



# Examining water conservation behaviors and attitudes: evidence from the city of Ada, Oklahoma, USA

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## Abstract

The study reported here provides the most current empirical data on household water conservation strategies and behaviors in the city of Ada, Oklahoma. Survey data was collected in the summer of 2017. The results indicate that households in Ada employ several strategies to conserve water including checking and repairing water leakages around the house (90%), washing dishes by hand (83%), lowering the water level on washing machines and using the dishwasher with full loads (72%). Additionally, the following factors are identified as having the greatest influence on a household water conservation drive; drought (92%), pollution of fresh water, and substantial increases in water bills (91%). In contrast to previous works, it is notable that our findings on pollution of freshwater sources as a water conservation motive are unique to this study. Regarding efficacy, the results indicate that households in Ada are aware of the need to conserve water and generally have a positive attitude towards water conservation (90%). These findings are remarkable for several reasons. Most importantly, they provide recent data on a collection of conservation strategies employed by household in a rural American town. We conclude the study by suggesting policy options that should be considered by policymakers when developing strategies to incentivize effective water conservation practices. These include; encouraging water efficiencies regarding the use of household appliances, the use of pricing, and the application of restrictive local ordinances.

**Keywords** Water conservation · Rural American city · Policy · Management

## Introduction and problem identification

Demand for domestic water use is a rapidly growing urban problem in cities across the developed and developing world. One study indicates that domestic water use in urban centers in the developed world ranges from 100 to 180 L per person (Friedler and Hadari 2006). Specifically, in the United States, the Environmental Protection Agency (EPA 2016) acknowledges the same by reporting that the average American family in an urban setting uses more than 3000 gallons of water per

day at home. Roughly 70% of this usage occurs indoors. Moreover, nationally in the United States, the EPA further indicates that outdoor water use accounts for 30% of household use yet the percentage is projected to be higher in drier states like Oklahoma. The increase in domestic water use in North American cities has been attributed to population increase, drought/climate change and unsustainable human lifestyle patterns throughout the past few decades. Because of these changes, it becomes imperative for urban policy-makers and researchers to be engaged in studies that are able to provide the much-needed empirical data on household water conservation strategies especially in the case of expanding urban centers such as Ada Oklahoma. These strategies can be employed by urban centers to improve water conservation and improvements in environmental health at large. In this study we contribute to this endeavor by identifying the following: (1) strategies employed by households to conserve water in Ada Oklahoma, (2) circumstances that motivate households to conserve water, (3) perception of households water conservation awareness, (4) households efficacy towards water conservation, (5) perception of households knowledge with regards to water availability

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in Ada and Pontotoc County, (6) household opinions about potential penalties that should be levied on wasteful users, and lastly (7) opinions about the role of local, state and federal governments regarding water source protection. We identified these household strategies using survey data collected during the summer of 2017 in Ada, Oklahoma.

This study is important for the city of Ada and other communities around the United States for the following four reasons. First, the state of Oklahoma has experienced extreme drought in the last few years. In fact, droughts lasting years are common occurrences in Oklahoma (Knittle 2010). The Oklahoma Climatological Survey, which began record-keeping in 1895, has recorded multi-year droughts in the 1910s, 1930s, and 1950s; shorter droughts in the 1960s and 1970s, and intermittent drought beginning in 2000. The state finally became drought free in 2015 which was the first time since October 2010 (Oklahoma Climatological Survey 2017). In this respect, the identification of household attitudes and behaviors towards water conservation initiates a significant step in developing drought mitigation strategies in drought-prone States like Oklahoma. Second, the city of Ada has the potential to grow, thus increasing our understanding of household attitudes towards water conservation provides knowledge that can be replicated by city managers across the USA in the development of public policy measures and awareness campaigns directed toward improving conservation. Historical trends suggest that when the population of a city increases, managers often respond by expanding the water infrastructure rather than opting for soft path mechanisms such as promoting knowledge-based conservation campaigns. The expansion of water infrastructure is understood to be costly, and most importantly, does not influence the more affluent who can afford to use as much water as they need. Third, this study reveals the attitudes and perceptions of local citizens, especially concerning their views and values regarding water conservation issues. Finally, we provide one of the most current datasets on attitudes/opinions about water conservation in the state of Oklahoma.

In the coming sections, we review the relevant literature and previous research to highlight where and how our study fits within the broader scholarship of water conservation. Next, we present a brief profile of the study area, followed by a description of the data source and the methodology used in the study. The last two sections contain the main findings, discussion, policy suggestions and avenue for further research.

## Previous research

Studies on water conservation behaviors and attitudes can be discussed under two broad categories. The first category includes studies that examine water consumption,

behaviors associated with conservation, and behaviors that influence consumption (see, e.g., Addo et al. 2018a, b; Moglia et al. 2018; Ramsey et al. 2017; Smith et al. 2018; Hoque 2014; Head and Muir 2007; Allon and Sofoulis 2006; Loh and Coghlan 2003; Aitken et al. 1991; Troy et al. 2006). The second category includes studies that evaluate people's attitudes towards water shortages and conservation (see, e.g., Roseth 2006; Nancarrow and Syme 1989; Collely et al. 1991; Institute for Sustainable Futures 2003). Attesting to works in the first category is a study by Addo et al. (2018a). In this research, framework of the behavior change wheel was used to examine the relationship between water use behaviors and the following predictor variables: (1) capability defined in terms of an individual having the skills to repair minor water leakages and an understanding of the impact of water scarcity, (2) opportunity characterized by physical opportunities afforded by the environment, i.e., time or economic enablers of water conservation, and (3) motivation comprising of beliefs about what is good and bad, conscious intentions, emotional reactions and reflective responses. Results reveal that the three variables, also labeled as COM dimensions, were statistically significant in predicting household water use-behavior. In other words households adopted water conservation behaviors when they had a higher perception of being capable ( $r=0.18$ ,  $p<0.001$ ), when having all the necessary opportunities at their disposal ( $r=0.25$ ,  $p<0.001$ ) and lastly, when they were motivated to conserve water ( $r=0.24$ ,  $p<0.001$ ).

