Water Policy 21 (2019) 742–757

Regional differences in citizens' water behaviors: a comparative study of typical cities based on AMOS

Yanrong Wang[a,*], Kang Tian[a], Han Wang[b] and Binbin Zhang[a]

[a] *School of Management and Economics, North China University of Water Resources and Electric Power, Zhengzhou 450046, Henan, China*

**Corresponding author. E-mail: wyr223@126.com*

[b] *School of Water Conservancy, North China University of Water Resources and Electric Power, Zhengzhou 450046, Henan, China*

Abstract

At present, the urban water issue has attracted great attention from government. The transition from 'engineering measures' to 'human behaviors' is a new angle for water resources protection in the new era. In this paper, 12 characterization parameters were obtained based on the analysis of characteristics of residents' water behaviors. Beijing and Shanghai are selected as the representative cities in the north and south regions respectively, and a questionnaire about residents' water behaviors, which includes three basic personal characteristics and 12 indicators, was prepared. By using a structural equation model, a comparative study on the differences of the impact paths of characterization parameters of residents' water behavior in two cities was discussed. Finally, suggestions are proposed on the basis of the evaluation model and the results of analysis. The results showed that: Beijing had similar impacting paths in Ecological Water Environment management behaviors and persuasive behaviors to Shanghai. There were obvious differences in residents' water behaviors impact paths by basic individual characteristics, consuming behaviors and legal behaviors in Beijing and Shanghai. Finally, suggestions are proposed on the basis of the evaluation model and the results of analysis.

Keywords: Regional differences; Structural equation; Typical city; Water behavior model

Introduction

Rapid development of the economy and population will cause ever increasing demand for water. Thus, water shortage has become a critical bottleneck for urban development. Apart from some engineering measures such as dams and water transfer projects, saving water and more intensive management are also important ways to solve the contradiction between availability and demand for water resources. Water demands include municipal water and industrial water, as well as eco-environmental water. Due to

doi: 10.2166/wp.2019.204

economic structure optimization and technological progress, industrial water consumption tends to decline steadily. Owing to the accelerating process of urbanization and higher living standards of urban residents, municipal water consumption continues to increase (Zhou, 2005). Therefore, the standardization of residents' water behavior directly affects the sustainable utilization of regional water resources.

In recent years, domestic and foreign scholars have conducted many beneficial explorations of residents' water behaviors, which mainly focused on the urban residents' water consumption, main factors of residential water-consuming and water-saving behavior as well as the characteristics and differences in water saving and water consumption habits in different regions, etc. There are a great variety of studies focusing on urban residents' water consumption and water-consuming behaviors. From the perspective of public management, some studies point out that the main factors affecting the residents' water consumption were water restriction tactics, relevant regulations and laws on water management such as local and industrial laws and regulations, etc. (Renwick & Green, 2000; Kenney *et al*., 2008). From the individual perspective, the studies highlight individual subjective factors including subjective norms, behavioral control and attitude as the main factors influencing the residents' water-consuming behavior (Hassell, 2007; Jia *et al*., 2010; Li *et al*., 2010b; Willis *et al*., 2011). Some studies confirmed that the residents' living conditions (such as bathroom, swimming pool, house size, house age, etc.) and family characteristics (such as composition, structure, water saving measures, income, etc.) will affect residents' water-consuming behavior (Gilg *et al*., 2005; Potter & Darmame, 2010; Bai *et al*., 2011; Zhang & Zhang, 2011). Additionally, other studies showed that external factors such as decision-making processes, water supply restrictions, and water pricing mechanisms will also affect the residents' municipal water consumption behaviors (Cao & Cai, 2010; Li *et al*., 2010a; Zhang *et al*., 2011).

There are also many meaningful studies on water-saving behaviors both at home and abroad. According to Yang & Liang (2007), the main influencing factors of water-saving behaviors were cultural background, water price, income, sense of crisis on water resources and regional differences. Liu *et al*. (2009) investigated residents' water-consuming behaviors, with the results showing that the main influencing factors were education level, GDP per capita, water resources risk coefficient and water price (Liu *et al*., 2009; Zhao, 2015). Aisa & Larramona (2012) divided water-saving behaviors into water-saving equipment utilization and water-saving behaviors, and found that these two behaviors had different driving forces (Aisa & Larramona, 2012). Mu *et al*. (2014) and Jiang & Zhao (2015) found that when it came to the cultivation of water-saving behaviors, or the updating of water-saving equipment, residents' water-saving awareness was the most important factor (Mu *et al*., 2014; Jiang & Zhao, 2015). A study by Cong *et al*. (2018) indicated that understanding of water-saving awareness, water-saving attitude, water-saving policies, water-saving subjective norms, self-control of water-saving, and water-saving knowledge had a positive influence on the water-saving behaviors of college students.

Few studies have focused on the regional disparities of residents' water behavior. Gilbertson *et al*. (2011) analyzed the impact of regional differences on residents' water-saving behaviors, finding that different water environments led to different water-saving attitudes and water-saving behaviors of local residents. Shen *et al*. (2015) studied household water consumption characteristics, water consumption and water consumption intensity under different climate, administrative levels and economic development levels through typical tests and questionnaire surveys of nine cities in China. Most of the studies on water behaviors are carried out by residents in a certain area. Few scholars have analyzed the characterization factors of residents' water behaviors and compared the influence path of water behavior characterization factors in different regional cities.

In this paper, two typical cities, Beijing and Shanghai, are selected as the research objects in the north and south regions of China. We compared the residents' water behavior in the two cities from a microcosmic perspective, discussed the differences among residents' water behaviors in different areas, and clarified the influencing path among residents' water behavior characterization factors. The conclusion will provide a scientific basis for the relevant departments to improve the utilization ratio of water resources, improve the water price mechanism and formulate targeted water resources protection policies.

