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From project to planning: development and effectiveness of the water-draw and utilization assessment policy in China

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ABSTRACT

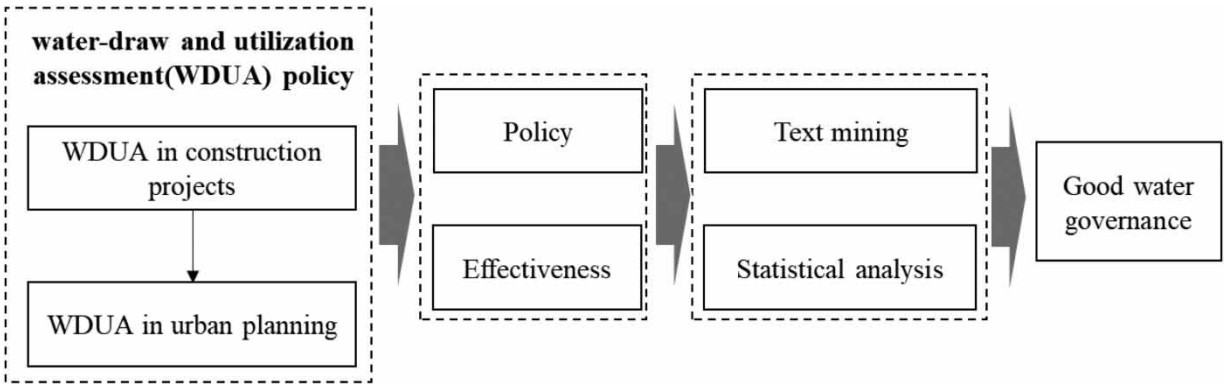
The water-draw and utilization assessment (WDUA) policy is crucial for ensuring sustainable water development and good water governance in China. It consists of the WDUA in construction projects (WDUA-CP) and WDUA in urban planning (WDUA-UP). Based on a systematic review of the WDUA policy's development, this study evaluated the WDUA policy from the perspectives of policy text and implementation effectiveness using text-mining and statistical analysis methods. The results show that the WDUA policy is generally successful and has progressed across all regions in China. Despite existing regional gaps, effectiveness will continue to grow at the current situation of implementation. This study broadens the field of inquiry into China's water policy, enhances the method for assessing global water policy, and offers a fresh viewpoint for the international water community to understand China's integrated water resources management and water governance.

Key words: policy evaluation, sustainable water development, water governance, water policy

HIGHLIGHTS

- The water-draw and utilization assessment policy, including project construction and urban planning, is a critical policy in China's integrated water resources management.
- The text-mining and statistical analysis methods have been used to systematically assess the WDUA policy in China.
- The WDUA policy is generally successful and has been formulated scientifically and its implementation has been effective.

GRAPHICAL ABSTRACT



1. INTRODUCTION

Water resources are critical to urban development and economic growth (Jang *et al.* 2016). Water scarcity and pollution are a global challenge and the sixth of the United Nations' Sustainable Development Goals (SDGs) (Liu *et al.* 2019). The effective water resources utilization and management is one of the key drivers of sustainable development (Monney & Ocloo 2017).

China is a country with a shortage and uneven distribution of time and space of water resources, and integrated water resources management has become more urgent (Liu *et al.* 2020). To address the water shortage, water security, and water ecology, the Chinese government has promoted water governance through policy intervention and project construction (Cheng *et al.* 2022a). In addition to mega water projects such as the South-to-North Water Diversion project, the Chinese government has also implemented a series of water policies, such as the strictest water resources management policy (Cheng *et al.* 2023; Zhao *et al.* 2023).

