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Payments for Watershed Ecosystem Services in the Eyes of the Public, China

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Abstract: Recent decades have witnessed an increased development of schemes for payment for watershed ecosystem services (PWES). However, the public is usually excluded from PWES systems. Reliable and empirical research on PWES from the public perspective is scarce. Aiming to understand public perceptions, attitudes, participation, and responses to PWES, this paper investigated local residents living in the Yongding River watershed area through a face-to-face questionnaire survey. The results showed that the public had limited knowledge of PWES. The public was keen to be involved in PWES decision-making, but the current level of public participation was very low. Regarding willingness to pay (WTP) and willingness to accept (WTA), nearly 55% of the respondents supported paying the upstream residents for protecting the environment if they were beneficiaries in the downstream areas, while 85% of the respondents agreed to accept compensation if they were contributors to environmental improvement in the upstream areas. Although some of the respondents' daily lives were affected by the watershed environment, they were reluctant to pay, reflecting a sign of "free-riding". The regression analysis showed that public concerns, values, knowledge of PWES and the watershed environment, and demographic factors determined the WTP and WTA. The results of the contingent valuation method and opportunity costs method showed that the annual payment for headwater conservation areas (Huailai and Yanqing) ranged from CNY 245 to 718 million (USD 36 to 106 million). This study contributes to our limited knowledge and understanding of public sentiment and makes recommendations for improving public receptivity to PWES.

Keywords: public perceptions; payment for watershed ecosystem services; willingness to pay; willingness to accept; public participation

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1. Introduction

Payment for ecosystem services (PES) can be identified as a voluntary transaction between ecosystem services users and providers that results in a conditional payment based on mutual agreement [1]. The PES seeks to fulfill both environmental and social goals such as environmental improvement and poverty reduction [2,3]. The National Forest Conservation Schemes in Costa Rica and Mexico and the Reducing Emissions from Deforestation and Degradation (REDD+) scheme have been widely reported as important PES practices [4,5]. There are currently more than 550 schemes around the world, with annual payments totaling over USD 36 billion [6]. In economic terms, PES can internalize the environmental externalities and create incentives for the landowner to ensure the provision of ecosystem services [7,8]. Kinzig et al. [9] highlighted that if PES is properly designed, it could eventually achieve win–win goals, creating special attractions in developing countries. Pagiola, Muradian, Wunder, and other prominent scholars have debated

PES efficiency, arguing that too many goals could weaken PES efficiency and lead to trade-offs in ecosystem services [1,10,11]. Wunder et al. [12] indicated that environmental goals and non-environmental goals (welfare, equity, etc.) were both important. PES schemes are usually packaged as a series of social visions [13–15]. PES is considered to be the equivalent concept to ecological compensation in China and has been applied in different types of areas such as watersheds, forests, and wetlands [16–20].

Payment for watershed ecosystem services (PWES) is a voluntary scheme that offers cash payment or other benefits to ecosystem services providers in exchange for providing watershed services that help protect the watershed environment and water quality. PWES is a policy instrument to curb environmental deterioration, ensure water supply, prevent flooding, and maintain habitats for aquatic species and has received attention at both local and global scales over the past two decades [21–23]. There are currently 387 schemes, more than half of which are funded by governments, and nearly CNY 155.7 billion (USD 24.7 billion) was spent in 62 countries in 2015 [6]. PWES mechanisms are of three types. (1) Government-financed PWES refers to public finance rewards for landowners for promoting and protecting ecosystem services. As the government is the purchaser of the ecosystem services, the PWES scheme is implemented in a wide range of areas with uniform payment methods and standards. (2) Government- and user-financed PWES represents an institution that pools resources from multiple water users (private parties, government bodies, etc.) to pay upstream landowners for ensuring ecosystem services provision. (3) compliance PWES refers to quality trading and offsets. Ecosystem services (water) providers comply by paying upstream landowners for improving water quality in exchange for credits. China is the largest country to implement PWES; the total number of PWES schemes reached 69 in 2015, and the investment accounted for about 55% of total global investment. Water funds in South America presented the most rapid growth in the number of PWES schemes. More than 57 water funds were created in the past decade [6,24]. PWES schemes operate in different national contexts, with varying levels of government intervention through legislation and policy (Supplementary Table S1). Laws and supportive policies specific to PWES can establish regulatory oversight and provide funding for PWES schemes. The legal framework can influence the design and implementation of PWES. China's revised Environmental Protection Law (Supplementary Table S2) also emphasized the importance of PWES.

PWES has been high on China's environmental policy agenda since the late 1990s due to a series of floods and droughts. China's unique political and centralized power has allowed it to implement PES schemes at a tremendous scale and speed, improving ecological conditions and reshaping policy and the ecological landscape in a very short time [25]. The Sloping Land Conservation Program (SLCP) and the Natural Forest Conservation Program (NFCP) are the largest schemes in the world and play an important role in improving all ecosystem services (except for biodiversity habitat) and achieving additional purposes for rural development [26]. China dominates government-financed PWES schemes. The central government has issued guidelines for transboundary issues, encouraging provincial governments to agree on PWES schemes. In November 2020, the Regulation on Ecological Protection Compensation (Public Consultation Draft) was released, which is an incentive-based measure that adopts financial transfer payments or market transactions for environmental protection. Many provinces have established PWES schemes to protect watersheds. For example, Hebei Province issued a notice entitled Further Strengthening the Ecological Compensation for Water Quality at the Transboundary Section of Rivers. These practices have led to a series of provincial regulations regarding PWES in Hebei, Jiangxi, Zhejiang, and Jiangsu Provinces. A series of cases have been implemented for Xin'an River in Anhui and Zhejiang Provinces, Dongjiang River in Jiangxi Province, and Chaobai River in Beijing and Hebei Province [27–29]. There are four types of PWES in China. (1) Negotiated transactions among upstream governments and downstream governments. Under the jurisdiction of the higher-level government, upstream governments negotiate for and trade water resources, mostly using water rights trading,

off-site development, and other ways to implement PWES schemes. (2) Jointly financed among governments. The upstream and downstream governments in the watershed co-finance schemes to protect the watershed environment, which has a two-way incentive for upstream and downstream governments. There are significant differences in economic development between upstream and downstream areas, and upstream environmental and economic behaviors affect the downstream demand for water resources. (3) Financial transfer payments among governments, including vertical transfers from the central government to local governments and horizontal transfers among local governments, which can fully mobilize the enthusiasm of local governments to strengthen environmental protection and pollution control. (4) Inter-government compulsory withholding based on water-quality changes, mainly applied in transboundary PWES schemes. The government in the watershed must determine the payment subject and object and the water quality of the monitoring section. When the water quality is lower than the standard, the upstream government's compensation funds are withheld, and when the water quality is higher than the standard, the upstream government is rewarded with funds [30,31]. In 2019, the central financial budget for transfer payments for key ecological function zones was CNY 81.1 billion (USD 11.8 billion). China planned to establish a mechanism and full coverage of key fields and major ecological function zones by 2020. In 2021, China planned to establish PWES in the Yangtze River Economic Belt (YREB) to improve investment and payment mechanisms.

