




## Article

# Water Policy Evaluation Based on the Multi-Source Data-Driven Text Mining: A Case Study of the Strictest Water Resource Management Policy in China

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**Abstract:** The strictest water resources management (SWRM) policy is a critical policy to address China's severe water shortage and pollution problems, and aims to promote sustainable water development and water governance. Based on data mining from multiple sources, including policy text from the strictest water resource management policy from 2011 to 2021, the reports of major media websites, and the Baidu Index, this study used the ROST-CM6 text-analysis tool to analyze the policy content, public opinion, and public perception of the strictest water resources management policy quantitatively and visually. The results found that the policy text and public-opinion are given high attention to the water resources assessment, water control management, and water resources protection, but the policy text focuses on the macro level, and pays more attention to national development and long-term planning. The public opinion belongs to the micro level and is more economic, and there is a certain degree of media bias. With notable regional disparities, the general public's opinion of the harshest water resource management policy has been rising every year. This research adds to the global body of knowledge on water governance, and serves as a guide for Chinese and other governments looking to improve their water resource management strategies.

**Keywords:** the strictest water resource management policy; text mining; multi-source data; Baidu Index; policy evaluation; water governance



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## 1. Introduction

The shortage of water resources, serious water pollution, and the deterioration of water's ecological environment have become major bottlenecks restricting water resource development in China [1,2]. Good water governance plays a key role in addressing the water crisis and achieving the Sustainable Development Goals. As a policy response, the strictest water resources management policy is a critical strategic decision made by the government to address the challenge of water governance [3]. It is an important approach to change water resource utilization, facilitate integrated water management, and promote the modernization of water management institutions and capabilities. The Ministry of Water Resources first proposed the strictest water resources management policy in 2009. The 2011 Central Committee Document No. 1, titled, "Decision of the State Council of the CPC Central Committee on Speeding Up the Reform and Development of Water Resources", clearly requires the implementation of the strictest water resources management policy. The strictest water resources management policy mainly includes the "three red lines": the red line of water resources development and utilization control, the red line of water efficiency control, and the red line of water-functional areas to limit pollution intake. The policy also includes the "Four Systems": the Total Water Use Control System, Water Efficiency

Control System, Water Function Area Limiting Pollution System, and Water Resources Management Responsibility and Assessment System.

As an important water governance policy, the strictest water resources management policy has received more scholarly attention. Existing studies mainly focused on the construction of the policy's theoretical framework, evaluation of the policy's effect, impact on industrial development, and policy comparison in the institutional context [4–7]. These studies help us comprehend how policies work, how they are made, and how they affect different sectors of the economy and geographical areas. However, on the one hand, an in-depth analysis of the strictest water resources management policy based on classical policy process theory, such as multiple streams, punctuated equilibrium, and the advocacy coalition framework, has not been carried out. On the other hand, less is known about a thorough understanding and comparative analysis of policy texts, public opinions, and public perceptions of the strictest water resources management policy, especially in recent years.

This study aims to examine and deepen the understanding of the strictest water resources management policy through multi-source public and open data mining of policy texts, public opinion reports, and the Baidu Index. We also offer a multi-dimensional analysis of the strictest water resource management policy to analyze water governance trends in China. This study makes two primary contributions. First, this study explores the hot topic and weaknesses of the strictest water resources management policy over the past ten years according to the analysis of key word frequency, visualization, and a semantic network of policy texts, public reports, and web resources. Second, this study offers a new perspective to assess water governance policy progress toward sustainable water development goals. To accomplish this, we developed a multi-source, data-driven analytical framework for water policy. This study enriches global knowledge surrounding water governance and policy. It also provides a decision-making reference for the optimization and promotion of water resources management policy in China, which is helpful to promote the high-quality development of water resources to support the social economy.

The rest of the article is structured as follows. Section 2 provides a brief overview of the policy process theory and strictest water resources management policy. Section 3 details the analytical framework, data, and methods used. Section 4 presents an in-depth, multi-dimensional and comparative analysis of the strictest water resource management policy including policy text, public opinion, and public perception in China. Section 5 concludes the article and analyzes the policy's implications.

## 2. Literature Review

### 2.1. Brief Review of Policy Process Theory

Policy process theory is an important topic in the discipline of public management. Policy process theory can be divided into knowledge of policy process and knowledge in policy process [8]. Policy process theory began in the middle of the 20th century and has now developed to the third generation [9]. Lerner and Raswell's *The Policy Science: Recent Developments in Scope and Method*, published in 1951, marks the beginning of policy process theory as a separate field of study in public administration. The first generation of policy process theory began with the seven-stage theory Raswell put forward. Since the 1980s, scholars have conducted more in-depth research. One of the most representative scholars is Paul Sabatier, whose book *Policy Process Theory* marks the development of policy process theory to the second stage [10]. Since the 21st century, based on the several representative theories listed in second-generation policy process theory, such as multiple streams, punctuated equilibrium, the advocacy coalition framework, institutional analysis and development framework, and policy diffusion, verifying, perfecting, and expanding these policy frameworks has become an important research direction in the discipline of public administration [11]. Through the criticism, inheritance, innovation, and reformation of second-generation policy process theory, third-generation policy process theory has emerged in recent years, and some new theoretical frameworks, such as narrative policy

framework and policy feedback theory, have been developed [12]. It should be noted that the evolution of policy process theory is not linear and unidirectional; that is, new theories do not replace previous theories, but rather co-evolve with them [13]. However, policy process theory originated in Western countries, and its development is rooted in democratic institutions, stable social environments, and well-functioning market mechanisms [14]. These preconditions have posed some challenges to the development of policy process theory in other countries. In the past two decades, Chinese researchers have made several attempts to localize the theory of policy process, however, there is a trend of rigorously imitating Western theory [15]. For a long time, the study of policy process theory in China has been dominated by research that is based on academic perspectives from the West. In this theoretical development environment, Chinese scholars have also conducted a lot of localization research in the past 20 years. The most representative theories are the consensus decision model, brainstorming model, political potential energy theory, policy change theory, hierarchical promotion-strategic response theory, path-incentive analysis framework, and consensus democracy model [16,17].

With the development of policy process theory, policy research gradually involves policy formulation, analysis, implementation, and evaluation [18]. Policy evaluation and analysis can reasonably avoid the problems and risks of the policy process, which is an extremely important part of the policy process and a guarantee for the healthy operation of public policy [19]. Policy evaluation is also known as policy assessment, including policy pre-assessment, implementation assessment, and effectiveness assessment [20]. There are two kinds of public policy evaluation methods: cost-benefit analysis (CBA) and cost-effect analysis (CEA). At present, policy evaluation research involves various fields of industry, such as industrial policy, science and technology policy, social security, ecological environment, financial policy, education policy, and poverty alleviation policy [21–25]. More and more scholars are focusing on evaluating the effectiveness of various policy implementations. In the past ten years, a large number of policy-effect evaluations have focused on empirical research using various quantitative methods for policy post-assessment, including the difference in difference (DID) method, synthetic control method, and regression discontinuity design method [18,26,27].

