

Article

The Local Residents' Concerns about Environmental Issues in Northwest China

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Abstract: This paper analyzes public awareness and perception about current issues of environmental and water resources in China in comparison to the socio-economic issues. The ranking, Likert scale, and ordered logit analysis were applied to data from 1773 sample residents in northwest China. The results show that the residents rank the degradation of the ecological environment and water resources as the most important issue, and education, political involvement, gender, employment, and residential location play significant roles in explaining the observed differences in concern. Of the possible environmental and water resource restoration policies, residents ranked water quantity and quality, agricultural and industrial water use, erosion control, vegetation restoration, wildlife habitat, animal brooding and migration services, biodiversity landscape, and eco-tourism from one to nine in order of importance, respectively. The results are relevant for policymaking and imply that environmental restoration is a high public demand. Welfare gains from investments in it would be higher or equal to gains from other socio-economic and livelihood activities. Thus, public policies must emphasize restoring and maintaining a sustainable ecological environment.

Keywords: environmental awareness; perceptions; water quality; Shiyang River; Weihe River; environmental policy

1. Introduction

Water and environmental problems are important issues with far-reaching impacts on livelihood and socio-economic development in China [1–4]. Overexploitation of natural resources [5], outdoor air pollution and sandstorms [6], land degradation and acidity, and excessive industrial and domestic waste materials in water bodies [7] are concurrent issues in the post-economic reform era (since the late 1970s). The economic cost of these issues was estimated at 9% of the country's gross national income in 2008 [1].

Considerable progress has been made in the last few decades in understanding people's value on environmental goods and services. There is a large existing literature on the local, national and international level. This shows the preference of people for welfare estimation and cost-benefit analysis of environmental policies [8–14]. Based on those previous studies, there is little doubt that the environment is important to people. However, the importance of the environment relative to socio-economic issues is not as clear. Despite its importance for scientific information and policymaking, public concern about the state of the ecological environment and water resources management in comparison to other related socio-economic issues is poorly understood and unstudied in China. Some relevant evidence from other countries includes a report from the ministry of Environment of New Zealand which states that 87% of New Zealanders consider the environment to be important

or very important to them. They rate the quality of the natural environment as the third most important aspect of New Zealand, behind quality of life and the quality of education [15]. Dunlap's [16] multi-country analysis also reports that less-developed countries are more likely view environmental issues as serious community problems than developed countries. The relative importance of different environmental issues differs across countries.

Therefore, the main objective of this paper is to investigate the importance of environmental and water resource amenities relative to other social and economic needs in northwest China. It also identifies the relative importance of different ecological and environmental issues to the public. Moreover, it discovers heterogeneity with respect to two geographic regions—the Shiyang River Basin in Gansu Province and the Weihe River Basin in Shaanxi Province—as case studies. The rest of the paper is organized as follows. Section 2 describes the data and study area, and a description of the questionnaire design is given in Section 3. Section 4 discusses the empirical results followed by a discussion and conclusion in Section 5.

2. Study Area and Sample Description

2.1. Weihe River Basin

The Weihe River is the largest tributary of the Yellow River. It originates from a mountain near Weyuan County of Gansu Province and is referred to as the mother of Shaanxi Province because it has played a very important role in the development of Shaanxi Province since ancient times and is still playing a crucial role in Western China's development [17]. Almost half of the total area coverage of the basin (135,000 km²) lies in Shaanxi Province (Figure 1). It annually generates 6992 million m³ of water. This river runs from west to east across the Guanzhong plain. The population in the river basin is about 22 million, which is 61% of the total population of Shaanxi. At its Shaanxi section, this basin covers a cultivated area of 1,665,000 hectares, 950,000 hectares of which are irrigated. The area plays a crucial strategic role in the China Western Development Program. However, many environmental problems exist in the region. In the Weihe River Basin, the water availability per capita per annum is only 13% of the national level. With rapid economic development in the in recent years, many problems have arisen. These include an increasing scarcity of water resources [17], climate change [18], water pollution and regional ecological environment deterioration. A stratified random sampling strategy was used to include all the major drainage areas and direct beneficiaries of the basin as described in Table 1 below. The socio-economic description of the sample respondents is given in Table 2.

