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Can Water Knowledge Change Citizens' Water Behavior? A Case Study in Zhengzhou, China

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Abstract

The imbalance between water supply and demand has become prominent increasingly, and the quantity and quality of water has limited the social and economic development. Public participation can solve this problem effectively. Based on the existing research, the impacts of citizens' water behavior are put forward. Through the application of paper inquiry, the relationship among water knowledge, water attitude and water behavior is analyzed. It is proved that water knowledge, water emotion and water responsibility have significant effect on water behavior. The mediating role of water emotion and water liability in water knowledge and water behavior is confirmed. For the government and social organizations, in order to ensure the sustainable use of water and regulate citizens' water behavior, not only water knowledge, but emotion and responsibility should be propagated.

Keywords: water knowledge, water attitude, water behavior, mediating effect

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INTRODUCTION

With the rapid economic development, water shortage, water frequent calamities, water ecological damage, and water pollution become prominent increasingly. On the one hand, the problem of water is mainly caused by the behavior of the human; on the other hand, it also has a direct impact and threat on the daily lives of human. To protect water resources, it is need administrative, economic, legal and technological means, but also public participation. The impact of proactive water behavior on sustainable water resources utilization is long lasting.

To reveal the characteristics, rules and impacts of citizens' water behavior, it is helpful to pay close attention to individual experience of water behavior and its difference. Thereupon then effective measures will be taken to guide citizens to master water required knowledge, form water scientific attitude and implement water normative behavior.

LITERATURE REVIEW

Definition of Water Behavior

According to previous research of citizens' water behavior, the water-saving and consumption behavior are the hot points. There are two main types of research on individual water-saving and consumption behavior. One is to check water bills to reflect the water conservation, which is based on the economic principles and econometric models. The average monthly household water consumption or daily consumption per capita is used as measures of citizens' water behavior (Shi et al. 2015, Zhang and Zhang 2011). The other is to use self-reporting or questionnaire to describe water-saving behavior multi-dimensionally. The use of water-efficient home appliances, water habits, ways and purposes of using water are often used to depict the water-saving behavior (Chang et al. 2012, Jiang and Zhao 2015, Mu et al. 2014, Yang and Liang 2007, Yuan et al. 2015). Some scholars took public support for water conservation policies as a research object, for they considered it as a component of water-saving behavior (Chang et al. 2016, Salvaggio et al. 2014). Furthermore, some researchers present a clearly defined notion of the water-saving behavior. Hao et al. (2010) believed that water-saving behavior referred to individual's choice to improve the efficiency of water utilization. That included not only self-restricting water-using behavior under water efficiency target constraint, but also other acts of regulating water use. Qing et al. (2012) had defined water-saving behavior as a series of actions that people took practical and feasible measures to explore

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Table 1. A list of non-price factors of water-saving behavior

Category	Factors	Literature
Demographic variables	Family characteristics (household income, family size), House features (area, types, situation) Personal characteristics (gender, age, income, education level, occupation)	De Oliver (1999), Domene et al. (2006), Mu et al. (2014), Jiang et al. (2015), Shi et al. (2015), Yang et al. (2007), Chang et al. (2012)
Information variables	Cognition Water-saving principles and skills Perception of water disaster Cognition of water pollution hazards Environmental knowledge	Barr S (2003), Malhotra et al. (2005), Clark W A et al. (2007), Hao et al. (2010), Lu (2015)
Psychological variables	Water-saving awareness Value orientation Consequence consciousness Water-saving attitude Social norms Ecological emotion Concern for water conservation and protection Water-saving desire Water attitude Sensitivity Sense of responsibility	Mu et al. (2014), Jiang et al. (2015), Chang et al. (2016), Qing et al. (2012), Garcia et al. (2013), Shi et al. (2015), Yang et al. (2007), Yuan et al. (2015), Wang et al. (2016), Hao et al. (2010), Lu (2015)

potential, improve efficiency, and achieve comprehensive and rational utilization of water. These literatures limits citizens' water behavior to water-using or water-saving behavior, including the behavior that can reduce water consumption and regulate other's water-using behavior, but ignores behavior that can affect the water quality and water environment.

