023) cautioned about the potential confusion and complexity introduced by irrigation restrictions that changed based on the time of year, suggesting concern for more complex irrigation restrictions. Similarly, a study conducted in Japan on educational curriculum policies revealed that perceived complexity of policy (particularly the content) was a barrier to adoption (Sasaki 2018). An additional consideration is the complexity perceived in operating one's irrigation technology to achieve compliance with permitted days and times. Beyond residents' adoption, complexity can even prevent diffusion of policies themselves among policy-setting entities (Makse and Volden 2011). Based on this finding, we recommend simplifying irrigation restrictions and the communications about them to improve compliance among target populations.

As compatibility was the most favorably perceived (i.e. rated most positively) characteristic according to the descriptive statistics and as a significant predictor of intent to comply, policies need to be understood as compatible with people's values and lives given the relationship between this characteristic and a higher likelihood of adoption (Ozaki and Sevastyanova 2011; Rogers 2003; Shipan and Volden 2012; Warner et al. 2021; Warner, Lamm, and Silvert 2020). One suggestion to harness the power of this characteristic is to link irrigation restriction communication and education with other elements people value. For example, a proportion of people, and especially in-ground irrigation users, place extremely high value on landscape aesthetics (Bremer et al. 2012; Hayden et al. 2015; Massachusetts Division of Ecological Restoration 2018). These individuals may be less likely to comply with irrigation restrictions because to them, the perceived cost of not watering their yard, such as potential aesthetic decline, is incompatible with their values and consequently not worth the benefits of complying (Kong et al. 2023). Thus, messaging centered around how lawn health can be maintained or improved on prescribed irrigation restrictions and how reductions in overwatering can prevent weeds and pest issues through reduced overwatering could be central to improving perceptions of compatibility. Others have indicated social norms (e.g. by neighbors' approval) and codified norms (e.g. through homeowners association covenants) prevent outdoor water conservation (Sisser et al. 2016; Warner et al. 2023), and it is likely these norms need to be addressed to integrate the effect of perceived compatibility on compliance. It is also important to educate homeowners association leadership on irrigation restrictions so they do not penalize residents for complying with these regulations. For example, researchers have cited residents' attempts to comply with homeowners association rules as a reason behind irrigation restriction violations (Ozan and Alsharif 2013), and there may be an opportunity to support alignment between such conflicting policies to improve compliance.

While relative advantage was a significant predictor at $p = .10$, it was not the most important factor. It is possible the relative advantages of compliance are unrecognized and efforts to convey the relative advantage of doing so, such as social advantages, would bolster engagement. Rogers (2003) described how relative advantage is reinforced in mandatory innovations because there is some type of penalty that decreases the advantages of not adopting. Interestingly, only about 60% of the aware individuals believe irrigation restrictions are mandatory, suggesting a lack of seriousness in understanding that these policies are in fact regulations with associated penalties. It could be that individuals have not witnessed or heard of penalties associated with noncompliance with irrigation restrictions which aligns with reports that irrigation restrictions are most effective when enforced (Borisova, Rawls, and Adams 2013). Technical researchers have reported voluntary restrictions do not reduce water consumption (Mini, Hogue, and Pincetl 2015) and it is very possible the 40% of respondents who do not believe irrigation restrictions are mandatory are not inclined to follow them. We note, due to filtering out individuals that were not subject to irrigation restrictions, these policies *are* actually mandatory for 100% of respondents. Kenney et al. (2004) reported the efficacy of mandatory restrictions exceeded that of voluntary restrictions; however, we suggest the potential impact could be reduced when a large proportion of individuals does not understand irrigation restrictions are mandatory. Thus, one element policymakers, educators, and communicators should focus on is raising awareness of the mandatory nature of these restrictions. With a greater understanding of the mandatory nature of irrigation restrictions, perceptions of relative advantage should increase, and it is likely the influence of this characteristic would then be activated. There is undoubtedly a role for enforcement to play in correcting inaccurate perceptions. Perhaps one initial approach would be to target education regarding irrigation restrictions to the subset of individuals who over-irrigate substantially (Mayer 2016).

Respondents were neutral in their perceptions that their irrigation water source could run out, especially in the shorter time frames. They were slightly in disagreement that this could happen in the next year or next 10 years but slightly in agreement this could happen in their lifetime. More than half of the individuals had experienced a water shortage of some sort in their lifetime and more than half perceived irrigation restrictions as mandatory.

Only perceived likelihood of future water shortage in respondents' lifetime was a significant predictor when the perceive likelihood of running out of water and mandatory variables were added but this second model did not offer a statistically improved prediction over the theory-informed characteristics. It could be that since overall our respondents disagreed their irrigation water source could run out in the closer timeframes that there was simply not a relationship. Or, perhaps the possible urgency to act given potential for irrigation water sources to run out was captured by the characteristic of compatibility, where irrigation restriction compliance would mean acting in alignment with one's values or sense of responsibility. However, the relationship with respondents' belief that their irrigation water source could run out in their lifetime, paired with slight agreement of this possibility, hints that while people recognize a possibility of such a crisis, they do not find it very likely.

Study limitations includes the use of nonprobability sampling which were mitigated somewhat by using quota sampling. This research is also limited by a small sample size. Given the lack of an available sampling frame, it is difficult to access large samples from this very specific target audience.

Shipan and Volden (2012) suggested policies should evolve over time based on what is discovered during their implementation. Accordingly, policymakers and others promoting urban water conservation are encouraged to simplify irrigation restrictions themselves as well as education about them. These important decision-makers might also consider ensuring policies are communicated in a way that is perceived as compatible and advantageous, while also communicating the very real possibility of running out of water.

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Data availability statement

The data that support the findings of this study are available from the corresponding author, LW, upon reasonable request.

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