The water resources management policies and institutions are crucial to establishing good water governance. Countries around the world address water management and policy issues in different ways (Bettini *et al.* 2013; Ingold *et al.* 2016; Loch *et al.* 2020; Cheng *et al.* 2022c). For example, the United States has established a comprehensive water resources information-sharing platform to achieve effective monitoring of hydrology and water resources (Tsatsaros *et al.* 2018). In addition, the United States also implements the water rights management system with the water rights registration system as the core, establishes the market mechanism on the basis of clearly defining water rights, and realizes the efficient use and allocation of water resources (Bark *et al.* 2012). The important policies of water resources management in Japan include the two-part water price mechanism, regulating the setting and function of water resources management institutions, and combining comprehensive management and classified management (Okada 2016). China's government focuses on the local situation of water resources, drawing lessons from foreign water resources management experience, and forms a characteristic water resources management system that combines watershed management with administrative management (Li *et al.* 2020). The water-draw and utilization assessment (WDUA) is a novel policy in the context of integrated water resources management and sustainable water development.

The Chinese government has proposed that water resources should be taken as an important prerequisite for urban planning and construction, and that 'city, land, people, and production should be determined by water resources' and implemented in urban and town planning (Li *et al.* 2020). The WDUA aims to solve the adaptability problem between the construction scale, layout, and regional water resources carrying capacity in different scales of cities and projects, which is necessary to ensure the rational use and sustainable development of regional water resources and promote the coordination and match between urban development and water resources. The WDUA policy comprises a dynamic process, including the WDUA in construction projects and urban planning. In 2002, the Ministry of Water Resources (MWR) issued the *Administrative Measures for the Water-draw and Utilization Assessment in Construction Projects*. With the development of cities and economies, the Chinese government recognized the need to implement the WDUA in urban planning. Therefore, the MWR issued the *Notice on Carrying out the Pilot Work of Water-draw and Utilization Assessment in Urban Planning* in 2010. Policy systems addressing WDUA have consistently expanded since 2002. Therefore, the timely evaluation of the WDUA policy not only contributes to the improvement of policy and water governance but also helps global water scholars and practitioners better understand China's WDUA policy.

The WDUA policy is a significant but less well-researched policy of water management in China. Most analyses of water resources management and water governance focus on popular water policies, such as the strictest water resources management policy (Cheng *et al.* 2022a), water resources tax (Ouyang *et al.* 2024), and river chief system (Wang *et al.* 2021). Limited attention has been paid to the WDUA policy as an emerging water policy and cross-sector regulation affecting China's water resources management and water governance.

The goal of this study was to assess the WDUA policy's formulation and implementation effect based on a policy text analysis and an assessment report analysis following a text-mining approach. Specifically, this study focused on the following key questions: How did the WDUA policy develop? Is policy-making sound? How effective is the policy? To achieve this goal, we first reviewed the WDUA policy's development in China, then collected the data of policy and report texts of the WDUA through a text-mining method. ROST-CM6 software and statistical analysis methods were used to evaluate policy characteristics and implementation effects and identify existing problems. Finally, we propose tailored policy recommendations reflecting various cross-sectoral, multi-level, and multi-stakeholder water governance contexts.

The contribution of this study is multifold. This study not only summarizes the key characteristics and patterns of the WDUA policy development in China but also investigates the effectiveness and obstacles of implementation of the WDUA policy. In addition, this study gives some scholarly accounts for studying and understanding the WDUA policy in affecting urban and regional sustainable development, and also to enrich the existing literature of global water governance.

2. DEVELOPMENT OF THE WDUA POLICY

Water resources assessment is a series of comprehensive analyses of the reasonableness of water-draw, water utilization, and water drainage for urban planning, construction projects, and regional development (Xu & Singh 2004; Shams & Muhammad 2022). The assessment results are in the form of reports according to the rules of China's government. The contents of the assessment reports include the permissible scope of water-draw and utilization, the rationality of water-draw and utilization, the protection of water resources, and the public participation to propose tailored suggestions and measures. In the past, the government did not fully consider the restrictive role of water resources in the construction of mega projects, urban planning, and major economic decisions, resulting in many problems in the utilization of water resources and sustainable development (Qi *et al.* 2019). In particular, river basins and administrative divisions are not consistent, and inter-city water access within and inter-basins often leads to conflicts between cities.