Residents' water behavior indicating factors analysis

Water behavior is an action taken by residents with necessary water knowledge and a scientific attitude towards solving various water problems. Water behaviors are manifestations of individual actions, emotions, responsibilities, ethics and moral values for water under different situations and these reflect the unity of knowledge and behaviors and mainly include skills of analyzing, solving and dealing with the problems of water resources utilization and aquatic ecological environment issues; developing habits with high efficiency of water consumption and aquatic environment protection; choosing better usage patterns that are beneficial to the water resources and aquatic environment; persuading and affecting others to conserve water resources and protect the water environment; taking legal measures to urge others or relevant departments to solve related water resources issues. Therefore, the indicating factors can be extracted by expert consultations and literature reviews, and then the main expressions of the indicating factors can be concluded.

Water behavior indicating factors are shown in Table 1.

Data sources and analysis methods

Typical city selection

A city is a large civic point formed by non-agricultural industry and non-agricultural population, which has a dense population and developed commerce. In addition, it is often the political, economic and cultural center of a region. With the rapid development of the economy, the number of cities in our country is increasing and their scale is expanding constantly. Hence, under the developed economics and higher living standards, together with the complete water related supporting facilities, residents require more water and higher water quality. According to water resource distribution and water supply, the first level of water resources can be divided into six districts in the north and four districts in the south. This paper selected one representative city from the six northern districts and four southern districts respectively for a comparative study of residents' water behaviors. According to the current water resource situation in the six northern districts and four southern districts, and the nearly five-year index data of total water supply, total water consumption and water consumption per capita in the two cities (Table 2), we made a detailed comparative analysis and sought advice from experts and professors, and ultimately selected Beijing and Shanghai as typical cities for the questionnaire survey.

Data sources

A questionnaire was designed based on the analysis of the indicating factors of residents' water behaviors. The questionnaire consisted of 15 questions, including three basic personal indicators: education

Table 1. Water behavior indicating factors.

	Indicating factors	Main expressions
Water behavior	Participate in publicity of water saving and water protection	World Water Day, China Water Week and other theme activities; Water-related public service ads; water-saving and water-protection propaganda organized by community/school
	Participate in the protection of ecological water environment	Afforestation, water source conservation
	Proactive learning of water saving skills	Water-saving education experience, cultivate the water-saving skills
	Proactive learning of disaster avoidance skills	Understanding the types and hazards of water disasters; master the emergency measures
	Participate in prevention of water pollution events	Prevent other people or organizations from polluting water
	Participate in public welfare activities of environment-protection organizations	Accept and participate in the activities carried out by public welfare environment protection organizations
	Municipal sewage recycling behavior	Water reuse and municipal sewage recycling
	Municipal water consumption	Impact of habits and lifestyle on water consumption (hand washing, bathing, laundry, etc.)
	Water-saving facilities utility	Water-saving facilities utility in family, company/ community
	Abidance by the water-related laws and regulations	The acts which break the water-related laws and regulations
	Report or supervise water environment incidents	Report the illegal activities to the environment supervision and law enforcement department
	Supervise the management effectiveness of law enforcement department	Judgment on the management effectiveness of law enforcement department

Table 2. Water supply and demand in Beijing and Shanghai (unit: 100 million m^3).

		2016		2015		2014		2013		2012	
		B	S	B	S	B	S	B	S	B	S
Water supply	Surface water	11.3	104.8	10.5	103.8	9.3	105.9	8.3	123.1	8.0	115.9
	Groundwater	17.5	0.0	18.2	0.0	19.6	0.1	20.0	0.1	20.4	0.1
	Other	10.0	0.0	9.5	0.0	8.6	0.0	8.0	0.0	7.5	0.0
	Total water supply	38.8	104.8	38.2	103.8	37.5	105.9	36.4	123.2	35.9	116.0
Water consumption	Drinking water	17.8	25.1	17.5	24.1	17.0	66.2	16.3	25.7	16.0	24.9
	Industrial water	3.8	64.4	3.8	64.6	5.1	14.6	5.1	80.4	4.9	72.9
	Agricultural water	6.0	14.5	6.4	14.3	8.2	14.6	9.1	16.3	9.3	17.5
	Ecological water[1]	11.1	0.8	10.4	0.8	7.2	0.8	5.9	0.8	5.7	0.7
	The total amount of water	38.8	104.8	38.2	103.8	37.5	105.9	36.4	123.2	35.9	116.0
Per capita water consumption (m^3)[2]		178.6	433.5	176.8	428.8	175.7	437.6	173.9	513.9	175.5	490.6

Source: China Statistical Yearbook for 2013–2017.

[1]Ecological water use only includes some rivers and lakes, wetland artificial water supplement and urban environmental water use.

[2]Per capita water consumption is calculated as the average annual population of urban residents.

level (X1), occupation (X2) and average monthly income (X3), as well as 12 impact indicators: participate in publicity of water saving water protection and water protection (X4); participate in the protection of ecological water environment (X5); proactive learning of water saving skills (X6); proactive learning of disaster avoidance skills (X7); participate in prevention of water pollution events (X8); participate in public welfare activities of environment-protection organizations (X9); municipal sewage recycling behavior (X10); municipal water consumption (X11); water-saving facilities utility (X12); abidance by water-related laws and regulations (X13); report or supervise water environment incidents (X14); supervise the management effectiveness of law enforcement department (X15). The evaluation criteria used the Likert five-level scale (always, often, sometimes, rarely, never). In addition, the questionnaire also set two behavioral indicators: the impact level on water behaviors by the indicators (Y1), and the degree of behavioral preferences (Y2).

The data were collected by a questionnaire random sampling method. Between 2016 and 2017, permanent residents in Beijing and Shanghai were surveyed, and both an online survey and a field survey were adopted. The online survey used the professional online questionnaire-survey platform to obtain samples, and the field survey was conducted based on the actual situation of the survey area which included regional economic development, population, regional regulations and natural resources, and then used diversified, multi-angle and multi-population survey methods to ensure adequate and representative survey data.