## 2.2. Overview of the Strictest Water Resources Management Policy

The strictest water resources management policy is a comprehensive water policy the Ministry of Water Resources, proposed in 2009. Influenced by China's economic restructuring, natural resource endowment, and water pollution, the formulation and implementation of the strictest water resources management policy plays an important role in integrated water management and sustainable development [28]. Since its implementation, the strictest water resources management policy has achieved some remarkable results. Based on data from the China Water Bulletin 2000–2018 (as shown in Table 1), water consumption of the country's gross domestic product has been steadily declining year by year; furthermore, sewage discharge has risen year by year from 2000 to 2011 and has been steadily declining since it peaked in 2011. The utilization of seawater has increased year by year since 2000, but its growth has accelerated markedly since 2010. River water quality and the annual water-functional area compliance rate are also increasing year by year. The data show that the effect of the strictest water resources management policy is significant, but the policy implementation process is not transparent, requiring a comprehensive evaluation from multiple perspectives.

**Table 1.** Water resources utilization from 2000 to 2018.

Year	Annual Water Consumption/Water Supply Volume (100 million m <sup>3</sup> )	Water Consumption per Ten Thousand Yuan GDP (m <sup>3</sup> )	Total Sewage Discharge (100 Million m <sup>3</sup> )	The Water Quality of River Water Is Better Than or Equal to the Proportion of Grade III	Seawater Utilization (100 Million m <sup>3</sup> )
2000	5498/5531	610	620	58.70%	141
2001	5567	580	626	61.40%	150
2002	5497	537	631	64.70%	216
2003	5320	448	680	62.60%	220
2004	5547.8	399	693	59.40%	234
2005	5633	304	717	-	237
2006	5795	272	731	-	269
2007	5819	229	750	-	332
2008	5910	193	758	61.20%	411
2009	5965.2	178	768	58.90%	488.8
2010	6022	150	792	61.40%	488
2011	6107.2	129	807	64.20%	604.6
2012	6131.2	118	785	67%	663.1
2013	6183.4	109	775	68.60%	692.7
2014	6095	96	771	-	714
2015	6103.2	90	770	-	814.8
2016	6040.2	81	765	76.90%	887.1
2017	6043.4	73	756	79%	1022.7
2018	6015.5	66.8	750	81.6	1125.8

Note: Data source: compiled by the author.

Existing research on the strictest water resources management policy has mainly focused on the following topics. The first is the construction of the policy system and related theoretical research, such as the policy's interpretation and theoretical background analysis, water rights theory analysis under the strictest water resources management policy, and technical support analysis of policy implementation [29]. The second is the impact of policy implementation on regional and industrial development [7]. The third is policy comparison, resource allocation, indicator construction in the context of the institution, such as the comparative analysis of water resources management network, the water resources allocation analysis, and “three red lines” indicators in the strictest water resources management policy [30,31]. Overall, research on the strictest water resources management policy has mainly focused on the theoretical analysis of policy, influence of policy on regional development, and evaluation of policy effect. The research method is mainly qualitative, because quantitative research is not enough. Current policy evaluation focuses on the implementation effect of industries and regions based on case studies, and lacks the evaluation of the implementation effect of the policy itself at the national level.

Therefore, from the perspective of sustainable water development and water governance, this study aims to quantitatively analyze the characteristics, public response, and public perception of the strictest water resources management policy through the text-mining method to provide reference for the development and optimization of water policy.

