frontiers in Marine Science

ORIGINAL RESEARCH
published: 11 February 2022
doi: 10.3389/fmars.2022.842491

Does the Protection of River Basin Ecosystems Produce Broken Window Effect? Evidence From Spatial Choice Experiment in Xijiang River Basin, China

*Xin Nie[1,2,3], Zhoupeng Chen[1], Linfang Yang[1], Yiting Qing[4] and Han Wang[1,2,3]**

[1] School of Public Administration of Guangxi University, Nanning, China, [2] China Center for Agricultural Policy (CCAP), School of Advanced Agricultural Sciences, Peking University, Beijing, China, [3] Department of City and Regional Planning, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States, [4] Sino-Danish College of University of Chinese Academy of Sciences, Beijing, China

OPEN ACCESS

Edited by:
Qingsong He,
Huazhong University of Science and Technology, China

Reviewed by:
Anlu Zhang,
Huazhong Agricultural University, China
Jiayu Wu,
Zhejiang University, China

****Correspondence:***
Han Wang
hanwang@gxu.edu.cn

Specialty section:
This article was submitted to Marine Ecosystem Ecology, a section of the journal Frontiers in Marine Science

Received: *23 December 2021*
Accepted: *21 January 2022*
Published: *11 February 2022*

Citation:
Nie X, Chen Z, Yang L, Qing Y and Wang H (2022) Does the Protection of River Basin Ecosystems Produce Broken Window Effect? Evidence From Spatial Choice Experiment in Xijiang River Basin, China. Front. Mar. Sci. 9:842491. doi: 10.3389/fmars.2022.842491

Eco-environmental protection of river basins and compensation for damages have been important issues for researchers around the world for a long time. Many studies have focused on the correlations among individual socioeconomic characteristics, ecological cognition, and differences in the willingness to pay. However, no research has been conducted from the perspective of perceived environmental quality. According to the Broken Windows Theory, the public's willingness and behaviors regarding environmental protection are determined largely by earlier perceptions of environmental quality. Therefore, we used a spatial choice experiment to investigate the willingness of the public to pay for ecosystem restoration in the upper, middle, and lower reaches of the Xijiang River Basin in China. This paper discusses if perceived environmental quality is a factor that creates different levels in the willingness to pay. Our results show that the Broken Window Effect can better explain these differences. Living in a better ecological environment, the upper-reaches public expect to pay for the restoration of the river basin's ecosystem to a higher state and is willing to be the "first person" to repair the "broken windows," whereas those in the middle and lower reaches are willing to pay only for a restoration to a good state.

Keywords: Broken Window Effect, perceived environmental quality, river basin's ecosystem, spatial choice experiment, willingness to pay for ecological protection, mixed logit model

INTRODUCTION

Watershed ecosystem is a huge complex ecosystem composed of social-economic-natural ecosystem, which is crucial for regional ecological security, sustainable development and human well-being, and their positive and negative externalities are transferred along the basin in time and space (Carvalho et al., 2019; Yee et al., 2020; Zhang et al., 2020; Berger et al., 2021). The balance between supply and demand of watershed ecosystem services is the key to realizing watershed green development. However, the watershed ecosystem issues are becoming increasingly diversified and complex, and various conflicts of interest are becoming increasingly acute and ecosystem service functions at risk of degradation. The lack of willingness to pay (hereinafter abbreviated as "WTP") assessment of watershed ecosystem services at a holistic level will inevitably lead to inconsistencies between the implementing and benefiting parties in sustainable development in the upper, middle, and lower reaches of the watershed, which will easily cause a Broken Window Effect of wrong demonstration on watershed ecological environment management and development (González Dávila et al., 2017; Carlsson et al., 2018; Khan et al., 2018). As the direct beneficiary of ecological protection and the ultimate executor and implementor of ecological restoration policies, the public's WTP and behaviors regarding environmental protection carry the important function of "cutting off the irrational interference and intervention of human factors in the environment" (Zhao, 2016; Odonkor and Adom, 2020; Wei et al., 2020). Its enthusiasm and initiative to participate in the payment of ecological services in the watershed is an important guarantee for the successful promotion of related policies (Cheng et al., 2018). Therefore, an accurate analysis of the factors affecting the public's willingness to participate in environmental protection is more conducive to the orderly restoration of watershed ecosystems. As residents pay more and more attention to the positive and negative impacts of the watershed environment, individuals' first impression of local environmental quality tends to influence their behavior more than early intervention measures, so as to effectively study residents' willingness to participate in the watershed ecosystem protection and explore changes in watershed ecosystem service functions and their driving factors. It has important practical significance to promote the improvement of watershed ecological governance and the formulation of ecological compensation standards. At the same time, it has enlightenment significance to promote the protection and high-quality development of the watershed ecosystem.

Many studies at home and abroad based on Planned Behavior Theory or its extended models have discussed how psychological factors, such as personal attitudes, subjective judgment, moral obligations, and perceived behavior control, affect the willingness and behaviors that protect the environment (Moreno-Sanchez et al., 2012; López-Mosquera, 2016; He et al., 2018; Shan et al., 2019). However, few empirical studies have examined the antecedents of the theoretical elements that form the behavioral plans of the intentions for public environmental protection. Although many studies have used direct and indirect methods to measure the public's willingness to protect the environment, the stated preference methods have been found to better reflect the public's willingness and preference (You, 2016; Wang et al., 2017; Wu et al., 2020). The stated preference methods include the conditional value method (hereinafter abbreviated as "CVM") and choice experiment (hereinafter abbreviated as "CE") (Randall, 1981). The former directly reflects the public's willingness to protect the environment by directly asking about a respondent's WTP or willingness to accept (hereinafter abbreviated as "WTA") for certain improvements in environmental resources or losses of quality (Xu et al., 2012; Zen and Siwar, 2015; Dahal et al., 2018). There are certain hypothetical deviations and subjective deviations (Boerger, 2013; Moon et al., 2021). With a finer division of river basin ecosystem services, the CE method provides responders with a selection set made of multiple attribute states of a resource or environmental item through the construction of a hypothetical market, including the ecological attributes and price attributes, more able to enable interviewees to make corresponding judgments and choices based on their understanding of the ecological environment and their own economic and social conditions (Brouwer et al., 2010; Matthews et al., 2017; Almazán et al., 2019; Aoki et al., 2019). Here, each alternative is determined by multiple attributes. A change in the level of an attribute may cause respondents to change their choices, each of which is aimed at maximizing utility and is measured according to the improvement in status that each attribute could achieve. Thus, it can reflect people's WTP for environmental protection to the greatest extent (Owuor et al., 2019; Shan et al., 2019).

With the expansion of stated preference research (hereinafter abbreviated as "SP"), the discussion of the spatial dimensions of SP research has become more and more in-depth, and all aspects of the research need to be paid attention to solve the current environmental problems more accurately (Valck and Rolfe, 2018; Badura et al., 2020). Although economists have made progress in dealing with spatial dimensions, the SP literature as a whole still does not fully recognize the relevance and complexity of these issues. According to the findings, certain research that appear to have nothing to do with economic theory might offer fresh explanations for the observed geographical pattern, and ideally provide insights, thereby stimulating the development of new theories (Glenk et al., 2020). Welfare effects are sensitive to scope in all dimensions. The scope may vary with space and the influence of spatial scope is related to SP valuation in many ways. Therefore, we believe that exploring whether the public's environmental improvement SP valuation is related to its perceived environmental quality and whether people's willingness to protect the environment will be affected by the Broken Window Effect in criminal psychology could provide new perspectives for solving the problem in space administration of river basin.

As a major corridor for the southwest to have access to the sea, the Xijiang River Basin not only cuts through the Pearl River-Xijiang River Economic Belt, but also serves as an important corridor of the land-sea Silk Road, and is an important ecological barrier for the main grain-producing region of Guangxi and the Pan-Pearl River Delta, and is representative for reflecting the value of ecosystem services in the basin. Based on this fact, this paper selects the Xijiang River basin as the research object, applies the theoretical analysis framework of the psychological Broken Window Effect, combines the CE method and the random parameter Logit model to explore the impact of perceived environmental quality on the basin residents' willingness to pay for ecological compensation, in order to gain a better understanding of the basin residents' ecological cognition.

