


Article

Sustainable Watershed Protection from the Public Perspective, China

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Abstract: The conservation and sustainability of the Yongding River Watershed attracted great attention as Beijing and Zhangjiakou jointly hosted the Winter Olympics in 2022. The government has implemented many management measures and restoration programs in the past decade. However, information and opinions from the public perspective were rarely considered. This paper investigates 626 residents neighboring the Yongding River Watershed through a face-to-face questionnaire survey to reveal public perceptions, attitudes, concerns, and behaviors toward sustainable watershed protection and proposes multiple regression models to explore factors affecting their concerns and behaviors. The results show that the majority of respondents (52–58%) have limited knowledge about the watershed environment, and their views are influenced by living places. More than half of the respondents (52%) believe that upstream should take responsibility for watershed protection, but 72% are not aware that upstream suffers economic restrictions. Public behaviors toward watershed protection are diverse depending on knowledge, attitudes, and concerns about the watershed environment as well as on sociodemographic background. Our results highlight that a better understanding of watershed protection can be used to foster public participation and increase support for watershed management initiatives.

Keywords: public perceptions; pro-environmental behaviors; public attitudes; sustainable watershed protection



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1. Introduction

Watershed protection and sustainable management are vital for water resources and watershed sustainability, facing many challenges such as water overuse, habitat loss, and environmental pollution [1]. China implemented the Water Pollution Prevention and Control Action Plan (WPPCAP) in 2015, which included controlling the discharges of pollutants, ensuring the safety of water ecology and environment, and improving watershed management. The Yongding River Watershed is of great concern to the government and public because it is the green link and ecological corridor to the Beijing–Tianjin–Hebei region and an important water source for economic development in China. Moreover, the 2022 Olympic and Paralympic Winter Games were held in Beijing and Zhangjiakou, including three competition zones of Beijing, Yanqing, and Chongli. The watershed environment would influence host cities and competition zones, and the watershed was likely to see increasing pollution, especially from winter sporting goods [2]. Therefore, higher demands are placed on watershed protection, not only to provide a beautiful environment for the Olympic Games but also to achieve Sustainable Development Goals (SDGs) such as SDG 6 (clean water and sanitation), SDG 11 (sustainable cities and communities), and SDG 15 (life on land). The Chinese government listed sustainability as one of its governance concepts and is actively implementing the UN 2030 Agenda for Sustainable Development. In the lead-up to Beijing’s 2022 Olympic and Paralympic Winter Games, China has been eager to

highlight its push to make the event as environmentally sustainable as possible in Beijing and Zhangjiakou, in line with the UN 2030 Agenda for Sustainable Development. Positive environmental impact, including water source conservation and watershed protection, is one of three key themes of a sustainability plan published by the Games organizers in 2020.

The central and local governments have implemented many initiatives to restore the function of the river ecosystem and improve water quality in the Yongding River Watershed [3]. Efforts typically rely on government officials or experts to provide information about impacts and to propose policy options, but they rarely obtain information from the public. To improve the watershed environment, changes in the way the public interacts with the environment are required, which can be addressed by individual actions and government policies [4]. These efforts require public perceptions of underlying issues and their support for mitigation measures [5]. Public support is a key factor for the successful implementation of environmental policies, and it is unwise to ignore public perceptions and attitudes [6,7]. Further, perceptions are the most dominant form of cognitive engagement with the environment and are important for understanding environmental behaviors [8]. Many cases of successful watershed management incorporate public perceptions, such as Murray Watershed in Australia and the Rhine Watershed in Europe [9,10]. Therefore, detailed knowledge of how people perceive and behave becomes necessary for policymakers and researchers seeking solutions to manage natural resources and environmental protection. Researchers have invented a series of methods to measure public knowledge and responses to environmental issues, including surveys (e.g., interviews, questionnaires, etc.), focus group interviews, participant observation, document analysis, and case studies. Surveys can provide first-hand and additional information that is especially useful for policymakers by showing public perceptions toward sustainable watershed protection.

As an important water source and ecological barrier, the Yongding River Watershed has been the subject of many studies. Some studies focused on the impact of climate change and anthropogenic activities on stream flows [5,11]. Some other studies analyzed the changes in water quality, especially the ecological risk assessment of pollutants such as heavy metals, nutrients, and persistent organic pollutants [3,12]. Watershed management strategies have been emphasized, particularly in the payment for watershed ecosystem services and wetland protection [13,14]. Although sustainable watershed development and government responses to the watershed pollution crisis have received widespread government, media, and researcher attention, few studies focus on sustainable watershed protection from the public perspective, including attitudes, knowledge, concerns, and environmental behaviors, which are crucial factors driving more effective watershed governance. At the individual level, public environmental behavior is associated with the level of perceptions, attitudes, and concerns about environmental issues, and requires both motivation to change and practical know-how. Therefore, it is important to understand the key factors behind pro-environmental behavior and low environmental awareness of the public in Olympic venues. To what extent does the public know about the watershed environment? What are public attitudes toward watershed governance? What are public perceptions toward changes in the watershed environment? What are the factors influencing their concerns about watershed issues and environmental behaviors for watershed protection? What are the information sources they trust to obtain data and information about the watershed environment?

This study aims to answer these questions, drawing upon data collected through qualitative interviews and quantitative survey questionnaires with 626 residents undertaken in the Yongding River Watershed. Specifically, (1) a structured questionnaire survey was used to measure public perceptions and attitudes toward watershed governance and protection. (2) A multivariate regression model was used to analyze the influencing factors that were related to public knowledge, attitudes, concerns, and environmental behaviors toward watershed governance and protection. (3) We interpreted the findings in conjunction with qualitative data and narratives collected from respondents about their daily experiences with watershed protection. The study contributes to social dimensions of watershed protec-

tion because public perceptions and implicit values and governance appear to be highly relevant but insufficient areas of ecology and psychology.

2. Literature Review

To compare studies worldwide, we conducted a literature search using the “Web of Science” core collection system. The following terms and words were selected to reflect the common survey methods and main research topics: public AND (perception* OR awareness OR survey* OR concern* OR opinion) AND (watershed* OR water* OR basin* OR river) AND (1) (protect* OR conservation*) (2) (management* OR restoration*) (3) (knowledge* OR behavior*) (4) (environment*). The asterisk represents wildcards and the capitalized AND and OR are Booleans in WOS searching. Overall, this search found 207 articles, of which 49 were relevant and 15 were useful for our analysis (Table 1). Methods used in these studies included face-to-face interviews, mail questionnaires, semi-open questionnaires, and photo questionnaires. Respondents were mostly adults, as well as younger age groups, and the survey sample size ranges from 100 to 600 on the watershed scale and is more than 1000 on the national scale.

