Public Participation and the Effect of Environmental Governance in China: A Systematic Review and Meta-Analysis

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Abstract: The public plays a key role in environmental governance systems. Many studies have discussed the effects of public participation on environmental governance in China from different perspectives. However, there has been no systematic integrated analysis of the effects of public participation on environmental governance and the causes of its heterogeneity. To help fill this gap, we developed a comprehensive analysis framework of the regional differences–participation method–pollution type, and 85 effect sizes were tested by the meta-analysis method. The results showed that there was a weak positive correlation between public environmental participation and the environmental governance effect ($ES = 0.044$, $p < 0.001$). The correlation between the two was regulated by regional space and pollution type. The promotion effect of public participation on waste and noise was significantly higher than that of central and western areas. However, there was no significant difference between the different participation methods. Taken together, these results have important significance for increasing public participation and optimizing the effect of environmental governance.

Keywords: public participation; environmental governance; meta-analysis; China's local government

1. Introduction

In the past ten years or so, political trends and scholarly research have promoted collaborative and participatory governance in multilevel systems to achieve more sustainable and effective environmental governance [1,2]. With the development of society, environmental governance has become a complicated issue that most countries need to address. It is necessary to increase the participation of more stakeholders to rebuild environmental governance systems and promote environmental sustainability [3]. In this context, the public has been singled out as a major partner in the quest for sustainable development, and their participation can help with the design of more scientific policies [4]. In the United States, participatory structures such as citizen advisory committees were adopted in the 1980s and 1990s to improve the one-way flow of information at public hearings on proposed environmental policies. Russia implemented the Environmental Protection Law of the Russian Federation in 2002, which provides citizens, social organizations, and other noncommercial groups with the right to social supervision of environmental protection. China, as a country with serious environmental problems, is no exception. Since the 21st century, environmental problems caused by rapid economic development have rapidly emerged [5]. China has begun to rethink its environmental governance systems due to the shortcomings of the government and enterprises, with public participation as key to solving environmental problems and sustainable development [6]. The central government of China proposed the construction of a modern environmental governance system, with party committees providing leadership, the government taking main responsibility, enterprises being the main body, social organizations and the public jointly participating. According to the Annual Report of China's Ecological and Environmental Statistics 2020, 231,297 cases of environmental problems were reported in that year. China, as one of

the countries with the highest level of public participation and prominent environmental problems, provides a particularly useful case for studying the impact and influencing factors of public participation in environmental governance. Our findings have important guiding implications for enhancing public participation and optimizing the effectiveness of global environmental governance.

Although the frequency and forms of public participation in environmental governance are increasing, no consensus has been reached on the effect of public participation in environmental governance according to the current research conclusions. There are several contradictory conclusions that public participation can both significantly promote the effect of environmental governance and have a limited effect on environmental treatment or may even not promote the effect of environmental governance [7–9]. This may be because existing studies have lacked systematic attention to the relationship between the effects of public participation in environmental governance, and different scholars have chosen different variables and samples to study this issue, leading to inconsistent research conclusions. For example, they have only studied the impact of public participation in a certain region on environmental governance or the effect of public participation in the governance of a certain pollutant. Thus, the existing relevant research conclusions have limitations. Therefore, to what extent public participation improves the effect of environmental governance and what factors affect the relationship between public participation and the effect of environmental governance have not yet been fully and clearly elucidated. These questions need further testing and answers.

This study conducted a quantitative analysis of the above issues based on a meta-analysis, comprehensively and systematically analyzing the impact of public participation on the effect of environmental governance by integrating the domestic and foreign empirical literature on the relationship between public participation and environmental governance results. We further integrated the multiple factors that lead to the difference in governance effects. Our study promotes better public participation in environmental governance and the construction of ecological civilization through providing a reference.

2. Public Participation and Environmental Governance Effect

Scholars generally regard the intention of participants as the key criterion for judging public participation and think that public participation refers to "actions taken by ordinary citizens to directly or indirectly influence the choice of government officials or the policy decisions they make" [10]. Specifically, public participation in environmental governance refers to the direct or indirect participation of individuals, social organizations, and groups with environmental interests in the process of environmental policy in promoting the effect of environmental governance [11]. Public participation in environmental governance is the result of multiple factors, such as the environmental situation, rational choice, and result feedback. An important behavioral motivation for the public to participate in environmental governance as stakeholders of environmental issues is to safeguard their own rights and interests.

However, regarding the evaluation of the effect of public participation on environmental governance, the conclusions are inconsistent and fragmented. Some scholars think that public participation can significantly promote the effect of environmental governance. For example, some scholars found that public participation can significantly promote binding environmental pollution indicators and nonbinding emissions of environmental pollutants related to their own health and quality of life [12]. Zhang et al. evaluated the role of public participation in regional emission reduction and found that public participation significantly reduced regional carbon emissions and regional carbon intensity [13]. However, some scholars think that the government's administrative environmental control still plays a major role at the present stage, and the existing studies have exaggerated the role of public participation in improving the environment [8,14]. On the one hand, public participation in environmental governance is the result of psychological motivation, rational choice, structural background, and culture. Public participation in environmental governance is

not always active and proactive, resulting in poor environmental governance results [15]. On the other hand, whether government environmental agencies can effectively address the environmental demands of the public also depends on multiple factors. Morrison et al. found through interviews that the governance of environmental issues often depends on the mix of organizational tasks, needs, and personal interests of government agencies. Policy actors often avoid collaborating when environmental policy issues exhibit reinforcing interdependencies [16]. As a result, public participation cannot always significantly promote the effect of environmental governance. In general, researchers have analyzed the relationship between public participation and environmental governance from different perspectives, but the conclusions have been contradictory. It is necessary to clarify the relationship between public participation and environmental governance as a whole. Therefore, we proposed the first research hypothesis:

H1: *Public participation positively affects the effect of environmental governance.*

3. A New Framework of Public Participation in Environmental Governance

Through relevant studies on the effect of public participation in promoting environmental governance, it can be found that the relationship between them is also affected by moderating factors. Existing studies have explored the impact of public participation on the effect of environmental governance from different perspectives, but, in general, the existing discussions are relatively single and scattered. In view of this, we drew upon the existing research literature and explored the factors regulating public participation in promoting the effect of environmental governance from the perspectives of regional differences, participation paths, and pollution types.

3.1. Regional Differences

Through a literature review, we found that the effects of public participation on environmental governance in different regions may be heterogeneous because of the different economic and social development conditions and environmental problems among the different regions. In recent years, although the ecological and environmental quality of China's provinces and six regions have significantly improved, the level of improvement has varied among different regions [17]. According to the China Environmental Statistical Yearbook 2021, the rates of solid waste utilization and municipal waste water treatment were 72.6 percent and 97.4 percent in eastern China, 57.0 percent and 97.7 percent in central China, and 45.4 percent and 97.6 percent in western China. The public and local governments in the eastern region pay more attention to environmental issues [18]. It is difficult for public participation in the central and western regions to meet the requirements of social and economic development in terms of either procedural provisions or government response, which leads to additional problems with "participation failure" in environmental governance in western regions. To test the regional heterogeneity of the effect of public participation, the second research hypothesis in this paper was proposed:

H2: *There are significant regional differences in the effectiveness of public participation in promoting environmental governance.*

3.2. Methods of Public Participation

Environmental letters, environmental visits, suggestions from National People's Congress (NPC) deputies, and proposals from Chinese People's Political Consultative Conference (CPPCC) members are the four main channels for public participation in environmental governance [19]. It is easy to obtain a clear data structure for indicators such as "total number of environmental letters", "number of motions or suggestions of NPC deputies", "number of proposals of CPPCC committees", and "number of environmental letters and visits". These have been widely used in many studies on public participation in environmental governance [20]. However, with the development of Internet information technology, an increasing number of people are participating in environmental governance

through the Internet, and scholars are paying increasing attention to it. For example, Zheng et al. used the Google Search index to measure the public's participation in "environmental pollution" and though that the issues concerning the public were positively correlated with the content reprinted and reported by news media, so the Google Search index could reflect the public's concern with and participation in environmental issues [21]. Some scholars have combined the above two measurement methods [22].

Public participation in environmental governance presents a diversified picture. Different participation methods of public participation motivation, opinion expression, communication skills, and the degree of pressure on environmental protection departments also have different impacts on the environmental governance effect. For example, some studies found that the effect of public environmental visits on environmental governance is better than that of online public opinions on environmental protection, while the positive effect of CPPCC proposals and the motions of the National People's Congress is not significant [23]. A study also found that public participation through Baidu search and Weibo public opinion had a significantly better positive impact on pollutant emission reduction than traditional participation through letter writing and visiting [24]. Therefore, to further test the impact of public participation on the effect of environmental governance, this study proposed the following hypothesis:

H3: *The effect of public participation in environmental governance is affected by the method of participation.*

3.3. Types of Pollution

According to the source, environmental pollution can be divided into air, water, solid waste, and noise pollution [25]. Existing studies have concluded that the effect of public participation on environmental governance is influenced by pollution type. There are individual differences in perception of and tolerance to various pollutants as well as requirements for environmental quality; thus, people show different logics for participating in different types of pollution. Under the influence of social policy background and the complexity of environmental risks, environmental protection departments show different efforts and experience various difficulties in controlling different types of pollution, which will also affect the effect of environmental governance. However, there are also differences in the research conclusions on the effect of public participation on the treatment of different pollution types. For example, some studies found that public participation in the treatment of water environment, solid waste, and noise environment pollution is relatively high and has achieved significant treatment effects, but the effect of participation in the treatment of air environmental pollution is not significant [26]. Some studies found that public participation can significantly promote the effects of air pollution, as well as those of noise and solid waste pollution. The effect of water pollution treatment is less ideal [23]. To test the impact of public participation on the effect of different pollutants, we proposed the following hypothesis:

H4: *The effect of public participation on environmental governance is affected by the type of pollution.*