THEORETICAL ANALYSIS FRAMEWORK

Environmental Awareness, Behavioral Tendency, and Perceived Environmental Quality

Environmental awareness refers to the willingness and tendency of individuals to carry out environmental protection based on their views on the interrelationship of humans and nature (Brouwer et al., 2016; Aguilar et al., 2018; Fu et al., 2020). The public's willingness to environmental behavior is often based on environmental perception (Chen and Hu, 2015; Zhang et al., 2017; Ren et al., 2020). Accurate environmental perception is the premise of reasonable environmental behavior, and also can effectively promote the improvement of people's environmental awareness. Cheng et al. (2019) further explored the relationship between corporate environmental behavior, environmental motivation, business motivation, and environmental management systems by developing a conceptual model of corporate environmental behavior. From the perspective of social dilemma, Tam and Chan (2018) investigated why there was a barrier between environmental awareness and environmental behavior and how to reduce or eliminate this barrier, and further pointed out that environmental trust helped to promote the transformation of environmental awareness into environmental behavior. Uzun and Keles (2012) investigated the impact of the project "Nature Education 2010 in the Ihalara Valley (Aksaray) and its surrounding areas" on the environmental awareness and behavior of pre-service teachers. The Broken Window Effect believes that environmental factors can have a strong effect on behavior and describes the relationship among external environmental factors, individual psychology, and individual behaviors from the perspective of psychology and behaviorism (Crichlow, 2016; Hira, 2016; Marat, 2019). Specifically, the theory likens disturbances of public order, minor crimes, and similar phenomena to broken and unrepaired windows. If such disorderly conduct is left unchecked and a community seems uninterested in preventing such conduct, the open door to increasingly serious crimes would widen (Wilson and Kelling, 1982). For example, if littering occurs somewhere, then other people will receive the impression that the environment is already dirty and encourage them to litter as well. In contrast, when people are in a better environment, they will spontaneously appreciate and maintain it. The Broken Window Effect suggests that a hostile environment encourages people to accelerate environmental destruction. In contrast, orderly environmental conditions could curb public misconduct and improve environmental responsibility (Wilson and Kelling, 1982; van der Weele et al., 2017). According to the theory of the Broken Window Effect, the public's willingness and behavioral tendency to protect the environment depend largely on the early perceived environmental quality. Based on the above analysis, we propose the first hypothesis in this paper as follows.

H1. There is a significant relationship between residents' environmental awareness, behavioral tendencies and perceived environmental quality.

Theoretical Analysis of How Residents' Perception of Environmental Quality Affects Their WTP for Watershed Ecosystem Services

The application and expansion of the Broken window effect theory provide a new perspective for the study of environmental protection and sustainable development. During the use of watershed ecosystem services, the public in the upper reaches lives in a high-quality river basin ecosystem and enjoys its ample services. However, it is easy to cause "broken windows" in the ecological environment by excessively, disorderly behaviors. As ecological damages accumulate, the "broken windows" of the middle and lower reaches of the ecosystem continue to intensify. The findings of traditional research have indicated that the public in the Middle and lower reaches with more developed economies has a higher WTP for environmental protection and should pay for the upper-reaches public's achievements in environmental protection. Also, the level of public's WTP is determined by the economic and social levels of individuals and regions (Brouwer et al., 2016; Lizin et al., 2016). For example, Liu et al. (2019) found that the perception of environmental quality is an important prerequisite for tourists to generate positive and environmentally responsible behaviors. Using a structural equation model (abbreviated as "SEM") and multi-group analysis (abbreviated as "MGA"), Wang et al. (2019) believed that the environmental factors of tourist attractions influenced the environmentally responsible behaviors of tourists. As the birthplace of human civilization, the orderly and sustainable development of river basin's ecological environment is closely related to the public's production and life. In the main view of the Broken Window Effect, people are susceptible to the influence of their environments and consciously or unconsciously produce behaviors that maintain or change their existing environmental conditions, i.e., the public's willingness to protect the environment may be triggered by signals conveyed by the environmental quality of a river basin's ecosystem. Therefore, the public may have different wishes about environmental protection according to the quality of the ecological environment in which they are located. The upper-reaches public tends to protect the orderly and healthy use of the upstream ecosystem, but those in the middle and lower reaches are also willing to safeguard the environmental protection of the upper-reaches areas. However, there is limited research on an explanation of the public's willingness to protect the environment by sensing the environmental quality of the river basin ecosystem. Hence, further research into this issue is needed. Based on the above literature analysis, we propose the second hypothesis in this paper as follows.

H2. Residents' perceived environmental quality has a significant positive impact on the willingness to pay for watershed ecosystem services, and there is a Broken Window Effect.

Based on the analysis above, the theoretical analysis framework of residents' perception of environmental quality, WTP for watershed ecosystem protection and Broken Window Effect was constructed in order to provide reference for watershed ecological protection, as shown in **Figure 1**.

STUDY AREA AND METHODOLOGY

Study Area

The Pearl River–Xijiang River Basin is a river that connects the economically underdeveloped areas of southwestern China with the economically developed areas of the Pearl River Delta in southern China. With a total length of 2,214 km, an area of about 353,120 square kilometers of accumulated water, and an average annual runoff of 69.53 billion cubic meters, the Xijiang River is the fourth largest river in China and the longest river in the Pearl River system, crossing four provinces (regions) of Guizhou, Yunnan, Guangxi, and Guangdong. In this study, the typical representative areas of the Xijiang River Basin flowing through Guangxi and Guangdong were selected for field research.

The study area involved in the CE is the Xijiang Economic Belt from Guangxi to Guangdong Province.[1] It includes the following three areas. The upper reaches are tributaries of the Hongshui River in Laibin, Guangxi. The city of Laibin, the largest energy production base in Guangxi, is one of the major cities in the middle and upper reaches of the Xijiang River, and the Hongshui River (a major tributary of the Pearl River) passes through the city. The city was chosen mainly to examine the impact of the upstream city's development of industrial energy on the environment of the Xijiang River basin. The middle reaches are two tributaries of the Qianjiang and Xunjiang rivers in Wuzhou City, Guangxi. Wuzhou City is located near the division point of the middle reaches of the main stream of the Pearl River (Xijiang River) and is greatly influenced by the river. The main stream of Xijiang River flows through the main urban area and covers a wide area along the river; its lower reaches are the main watercourse of Xijiang River connecting Wuzhou City of Guangxi Zhuang Autonomous Region and Foshan and Zhaoqing cities of Guangdong Province (**Figure 2**). Foshan City of Guangdong Province, as the third largest city in Guangdong, is located in the central part of this Province and the hinterland of the Pearl River Delta and in the Pearl River-Xijiang economic zone; Zhaoqing City is located in the middle part of the main stream of the Pearl River (Xijiang River). Zhaoqing is located near the division point between the middle reaches and the lower reaches of the main stream of the Pearl River (Xijiang River), which is largely influenced by the river and is located at the junction of Guangdong and Guangxi, and chosen to assess the impact of different policies on environmental management in the Xijiang River Basin under the same natural environment.

[1]The Xijiang Economic Belt is designated in the regional overall development plan by the Guangxi and Guangdong Provincial Government Offices. Guangxi includes seven cities: Wuzhou, Guigang, Laibin, Liuzhou, Nanning, Baise, and Chongzuo, accounting for 55.2% of the total land area of the region. The Belt in Guangdong Province extends to the Pearl River estuary, connecting the economic, cultural, and political centers of Guangdong Province while including cities such as Guangzhou, Foshan, Shenzhen, Dongguan, Zhongshan, Zhuhai, and Jiangmen. The total economic output accounts for more than 80% of that of Guangdong Province.

The topographical conditions in the study area are complex with hilly land, and the meteorological conditions are high temperature and rainy in summer, moderate temperature and abundant rainfall in winter. The geographical location of the study area is superior. With the steady implementation of the Western Development Strategy and the orderly development of the Xijiang Economic Belt, the levels of economic development in the middle and lower reaches have greatly improved to become important links between the economic development of southwestern China and that of the southeastern coast. However, the pressures of economic development and society have reduced the forest coverage in the upper and middle reaches by 0.5 times and increased the area of soil erosion by 1.5 times. The water quality in most of the lower reaches of the suburban areas and economically developed areas was lower than the drinking water standard (Liao et al., 2017).

Research Methodology

CE can identify random changes in different attributes, better estimate the marginal contributions of river basin ecosystem service components or attributes, and the measurement results of the WTP can effectively reveal the environmental protection intentions of the interviewees.