An extension of the foregoing study is found in other research by Addo et al. (2018b). This research latent profile analysis was used to identify barriers and drivers of conservation behaviors. Findings indicate that the variables influencing this process were time constraints, acuity of water-efficient devices, lack of skills to adopt conservation practices, and availability of incentives/disincentives for water saving devices. These findings are in unison with other works. For instance, Smith et al. (2018) observe that water conservation behaviors are affected by many factors including psychological factors, socio-economic factors and environmental factors. Along the same vein Dolnicar et al. (2012) employed a multiple linear regression technique to test a list of variables perceived to contribute to conservation, i.e., information, environmental attitudes measured through an ecological paradigm and demographic variables such as age and education. The key findings from this study indicated that water conservation is strongly correlated with pro-environmental behaviors. People tend to engage in water conservation behaviors when they have an interest in protecting the environment. Moreover, people who conserve water not only behave in an environmentally friendly way, they also tend to feel morally obliged to do so. We find this study quite remarkable because it provided insight on identifying

communication messages and strategies most likely to gear people's attention on water conservation.

Next, using bivariate and ordered bivariate probit regression techniques Dupont and Renzetti (2013) investigated factors that may influence household decision-making regarding indoor and outdoor water conservation behaviors. Data in this study came from the 2006 Canadian Household Level Statistics on Environmental Sustainability Indicators. The principal findings were consistent with the often over-referenced economic theory that water price plays a significant role in influencing the adoption of water-conservation behaviors. However, it is important to note that the study also showed that price only seemed to play a more significant role in influencing decision-making regarding indoor rather than outdoor water conservation choices. Other useful household characteristics found to influence conservation behaviors include; income, education level and family size.

Similar findings are echoed in a study by Hurd (2006), which revealed that households' choices regarding landscape type were sensitive to the following conservation indicators; water price, public utilities education programs, and households' awareness. Particularly, households' price elasticity of landscape choice ranges from  $-2.8$  to  $-0.6$  as landscape type changes from all turf-grass to no turf-grass. Within the same rubric is a study by Cameron and Wright (1990), who employed a series of multinomial logit models to predict factors that may influence households in their decision to install water-conservation devices either in the shower room or in their toilet. Data for this study were generated from a cross-sectional survey of households in the Los Angeles, CA area. The results showed that households' decisions to install shower flow restrictors are mainly influenced by the potential to save on utility costs. Toilet retrofits, however, are more influenced by what they referred to as "General Conservation Mindedness".

With regards to water conservation activities within the households Askew and McGuirk (2010) explored the intersections between domestic water use and the consumption behaviors specifically on lawn maintenance. The study used a questionnaire to gather data from 48 households. Items contained in the questionnaire were divided into three sections concerning the frequency of water use, the socio-cultural considerations that residents perceived to shape their water use and, most importantly, the associated attitudes and behaviors regarding issues of water conservation in relation to garden watering. The main findings revealed that 71% of respondents used mulch in their gardens, 63% planted water efficient plants while 54% had water efficient lawns. Similarly, Gilg and Barr (2005) sought to examine the social, attitudinal and behavioral composition of water saving activities adopted by households. Regression techniques were used to analyze the data. The key findings indicated that the most

regularly employed water conservation strategies included activities such as; turning off the tap when brushing teeth or washing the dishes, using a shower rather than a bath, turning off water while soaping up in a shower, reducing the number of toilet flushes, taking fewer baths and using the sprinkler less frequently in the garden. Some of these activities involve a greater degree of personal sacrifice, such as turning off the water when soaping up in a shower.

Clarke and Brown (2006) also considered factors that influence water conservation in Melbourne, Australian. They used survey data and focused on three water use behaviors involving the use of appliances. Their results revealed that 6% of respondents use a rainwater tank as a way of conserving water, 52% installed efficient showerheads and 5% use recycled water. They found that water behavioral change is dependent upon the capacity of individuals to acquire and apply water saving and reuse measures.

The afore-reviewed literature highlights studies that evaluate water consumption and the associated behaviors and factors that influence conservation. Next, we review studies that focuses on peoples' attitudes towards water conservation. Prominent among these studies is Hannibal et al. (2018) whose primary finding determined that individuals who live in counties that experience drought are more receptive to making behavioral changes to conserve water than are those who live in water-rich regions. Similar findings are echoed by March et al. 2015; Palazzo et al. 2017; Wang and Dong 2017. These studies demonstrate that local environmental changes make households more responsive to conservation demands. Wang and Dong (2017) for instance, report that citizens are likely to take adaptive measures, such as retrofitting appliances and cutting back water usage when there is drought. Moreover, Mahafza (2016) confirms that decisions to curtail water usage are seen to be partially influenced by local climatic patterns and perception of the water crisis. Additionally, a study by the Institute for Sustainable Futures (2003) revealed that peoples' attitudes toward water conservation in water-scarce countries like Australia were generally positive; however, respondents seemed to be moved by significant financial rewards.