Five hundred and fifty questionnaires were distributed to Beijing and Shanghai separately, including 400 online questionnaires and 150 paper questionnaires. The number of questionnaires collected in Beijing was 532, the available questionnaires were 505 and the effective rate was 94.9%. In Shanghai, the number of questionnaires returned was 526, only 456 questionnaires were available, and the effective rate was 86.7%. Although there was a lower effective rate of online questionnaires in Shanghai, sufficient samples ensured the validity of the results. For the respondents in Beijing and Shanghai, there was a relatively balanced male-female ratio. The survey was divided into five grades according to age: 6–17, 18–35, 36–45, 46–59 and over 60-year-olds, the results showed that respondents were mostly aged between 18 and 35 years old, accounting for 52.28 and 48.68% in Beijing and Shanghai respectively. The education level mainly focused on undergraduates (including college), accounting for 60 and 50.22% in Beijing and Shanghai respectively. There was no obvious difference between urban and rural surveyed sample numbers. According to the results of the questionnaires, the validity and reliability of the data in Beijing and Shanghai were tested respectively. The Cronbach's alpha coefficients of data were 0.907 and 0.948, which means that the questionnaire survey of the two cities has considerable reliability. The data were tested by the partial correlation among the variables, the KMO values in Beijing were 0.902, and 0.949 in Shanghai, which indicates that there is no large difference in the correlation among the variables. For the significance test, Sig. value is $0.000 < 0.05$, indicating that the questionnaire data has higher structural validity.

Analysis method

Based on the significant variables of indicating factors on residents' water behavior obtained from the questionnaire survey in Beijing and Shanghai, together with the basic individual characteristic differences and water behavior participation degree, category consistency and regional differences between north and south China was determined through the comparative study. On this basis, a structure interpretation equation was constructed to explore the influencing path of residents' water behavior in different regions.

The structure equation model was put forward by Swedish statisticians Karl Joreskog and Dag Sordorm in the 1970s. It is a linear equation system that represents the relationships between observation and potential variables as well as the relationship among potential variables, and the relationship between hypothetic potential variables can be validated in a theoretical model by experimental data. The relationship between observation variables and potential variables can be validated by combined path analysis and factor analysis in the structure equation model, and finally it obtains the overall effect, direct effect and indirect effect between dependent and independent variables. This method is widely used in psychology, sociology, management and other disciplines.

The model equations are as follows:

$$Y = \gamma_Y \eta + \varepsilon \quad (1)$$

$$X = \gamma_X \xi + \sigma \quad (2)$$

$$\eta = B\eta + \tau\xi + \zeta \quad (3)$$

where Y is a vector formed by endogenous observation variables; X is a vector formed by exogenous observation variables; η are the endogenous potential variables; ξ are the exogenous potential variables; γ_Y is the factor load matrix; ε and σ are the measurement error matrix of endogenous potential variables and exogenous potential variables, respectively; B represents the interactions among constituents of endogenous potential variables in the structure equation model; τ represents the effects of exogenous potential variables ξ on endogenous potential variables η and ζ is the residual matrix.

Amos 21.0 was performed to develop the structural equation model for comparative study, and then to determine the impacting path differences of residents' water behaviors in different regions by comparative verification and analysis.

Comparative study of data

In order to analyze whether there were differences in water behaviors in different regions, we directly compared the number of behavior frequency of 12 indicating factors in different cities. The available sample amounts in Beijing and Shanghai were different, thus the amount was replaced by the percentage for the comparison, which means how frequent (always, often, sometimes, rarely, never) the behaviors will happen.

Figure 1 shows the 'always' behavior frequency in different cities. There were no significant differences between the behavior frequency in two cities, while the frequency is generally low for the percentage of the population. For the indicator 'municipal water consumption', the frequency is relatively high, at over 50%, and for the indicators 'municipal sewage recycling behavior', 'municipal water consumption' and 'water-saving facilities utility', Beijing had higher frequency than Shanghai, which means the residents in Beijing had better water-saving behaviors than the residents in Shanghai.

Figure 2 shows the 'often' behavior frequency in two cities. From the results, the percentage of water behaviors are not high for both Beijing and Shanghai. For the indicators 'participate in publicity of water saving and water protection', 'proactive learning of water saving skills', 'municipal sewage recycling

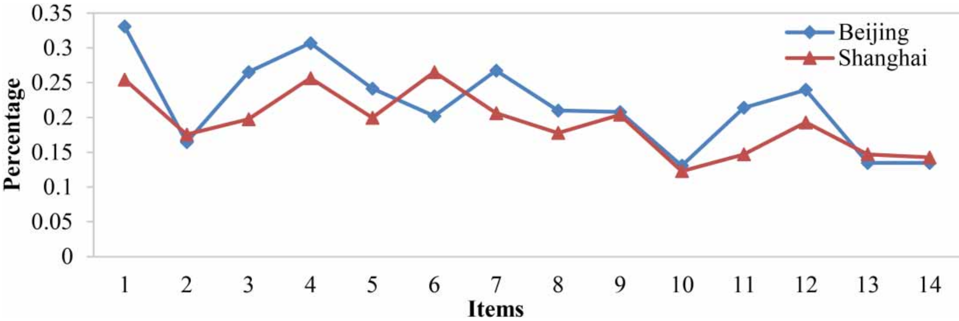

Fig. 1. 'Always' comparisons in different cities. *Note*: In Figures 1–5, 1–14 represent 1: participate in publicity of water saving and water protection; 2: participate in prevention of water pollution events; 3: proactive learning of water saving skills; 4: municipal sewage recycling behavior (a); 5: municipal sewage recycling behavior (b); 6: municipal water consumption (a); 7: water-saving facilities utility; 8: municipal water consumption (b); 9: participate in the protection of the ecological water environment; 10: abidance by the water-related laws and regulations; 11: participate in public welfare activities of environment-protection organizations; 12: proactive learning of disaster avoidance skills; 13: report or supervise water environment incidents; 14: supervise the management effectiveness of law enforcement department.