Table 1. Relevant studies of public perceptions toward watersheds.

Reference	Country	Method and Sample Size (n)	Research Topic
[15]	US	Stratified random survey (n = 700)	Public knowledge of watershed and water resources
[16]	US	Mail survey in 2006 (n = 352), 2009 (n = 309), 2014 (n = 278), and 2016 (n = 255)	Public perceptions of water conservation
[17]	EU	Face-to-face survey and open-ended questionnaire (n = 498)	Public perceptions of water shortages and saving
[18]	Australia	Face-to-face survey and open-ended questionnaire (n = 112)	Public perceptions of watershed pollution and fertilizer use
[19]	Italy	Photo-questionnaire (n = 127)	Public perceptions of watershed landscapes
[20]	France	Email survey (n = 1000)	Public perceptions of biodiversity of river ecosystem
[21]	China	Face-to-face, paper-based, mixed methods survey (n = 582)	Public perceptions of watershed ecosystem services
[22]	China	Questionnaire interviews (n = 777)	Public preferences for watershed ecosystem services
[23]	Netherland	Quantitative questionnaires (n = 562), open interviews (n = 29)	Public awareness of river restoration projects
[24]	China	Face-to-face survey (n = 395)	Public perceptions of ecosystem restoration
[25]	China	Face-to-face survey (n = 1012)	Public preference for ecological restoration
[26]	US	Mail questionnaire (n = 508)	Stakeholder opinions on watershed management
[27]	Australia	Mail-out survey (n = 291)	Public perceptions of policy and management priorities
[28]	India	Face-to-face survey (n = 2706)	Public perceptions, knowledge, and behavior for watershed management
[29]	US	National public survey (n = 1313)	Public concerns about the environment

Previous studies have explored public perception and values toward water resources, water pollution, ecosystem services, management strategies and projects, and water sustainability under the impact of climate change [15–30]. The main research area is to explore the relationship between public perceptions and public acceptance of watershed restoration plans and factors affecting public pro-environmental behaviors. The public made acceptance decisions depending on how they weighed benefits and risks [30,31]. Public perceived risks and benefits are usually related to their direct dependence on the watershed for daily needs. Some studies indicate that the public usually has positive attitudes toward watershed protection plans [23,32]. Public attitudes toward watershed restoration and governance are not only influenced by perceived risks and benefits but also affected by public knowledge and awareness about the watershed [33]. Knowledge is an important

psychological factor that has a significant impact on public attitudes and pro-environmental behavior [34]. Some studies indicate that insufficient knowledge impedes the implementation of restoration schemes [28]. In the meantime, knowledge affects their perceived risks and benefits [25,35]. In addition, some studies note that public concerns should be considered when discussing watershed protection priorities (e.g., water quality improvement) [27]. Public perceptions and values on human–nature relationships and sociodemographic factors influence their concerns about environmental issues [29]. Understanding public concerns about watershed problems is helpful to make more socially acceptable decisions to meet public common or different goals and to increase public support and satisfaction [22,26]. Public perceptions toward sustainable watershed protection are still not well explored, especially in Winter Olympic sites, but human welfare increasingly requires sustainable watershed protection. Studying public perceptions toward watershed protection and governance has important implications for developing new policies and technologies to improve the watershed environment.

Researchers from the fields of psychology, sociology, ecology, environmental management, and political science have contributed scientific results to the study of environmental behavior [36,37]. Many theories are proposed to explain public positive or negative environmental behavior: (1) the theory of planned behavior (TPB) suggests that public attitudes, subjective norms, and perceived behavioral control influence their behavioral intentions and in turn, affect their behaviors; (2) the theory of value–belief–norm (VBN) emphasizes the impact of public values, concerns, and responsibility attribution on environmental behavior; (3) the theory of norm activation (NA) consists of awareness of consequence, the ascription of responsibility, and personal norm; and (4) knowledge deficit model (KDM) suggests that public skepticism or acceptance toward environmental issues or science and technology is attributed to their limited knowledge compared to experts [38]. Theoretical models and empirical analyses show that public perceived behavioral control, subjective norms, and attitudes influence environmental intentions and indirectly influence public behaviors [39]. In addition, demographic factors, economic factors, and social and cultural factors also affect public environmental intentions and behaviors. Overall, we believe it is meaningful to consider public perceptions, attitudes, concerns, and protection-oriented behaviors in this study. It is not feasible to combine all of these factors in the analysis because they are based on different assumptions. In view of this, this study conducted an analysis of environmental behavior based on TPB and KDM, combined with demographic factors.

3. Materials and Methods

3.1. Study Area

The Yongding River flows through Hebei, Beijing, and Tianjin and has two major tributaries, the Sanggan River and the Yanghe River that meet in Zhuguantun village in Zhangjiakou, Hebei Province. The following river section is called Yongding River and flows into Guanting Reservoir, and then it enters the territory of Beijing. The study area is Beijing and Zhangjiakou, two host cities for the Beijing 2022 Olympic and Paralympic Winter Games. A total of 42 venues were used across three competition zone in Beijing, Yanqing, and Zhangjiakou (Figure 1). To integrate the Games with the economy, environment, and society, the organizers of the Games promoted establishing a sustainability management mechanism [40]. Positive environmental impact (e.g., watershed protection) is one of three key themes of a sustainability plan. Given the importance of Yongding River and Guanting Reservoir to the water supply of the three competition zones, Beijing and Hebei have jointly undertaken watershed management upstream to prevent pollution and control floods. The priority of watershed management is to provide a beautiful environment for the Games and restore the drinking water function of the reservoir. The watershed protection and restoration schemes relied heavily on the opinions of government officials and experts and did not consider obtaining information from the public perspective. Moreover, the contradiction between water supply and demand is increasingly prominent due to economic expansion and population growth. To ensure water quality, the Guanting Reservoir and its upstream

have severely restricted economic development, resulting in conflicts between economic development and environmental protection. These problems have attracted a wide range of public attention. Therefore, we selected the Yongding River Watershed to analyze public perceptions, attitudes, concerns, and behaviors for sustainable watershed protection.