Water resources assessment in China is a dynamic process. Since 2002, the WDUA in construction projects was proposed, and later, based on the needs of water resources planning and management, it has expanded to urban planning and played an increasingly important role in territory spatial planning. Water resources assessment promotes the optimal allocation, rational utilization, and protection of water resources and ensures reasonable water intake for construction projects and urban development to support sustainable development. From construction projects to urban planning, water resources assessment is a process from micro to macro, and one of scientific and continuous improvement regarding integrated water resources management.

2.1. Development of the WDUA-CP

The WDUA in construction projects (WDUA-CP) is an important instrument for implementing integrated water resources management and plays an important role in promoting water governance and sustainable water development. The MWR issued the *Administrative Measures for the Water-draw and Utilization Assessment in Construction Projects* in 2002, which officially proposed the WDUA-CP. The purpose was to ensure the rational use of water, improve the efficiency of water use, reduce the adverse impact of water intake and water drainage on the surrounding ecological environment, and ensure the sustainable development of regional water resources. The contents of the WDUA-CP include the scope of analysis, water intake source assessment, water intake influence, and water drainage influence.

The WDUA-CP are conducted according to the design water usage of the construction project. The policy stipulates that the scope of construction projects to carry out water resource assessment is as follows. The construction period of more than 3 years or the construction period of water intake and water regression impact of the construction project to reach more than two levels should be carried out water drainage rationality and water intake and water drainage impact of the construction project. For inland nuclear power plants, large tunnels, and other construction projects that may affect water resources security, hydrological and water resource conditions assessments should be carried out at the site-selection stage. Water resources assessments of construction projects should also be carried out for construction projects in industrial agglomeration areas such as comprehensive development zones, industrial parks, and economic and technological development zones. For construction projects to solve the water source by adjusting the water intake, such as water right transfer, the water resource assessment of the construction project should be carried out on the basis of the feasibility study of water right transfer.

The WDUA-CP emphasizes the evaluation of construction projects in water conservancy, thermal power, petrochemical, mining, service, food, metallurgy, and other industries with high water consumption and high pollution. The WDUA-CP has been instrumental in strengthening the protection of water resources, increasing the efficiency of water usage, and rationally allocating and optimizing water resources. The WDUA-CP, however, primarily focuses on a single project, making it unable to address the cumulative, indirect, and induced effects of several projects as well as the issue with water supplies brought on by the entire city's design and layout. Additionally, it is unable to address the issue of water rivalry between various building projects, industry sectors, and human and nature.

2.2. Development of the WDUA-UP

Practice shows there are some limitations in the WDUA-CP, and the Chinese government proposed the WDUA in urban planning (WDUA-UP). The WDUA-UP analyzes the coordination between planning and the carrying capacity of water resources, the rationality of water use efficiency, and the impact on the water environment at the macro level. It then makes recommendations on water resources, which is crucial for advancing the rigor and science of urban and town planning.

The Chinese government suggests that the formulation of national economic and social development plans, urban master planning, and the layout of mega construction projects should be compatible with the conditions of the local water resources and needs for flood control. The WDUA-UP examines the rationality of planning water demand and water resource carrying capacity, shows how planning layout and water resource carrying capacity are coordinated, makes recommendations for adjusting and optimizing planning schemes, and encourages, from a strategic standpoint, the adaptation of economic and social development to regional water resource carrying capacity.