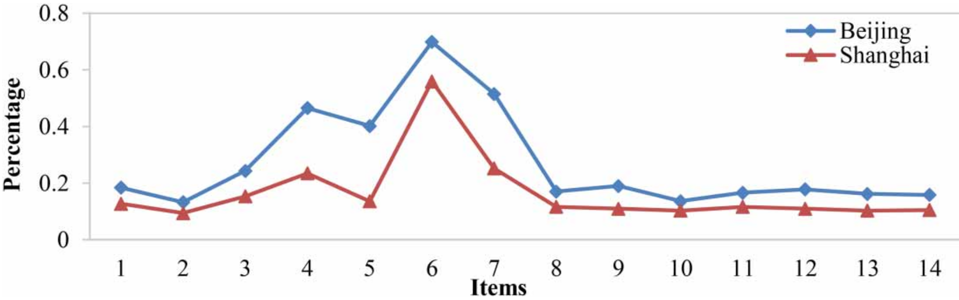

Fig. 2. 'Often' comparisons in different cities.

behavior', 'water-saving facilities utility', 'participate in public welfare activities of environment-protection organizations', 'proactive learning of disaster avoidance skills' etc., the frequency in Beijing is slightly higher than Shanghai. For the indicator 'municipal water consumption', Shanghai has higher frequency. The results showed that the residents in Beijing expressed more positivity in learning behaviors, but the overall level is relatively low.

In Figure 3, most of the indicators in Shanghai were higher than Beijing for the 'sometimes' behavior frequency comparisons, and there was no significant difference in the indicators 'participate in publicity of water saving and water protection', 'proactive learning of water saving skills' and 'supervise the management effectiveness of law enforcement department' between the two cities, which means the residents in Shanghai are more willing to regulate their water behaviors on the basis of medium behavior frequency.

Figure 4 illustrates the 'few' behaviors frequency in Beijing and Shanghai. In general, the frequency fluctuated considerably among the water behaviors and showed almost the same trends. From the figure, we also found that the percentage of residents in Shanghai was higher than that of Beijing. For the behavior 'municipal water consumption', the behavior frequency in Beijing was almost zero, and in

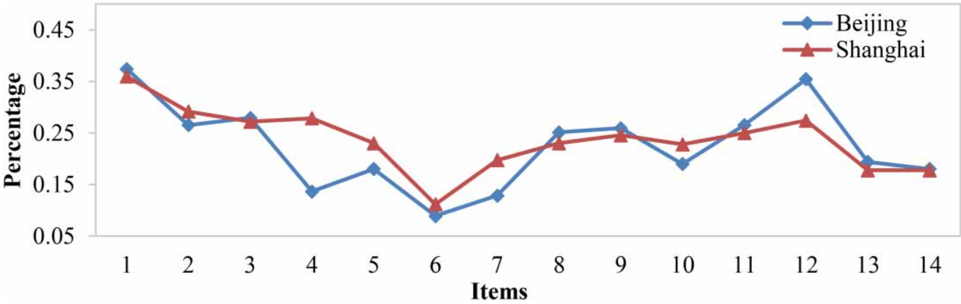

Fig. 3. 'Sometimes' comparisons in different cities.

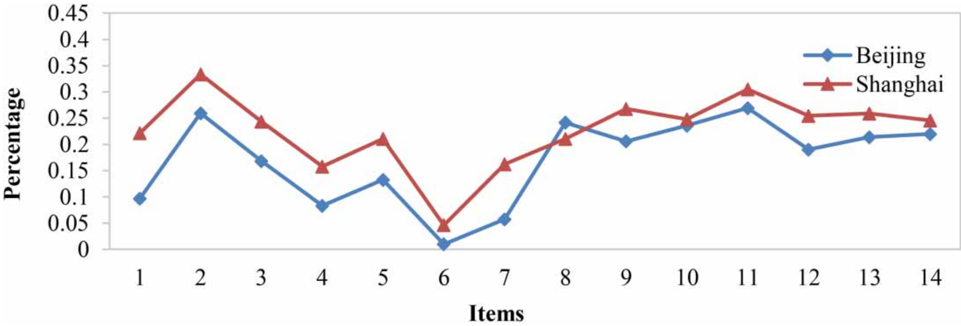

Fig. 4. 'Few' comparisons in different cities.

Shanghai this was also at a quite low level. There were almost no differences in the frequency of 'abidance by the water-related laws and regulations' and 'supervise the management effectiveness of law enforcement department' between Beijing and Shanghai.

Generally speaking, for all indicators of residents' water behaviors, the 'never' behavior frequency was relatively low. From Figure 5 we found that the percentage of residents in Shanghai was slightly higher than that of Beijing, and the percentage in two cities is almost zero in the frequency of 'participate in publicity of water saving and water protection' and 'municipal water consumption'. Moreover, when the water behaviors related to legal acts, such as 'abidance by the water-related laws and regulations', 'report or

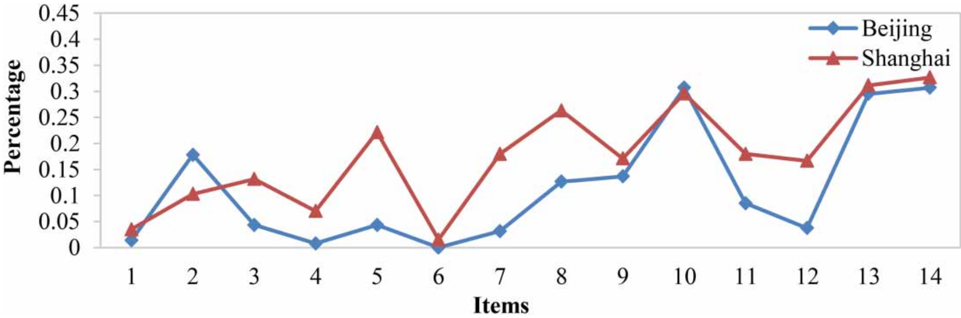

Fig. 5. 'Never' comparisons in different cities.

supervise water environment incidents' and 'supervise the management effectiveness of law enforcement department', the residents in both Beijing and Shanghai showed a much higher frequency.

Overall, regional differences existed in the frequency of water behaviors, which meant the indicating factors for the behavior frequency in Beijing and Shanghai were inconsistent. Second, according to the fluctuations in different behavior frequency, they reflected different categories of indicating factors. Next, due to regional differences, the diversity of residents' water behavior frequency was decided by the difference in education level, occupation distribution and family monthly income. On this basis, it is necessary to apply the structural equation model to test the water behaviors in Beijing and Shanghai, and then to discuss whether there exist differences in the impacting paths of indicating factors by model construction and analysis.