The rapid development of PWES schemes is not matched by sufficient theoretical research. PWES theory focuses on solving environmental externalities, including government regulation (based on a Pigouvian tax) and market incentives (based on the Coase theorem) [32], while the less frequent theoretical studies have addressed the cognitive and psychological dimensions of residents. The development of watershed conservation areas has long lagged behind that of non-conservation areas, and residents must make choices between improving livelihoods and protecting the environment. Determining whether PWES can achieve win–win goals (poverty alleviation and environmental improvement) requires a full study of residents' perceptions, values, participation, and behavior toward PWES [33]. However, residents are excluded from PWES management systems in most cases.

There are two forms of PWES management in China: (1) the vertical control form led by the central government and its functional departments and (2) the horizontal management form led by the local government and its departments (Figure 1). PWES management systems include PES formulation, water resources, environment, fisheries, natural resources, forests, wetlands, and finance. The National Development and Reform Commission (NDRC) is the decision-making authority for developing PWES policies, and other departments play supporting roles, e.g., financial departments manage funds, water resources departments manage water resources, and ecological environmental departments monitor water quality, etc.

PWES management in China is mainly led by government. Public participation in PWES schemes is still at the stage of conceptual advocacy, and no systematic participation mechanism has been formed. Previous studies illustrate strong personal connections to the environment, affected by identity, practical considerations, and livelihoods in the case of watershed protection, water shortages and reuse, risks of chemical parks and industry, the marine environment, climate change, etc. [34–40]. However, little attention has been paid to PWES from the public perspective. The existing studies are instructive but are typically focused on the assessment of PWES schemes, e.g., considering factors affecting public perceptions as part of the valuation of nonmonetary goods and services [41,42]. Regarding the gaps in PWES studies, we wish to examine public perspectives on PWES with a case study in the Yongding River watershed, a typical water-deficient region in northern China.

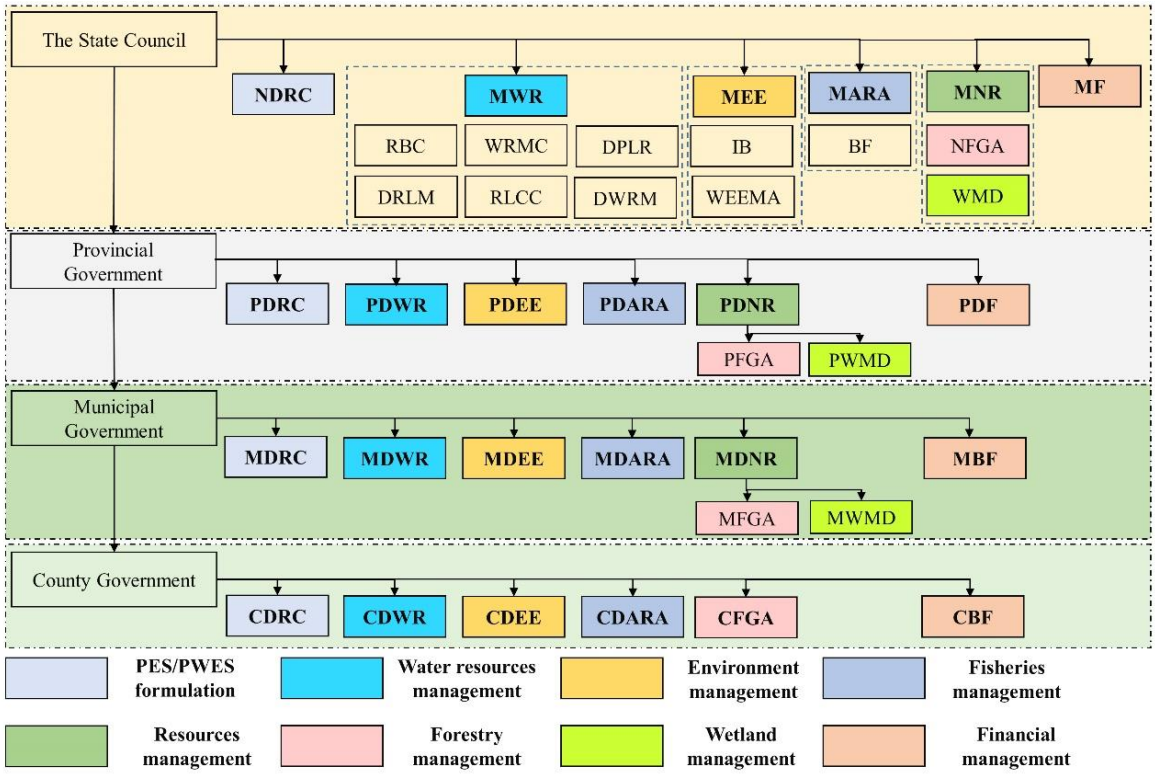


Figure 1. System of PWES-scheme-related departments and watershed management in China.

Note: NDRC, PDRC, MDRC, and CDRC: National, Provincial, Municipal, and County Development and Reform Commission, respectively; MWR: Ministry of Water Resources; RBC: River Basin Commission; WRMC: Water Resources Management Center; DPLR: Department of Policy, Law, and Regulation; DRLM: Department of River and Lake Management; RLCC River and Lake Conservation Center; DWRM: Department of Water Resources Management; PDWR, MDWR, and CDWR: Provincial, Municipal, and County Department of Water Resources, respectively; MEE: Ministry of Ecology and Environment; IB: Inspection Bureau; WEEMA: Watershed Ecological and Environmental Monitoring Administration; PDEE, MDEE, and CDEE: Provincial, Municipal, and County Department of Ecology and Environment, respectively; MARA: Ministry of Agriculture and Rural Affairs; BF: Bureau of Fisheries; PDARA, MDARA, and CDARA: Provincial, Municipal, and County Department of Agriculture and Rural Affairs, respectively; MNR: Ministry of Natural Resources; PDNR and NDNR: Provincial and Municipal Department of Natural Resources, respectively; NFGA, PFGA, MFGA, and CFGA: National, Provincial, Municipal, and County Forestry and Grassland Administration, respectively; WMD: Wetland Management Division; PWMD and MWMD: Provincial and Municipal Wetland Management Division, respectively; MF: Ministry of Finance; PDF: Provincial Department of Finance; MBF and CBF: Municipal and County Bureau of Finance, respectively.