Based on the systematic analysis of the above factors, we built a comprehensive analysis framework of the effect of public participation on environmental governance. This case is depicted in Figure 1.
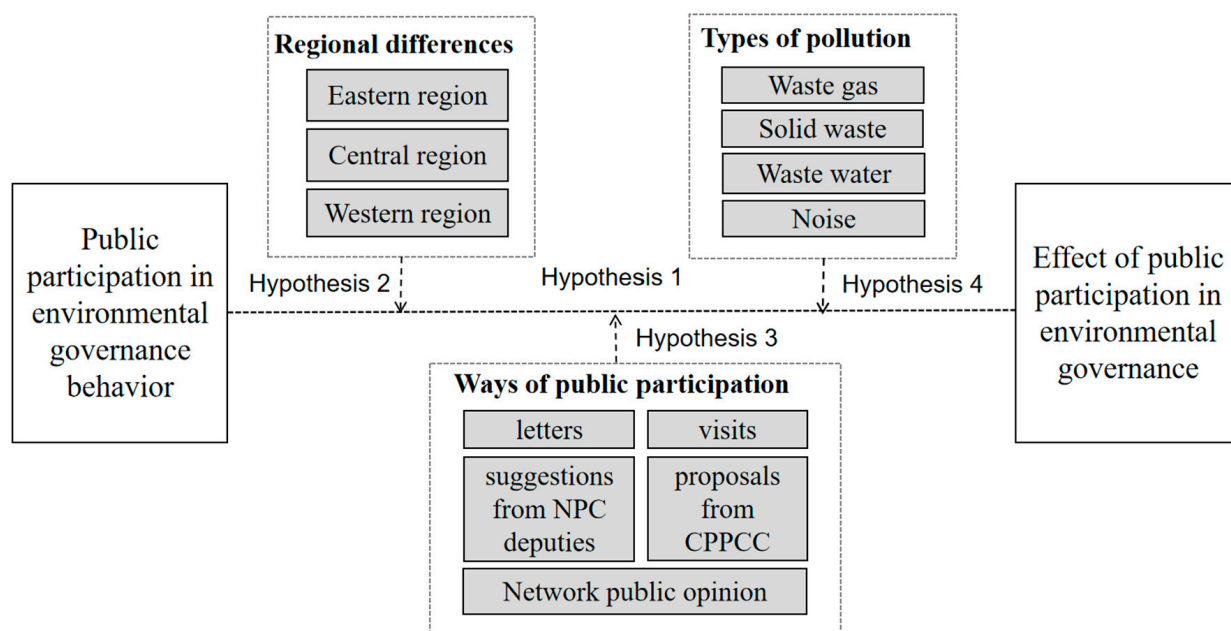
Figure 1. Comprehensive analytical framework of the effect of public participation in environmental governance.

4. Method

4.1. Search Strategy

The systematic review and meta-analysis were conducted according to the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) statement, and performed the CRD42023396375 protocol in Prospero [27,28]. First, we searched the China National Knowledge Network (CNKI) database for articles. We used terms such as "public participation", "environmental governance effectiveness", and "environmental governance impact". Second, we searched for articles in databases such as Web of Science, EBSCO, Pro Quest, etc., using the term "public participation" to match with "environmental governance effect", "environmental results", and "environmental protection". In addition, to avoid retrieval omission, scholars who had long been studying public participation and environmental governance were specifically searched in the literature reading process, and the citations were reviewed and supplemented. The search was completed on 18 April 2022. Reports, reviews, expert opinions, and conference abstracts were excluded.

4.2. Study Selection

We formulated inclusion criteria for the retrieved literature and screened those that met the conditions. First, the study needed to be quantitative research. Second, the study needed to contain statistics on the relationship between two variables of public participation and the environmental governance effect (pollution emission), such as sample size N, correlation coefficient r, t value, β, χ^2, F value, significance, p value, etc. Finally, the study needed to be limited to studying the effects of public participation and environmental governance in China. Two researchers independently searched the databases. If disagreements occurred, the results were delivered to another researcher for evaluation.

4.3. Quality Assessment

To ensure the validity of the meta-analysis, it is necessary to evaluate the quality of the studies after the initial collection [29]: (1) The 0 points for a sample size is 0 points for of 0–50, 1 point for 51–200, and 2 points for more than 200. (2) According to the publication level, 0.5 points should be assigned for general journals, 1 point should be calculated for "Research Center for Chinese Science Evaluation"(RCCSE) journals, and 2 points should be

assigned for source studies of "Social Sciences Citation Index"(SSCI) journals and "Chinese Social Sciences Citation Index"(CSSCI) journals. (3) Experience of the researcher: a score of 1 is given to a researcher who has published only one paper on the same topic; a score of 2 is given to a researcher who has published more than one paper on the same topic. (4) The studies without panel data test are worth 0.5 points, and those with a panel data test are worth 2 points. (5) If the panel data of the study did not contain the statistical data of the last ten years, this was calculated as 0.5 points; if the panel data included the statistical data of the last ten years, this was calculated as 2 points. The total score of each study was between 0 and 10, where the higher the score, the better the quality of the study. Studies with a quality score of less than 3 were excluded. The scores were independently assigned by two researchers.

4.4. Data Extraction

The effect size of the relationship between the effects of public participation in environmental governance in this study involved the relationship between two variables, so the effect size based on the Pearson correlation coefficient *r* was selected. For articles without correlation coefficients, we calculated the correlation coefficients based on the *t* statistic (*t*) and degrees of freedom (*df*). The calculation formula is as follows [30]:

$$r = \sqrt{t^2/(t^2 + df)}$$

For studies that provided neither correlation coefficient nor a *t* statistic but reported the regression coefficient *β*, the regression coefficient was converted to *r* as the effect size, and the formulas are as follows:

$$r = \beta \times 0.98 + 0.05 \ (\beta \geq 0)$$

$$r = \beta \times 0.98 - 0.05 \ (\beta \leq 0)$$

Before the meta-analysis, *r* was converted to Fisher's *Z*:

$$ES_{z_r} = 0.5 \ \log_e \left[\frac{1+r}{1-r} \right]$$

Comprehensive Meta-Analysis 3.3 was used to extract data.