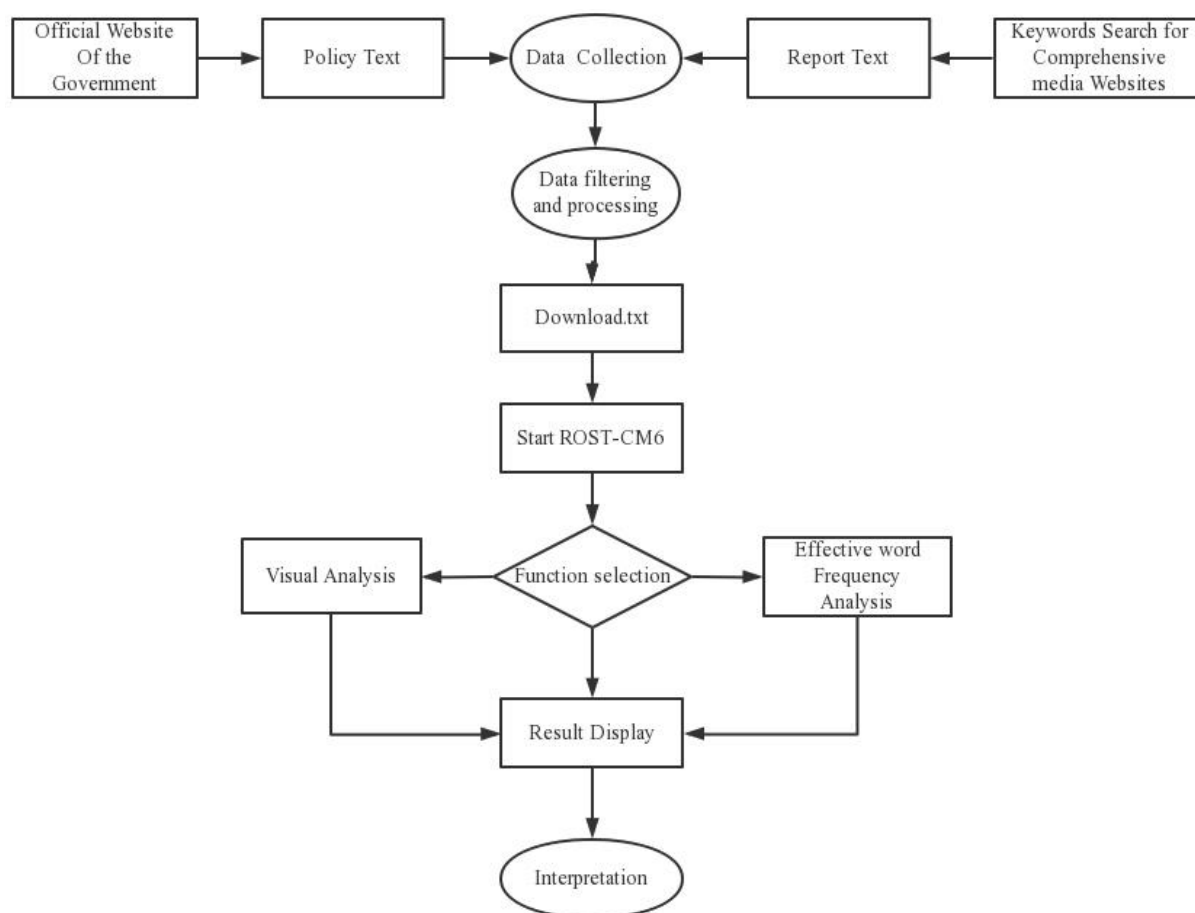
### 3. Materials and Methods

#### 3.1. Research Method

Text mining, or text data mining, is an important research tool that is becoming more and more popular in data mining technology, and it is a research branch of data mining [32]. Text mining aims to discover and analyze the extracted hidden, unknown, and potentially valuable information from a large-scale text database [33]. As a typical quantitative policy method, text mining analyzes policy text by integrating computer science, linguistics, and political science theory [34]. To analyze the large amount of information in policy texts, text mining has more advantages than manual reading and summarizing, which is inefficient

and subjective [35]. Therefore, text mining has received more and more attention and application in policy studies.

To achieve a more elaborate, reasonable, and comprehensive understanding of the strictest water resources management policy, this study conducted a text mining and multi-dimensional analysis framework as presented in Figure 1. First, we collected policy texts from government websites, public opinion reports from major comprehensive websites, and conducted a preliminary screening. Second, ROST-CM6 software was used for word segmentation of the policy and report text. Third, through word frequency statistics and semantic network analysis, we visualized and analyzed the preferences of policy and public opinion reports. Then, we conducted a multi-dimensional comparative analysis based on policy and public opinion reports, combined with the Baidu Index. Finally, we discussed the policy implications and measures.



**Figure 1.** Research framework.

### 3.2. Data Sources and Processing

First, we collected the policy texts of the strictest water resources management policy from 2011 to 2020 through relevant open public websites, such as the Central Government of the People's Republic of China, Provincial Governments, Ministry of Water Resources, the departments of water resources of provinces, and Chinalawinfo Database. The collection and selection of policy texts follow the principles. The State Council and provincial people's governments are the issuing units of documents, closely related to the strictest water resources management policy. The policy text selects statutory policy types, such as implementation opinions, notices, and measures, not including policy-assessment-specific guideline documents. Finally, 30 effective policy samples were selected, as shown in Table 2.



**Table 2.** The strictest water resources management policy text.

No.	Policy Name	Year
1	Decision of the State Council of the CPC Central Committee on Accelerating Water Resources Reform and Development	2011
2	Opinions of the State Council on Implementing the Strictest Water Resources Management System (State Council [2012] No. 3)	2012
3	Opinions of Beijing Municipal People's Government on Implementing the Strictest Water Resources Management System	2012
4	Notice of Tianjin Water Bureau on Implementing the Strictest Water Resources Management System	2011
5	Opinions of Chongqing Municipal People's Government on the Implementation of the Strictest Water Resources Management System	2012
6	Notice of the Shanghai Municipal People's Government on Publishing and Distributing Opinions on Implementing the Strictest Water Resources Management System in Shanghai to Accelerate the Construction of Water Ecology Civilization	2014
7	Opinions of Shaanxi Provincial People's Government on the Implementation of the Strictest Water Resources Management System	2013
8	Opinions of Shanxi Provincial People's Government on the Implementation of the Strictest Water Resources Management System	2014
9	Opinions of Fujian Provincial People's Government on the Implementation of the Strictest Water Resources Management System	2013
10	Notice of General Office of Gansu Provincial People's Government on Publishing and Distributing the Strictest Water Resources Management in Gansu Province	2011
11	Notice on Printing and Distributing the Implementation Plan of the Strictest Water Resources Management System in Guangdong Province	2011
12	Opinions of the People's Government of Guangxi Autonomous Region on Implementing the Strictest Water Resources Management System to Promote Industrial Transformation and Upgrade	2012
13	Implementation Plan of the Strictest Water Resources Management System in Hebei Province	2012
14	Opinions on the Implementation of the Strictest Water Resources Management System of Henan Provincial People's Government	2013
15	Opinions of Hubei Provincial People's Government on Implementing the Strictest Water Resources Management System	2013
16	Notice on Publishing and Distributing the Implementation Scheme of the Strictest Water Resources Management System in Hunan Province	2013
17	Opinions of the People's Government of Ningxia Hui Autonomous Region on Implementing the Strictest Water Resources Management System	2012
18	Opinions of Shandong Provincial People's Government on Implementing Document No. 3 of the State Council [2012] and the Strictest Water Resources Management System	2012
19	Opinions of Yunnan Provincial People's Government on Implementing the Strictest Water Resources Management System	2012
20	Opinions of Zhejiang Provincial People's Government on Implementing the Strictest Water Resources Management System to Promote Construction of Water-saving Society in an All-round Way	2012
21	Opinions of Sichuan Provincial People's Government on the Implementation of the Strictest Water Resources Management System	2014
22	Opinions of Guizhou Provincial People's Government on Implementing the Strictest Water Resources Management System	2013
23	Opinions of Anhui Provincial People's Government on Implementing the Strictest Water Resources Management System	2013
24	Opinions of Jiangsu Provincial People's Government on Implementing the Strictest Water Resources Management System	2012
25	Opinions of Jiangxi Provincial People's Government on Implementing the Strictest Water Resources Management System	2012
26	Opinions of Jilin Provincial People's Government on Implementing the Strictest Water Resources Management System	2012
27	Opinions of Liaoning Provincial People's Government on Implementing the Strictest Water Resources Management System	2011
28	Opinions of the General Office of the People's Government of Liaoning Province on Publishing and Distributing the Work Program of the Strictest Water Resources Management System in Liaoning Province during the 13th Five-year Plan Period	2016
29	Opinions of General Office of Qinghai Provincial People's Government on Implementing the Strictest Water Resources Management System	2012
30	Notice of the People's Government of Inner Mongolia Autonomous Region on Approving and Transmitting the Opinions of the Department of Water Resources of the Autonomous Region on Implementing the Strictest Water Resources Management System	2014

Public opinion mainly comes from relevant social news reports on the strictest water resources management policy in five major media sites, including Sina.com, Sohu.com, Phoenix.com, ThePaper.cn, and TouTiao.com, from 2011 to 2021. We searched with “strictest water resources management” as the key word. Because each keyword search is sorted by relevance, it is necessary to filter massive texts; the principles of preliminary screening are as follows. First, the public opinion reports come from the selected five social media platforms, second, the headlines containing the keyword “strictest water resources management”, or news content directly related to the strictest water resources management policy. We do not consider the same account's repeated news, and do not count news in the form of polls and videos. Finally, a total of 339 valid public opinion reports were selected, and the number of reports on each website was distributed, as shown in Table 3.