Study on Influencing Factors of Water Behavior

Due to lack of systematic study on water behavior, scholars have had more research on the impacts of water-saving behavior. Impacts of water-saving behavior can be divided into two categories, namely, price factors and non-price factors. As water is the necessaries of life, the price factor had no obvious influence on water-saving behavior. Ma et al. (2012) analyzed the price elasticity of water in different income groups and found that the elasticity was not significant for both the lowest and highest group. This reflects the limitation of water price on regulation of water-saving behavior.

According to previous research, the non-price factors covered an extensive range of specific elements, which can be divided into demographic variables, information variables and psychological variables in three categories, as listed in **Table 1**.

The influence of demographic variables is different. Taking income as an example, the findings from the San Antonio study in Texas, USA, showed a negative correlation between income and water saving behavior (De Oliver 1991). However, findings from Hangzhou in Zhejiang and Tianjin, both in China, were the opposite (Shi et al. 2015, Zhang and Zhang 2011). Moreover, the study of Barcelona in Spain found out that there was no significant correlation between income and water-saving behavior (Domene and Saurí 2006).

There is little research on the influence of information variables. The finding of Clark and Finley (2007) showed that the understanding of water-saving methods had a significant impact on water-using behavior. The study on junior school student in Beijing, China, showed that the impact of water-saving knowledge on water-saving behavior included two ways, directly affecting and indirectly affecting water-saving behavior through water-saving awareness (Hao et al. 2010).

The research into the effects of psychological variables on water-saving behavior is relatively rich. Most of the research results have proved that water-saving attitudes, social norms and emotional factors have appreciable effects on the citizens' water-saving behavior. Hao et al. (2010) put forward water conservation attitudes, sensitivity and responsibility to constitute water-saving awareness, and draw a conclusion that water-saving consciousness significantly impacted water conservation behavior, based upon the survey data. Chang et al. (2012) used the structural equation model to verify the influence of water resource value on water-using behavior, and found that the value orientation and consequence consciousness significantly affected citizens' water-using behavior, especially the self-sever value. Based on the theory of planned behavior, Qing et al. (2012) discussed the influence of ecological emotion, water-saving attitude and social norms on water-saving behavior, and concluded that water-saving attitude,

social norms and ecological emotions had significant positive effect on water-saving behavior. In the case study of Deyang in Sichuan, China, Yuan et al. (2015) also validated the positive effect of water-saving attitude on water-saving behavior by means of EFA, CFA and hierarchical regression. Although scholars have reached a consensus that the non-price factors, such as information variables and psychological variables, significantly affect citizens' water-saving behavior, the influence of water knowledge and water attitudes on water behavior has not been seen.

THEORETICAL BASIS AND RESEARCH HYPOTHESIS

Water Knowledge and Water Behavior

Knowledge is regarded as an important factor in influencing behavior. Is there a relationship between water knowledge and water behavior? At present, the influence of water knowledge on water behavior is relatively few. However, much research had been made on the relationship between environmental knowledge and environmental behavior. Maloney et al. (1973) argued that there was no correlation between environmental knowledge and environmental behavior, because the content of environmental knowledge was broad and difficult to assess, additionally, the level of citizens' environmental knowledge was low. Nevertheless, Theodori and Luloff (2002) believed that educational factors were positively related to environmental behavior. Some studies had found that specific environmental knowledge, such as knowledge and behavioral consequences related to specific environmental behavior, had a greater impact on environmental behavior (Ellen 1994, Frick et al. 2004, Marcinkowski 1988, Sun et al. 2012).

Behavior is guided and restricted by knowledge. Understanding of the distribution and properties of water, being familiar with knowledge and skills to protect water and aquatic environment, help citizens to self-restraint on water behavior and regulation of the water behavior of others.

So we make the following hypothesis:

H_1: Water knowledge has a significant effect on water behavior.