Demographic characteristics have also been identified as influencing individual attitudes and behaviors towards water conservation. Clark and Finley (2007) reveal that older individuals have a tendency to conserve water than younger people. Stern (2000) on the same notes that apart from age, education and income levels are crucial variables which correlate to increases in water conservation attitudes.

As illustrated above, all the reviewed literature provide important insights into people's water consumption and conservation behaviors and the factors that influence those behaviors. Most of these studies were done in some of the major metropolitan cities around the world. Conversely, our study seeks to provide the most recent evidence into these

behaviors/opinions and attitudes in what most would call an American rural town in a water-scarce State.

## Background of the study area

This study was carried out in Ada, Oklahoma (Fig. 1). The city of Ada is located in Pontotoc County and is the home of the Chickasaw Nation, one of the largest and wealthiest Native American Tribes in the United States. Pontotoc County has a blended economy, much of which comes from a combination of oil and gas production and livestock operations. These activities have been known to create much stress on water facilities, especially due to fracking and agricultural irrigation. Pontotoc County is also known for its rich deposits of limestone, sand, silica, and clay. Accessibility to these minerals has led to the development of a major concrete plant, Holcim, which is located in the city of Ada. Solo Cup, along with East Central University and the Kerr Research Laboratory, one of the largest Environmental Protection Agency laboratory specializing in groundwater studies in the United States are also large institutions located in Ada, Oklahoma. Other major industries found in the city are; Valley View Regional Hospital, Rolling Hills Psychiatric

Hospital, Camrose Technologies and Anderson. Currently, the city is providing services to 12 counties and approximately 120,000 people.

The average per capita income in Ada is \$20,633, which ranks 24th among all towns in the 77 counties in the State of Oklahoma. Female residents account for 52% of the city population and 48% are males. The ethnic make-up of the city is 72% Caucasians, 2.5% African Americans, 15% Native Americans, 2% Asian Americans, and 10% classified as other (Oklahoma Almanac 2013).

The city receives its municipal water supply from Byrd's Mill Spring, an Arbuckle Simpson Aquifer (ASA)—fed stream located a few miles north of the city. The water is gravity fed through a series of above and below ground pipes and assisted when needed, by diesel pumping. The ASA is a “sole source” aquifer. It is the only source of water for Ada and the water service area. The water is stored at various locations, most of which are a series of water tower storage units. The tower storage is utilized in the event of high use periods or drought. Ada has recently instituted utility fee increases to fund an effort to improve aging infrastructure, some of which was constructed in the 1930s. The main concern for the city is the presence of leaks. City leaders estimate approximately one million gallons of water loss

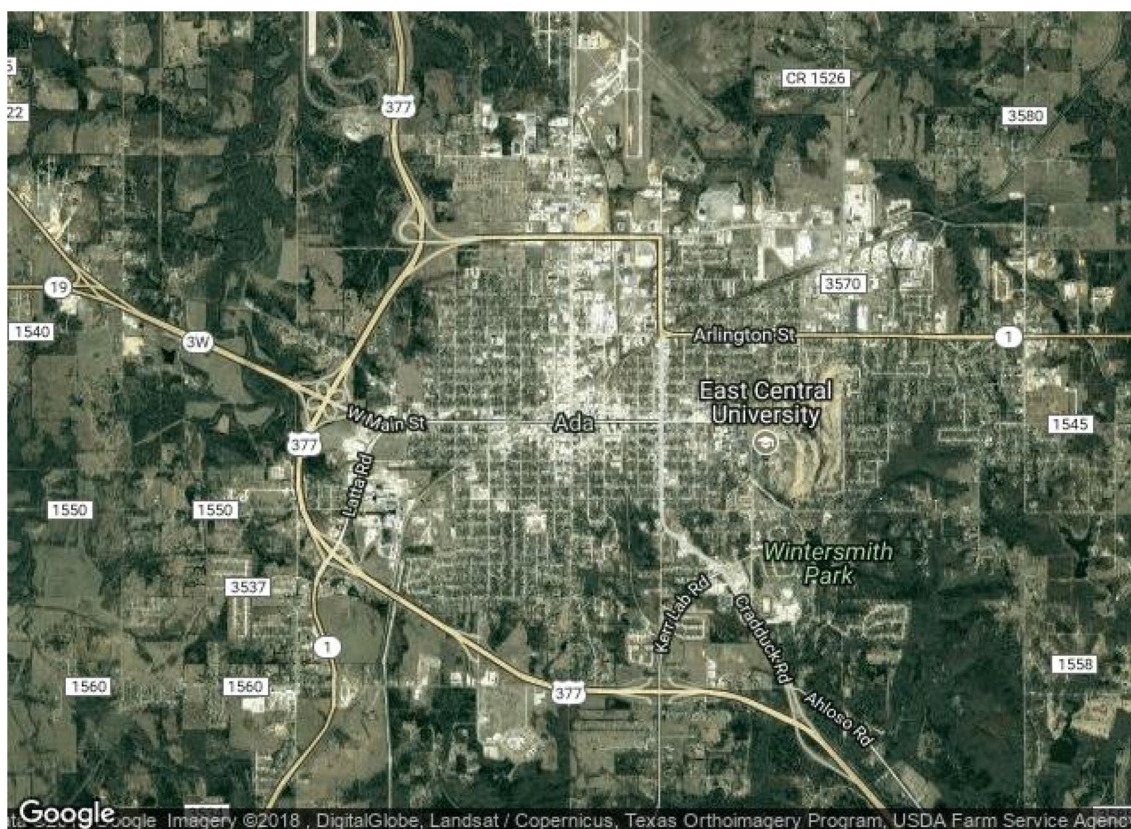


Fig. 1 The city of Ada location map

per year due to the effects of age and a state of disrepair on the water delivery system. The city estimates the total cost of this improvement project at \$31 million. Adding to the urgency to improve the water infrastructure of the city is the changed permitting regime that governs the use of the water from the ASA. The cost of water has increased, and the amount drawn from the ASA has been limited. These two developments have contributed to the growing need for city policymakers to devise strategies and tactics to increase water delivery efficiencies and also to incorporate conservation mechanisms (City of Ada 2018).