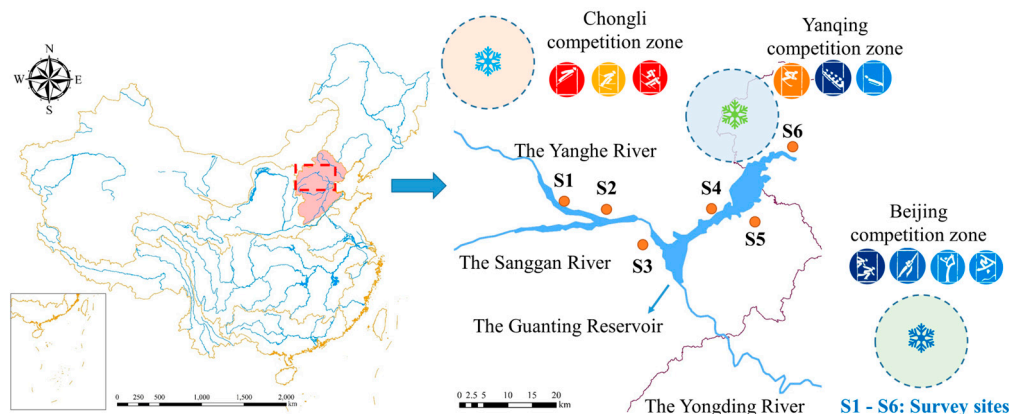


Figure 1. Survey places in the Yongding River Watershed, Guanting Reservoir, and Beijing 2022 Olympic Winter Games competition zones (S1 to S6 represent survey sites including Chaigoubu Town, Xiahuayuan District, Sangyuan Town, Beixinpu Town, the wild duck lake resort, and the Yanqing downtown area).

3.2. Research Design and Data Analysis

3.2.1. Selection of Survey Sites

The important criteria for survey places were the location and distance to the Yongding River. We selected six survey sites along the river and reservoir based on field observations, personal experiences, and expert judgments (Figure 1). The sociodemographic conditions (population, gender, education, etc.) were similar across these areas. The interviewees were residents living close to the Yanghe River, Yongding River, and the Guanting Reservoir. Therefore, dozens of villages dispersed in Beijing and Hebei were investigated as survey sites (Figure 1), of which S1 is Chaigoubu Town, S2 is Xiahuayuan District, S3 is Sangyuan Town, S4 is Beixinpu Town, S5 is near the wild duck lake resort, and S6 is Yanqing downtown area. The sample sizes of the surveys in S1–S6 were 155, 104, 87, 71, 104, and 105, respectively. To analyze the perceptions of respondents in different areas, we divided the survey sites into two parts, where S1, S2, and S3 were the upstream, and S4, S5, and S6 were water source zones.

3.2.2. Questionnaire Design and Survey Implementation

To assess respondents' perceptions toward watershed protection and suitable approaches for watershed management, we used a questionnaire-based preference method. This method supports analyzing public perceptions of sustainable watershed protection in a consultative way and understands respondents' prioritization of watershed management. The preparation work for the questionnaire design and survey included an extensive review of the relevant literature concerning watershed protection and three rounds of pre-tested questionnaire surveys with experts and residents in February and March of 2017. The final version consisted of three sections: (1) sociodemographic information of interviewees, such as gender, age, income, education, and living places; (2) public knowledge about the watershed environment, such as water resource status; (3) public attitudes toward watershed protection and water source conservation (Supplementary Materials). For some questions, a 5-point Likert scale was used to allow the respondents to rate their knowledge, awareness, values, etc. Reliability and validity analysis for the questionnaire yields an average Cronbach's α value and KMO and Bartlett test, and the overall reliability and validity coefficients are 0.70 and 0.76. This suggests that the questionnaire has good internal consistency and likely provides reliable and valid information [17].

The researchers randomly selected samples among residents from survey sites, and each respondent represented a family. The survey was conducted in March 2017 via face-to-face interviews conducted by the researchers and investigators. Investigators' employment and training were conducted by our research team. The sample size was determined based on the overall proportion of sample random sampling at a 95% confidence level, with a margin error of no more than 4% at the watershed scale. The required sample size was 601 based on the calculation, and a total of 626 valid samples were obtained. Samples of previous surveys at the watershed scale were typically in the hundreds. Mcduff et al. [15] used a stratified random survey method to survey 700 respondents about their knowledge of watersheds and water resources. Seelen et al. [17] surveyed 498 respondents on their knowledge of water scarcity and conservation through face-to-face surveys and open-ended questionnaires. Zhang et al. [21] investigated 582 respondents' knowledge of watershed ecosystem services using face-to-face and paper-based methods. Therefore, the sample size in our study is large enough for this kind of public perception survey.

Each interview was conducted as a face-to-face survey. We hypothesize that, given consistent socioeconomic factors (income, education, etc.), interviewees who are willing to contribute more have stronger behavior trends to protect. The social and demographic information of the interviewees in our survey is shown in Table 2. Considering the high degree of social and demographic heterogeneity of this population, the sample is representative.

Table 2. Sociodemographic information of the respondents.

Item	Status	Percent	Item	Status	Percent
Gender	Female	53.2	Education	Primary school	17.6
	Male	46.8		Middle school	40.7
Age	18–60	85.1		High school	26.5
	>60	14.9		University	15.2
Household annual income (thousand yuan)	≤10	23.8	Profession	Farmer	48.4
	10.1–20	20.6		Self-employed	12.9
	20.1–50	38.0		Enterprise employee	12.5
	50.1–100	13.7		Student	6.7
	>100	3.9		Retired	6.7
				Others	12.8

3.2.3. Data Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 24. The mean values of public knowledge, attitudes, perceived risks of environmental changes, public concerns about watershed environmental problems, and public behaviors for watershed protection were calculated. We assessed differences in the perceptions of upstream and downstream respondents using chi-square tests. The regression model was used to investigate the relationship between respondents' attitudes, knowledge, perceived risk, concerns, and behaviors toward watershed protection.

3.3. Research Assumptions and Model

The theory of planned behavior (TPB) suggests that public attitudes and perceived behavioral control influence behavioral intentions and in turn affect behavior. According to the knowledge deficit model (KDM), public knowledge also affects their pro-environmental behaviors. Therefore, we propose two hypotheses for the factors influencing public concerns and their behavioral intentions under controlling socioeconomic variables (Figure 2).