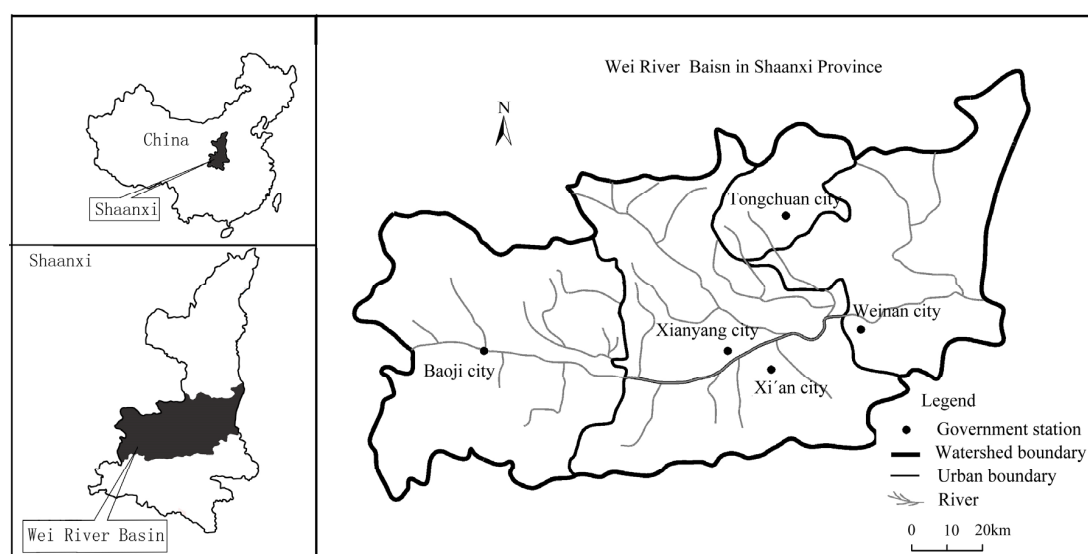


Figure 1. Map of Weihe River Basin.

Table 1. Sample area and composition of the Weihe River Basin.

Sample Area	Non-Farmers	Farmers	Total
Baoji	115	115	230
Xianyang	95	125	220
Weinan	102	121	223
Huayin (county-level city in Weinan prefecture)	114	113	227
Total	426	474	900

Table 2. Socio-economic description of Weihe and Shiyang river basin respondents.

Variables	Weihe River Sample		Shiyang River Sample	
	Mean	Standard Deviation	Mean	Standard Deviation
Age	42.17	13.03	41.73	11.87
Family size	4.26	1.44	3.94	1.31
Total revenue (Yuan/year)	51,359.77	52,832.82	46,105.46	27,851.82
	percentage		percentage	
Sex (male head household = 1)	58%		65%	
edu1 (≤ 5 years)	10%		15%	
edu2 ($>5 \leq 8$ years)	35%		30%	
edu3 ($>8 \leq 12$ years)	25%		21%	
edu4 (college)	15%		14%	
edu5 (≥ 16 years)	15%		20%	
Status: family member as cadre or village facilitator = 1	24%		26%	
Dummy job (farmer = 1; other = 0)	49%		49%	

Note: Status assesses whether the interviewee or any of his family members are involved in jobs such as government advocates (such as political cadre, village representative, or village administrator).

2.2. Shiyang River Basin

The Shiyang River Basin is an inland river basin located in the western part of Gansu, with a typical arid to semi-arid climate and a population of 2.27 million, 1.34 million of which are rural. The area's per capita income is \$390 USD. The specific socio-economic characteristics of the sample respondents are given in Tables 2 and 3 presents the specific sample area. The Shiyang River originates from Qilian Mountain and drains about 300 km, through a midstream in the Wuwei sub-basin, downstream in the Minqin sub-basin, and disappears in the Tengger Desert before reaching its terminal lake, Baiting Lake in Minqin (Figure 2). Covering a drainage area of about 41,600 km², it is characterized by a populated and developed economy with the least-developed water resources in the province [19]. It forms from eight major tributary rivers.

Table 3. Sample area and composition of Shiyang River Basin.