Comparative study on water behavior indicating factor models based on AMOS

Initial model of water behavior indicating index establishment

Analysis was performed by using 12 indicating factors as variables, and all the sample data in Beijing and Shanghai were analyzed and processed. In the significance test, the Sig. value is 0.000 and the KMO value is 0.895, which are suitable for factor analysis. The principal component analysis method was applied for the analysis and common factors can be obtained by maximum orthogonal rotation of variance and then integrated variables can be explained. Through the analysis, four principal component factors (ecological water environment management behavior, persuasion behavior, consuming behavior, legal behavior) were obtained, and the eigenvalues were greater than 1. Besides, each factor had different quantitative indicating factors and the cumulative variance contribution of the principal component factors was 67.964%. The load value of each indicating factor on one common factor is greater than 0.5 and the other common factor load value is under 0.5 (Table 3).

Four principal component indicating factors which were set as potential variables, joined with individual characteristic potential variables and water behavior potential variables, were used as the potential variables for model construction. Based on the related references, literature review, behavioristics theory and expert consultation, we set the relationship among these potential variables to determine their positive significance or non-significance. Then we adopted AMOS 21.0 software for multiple-fitting and comparisons of the model to finalize the initial conceptual model path map (Figure 6). The model included five potential variables (ecological water environment management behavior, persuasion behavior, consuming behavior, legal behavior and water behavior), in which water behavior was the final variable.

Comparisons of water behavior indicating factor models based on AMOS

According to the initial conceptual model, the conceptual model of Beijing residents' water behavior indicating factor model was validated. The results are shown in Figure 7.

From the model study we determined the following:

(1) In the measurement model, the standardized parameters estimation of the impacting path of each observed and potential variable were in the range of 0.10–1.18. There was a significant difference among the impacting indicators, which had a comprehensive explanatory ability on the model.

Table 3. Rotated component matrix by variance.

	Principal component factor			
	Factor 1 Ecological water environment management behavior	Factor 2 Persuasion behavior	Factor 3 Consuming behavior	Factor 4 Legal Behavior
Participate in publicity of water saving water protection and water protection (X4)	0.544			
Participate in the protection of water ecological environment (X5)	0.845			
Proactive learning of water saving skills (X6)	0.619			
Proactive learning of disaster avoidance skills (X7)	0.727			
Participate in prevention of water pollution events (X8)		0.781		
Participate in public welfare activities of environmental organizations (X9)		0.825		
Municipal sewage recycling behavior (X10)			0.818	
Municipal sewage recycling behavior (X10)			0.812	
Municipal water consumption (X11)			0.645	
Municipal water consumption (X11)			0.721	
Water-saving facilities to use (X12)			0.749	
Personal compliance with water-related laws and regulations of the act (X13)				0.901
Report or supervise water and environmental incidents (X14)				0.920
Supervise the effectiveness of law enforcement management (X15)				0.917

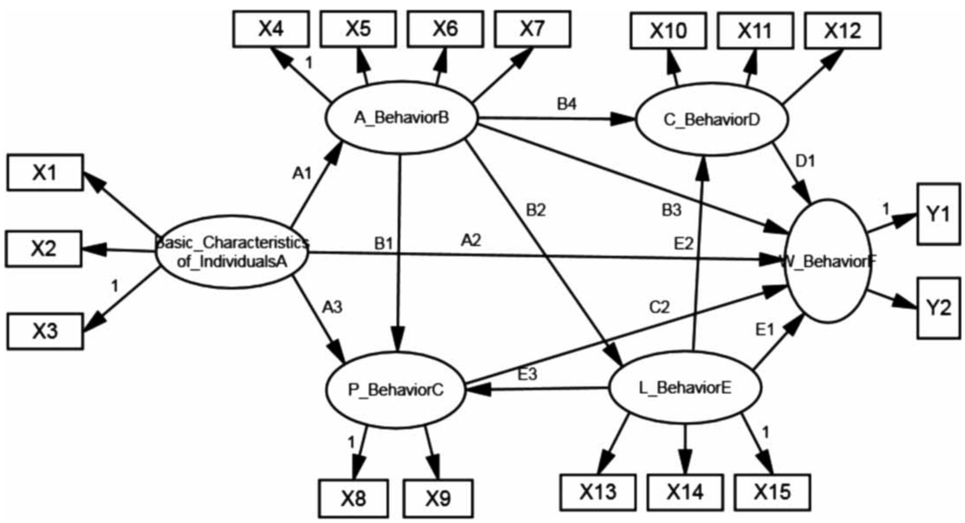

Fig. 6. Initial conceptual model of water behavior characterization parameters.

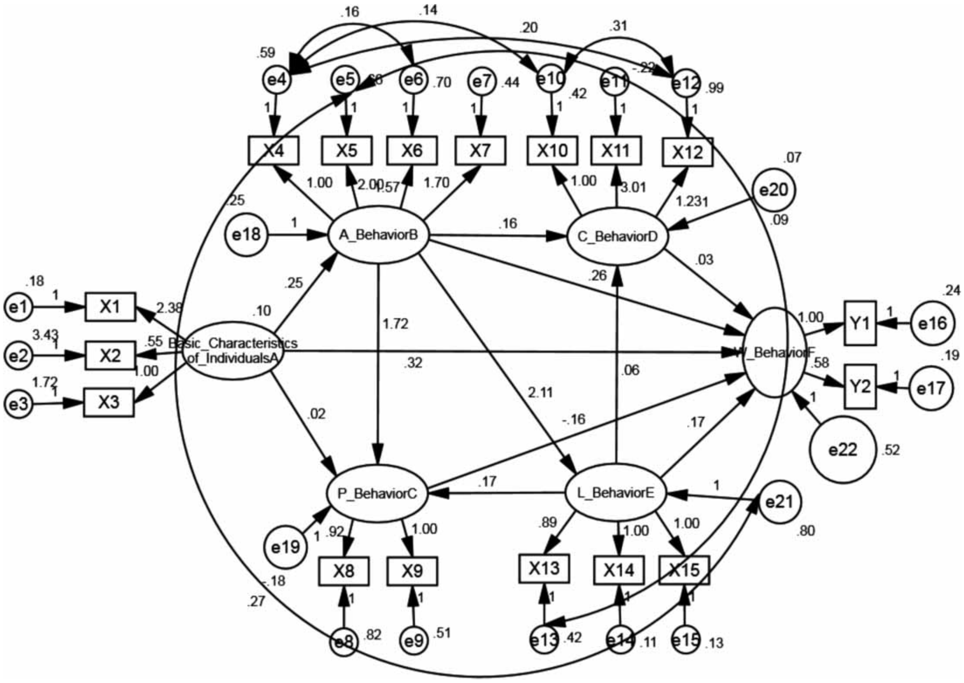

Fig. 7. Beijing residents' water behavior indicating factor model.