## Methodology and data collection techniques

Data for this study were collected through an individually administered questionnaire survey. The survey instrument contained 55 items. The items were designed to elicit information about households': (1) water conservation strategies, (2) circumstances that motivate households' to conserve water, (3) peoples' attitudes about water conservation, (4) water situation in the city and Pontotoc County, (5) households' attitudes about whether the household or the local, state and/or federal governments responsibility to conserve water. Other relevant items included in the survey were household demographic details such as gender, age, the number of people living in a household, number of years lived in Ada, and gross annual income.

A sampling frame was generated from the Ada City Utilities, a city department that provides water and sanitation services for the city. Because the city mails billing notices regularly, the department has access to addresses of its customers, all of whom reside in the City. From the utility database, we generated approximately 13,000 names and addresses from which we randomly selected 300 respondents. We successfully administered the questionnaire to 53 households, a 30% response rate. The survey required 20 days to administer.

To ensure validity, the questions/items in the survey were mostly derived from insight gained from existing literature (Theodori and Fox 2009; Evans et al. 2011; Becerra and Middendorf 2015; Shan et al. 2015). Most of these questions/items are summarized in Table 1. As can be seen in Table 1, the items/questions were formulated in the form of forced choice binary questions, i.e., yes/no, agree/disagree. Further details of the questions/items are provided in the findings/results section.

Pre-testing involving a trial administration of the draft questionnaire was undertaken by two trained assistants. The aim was to ensure that the items in the survey were well-understood by the target population. The research assistant is a native of Oklahoma and was able to explain the items contained in the survey to the respondents in the

native Oklahoma accent wherever necessary. They were also familiar with the geographic arrangements of the city. The principal investigators managed the data entry and analysis portion.

Data entry and processing began simultaneously with data collection. Data processing involved activities such as consistency checks. The collected data were analyzed using SPSS software.

## Results and discussion

### Strategies employed by households to conserve water

Respondents were asked whether they have implemented a series of 14 water conservation measures in their household. Results are presented in Table 2.

As can be seen from the table, 90% of households' surveyed identified the most commonly used water conservation strategy is checking and/or repairing water leakages around the house. On the contrary, opting for landscaping that requires less water, is never practiced (0%). Frequently, observed water conservation strategies among households are; washing dishes by hand (83% of households), lowering water level of washing machines for smaller loads (72% of households), taking short showers lasting less than or equal to 5 min (66% of households), turning off faucets while brushing teeth/shaving (62% of households) and using the dishwasher with only a full load (57% of households).

Poorly practiced water conservation strategies, according to the survey data, included avoiding filling bathtub full (47% of households), collecting cold water for other uses while waiting for water to heat up (15% of households), harvesting rainwater (13% of households) and decreasing how often yard/grass is watered (3% of households).

The above findings provide some empirically grounded support for the commonly practiced water conservation strategies employed by household in different cities around the world. Askew and McGuirk (2010) observed that the most commonly employed behavioral water conservation techniques at the household level were; turning off the tap when brushing teeth or washing the dishes, using a shower rather than a bath, turning off water while soaping up in a shower or reducing the amount of toilet flushes, taking fewer baths and/or showers, and lastly using the sprinkler less frequently in the garden. Further support to similar findings like ours is echoed in a study by Clarke and Brown (2006) in Melbourne, Australia where the majority of household install efficient showerheads as a water saving mechanism.

**Table 1** Variables and their associated survey questions plus how they were measured

Variable	Items/survey question	Measurement/scale
Strategies employed by households to conserve water	<p>Please indicate if you or members of your household employ any of the following to conserve water. Please circle the number of all that apply?</p> <ol style="list-style-type: none"> <li>1. Take short showers (5 min or less)</li> <li>2. Don't fill the bathtub full</li> <li>3. Turn off the faucet while brushing your teeth or shaving</li> <li>4. Lower the water level of the washing machine for smaller loads</li> <li>5. Check for or repair water leaks around the house</li> <li>6. Collect cold water for other uses while waiting for water to heat up</li> <li>7. Install low flow faucets or other water saving appliances</li> <li>8. Use dishwasher with only a full load</li> <li>9. Wash dishes by hand</li> <li>10. Changed the way your yard is landscaped (landscape that requires less watering)</li> <li>11. Decreased how often you water your yard/grass</li> <li>12. Redirect downspouts towards lawn/plants</li> <li>13. Rainwater harvesting</li> <li>14. Other (please specify)</li> </ol>	<p>Categorical Circle that all apply</p>
Circumstances that motivate households to conserve water	<p>What circumstances would motivate you to save water? Please circle the number that all ally?</p> <ol style="list-style-type: none"> <li>1. Severe drought</li> <li>2. Substantial increase in water bill</li> <li>3. Reduced rates for reduced water use</li> <li>4. Free low-flow device(s)</li> <li>5. Vanishing wildlife habitats</li> <li>6. Growing number of endangered species</li> <li>7. Pollution of freshwater</li> <li>8. Disappearing wetlands</li> <li>9. Odd/even day watering restrictions</li> <li>10. Outdoor watering ban</li> <li>11. Other (please specify a scenario)</li> </ol>	<p>Categorical Circle that apply</p>
Awareness about water conservation in a household	<p>Of the statements listed below, please mark all that express your opinions and those of your households with regards to water conservation?</p> <ol style="list-style-type: none"> <li>1. I don't know if household conservation efforts are effective</li> <li>2. I don't think my household is wasting water.</li> <li>3. Residential users do not use enough water to make a difference in water conservation efforts.</li> <li>4. I don't know how to conserve water.</li> <li>5. I have the right to use any amount of water I choose.</li> <li>6. Other (Please specify a reason)</li> </ol>	<p>Categorical Circle that apply</p>
Efficacy towards water conservation	<p>When thinking about water conservation, please mark the statement that best represent your opinion</p> <p>Everyone should make an equal effort to conserve water wherever possible</p> <p>Restricting water use should focus only on excessive or careless water users</p> <p>People are entitled to use as much water as they like and should be trusted to make the right decision</p> <p>People who water their yards during a water shortage should be fined by the city</p> <p>People who water their vegetable gardens during a water shortage should be fined by the city</p> <p>People who wash their cars during a water shortage should be fined by the city</p>	<p>Ordinal, bipolar 1 = Disagree 2 = Agree 3 = Neither Agree nor disagree</p>