The Yongding River watershed has been affected by human activities for a long time. Reducing these pressures requires changes in the way residents interact with the watershed environment, which can be achieved through individual actions as well as governmental policies such as PWES schemes [43–45]. However, these efforts require public awareness of potential problems and support for mitigation actions [46,47]. To understand public perceptions, attitudes, and responses to PWES, survey methods are most often used [48–51]. In the past decade, research on public perceptions toward environmental issues has grown rapidly and has emerged as an important tool for policymakers and researchers. Public perceptions and responses to conservation schemes have recently been identified as emerging frontiers in research and have not yet been brought to the attention of decision-makers.

The aims of this study are therefore as follows: (1) to assess how the public views PWES, including the payment subject, object, method, and standard, and the sources of funds; (2) to identify the willingness to pay (WTP) and willingness to accept (WTA) of residents regarding PWES and the factors underlying their options; and (3) to evaluate how effective PWES is in implementation and how the public participates in PWES. To this end, face-to-face questionnaire surveys were conducted in the Yongding River watershed area. This study expands our limited knowledge and provides valuable information for policymakers via specific results on public knowledge and receptivity towards PWES. Combined with the background information from the public, the problems of PWES can be analyzed coherently so that specific recommendations can be made for improving PWES schemes. Section 2 introduces the research methods and data collection. Section 3 gives the results regarding public perceptions, attitudes, participation, and responses toward PWES. Section 4 presents the discussion and conclusions.

2. Methods and Data Collection

2.1. Study Area

The Yongding River watershed has a drainage area of 47,016 km^2. The Yongding River originates from the Sanggan River and the Yanghe River and flows into Guanting Reservoir, with a total length of 747 km (Figure 2a). The Yongding River and Guanting Reservoir were also important for safeguarding water resources and the watershed environment for the 2022 Winter Olympic Games. Both Hebei Province and Beijing City face a water crisis regarding development [52]. The competition for water resources between upstream (Hebei) and downstream (Beijing) is intensifying. To solve the conflicts, the governments have introduced some PWES schemes (e.g., PLDL) and policies in recent years, including water-quality target assessment and compulsory withholding of PWES in the Yongding River watershed (Figure 2b). In 2017, Beijing and Hebei jointly signed the Agreement on Compensation for Ecological Protection of the Water Conservation Area of the Chaobai River. The area was selected as a typical study watershed, considering the conflicts regarding water resources between the upstream (Hebei) and downstream (Beijing) areas and the high need for PWES.

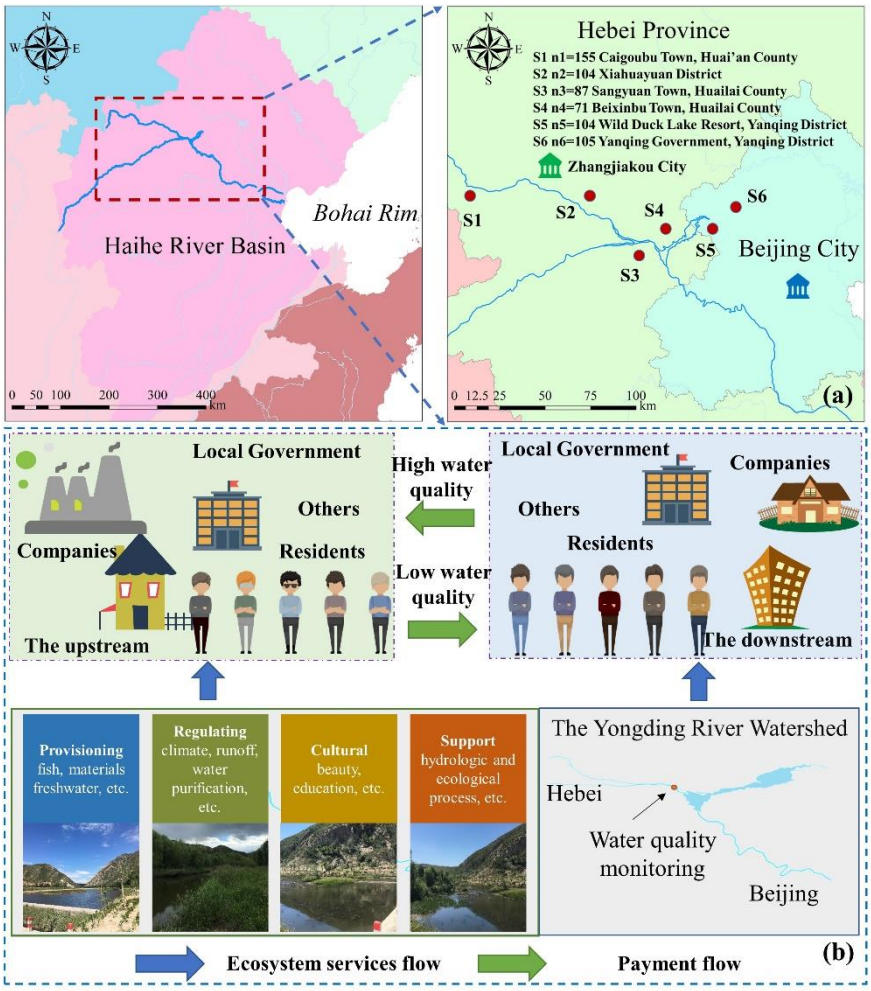


Figure 2. (**a**) Location of the Yongding River Basin and survey sites; (**b**) PWES mechanism in the Yongding River watershed, i.e., inter-government compulsory withholding pattern based on outbound water quality. Zhangjiakou provides water resources to Beijing. If the water quality of the monitored section does not reach the standard, Zhangjiakou's compensation funds are withheld. If the water quality of the monitored sector meets the standard, Zhangjiakou is rewarded with cash funds.

2.2. Survey Design and Implementation

A survey was conducted through our designed questionnaire. The questionnaire was initially designed after data collection and preparation and was pre-tested in a series of rounds of face-to-face interviews with three experts and five residents in March 2017. The final questionnaire consisted of three parts (see the Appendix SA in the Supplementary Materials). Firstly, we investigated public values regarding watershed ecosystem services, public knowledge, and their preferences for the PWES subject, object, method, and standard. Secondly, we surveyed their WTP and WTA. Thirdly, we investigated public participation and the impact of PWES on livelihoods. The interviewees were residents living close to Yongding River and the Guanting Reservoir, based on assumption that these residents are stakeholders in, and are concerned about, the implementation of PWES. Four towns in Zhangjiakou City, Hebei Province and two towns in Yanqing District, Beijing were selected as survey sites (Figure 2). The survey sample size was determined based on the estimated overall proportion of simple random sampling, calculated at a 95% confidence level and with an absolute error of less than 4%. The required sample size was 601 for the survey locations with a total population of over 1 million (Supplementary Table S2).