(2) In the structural model, through the aggregation degree test between model and data, the significant P value was less than 0.001, which meant that model had good conformity with data.
(3) When using the data from Beijing to verify the initial model, the critical value was less than the standard level in the hypothetical paths 'basic individual characteristics had positive effects on persuasive behavior', 'persuasive behavior had positive effects on water behavior' and 'consuming behavior has positive effects on water behavior', and its significance was quite low. Therefore, three hypothetical paths were invalid.
(4) There were direct and indirect impacts among the observed variables. For example, basic individual characteristics had positive effects on the ecological water environment management behavior, and there were no direct effects on persuasive behavior. However, basic individual characteristics indirectly influence persuasive behavior by affecting aquatic ecological management behavior.

The conceptual model validation of the Shanghai residents' water behavior indicating factor models is shown in Figure 8.

(1) In the measurement model, the standardized parameters estimation of the impacting path of each observed and potential variable were in the range of 0.10–1.18. There was a significant difference among the impacting indicators, which had a comprehensive explanatory ability on the model.
(2) In the structural model, through the aggregation degree test between model and data, the significant P value was less than 0.001, which meant that model had good conformity with data.
(3) When using the data from Shanghai to verify the initial model, the critical value was less than the standard level in the hypothetical paths 'basic individual characteristics had positive effects on

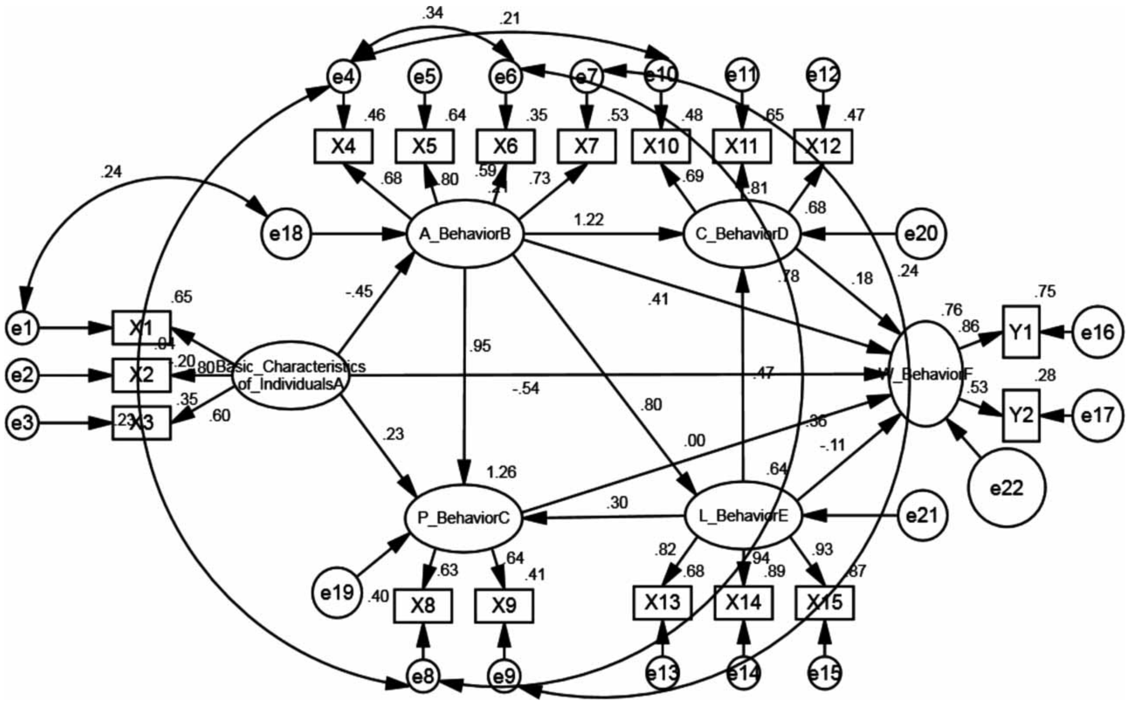

Fig. 8. Shanghai residents' water behavior indicating factor model.

ecological water environment management behavior', 'basic individual characteristics have positive effects on water behavior', 'persuasive behavior has positive effects on water behavior' and 'legal behavior has positive effects on water behavior', and its significance was quite low. Therefore, three hypothetical paths were invalid.

(4) There were direct and indirect impacts among the observed variables. For example, basic individual characteristics had positive effects on the ecological water environment management behavior, and there were no direct effects on persuasive behavior. However, basic individual characteristics indirectly influence persuasive behavior by affecting aquatic ecological management behavior.

From the model study we determined the following:

(1) In the measurement model, the standardized parameters estimation of the impacting path of each observed and potential variable were in the range of 0.20–0.94. There was a significant difference among the impacting indicators, which had a comprehensive explanatory ability on the model.
(2) In the structural model, through the aggregation degree test between model and data, the significant *P* value was less than 0.001, which meant that model had good conformity with data.
(3) When using the data from Shanghai to verify the initial model, the critical value was less than the standard level in the hypothetical paths 'basic individual characteristics had positive effects on ecological water environment management behavior', 'basic individual characteristics have positive

effects on water behavior', 'persuasive behavior has positive effects on water behavior' and 'legal behavior has positive effects on water behavior', and its significance was quite low. Therefore, four hypothetical paths were invalid.

(4) There were direct and indirect impacts among the observed variables. For example, the assumption 'legal behavior has positive effects on water behavior' was invalid, while legal behaviors had positive effects on consuming behaviors and consuming behaviors had positive effects on water behaviors. Thus, legal behaviors indirectly affect water behaviors.