The WDUA-UP is a systematic and comprehensive work. In 2010, the MWR issued the '*Notice on Carrying out the Pilot Work of Water-draw and Utilization Assessment in Urban Planning*.' Local governments, such as Jiangsu and Guizhou, have actively carried out pilot assessments, and in recent years, it has been widely applied throughout China. The '*Technical Guidelines for Water-draw and Utilization Assessment on Plans*' (SL/T813-2021) issued by the MWR in 2021 provides guidelines for the technical work of the WDUA-UP. The WDUA-UP is one of the effective means for urban planning to implement the SDGs in water resources management by coordinating the relationship between economic growth and sustainable utilization of water resources. The local governments have actively carried out WDUA-UP, the main types of which include the WDUA in urban master planning, such as water resources assessment of Neijiang master planning of Sichuan, water resources assessment of Suzhou master planning of Anhui, water resources assessment of Xingren master planning of Guizhou; The WDUA in new town planning, such as Nanjing Jiangbei New town planning water resources assessment, Beijing-Tianjin Industrial New town planning water resources assessment; The WDUA in township planning, such as Beijing Yanji town planning water resources assessment.

In short, the WDUA-CP is an assessment specific to a project, which is carried out at the micro level, focusing on addressing water intake, utilization, and the impact of specific projects on water resources, conducted in the implementation stage. The WDUA-UP is an assessment of water resources for urban and town planning, which focuses on analyzing water resources allocation and implementation within a certain range and period, conducted in the planning stage. The WDUA-UP is not only the technical basis of planning approval, but the basis of approval of the WDUA-CP.

3. MATERIALS AND METHODS

Two perspectives are typically the basis for a rational and scientific assessment of a policy. One aspect of policy development is its logic and operability, which encompasses the analysis of policy text and policy tools. On the other hand, the policy's implementation effect pertains to whether the policy has been put into practice and whether the outcomes have aligned with the intended objectives. Numerous qualitative and quantitative techniques, such as differences-in-differences (DID) and regression discontinuity design (RDD), are available. Considering the availability of data and the suitability of methods, this study selected text analysis to evaluate the WDUA policy and applied statistical analysis to evaluate the policy implementation effect.

Text mining is a special data-mining method, which is a process of extracting potential, understandable, and usable important knowledge from unstructured text information (Cheng *et al.* 2022a). Text mining has been widely used in many fields, especially policy evaluation (Schoderer *et al.* 2020; Cheng *et al.* 2022b; Liu & Liu 2022; Wang *et al.* 2022). The main form of the WDUA is the report for both construction projects and planning. Therefore, the examination of reports represents the implementation effect of the WDUA policy. This study collects the data of the reports and analyzes the reports' characteristics through statistical analysis to assess the implementation effect of the policy.

The design and process of this study is as follows (Figure 1). First, this study collected the policy texts of the WDUA-CP and WDUA-UP from 2013 to 2018 through the official websites of governments of various provinces and cities and local water resources bureaus in China. Then, text analysis software ROST-CM6 was used to conduct text analysis to evaluate the scientific rationality of policy-making. Finally, the report data of the WDUA-CP and WDUA-UP from 2013 to 2018 were collected through the annual report of China's water resources management issued by China's MWR, and the implementation effect was evaluated through statistical analysis.

Following this process, we collected a total of 50 policy texts of the WDUA-CP from 2013 to 2018, a total of 50 policy texts of the WDUA-UP from 2013 to 2018, a total of 25,067 reports of the WDUA-CP from 2013 to 2016, and a total of 736 reports of the WDUA-UP from 2014 to 2018. Government policy documents are available on the official website. The data for the reports were collected through the *China Water Resources Management Annual Report* published by the Ministry of Water Resources of China from 2013 to 2018.