4.5. Statistical Analysis

First, we tested the heterogeneity of the effect size distribution. The heterogeneity test was based on the *Q* statistic and I^2 test. The *Q* statistic obeys the chi-square distribution of freedom $K-1$, where *K* is the number of effect sizes, and the *Q* formula is as follows:

$$Q = \sum w_i \left(ES_i - \overline{ES} \right)^2$$

where ES_i is the individual effect size, *i* ranges from 1 to *K*, $\overline{ES}$ is the weighted average effect size of *K* individual effect sizes, and w_i is the individual weight of ES_i. The test level of the *Q* test was $p = 0.10$, the studies were considered heterogeneous when $p < 0.10$. The I^2 statistic also reflects the proportion of heterogeneity in the total variation in the effect size. I^2 is between 0 and 100. If I^2 is between 0 and 50, there was homogeneity between studies. If I^2 was between 50 and 100, the studies were heterogeneous. I^2 was calculated with the following formula:

$$I^2 = \frac{Q - (K - 1)}{Q} \times 100\%$$

Second, funnel plots and relevant statistical tests were used to determine the severity of publication bias. Funnel plots can be used to detect the publication bias caused by a small sample representation. If the effect sizes in a funnel plot are mainly distributed at

the top and symmetrical, the results can be considered to be relatively robust. To further measure the publication deviation of the studies, we also calculated Rosenthal's fail-safe *N* (fail-safe *N*) [31]. The fail-safe *N* reports the number of unpublished studies with invalid results. The more unpublished studies are needed, the more credible the results of the study. The formula is:

$$N = \left[\left(\sum Z \right)^2 / 2.706 \right] - K$$

where $\sum Z$ represents the total number of effect sizes. If $N > 5 \times K + 10$, the analysis results are not sensitive to publication bias. Statistical analysis was carried out using Comprehensive Meta-Analysis 3.3.

5. Results

5.1. Search Results

The flow chart shown in Figure 2 demonstrates the selection of studies included in this meta-analysis. A total of 2957 studies were found through the initial search of the electronic databases. A total of 2930 articles were excluded based on the 3 criteria in the study selection. According to the quality assessment, three articles were excluded, and the average quality score of the finally included articles was 8.54 points, indicating a good level. In addition, two studies were supplemented by literature reading and special search. Finally, a total of 26 articles were included in the analysis, including 23 journal articles and 3 dissertations. As some papers reported statistical analysis on multiple samples in one study, 85 independent effect sizes were finally obtained, including 61,231 samples (Figure 2).
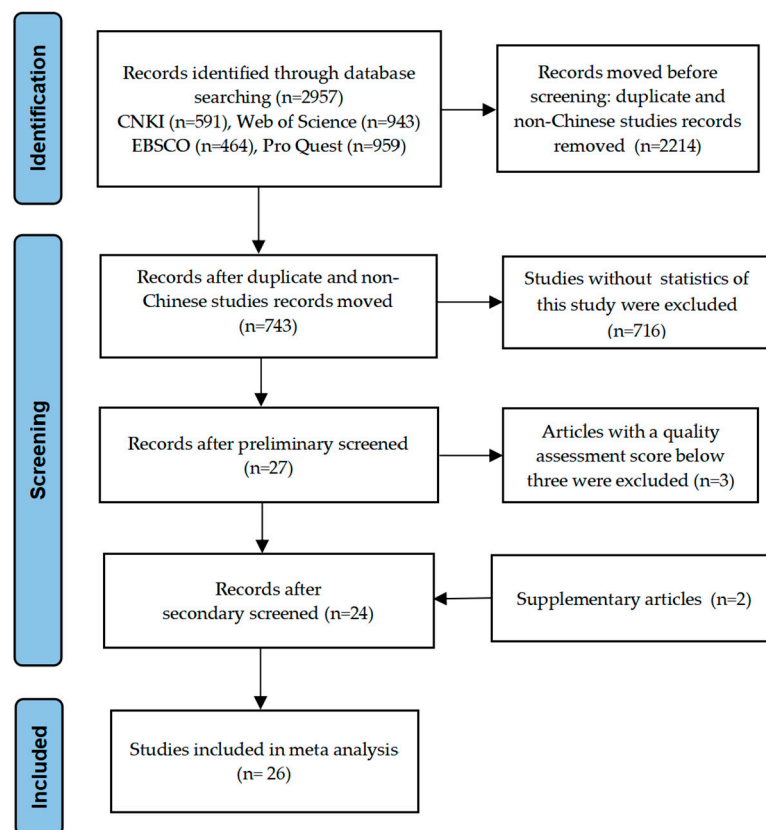
Figure 2. Literature search protocol and results.

5.2. Study Characteristics

The effect size was calculated for the 26 included studies, and the characteristics of each study were coded. A total of 85 effect sizes were obtained. Table 1 shows the main

characteristics and details extracted from all included studies. The studies covered the period from 2022 to 2015. The calculated effect sizes of the included studies ranged from −0.466 to 0.224. Negative effect sizes indicated that public participation could reduce pollution and promote the effect of environmental governance. There were three moderating variables in this meta-analysis, including participation methods, region, and pollution type. The 59 effect sizes reported the relationship between public participation and the environmental governance effect under different participation methods, 27 effect sizes reported the relationship between public participation and the environmental governance effect in different regions, and 46 effect sizes reported the relationship between public participation and the environmental governance effect under different pollution types. Table 1 shows the main characteristics and details extracted from all included studies.