CE is based on value feature theory (Lancaster, 1976) and random utility theory (McFadden, 1974).

$$\mathrm{U_{in}} = \mathrm{V_{in}}\left(\mathrm{Z_i}, \mathrm{S_n}\right) + \varepsilon_{\mathrm{in}}\left(\mathrm{Z_i}, \mathrm{S_n}\right) \tag{1}$$

where n represents the number of the sampled respondents, i represents the alternatives in the defined selection set, and U_{in} represents the total marginal utility of the random choices i of respondent n. V_{in} is the observable utility consisting of option attributes and public socioeconomic characteristics, ε_{in} is the unobservable utility represented by the random error term, Z_i is the attribute of the selection scheme, and S_n represents the socioeconomic characteristics of the respondents. In the random utility function, the probability that respondent n chooses plan i instead of plan j is:

$$\mathrm{P_{in}} = P_r\left\{U_{in} > U_{jn}, i \neq j, j \in C\right\} \tag{2}$$

Different assumptions about the distribution of the random error term ε_{in} form different probability selection models. C is the set of all the alternatives in the design of the questionnaire.

The specific type of CE is determined by the distribution of the random error term ε. Generally, it is assumed that the scheme and options are independent of each other while the random utility ε, as well as the selection scheme and options, are subject to the Gumbel distribution to obtain a multiple logit model, in which the probability that respondent n chooses the best solution i is:

$$\mathrm{P_{in}} = \frac{\exp\left(V_{in}\left(Z_i, S_n\right)\right)}{\sum_{j=1}^{J}\exp\left(V_{in}\left(Z_j, S_n\right)\right)} \tag{3}$$

The heterogeneity of individual respondents in a multiple logit model is difficult to capture. To solve this problem, Revelt and Train (1998) proposed a random parameter logit (hereinafter abbreviated as "RPL") model, also called a mixed logit model,

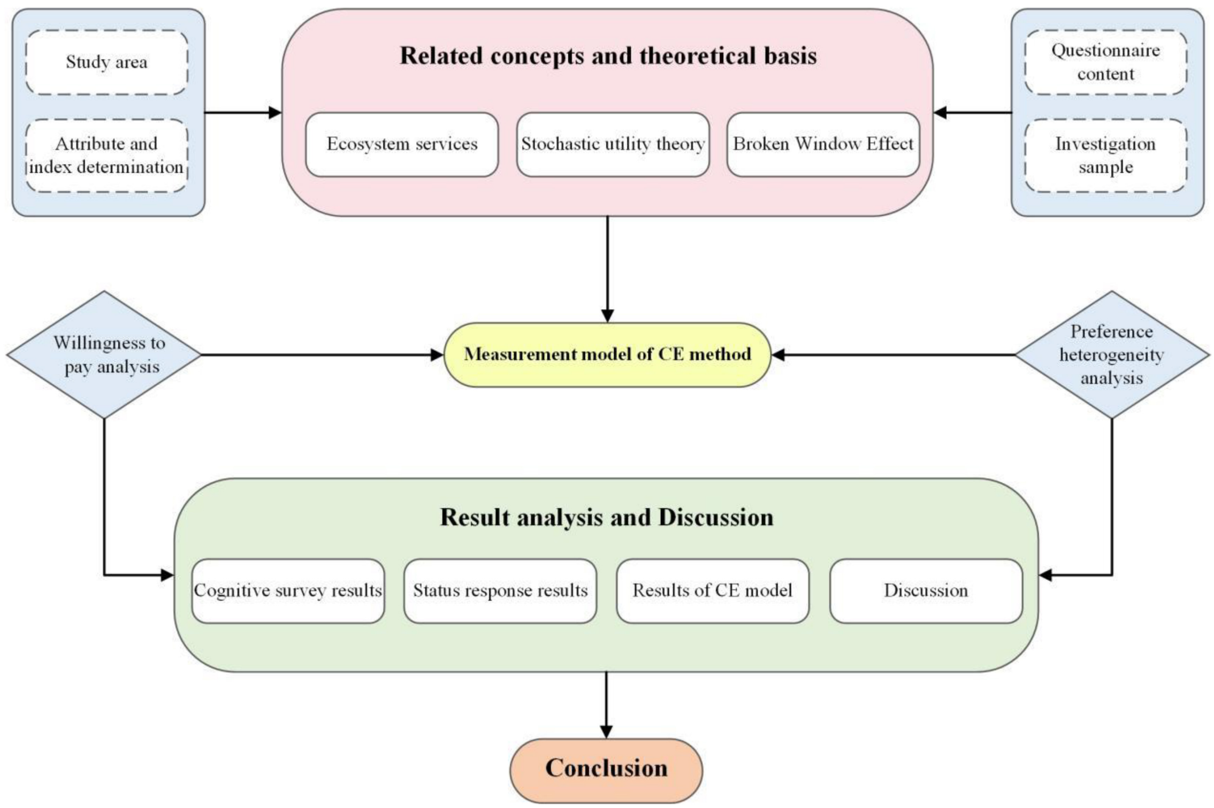

FIGURE 1 | Theoretical analysis framework.

that can examine the heterogeneity of the individual preferences of respondents through randomly changing parameters. In the context of random interrogation, the RPL model exhibits smaller errors.

$$\mathrm{U_{in}} = V_{in}\left(Z_i\left(\beta + \theta_i\right), S_n\right) + \varepsilon_{in}\left(Z_i, S_n\right) \quad (4)$$

The heterogeneity of a respondent's preferences can change through random components. Each respondent's socioeconomic attributes and indirect utility are assumed to be a function with a parameter β and selection attribute Z_i.

$$\mathrm{P_{in}} = \frac{\exp\left(V_{in}\left(Z_i\left(\beta_r + \theta_i\right), S_n\right)\right)}{\sum_{j=1}^{J} \exp\left(V_{in}\left(Z_j\left(\beta + \theta_j\right), S_n\right)\right)} \quad (5)$$

If the utility of all service attributes is a linear function, then the WTP the value of the respondents to improve the river basin ecosystem can be derived from the utility function, Eq. (1). The maximization of the utility level is:

$$\mathrm{MWTP} = -\frac{\beta_r}{\beta_p} \quad (6)$$

where β_r indicates a parameter of the non-monetary attribute r and β_p indicates a parameter of the monetary attribute p.

Design of Choice Experiment

Accurate and reasonable classification is not only the basis for assessing the watershed ecosystem values but also helping respondents to judge the background of the quality of the ecological environment, as well as to make choices about scientific and effective payment solutions. In this study, the selection set was designed according to the scientific classification, status quo, and regional differences of river basin ecosystem services. Specifically, it was based on the four major categories of supply service, regulation service, cultural service, and support service divided by ecosystem service functions in the Millennium Ecosystem Assessment (MEA, 2005). And Combined with the actual ecological environment quality, the current use status of the inter-regional river basin ecosystems in Guangxi and Guangdong Provinces, and the production and living needs of residents in the surrounding areas of the two provinces (regions). Finally, the selection set's attributes were classified into the following six: proportion of natural landscape, tourism index, forest coverage, water quality, biodiversity, and water quantity. Among them, the natural landscape is divided into the natural landscape and man-made landscape, and the proportion of natural landscape refers to the proportion of biological landscape, water landscape, cultural landscape, and other natural landscape in the region; The tourism index is the travel advice provided by the meteorological department to citizens from the perspective of weather according to the changes