Water Attitude and Water Behavior

Attitude impact behavior is a more unified view of the academic community. The positive impact of citizens' environmental attitudes on their environmental behavior has been confirmed in a large number of theoretical and case studies, furthermore, the effect of water attitude on water-saving behavior has been confirmed in many literatures.

From the existing research, when citizens have more hydrophilic emotion, water crisis consciousness and water conservation responsibility, in addition, fell the pressure of social norms, such as ethics and moral principles from outside, they would like to take the initiative to learn more about water conservation, change habits, and persuade others to change water behavior in different ways, so as to reduce water consumption. Although the implementation of the behavior has eventually be affected by other factors, but the impact of attitude on behavior is significant and clear.

Based on previous literatures and experts' opinion, we argues that water attitude is composed of water emotion, water responsibility and water ethics. Specifically, water emotions include both hydrophilic and environmental concerns, water responsibility reflects saving water and protecting the water environment, and water ethics is the value orientation and moral principle that the citizens follow when they implement the water behavior.

So we make the following hypothesis:

H_2: Water emotion has a significant effect on water behavior.

H_3: Water responsibility has a significant effect on water behavior.

H_4: Water ethics has a significant effect on water behavior.

Mediating Effect of Water Attitude

The mediator is an important statistical concept. If the independent variable (X) has a certain effect on the dependent variable (Y) through a variable (M), it is called (M) as the mediator variable of (X) and (Y), and has an intermediary effect in the relationship between (X) and (Y). Compared with the independent variable analysis, the mediator effect model can deeply analyze the process and mechanism of independent variable influencing the dependent variable. Hao et al. (2010) proposed that water-saving awareness was a mediator variable of water-saving knowledge and behavior, , and used model to prove the existence of "mediator effect", that was, the influence of water-saving knowledge on water-saving behavior included two ways, direct and indirect through water-saving awareness (Hao et al. 2010).

Table 2. Structure of the questionnaire

Variable	Type	Dimension	Examples	Numbers
Water knowledge	Independent variable		What is your view of water price?	4
Water attitude	Independent variable /Mediator variable	Water emotion	Are you concerned about the current water problems?	7
		Water responsibility	Are you willing to save water?	
		Water ethics	Do you object to that statement, that Our contemporary people do not need to consider water and water pollution problems, future generations will have a way to solve	
Water behavior	Dependent variable		Have you collected the rinse water from the washing machine for dehydration or hand washing?	14
Gender	Control variable			
Age				
Education level				
Career				
Place of residence				
Household income				

Table 3. Control variable assignment

Assignment	1	2	3	4	5	6	7
Gender	Male	Female					
Age	6-17	18-35	36-45	46-59	60 and above		
Education level	Elementary school and below	Junior high school	High school	College	Master and above		
Career	Government functionaries	Utility personnel	Enterprise personnel	Farmer	Students	Freelancers	Others
Place of residence	urban area	rural area					
Household income	30,000 yuan and below	30,000-80,000 yuan	80,000-120,000 yuan	120,000-200,000 yuan	200,000yuan and above		

So we make the following hypothesis:

H_5: Water emotion is the mediator of water knowledge and behavior.

H_6: Water responsibility is the mediator of water knowledge and behavior.

H_7: Water ethics is the mediator of water knowledge and behavior.

EMPIRICAL ANALYSIS

Design of Questionnaire

Design of questionnaire

The data used in this study was from a self-designed questionnaire. First of all, through the interviews and literature, the original information was collected and sorted out. Then, the first draft of the questionnaire was designed combining the hypotheses, after repeated panel discussions. Besides, a preliminary survey was conducted for different groups of people. After that, the final draft of the questionnaire was determined.

The questionnaire consisted of water knowledge, water attitude and water behavior. There were 4 questions in water knowledge section, which were evaluated by multiple choice. The corresponding assignments were as follows: *all correct* = 4 points, *some correct and no false* = 3 points, *some correct and some false* = 2 points, *no correct* = 1 points. The water attitude section had 7 terms, and water behavior section contained 14 ones. In the two sections, there were Likert-type scales consisting of 4 responses: *strongly willing/always*, *willing/often*, *reluctant/occasionally*, *strongly reluctant/never*. The responses were scored as: *strongly willing/always* = 4 points, *willing/often* = 3 points, *reluctant/occasionally* = 2 points, *strongly reluctant/never* = 1 points. **Table 2** shows the structure of the questionnaire. **Table 3** shows the assignment of control variables.