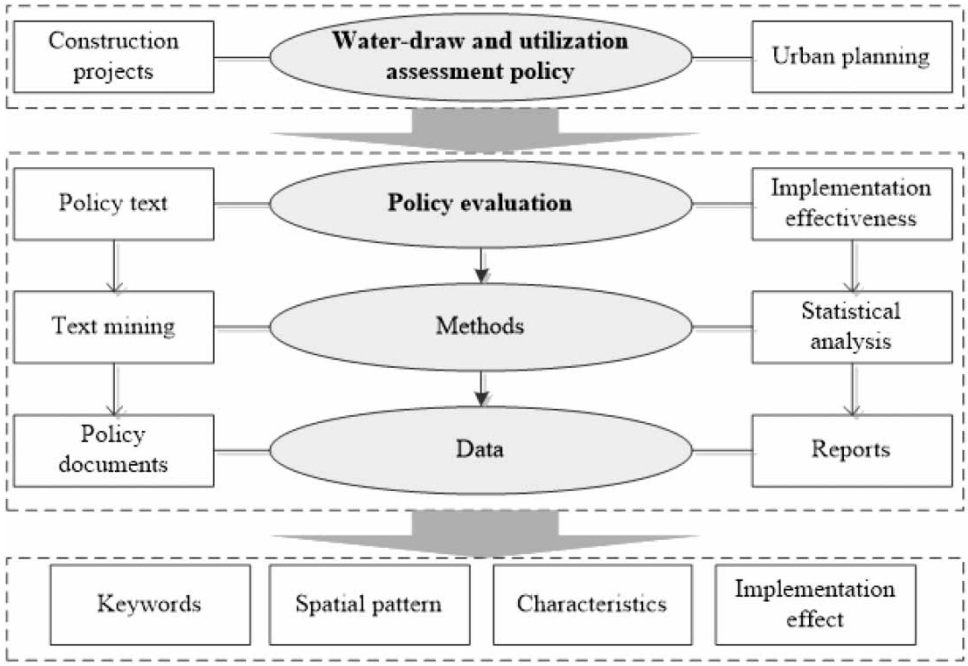


Figure 1 | Research design.

4. RESULTS

4.1. Analysis of the policy text

4.1.1. Analysis of policy text on the WDUA-CP

Based on the collected 50 policy texts of the WDUA-CP from 2013 to 2018, keywords were extracted and analyzed, and the results are as follows (Table 1). The keywords 'water intake' and 'construction project' had a high frequency, reaching 1,462 and 1,247 times, respectively. The frequency of keywords 'review' and 'administration' was also high, with 999 and 749 times, respectively. This indicates that the policy text of the WDUA-CP has strong pertinence and directivity. In addition, the WDUA-CP policy is primarily regulatory. Furthermore, the frequency of keywords such as 'license' and 'regulations' was 546 and 451 times, respectively, and shows that the WDUA-CP policy is relatively legitimate and reasonable.

However, some shortcomings exist in the WDUA-CP policy. On the one hand, the frequency of the keyword 'ecology' was 270 times, which demonstrates that the ecological protection of water resources in the WDUA-CP policy must be improved. On the other hand, the frequency of the keyword 'reclaimed water' was only 33 times, which indicates that the reuse rate of water resources in China is not high, the attention to unconventional water is not enough, and the governments should strengthen the technology and improve the utilization of recycled water. In addition, the frequency of water saving in the WDUA-CP is not high indicating that not enough attention is paid to water saving.

4.1.2. Analysis of policy text on the WDUA-UP

The results of the keyword analysis of the collected 50 policy texts of the WDUA-UP from 2013 to 2018 are as follows (Table 1). The keywords 'water resources' and 'management' appeared the most frequently, with 899 and 806 times, respectively, and 'planning' appeared 625 times, which indicates that the WDUA-UP is tailored and scientific and the formulation is reasonable. Second, keywords 'water saving' and 'ecology', and 'protection' appeared 774 and 730 times, respectively. This shows that the Chinese government places great importance on the protection of water resources and the construction of a water-saving society. The keyword 'government' appeared 357 times, ranking seventh in all keywords, indicating that the WDUA-UP policy is administration-oriented. The keywords 'industry,' 'agriculture,' and 'enterprise' appeared in frequency as Industry > Agriculture > Enterprises, which shows that the WDUA-UP policy is mainly focused on industry. The keywords 'surface water' and 'groundwater' appeared 68 and 323 times, respectively, with a large gap. Groundwater is the main source