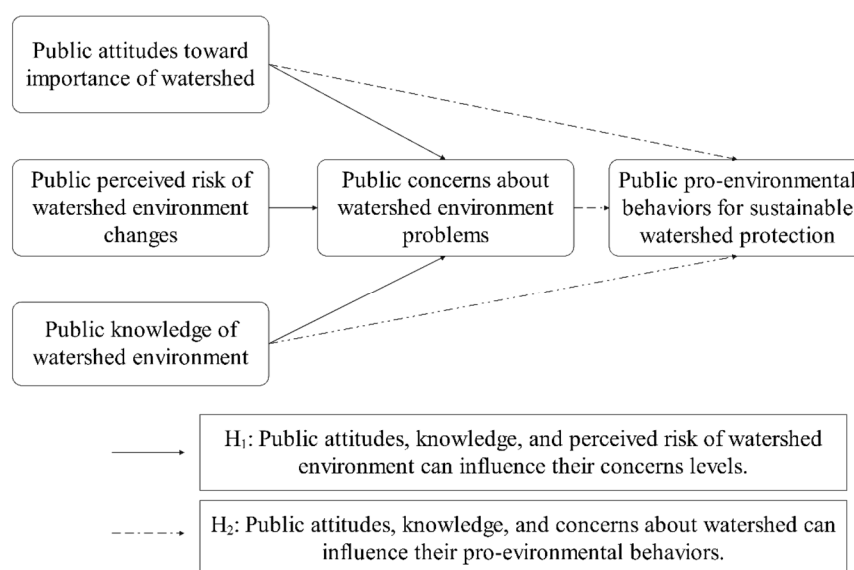


Figure 2. Proposed research assumptions for analyzing public perspectives toward watershed protection.

H1. Public attitudes toward watershed governance, public knowledge about the watershed environment, and perceived risk of environmental changes affect their concerns about the watershed.

H2. Public attitudes, knowledge, and concerns affect their pro-environmental behaviors.

Specifically, (1) public attitudes toward watershed governance and protection would affect their concerns and behaviors. (2) Public perceived risk of environmental changes refers to public perceptions toward the impact of environmental change in the watershed on their lives. If the public does not care about environmental changes, then “free-rider” behavior is likely to occur. (3) Public knowledge refers to their knowledge of the watershed environment and water resources. (4) Public concerns about watershed issues would lead them to take action to protect the environment. (5) Public behaviors toward watershed protection represent the fact that the more respondents were willing to contribute, the more they would like to protect and improve the environment under the same social context. In addition, demographic factors, economic factors, and social and cultural factors also affect public environmental intentions and behaviors. Overall, we believe that it is valuable to consider public knowledge, attitudes, and concerns about watershed protection and governance at the site of the Winter Olympic Games. It is not feasible to combine all of these factors in the analysis because they are based on different assumptions. In view of this, this study conducted the analysis of environmental behavior based on TPB and KDM, combined with demographic factors.

4. Results and Discussion

4.1. Public Fundamental Knowledge about the Watershed

4.1.1. Public Knowledge about the Watershed Environment

To assess how much knowledge the local people have gained on the watershed environment, we asked them five questions about the local water stress, water resource status of the reservoir, water quality status, water flow status, and water quality change in the past five years (Table 3). Five-point scales were used to allow the respondents to rate their knowledge levels about the first two questions, with 5 representing much knowledge and 1 being little knowledge. The average scores were 2.71 and 2.63. The results showed that 52.2–57.5% of the respondents were not aware of the water deficit and water resource status within the watershed, and only 22.0–23.8% were more aware of that. In general, the respondents had limited knowledge about water resources. The higher the income and education of respondents, the more knowledge they gained about water resources

($p < 0.01$). The respondents living upstream were more aware of water shortages than those near the water source zones of the reservoir ($\chi^2 = 50.558, p < 0.001$; $\chi^2 = 99.577, p < 0.001$).

Table 3. Public knowledge and perceptions toward the watershed environment.

Question	Dominant Option	Percent
Public knowledge of local water deficit	Do not know much	52%
Public knowledge of water resource status of reservoir	Do not know much	57%
Public perceptions toward water flow	A normal amount of water	50%
Public views on water quality	A bit turbid and odorless	43%
Public views on water quality changes in the past 5 years	Improved	35%

Nearly 25% of respondents believed that the watershed had a lot of water, 50% thought that water flow was normal, and another 25% indicated that water flow was insufficient in the past years. Public view toward water quality was mostly influenced by organoleptic properties; we used turbidity and odor to describe water quality. Forty percent of the respondents perceived water quality to be good (clean and odorless), 43% perceived it to be not good or bad (a bit turbid and odorless), and 17% considered it poor (turbid and odorous). Public perceptions of water quantity and quality varied widely, indicating that the watershed environments were different across geographic locations. Nearly 35% of respondents believed that water quality had improved in the last five years, while 34% considered it had deteriorated, and another 28% thought it had remained unchanged. The analysis showed that respondents in the water source zone tended to perceive larger water flows ($\chi^2 = 167.596, p < 0.001$), better water quality ($\chi^2 = 46.298, p < 0.001$), and obvious water quality improvement ($\chi^2 = 65.042, p < 0.001$). The water supplement plan for downstream and reservoir improved the environment, which could explain why respondents' perceptions of the watershed environment differed.

4.1.2. Public Perceptions toward Watershed Protection

The transboundary nature of the Yongding River makes it more complex to manage than other watersheds, as it is difficult to achieve effective co-management between upstream and downstream. There is a long-term conflict between economic development and watershed protection. As a result, the watershed faces two major ecological problems in its governance, namely the drying up of the river and pollution. The causes of these problems not only originate from industrial development but also include non-point pollution from agricultural and livestock development and soil erosion along the river. This is consistent with public perceptions toward major ecological problems in the Yongding River Watershed. When respondents were asked about ecological problems that currently need to be addressed to meet the requirements of the Games site, most responses focused on domestic waste pollution (29%), poor water quality (16%), insufficient water supply for drinking and irrigation (14%), and severe soil erosion (12%) (Table 4).

Table 4. Public perceptions and views on watershed protection.