**Table 1** (continued)

Variable	Items/survey question	Measurement/scale
Household knowledge with regards to water availability in Ada and Pontotoc County	When thinking about water availability in Ada and Pontotoc county, please mark the statement that best represent what you believe in	Ordinal, bipolar 1 = Disagree 2 = Agree 3 = Neither agree nor disagree
	The need to conserve water is real	
	The Ada/Pontotoc county has enough water to meet the current and future needs	
	The Ada/Pontotoc has enough water to meet the current needs of its citizens, but it will be more difficult to meet future needs	
Household opinions on water conservation related issues and penalties for violations	The Ada/Pontotoc county does not have enough water to meet the current or future needs of its citizens	
	When thinking about the water conservation related issues and the penalties for violators please mark the statement that best represent what you believe in	Ordinal, bipolar 1 = Disagree 2 = Agree 3 = Neither agree nor disagree
	Everyone should make an equal effort to conserve water wherever possible	
	Restricting water use should focus only on excessive or careless water users	
	People are entitled to use as much water as they like and should be trusted to make the right decision	
	People who water their yards during a water shortage should be fined by the city	
	People who water their vegetable gardens during a water shortage should be fined by the city	
Opinions about local, state and federal government roles in water source protection	People who wash their cars during a water shortage should be fined by the city	
	Who do you think should be most responsible for protecting water resources? Please mark all that apply.	Categorical Circle that apply
	1. Federal government	
	2. State government	
	3. Local governments (county, city or town)	
	4. Other local government (agency) entity	
	5. Private entities (industries, businesses, groups, organizations)	
	6. Individuals (private citizens)	
7. I don't know		

**Table 2** Strategy employed by household to conserve water

Household water conservation strategy		Count and percentages	
		Yes	No
1	Household members take short showers ( $\leq 5$ min)	35 (66%)	18 (34%)
2	Household members don't fill bathtub full	25 (47%)	28 (53%)
3	Household members turn off faucets while brushing teeth/shaving	33 (62%)	15 (38%)
4	Household members lower water level of washing machine for smaller loads	38 (72%)	15 (28%)
5	Household members check for/repair water leaks around the house	48 (91%)	5 (9%)
6	Household members collect cold water for other uses while waiting for water to heat up	8 (15%)	45 (85%)
7	Household flow faucets/other water saving appliances installed	24 (45%)	29 (55%)
8	Household members use dishwasher with only a full load	30 (57%)	23 (43%)
9	Household members wash dishes by hand	44 (83%)	9 (17%)
10	Household changed to landscape that require less water	0 (0%)	53 (100%)
11	Household decreased how often yard/grass is watered	3 (6%)	50 (94%)
12	Household members redirected downspouts towards lawn/plants	16 (30%)	37 (70%)
13	Household members harvest rainwater	7 (13%)	46 (87%)

HH household

### Circumstances that motivate households to conserve water

Respondents were asked to select from a list of statements the circumstances or factors that would motivate them to conserve water (Table 3).

The results reflected in Table 3 indicate that the factors with the greatest positive influence on households' water conservation include; severe drought (92% of households), pollution of fresh water (91% of households), substantial increase in water bill (85% of households) and outdoor watering ban (77% of households). These findings are in concert with past research. Wang and Dong (2017) report that people are more likely to adopt water conservation adaptive measures when they are warned of looming drought conditions. In such instances Mahafza (2016) state that households would significantly curtail wasteful water usage behaviors when they are conscious of local changing climatic patterns. Fielding et al. (2012) also found that households in regions recently exposed to drought conditions coupled with a higher level of water restrictions laws were more likely to use less water. As compared to previous works, it is important to note that our findings on pollution of freshwater sources as a motive to conservation is unique to this study. Indeed, only a study by Dolnicar et al. (2012) found that people will engage in water conservation because of environmental protection interests.

### Water conservation awareness

Respondents were asked to choose from a list of statements that closely aligned with their opinions and those of their households with regards to water conservation. Results are presented in Table 4.