A total of 637 interviewees were from these towns. The researchers randomly selected interviewees from among the residents of twenty villages in the four towns. Each respondent represented a family. Considering the high degree of social and demographic heterogeneity of this population, the sample was representative. The survey was carried out in March 2017 by six investigators, through face-to-face interviews. Interviewers took notes on binary, multiple-choice, and free-response answers.

2.3. Ecosystem Services and Opportunity Costs Evaluation

The contingent valuation method (CVM) was used for assessing the non-market value of ecosystem services. The CVM has its root in welfare economics and uses hypothetical, payment-based scenarios to trigger individuals' willingness to pay (WTP) or to accept compensation (WTA) for environmental improvement [53,54]. There remains a long-standing debate about the reliability of the CVM, with critics outlining several issues such as assumption bias and differences between WTP and WTA [55]. To avoid assumption bias, all investigators were trained prior to the survey to provide respondents with accurate descriptive information. The value of ecosystem services for the Yongding River watershed was estimated based on the following equations:

$$WTP = \sum_{i=1}^{k} AWTP_i \frac{n_i}{N} \quad (1)$$

$$WTA = \sum_{i=1}^{k} AWTA_i \frac{n_i}{N} \quad (2)$$

$$ES = \frac{N}{2}(WTP + WTA) \quad (3)$$

where WTP and WTA represent respondents' willingness to pay or to be paid and ES is the evaluation of ecosystem services by the public. AWTPi and AWTAi represent the WTP and WTA at level i, n_i is the corresponding number of respondents, and N is the total number of respondents.

Then, we calculated the payment standard based on the opportunity costs model [56]. Huailai County and Yanqing District, where the Guanting Reservoir is located, are limiting industrial development to protect the watershed and therefore also limiting the livelihood improvement of residents. This is the opportunity cost in the upstream area and is mainly reflected in the difference in disposable income of residents in the restricted area (Huailai and Yanqing) and those in the unrestricted area (Zhangjiakou and Beijing). The annual opportunity costs are estimated based on the following equation:

$$OC = (T_C - T_S) \times N_t + (W_C - W_S) \times N_w \quad (4)$$

where OC is the opportunity cost of economic development, Tc and Wc are the disposable incomes of urban and rural residents in unrestricted areas, Ts and Ws are the disposable incomes of urban and rural residents in water-source areas, and Nt and Nw are the numbers of urban and rural residents.

2.4. Data Analysis

A total of 626 valid questionnaires were returned. Table 1 shows the social and demographic information of the respondents. Nearly 85% of respondents were under the university education level. The average age was about 44 years old. Nearly 65% lived within 10 kilometers of the watershed. Statistical analysis and data management were performed using SPSS 24.0. Descriptive analysis, correlation analysis, and logistic regression were applied to the survey data. The contingent valuation method was used to account for the value of the watershed.

Table 1. Socio-demographic information of respondents in the Yongding River watershed, China (n = 626).

Item	Status	Percentage (%)	Item	Status	Percentage (%)
Gender	Women	53.2	Occupation	Farmer	48.4
	Men	46.8		Government employee	3.8
Average age	Years old	44.1		Enterprise employee	12.5
Education level	Primary school	17.6		Teacher	2.1
	Middle school	40.7		Researcher and scientist	0.6
	High school	26.5		Self-employed	12.9
	University	14.7		Student	6.7
	Graduate	0.5		Retired	6.7
Annual income (thousand CNY)	≤10	23.8		NGO employee	0.6
	10.1–20	20.6		Media practitioner	0.5
	20.1–50	38.0		Others	5.1
	50.1–100	13.7	Family members	Average (persons)	3.6
	>100	3.9			

3. Results

3.1. Public Knowledge of Ecosystem Services and PWES

The Yongding River and the Guanting Reservoir hold great potential to provide ecosystem services for surrounding cities and communities. We listed ten types of ecosystem services, covering all four aspects of product provision services, regulation services, support services, and cultural services. Three-point scales were used for respondents to state their perceptions about the ecosystem services of the watershed, with scores of 1 to 3 representing unimportant to important. Average scores for these ten aspects were 2.87, 2.85, 2.87, 2.65, 2.78, 2.72, 2.77, 2.74, 2.70, and 2.75. The scoring for landscape value (entertainment, eco-tourism, etc.) was the lowest. The results indicated that about 68.5% to 87.8% of respondents thought that ecosystem services were important (Figure 3). Among them, soil and water conservation was perceived as an important ecosystem service by most respondents (87.8%), followed by water purification (87.6% of the interviewees). However, the lowest number of respondents (68.5%) chose landscape value. The public often evaluates the importance of different ecosystem services for their purposes (e.g., recreation, scenery, etc.) rather than their ecological value. This poses a challenge for watershed protection due to potential differences between the ecosystem services protected and public preferences.