Sample Distribution	Non-Farmers	Farmers
Gulang	79	123
Wuwei	121	124
Jinchang	90	96
Minqin	105	158
Total	395	501

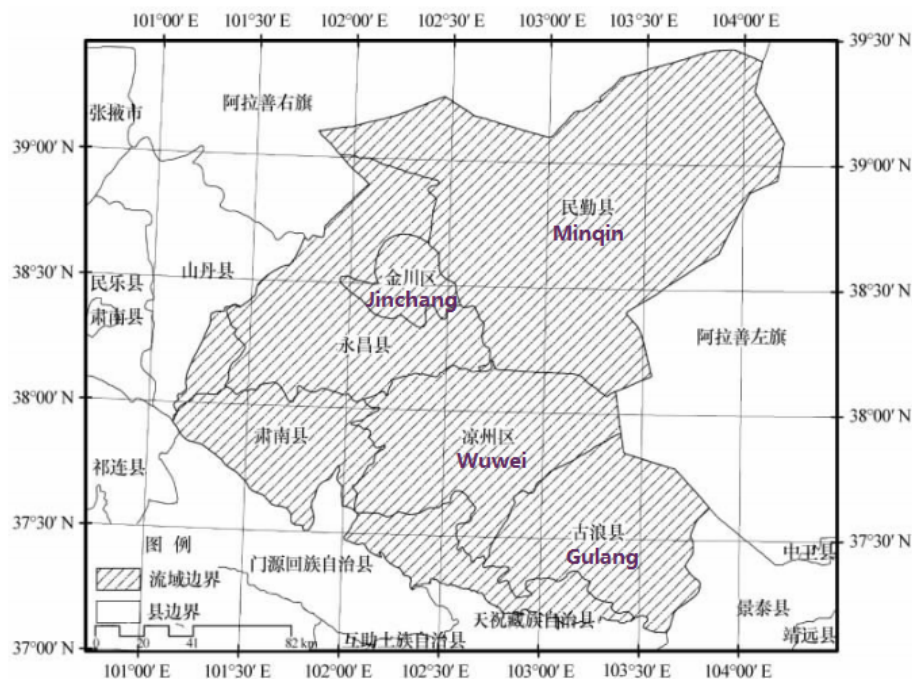


Figure 2. Map of Shiyang River Basin. Source: Li, Zhu and GuO [21] and Wang, Zheng and Wang [19].

Shiyang River's water resources are mostly utilized for economic activities including agricultural, industrial and domestic uses. The river basin's total renewable water resources are about 1.66 billion m^3 , including an annual average surface water resource of 1.56 billion m^3 , and groundwater water resources of 99 million m^3 . Precipitation and snowmelt from the mountain ranges that surround it to the south and southeast are the source of nearly all water resources in the basin [20]. Currently, agricultural water consumption accounts for about 70% of the water resources while aggregated domestic, industry, and basic ecological water consumes only about 13%. The losses due to evaporation at different levels account for about 17% [21]. However, there is a water extraction imbalance between the sub-basins. For example, in the lower sub-basin (Minqin Oasis), the total water consumption is 793 million m^3 , of which agricultural, domestic and industrial use account for 97.85%, 1.26%, and 0.88%, respectively. This leaves none for ecological use.

Currently, the region is critically stressed with rapid population growth and economic developments. This has caused excessive water demand in the upper and middle reaches. This has led to tributaries drying and a shortening of the river's estuary. This degraded ecological environment is one of the most overexploited inland basins in northwest China [20,21].

3. The Questionnaire Design

This survey was conducted with a questionnaire based on face-to-face interviews with the local residents of the two basins. The questionnaire is composed of three parts. The introductory part gathers information on the socio-economic characteristics of the respondents. The second part assesses respondents' opinions about the existing environmental and water resource issues, using a ranking process, in comparison to other socio-economic variables such as economic growth and employment, education, health care services, transportation infrastructure and poverty reduction. Finally, the relative importance of different water and environmental issues to the individual respondents was gathered using ranking and scaling tasks. The sample responses are from the Shiyang and Weihe river basins survey conducted in the summer and winter vacation of 2012/2013 by about 20 graduate students majoring in Agricultural Economics and Management. Those two basins are typical, representative of the northwest China basins, because they are both characterized by water shortage, water pollution and environmental degradation including pollution and sandstorms similar to other river basins in

the region. The research outcomes may also have some implications for basins in other parts of China because environmental and water resource degradation is prevalent throughout the country, although the causes differ.