**Table 3.** Number of media reports on major website.

Media Source	Searched Number of Reports	Qualified Number of Reports
Phoenix	50	45
Sina	75	62
Sohu	200	103
ThePaper	174	29
TouTiao	130	100

#### 4. Multi-Dimensional Analysis of the Strictest Water Resource Management Policy

##### 4.1. Analysis of Policy Text

The 30 samples of the strictest water resources management policies were imported into the ROST-CM6 software's text database. The documents set from the samples are processed by word segmentation and then word frequency statistics are performed; the output of word segmentation results were arranged according to word frequency from high to low. Words such as "strict" and "water resource" appeared frequently, but they were redundant and had no obvious effect on the result analysis. In addition, degree verbs such as "perfect", "promote", "accelerate", "improve", "strengthen", and "implement" also had no obvious effect, so they were all eliminated. After the above process, the effective high-frequency words we analyzed in this paper were sorted out, and the top 60 are listed in Table 4.

**Table 4.** Top 60 effective high-frequency words in policy text.

No.	Word	Word Frequency	No.	Word	Word Frequency	No.	Word	Word Frequency
1	manage	1467	21	Scheduling	264	41	Red line	187
2	Water use	1356	22	drinking water	262	42	standard	187
3	control	652	23	director	262	43	Water conservancy	185
4	Protect	529	24	administrative	249	44	area	182
5	Water saving	527	25	government	243	45	plan	181
6	Department	519	26	Water quality	240	46	Supervise	178
7	system	510	27	project	236	47	Water source	178
8	Fetch water	449	28	monitor	229	48	Water saving type	176
9	groundwater	425	29	Assure	227	49	Technology	175
10	planning	423	30	Approve	219	50	Argument	175
11	Ecology	419	31	Safety	211	51	Watershed	170
12	developing	410	32	Development	208	52	license	167
13	Functional area	401	33	limit	207	53	Emergency	163
14	use	397	34	Assessment	206	54	reform	160
15	project	352	35	facility	201	55	collection	158
16	saving	294	36	Water resource fee	201	56	According to law	157
17	index	289	37	industry	197	57	Sewage outlet	153
18	Water source	285	38	efficient	196	58	Configuration	145
19	Water supply	277	39	society	195	59	surroundings	145
20	system	275	40	Unite	188	60	agriculture	145

From the distribution of word frequency, administrative control measures are widely used such as management, control, monitoring, assessment, and supervision. The government, enterprises, and social subjects are involved, but the government still occupies the leading position. From the high-frequency words such as water conservation, protection, ecology, groundwater, water quality, functional areas, water sources, water conservation, and sewage outlet, we can conclude that the government actively promotes the progress of water conservation and ecological protection, and pays more attention to sustainable water development and governance.

##### 4.2. Analysis of Public Opinion

The 339 samples of the strictest water resources management policy reports were imported into the ROST-CM6 software's text database. Through the same process as the previous policy text, we selected valid words to be analyzed in this paper and listed the top 60 as shown in Table 5.

**Table 5.** Top 60 effective high-frequency words in public opinion.

No.	Word	Word Frequency	No.	Word	Word Frequency	No.	Word	Word Frequency
1	Water use	1802	21	project	351	41	Assure	273
2	manage	1682	22	programme	327	42	nation	268
3	Assessment	1422	23	project	322	43	Red line	266
4	Water saving	1208	24	Citywide	319	44	Safety	262
5	Ecology	787	25	plan	305	45	Yangtze	260
6	Protect	694	26	Water	301	46	Supervision	258
7	year	551	27	conservancy	300	47	The city	255
8	Fetch water	545	28	action	299	48	Functional area	245
9	groundwater	544	29	Water	299	49	Ministry of	245
10	Total	538	30	Governance	297	50	Water Resources	239
11	cubic meter	482	31	Water quality	296	51	society	232
12	index	436	32	Water source	292	52	autonomous	232
13	comprehensive	429	33	Water supply	290	53	region	228
14	Water saving	427	34	enterprise	288	54	positive	224
15	type	398	35	measure	287	55	efficient	223
16	Target	391	36	industry	287	56	irrigation	216
17	surroundings	366	37	planning	279	57	efficiency	214
18	problem	360	38	Whole province	278	58	agriculture	212
19	Watershed	359	39	Focus	278	59	Rural area	188
20	Department	358	40	unit	276	60	Water source	186
	saving			license	275		Sewage	177
							Supervise	

From the distribution of word frequency of public opinion, the focus of media reporting is mainly on results assessment such as “water use”, “management”, “assessment”, “water conservation”, “ecological”, and “protection”. Compared with the policy text analysis, the high-frequency words added were “annual”, “total”, “cubic meters”, “department”, “Ministry of Water Resources”, “the whole city”, “the whole province”, “country”, “the city”, and “autonomous region”. It shows that media reports pay more attention to region, time, and results. In the field of industrial development, high-frequency words such as “agriculture”, “rural”, “irrigation”, “enterprise”, “industry”, and “sewage” reflect the detailed implementation of water management. Regarding reporting emotion, high-frequency words such as “positive” and “effective” indicate positive emotions dominate in the strictest water resources management policy. However, “problems” are mentioned many times, indicating that many problems must be solved in the process of policy implementation.

#### 4.3. Analysis of Public Policy Perception

Public policy perception not only depends on media reports, but is also closely related to public awareness. Publicity and education should be combined to improve public acceptance of water policy. Baidu is the Chinese search engine with the most users in China. The Baidu Index is a data-sharing platform based on Baidu’s massive netizen behavior data, which provides a new channel for studying keyword search trends, insight into the interests, and needs of netizens. It also targets the audience’s characteristics, and can measure the changing trends of public perception about policy issues. As an interactive software, social media is different from the one-way communication function of traditional media. With the rapid development of internet technology, netizens can use social media and internet search engines to obtain information as quickly and massively they want. The search records they keep will bring a new perspective for researching the public’s information preferences. In the reporting of policy news, this new media platform has great advantages in network information dissemination and public opinion. This study mainly considered “The strictest water resources management” as the policy case, researched the audience’s information preference, choice and spatial difference in the media, and took the audience’s frequency of searching or clicking keywords as the attention indicator. As the strictest water resources



management policy is not currently included in the Baidu Index, search keywords selected are closely related to the policy, such as “water resources”, “water resources protection”, “water pollution”, “water conservation”, and “water resources tax and water resources fee”, to measure the public’s perception about the strictest water resources management policy.