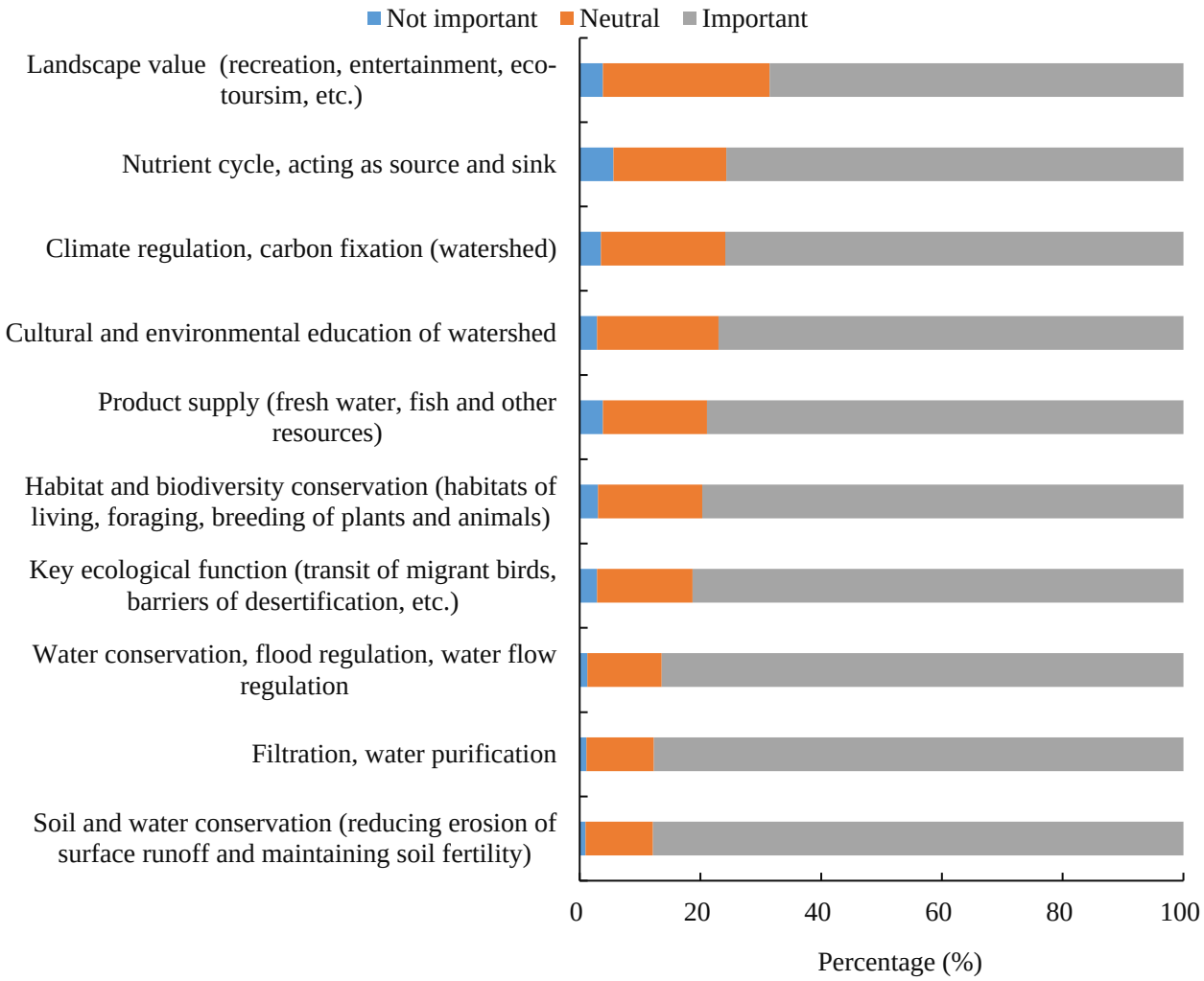


Figure 3. Public perceptions towards ecosystem services of the Yongding River, China (n = 626).

To measure how much knowledge the local people had acquired regarding PWES, we designed and asked questions about the concept and implementation of PWES. The results showed that most respondents (>70%) were unaware of watershed protection policies and PWES policies. Ordinal logistic regression analysis indicated that public occupation, place of residence, concerns, and education affected their knowledge of PWES (Table 2). The level of public concern about environmental issues contributed most to public knowledge about PWES. It is noteworthy that respondents in Beijing were more aware of PWES policies. When respondents were asked to prioritize management methods for solving environmental problems, they tended to indicate laws and regulations (35.1%), publicity, education, and information disclosure (21.4%), and economic methods (18.1%) as their top three priorities, with the least priority given to technical means. The results were within expectations, due to the existence of laws and regulations that can effectively reduce pollutant emissions [57]. Moreover, over half of the respondents (>50%) believed that they could play important roles in PWES decision-making and implementation. The Paddy Land to Dry Land (PLDL) scheme, which was implemented by Beijing, Zhangjiakou, and Chengde, was the PWES best known to respondents.

Table 2. Ordinal logistic regression analysis of public knowledge about PWES in the Yongding River watershed, China.

Factors	B	Sig.	Std.Error
Education level	0.206	0.043 *	0.102
Gender	−0.039	0.807	0.161
Age	0.012	0.730	0.036
Household income	0.119	0.161	0.085
Level of public concerns about environmental issues	0.403	0.000 **	0.085
Place of residence	−0.470	0.011 *	0.185
Relevance of occupation to environmental protection	0.109	0.038 *	0.053

Note: * $p < 0.05$; ** $p < 0.01$.

3.2. Public Perceptions of PWES

We designed and asked five questions about PWES, including payment subject, object, method, funding source, and standard. The responses are summarized in Figure 4. The PWES subject includes both the purchasers and providers of ecosystem services. The complexity of watershed environmental governance lies in the fact that not only does it involve externalities of residents' behavior but the watershed environment also has the characteristics of a public good when it exceeds a certain extent. The government assumes different roles when it manages PWES schemes in different ways. One way is when the government dominates the PWES and charges the beneficiaries and pays the providers of ecosystem services. The other way is when the beneficiaries of ecosystem services operate PWES in a market-oriented way, and the government undertakes tasks such as setting up the trading platform and releasing information. The majority (60.5%) of respondents thought that the central government should be the payment subject, while only 6% chose the beneficiaries, indicating that public perceptions toward PWES were that the government was the dominant player in PWES. Public opinion was not unanimous regarding payment objects, with 35.6% of respondents choosing poor and backward areas, followed by downstream areas suffering from pollution and damage, and only 19.2% choosing upstream areas. The public's expected payment methods were cash (54.0%) and ecological projects (25.4%). Regarding PWES funding sources, almost two thirds (66.3%) of respondents believed that funds should be raised by transfer payment from the central government to the local government. In response to the question on the payment standard, a range of responses was elicited. Nearly 36.1% of respondents thought the payment standard should meet personal basic needs, 23.2% considered that it should reach the average income level of the watershed, and the other 20.2% regarded the standard as covering direct economic losses caused by environmental protection. Respondents reported that the compensation funds should be used for the comprehensive improvement of the water environment and floating debris removal (19.3%), rural waste treatment and removal system construction (16.8%), and water-saving facilities construction (15.6%). Respondents believed that three main aspects of the benefits brought by PWES schemes were ensuring drinking water safety, protecting the environment and improving the quality of life, and guaranteeing food production security.