Table 1. Studies coding summary.

Articles	ES	Standard Error	Data Size	Method of Participation	Type of Pollution	Regional	Article Source
Zhen Lu, 2021 [32]	−0.029	0.082	150	LET	TW	C	D
	−0.030	0.082	150	VIS	TW	C	D
	−0.041	0.082	150	SUG	TW	C	D
	−0.027	0.082	150	PRO	TW	C	D
	−0.136	0.082	150	NET	TW	C	D
Zhibin Zhang, 2021 [33]	−0.016	0.064	245	NET	WG	C	J
Guoxing Zhang, 2021 [34]	0.001	0.053	360	LET	TW	C	J
	0.002	0.053	360	VIS	TW	C	J
	−0.114	0.053	360	SUG	TW	C	J
	−0.074	0.053	360	PRO	TW	C	J
Anjie Lu, 2021 [23]	−0.121	0.084	145	ALL	WG	C	J
	−0.162	0.094	116	ALL	WW	C	J
	−0.089	0.084	145	ALL	SP	C	J
Zhike Lv, 2021 [35]	−0.029	0.082	150	LET	TW	C	J
	−0.030	0.082	150	VIS	TW	C	J
	−0.041	0.082	150	SUG	TW	C	J
	−0.027	0.082	150	PRO	TW	C	J
	−0.136	0.082	150	NET	TW	C	J
Xiuyuan Guo, 2020 [36]	−0.130	0.108	88	NET	WG	E	J
	0.038	0.128	64	NET	WG	M	J
	0.015	0.108	88	NET	WG	W	J
Liang Yu, 2019 [26]	−0.084	0.070	210	ALL	WG	C	J
	−0.226	0.070	210	ALL	SP	C	J
	−0.130	0.111	84	ALL	WG	E	J
	−0.052	0.111	84	ALL	SP	E	J
	−0.303	0.129	63	ALL	WG	M	J
	0.065	0.129	63	ALL	WG	W	J
Tong Zhang, 2018 [24]	0.152	0.082	150	LET	TW	C	J
	−0.039	0.082	150	VIS	TW	C	J
	−0.427	0.082	150	NET	TW	C	J
	−0.168	0.082	150	NET	TW	E	J
	0.224	0.082	150	LET	TW	M	J
	−0.328	0.082	150	VIS	TW	M	J
	0.093	0.082	150	NET	TW	M	J
	0.021	0.082	150	LET	TW	W	J
	0.098	0.082	150	VIS	TW	W	J
	0.101	0.082	150	NET	TW	W	J
Shuxin Tan, 2017 [37]	−0.009	0.058	300	ALL	WW	C	D
	0.000	0.058	300	ALL	WG	C	D
Chao Han, 2016 [38]	−0.003	0.031	1070	ALL	TW	C	J
Jingjing Zeng, 2015 [39]	0.146	0.057	310	LET	WW	C	J
	−0.060	0.057	310	LET	WG	C	J
	−0.103	0.057	310	LET	SW	C	J

Table 1. *Cont.*

Articles	ES	Standard Error	Data Size	Method of Participation	Type of Pollution	Regional	Article Source
	0.08	0.057	310	VIS	WW	C	J
	−0.029	0.057	310	VIS	WG	C	J
	−0.124	0.057	310	VIS	SW	C	J
	−0.023	0.057	310	SUG	WW	C	J
	−0.076	0.057	310	SUG	WG	C	J
	−0.064	0.057	310	SUG	SW	C	J
	−0.026	0.057	310	PRO	WW	C	J
	0.011	0.057	310	PRO	WG	C	J
	−0.079	0.057	310	PRO	SW	C	J
Huimin Lei, 2021 [40]	−0.002	0.092	120	PRO	TW	W	D
	0.001	0.092	120	VIS	TW	W	D
	0.001	0.092	120	LET	TW	W	D
	−0.002	0.098	108	PRO	TW	M	D
	0.002	0.098	108	VIS	TW	M	D
	−0.001	0.098	108	LET	TW	M	D
	−0.002	0.088	132	PRO	TW	E	D
	−0.003	0.088	132	VIS	TW	E	D
	−0.001	0.088	132	LET	TW	E	D
	−0.022	0.088	132	SUG	TW	E	D
Xing Li, 2022 [41]	0.000	0.060	278	NET	WG	C	J
Ying Han, 2022 [42]	−0.266	0.047	450	ALL	WG	C	J
Tao Ge, 2021 [8]	−0.105	0.044	510	LET	TW	C	J
	−0.112	0.044	510	PRO	TW	C	J
Xuan Leng, 2021 [43]	−0.044	0.019	2704	NET	WG	C	J
Ming Zhang, 2021 [44]	−0.092	0.058	300	VIS	WG	C	J
	−0.161	0.058	300	PRO	WG	C	J
Lihua WU, 2020 [14]	0.069	0.047	450	ALL	TW	C	J
Jingyan Fu, 2019 [45]	−0.031	0.056	327	LET	WG	C	J
	0.155	0.056	326	VIS	WG	C	J
Jin Guo, 2019 [3]	−0.215	0.082	150	ALL	TW	C	J
Zhengge Tu, 2019 [46]	−0.001	0.017	3666	ALL	WG	C	J
	−0.001	0.017	3666	ALL	WW	C	J
Yingxin Chen, 2019 [47]	−0.018	0.010	10000	ALL	WG	C	J
	−0.020	0.010	10000	ALL	WW	C	J
	−0.022	0.010	10000	ALL	SW	C	J
JiannanWu, 2018 [48]	−0.238	0.054	341	ALL	WW	C	J
Ling Li, 2018 [49]	−0.006	0.044	518	ALL	WG	C	J
Tong Zhang, 2018 [9]	0.064	0.082	150	ALL	WG	C	J
	−0.263	0.082	150	ALL	WG	E	J
	−0.219	0.082	150	ALL	WG	M	J
	−0.093	0.082	150	ALL	WG	W	J
Shengling Zhang, 2018 [50]	−0.004	0.017	3488	NET	WG	C	J