Question	Dominant Option	Percent
Public perceptions of environmental problems need to be addressed at the Olympic Games site	Domestic waste pollution	29%
Public views on the importance of investing in the reservoir to improve the environment	Very important	46%
Public views on the importance of protecting the reservoir to supply water downstream	Relatively important	40%
Public perceptions toward watershed protection measures	Returning farmland to forests	51%
Public views on environmental changes due to watershed protection measures	The environment has improved	61%

The majority of respondents (78%) indicated that it was critical to protect upstream to ensure water supply for downstream (Beijing), and nearly 90% believed that construction (watershed conservancy facilities, wastewater treatment plants, etc.) was also important. When respondents were asked to list watershed protection measures, the main responses identified returning farmland to forests (51%) and new rural construction (42%) as the measures they knew the most. Respondents knew less about specific measures such as ecological restoration and management (8%), surface water protection zones (10%), and pollutant enterprise regulation (19%). However, most of the respondents (61%) were unaware of the watershed conservation policy except for the “returning farmland to forests policy” (Table 4). More than 60% of respondents believed that these measures improved the watershed environment, while 34% indicated that the watershed environment had not changed. Respondents in the water source zones were more likely to perceive that these measures had improved the watershed environment ($\chi^2 = 21.003$, $p < 0.001$), which suggests that watershed protection in water source zones is more effective than that in the upstream.

4.1.3. Public Knowledge about the Water Source Zones of the Reservoir

In order to know how the respondents view the water source zone, we asked them questions about their perceptions toward the water source zone, environmental problems, and the benefits of the watershed and reservoir. Nearly 65% of respondents were aware of the Guanting Reservoir Water Source Zone located at the border of Huailai County (Zhangjiakou City, Hebei Province) and Yanqing District (Beijing City), and the upstream respondents were significantly less aware of the water source zone ($\chi^2 = 46.715$, $p < 0.001$). When the respondents were asked to list the most serious environmental problem that spontaneously comes to mind, the main responses identified poor water quality and serious pollution (41%), reduced water quantity and drying up (27%), damages to aquatic ecosystems (15%), and damages to riverbanks and water and soil loss (12%) as the most important problems. In response to the benefits brought by the Yongding River–Guanting Reservoir, the main response identified water supply for industrial and domestic use (26%) and agricultural irrigation (22%), flood control (15%), and economic benefits (13%) as the most important benefits (Figure 3).

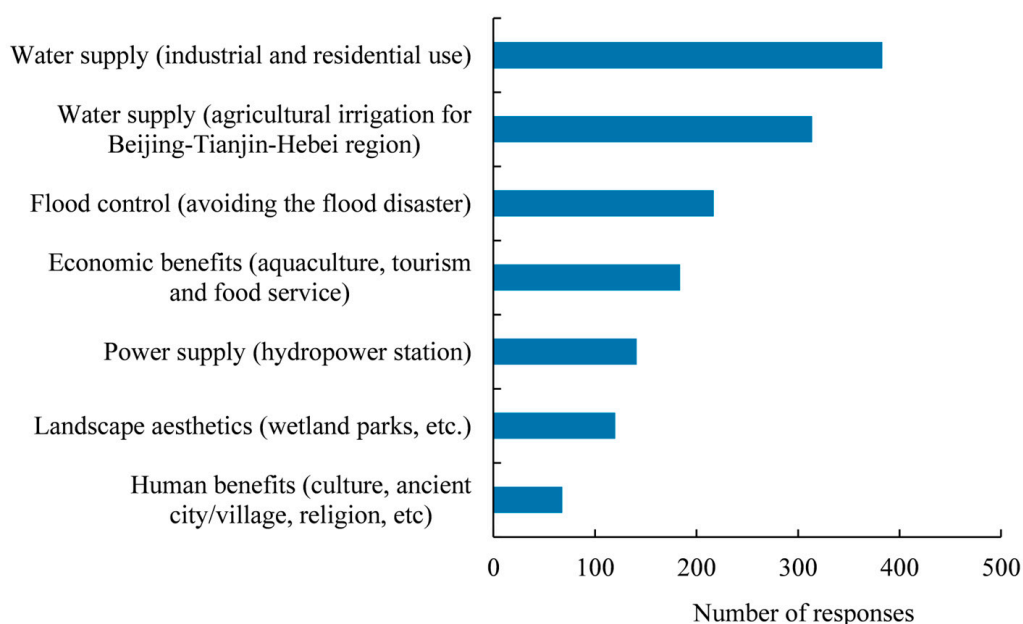


Figure 3. Public perceived benefits of Yongding River and Guanting Reservoir ($n = 626$).

The results indicate that the public has limited knowledge about the watershed, reflecting the level of public perception of the characteristics of the watershed. Concerns about the sustainability of the watershed, reduced water flows, and deteriorating water quality were identified by the public as the most important issues, which may lead to more stringent government measures and policies, as well as public participation and social supervision for sustainable watershed protection [41]. Enlightening studies have been conducted focusing on public knowledge about specific issues such as watershed restoration, landscape aesthetics, and ecosystem services (e.g., recreation), all of which illustrate the strong connection between individuals and watershed environments [23,42]. Promoting public knowledge of the environment could help managers maximize the social acceptability of their actions and minimize potential conflicts [43].

4.2. Public Attitudes toward Watershed Governance and Protection

4.2.1. Public Attitudes toward Watershed Governance

To understand how the public views watershed governance, we asked the respondents about the need to govern the environment, the level of their concerns about environmental issues, and the impact of environmental changes on their lives. More than 80% of the respondents thought that it was necessary to treat the watershed environment (control pollution, ecological restoration, etc.), even though most of them (73%) did not pay much attention to environmental issues. Only 27% of the respondents were concerned about ecological issues (water resources, ecological damage). However, the respondents in the water source zones were more concerned about ecological issues than those upstream ($\chi^2 = 47.481, p < 0.001$). When the respondents were asked to give their opinions on how environmental changes (whether for the better or the worse) relate to them, the majority of respondents (91%) believed environmental changes would affect their lives, of which 13% of respondents indicated that environmental improvement did not benefit them, and only 9% of respondents thought that these changes were not relevant to their lives. The analysis showed that the higher their education level, the more they perceived to be affected by watershed environmental changes ($p < 0.001$), and the more they believed the watershed needed to be treated ($p < 0.001$).