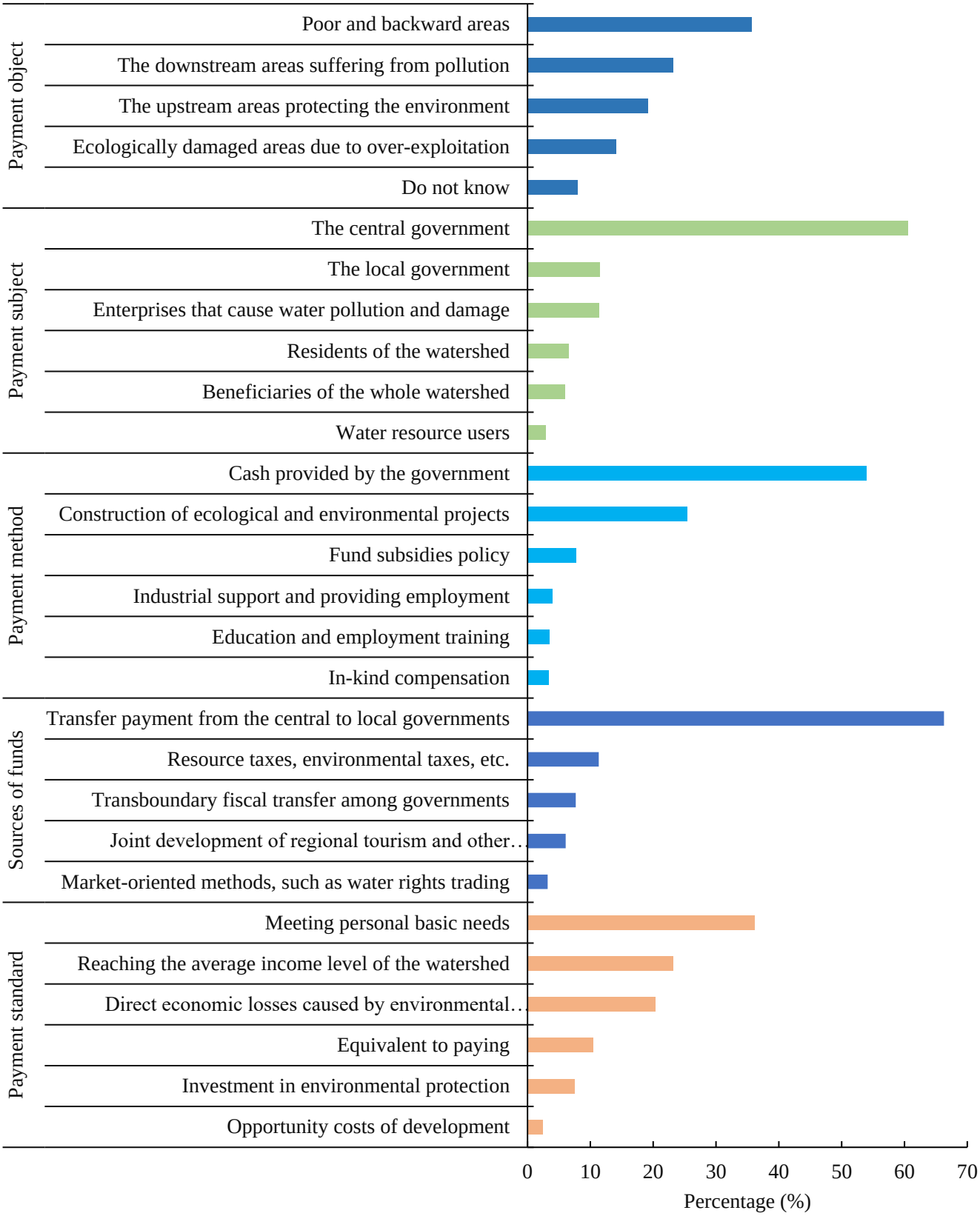


Figure 4. Public perceptions of PWES in the Yongding River watershed, China (n = 626).

3.3. Public WTA and WTP for PWES Standard

Assessment of standards is one of the difficult issues in PWES research. Many methods have been proposed and applied to determine PWES standards, including evaluation of ecosystem services, opportunity cost, WTP and WTA methods, etc. [58]. When the payment of the PWES is greater than the opportunity cost and less than the ecosystem service value, it creates an effective incentive for both purchasers and providers of ecosystem services [59]. Although the value of watershed ecosystem services is difficult to measure, the existing value and social benefits of PWES schemes can be determined by applying the CVM [60,61].

Firstly, we investigated respondents' WTP and WTA. Over half of them (55.0%) indicated that they were willing to pay for environmental improvement upstream if they lived downstream and were the beneficiaries of the environmental improvement. Surprisingly, using living distance as a variable, the analysis showed that respondents living within 5 km of the Yongding River were significantly less willing to pay than those living further away ($p < 0.05$). Respondents preferred to pay in cash (43.0%), voluntary contributions (22.1%), and voluntary work (17.2%). Of the 282 respondents who were unwilling to pay, nearly 73% cited their low household income as the main reason. Some respondents (12.8%) said that individual payments were not sufficient, and the government should take responsibility for improving the watershed environment and funding watershed ecological restoration. The majority (85%) of respondents indicated that they were willing to accept compensation if they lived upstream and were contributors to environmental improvement. Nearly 70% expected cash compensation, and 15.2% wanted to be offered job opportunities. Conditional cash compensation is theoretically the best form of incentive; however, indirect non-cash compensation methods are more commonly used [62]. Although some of the interviewees felt that the watershed environment affected their daily lives, they were reluctant to pay for environmental goods, reflecting a sign of "free-riding". The results showed that the WTP and WTA were very different, with WTP and WTA mainly distributed in the interval of less than CNY 100 (USD 14.8) and over CNY 300 (USD 44.4), respectively (Supplementary Figure S1). Moreover, we found that the average annual values for WTP and WTA were CNY 96 (USD 14.2) and CNY 633 (USD 93.8), respectively. WTA was 6.6 times larger than WTP. The reasons for the difference between WTP and WTA were not only the social background of the residents but also their insufficient awareness of PWES. It is easy for them to overestimate their losses and underestimate their benefits, which leads to a higher WTA than WTP. Moreover, some studies on PWES point out that the tendency to punish ecologically damaging behaviors may also be a cause [63–66].

Then, we applied the CVM method to account for PWES standards, and the results showed that the annual payment was a total of CNY 245 million (USD 36.3 million) for Huailai County and Yanqing District, with CNY 131 million (USD 19.4 million) for Huailai County and CNY 114 million (USD 16.9 million) for Yanqing District (Figure 5). The reservoir area, as well as the upstream area of the Yongding River watershed had limited industrial development, in order to protect the environment; however, nearly 48% of respondents were not aware of that. We estimated the PWES standard under different scenarios based on opportunity costs. The results showed that the annual payments for Huaila County and Yanqing District were CNY 277 million (USD 41.0 million) and CNY 279 million (USD 41.3 million), based on the assumption of reaching the average income of other similar areas within the watershed. The result was close to the PLDL scheme (Figure 5). In 2018, Beijing paid CNY 322 million (USD 47.7 million) to Zhangjiakou City and Chengde City in Hebei Province to protect the Miyun Reservoir. The annual payments for Huaila County and Yanqing District were CNY 436 million (USD 64.6 million) and CNY 718 million (USD 106.3 million), based on the assumption of reaching the economic development level of other similar areas within the watershed. This result was significantly higher than the opportunity costs based on average income and the CVM-based assessment of ecosystem services.