The sample selection process followed similar procedures in the two basins as follows. The entire basins were covered in the survey. Sample selection involved three stages. First, three integral parts of the basin were identified as the upper, middle and lower sub-basins based on the existing administrative division. In each respective basin, the main cities (prefecture administrative level) that the river covers were the references. Then, a random selection was applied to select the sample townships, followed by random sample village selections from which sample respondents were drawn randomly. About 900 respondents were interviewed in each sub-basin; the response rate (completed questionnaires) was about 93%.

4. Results

4.1. Importance of Water and Environmental Issues Relative to Other Socio-Economic Issues

The respondents were asked to rank the issues related to ecological environment, water, poverty reduction, infrastructure, employment, education and medical care, according importance to them by assigning them from “1” as most important to “7” as least important. In the Weihe River Basin (Shaanxi Province), about 38% of respondents value the environment as their first and second priorities, and 52.2% ranked it in the top three. Water was ranked second, and around 31.7% perceived it either as the first or second most important issue. Water and environment together make up about 39.6% of the first place rankings. On the other hand, poverty reduction and infrastructure are the least important issues. Figure 3 depicts the specific ranks for each issue.

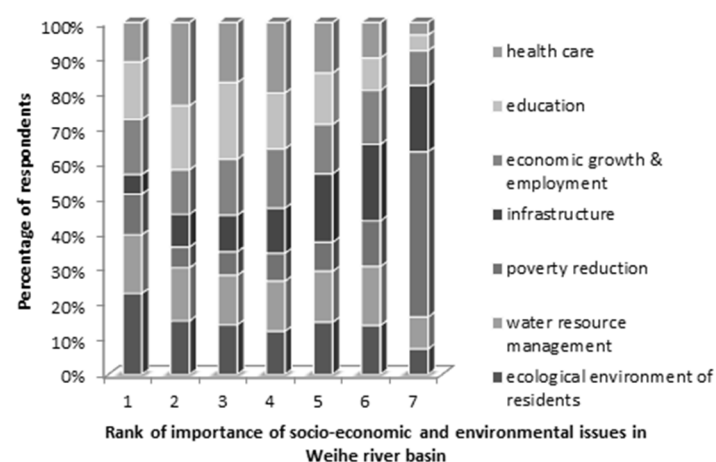


Figure 3. Rank of the socio-economic and environmental issues according to importance for Weihe River Basin residents.

As depicted in Figure 4, Shiyang River (Gansu Province) residents have very similar opinions about the socio-economic and environmental issues. Water and ecological environment together were viewed as the first top concern by about 60% of respondents; 53.7% and 49.8% of residents ranked the water and ecological environment as the first or second most pressing issues, respectively. Poverty reduction and infrastructure make up the two lowest public concerns.

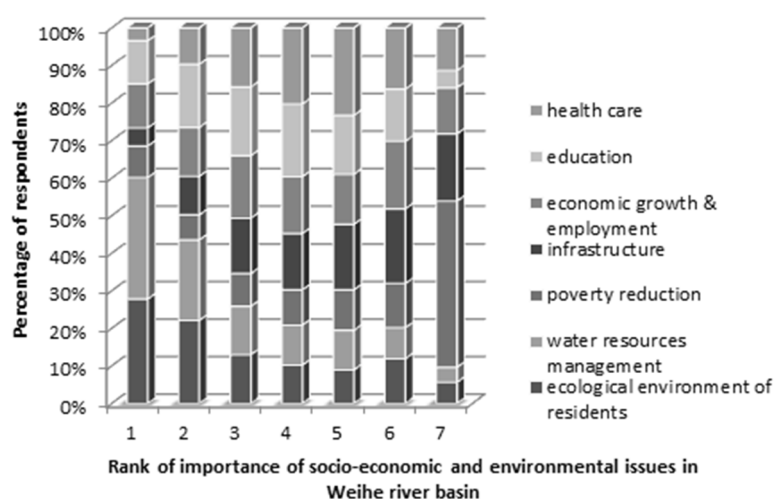


Figure 4. Rank of the socio-economic and environmental issues according to importance for Shiyang River Basin residents.