4.2.2. Public Attitude toward Watershed and Water Conservation

We also asked respondents questions about the priority of watersheds and water conservation versus economic development. Nearly 42% of the respondents considered watershed protection to be more important than economic development; 15% of them believed that economic development should be given priority, while about 42% of them thought that they were equally important, and upstream respondents preferred this choice ($\chi^2 = 41.835, p < 0.001$) (Figure 4). These results indicated the public intention to protect the watershed environment. Therefore, the vast of respondents pointed out that economic development should not damage the watershed environment (e.g., the use of water resources and discharge of pollutants). The ecological protection of water sources is becoming increasingly important for urban water supply. However, the economic burden is also growing, as authorities have imposed strict regulations and restrictions on industrial development. Therefore, we also explored how respondents viewed this question. More than 70% of respondents were not aware that economic development has been restricted upstream to protect the watershed environment.

4.2.3. Information Sources and Public Values of Responsibility for Watershed Governance

We investigated how the public accessed information. The respondents primarily relied on television (59%) and broadcasting (13%) as sources of information about watershed governance and water conservation. Regarding the influence of media type on public perceptions toward watershed issues, older respondents were more influenced by traditional media such as television ($p < 0.001$), while younger respondents preferred emerging media such as the Internet and WeChat ($p < 0.001$). Regional water information disclosure can

enhance public perceptions toward the environment and thus promote public awareness of water environmental protection [44]. Different channels of access to information should be provided for different age groups to enhance their environmental awareness about watershed protection.

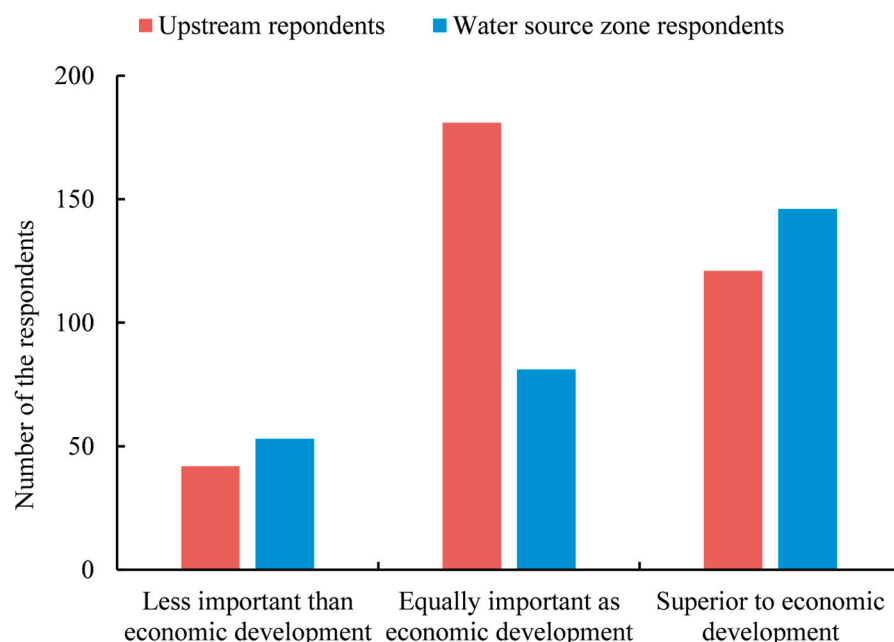


Figure 4. Public values of the importance of watershed protection versus economic development ($n = 626$).

The respondents responded that they trusted the central government officials the most (decision-making officials of the National Development and Reform Commission and the Ministry of Ecology and Environment), followed by local government officials. In general, the public did not have a high level of trust in scientists and experts who participated in policy arguments, journalists covering watershed protection news, and enterprise employees involved in watershed protection projects (not statistically different from one another). NGOs and groups concerned with environmental protection were distrusted the most. Efforts to enhance public trust can help elicit more pro-environmental behavior from those who are already concerned about environmental problems [41]. Therefore, communication between government officials and residents, especially at the Olympic Games sites, should be used to motivate them to protect the watershed and achieve sustainable development.

The question of the division of responsibility for watershed protection reflects the complexity of respondents' gaming psychology. The public believed that upstream (52%) and the whole watershed (41%) should take responsibility for watershed protection, with very few choosing the downstream (7%) (Figure 5). The dominant selection was "all of them" (including enterprises, residents, the local government, and the central government), while the least frequent one was "enterprises". Most respondents believed that upstream should protect the watershed, but they did not have a clear understanding that upstream suffered economic losses because of watershed protection. Therefore, the government, enterprises, and the public should increase interaction and promote public participation to reduce watershed pollution.

4.3. Public Behaviors toward Watershed Protection

This sector analyzed the factors influencing public behavior trends toward watershed protection. Previous studies on environmental behavior covered variables such as attitudes (environmental belief, ethics, awareness), subjective norms (social norms, personal norms), and perceptual behavior control (e.g., knowledge) [45]. Therefore, the selected explanatory

variables were public knowledge, public attitudes, perceived risk, public concerns, and sociodemographic factors in this study. We employed multivariate regression analysis to analyze the relationship among these variables. The results proved hypotheses H1 and H2, and the full forms of the equations are shown below (Figure 6). Public attitudes toward watershed governance and management, public knowledge about the watershed environment, and public concerns about watershed issues positively influence public pro-environmental behaviors, and their coefficients were 0.175, 0.338, and 0.320, respectively. Meanwhile, public attitudes, knowledge, and public perceived risks of environmental change jointly influenced public concern, and their coefficients were 0.076, 0.384, and 0.189, respectively. The more respondents learned about the watershed environment, the more important they perceived watershed protection to be, the more motivated they were to pay attention to environmental issues, and the more likely they were to develop pro-environmental behaviors. Public concerns about the watershed environment bridge public knowledge, attitudes, and perceived risk with behavior toward watershed protection.