Reliability and validity analysis of questionnaire

SPSS22.0 software was used to test the structural validity of this survey. The results showed that the KMO value was 0.868, which was higher than 0.60, and the χ^2value of Bartlett's spherical test was 2649.097 (df = 300, $P < 0.001$), indicating that the scale had a good structural validity. The Cronbach's α-coefficients was 0.832, which was higher than 0.70. It was found to be reliable.

Table 4. Sample demographic variables description statistics

Variable	Category	Frequency	Percentage (%)
Gender	Male	181	52.31
	Female	165	47.69
Age	6-17	26	7.51
	18-3	194	56.07
	36-45	79	22.83
	46-59	34	9.83
	60 and beyond	13	3.76
Education level	Elementary school and below	27	7.80
	Junior high school	72	20.81
	High school	53	15.32
	College	132	38.15
	Master and above	62	17.92
Career	Government functionaries	36	10.41
	Utility personnel	88	25.43
	Enterprise personnel	60	17.34
	Farmer	52	15.03
	Students	33	9.54
	Freelancers	49	14.16
	Others	28	8.09
Place of residence	Urban area	214	61.85
	Rural area	132	38.15
Household income	30,000 yuan and below	124	35.84
	30,000-80,000 yuan	125	36.13
	80,000-120,000 yuan	65	18.79
	120,000-200,000 yuan	24	6.94
	200,000 yuan and above	8	2.30

Sample Analysis

Analysis of the characteristics of samples

The data were obtained from households or street random surveys. All samples were randomly selected using quota sampling. In order to ensure the representation of the questionnaire, the characteristics of the respondents, such as age, education, occupation and income, were controlled in the sample, thus ensuring that all kinds of people were covered. The questionnaire was distributed and recovered in July 2017. A total of 350 questionnaires were issued, and all were recovered. The recovery rate was 100%. However, 4 valid copies were eliminated, and 346 valid questionnaires were obtained. The effective recovery rate was 98.86%. The characteristics of the respondents were shown in **Table 4**.

Assumptions Test

Correlation analysis

The Pearson correlation coefficient was used to test the correlation between different variables, as shown in **Table 5**.

Table 5. Correlation coefficient matrix for variables

Variables	1	2	3	4	5	6	7	8	9	10	11
1 Gender	1										
2 Age	-0.021	1									
3 Education level	0.024	0.026	1								
4 Career	-0.058	-0.200***	-0.450***	1							
5 Place of residence	-0.035	0.000	-0.605***	0.381***	1						
6 Household income	-0.047	0.210***	0.585***	-0.366***	-0.452***	1					
7 Water knowledge	.017	-0.039	0.581***	-0.284***	-0.382***	0.332***	1				
8 Water emotion	0.027	0.091	0.326***	-0.255***	-0.246***	0.217***	0.320***	1			
9 Water responsibility	0.076	0.010	-0.033	-0.008	-0.016	-0.120**	0.049*	0.238***	1		
10 Water ethics	-0.016	0.079	0.202***	-0.116	-0.115**	0.220**	0.202***	0.031	-0.007	1	
11 Water behavior	0.010	0.027	0.018	-0.026	-0.019	-0.117**	0.111**	0.454**	0.462***	-0.069	1
mean	1.48	2.46	3.38	3.62	1.38	2.03	3.1481	3.1618	3.4528	3.1431	2.6967
SD	0.5	0.907	1.217	1.846	0.486	1.017	0.7182	0.6018	0.4043	0.5877	0.5298