According to Figures 2 and 3, it is clearly seen that public concern about water policy is increasing year by year. However, public concern is more stable regarding water resources, water resources protection, and water pollution, while public attention on water conservation, water resources fees and taxes, has great fluctuation. In terms of water conservation, China has issued a series of policies. In 2012, the Ministry of Water Resources issued *The 12th Five-Year Plan for Water-Saving Social Construction* and the State Council issued *The Opinions on the Implementation of The Strictest Water Resources Management*, which regards the red line of water efficiency control as one of the “three red lines” of the strictest water resources management policy. In October 2014, General Secretary Xi Jinping put forward the policy of water conservancy work in the new period of “water conservation priority, space balance, systematic management and two-handed effort.” In 2016, the relevant departments of the State Council issued *The Implementation Plan for Water Efficiency Leader Leadership Action*, *Opinions on the Implementation of Contract Water Management to Promote the Development of Water Saving Service Industry*. In October 2016, the National Development and Reform Commission jointly issued *The National Water Conservation Action Plan* with the Ministry of Water Resources and other departments. In October 2017, the report of the 19th National Congress of the Communist Party of China explicitly proposed the implementation of national water conservation action, which marked water conservation as the national will and action. In 2019, the National Development and Reform Commission (NARC) jointly launched *The National Water Saving Action Plan*. Respectively corresponding to the peak water-saving attention in 2012, 2014, 2016, 2018 and 2019, indicated that the awareness of citizen policy is good. In terms of water taxes and fees, after the implementation of the reform of water resource tax (*Feigaishui*) in China in July 2016, public attention increased significantly in 2018, 2019 and 2020. According to Baidu search data, data-mining methods were adopted to cluster the attributes of the keyword population. Visually reflecting the age distribution of users, Figure 4 shows that nearly 70% of the audience is between 20 and 39 years old. It shows that young people are more concerned about water policy and water-saving social construction. However, it also shows that other people’s concerns about water policy and water resources management must be further enhanced. Figure 5 shows the geographical distribution of each keyword search and we can see the characteristics of water resources geographical preference. Overall, the eastern coastal area groups pay more attention to water resources, especially in the Beijing, Shandong, Guangdong, Jiangsu, Zhejiang, and Sichuan provinces, which are more concerned about the current situation of water resources. This phenomenon is directly related to the level of regional economic development, education, and water resources ecological environment.

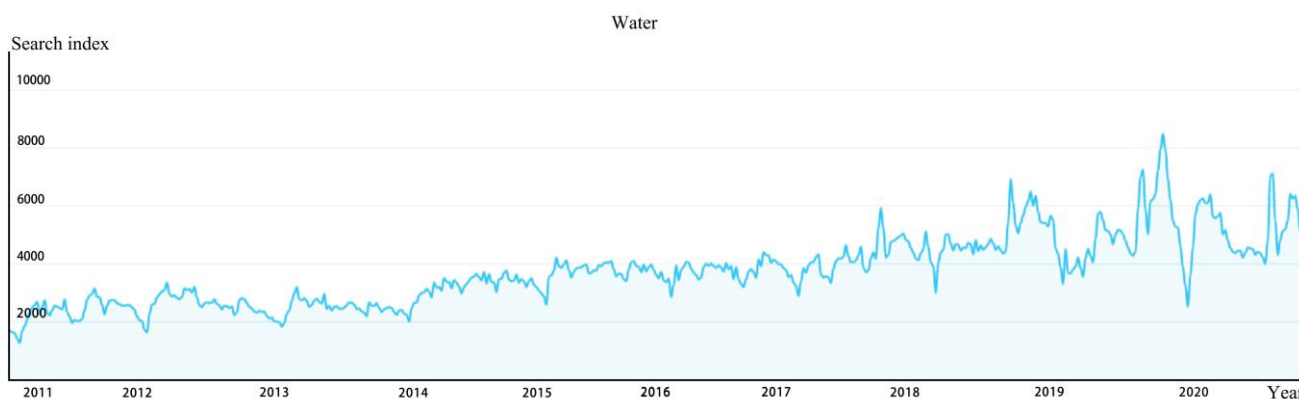
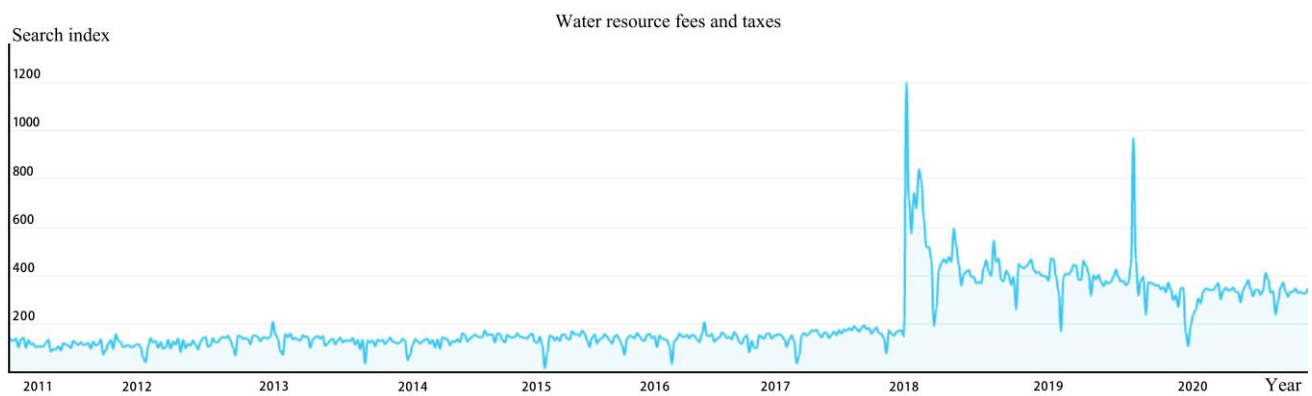


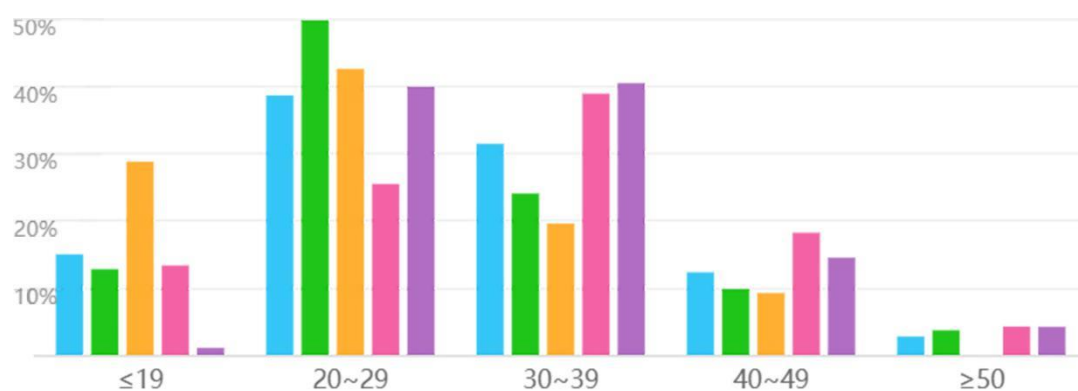
Figure 2. Baidu Index Trend of keyword “water”, 2011–2020.