Note: LET = letter of environmental protection, VIS = visit of environmental protection, SUG = suggestion of NPC, PRO = proposal of CPPCC, NET = online public opinion, and ALL = all participation; WG = waste gas, WW = waste water, SW = solid waste, SP = sound pollution, and TW = all pollutants; C = whole country, E = east, M = central part, and W = the west; J = journal, D = dissertation.

5.3. Statistical Analysis

Table 2 shows the combined effect sizes of the 85 statistics from the 24 studies. The results of the sample heterogeneity test showed that Q = 209.285, p = 0.001 < 0.10, and I^2 = 59.863, indicating heterogeneity among samples. The estimates between studies could have been affected by some characteristic factors of the studies, such as the moderating variables mentioned in this paper. According to the statistical principle of meta-analysis, the random effects model was used when the heterogeneity was high, and the fixed effects model was used when the heterogeneity was low. We chose the random effects model. In addition, it can be seen from the p values and effect sizes in Table 2 that public participation

in environmental governance could significantly inhibit the emission of pollutants and promote the effect of environmental governance, so Hypothesis 1 was verified.

Table 2. The effect of public participation on environmental governance.

Model	Sample Size	Effect Size	95% CI Lower Limit	Upper Limit	Test of Null Z	p	Heterogeneity Q	df	p	I^2
Fixed effect	85	−0.026	−0.026	−0.019	−6.532	0.000	209.285	84	0.000	59.863
Random effect	85	−0.044	−0.061	−0.027	−5.110	0.000				

The funnel plot in Figure 3 represents the results of publication bias in our meta-analysis. The horizontal axis represents the effect size transformed by Fisher's Z, and the vertical axis represents the standard error of the effect size. The effect sizes are mainly distributed at the top and are symmetrical, which preliminarily showed that the results were relatively robust. The Rosenthal's fail-safe N of our meta-analysis was N=1054, which met the standard. Therefore, there was no publication bias in the literature selected in this study, and the calculated weighted average effect size was close to the real level, with high robustness.
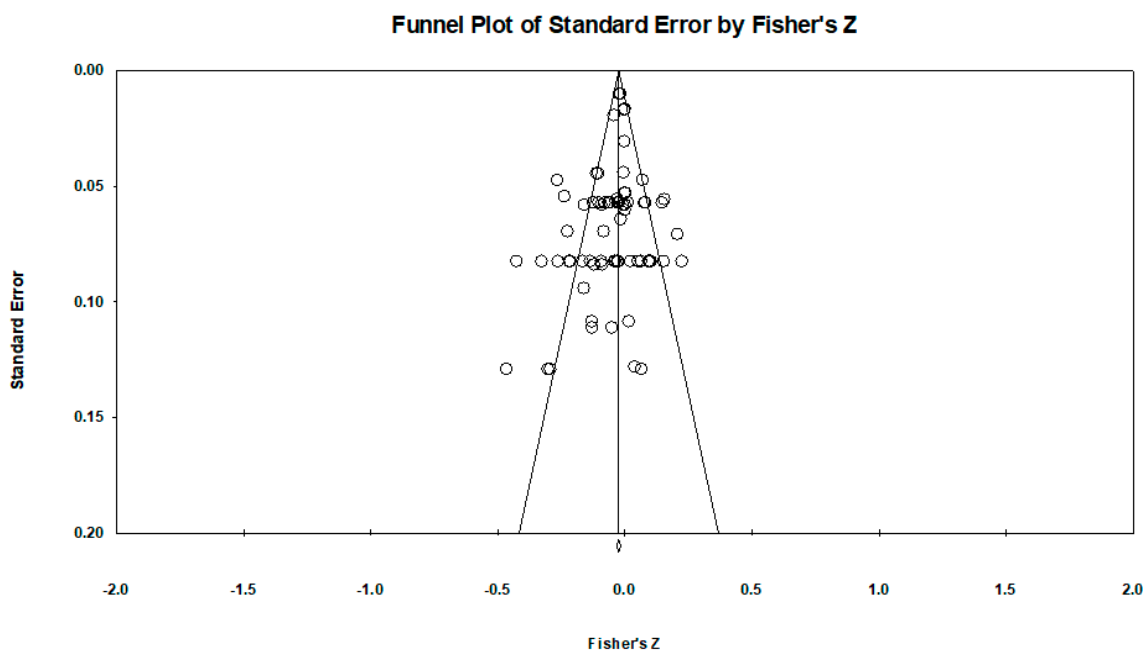
Figure 3. Funnel plot of standard error by Fisher's Z.