Table 4 presents side by side comparison of the ranks of the socio-economic and environmental issues by the two basin residents. On average, Shiyang Basin residents value water resource management and ecological environment as the two top issues. These were the third and fourth most important issues to the Weihe residents. Poverty reduction and infrastructure were ranked last by both groups. This indicates that poverty is no longer an issue in northwest China. These results are not surprising because significant infrastructure construction [22,23] and poverty reduction [24,25] have been achieved in the last 40 years, but at the expense of health risks [26] and environmental degradation [17,21].

Table 4. Average rank score of the different socio-economic and environmental issues.

Socio-economics and environmental Issues	Shiyang Basin		Weihe Basin	
	Mean	Standard Deviation	Mean	Standard Deviation
Ecological environment of residents	3.083812	1.941347	3.50723	1.984546
Water resources management	2.459242	1.320181	3.808676	1.959811
Poverty reduction	5.198622	2.057964	5.221357	2.163411
Infrastructure	4.613088	1.788408	4.734149	1.786319
Economic growth & employment	4.086108	1.922206	3.864294	1.923204
Education	3.710677	1.712393	3.390434	1.72172
Health care	4.445465	1.601422	3.462736	1.64956

4.2. Which Environmental and Water Resources Issues Are the Biggest Concern to the Public?

Northwest China is characterized by multiple inter-related ecological and water resource issues. The questionnaire included all of the existing issues identified based on a comprehensive literature review of the ecological conditions of the area including a discussion with relevant scientists and researchers in universities as well as administrative bodies and a pilot group. The sample respondents were then asked to rank pre-identified issues from most concerning “1” to least concerning “9”.

Interestingly, the ranking outcomes from the two basin respondents were very similar (Figures 5 and 6). The issues of water quantity and quality, agricultural and industrial water uses, erosion control, vegetation restoration, wildlife habitat disturbance, animal brooding and migration services reduction, biodiversity, landscape deterioration and eco-tourism amenities were ranked from the most important to least important issues, respectively.

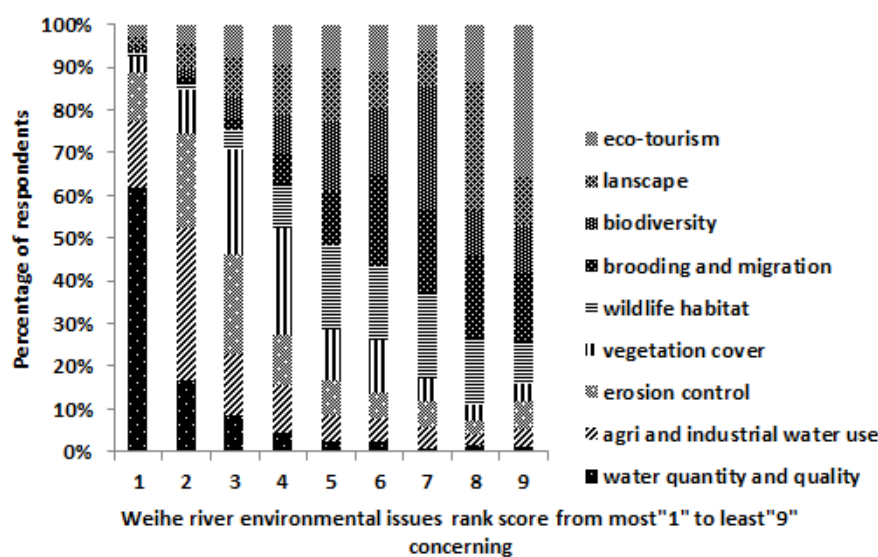


Figure 5. Weihe residents' ranking of environmental degradation issues based on their importance.