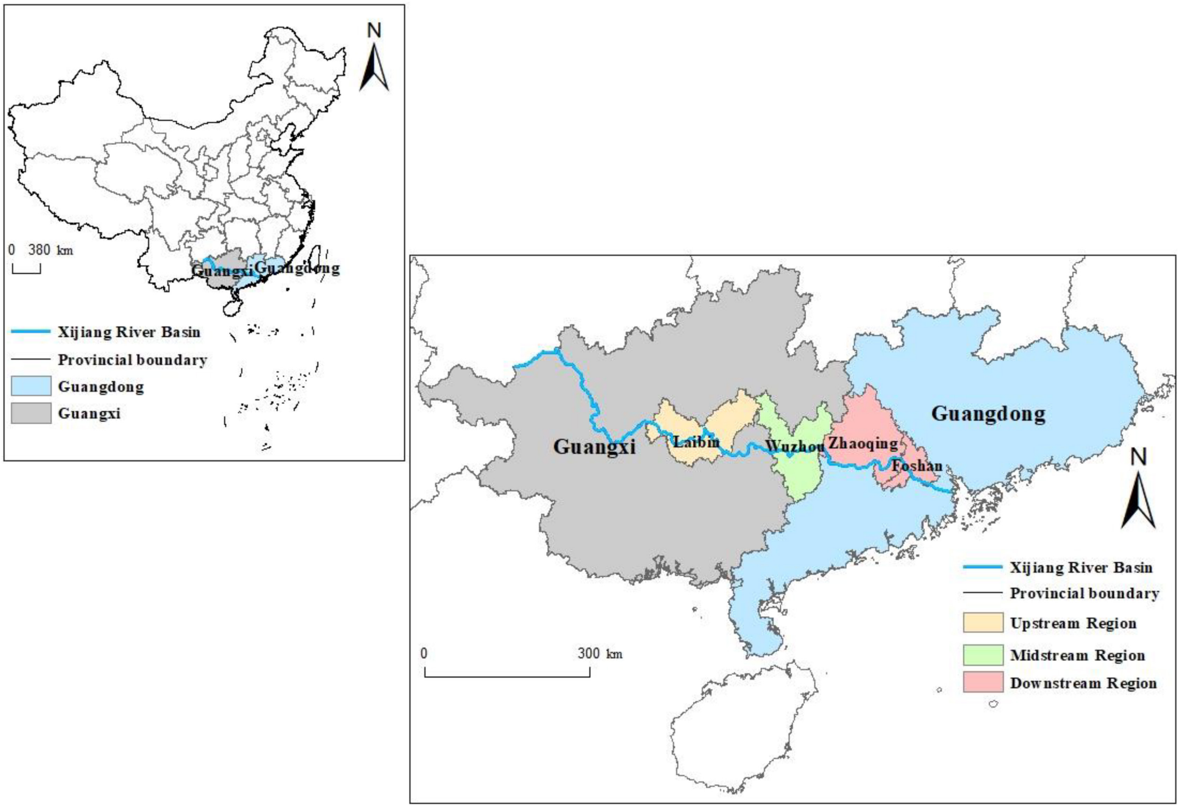

FIGURE 2 | The study area.

in local weather, combined with temperature, wind speed, and specific weather phenomena; Forest coverage is the ratio of forest area to total land area; Trade-offs among services of different land use/cover types in a watershed affect ecosystem stability and sustainability. Biodiversity specifically refers to the diversity of the total amount of living beings; Biodiversity conservation is not only about protecting its intrinsic value but also plays a vital role in the functioning of ecosystems that provide essential services to humans. Water quality is the status of evaluating the water quality of a basin; Water quantity is the size of the flow of the basin.

The distributions of attribute variables and attribute levels are determined by the current levels of the attribute variables and the optimal state that can be achieved after river basin ecosystem governance has been achieved. After surveying the pilot cities in the upper, middle, and lower reaches, we divided the WTP into eight levels according to the socioeconomic conditions of the residents around the river basin. The specific attribute variables of the levels of WTP are shown in **Table 1**.

The attributes and their levels in **Table 1** were arranged and combined to obtain $(3 \times 2 \times 3 \times 2 \times 3 \times 3)^2 \times 7 = 734{,}862$ possible all-factor selection pairs. Considering the cognitive burden and reading fatigue of the respondents, SAS software and D-optimality criteria were used to optimize experimental design and selection (Scarpa and Rose, 2008). This simplicity may help reduce potential structural biases in selection experiments, such as complexity's leading to increased preferences for the status quo (Boxall et al., 2009) or help the use non-neoclassical information processing strategies (Mazzotta and Source, 1995; Hensher, 2006). Finally, 24 selection sets with different combinations of attribute level options were selected and randomly divided into four versions, each of which had six selection sets. Examples of the selection sets are shown in **Table 2**.

To effectively reveal the respondents' intentions for environmental protection, we provided them with a hypothetical market environment in the choice set. Among the six options for improvements of river basin ecosystem services, the study area is used as a reference and improvement, and different solutions correspond to different price indicators. The payment price of CNY0 per household per year represents the protection status. Respondents had to make two choices according to their own situation and desired improvement.

Questionnaire and Survey Data Collection

After 50 discussions and amendments to the questionnaire, we conducted a 3-month pre-test and formulated the final questionnaire, which consisted of five parts. The first part tested the respondents' understanding of the Xijiang River Basin and their awareness of its ecosystem functions and services. The second part used CE to examine their preferences and WTP for ecosystem service improvements. The third part asked for their views on the future supervision and management of the Xijiang River Basin. The fourth part is the basic survey of the basic social

TABLE 1 | Attributes and levels in CE.

Attributes	Unit and description	Levels
Proportion of natural landscape	%	21%[SQ], 30%, 40%, 50%
Tourism index	Lever 1 = Ideal for tourism; Lever 2 = Suitable for tourism; Lever 3 = More suitable for tourism	Lever 3[SQ], Lever 2, Lever 1
Forest coverage	%	53.99% [SQ], 58%, 68%, 75%
Water quality	[a] Class I; Class II; Class III	Class III [SQ], Class II, Class I
Biodiversity	Total biomass	+10%, +20%, +30%
Water quantity	One hundred million cubic meters	+10%, +20%, +30%
WTP	CNY/household/year	0, 50, 100, 150, 200, 250, 350

[a]*Class I: source water, national nature reserve, can be directly consumed. Class II: clean, can be used as drinking water after routine purification, the first-class protection area of surface source water; Class III: The secondary protection area of surface source water.*
[SQ]*, status quo.*

TABLE 2 | Example of choice set used in CE.

Attributes	SQ	Option A	Option B
Proportion of natural landscape	21%	50%	50%
Tourism index	Lever 3	Lever 1 (Favorable to tourism)	Lever 1
Forest coverage	53.99%	68%	75%
Water quality	Class III	Class I	Class I
Biodiversity	–	10% increase in total aquatic and terrestrial biomass	10% increase in total aquatic and terrestrial biomass
Water quantity	–	10% increase in annual standard water available per capita	10% increase in annual standard water available per capita
WTP (CNY/household/year)	0	300	350

situations of the interviewees and their families. The last part is the validity test of the questionnaire.

After face-to-face interviews with interviewees from the urban and rural sections of the four study areas, we collected a total of 755 completed questionnaires. After screening, 57 (7.55%) invalid questionnaires (including those missing data on gender and payment results) were removed and a total of 698 valid questionnaires were available for analysis. **Table 3** shows the statistics and social demographic characteristics of the sample respondents. We collected 164 (23.50%), 150 (21.49%), and 384 (55.01%) responses from respondents in the upper, middle, and lower reaches of the river basin. There were no significant differences among the three regions in gender ratio, average age, average education level, and average number of family members. Average family labor force in the middle reaches was relatively low while annual income was highest in the lower reaches.

RESULTS AND ANALYSIS

Cognitive Survey Results

The respondents' understanding of the ecosystem service functions of the Xijiang River Basin and their importance directly reflects the degree of attention paid by them to the ecological environment. **Table 4** shows their evaluations of the importance of the ecosystem service functions of the Xijiang River Basin.

We used the Likert scale to examine the respondents' perceptions of the ecosystem services in the Xijiang River Basin and their importance. The results show that, from an overall perspective, the respondents in the upper reaches have an awareness of the basin's ecosystem. Compared with the residents in the upper and middle reaches, those in the lower reaches lack sufficient understanding of the importance of the ecosystem service functions. Although these results do not reflect the sense of responsibility and willingness to protect the environment, they help us to understand the interviewees' cognitive situations in advance of face-to-face interviews, provide relevant content explanations to increase the respondents' recognition of the basin's ecosystem services, and help the respondents to perceive the quality of the basin's ecological environment so as to encourage them to make more scientific decisions about the trade-offs involved in the improvements of the WTP for solutions.

Status Response Results

Of the 798 available questionnaires, only 50 (7.16%) of the respondents were unwilling to pay for the improvements in the ecosystem services of the Xijiang River Basin. Of these 50 respondents, 13 respondents (accounting for 26.00% of the total number of respondents) made zero payments with 100% certainty, indicating that they were unwilling to pay. Respondents who chose the status quo in the alternative choices were asked to explain why their WTP was zero. (Here, multiple choices could have been made.) Of these respondents, 72% believed that improvements were the responsibility of the government and ordinary residents should not bear the costs. Of the respondents, 46% mentioned their lack of ability to pay for the improvements while only 4% responded that the ecological environment in the Xijiang River Basin was satisfactory and did not require protection.