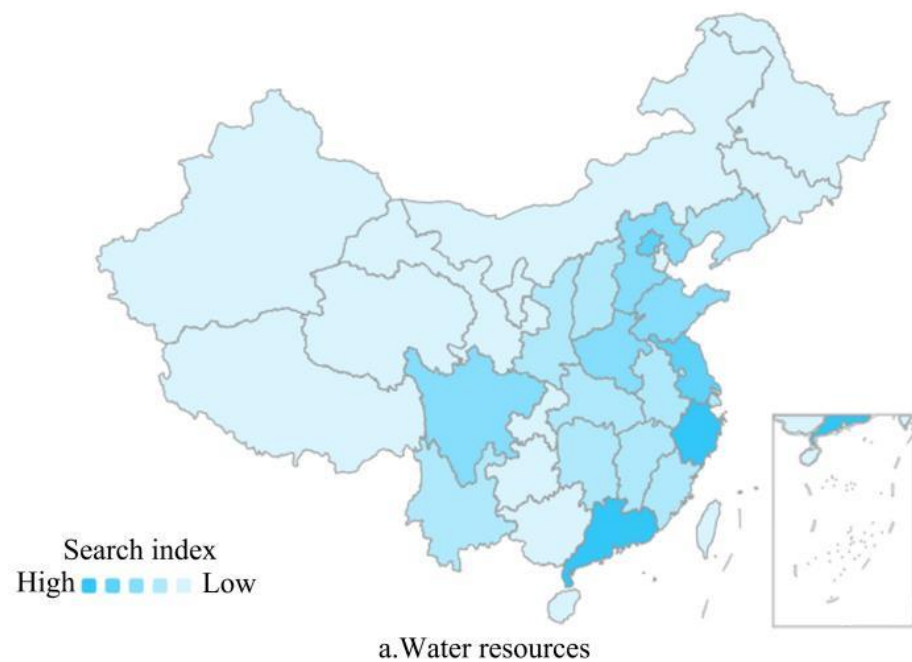
Figure 3. Cont.



**Figure 3.** Baidu index trend of water-related keywords, 2011–2021.



**Figure 4.** Baidu search age distribution of water-related vocabulary (In turn, they represent the age distribution proportions of searches for water resources, water resources protection, water pollution, water saving, and water resource fees and taxes).