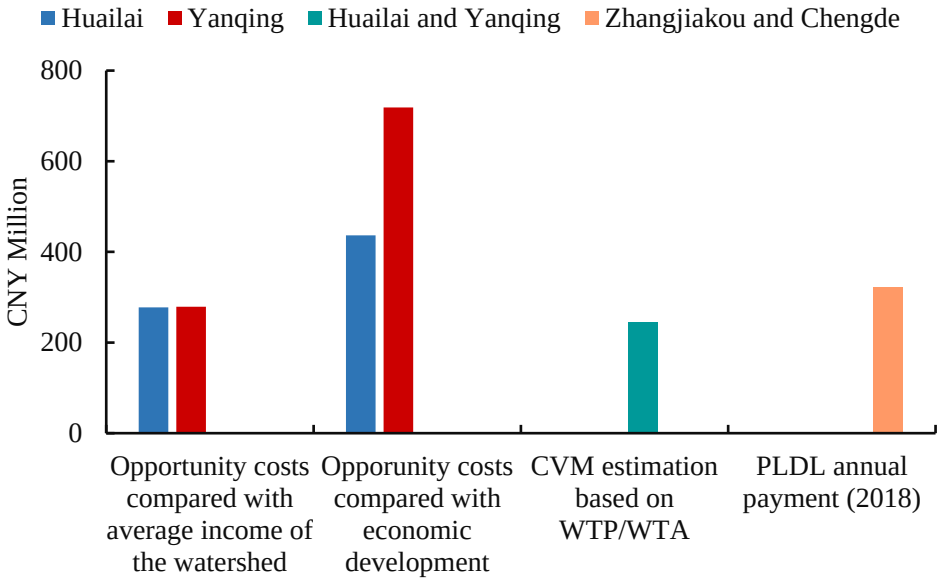


Figure 5. The PWES standard for the headwater conservation areas.

Thirdly, we analyzed factors influencing WTP and WTA based on binary logistic regression. Public concerns, knowledge, perceptions, and demographic factors regarding PWES and environmental issues were incorporated into the model (Table 3). The results showed that higher education levels were associated with lower WTP and no significant change in WTA. Male respondents were more reluctant to receive compensation than females. The more they were concerned about environmental issues and the higher their income, the more they wanted to pay and the less they wanted to be compensated. In addition, respondents living in Hebei were willing to pay less than those in Beijing, while this was the opposite for WTA. Respondents who were more aware of PWES were more willing to pay, as were respondents who believed the environment had improved.

Table 3. BLR analysis of WTP in the Yongding River watershed, China.

Factors	WTP			WTA		
	B	Sig	Exp (B)	B	Sig	Exp (B)
Education level	−0.406	0.013 *	0.667	0.302	0.223	1.353
Gender	0.104	0.644	1.109	−1.016	0.004 **	0.362
Household income level	0.081	0.023 *	1.804	−0.377	0.036 *	0.686
Environmental improvement	0.771	0.000 **	2.162	0.442	0.064	1.556
Level of public concerns about environmental issues	0.256	0.043 *	1.292	−0.484	0.018 *	1.623
Place of residence	1.090	0.038 *	2.663	−1.312	0.046 *	0.269
Public knowledge about PWES	0.169	0.034 *	1.184	0.247	0.269	1.281

Note: * $p < 0.05$; ** $p < 0.01$.

3.4. Public Participation in the PWES Implementation

Public participation and involvement are prerequisites for promoting and developing China's water sustainability action [67]. This section of the survey was concerned with some issues regarding the PWES implementation. The overall responses on participation in some schemes were not very salient, with a total number of 90 responses, accounting for 14.4 % of respondents. Surprisingly, over half (55.8%) thought they had no direct relationship with watershed management. More than 37% of respondents thought their occupations had little relevance to environmental protection. Table 4 shows that public participation was mainly in the "Sloping Land Conversion Program". Only 41.1% indicated that officials (such as government staff, village officials, etc.) consulted their opinions and suggestions before and during the implementation phase. However, most respondents (77.7%) were still willing to participate in PWES schemes.

More than 90% thought they would like to support these schemes for improving the environment. The PWES method was mainly cash, according to the responses. Among respondents who participated in PWES schemes, almost all of them thought the PWES standard was not high. The current PWES schemes in the Yongding River watershed have not been effective in improving the income and living standards of the residents and the environment (Table 4). A majority of respondents would consider environmental impact and water consumption when choosing to engage in other occupations if the government stopped compensation schemes. Only 36.7% said they would continue to be engaged in agricultural production. Overall, these results indicated that public perceptions could generate impacts on behaviors and choices following participation in PWES schemes.

Table 4. Public participation in PWES schemes.

Question	Dominant Opinion	Percentage (%)
PWES scheme participation	SLCP	78.9
Whether to consult respondents	No	58.9
Desire to engage in decision-making	Yes	77.7
Whether to support or not	Yes	90.0
Reason for support	Can improve the environment	60.0
PWES methods	Cash or subsidy	92.2
PWES standard	Ordinary	60.0
Household income changes	Unchanged	72.2
Environmental improvement	Little improvement	48.9
Living standard improvement	Ordinary	46.7

4. Discussion and Conclusions

PWES schemes and policies have been implemented for a long time, since the Chinese government realized that deforestation posed serious water-quality and flooding threats [68,69]. This study reviewed the evolution and mechanisms of PES and PWES and assessed how the public viewed PWES and the factors underlying WTP and WTA. In the following section, we summarize the main findings of the above analysis.

4.1. WTP and WTA for PWES Standard

Watershed ecosystem services include water purification, soil and water conservation, flooding control, etc., which are difficult to measure, while the existing value of the social benefits can be determined by applying the CVM [70,71]. Many watershed-specific studies have also measured the public's WTP and WTA and calculated PWES standards based on the CVM. The study in the Heihe River watershed area showed that the residents had a strong willingness to participate in ecological management, and their WTP ranged from CNY 187 to 226 per year [72]. The WTP of the residents in the Weihe River watershed area was CNY 624 per year and the annual non-market value of watershed ecosystem

services in Shaanxi Province was CNY 868 million [73]. The residents' WTP ranged from CNY 60 to 90 per year for the South–North Water Transfer Project in Zhengzhou. The residents' income level, education level, age, and preference had a significant impact on their WTP. Respondents thought that they had the right to use clean water, and their WTP had a strong self-interest motive. Changes in water quantity and quality affected their WTP [74]. Some of the residents thought that the watershed environment affected their daily lives, but they were reluctant to pay for public goods, reflecting a "free-riding" phenomenon that resulted in WTP being lower than WTA. A certain degree of wealth disparity between purchasers and providers of ecosystem services can help to increase the WTP/WTA ratio and potentially overcome the barriers posed by transaction costs. Thus, PWES schemes have a greater likelihood of success when they are established in an environment where there is a wealth disparity between purchasers and providers [64]. The PWES scheme should incorporate the non-market value of watershed ecosystem services, and the PWES standard should be explored in conjunction with the WTP and WTA.