According to the respondents, a near consensus (96%) of households reported that they are aware that household water conservation efforts are effective and that they know how to conserve water. Furthermore, the entire sample interviewed shared the opinion that residential water users make a difference in water conservation. On the contrary, our findings under this sub-heading demonstrate that approximately one-third of households did not think they were wasting water and consequently were of the opinion that they have the right to use any amount of water they choose. While we did not link these findings to respondents' education level and income, previous works have demonstrated that education level and income play a significant role in water conservation behaviors. Gilg and Barr (2006) for example, report that in terms of education, households with higher education levels tend to have better awareness and stronger intentions to conserve water. For income, Lam (2006) reinforces the fact the households with extra income have a higher propensity to install water efficient appliances.

**Table 3** Circumstances that motivate households to conserve water

Circumstances motivating households to conserve water		Count and percentages	
		Yes	No
1	Household members motivated by severe drought to save water	49 (92%)	4 (8%)
2	Household members motivated by increase in water bill to save water	45 (85%)	8 (15%)
3	Household members motivated by reduced rates for reduced water use to save water	4 (8%)	49 (92%)
4	Household members motivated by free low-flow device(s) to save water	32 (60%)	21 (40%)
5	Household members motivated by vanishing wildlife habitats to save water	2 (4%)	51 (96%)
6	Household members motivated by number of endangered species to save water	3 (6%)	50 (94%)
7	Household members motivated by pollution of fresh water to save water	48 (91%)	5 (9%)
8	Household members motivated by disappearing wetlands to save water	3 (6%)	50 (94%)
9	Household members motivated by Odd/even day watering restriction to save water	43 (81%)	10 (19%)
10	Household members motivated by Outdoor watering ban to save water	41 (77%)	12 (23%)

**Table 4** Opinions about household water conservation awareness

Opinion about household water conservation awareness		Count and percentages	
		Yes	No
1	Household members don't know if household water conservation efforts are effective	2 (4%)	51 (96%)
2	Household members don't think they are wasting water	16 (30%)	37 (70%)
3	Residential users do not make a difference in water conservation	0 (0%)	53 (100%)
4	Household members don't know how to conserve water	2 (4%)	51 (96%)
5	Household members have the right to use any amount of water they choose	18 (34%)	35 (66%)



### Efficacy towards water conservation

Respondents were asked the following question “when thinking about water conservation, please mark the statement that best represents your opinion?” Table 5 provides interviewees level of agreement with each statement.

Respondents largely agreed (98%) that everyone should make an equal effort to conserve water wherever possible. About 90% of those interviewed also agreed that people who wash their cars during a period of water scarcity should be fined by the city and only 6% disagreed with the same statement. A higher proportion (83%) of respondents agreed that people who water their yards during water shortages should be fined by the city. Moreover, a large share of respondents (53%) disagreed with the statements that people are entitled to use as much water as they like and should be trusted to make the right decision and that restricting water use should focus only on excessive or careless or wasteful users. By the same token, almost 60% of respondents disagreed with the statement that people who water their yards during a water shortage should be fined by the city, while only 30% agreed to the same.

The evidence here is supported by Pumphrey et al. (2008). Particularly, this study completed in a semi-arid region of Texas revealed that most households are supportive of hybrid conservation policies that include mandatory restrictions and fines levied on those seen to be wasting

water, i.e., those washing their cars or watering their yards during water shortage periods. Similarly, in South Australia water users showed support for stricter restrictions on those who misuse water regardless of location, demographics and socio-economic conditions (Pearce et al. 2012).

### Household knowledge with regards to water availability in Ada and Pontotoc County

Respondents were asked the following question “when thinking about water availability in Ada and Pontotoc County, please mark the statement that best represents what you believe (Table 6).

As demonstrated in Table 6, an overwhelming majority (93%) of respondents agreed with the statement that the need to conserve water is real and only 4% were undecided. About one half (47%) of respondents agreed that the Ada/Southeast Oklahoma region has enough water to meet the current needs of its citizens, but difficulties could be encountered to meet its future needs. The proportion of those undecided on this issue is (40%), while those who disagreed only constitute 13%. One-third (34%) of respondents agreed with the statement that Ada/Southeast Oklahoma area has enough water for current and future needs and slightly more than one-third (36%) of respondents neither agreed nor disagreed with the statement. More than one-quarter (28%) of the respondents agreed with the statement that the Ada/Southeast Oklahoma area does not have enough

**Table 5** Efficacy towards water conservation

Efficacy towards water conservation	Count and percentages		
	Disagree	Agree	Neither agree nor disagree
Everyone should make an equal effort to conserve water wherever possible	0 (0%)	52 (98%)	1 (2%)
Restricting water use should focus only on excessive or careless water users	28 (53%)	22 (41%)	3 (6%)
People are entitled to use as much water as they like and should be trusted to make the right decision	28 (53%)	22 (41%)	3 (6%)
People who water their yards during a water shortage should be fined by the city	4 (8%)	44 (83%)	5 (9%)
People who water their vegetable gardens during a water shortage should be fined by the city	31 (59%)	16 (30%)	6 (11%)
People who wash their cars during a water shortage should be fined by the city	3 (6%)	48 (90%)	2 (4%)

**Table 6** Household knowledge with regards to water availability in Ada and Pontotoc County

Household knowledge with regards to water availability in Ada and Pontotoc County	Count and percentages		
	Disagree	Agree	Neither agree nor disagree
The need to conserve water is real	2 (4%)	49 (93%)	2 (4%)
Ada/Southeast Oklahoma area has enough water for current and future needs	16 (30%)	18 (34%)	19 (36%)
Ada/Southeast Oklahoma area now has enough water to meet the current needs of its citizens, but it will be more difficult to future needs	7 (13%)	25 (47%)	21 (40%)
Ada/Southeast Oklahoma area does not have enough water to meet the current or future needs of its citizens	12 (23%)	15 (28%)	26 (49%)

water to meet the current and future needs of its citizens, while about one half (49%) are undecided on the issue.