Results of CE Model

The results were more informative and scientific than the surveys of cognitive situations because the results revealed the public's willingness to make choices and trade-offs between improving attributes, including costs. **Table 5** shows the results of Model I: "Overall Basin Area" and Model II: "Upper, Middle, and Lower Reaches Segmented Basin Areas." We used the STATA15.0 software application to simulate both models with an RPL model. For each sample simulation, we used the method of

TABLE 3 | Socioeconomic characteristics of respondents.

Variables	Code/Unit	Upper reaches				Middle reaches				Lower reaches			
		Min	Max	Mean	*SD*	Min	Max	Mean	*SD*	Min	Max	Mean	*SD*
Sample size	n	164 (23.50%)				150 (21.49%)				384 (55.01%)			
Gender	1 = Male; 2 = female	1	2	1.40	0.49	1	2	1.51	0.50	1	2	1.49	0.50
Age	–	11	81	36.02	19.92	14	78	36.82	16.46	11	92	43.82	17.84
Edu	1 = Primary school or below; 2 = Junior high school; 3 = High school and technical secondary school; 4 = Undergraduate and junior college; 5 = Graduate or above	1	4	2.82	1.08	1	4	2.87	0.99	1	5	2.24	1.09
Family income	x.xx (Ten thousand CNY/year)	0.5	20.0	2.08	3.49	1.0	25.0	1.48	3.36	0.4	100.0	8.47	9.99
Family labor	N	0	11	2.13	1.73	0	7	0.81	1.32	0	6	1.84	1.44
Residence	City = 1 = ; Rural = 2; Urban-rural fringe 3	1	3	1.51	0.70	1	3	1.85	0.72	1	3	1.73	0.71

500 Halton extraction for maximum likelihood estimation to explore the differences in WTP for services and restoration of the ecosystem. To improve the estimation efficiency of the model, we assumed that all ecological index parameters were random parameters obeying the normal distribution. Here, the payment price parameter was modeled for Hicks welfare, so it was designated as a non-random parameter.

Overall, the results of Models I and II indicate that the public generally shows a tendency to deviate from the status quo, which is consistent with previous research (Che et al., 2014; Vásquez and de Rezende, 2019). The non-random parameters (price) of the models are all significant at 5%. In most cases, the standard deviation of the random term proved to be significant, supporting the choice of the mixed logit model (Martin-Ortega et al., 2012). A small number of standard deviations greater than the average indicate that some respondents have unexpected preferences (more inclined to poor water quality and low ecological diversity). Model I shows the public's willingness and preference for the improvement of the ecosystem service attributes of the basin as a whole. In general, the public is willing to pay for improvements in ecological attributes other than biodiversity, and in particular, all regions are willing to pay for improvements in forest cover. The non-random parameters (price) of the samples in the middle and lower reaches of the simulation results of Model II are significantly negative, indicating that the payment price has had a significant impact on the WTP of the public in the middle and lower reaches. The higher cost alternatives are rarely selected as the public is more inclined to improve at the lowest cost, i.e., the public of the middle and lower reaches expect only the river basin ecosystem to be restored. The sample of the upper reaches showed that the non-random parameters (price) were significantly positive, i.e., the public is willing to pay for the restoration of the river basin ecosystem to a better ecological environment, validating our main hypothesis. Hence, the upper-reaches public living in areas with a high quality of ecological environment is willing to pay for a restoration to a higher state and willing to be the "first person" to repair the "broken windows."

To examine if the public is affected by personal factors improving the choices of solutions, we also introduced the interaction of the payment price attribute with the individual socioeconomic variables (see **Supplementary Appendix A** for the results) (Mastrangelo et al., 2019). The value of the regression coefficient shows that, for each region of the upper, middle, and lower reaches, the influence of individual socioeconomic variables on their choice of scheme is extremely small and can

TABLE 4 | Respondents' awareness of ecosystem services in the Xijiang River Basin.

Variables	Upper reaches		Middle reaches		Lower reaches	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
V1[a,b]	2.54	1.29	3.77	0.82	3.89	0.78
V2[a,b]	2.34	0.96	3.88	0.90	3.95	0.78
V3[a,b]	2.33	0.97	3.57	0.91	3.83	0.76
V4[a,b]	2.76	1.21	3.57	0.92	3.62	0.78
V5[a,b]	2.30	0.99	3.41	0.96	3.81	0.83
V6[a,b]	1.88	0.80	3.70	0.92	4.04	0.82

[a] *V1, Climate regulation; V2, Maintain the natural landscape; V3, Protecting the ecosystem; V4, Provide climate change information; V5, Maintain water quality; V6, Maintain sufficient water.*

[b] *1 = Agree completely; 2 = Agree; 3 = General; 4 = Not agree; 5 = Disagree completely; 6 = Do not know.*

TABLE 5 | Results of RPL modeling of CE model.

Variables	**Model I**		**Model II**					
	Overall Basin Area		**Upper reaches**		**Middle reaches**		**Lower reaches**	
	Coef.(z)	**[95% Conf. Interval]**	**Coef.(z)**	**[95% Conf. Interval]**	**Coef. (z)**	**[95% Conf. Interval]**	**Coef. (z)**	**[95% Conf. Interval]**
Random parameter								
Proportion of natural landscape	0.545*** (5.20)	(0.33944, 0.75049)	0.204 (1.21)	(−0.12682, 0.53430)	0.663* (2.43)	(0.12871, 1.19737)	0.213 (1.08)	(−0.17432, 0.59950)
Tourism index	1.242*** (7.09)	(0.89918, 1.58562)	−0.158 (−0.67)	(−0.61786, 0.30208)	1.261** (2.97)	(0.42945, 2.09240)	1.613*** (7.70)	(1.20236, 2.02397)
Forest coverage	0.590*** (6.57)	(0.41423, 0.76661)	0.424** (2.82)	(0.12968, 0.71843)	0.890** (3.04)	(0.31544, 1.46535)	0.947*** (7.56)	(0.70159, 1.19275)
Water quality	1.145*** (11.09)	(0.94256, 1.34721)	0.223 (1.00)	(−0.21528, 0.66168)	1.774*** (5.30)	1.11814, 2.43052)	0.882*** (5.63)	(0.57509, 1.18923)
Biodiversity	−0.107 (−0.92)	(−0.33526, 0.12156)	0.0651 (0.37)	(−0.27551, 0.40575)	−0.463 (−1.52)	(−1.06000, 0.13477)	−0.083 (−0.44)	(−0.44894, 0.28301)
Water quantity	0.571*** (4.93)	(0.34433, 0.79866)	0.0737 (0.38)	(−0.30548, 0.45289)	0.839* (2.54)	(0.19282, 1.48511)	0.395* (2.27)	(0.05343, 0.73659)
Non-random parameter								
Price	−0.0154*** (−6.57)	(−0.02003, 0.01083)	0.00855* (2.21)	(0.00096, 0.01615)	−0.0250*** −3.48)	(−0.03903, −0.01092)	−0.0203*** −6.49)	(−0.02641, 0.01416)
SD of random parameters								
Proportion of natural landscape	1.230*** (9.90)	(0.98671, 1.47393)	0.00402 (0.04)	(−0.18744, 0.19547)	−0.0818 (−0.52)	(−0.39104, 0.22735)	0.761*** (4.24)	(0.40942, 1.11206)
Tourism index	0.260* (2.52)	(0.05760, 0.46147)	−0.00482 (−0.03)	(−0.27777, 0.26812)	−0.190 (−0.59)	(−0.82037, 0.43946)	−0.256* (−2.44)	(−0.46162, −0.05044)
Tourism index	0.398*** (8.60)	0.30723, 0.48865)	0.0159 (0.12)	(−0.23556, 0.26727)	0.608** (2.63)	(0.15430, 1.06203)	0.542*** (4.85)	(0.32291, 0.76064)
Forest coverage	1.225*** (10.99)	(1.00616, 1.44298)	0.285 (1.35)	(−0.12725, 0.69691)	−0.0152 (−0.07)	(−0.42541, 0.39495)	−0.583*** (-3.72)	(−0.88982, −0.27549)
Water quality	0.312*** (4.56)	(0.17776, 0.44542)	−0.00255 (−0.03)	(−0.19150, 0.18639)	0.499 (1.54)	(−0.13690, 1.13484)	0.0113 (0.18)	(−0.11259, 0.13512)
Biodiversity	0.481*** (6.24)	(0.32973, 0.63156)	−0.0203 −0.11)	(−0.39489, 0.35436)	0.0815 (0.27)	(−0.50039, 0.66334)	0.146 (0.99)	(−0.14442, 0.43690)
n	4,188		984		900		2,304	
Log likelihood	−1064.831		−266.408		−188.727		−555.6378	
LR Chi^2 (6)	149.150		1.19		21.040		22.94	
Prob > chi^2	0.000		0.9773		0.0018		0.0008	

$^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

TABLE 6 | Estimation of marginal WTP/WTA on RPL model.