4.2. Residents' Livelihoods in PWES Implementation

As the most important form of compensatory conservation, PWES has become a central component of the environmental protection strategy in China [75]. The upstream areas provide ecosystem services to the downstream areas and the downstream areas provide funds to the upstream areas. The better the water quality, the more the downstream areas pay to the upstream areas, and the worse the water quality, the more the upstream areas pay to the downstream areas. This is one of the most widespread forms of PWES practice. Therefore, PWES with this two-sided feature is an incentive instrument to address water-use conflicts and transboundary pollution problems [76–78]. However, it has also increased the financial burden and subsequent social responsibility of the upstream areas because the opportunity costs of development restrictions in the upstream areas often outweigh the funds available from the PWES scheme. Nonetheless, the PWES funds are mostly used for pollution control and river regulation rather than for improving residents' livelihoods, which is the main reason for the low motivation for public participation in PWES implementation. Based on the survey, the public thought the current PWES schemes implemented in the Yongding River watershed were not effective in improving their livelihoods, incomes, and the watershed environment. Therefore, the PWES implementation should be enhanced so that both water quality and residents' livelihoods can be improved. Zheng et al. [29] pointed out that the PLDL scheme achieved a win–win goal, increasing water quantity while reducing nitrogen and phosphorus input. The benefits outweighed the costs for both the upstream and the downstream areas. PWES implementation requires attention to farmers' behaviors to maintain a win–win situation. The PLDL implementation also found that the input of pesticides and fertilizers to farmland increased significantly. We investigated the potential behavioral changes of residents after the cessation of the PWES. The results showed that many of them would probably resume their rural jobs, but most of them would consider environmental impacts and water consumption when choosing different occupations. This suggested that their behavior may change as a result of their involvement in PWES schemes. Therefore, PWES implementation should be more concerned with residents' livelihoods and behaviors. Future watershed management should pay more attention to the application of PWES schemes based on shared responsibilities between upstream and downstream areas [79].

4.3. Implication for Policy and Watershed Management

Over the past two decades, China has promoted PWES mechanisms to internalize environmental externalities from human activities in the context of integrated water resources management [17]. PWES is closely related to rural development and farmers' interests. To protect and restore ecosystems, watershed protection areas are inevitably constrained in terms of industrial and economic development. Therefore, PWES schemes play important roles in the sustainable development of poverty-removing areas, narrowing the

gap between urban and rural development. PWES implementation, like other major ecological projects, is an important means for enhancing and improving ecosystem services. However, some types of ecosystem services (e.g., water-quality improvement) often come at the expense of other ecosystem services (e.g., agricultural production). Such trade-offs in ecosystem services are widespread and manifest at different spatial and temporal scales, thus creating uncertainty in the realization of ecological benefits [33]. Therefore, they should be considered in PWES management. PWES implementation is close to watershed management, which often transcends administrative jurisdictions. PWES schemes such as SLCP and PLDL are important components of sustainable watershed management and help to resolve water conflicts [80]. Moreover, transboundary PWES schemes represent a necessary strategy for horizontal cooperation between local governments for managing watersheds. There is a need to develop a transboundary PWES scheme in consultation with governments within watersheds and to take into account the interconnections between upstream and downstream areas, i.e., the ecological and social complexity [81].

The improvement of the PWES mechanism in China is inseparable from public participation. However, our analysis showed that the public was usually excluded from the PWES system, and public participation was at a low level. Members of the public can only passively accept PWES schemes and have little voice as participants, even though they believe they can play a large role in PWES development and implementation. Therefore, PWES management should be more inclusive, incorporating the public into the management system and providing the public with information on watershed governance, thus motivating people to participate in PWES management. Due to the weak ability and awareness of the public regarding access to information, certain strategies are still needed for policy advocacy and knowledge dissemination related to PWES [19]. The government plays an irreplaceable role in PWES implementation, and the public may place higher demands on the government's transparency and execution. Therefore, the government should improve public participation, disclose watershed governance information, and enhance transparency and fairness, thereby increasing public trust in the relevant authorities. These findings reveal the need for public participation in PWES, and the same approach can be applied to other regions of China. This study explored public perceptions, attitudes, participation, responses, and factors affecting the WTP and WTA, which were important for the future design and implementation of PWES and for providing practical insights into understanding public perceptions in other watershed areas. The results showed that the public had limited knowledge of watershed protection and PWES policies and was unaware of PWES mechanisms. Some of the respondents did not even know that upstream areas suffered economic loss as a result of protecting the environment. Therefore, the government and the media should take responsibility for disseminating information related to PWES policies. In addition, the government should help build public confidence in PWES via training, hearings, reports, and other means. The residents perceived the PWES standard as low, and their perceptions were closely related to their livelihoods. Although cash was the first choice for WTP and WTA, some would prefer to choose other ways to pay compensation (e.g., voluntary labor) or receive compensation (e.g., employment opportunities). Differentiated PWES standards and diversified PWES methods should be established in the Yongding River watershed area, considering residents' livelihoods, especially the affordability for low-income households and the preferred payment methods of the residents. Members of the public were willing to participate in decision-making regarding PWES and believed that they could play a very important role; however, the current level of public participation is very low. To mobilize public participation in watershed protection and PWES schemes, the government should make efforts to broaden the ways the public can participate and gradually institutionalize them. Public attitudes can take different forms such as active support or passive acceptance by different stakeholders and should be dealt with within the context of environmental psychology and social-science-oriented work.

Though some limitations exist, we intend to work further on this topic in the future. Firstly, the data were collected from two cities, with a relatively small sample size. Although the whole basin was not covered and the number of respondents was small, the respondents included a wide diversity of participants. More cases, covering the whole basin and giving a larger sample size, could contribute to better accuracy of the conclusion. Secondly, variables such as procedural justice, benefit, cost, and public norms are not within the scope of this study, which may also affect the full understanding of public attitudes and their WTP and WTA. In future work, we should include the above factors in the regression analysis. Thirdly, the scope of this study is limited to local responses at a specific time. Further studies will be conducted to examine the trend of support over time and the impacts of PWES on the livelihoods of the residents within the watershed area.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su14159550/s1. Figure S1: The public's expected methods regarding WTP and WTA in the Yongding River watershed, China; Figure S2: Public willingness to pay and willingness to accept in the Yongding River watershed, China; Table S1: International legislative experience in PWES; Table S2: Relevant PWES policies and laws in China; Table S3: Sample size determination; Appendix SA: Questionnaire.

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