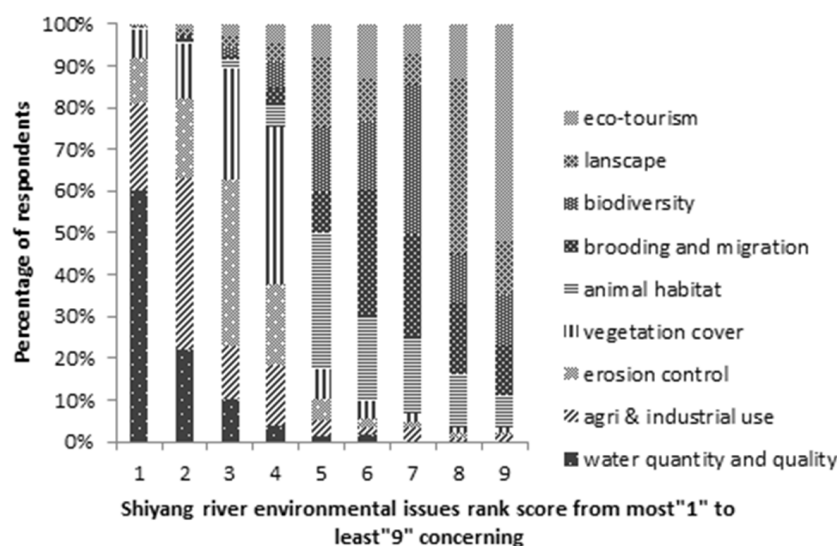


Figure 6. Shiyang Basin residents' rank of the environmental issues based on their importance.

4.3. How Important is Each Environmental and Water Resource Policy to the Residents?

Residents of the two river basins were asked, "How important to you are each of the following environmental amenities when considering intervention policies that influence the respective river?" in the questionnaire. The answers ranged from "1" as not important to "5" as very important. Residents of the two independent basins prefer very similar policy changes for their rivers as shown in Figures 7 and 8. To them, restoring water quality and irrigation conditions are related policies and they are the most important policy issues. These are followed by vegetation cover and water flow. About 90% of respondents in both the basins agree that water quality needs to be a priority (choice of either strongly important or important). This is probably because of the seriously degraded water qualities in the these regions [21,27]. These residents' preferences regarding water quality concur with other nationals as in the report of Shang *et al.* [28] for Shanghai residents who value water quality the most. Irrigation condition improvement policy scores about 91% in the Shiyang Basin and 80% in the Weihe Basin. Residents rank policies that improve fish and wildlife habitats as least important.

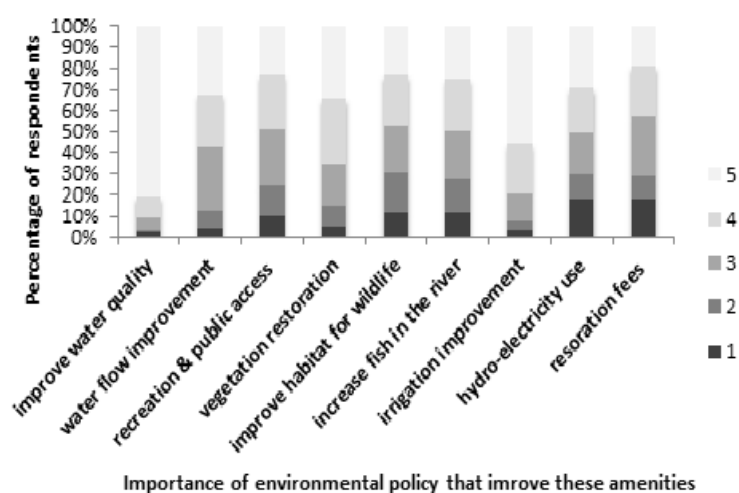


Figure 7. Desirability of policy interventions for each issue in the Weihe Basin (opinions range from very important “5” to not important “1”).

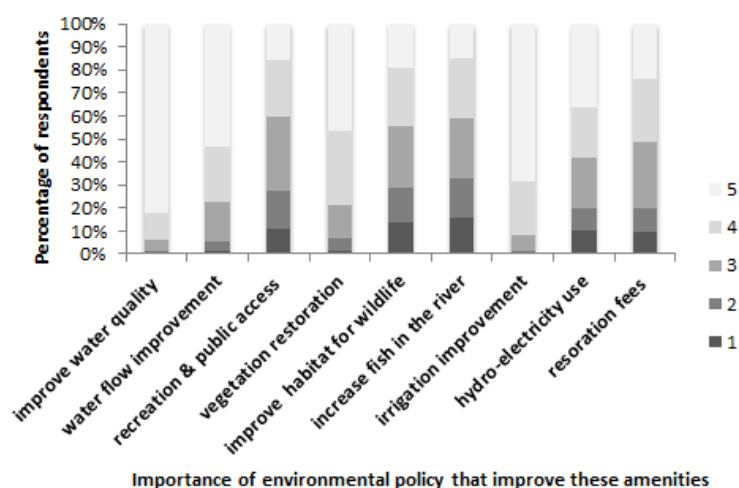


Figure 8. Desirability of policy interventions for each issue in the Shiyang River Basin (opinions range from very important “5” to not important “1”).