Tips: ***stands for $P < 0.01$, **stands for $P < 0.05$, *stands for $P < 0.1$

Table 6. Regression analysis of water behavior

			model 1	model 2	model 3
Explanatory variables		Frequency	OR	OR	OR
Household income	30,000 yuan and below	124	5.86***	8.50***	12.58***
	30,000-80,000 yuan	125	7.01***	8.38***	10.76***
	80,000-120,000 yuan	65	3.32*	3.65**	5.21**
	120,000-200,000 yuan	24	4.80**	5.25**	5.53**
	200,000 yuan and above (reference group)	8	1.00	1.00	1.00
Water knowledge		346		1.55***	1.09*
Water attitude	Water emotion	346			4.50***
	Water responsibility	346			6.48***
Model fit degree χ^2			14.487***	24.311***	164.65***
Cox & Snell R^2			0.041	0.068	0.377
Nagelkerke R^2			0.041	0.068	0.377

Tips: ***stands for $P < 0.01$, **stands for $P < 0.05$, *stands for $P < 0.1$

For all the control variables, only household income was negatively correlated with water behavior (r = -0.117, $P < 0.05$), and the others did not show significant correlation. However, for independent variables, there was a significant positive correlation between water knowledge and water behavior (r = 0.111, $P < 0.05$). The same correlation also existed between water emotion and water behavior (r = 0.454, $P < 0.05$), both water responsibility and water behavior (r = 0.462, $P <$ 0.05). So H_1, H_2, H_3 were initially verified, yet H_4 did not pass the test.

Regression analysis

Based on the foregoing analysis, only household income, water knowledge, water emotion and water responsibility were significantly related to water behavior. Accordingly, in this part, the household income, water knowledge, water emotion and water responsibility were used as independent variables, while water behavior was dependent variable, and the orderly multivariate logistic regression model was constructed. *Model 1* verified whether household income had an impact on water behavior. On the basis of *model 1*, *model 2* introduced water knowledge to verify whether water knowledge affected water behavior. Furtherly, water emotion, water responsibility was introduced into *model 3*. Regression analysis results are shown in **Table 6**.

Model 1 examined the impact of household income on water behavior, the result was that citizens with lower household incomes would implement more regulated water behavior. The model fitting degree of *model 2* was better than *model 1*, and the R^2-coefficient of model 2 was also higher than that of *model 1*.This showed that the introduction of water knowledge leaded to a significant increase in interpretation of water behavior in *model 2* (OR = 1.55, P = 0.020).The results showed that water knowledge had positive effect on water behavior. Assuming that H_1 passed the test, that was, citizens with more necessary water knowledge

Table 7. Mediating role of water emotion

Procedure	Explanatory variables	Explained variable	β	Assumed condition
1	Independent variable	Dependent variable	β_1	β_1 is significant
	Water knowledge	*Water behavior*	*0.111***	*There is significant correlation between water knowledge and water behavior.*
2	Independent variable	Mediating variable	β_2	β_2 is significant
	Water knowledge	*Water emotion*	*0.320****	*There is significant correlation between water knowledge and emotion*
3	Independent variable	Dependent variable	β_3	$\beta_3 < \beta_1$, β_4 is significant
	Water knowledge	*Water behavior*	*0.038(p = 0.451)*	*No significant, complete mediating effect*
	Mediating variable		β_4	β_4 *is significant*
	Water emotion		0.466*****	

Tips: ***stands for $P < 0.01$, **stands for $P < 0.05$, *stands for $P < 00.1$

Table 8. Mediating role of water reliability

Procedure	Explanatory variables	Explained variable	β	Assumed condition
1	Independent variable	Dependent variable	β_1	β_1 is significant
	Water knowledge	*Water behavior*	*0.111***	*There is significant correlation between water knowledge and water behavior*
2	Independent variable	Mediating variable	β_2	β_2 is significant
	Water knowledge	*Water reliability*	*0.049**	*There is significant correlation between water knowledge and reliability*
3	Independent variable	Dependent variable	β_3	$\beta_3 < \beta_1$, β_4 is significant
	Water knowledge	*Water behavior*	*0.088**	*significant, partial mediating effect*
	Mediating variable		β_4	β_4 *is significant*
	Water reliability		*0.458****	