Attributes	MWTP (CNY/household/year)					
	Upper reaches (95% Conf. Interval)		Middle reaches (95% Conf. Interval)		Lower reaches (95% Conf. Interval)	
Proportion of natural landscape	−23.82	(−131.97, 33.09)	26.55	(3.30, 109.63)	10.48	(−6.60, 42.35)
Tourism index	18.46	(642.94, −18.71)	50.48	(11.00, 191.57)	79.53	(45.53, 142.97)
Forest coverage	−49.57	(−134.95, −44.49)	35.65	(8.08, 134.16)	46.70	(26.57, 84.25)
Water quality	−26.09	(224.02, −40.97)	71.04	(28.65, 222.53)	43.49	(21.78, 84.01)
Biodiversity	−7.61	(286.69, −25.13)	−18.52	(−27.16, 12.34)	−4.09	(−17.00, 19.99)
Water quantity	−8.62	(317.88, −28.05)	33.59	(4.94, 135.97)	19.47	(2.02, 52.03)
Total	−97.25	(1468.55, −190.43)	198.78	(28.81, 806.19)	195.58	(72.29, 425.60)

be ignored. In addition, we also explored whether the interaction between ecological attributes and the characteristics of individual economic variables affects their choice of improvement in the ecosystem services (see **Supplementary Appendix B** for the results). The data showed that the relationship between these characteristics and ecological attributes had little impact on the change of preference of the improvement in the ecosystem services, which could not explain whether the heterogeneity of preference was caused by the difference of individual economic variables, or could be ignored.

Based on the results of the RPL model in **Table 5**, then the public's WTP/ WTA is calculated for each region of the upper, middle, and lower reaches. The results are shown in **Table 6**. In terms of WTA, the public in the upper reaches wanted to accept compensation of CNY97.25 per household per year from the middle and lower reaches. whereas those in the middle and lower reaches were willing to pay CNY198.78 and CNY195.58 per household per year, respectively, in economic compensation for the protection of the upper reaches. The results also indirectly indicate that the upper-reaches public was willing to participate spontaneously in environmental protection with low economic compensation.

DISCUSSION

When faced with the urgent demands of developing countries for the restoration of river basin ecosystems and when responding to the call for the "sustainable development of man and nature to ensure a virtuous cycle of the ecological environment," it is particularly important to understand the factors influencing the public's WTP. Defining the influencing factors and determining the influencing ways are not only an important means of effectively controlling the costs of governance but also can optimize the allocation of ecological compensation resources from the sources of ecological damage. Compared with the existing literature, this paper's contribution is reflected in two main aspects.

The first aspect is the expansion of research fields. The Broken Window Effect originated from criminal psychology and was used mostly in research on crime control and security management but rarely involved the protection and governance of the ecological environment. Combining with the viewpoint of the Broken Window Effect, this study explored the public's willingness to protect the environment in the upper, middle, and lower reaches of the Xijiang River Basin under different ecological environment quality backgrounds. Specifically, this study confirmed that, for the public, the higher the perceived quality of the ecological environment, the more willing they were to pay for watershed ecosystems to a better state. Consistent with the Broken Window Effect, an orderly and standardized environment would form a good perception of the quality of the ecological environment (Lang et al., 2010), thereby increasing the public's willingness to protect the environment. Compared to the government's early governance intervention, the public's perception of the quality of the ecological environment has a greater impact on their willingness to protect the environment (Sampson and Raudenbush, 2004; Baharoon et al., 2016; Liu et al., 2020).

The second aspect is the research methods. To further evaluate the public's willingness to protect the environment in the watershed flow area. A questionnaire survey was conducted by CE method using the respondents' choices of different restoration projects, and we measured the public's willingness to protect the environment in different ecological environments. Here, respondents were able to intuitively select the alternatives that they expected to restore the ecosystem to a certain state (Nie et al., 2019). The CVM cannot identify the random variations among different attributes of river basin ecological environments or offer respondents alternative restoration projects. Also, CVM may lead directly to a large deviation in the evaluation of WTP/WTA (Boerger, 2013). In addition, the RPL model can check the heterogeneity of the individual preferences of the respondent by randomly changing parameters, and thus, exhibits smaller calculation errors in the context of random queries (Revelt and Train, 1998).

The results of this research not only can fill the gaps in the existing literature but also provide a new direction for the formulation of government programs for river basin governance. At present, the public in the upper reaches has a higher willingness to protect the environment than do those in the middle and lower reaches. Therefore, the relevant departments should actively proceed from upstream protection and governance, encourage the public to monitor and report each other, intervene at the beginning of the "broken windows." Then, increase publicity about environmental protection, help the public to realize that disorderly behaviors produce ecological destruction and spread the Broken Window

Effect, and increase the public's awareness of environmental responsibility. Also, we should actively pursue education on environmental protection, raise public awareness of the quality of the ecological environment in which we live, and guide the public to regulate their own behaviors and curb the spread of the Broken Window Effect.

This study provides relevant insights of the Broken Window Effect in the study of ecological environmental protection. Although it fills the gaps in the literature to a certain extent, it still has certain limitations. First, the study area we selected was the Xijiang tributaries of the Guangxi and Guangdong sections of China. There were fewer cities and regions involved, but the survey data are scientifically valid and do not affect the main conclusions of this paper. Second, there was a lack of discussion on whether the environmental background factor was a moderator variable or an intermediary variable. Therefore, further research is needed to better understand how the environmental background affects the public's willingness to protect the environment. Third, the survey of CE was conducted randomly around the river basin of different cities, the distance between the specific location of interviewees and the river basin was not indicated, and the location in each region would be improved, which is the direction of our future research.

CONCLUSION

The protection and restoration of the river basin ecosystem depend on the path of "starting with people." This study used a spatial CE to investigate the willingness of the public to pay for the protection and restoration of the upper, middle, and lower reaches of the Xijiang River Basin's ecosystem in China. Combining the main ideas of the Broken Window Effect, which originated in criminal psychology, we verified our main hypothesis with the results of a logit modeling of random parameters. The results showed that, in the upper reaches where the quality and status of the ecological environment are relatively good, the public is willing to pay for the restoration of the ecosystem to a better state. However, the public in the middle and lower reaches was more inclined to make improvements at the lowest costs, i.e., they expected only to restore the river basin ecosystem to a good state. The empirical results indicate that the ecological environment quality had a great impact on the public's willingness to protect the environment. Therefore, we believe that the protection of the river basin ecosystem exhibited the Broken Window Effect and the perception of environmental quality was an important factor affecting the public's willingness to participate in environmental protection. Only by maintaining a high-quality ecological environment at the source could we effectively prevent disorderly behaviors that damage the ecosystem, thereby changing the "broken windows" into "protected windows."

Compared with previous research perspectives, the previous discussion of the public's WTP for environmental protection from a psychological perspective focused more on the public's attitudes, subjective judgment, moral obligations, and perceived behavioral control factors while ignoring the impact of perceived environmental quality on their WTP. The results of our research indicate that the perception of environmental quality is an important factor affecting the public's willingness to participate in environmental protection and expanded the application of the Broken Window Effect in research on ecological protection, confirming that the protection of river basin ecosystems had a Broken Window Effect. The results of the study, "The upstream public is willing to be the 'first person' to repair the 'broken windows', " provides a new direction for the integrated management of river basins across regions.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

XN: conceptualization, methodology, formal analysis, data curation, investigation, visualization, writing—original draft, and writing—review and editing. ZC: conceptualization, supervision, and writing—review and editing. HW: experiment and writing—review and editing. LY: visualization and writing—review and editing. YQ: investigation. All authors contributed to the article and approved the submitted version.

FUNDING

This study was supported by the National Natural Science Foundation of China (Nos. 71763001 and 71973038) and the Social Nature Sciences Foundation of China (19BGL008).