Table 5 presents the average importance or desirability of intervention policies as rated by the two groups. On average, water quality, irrigation condition, water quantity or flow and vegetation improvement scores fall between very important and important, while most of the others also score above-average importance.

Table 5. The average importance of different restoration policy interventions valued by residents (opinions range from very important “5” to not important “1”).

Environmental issues or Degradation	Rated by Weihe Basin Residents (<i>n</i> = 900)	Rated by Shiyang Basin Residents (<i>n</i> = 872)
Water quality	4.65	4.75
Water flow	3.72	4.24
Recreation and public access	3.37	3.18
Vegetation	3.79	4.17
Habitat for wildlife	3.27	3.22
Fish in the river	3.34	3.08
Irrigation condition	4.24	4.59
Hydro-electricity	3.32	3.65
HH restoration fees	3.14	3.47

4.4. Socio-Economic Determinants of Ecological Environment and Water Resources Management

We used an ordered logit regression to determine the socio-economic variables that determine the difference in public concerns about the environmental and water resources management issues. The level of concern is evaluated relative to other socio-economic and health issues elicited in Figures 3 and 4. The dependent variable is the level of concern and it is divided into three ordered values: primary concern if ecological environment and water resources issues are top or ranked first, second or third; medium if ranked fourth and fifth; least concerning if ranked sixth or seventh out of the seven elements (ecological environment, water resources, poverty reduction, infrastructure, employment, education and medical care).

The results showed that socio-economic characteristics have less explanatory power on the concerns about water and environmental issues (very low McFadden's pseudo R^2), but the model fit as a whole is good as indicated by the chi-square value ($p < 0.005$). Some previous research has shown an insignificant relationship between socio-economic factors and environmental concerns [29]. Table 6 shows that education, job, and political involvement (either the interviewee or family members working as a government cadre or village facilitator) only marginally explain the difference in concerns over water resources management. Completing junior high school and high school increases the odds ratio of ranking water issues as a primary concern by 1.424 and 1.435, respectively, compared to the combined other levels of concerns (water issues as a medium concern and water issues as least concerning), *versus* an education of elementary school or less. However, college or above degree-holders do not differ significantly from elementary education persons in the pattern of environmental concern. Farmers have a 0.731 higher odds ratio for considering water as a primary concern compared to the other two levels of water issues *versus* residents with other occupations. Having a family member working as a village facilitator or cadre increases the odds ratio of considering water as a primary concern by 0.808. Significant differences were observed for the two basin residents in prioritizing patterns of water resources and ecological environmental issues. Shiyang River residents have 0.437 and 0.683 higher odds ratios of ranking water and environmental concerns as important issues than Weihe River residents, respectively.

Table 6. Ordered logit regression results of the difference in importance of water and the environment.

Explanatory Variables	Odds Ratio of the Variables	
	Water Resources Management	Ecological Environment
Sex (1 = male; 0 = female)	1.088 (0.111)	0.816 ** (0.08)
age	0.994 (0.004)	0.99 (0.004)
Education (reference ≤ 5 years)		
edu2 ($>5 \leq 8$)	1.424 ** (0.243)	0.71 ** (0.109)
edu3 ($>8 \leq 12$)	1.435 * (0.265)	0.476 *** (0.08)
edu4 (college)	1.189 (0.269)	0.271 *** (0.06)
edu5 (≥ 16 years)	1.00 (0.235)	0.29 *** (0.035)
Dummy job (farmer = 1; others = 0)	0.731 ** (0.092)	1.06 (0.123)
Status (family member or respondent are cadre or village facilitator)	0.808* (0.106)	0.757 ** (0.103)
gross revenue	1.00 (0.00)	1.00 (0.00)
Dummy basin (Shiyang River Basin residents = 1; Weihe River Basin residents = 0)	0.437 *** (0.043)	0.683 *** (0.067)
Family size	0.993 (0.037)	0.963 (0.036)
/cut1	−0.304 (0.336)	−0.865 (0.337)
/cut2	0.966 (0.337)	0.301 (0.336)
Number of obs.	1731	1731
LR chi2 (11)	104.95	122.28
Prob > chi2	0.000	0.000
Pseudo R2	0.031	0.036
Log likelihood	−1653.848	−1618.281

Notes: *, ** and *** refers to the 90%, 95% and 99% confidence level.