5.4. Moderator Analysis

The moderating variables selected in our study were all category variables, and subgroup analysis as used to test the moderating effects (specific moderating effects are shown in Table 3). It was found that (1) the moderating effects of regional differences were significant. Hypothesis 2 was verified: the effect of public participation on environmental governance was affected by regional differences. In the eastern region, public participation could significantly restrain pollution emissions and promote the environmental governance effect, while in the central and western regions, public participation could not significantly promote the environmental governance effect. (2) The adjustment effect of participation style was not significant, and Hypothesis 3 was not verified. (3) The adjustment effect of pollution type was significant, and Hypothesis 4 was verified. Public participation could significantly reduce the emissions of waste gas, wastewater, waste, and noise pollution, and the effect of public participation on the emissions of noise and waste pollution as stronger. The data are shown in Table 3.

Table 3. Moderating effect analysis of the effect of public participation in environmental governance.

Moderator	Heterogeneity			Category	K	Population Effect Size	p	95% CI	
	Q_B	df	p					Lower Limit	Upper Limit
Region	6.638	2	0.036	Eastern	9	−0.088	0.004	−0.147	−0.027
				Central	9	−0.048	0.468	−0.037	0.081
				Western	9	0.022	0.121	−0.109	0.013
Method of participttion	6.946	4	0.247	Letters	14	−0.040	0.384	−0.040	0.029
				Visits	14	−0.016	0.746	−0.052	0.020
				Suggestions	7	−0.062	0.010	−0.109	−0.015
				Proposals	11	−0.031	0.006	−0.99	−0.024
				Public opinion	13	−0.062	0.001	−0.053	−0.009
Types of pollution	8.118	3	0.044	Gas	29	−0.026	0.000	−0.035	−0.014
				Water	9	−0.016	0.049	−0.031	0.000
				Solid	5	−0.030	0.002	−0.048	−0.011
				Sound	3	−0.147	0.002	−0.238	−0.053

6. Discussion

6.1. The Relationship between Public Participation and the Environmental Governance Effect

The evidence analyzed in this study indicated that public participation had a significant negative impact on pollution emissions and could promote the effect of environmental governance, and Hypothesis 1 of this study was supported. It was found that public participation had a low degree of positive impact on the effect of environmental governance, which means that although public participation can promote the effect of environmental governance, but the degree of the effect is very limited.

This proves the importance of public participation in environmental governance. Compared with the traditional government-led top-down environmental governance model, the public, as stakeholders of environmental governance, can exert external pressure on the government's environmental governance work with their environmental attitude and supervision behavior and promote effective solutions to environmental problems. Public participation of those with some relevant environmental knowledge can provide scientific knowledge and wisdom for environmental governance and provide a useful reference for the government's environmental decision making. In addition, it also proved that public participation is not just a "fraud" for the government to increase its own legitimacy. Public participation in the environmental field is an effective way to promote the effect of governance [51]. More broadly, our conclusions confirmed the validity of political participation based on people's participation in the pursuit of collective interests. Different from previous research conclusions, our research results showed that although public participation can promote the effect of environmental governance, the degree of positive correlation is very weak, the "effect" of participation is still relatively small, and the ability of public participation and the response ability of local governments have not been fully achieved.

6.2. Factors Affecting the Effect of Public Participation on Environmental Governance

First, the results showed that the region played a moderating role, and the effect of public participation in environmental governance was different among regions. In eastern China, public participation could significantly promote the effect of environmental governance, while in central and western China, it could not significantly promote the effect of environmental governance. This may be related to the difference in the level of economic development between regions and the level of education of residents. Compared with the central and western regions, citizens in the east have higher political awareness, legal knowledge, and technical resources, so their participation can help the government formulate more scientific environmental policies. Comparatively, the economic level of

the central and western regions is relatively lagging, with relatively fewer resources, more intractable environmental problems, and more vulnerability to failure of public participation. Especially in the western region, although the ecological and environmental protection problems in the region have been effectively improved since the development of the region, the past development mode of emphasizing economy and undervaluing ecology, especially the transfer of labor-intensive industries and resource-intensive industries, has made the western region face greater pressure to balance economic development and environmental protection compared with the whole country and eastern coastal areas. As a result, it is costly, difficult, and ineffective for local governments to respond to public environmental demands.

Second, there was no significant difference in the influence of different participation methods on the environmental governance effect. From the perspective of the intragroup effect, it was found that the combined effect size of environmental protection letters was -0.040, of environmental protection visits was -0.016, of suggestions of the People's Congress was -0.062, of proposals of the CPPCC was -0.031, and of network public opinion was -0.062. The combined effect value of the suggestions of the People's Congress, the proposals of the CPPCC, and network public opinion passed the significance test. It showed that the suggestions of the People's Congress, the proposals of the CPPCC, and public Internet opinions can play a positive role in improving the effect of environmental governance. Because the government is more clear about the environmental issues raised by the NPC recommendations and CPPCC proposals and the government needs to respond formally, environmental governance is more effective. In addition, the reason why network public opinion can promote the effect of environmental governance may be to the constraint and supervision effects of public opinion. The rapid development of the Internet provides a more convenient method of public participation. It can expand the opportunities and impact of public participation on environmental governance. The exposure of public opinion and network media will form a kind of constraint on the pollution behavior of enterprises.