### Opinions about local, state and federal governments' role in protection of water sources

Respondents were asked to state which entity should bear the responsibilities of protecting sources of water (Table 7).

Most of the interviewees (89% of respondents) believe that the local government entities (city, town and county) should be responsible for protecting water resources. State governments (59% of respondents) and individuals (private citizens) (57% of respondents) are the second and third most thought entity to be responsible for protecting water resources in Ada. Among the least identified groups thought to be most responsible for protecting water resources are private entities (32% of respondents), the federal government (34% of respondents) and other local government entity (30% of respondents). Only about 4% of the sample interviewed did not know who or what institution bears the most responsibility for protecting water sources.

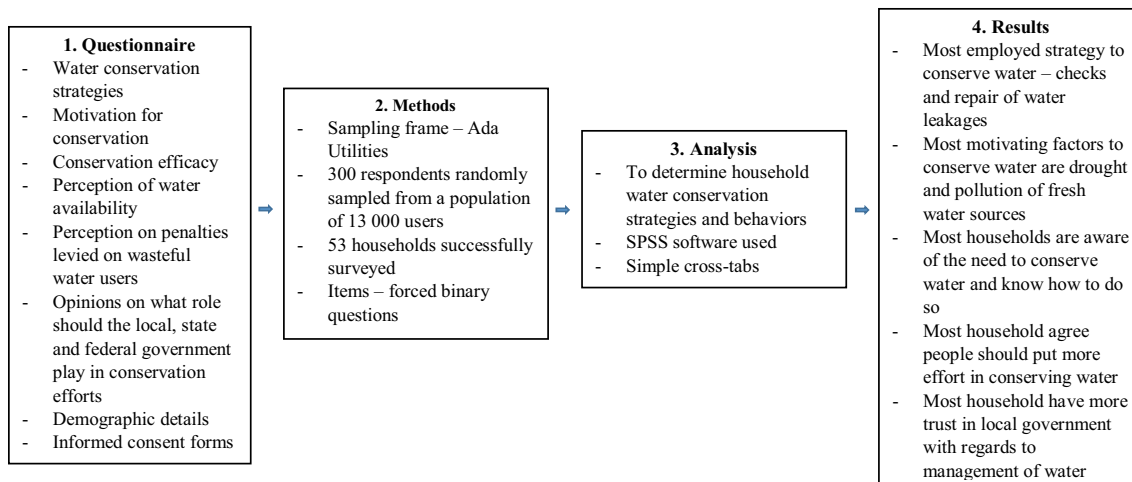
The above findings are in concert with the arguments being advanced by privatization opponents who posit that local authority should take charge of managing water resources. This is because access to water is a human right. When water resource management is passed to private entities, they commoditize water, which excludes the poor from access.

### Conclusion and policy implications

The aim of this research was to provide current empirical data and an in-depth understanding of some of the ongoing everyday behaviors and techniques practiced by households in their water conservation efforts in the city of Ada, Oklahoma. As detailed in the flowchart (see Fig. 2), some of the variables we examined included strategies employed by households to conserve water, circumstances that motivate households to conserve water, efficacy towards water conservation, household's opinion on penalties which should be levied on wasteful water users, and lastly the role of local, state and private entities in the management of water utilities. Cumulatively, our findings reveal the following: (1)

**Table 7** Opinions about local, state and federal government roles in water source protection

Opinions about local, state and federal government roles in water source protection	Count and percentages	
	YES	NO
Federal government most responsible	18 (34%)	35 (66%)
State government most responsible	31 (59%)	22 (42%)
Local governments (county, city or town)	47 (89%)	6 (11%)
Other local government (agency) entity	16 (30%)	37 (70%)
Private entities (industries, business, groups, organizations)	17 (32%)	36 (68%)
Individuals (private citizens)	30 (57%)	23 (43%)
I don't Know	2 (4%)	51 (96%)



**Fig. 2** Flow diagram of data collection, analysis, and results process

most households employ a wide range of strategies in their water conservation efforts, i.e., 90% check and repair water leakages, 80% lower water levels of washing machines, 72% take shorter showers, (2) on circumstances that motivate households to conserve water, pollution emerged first with 91% - this finding is particularly unique within the water conservation scholarship because to our knowledge only one study has revealed pollution as household water conservation motive factor, (3) on awareness, 96% are aware that water conservation efforts are effective and that they know how to conserve water. With regards to efficacy, 98% of households in Ada are in agreement that more people should put more efforts towards water conservation and (4) 89% of households believe that local government should take charge in the management of local water utilities.

Based on these findings we acknowledge that water efficient infrastructure does positively augment conservation. However, if household behaviors and practices are not well-understood they can undermine the use of efficient technologies. In fact, a study by Stewart et al. (2013) that examined the effectiveness of having installed saving monitors for showerheads found that although water use from showering was initially reduced by 27%, shower use returned to original levels over a 4-month period. One can argue that such studies confirm that engineering approaches to water conservation may help reduce water usage, however, a reduction can only be guaranteed when such practices are augmented with specific behavioral changes within households. Indeed, we recommend consideration be given to how humans interface with emerging engineering technologies. Understanding household conservation strategies and behaviors become crucial in conservation efforts.