Gender, political involvement and education are significant determinants of environmental concerns. Being male increases the odds ratio of ranking environment as a primary issue by 0.816 *versus* female residents. Political involvement (working as village facilitator or cadre) increases the environmental priority by an odds ratio of 0.757. As education level increases, the odds ratio of ranking environmental issues as a primary concern increases consistently. Very significant differences were also observed between the two basin residents' opinions about the importance of these issues.

5. Discussion and Conclusions

The Chinese economy is in a transition. Fast economic growth, significant poverty reduction, improved education and health care provisions, and remarkable infrastructure construction characterize the positive dimensions of this development. However, the negatives include ever-growing environmental and water resource degradation. Though the negative externalities of economic growth such as pollution and ecological degradation are inevitable, maintaining them at nature's maximum sustainable capacity would not disturb nature. However, sustainability requires a trade-off between the positive and the negative outcomes of development [30]. Hence, management policies and strategies are the key instruments while the public's demands and expectations are indicators of the needs. Thus, understanding the public's policy demand is very important because this critical transition stage faces a tight, repelling force between economic growth and the environment and natural resources' carrying capacity.

Our results suggest that at this point in time, residents have attached the highest importance to environmental and resource degradation issues. They ranked them above all the other socio-economic and health-related issues, indicating that the public will gain greater utility if environmental and water resource restoration policies are implemented compared to any other policy. Of the environmental and water resource policies, most people rank water quality, water quantity supply and water allocation issues as the most serious. This may not be surprising because the two basins have a critical water shortage and are listed as water poverty regions ($<1000 \text{ m}^3$ per capita per annum) and they have highly degraded water quality (level V). This cannot be used for any economic or recreational activity without treatment [21,27]. Moreover, the imbalanced water extraction in the different integral parts of the basins, water losses due to an inefficient irrigation system, and highly competitive water demand among different users coupled with the existing water supply deficit are additional sources of public concern. The environmental and water issues in China are not only limited to the northwest. Though the causes of concern differ (e.g., water shortage in northwest and water pollution and soil acidity in the south), it is a critical issue throughout the country. Hence, the results of this analysis may have implications for the rest of China.

The Likert scale analysis provides a further explanation on the existing environmental and water resources issues. The ranking-based analysis may order or arrange the environmental degradation issues relative to each other's importance, but it does not tell us how important or unimportant a specific issue is in absolute terms. The Likert scale (assigning value ranging from 1 to 5 based on importance) fills this weakness. As shown in Table 5, respondents have irrefutable agreement on the needs of the basins' ecological restoration. All the assessed ecological issues are important to the residents, ranging from very important (water quality and state of irrigation); important (water flow, vegetation cover); to average-to-important (hydro-electric power generation, eco-tourism or recreation, household ecology restoration fee, aquatic life or fish and wildlife habitats). Having confirmed the rank of their importance, the monetary values of the restoration demands can then provide important information for the welfare estimation and cost-benefit analysis of restoration policies.

In general, environment and natural resources are public goods. Unlike private goods, they are characterized as non-rivalry (one's person consumption of said good will not prevent another's consumption of it) and non-excludable (a particular person or group cannot be excluded from its usage). That means any individual who cares more/less about them is not necessarily going to get more/less of them. Similarly, a few people's decision to lead a green lifestyle might not have a significant

impact if society as a whole is immoral and non-rewarding. Therefore, even if the public is gravely concerned about the environment, they may not move to environmentally friendly policies. Hence, expressing environmental concern alone will not lead to direct behavioral change. It will provide the necessary motives for institutional changes. Thus, changes in residents' behavior would only occur with institutional change such as an ecological tax, which discourages harmful environmental resource utilization and rewards environmentally friendly behavior. Now is the right time for China to embrace ecological environment restoration given the high public demand and support for such programs. Supplementing restoration programs with educational instruments can also play an important role in enhancing people's concerns and awareness.

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