**Figure 5.** Cont.

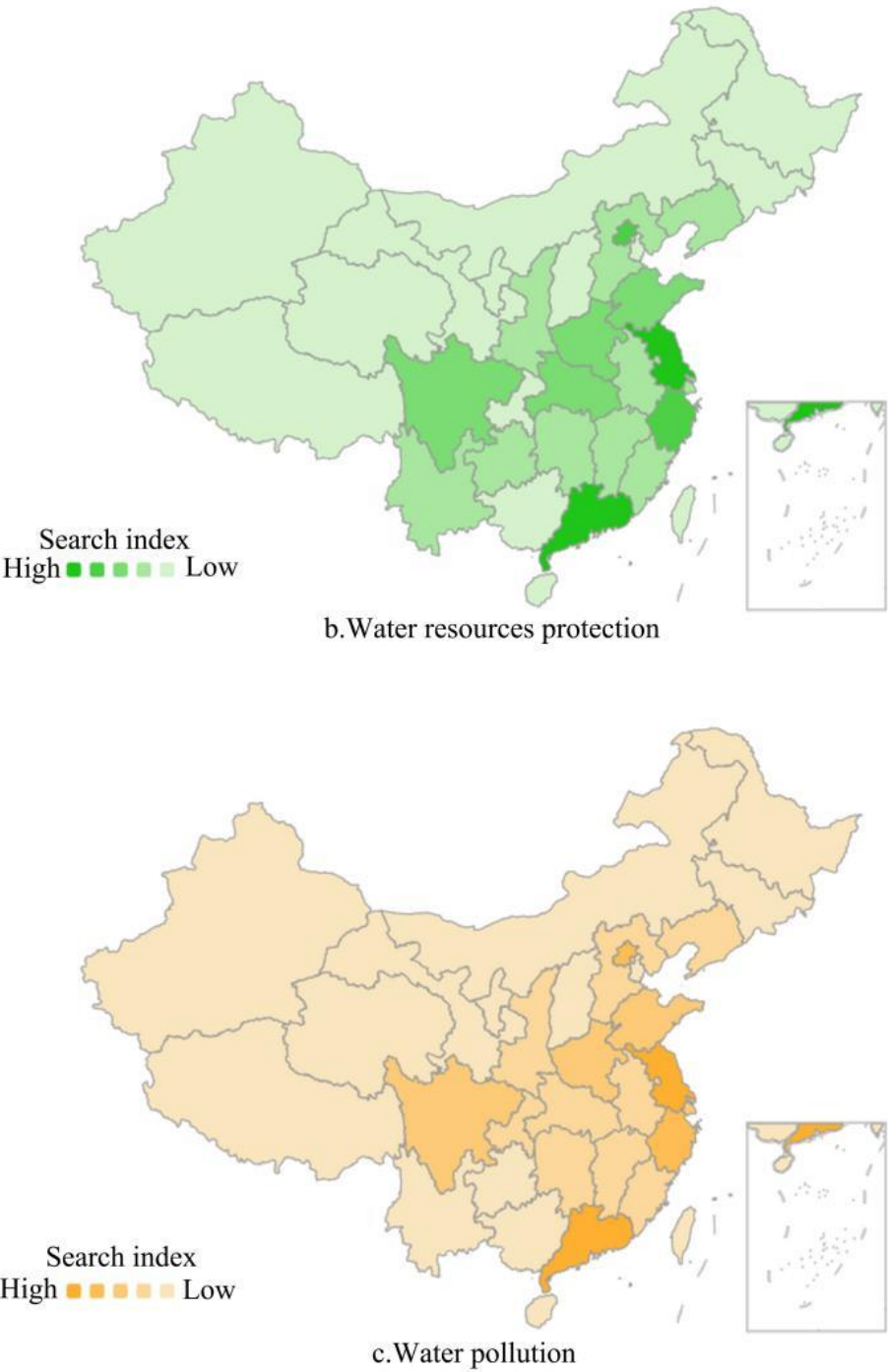
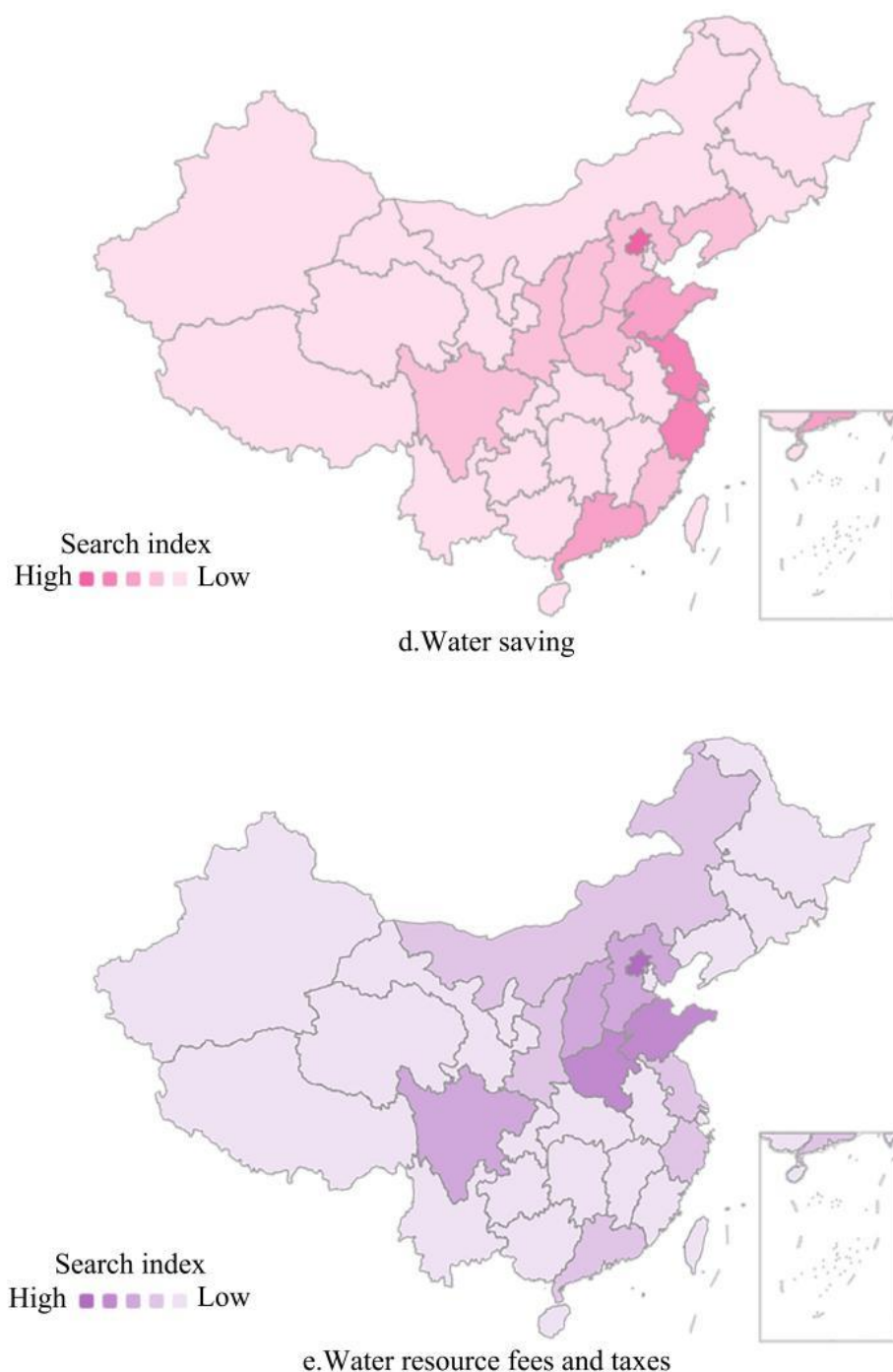


Figure 5. Cont.



**Figure 5.** The geographical distribution of the Baidu search index for water-related keywords, 2011–2020.

#### 4.4. Comparative Analysis

##### 4.4.1. Hot Topic of the Strictest Water Resources Management Policy

Keywords can largely indicate a policymaker's main intention. The frequency distribution characteristics of keywords can detect the hot topics and the differences between policy and media reports of the strictest water resources management policy. From Tables 4 and 5 we can see that "water use", "management", "control", "water saving", "ecological", and "protection" are the most frequently used words in policy and public opinion reports. Therefore, it can be supposed that both the government and the media are very concerned about the ecological effects of water resource management. Overall, the policy text is more focused on macro-level policy guidance and regulation. There is some guidance related to

the construction of the policy system, such as “regime”, “planning”, “development”, and “system”. The keywords such as “collection”, “water resource fee”, “in accordance with the law”, “administration”, and “examine and approve” are related to the use of policy tools. The keywords in media reports are more micro and specific, such as “total quantity”, “cubic meters”, “target”, “problem”, “program”, “action”, “measures”, “the whole city”, and “the city”.

In general, the policy text is macro-level and more focused on national development and long-term planning, such as “regime”, “planning”, “system”, “unification”, and “government”, which appear with high frequency. In terms of content, the policy text is more comprehensive, including system construction, assessment and evaluation, development planning, pollution control, social supervision, demonstration creation, technical support, and water-saving society, involving all aspects of policy implementation. Public opinion reporting is more tendentious; media reports prefer the quantification of assessment, regional difference, annual implementation of national planning, incentives, and penalties. Some social news platforms express obvious emotional tendencies, where “positive” and “effective” respectively appeared 228 and 224 times. To a certain extent, this reflects the recognition of water policy by media reports. “Problems” and “measures” respectively appeared 366 and 287 times, which also indicates that some shortcomings appear in the water policy that must be improved. Compared with the policy text’s comprehensiveness, the scope of media reports is relatively narrow, and there exists a certain degree of media slant. There are selective reports on the process and results of policy implementation; for example, technical support, financial subsidies, tax incentives, and public participation are rarely reported.