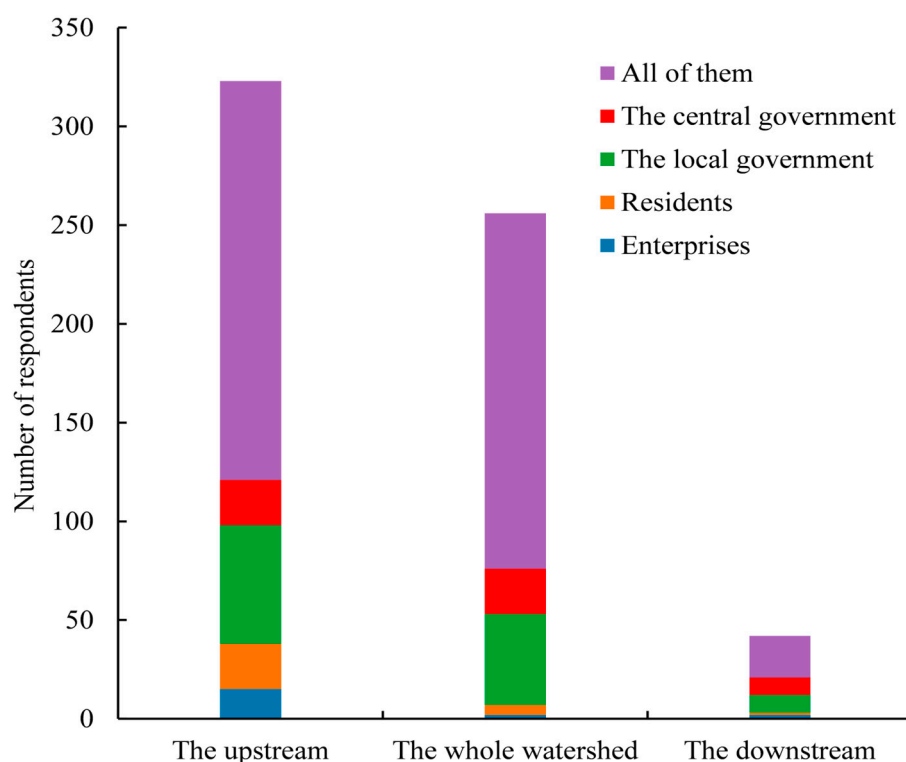


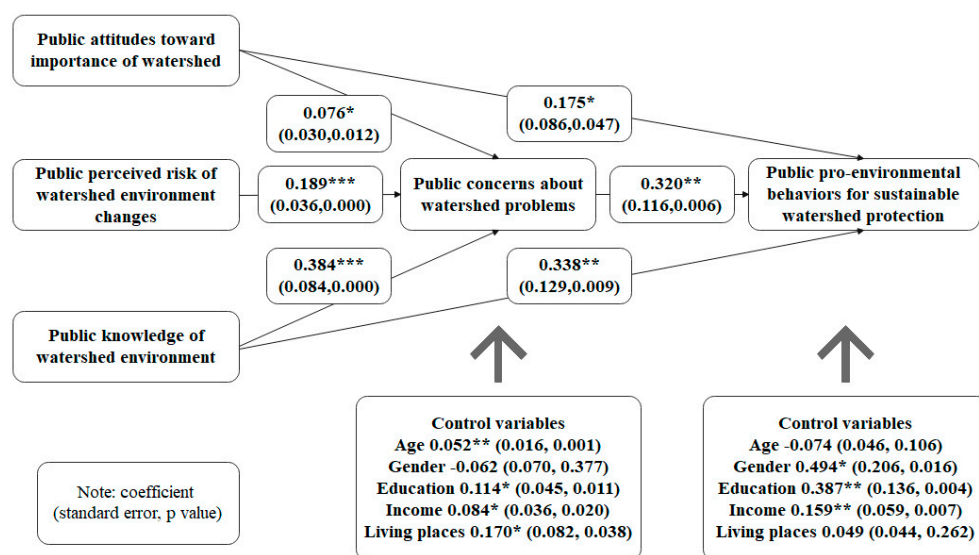
Figure 5. Public values of responsibility for watershed governance ($n = 626$).

$$\begin{aligned} \text{Ln (Public concerns)} = & 0.384 \times \text{Public knowledge} + 0.189 \times \text{Public perceived risk of} \\ & \text{environmental changes} + 0.076 \times \text{Public attitudes} + 0.052 \times \text{Age} + 0.114 \times \text{Education} + \\ & 0.084 \times \text{Income} + 0.170 \times \text{Living places} \end{aligned} \quad (1)$$

$$\begin{aligned} \text{Ln (Public pro-environmental behaviors)} = & 7.451 + 0.338 \times \text{Public knowledge} + 0.320 \\ & \times \text{Public concerns} + 0.175 \times \text{Public attitudes} + 0.494 \times \text{Gender} + 0.387 \times \text{Education} + \\ & 0.159 \times \text{Income} \end{aligned} \quad (2)$$

The most significant factors are knowledge of the watershed environment and knowledge of water resources. Many studies have also proven that public perceptions of things affected their behaviors and concerns [45]. In general, experts know more information than the public, which allows them to identify solutions that are more likely to be successful. This was reflected in the tendency of policymakers to seek out experts in the policy process. Increased public knowledge of watersheds refined public perceptions of watershed issues.

If the knowledge gap between experts and the public is narrowed, then their attitudes are more likely to be aligned and the views of the public will be treated more seriously. Both the theory of policy process and the knowledge deficit model emphasize the importance of public knowledge. Thus, there is a need to expand public access to environmental information and to keep the public well informed about the watershed environment as well as conservation options. Some studies focus on the analysis of the relationship between knowledge, attitude, and behavior [46]. Others divide knowledge into objective and subject knowledge, and empirical analyses have shown that subjective knowledge has a more significant effect on pro-environmental behaviors, meaning that the more public believes they know about the environment, the more likely they are to act [47]. Moreover, increasing the public's understanding of watersheds and refining their views on watershed issues will help to gain their support and active participation in the construction of the environment at the Olympic Games sites. In the past, the public was perceived to lack environmental awareness. Although much progress has been made in recent years, public awareness still needs to be improved [48]. Public knowledge about the watershed environment can directly predict pro-environmental behaviors and should not be underestimated, as it may help to draw public attention and concern, thus creating a starting point for willingness to engage in pro-environmental behaviors.



* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 6. Factors affecting public concerns and their behavior for sustainable watershed protection.