In conclusion, we prescribe the following to policymakers who want to promote responsible water usage around the home. On strategies employed by households' to conserve water, our findings reveal that respondents rarely opt for water-efficient landscapes and or lawns. This is a behavior that policymakers should focus on in their efforts towards the promotion of water conservation. Note that the U.S. Geological Survey has documented elsewhere that out of the 26 billion gallons of water consumed daily in the United States, approximately 7.8 billion gallons, or 30% is devoted to outdoor uses. Several studies indicate that the majority of this is used for landscaping (see, e.g., Grisham and Fleming 1989; Ali and Warner 2017; Borsari et al. 2018). Specifically, a study by Vickers (2001) estimated that a typical suburban lawn in the United States consumes about 10,000 gallons of water above and beyond rainwater each year. This is a problem that policymakers could address through collaborative partnerships with housing developers to introduce building codes/rules and regulations whereby upcoming new homes must be required to build homes fitted with water-efficient landscapes. Moreover, they can also be enticed through

different local, state or federal inspired/initiated subsidies to develop landscapes that utilize designs and plants suited to local conditions. Such policies have been effective in western States of the U.S. where watering residential landscapes was once the single greatest household use of water. In fact, some estimates in States such as Nevada and California, lawn watering accounted for up to 50% of household annual water consumption (Gleick et al. 2003). However, by altering their outdoor water usage patterns, i.e., developing houses fitted with water efficient lawns, significant water savings have been achieved. According to the EPA (2018) the introduction of water-efficient landscaping is a policy that should be adopted in urban centers because it has both economic and environmental benefits including; conservation of natural resources and preservation of habitat for plants and wildlife, decreased energy use, reduced home heating and cooling costs through careful placement of trees and most importantly extended life for water resources infrastructure.

On circumstances that motivate people to conserve water: unsurprisingly, our findings here indicate that pollution of fresh water sources and a substantial increase in the cost had the greatest positive influences on a households' drive to conserve water. These findings are quite remarkable for several reasons. Most importantly, they are comparable and or consistent with what is found in the existing literature. For example, using a bivariate probit regression technique Dupont and Renzetti (2013) revealed that water price plays a significant role in influencing adoption of water conservation behaviors among Australian household. In a related study, Hurd (2006) found that household choice regarding landscaping was sensitive to price. Similarly, a study by the Institute for Sustainable Future (2003) reported that most Australians were of the opinion that their water conservation efforts should be monetarily rewarded through reduced water bills. Moreover, the finding on pollution of freshwater sources being a motivator for conservation is also supported by existing literature. Indeed, as outlined in the literature review section, Dolnicar et al. (2012) presented a key finding that indicated that water conservation behaviors among households were strongly correlated to pro-environmental concerns. That is, people often engage in water conservation behaviors when they have an interest in protecting the environment. These findings raise a key policy question especially with regards to pricing. Can water policy-makers use pricing as a key catalyst for conservation? Most pro-market driven scholars (e.g., Rogers et al. 2002; Olmstead and Stavins 2008) would argue on the affirmative that past failures to recognize the economic value of water have led to wasteful and environmentally damaging uses. Such failures, they contend, could be remedied by managing water as an economic good. Others would, however, oppose such

propositions by noting that water is a human right. We recommend that policy makers should use pricing as a mechanism for advancing the concept of conservation by rewarding those who show a significant reduction in their water usage. With respect to household efficacy towards water conservation: The survey respondents largely agreed that everyone should make an equal effort to conserve water whenever possible. Furthermore, the majority of those surveyed agreed that those who waste water should be penalized, i.e., 90% of the interviewees agreed that those who either wash their cars or water their lawn during drought periods should at least pay some fine. This view presents a window of opportunity for policymakers because it shows that most people do not view penalties used in conjunction with water restriction laws in a negative way. New restriction laws should be implemented by policy-makers based on the local water conditions and circumstance. A study by Douglas et al. (2004) indicates that outdoor water restrictions are effective tools for reducing water demand during drought periods among Colorado Front Range municipalities. Specifically, the aforementioned study discovered that at the household level, water conservation increases as the frequency of permitted water day's declines and as time limits are strictly enforced. On household knowledge about water availability in Ada and Pontotoc County: surprisingly, about one half (47%) of respondents agree that the ADA/Southeast Oklahoma area has enough water to meet the current needs of its citizens, however, it will be more difficult to meet future needs. This finding provides policymakers with a range of opportunities. Most importantly, on a positive note, the community is aware that more needs to be done to meet future water needs. This implies that more people will be more willing to adopt some of the often neglected pragmatic water conservation measures, i.e., lowering water levels of washing machines, taking short showers, turning off faucets when brushing teeth, opting for showers instead of baths, collecting rainwater for other users and even unconventional means like collecting cold water for other uses while waiting for water to heat. Policy-makers, therefore, ought to deploy aggressive marketing strategies at promoting the aforementioned behavioral changes. They can also use this opportunity to develop persuasive messages through public communication and social media marketing platforms targeted at debunking the often perceived inconveniences of adopting the aforementioned everyday behavioral changes such as turning off the water when soaping up.

Finally, our findings and discussion section reveals much that warrants further investigation. For example, it would be useful to expand the survey tool to include questions regarding the attitudes and beliefs associated with raising public awareness with regards to household water conservation. Perhaps an additional step in our inquiry should involve an

interaction with the city manager, water managers, and other official stakeholders to determine their perspective on efforts that would be helpful in communicating to the public the need to conserve water.

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