Table 1 | Keywords of policy texts of the WDUA-CP and the WDUA-UP

The WDUA-CP			The WDUA-UP					
Number	Keywords	Word frequency	Number	Keywords	Word frequency	Number	Keywords	Word frequency
1	Water intake	1,462	1	Water resource	899	16	Technology	149
2	Construction project	1,247	2	Administration	806	17	Permit	137
3	Review	999	3	Water saving	774	18	Enterprise	119
4	Water resource	844	4	Ecology	730	19	Water resources fee	116
5	Water use	753	5	Water using	706	20	Water cost	106
6	Administration	749	6	Planning	625	21	Reclaimed water	100
7	License	546	7	Government	357	22	Water efficiency	80
8	Regulations	451	8	Water intake	347	23	Water quality	80
9	Water saving	357	9	Strict	345	24	Surface water	68
10	Report	342	10	Underground water	323	25	Water price	49
11	Water resources demonstration	312	11	Institution	274	26	Unconventional water	20
12	Ecology	270	12	Industrial	220	27	Progressive price	11
13	Quota	152	13	Agriculture	179			
14	Water quality	86	14	Waste sewage	178			
15	Reclaimed water	33	15	Planning water Resources	174			

of water in North China, and it faces serious pollution problems. Overexploitation of groundwater in North China has caused a series of problems such as land subsidence and ecological degradation. Therefore, the attention to groundwater is high, and the requirements for its draw and utilization are also higher.

The WDUA-UP policies also have shortcomings. On the one hand, the keywords 'reclaimed water,' 'water use efficiency,' and 'unconventional water' appeared a total of 200 times, which indicates that attention to unconventional water in urban planning and development is not enough and must be strengthened. On the other hand, the keywords 'water price,' 'water resources fee,' and 'progressive price increase' appeared less frequently, a total of 176 times, which indicates that the economic attribute and regulation function of the WDUA policy have not been paid enough attention.

A comparison of the key words between the WDUA-CP and WDUA-UP can be found. First, the WDUA policy is improving and is being developed in a way that is getting more and more scientific. Second, the WDUA's policy instruments become varied. Lastly, crucial practices for sustainable water development, like ecological water, water reuse, and water saving, are not given enough attention.

4.2. Evaluation of policy implementation effect

4.2.1. Spatial pattern of the WDUA policy

China can be divided into eastern, central, and western regions. Eastern China includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. Central China includes Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan. Western China includes Sichuan, Chongqing, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Guangxi, and Inner Mongolia.

From 2013 to 2016, the WDUA-CP reports were mainly concentrated in Eastern China, followed by Central China, and finally Western China (Figure 2). The proportion in Eastern China is close to 50%, whereas Central and Western China account for 29 and 25%, respectively. Eastern China is a coastal and economically developed area, with a dense population; thus, per-capita freshwater resources are relatively short. At the same time, there are more construction projects. Compared with the limited water resources, water management in the eastern region is stricter. Therefore, Eastern China has the largest number of WDUA-CP reports. From 2013 to 2015, the central region was slightly higher than the western region, and the gap