Results and discussion

Based on the AMOS technology, the structural equation model was established to compare the impacting paths of Beijing and Shanghai on water behaviors.

Beijing had similar impacting paths in ecological water environment management behaviors and persuasive behaviors with Shanghai. First of all, on the ecological water environment management behaviors, the influence coefficients of ecological water environment management behaviors on consuming behaviors, water behaviors, and persuasive behaviors were relatively high in Beijing and Shanghai. The influence was significant. This indicates that ecological water environment management behaviors had a higher impacting level on other behaviors in Beijing and Shanghai.

Next, on persuasive behavior, the influence coefficients of persuasive behavior on water behavior in Beijing and Shanghai were –0.21 and 0.00, respectively; the influence was insignificant. This indicated that the residents needed to participate in more activities to prevent water pollution incidents and public environmental protection organizations in both cities. In addition, better communication, and rationally and emotionally persuading others to protect and save water resources were needed.

There were obviously differences in residents' water behaviors impacting paths by basic individual characteristics, consuming behaviors and legal behaviors in Beijing and Shanghai. First, on the basic individual characteristics, the influence coefficients of the residents' basic individual characteristics on ecological water environment management behaviors and water behavior in Beijing were 0.16 and 0.14, respectively. Both of them had certain significances. However, the influence coefficients of basic individual characteristics on ecological water environment management behaviors and water behavior were relatively low, and it is necessary to focus on different groups of people and enhance the cultivation of ecological water environmental management behaviors. The influence coefficient of basic individual characteristics on persuasive behavior was 0.01, which is not significant. This illustrates that the education level, occupation and monthly income have few influences on persuasion behaviors, thus all the population need to enhance the persuasion behaviors. However, the influence coefficient of residents' basic individual characteristics on ecological water environment management behaviors and water behavior in Shanghai were –0.45 and –0.56 respectively, both of which had no significance. It was necessary to acquire the relevant skills of analyzing, solving and dealing with the problems of aquatic ecological environment, and focused on cultivating residents' behavioral intentions towards the aquatic ecological environment so as to standardize residents' water behaviors.

Second, on the consuming behavior, the influence coefficient of consuming behavior on water behavior was 0.01 in Beijing, and it was not significant. However, the influence coefficient of consuming behavior on water behavior was 0.18 in Shanghai, and it has a significant positive impact. Therefore, the residents of Beijing need to enhance their consuming behaviors, improve the ecological water environment by changing their lifestyle, and adopt a new living and consuming pattern which would be beneficial to the aquatic system.

Third, on the legal behavior, the influence coefficient of legal behavior on water behavior in Beijing was 0.31, which meant that the legal behavior had a significant positive impact on water behavior, while in Shanghai the influence coefficient was –0.11 and the impact was not significant. Therefore, Shanghai residents need to enhance their legal awareness, take proactive legal measures and strengthen the implementation of water-related laws to solve water problems.

Conclusions and suggestions

Conclusions

Based on the analysis of the indicating factors of residents' water behaviors, 12 indicating factors including publicity behaviors of water-saving and water-protection were obtained, and a questionnaire on residents' water behaviors was designed accordingly. According to the statistical results of the questionnaires, there existed some differences in the frequency of water behaviors between different regions through comparative analysis of the samples in Beijing and Shanghai, that is, there was inconsistency in the frequency of water behavior between Beijing and Shanghai. Based on the relevant theoretical framework of water behaviors, in order to explore the difference between various indicating factors in the impacting path, this paper constructed an interpretative structure model including water ecological environment behavior, persuasion behavior, consuming behavior and legal behavior. (1) On the ecological water environment management behaviors, the influence coefficients of ecological water environment management behaviors on consuming behaviors, water behaviors, and persuasive behaviors were relatively high in Beijing and Shanghai, the influence was significant. (2) The influence of persuasive behavior on water behavior in Beijing and Shanghai was insignificant. (3) There were obviously differences in residents' water behaviors impacting paths by basic individual characteristics, consuming behaviors and legal behaviors in Beijing and Shanghai.

Suggestions

(1) Beijing had similar impacting paths in ecological water environment management behaviors and persuasive behaviors with Shanghai. Some suggestions are put forward.

Cultivating residents' aquatic-environment management behaviors and motivating residents to learn water knowledge. On the publicity of water-saving and protection, residents are able to understand the importance of water resources management and raise the awareness of flood hazards through various media such as magazines, radio, television and seminars, which is conducive to the implementation of various water resources management measures. Next, in the behavior of participating in the protection of water ecological environments, the residents try their best to comply with the natural and economic laws of water, develop and use the water resources in a scientific way and protect the water resources environment by effective management, normative water behaviors and rational conservation of water. In the proactive learning of water saving skills, under the joint efforts of all families to save water, the utilization efficiency of water resources should be raised.

Second, strengthen residents' persuasion behaviors. Strengthen publicity to prevent water pollution incidents, and advocate for residents to enhance their understanding of water-related behaviors. Residents are encouraged to actively participate in the activities of non-profit environmental organizations, continuously improving their awareness of water environment protection.

(2) Some suggestions are given on differences in residents' water behaviors impacting paths by basic individual characteristics, consuming behaviors and legal behaviors in Beijing and Shanghai.

On the basic characteristics of individuals, the basic characteristics of Beijing residents have significant effects on aquatic environmental management behaviors and water behaviors, while there is no significant effect in Shanghai. Based on the differences in the basic characteristics of individuals, the education on water behaviors for Beijing residents should be focused on people with different qualifications and occupations. We should focus on training the people with weakened water behavior, establishing a concept of efficient water-use, and improving social awareness of water-use. In Shanghai, we need to raise residents' awareness of water behavior, governments should focus on popularizing water education throughout the city, and actively promote residents' establishing a scientific water attitude.