Finally, we explored the moderating effects of different pollutant types on the effects of public participation and environmental governance. It was found that the combined effect size of waste gas was -0.026, of wastewater was -0.016, of waste was -0.030, and of noise was -0.147, and the effect sizes of the four pollutants all reached statistical significance, indicating that public participation significantly promoted the treatment effect of the four kinds of polluting wastes. The analysis of intergroup heterogeneity of pollution types showed that the moderating effect of pollutant types was significant, and the effect of public participation on environmental governance was related to pollutant type. Among the four pollutants considered in this study, public participation had a higher inhibitory effect on noise and waste pollution than on wastewater and waste gas pollution. This suggests that people may be more sensitive to waste pollution and noise pollution and therefore pay more attention to these types of pollution. The public's participation in the treatment of waste gas and wastewater was weak, which may have been because they did not have a deep intuitive feeling and did not feel the obvious harmful effects of such pollution in the short term. Specifically, as wastewater is often discharged in rivers far away from residential areas, the public does not feel strongly about it. Air pollution contains six kinds of pollutants, namely, $PM_{2.5}$, PM_{10}, CO, SO_2, NO_2 and O_3, among which $PM_{2.5}$ and PM_{10} are the main components of haze and are relatively easy to perceive by the public, while SO_2 and NO_2 can only be perceived by the public when their concentration reaches a certain degree. Therefore, they only attract public attention under the condition of serious pollution. The concentrations of CO and O_3 in the air are relatively low and difficult to perceive, and the public pays little attention to them. Therefore, the public's attention to air pollution may only focus on some air pollutants, so its improvement effect on the remediation of this pollution type is not high.

7. Limitations and Future Research

The studies included in this systematic literature review are research on the effect of public participation on environmental governance in China; the literature on the effect of public participation on environmental governance in other countries was not included. Therefore, there may be limitations in the nationwide promotion of our meta-analysis conclusions. It is undeniable that our research conclusions have important reference significance for other countries with environmental conditions similar to those of China. In addition, in the analysis framework of the meta-analysis, we selected regional differences, participation methods, and pollution types. In reality, other factors may also affect the effect of public participation on environmental governance, such as citizens' education level, citizens' occupation, and the central government's attention to environmental protection issues [52]. However, given the lack of analysis of such factors in the existing relevant literature, our meta-analysis could not include the above influencing factors. More research is needed to obtain more relevant data to expand our knowledge of other moderating factors affecting the effect of public participation on environmental governance.

In the future, studies on the effects of public participation in environmental governance in other countries can be further incorporated, so that the conclusions are more convincing. The inclusion of more studies would enable a comparison of the effects of public participation in environmental governance in different countries to put forward more targeted policy recommendations. Moreover, we call for future experimental studies and more empirical tests of first-hand research data to generate more useful discussions in the field of public participation and environmental governance.

8. Conclusions and Policy Implication

Since the beginning of the 21st century, the discussion about public participation in environmental governance has become increasingly fierce. The emergence of new methods of public participation, such as online, has compensated for the shortcomings of traditional methods to a great extent. An increasing number of articles have proposed the theory of public participation through different research methods and have explored the effects of participation. However, there has long been controversy among the conclusions of the literature, and there has not been any comprehensive scientific evaluation of the literature, and a consensus on the key issues that require further study has not been reached. Therefore, we applied meta-analysis technology to build a three-dimensional analysis framework of regional differences, participation methods, and pollution types to expand upon the findings of existing studies, comprehensively explored the moderating factors of the effect of public participation on environmental governance, and clarified the differences between the conclusions of existing studies on the effect of public participation in environmental governance. The research conclusions have guiding value for promoting the sustainable development of public participation and optimizing the effect of environmental governance. Specifically, we verified that public participation can promote the environmental governance effect, but the effect is very weak. Moreover, the spatial empirical test showed that public participation in the eastern part of China can promote the environmental governance effect, but the relationship between the western and central areas is not significant. From the test of participation, our study found that the suggestions of the People's Congress, the proposals of the CPPCC, and network public opinions can more strongly promote the effect of environmental governance. From the pollution type test, it was found that public participation was more effective in curbing the discharge of waste and noise pollution.

Based on the results, we note several policy implications. First, the government should strengthen education and publicity, focusing on strengthening public awareness and guiding public participation in environmental governance in the central and western regions of China. Environmental education should be embedded into the daily lives of the public, and environmental knowledge should be publicized to the public through offline and online education and other means to guide the public to consciously fulfill their environmental protection responsibilities.

Second, the public can improve their environmental effect through the suggestions of the NPC, the proposals of the CPPCC, and online public opinion, which shows that the suggestions of the NPC, the proposal mechanism of the CPPCC, and the online participation mechanism play an important role in environmental governance. Therefore, the government should improve the system for deputies and committee members to keep in touch with the masses and give full play to the role of people's congresses and CPPCC committees at all levels in local environmental supervision. At the same time, online channels for the public to express their opinions on environmental governance should be unblocked, and an atmosphere conducive to online participation should be created.

Finally, the government should establish a rigorous environmental pollution accountability system. For environmental problems such as atmospheric environment and wastewater pollution that are unfamiliar to the public and for which treatment has been ineffective, the government should enhance the initiative and consciousness of environmental protection work. On the one hand, through environmental regulation legislation, law enforcement, and supervision, the central government should comprehensively eliminate local governments' nonaction, nonresponsibility, and non-confrontational behaviors in environmental governance. On the other hand, a long-term environmental accountability system should be implemented, improving the operating standards and rules for environmental assessment, standardizing the acceptance work of environmental governance, forming a closed loop of supervision, and publicizing the results to the society on schedule.

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