Tips: ***stands for $P < 0.01$, **stands for $P < 0.05$, *stands for $P < 0.1$

Table 9. Mediating role of water ethics

procedure	Explanatory variables	Explained variable	β	Assumed condition
1	Independent variable	Dependent variable	β_1	β_1 is significant
	Water knowledge	*Water behavior*	*0.111***	*There is significant correlation between water knowledge and water behavior*
2	Independent variable	Mediating variable	β_2	β_2 is significant
	Water knowledge	*Water ethics*	*0.202****	*There is significant correlation between water knowledge and water ethics*
3	Independent variable	Dependent variable	β_3	$\beta_3 < \beta_1$, β_4 is significant
	Water knowledge	*Water behavior*	*0.130***	*The mediating effect is not valid.*
	Mediating variable		β_4	β_4 is not significant.
	Water ethics		*-0.095 (P = 0.367)*	

Tips: ***stands for $P < 0.01$, **stands for $P < 0.05$, *stands for $P < 0.1$

would perform more standardized water behavior. Compared with *model 1* and *model2*, the model fitting and R^2-coefficients of *model 3* were significantly improved. Thereinto, water emotion significantly affected water behavior positively (OR = 4.50, P = 0.000), as well as water responsibility (OR = 6.48, P = 0.000). The hypotheses H_2 and H_3 had passed the test, it meant that citizens of more water emotion and responsibilities would implement more standardized water behavior.

Analysis of mediating effect

According to Baron et al. (1986), SPSS 22.0 was used to verify the mediating role of water emotion, water responsibility and water ethics between water knowledge and water behavior. The results are shown in **Table 7**, **Table 8**, and **Table 9**.

Through the above analysis, the following conclusions were obtained: (1) water emotion had a full mediation in the relationship between water knowledge and water behavior; (2) water responsibility had a partial mediation in the relationship between water knowledge and water behavior; (3) water ethics did not play a mediating effect in the relationship between water knowledge and water behavior. Consequently, the hypotheses H_5 and H_6 had passed the test, but hypotheses H_7 had not. **Fig. 1** shows the results of the mediating effect.

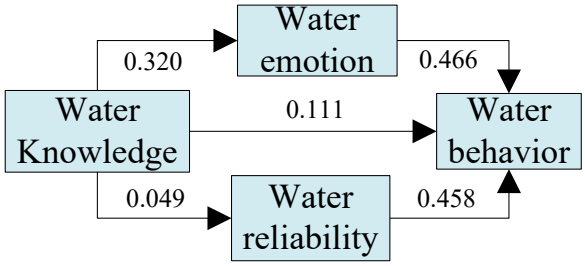

Fig. 1. Mediation of water emotion and water responsibility

CONCLUSION AND DISCUSSION

Based on the analysis of existing research results, this paper divides water knowledge and water attitude into influencing factors of citizens' water behavior, and divides water attitude into three dimensions: water emotion, water responsibility and water ethics. The water knowledge, water attitude and water behavior of the urban and rural residents in Zhengzhou City of Henan Province was analyzed by means of questionnaires, and the first-hand information was quantitatively analyzed. Empirical studies on the relationship among water knowledge, water attitudes and water behavior have been carried out. The conclusions are as follows: (1) water knowledge, water emotion and water responsibility all have a significant positive impact on citizens' water behavior; (2) water knowledge, on the one hand, influences water behavior directly; on the other hand, it affects water behavior indirectly through water emotion and water responsibility; (3) there is no significant correlation between water ethics and water behavior, and the author believes that it is because the citizen's water behavior belongs to the individual behavior, which occurs in the private domain, and is less influenced by social ethics, such as value orientation and moral principle.

Because that the direct influence of water knowledge on citizens' water behavior is limited and relatively weak, government and social organizations have mainly spread the knowledge of water to the public, but no significant results. Nevertheless, owing to the existence of mediating effects of water emotion and water responsibility, the indirect effects of water knowledge on water behavior are more significant through water emotion and water responsibility. Therefore, it should pay attention to the importance of citizens' water emotion and water responsibility, when launched campaigns of water conservation.

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