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2022.842491/full#supplementary-material

REFERENCES

Aguilar, F. X., Obeng, E. A., and Cai, Z. (2018). Water quality improvements elicit consistent willingness-to-pay for the enhancement of forested watershed ecosystem services. *Ecosyst. Serv.* 30, 158–171. doi: 10.1016/j.ecoser.2018.02.012

Almazán, S., Alfaro, J. F., and Sikra, S. (2019). Exploring household willingness to participate in solid waste collection services in Liberia. *Habitat Int.* 84, 57–64. doi: 10.1016/j.habitatint.2019.01.001

Aoki, K., Akai, K., Ujiie, K., Shimmura, T., and Nishino, N. (2019). The impact of information on taste ranking and cultivation method on rice types that protect endangered birds in Japan: non-hypothetical choice experiment with tasting. *Food. Qual. Prefer.* 75, 28–38. doi: 10.1016/j.foodqual.2018.11.021

Badura, T., Ferrini, S., Burton, M., Binner, A., and Bateman, I. J. (2020). Using Individualised choice maps to capture the spatial dimensions of value within choice experiments. *Environ. Resour. Econ.* 75, 297–322. doi: 10.1007/s10640-019-00358-3

Baharoon, D. A., Rahman, H. A., and Fadhl, S. O. (2016). Publics' knowledge, attitudes and behavioral toward the use of solar energy in Yemen power sector. *Renew. Sust. Energ. Rev.* 60, 498–515. doi: 10.1016/j.rser.2015.12.110

Berger, E., Bossenbroek, L., and Beermann, A. J. (2021). Social-ecological interactions in the draa river basin, southern morocco: towards nature conservation and human well-being using the IPBES framework. *Sci. Total Environ.* 769:144492. doi: 10.1016/j.scitotenv.2020.144492

Boerger, T. (2013). Keeping up appearances: Motivations for socially desirable responding in contingent valuation interviews. *Ecol. Econ.* 87, 155–165. doi: 10.1016/j.ecolecon.2012.12.019

Boxall, P., Adamowicz, W. L. V., and Moon, A. (2009). Complexity in choice experiments: choice of the status quo alternative and implications for welfare measurement. *Aust. J. Agr. Resour. Econ.* 53, 503–519. doi: 10.1111/j.1467-8489.2009.00469.x

Brouwer, R., Bliem, M., Getzner, M., Kerekes, S., Milton, S., Palarie, T., et al. (2016). Valuation and transferability of the non-market benefits of river restoration in the danube river basin using a choice experiment. *Ecol. Eng.* 87, 20–29. doi: 10.1016/j.ecoleng.2015.11.018

Brouwer, R., Martin-Ortega, J., and Berbel, J. (2010). Spatial preference heterogeneity: a choice experiment. *Land Econ.* 86, 552–568. doi: 10.3368/le.86.3.552

Carlsson, F., Kataria, M., and Lampi, E. (2018). Demand effects in stated preference surveys. *J. Environ. Econ. Manage.* 90, 294–302. doi: 10.1016/j.jeem.2018.06.003

Carvalho, L., Mackay, E. B., and Cardoso, A. C. (2019). Protecting and restoring Europe's waters: an analysis of the future development needs of the water framework directive. *Sci. Total Environ.* 658, 1228–1238. doi: 10.1016/j.scitotenv.2018.12.255

Che, Y., Li, W., Shang, Z., Liu, C., and Yang, K. (2014). Residential preferences for river network improvement: an exploration of choice experiments in zhujiajiao, shanghai, China. *Environ. Manage.* 54, 517–530. doi: 10.1007/s00267-014-0323-x

Chen, W. Y., and Hu, F. Z. Y. (2015). Producing nature for public: land-based urbanization and provision of public green spaces in China. *Appl. Geogr.* 58, 32–40. doi: 10.1016/j.apgeog.2015.01.007

Cheng, H., Hu, X., and Zhou, R. (2019). How firms select environmental behaviours in China: the framework of environmental motivations and performance. *J. Clean. Prod.* 208, 132–141. doi: 10.1016/j.jclepro.2018.09.096

Cheng, L., Liu, Y., Brown, G., and Searle, G. (2018). Factors affecting farmers' satisfaction with contemporary China's land allocation policy–the link policy: based on the empirical research of Ezhou. *Habitat Int.* 75, 38–49. doi: 10.1016/j.habitatint.2018.04.004

Crichlow, V. J. (2016). Will 'broken windows policing' work in trinidad and tobago? A critical perspective on zero tolerance and community policing in a multi-ethnic society. *Police Pract. Res.* 17, 570–581. doi: 10.1080/15614263.2016.1210009

Dahal, R. P., Grala, R. K., Gordon, J. S., Petrolia, D. R., and Munn, I. A. (2018). Estimating the willingness to pay to preserve waterfront open spaces using contingent valuation. *Land Use Policy* 78, 614–626. doi: 10.1016/j.landusepol.2018.07.027

Fu, L., Sun, Z., Zha, L., Liu, F., He, L., Sun, X., et al. (2020). Environmental awareness and pro-environmental behavior within china's road freight transportation industry: moderating role of perceived policy effectiveness. *J. Clean. Prod.* 252:119796. doi: 10.1016/j.jclepro.2019.119796

Glenk, K., Johnston, R. J., and Meyerhoff, J. (2020). Spatial dimensions of stated preference valuation in environmental and resource economics: methods, trends and challenges. *Environ. Resour. Econ.* 75, 215–242. doi: 10.1007/s10640-018-00311-w

González Dávila, O., Koundouri, P., Pantelidis, T., and Papandreou, A. (2017). Do agents' characteristics affect their valuation of 'common pool' resources? A full-preference ranking analysis for the value of sustainable river basin management. *Sci. Total Environ.* 575, 1462–1469. doi: 10.1016/j.scitotenv.2016.10.014

He, Q., Tan, R., Gao, Y., Zhang, M. K., Xie, P., and Liu, Y. l (2018). Modeling urban growth boundary based on the evaluation of the extension potential: a case study of Wuhan City in China. *Habitat Int.* 7, 57–65. doi: 10.1016/j.habitatint.2016.11.006

Hensher, D. A. (2006). How do respondents process stated choice experiments? Attribute consideration under varying information load. *J. Appl. Econom.* 21, 861–878. doi: 10.1002/jae.877

Hira, A. (2016). Broken windows: why culture matters in corruption reform. *J. Dev. Soc.* 32, 1–16. doi: 10.1177/0169796X15609710

Khan, I., Zhao, M., Khan, S. U., Yao, L., Ullah, A., and Xu, T. (2018). Spatial heterogeneity of preferences for improvements in river basin ecosystem services and its validity for benefit transfer. *Ecol. Indic.* 93, 627–637. doi: 10.1016/j.ecolind.2018.05.018

Lancaster, K. J. (1976). "A new approach to consumer theory," in *Mathematical Models in Marketing: A Collection of Abstracts*, ed. U. H. Funke (Heidelberg: Springer), 106–107.

Lang, D. L., Salazar, L. F., Crosby, R. A., DiClemente, R. J., Brown, L. K., and Donenberg, G. R. (2010). Neighborhood environment, sexual risk behaviors and acquisition of sexually transmitted infections among adolescents diagnosed with psychological disorders. *Am. J. Community Psychol.* 46, 303–311. doi: 10.1007/s10464-010-9352-7

Liao, Y., Xu, P., Zhao, C., Luan, S., and Zhang, Y. (2017). Analysis of water quality change trend and influencing factors in the middle reaches of Xijiang River from 1973 to 2013. *Environ. Sci. Technol.* 40, 145–152.