Second, public concern is also an important factor affecting public pro-environmental behavior. Public concern is a psychological variable of subjective emotion, which is different from objective feelings. In this study, public concern is an estimate of potential harm and likelihood of environmental changes within the watershed. The coefficient of concern level regarding environmental change of watershed is 0.320 and statistically significant, indicating that as the level of public concern increases, it promotes public pro-environmental behaviors. Because concern is a subjective judgment, there are individual differences in concern. The relationship between individual social status (usually measured by income and education) and concerns has also been hypothesized and investigated in previous studies [35,46]. The results confirm a significant positive relationship between these two sets of variables. One of the hypotheses, rooted in the hierarchy of human needs theory, explains that because the members of the public with more income and better education have met their basic material needs, they demand better environmental quality [49]. The results suggest that place of residence is another sociodemographic factor that influences public concerns about environmental issues. Some studies point out that the residence

effect exists, especially in urban and rural areas [50]. This is because urban residents live in environments that are more heavily altered by human activities and are more likely to be exposed to environmental degradation such as air, noise, and water pollution. Public demand for more policy attention and responses to environmental aspects of their living conditions is the critical link between economic development and pollution control [50]. The pollution control measures in China are the use of financial fines to punish noncompliance. Public concerns bridged knowledge, attitudes, and perceived risk with behaviors toward watershed protection. Public concerns about watersheds can enhance the enforcement of pollution controls through public protest to make the environmental impacts of pollution known and therefore prompt regulatory authorities to penalize companies for pollution. Thus, public concerns for the environment play an important role in promoting the implementation of environmentally proactive policies and pro-environmental behaviors [29,35]. The concepts of Green Games and sustainable development have been embedded in the preparation and hosting of the Games. This is an opportunity to raise public concerns to promote continuous watershed improvement.

Third, public attitudes toward watershed governance and protection are significant factors influencing public concerns and public pro-environmental behavior. Attitude is a psychological disposition that reflects the degree to which individuals evaluate behavioral performance favorably or unfavorably and is considered to be a key variable in predicting behavior. It is confirmed that attitude is an important factor that positively influences environmental intentions and indirectly affects public pro-environmental behaviors [39]. Some studies have linked knowledge and attitudes, arguing that knowledge could foster attitudes, environmental attitudes could promote pro-environmental behaviors, and attitudes could mediate the causal relationship between knowledge and behavior [51]. Turaga et al. [52] point out that there are many factors affecting behaviors, such as personal motivation and external factors. However, the public need to change their attitudes toward the environment before they can further change their behaviors.

In addition, socioeconomic factors are also important factors influencing their concerns and pro-environmental behaviors, including gender, age, income, education, and living places. As their age, income, and education increase, the motivation to care about and protect the watershed also increases. The reason for this result may be that they have a higher level of awareness and knowledge of environmental protection. The analysis showed that respondents' living places affected their concern levels, and upstream respondents were more concerned about environmental issues in the watershed. In addition, females are more inclined to pro-environmental behaviors than males. This finding is consistent with the gender hypothesis, which indicates that females are more environmentally friendly than males and have a stronger sense of environmental protection.

This study demonstrates the potential influences on public behaviors for sustainable watershed protection in terms of four dimensions, namely knowledge, attitudes, concerns, and social factors. Findings from a survey of public behaviors in Shannxi show that public perceptions toward the importance of environmental protection were the most important factor affecting individual environmental resource protection [8]. Du et al. [53] point out that perceptions, behaviors, and attitudes are the three components of environmental protection awareness; therefore, it is necessary to improve awareness through environmental improvement and publicity to promote the protection of the environment. Recent studies indicated that public pro-environmental behavior is only significantly related to their attitudes, such as that the environment should be protected even if the cost is high [51]. At the same time, studies also suggested that pro-environmental behaviors are divided into curtailment and efficiency behaviors, with curtailment behaviors being related to attitudes and efficiency behaviors being unrelated to attitudes. It is important to note, however, there are many barriers between behavioral intentions and actual behavior. A key obstacle is the widespread public perception that watershed protection is the responsibility of the government. This view is based on China's long tradition of environmental governance, which means that the public is often excluded from environmental management. This

management paradigm has begun to change with the preparation and hosting of the Games. By promoting and popularizing the concept of sustainability and carrying out various educational and promotional activities, the decision-makers have increased public awareness of watershed protection and the sustainability of the Games and the whole society.

Recent advances in environmental behavior theory suggested that there were mediating variables between behavioral preferences and actual behaviors [54]. At the individual level, behavioral intentions can be a good predictor of pro-environmental behavior. The first stage of behavior occurrence is motivation, which forms the behavioral intention and is influenced by perceptions, knowledge, and attitude. The second stage of behavior occurrence is the implementation stage, in which the public performs by developing specific behavior plans. The above analysis validated the first stage, and further research is needed for specific behavior plans.

5. Conclusions

Watershed protection is critical for China to achieve water-related sustainable development goals and entails the participation of different stakeholders such as enterprises, residents, and governments as well as inputs of technology, infrastructure, and resources [55]. The Yongding River Watershed provides a good ecological environment for the Beijing 2022 Olympic and Paralympic Winter Games. The concept of organizing the Beijing 2022 Games is “Green, Sharing, Open, and Clean”, leading Beijing–Tianjin–Hebei within the watershed to cooperate in many fields, such as environmental protection, transportation, and tourism. It is an opportunity for the Zhangjiakou and Yanqing District to develop into a national pilot ecological protection region to improve the environment. Therefore, sustainable watershed protection has received public attention. Using the survey data, we found that the public had limited knowledge about the watershed, but they were very concerned about watershed issues and perceive watershed governance as urgent to address ecological damage and environmental pollution, which are closely related to their daily life experiences. This study highlighted the fact that public knowledge, attitudes, perceived risk, and social factors influence public concerns and behavioral intentions for interacting with the watershed. Moreover, public concern is a mediation variable between public knowledge, attitudes, and behavioral intentions for sustainable watershed protection. Regression analysis shows that these findings support the proposed hypotheses (H1 and H2).

There are some limitations to this study. First, the data were collected from a typical watershed, and more cases and a larger sample size could potentially increase the accuracy of the conclusions. Second, while the results show a link between perceptions, concerns, and behavior intentions, other elements such as procedural justice and risk communication are not included in this research but may have impacts on public perceptions and attitudes. In the next step, we need to consider the above factors in the analysis and conduct a survey of public conservation behavior. Finally, the findings are restricted to local responses at specified periods. We will conduct further studies to examine public perceptions, attitudes, and trends over time.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su15076119/s1>, Questionnaire.

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