#### 4.4.2. Trend of the Strictest Water Resources Management Policy

According to the text analysis, combined with the socio-economic context of China and progress of water governance, there are some trends in the development of the strictest water resources management policy.

“Water use” appeared 1356 times in policy text and 1802 times in public opinion reports, ranking as one of the most frequent keywords, and reflecting its importance. Influenced by the speed and scale of China’s economic development and population size, the use of water resources increased in China from 2000 to 2013. Coupled with the pressures of global climate change and water pollution, reducing the use of water resources is an urgent task facing China’s government. The change of water consumption is also the most direct indicator of water policy effects. In recent years, China’s economic structure has been continuously optimized and upgraded, and water policy has been implemented. Since 2013, annual water consumption has steadily reduced. In terms of specific measures of water control, water efficiency is improving; some keywords such as “irrigation”, “agriculture”, “industry”, “sewage”, “life”, and “facilities” fully reflect the careful implementation of water saving in different industries.

“Management” is also one of the most frequent keywords, which respectively appeared 1467 and 1682 times in policy texts and public opinion reports. As a strategic resource related to the national economy and people’s livelihood, the government must regulate water resources using various measures. Although the keywords from the policy text and public-opinion reports do not directly indicate the specific combinations of various measures, many keywords, such as “administration”, “examine and approve”, “in accordance with the law”, “charge for water resources”, “levy”, “permission”, and “supervision”, show that the government has used diversified measures including administrative, legal, and economic measures.

Clean water and sanitation is the sixth goal of the sustainable development goals (SDGs) that the United Nations proposed. Sustainable water development is also the goal of water governance and integrated water management. In the past, China’s economic development and improvement of living standards were achieved at the cost of water resource depletion and water environment deterioration. The Chinese government recognizes the



importance of rational protection and development of water resources, and sustainable water development is the only effective way to achieve this goal. The government of China formally introduced sustainable development as a major national development strategy in 1995, including influencing and covering the entire process of water policy formulation and implementation.

In the strictest water resources management policy text and public-opinion reports, the high-frequency keywords on sustainable water development accounted for more than one-sixth of the total. For example, the keywords “water saving”, “economy”, “water-saving pattern”, “ecological”, “environment”, “protection”, “watershed”, “governance”, “sewage”, “water source”, “water quality”, and “functional area” appear with high frequency. In particular, “water conservation”, “ecological”, and “protection” in the media reports appeared with even higher frequency, respectively appearing 1208, 787, and 694 times, with an average of two to three mentions per report.

## 5. Conclusions and Policy Implications

Reasonable and effective water policy plays an important role in sustainable water development and governance [36]. This study analyzed and compared policy text, public opinion, and public perception of the strictest water resources management policy based on multi-source data, including policy documents, media reports, and the Baidu Index using ROST-CM6 software. The aim of this study was to explore the hot topic of the strictest water resources management policy, as well as the matches and synergy between the policy text, response of public opinion, and public perception surrounding the policy. We then aimed to provide a reference for the optimization and upgrading of the strictest water resources management policy in China. The study found that common topics in the policy text and public opinion include assessment, water control, supervision and management, and ecological protection. However, there also are some differences. For example, the scope is different; the policy text belongs to the macro level and is more focused on national development and long-term planning, whereas public opinion is at the micro level and more specific, with particular emphasis on region, time, and results. In addition, there is a certain degree of media bias that affects public opinion. Furthermore, this study also empirically validates the policy feedback theory, as Schattschneider states that “new policies create new politics” [37], and indirectly demonstrates the impact of water policy on public opinion or behavior.

There are some limitations in this study. First, the results’ accuracy may have been somewhat impacted by the fact that the policy text does not cover the municipal level, resulting in a small number of samples and limited websites from which to choose the public-opinion reports. However, under the framework of national policy formulation, the policy formulation of cities, districts, and counties is expanded and focused, so the research findings have their own scientific foundation. Second, the screening criteria for policy and report wording are somewhat subjective. For instance, social media with a wide range of audiences, non-government direct official media, and high social awareness is used as the screening mechanism for the media report text in this article. However, there is still room for improvement because there is no specific quantifiable social media ranking. Finally, word frequency analysis can only reflect the degree of importance and relevance, but status and progress are still unknown. The Baidu index may assess public preferences and policy knowledge to a certain extent, but there are still flaws in the way emotional slant is reflected, necessitating more study.

According to the results of this study, we propose some suggestions to address the situation and the development of the strictest water resources management policy. First, promoting the implementation of water policy and raising public awareness of saving and protecting water resources is necessary. Water resources management and development is a public service, but the implementation effect of water policy cannot be separated from the understanding and cooperation of the policy’s object, namely, the public [38]. The current strictest water resources management policy has achieved a positive effect

and remarkable results. However, in the process of policy implementation, there are some problems related to public coordination. To address this problem, it is necessary to strengthen law enforcement's ability, and the policy identity of the policy objects. China is a large agricultural country, and agricultural water consumption accounted for more than 60% of annual water consumption. Therefore, on the one hand, the government should strengthen farmers' water-saving awareness through information and education, and promote agricultural water-saving technology. On the other hand, the government should improve incentives and preferential policies for saving water. As for industrial water, the government should adopt diversified management methods beyond traditional administrative approaches, including economic measures, to motivate enterprises to save water, such as tax incentives, financial subsidies, and fines. Regarding domestic water consumption, China is under great pressure due to its large population. On the one hand, it is necessary to promote public water saving education continuously and extensively. On the other hand, China must strengthen the popularization of technology-driven water-saving facilities, such as self-closing, water-saving faucets, intelligent water-saving flushes, and water-free urinals.

Second, the government must promote public participation and information transparency, and build a diversified and modern policy-information exchange mechanism. According to the 47th China Internet Development Statistics Report, released by the China Internet Network Center, the number of Internet users in China will reach 989 million by the end of 2020, accounting for 70.6% of the total population. The huge number of Internet users determines the importance of new media and information-exchange mechanisms in China. As a new way to promote policy implementation, web media helps disseminate the government's water policy, and provides a broadest channel for the public to supervise policy implementation [39]. In addition, as an open and interactive tool—except for the traditional media's function of disseminating information—web media should also use its interactive advantages to attract the public to pay attention to, understand, and participate in water policy and sustainable water development, and enhance the public's recognition and familiarity with water policy [40].

This study shows that teenagers, children, and the elderly have weaker policy perceptions compared to young people. Therefore, in addition to the Internet, other policy-publicity approaches should be actively expanded, such as giving play to the community's collaborative governance role and using community activities to publicize water policy to improve the elderly population's acceptance of water policy. Lastly, publicizing water policy in school is necessary to improve students' water knowledge.

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