Liu, J., Wu, J. S., and Che, T. (2019). Understanding perceived environment quality in affecting tourists' environmentally responsible behaviours: a broken windows theory perspective. *Tour. Manag. Perspect.* 31, 236–244. doi: 10.1016/j.tmp.2019.05.007

Liu, T., Hu, W., Song, Y., and Zhang, A. (2020). Exploring spillover effects of ecological lands: a spatial multilevel hedonic price model of the housing market in Wuhan, China. *Ecol. Econ.* 170:106568. doi: 10.1016/j.ecolecon.2019.106568

Lizin, S., Brouwer, R., Liekens, I., and Broeckx, S. (2016). Accounting for substitution and spatial heterogeneity in a labelled choice experiment. *J. Environ. Manage.* 181, 289–297. doi: 10.1016/j.jenvman.2016.06.038

López-Mosquera, N. (2016). Gender differences, theory of planned behavior and willingness to pay. *J. Environ. Psychol* 45, 165–175. doi: 10.1016/j.jenvp.2016.01.006

Marat, E. (2019). Mimicking ? Broken windows? Policing in post-soviet cities: expanding social control in uncertain times. *Policy Soc.* 29, 1005–1021. doi: 10.1080/10439463.2018.1448396

Martin-Ortega, J., Brouwer, R., Ojea, E., and Berbel, J. (2012). Benefit transfer and spatial heterogeneity of preferences for water quality improvements. *J. Environ. Manage.* 106, 22–29. doi: 10.1016/j.jenvman.2012.03.031

Mastrangelo, M. E., Sun, Z., Seghezzo, L., and Müller, D. (2019). Survey-based modeling of land-use intensity in agricultural frontiers of the argentine dry Chaco. *Land Use Policy* 88:104183. doi: 10.1016/j.landusepol.2019.104183

Matthews, Y., Scarpa, R., and Marsh, D. (2017). Using virtual environments to improve the realism of choice experiments: a case study about coastal erosion management. *J. Environ. Econ. Manage.* 81, 193–208. doi: 10.1016/j.jeem.2016.08.001

Mazzotta, M. J., and Source, J. J. O. (1995). Decision making when choices are complex: a test of Heiner's hypothesis. *Land Econ.* 71, 500–515. doi: 10.2307/3146714

McFadden, D. (1974). "Conditional logit analysis of qualitative choice behavior,"in *Frontiers in Econometrics*, ed. P. Zarembka (New York, NY: Academic Press) 105-142.

MEA (2005). *Ecosystems and Human Well–Being: Biodiversity Synthesis*. Washington, DC: World Resources Institute.

Moon, H., Yoo, S. H., and Huh, S. Y. (2021). Monetary valuation of air quality improvement with the stated preference technique: a multi-pollutant perspective. *Sci. Total Environ.* 793:148604. doi: 10.1016/j.scitotenv.2021.148604

Moreno-Sanchez, R., Maldonado, J. H., Wunder, S., and Borda-Almanza, C. (2012). Heterogeneous users and willingness to pay in an ongoing payment for watershed protection initiative in the Colombian andes. *Ecol. Econ.* 75, 126–134. doi: 10.1016/j.ecolecon.2012.01.009

Nie, X., Chen, Q., Xiao, T., and Wang, H. (2019). Willingness to pay for ecological function regions protection based on a choice experiment method: a case study of the shiwandashan nature reserve. *Qual. Quant*. 53, 813–829.

Odonkor, S. T., and Adom, P. K. (2020). Environment and health nexus in ghana: a study on perceived relationship and willingness-to-participate (WTP) in environmental policy design. *Urban Clim*. 34:100689. doi: 10.1016/j.uclim.2020.100689

Owuor, M. A., Mulwa, R., Otieno, P., Icely, J., and Newton, A. (2019). Valuing mangrove biodiversity and ecosystem services: a deliberative choice experiment in mida creek, Kenya. *Ecosyst. Serv*. 40:101040. doi: 10.1016/j.ecoser.2019.101040

Randall, A. (1981). *Resource Economics: An Economic Approach to Natural-Resource and Environmental Policy*, 2nd Edn. New York, NY: John Wiley.

Ren, Y., Lu, L., Zhang, H., Chen, H., and Zhu, D. (2020). Residents' willingness to pay for ecosystem services and its influencing factors: a study of the Xin'an River basin. *J. Clean. Prod*. 268:22301. doi: 10.1016/j.jclepro.2020.122301

Revelt, D., and Train, K. (1998). Mixed logit with repeated choices: Households' choices of appliance efficiency level. *Rev. Econ. Stat*. 80, 647–657. doi: 10.1162/003465398557735

Sampson, R. J., and Raudenbush, S. W. (2004). Seeing disorder: neighborhood stigma and the social construction of "broken windows". *Soc. Psychol. Quart*. 67, 319–342. doi: 10.1177/019027250406700401

Scarpa, R., and Rose, J. M. (2008). Design efficiency for non-market valuation with choice modelling: how to measure it, what to report and why. *Aust. J. Agr. Resour. Econ.* 52, 253–282. doi: 10.1111/j.1467-8489.2007.00436.x

Shan, J., Li, J., and Xu, Z. (2019). Estimating ecological damage caused by green tides in the yellow sea: a choice experiment approach incorporating extended theory of planned behavior. *Ocean Coast. Manage* 181:104901. doi: 10.1016/j.ocecoaman.2019.104901

Tam, K. P., and Chan, H. W. (2018). Generalized trust narrows the gap between environmental concern and pro-environmental behavior: multilevel evidence. *Global Environ. Chang*. 48, 182–194. doi: 10.1016/j.gloenvcha.2017.12.001

Uzun, F. V., and Keles, O. (2012). The effects of nature education project on the environmental awareness and behavior. *Proc. Soc. Behav. Sci.* 46, 2912–2916. doi: 10.1016/j.sbspro.2012.05.588

Valck, J. D., and Rolfe, J. (2018). Spatial heterogeneity in stated preference valuation: status, challenges and road ahead. *Int. Rev. Environ. Resour. Econ.* 11, 355–422. doi: 10.1561/101.00000097

van der Weele, J., Flynn, M. P., and van der Wolk, R. J. (2017). "Broken window effect," in *Encyclopedia of Law and Economics*, eds A. Marciano, and G. B. Ramello (New York, NY: Springer), 1–4. doi: 10.1007/978-1-4614-7883-6_624-1

Vásquez, W. F., and de Rezende, C. E. (2019). Willingness to pay for the restoration of the paraíba do sul river: a contingent valuation study from Brazil. *Ecohydrol. Hydrobiol*. 19, 610–619. doi: 10.1016/j.ecohyd.2018.01.001

Wang, C., Zhang, J., Cao, J., Hu, H., and Yu, P. (2019). The influence of environmental background on tourists' environmentally responsible behaviour. *J. Environ. Manage*. 231, 804–810. doi: 10.1016/j.jenvman.2018.10.089

Wang, Y., Jin, C., Lu, M., and Lu, Y. (2017). Assessing the suitability of regional human settlements environment from a different preferences perspective: a case study of Zhejiang province, China. *Habitat Int*. 70, 1–12. doi: 10.1016/j.habitatint.2017.09.010

Wei, X., Khachatryan, H., and Zhu, H. (2020). Poyang lake wetlands restoration in china: an analysis of farmers' perceptions and willingness to participate. *J. Clean. Prod*. 284:125001. doi: 10.1016/j.jclepro.2020.125001

Wilson, J. Q., and Kelling, G. L. (1982). Broken windows. *Atl. Mon.* 249, 29–38.

Wu, J., Wu, G., Kong, X., Luo, Y., and Zhang, X. (2020). Why should landowners in protected areas be compensated? A theoretical framework based on value capture. *Land Use Policy* 95:104640. doi: 10.1016/j.landusepol.2020.104640

Xu, D. W., Chang, L., Hou, T. S., and Zhao, Y. F. (2012). Calculation of river basin ecological compensation standards based on wtp and wta: a case study of Liaohe River. *Res. Sci* 34, 1354–1361.

Yee, S. H., Paulukonis, E., and Buck, K. D. (2020). Downscaling a human well-being index for environmental management and environmental justice applications in Puerto Rico. *Appl. Geogr.* 123:102231. doi: 10.1016/j.apgeog.2020.102231

You, H. Y. (2016). Characterizing the inequalities in urban public green space provision in Shenzhen, China. *Habitat Int*. 56, 176–180. doi: 10.1016/j.habitatint.2016.05.006

Zen, I. S., and Siwar, C. (2015). An analysis of household acceptance of curbside recycling scheme in Kuala Lumpur, Malaysia. *Habitat Int*. 47, 248–255. doi: 10.1016/j.habitatint.2015.01.014

Zhang, W., Yu, Y., Wu, X., Pereira, P., and Borja, M. E. L. (2020). Integrating preferences and social values for ecosystem services in local ecological management: a framework applied in Xiaojiang basin Yunnan province, China. *Land Use Policy* 91:104339. doi: 10.1016/j.landusepol.2019.104339

Zhang, X., Geng, G., and Sun, P. (2017). Determinants and implications of citizens' environmental complaint in China: integrating theory of planned behavior and norm activation model. *J. Clean. Prod*. 166, 148–156. doi: 10.1016/j.jclepro.2017.08.020

Zhao, X. H. (2016). A review of researches on the influencing factors of citizens' environmental awareness in China. *Ecol. Econ*. 32, 189–192.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.