Second, on consuming behaviors, the consuming behavior of Beijing residents has no significant impact on water behavior, while there is a significant positive impact in Shanghai. Based on this, Beijing residents should deepen the concept of residents' water consumption behavior and form good consumption habits. Due to the fact that Beijing is in the six districts in the north, its water resources condition, water supply, and climate have great impacts on water-saving consciousness. Corresponding encouragement policies should be adopted to encourage residents to actively use water-saving facilities, strengthen residents' awareness of water resources management and enhance the efficiency of water resources utilization. The water conservancy department needs to regulate the water price and set the water price structure according to the residents' consumption and affordability. As a coastal city in the six districts in the south, Shanghai has a higher municipal and industrial water consumption. In order to speed up the process of building a resource-conserving and environmentally-friendly city, we need to further strengthen policy guidance and encourage the promotion of residents' rational water-use and conservation. According to the most stringent water resources management system and civil water ladder price system, combined with the actual situation in Shanghai, we need to increase the relevant water price control system and make municipal water consumption in Shanghai more fit for the regulated water price.

Third, on legal behavior, the legal behavior of Beijing residents has a significant positive impacts on water behavior, while there is no significant effect on water behavior in Shanghai. Therefore, Shanghai residents should deepen their understanding of water-related legal behaviors and enhance their legal awareness. China has basically established a water law system, but the implementation of law is a weak point. Therefore, local governments should actively carry out related water law education and enhance awareness of water laws and regulations. The scientific law enforcement system directly influences the effects of water administration law enforcement. Only in strict law enforcement procedures can the administrative bias and unfair treatment be avoided. Most importantly, residents can fully participate in the process of decision-making on water administration so that the acceptability of administrative actions for residents is higher.

References

Aisa, R. & Larramona, G. (2012). Household water saving: evidence from Spain. *Water Resources Research 48*(12), 203–214.

Bai, L., Si, X. L., Guan, D. J. & Si, J. Y. (2011). An empirical analysis of urban residents' daily water consumption in Xi'an. *Mathematics and Practice 41*(19), 13–21.

Cao, L. & Cai, Y. (2010). Analysis of water use status and water saving quota of Ningxia University of secondary school. *Water Saving Irrigation 6*, 58–61.

Cong, J., Chen, Y., Xu, N., Gao, Y. N. & Feng, X. F. (2018). Regression analysis of undergraduate water-saving behaviors and influencing factors – a case study of undergraduates in Nanjing. *Journal of Yangtze River Scientific Research Institute 35*(1), 29–35.

Gilbertson, M., Hurlimann, A. & Dolnicar, S. (2011). Does water context influence behaviour and attitudes to water conservation? *Australasian Journal of Environmental Management 18*(1), 47–60.

Gilg, A., Barr, S. & Ford, N. (2005). Green consumption or sustainable lifestyles? Identifying the sustainable consumer. *Futures 37*(6), 481–504.

Hassell, T. (2007). *Promoting Behavioural Change in Household Water Consumption: Literature Review*. Smart Water, Melbourne, Australia. Available from: www.vu.edu.au/sites/default/files/ptomoting%20behaviourl%20Change%20in%20Household%20%Water%20Consumption.pdf [20 April 2012].

Jia, B., Ye, Y., He, J. & Li, M. B. (2010). Study on civil water use and water saving in Beibei District of Chongqing. *China Rural Water and Hydropower 11*, 82–84.

Jiang, H.-S. & Zhao, W.-H. (2015). Investigation and analysis on water consumption of residents in Beijing and measures for water conservation. *Proceedings of Conservation of Water Resources 31*(5), 110–113.

Kenney, D. S., Goemans, C., Klein, R., Lowrey, J. & Reidy, K. (2008). Residential water demand management: lessons from Aurora, Colorado. *JAWRA Journal of the American Water Resources Association 44*(1), 192–207.

Li, C., Tao, T. & Liu, S. (2010a). Study on price elasticity of domestic water consumption in Suzhou. *Water Supply and Drainage 36*(5), 171–174.

Li, J., Tang, T. & Li, R. (2010b). Analysis of urban residents' cognition on the price of domestic water – based on the investigation of residents' families in some cities in Hebei Province. *Price Theory and Practice 8*, 22–23.

Liu, X., Jiang, Y., Xu, C., Li, J. J. & Lu, C. Y. (2009). Analysis of the impact of domestic water price on residents' water use in Shihezi City. *Water Saving Irrigation 5*, 44–46.

Mu, Q., Zhang, S. & Ma, X. (2014). Empirical analysis of the factors of Beijing residents saving behavior. *Journal of Peking University (Science and Technology) 50*(3), 587–594.

Potter, R. B. & Darmame, K. (2010). Contemporary social variations in household water use, management strategies and awareness under conditions of 'water stress': the case of Greater Amman, Jordan. *Habitat International 34*(1), 115–124.

Renwick, M. E. & Green, R. D. (2000). Do residential water demand side management policies measure up? An analysis of eight California water agencies. *Journal of Environmental Economics and Management 40*(1), 37–55.

Shen, T., Chen, Y. & Yang, Q. (2015). Analysis on the energy consumption intensity of urban household water and its influencing factors. *Resources Science 37*(4), 744–753.

Willis, R. M., Stewart, R. A., Panuwatwanich, K., Williams, P. R. & Hollingsworth, A. L. (2011). Quantifying the influence of environmental and water conservation attitudes on household end use water consumption. *Journal of Environmental Management 92*(8), 1996–2009.

Yang, X. & Liang, Y. (2007). Empirical analysis on water saving behavior of urban residents and its influencing factors – a case study of Yinchuan City. *Journal of Water Resources and Water Engineering 18*(2), 44–47.

Zhang, N. & Zhang, Y. (2011). Analysis of urban residents' domestic water use behavior and its impact on demand. *Journal of Hangzhou Dianzi University 31*(6), 155–158.

Zhang, L., Liu, J. Y., Liu, Z. T., Qian, S. Q. & Lin, F. B. (2011). Revised analysis and assessment of urban domestic water quota in Sanya. *Water Supply and Drainage S1*, 47–49.

Zhao, W. (2015). An empirical analysis of the influencing factors of household water consumption – based on the survey data of residents' water use behavior in Beijing. *Resources and Environment of Arid Regions 29*(4), 137–142.

Zhou, J. (2005). Analysis of influential factors of domestic residents' domestic water consumption in China. *Statistics and Decision 6s*, 75–76.

Received 7 October 2018; accepted in revised form 19 February 2019. Available online 11 April 2019