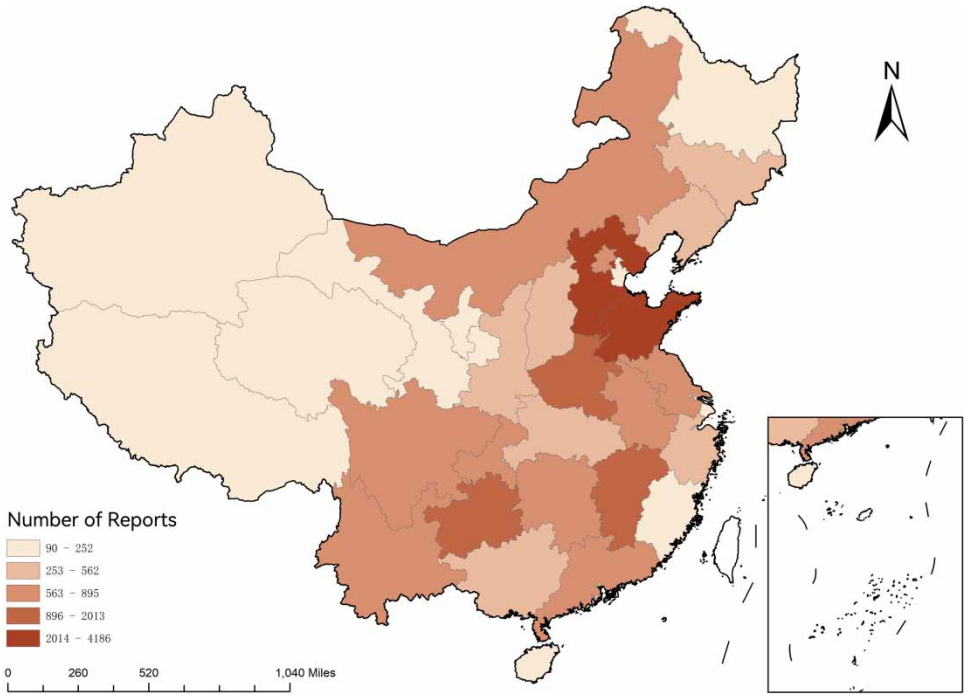


Figure 2 | Spatial distribution of the WDUA-CP reports.

in the number of WDUA-CP reports was not large. But in 2016, the number of WDUA-CP reports in the western region exceeded the central region (Figure 3). There is a significant spatial difference in water resources distribution in Western China. Northwest China is seriously short of water, whereas Southwest China is rich in water resources. Western China is an economically underdeveloped region, and the Chinese government has been actively supporting the development of the western region for many years, investing in a large number of projects. Accordingly, the WDUA-CP reports have been growing rapidly. However, the difference between the number of WDUA-CP reports between Eastern China and Central and Western China has been large.

From 2014 to 2018, the WDUA-UP was mainly in Western and Eastern China (Figure 4). Eastern China accounted for 46%, Western China accounted for 41%, and Central China only 13%. Although the WDUA-CP reports in Central China have been

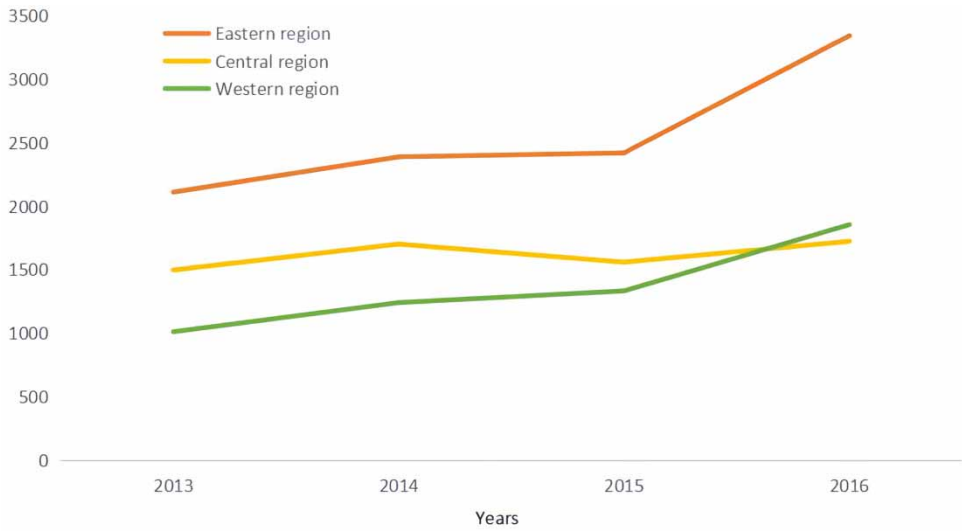


Figure 3 | Growth of the WDUA-CP reports, 2013–2016.

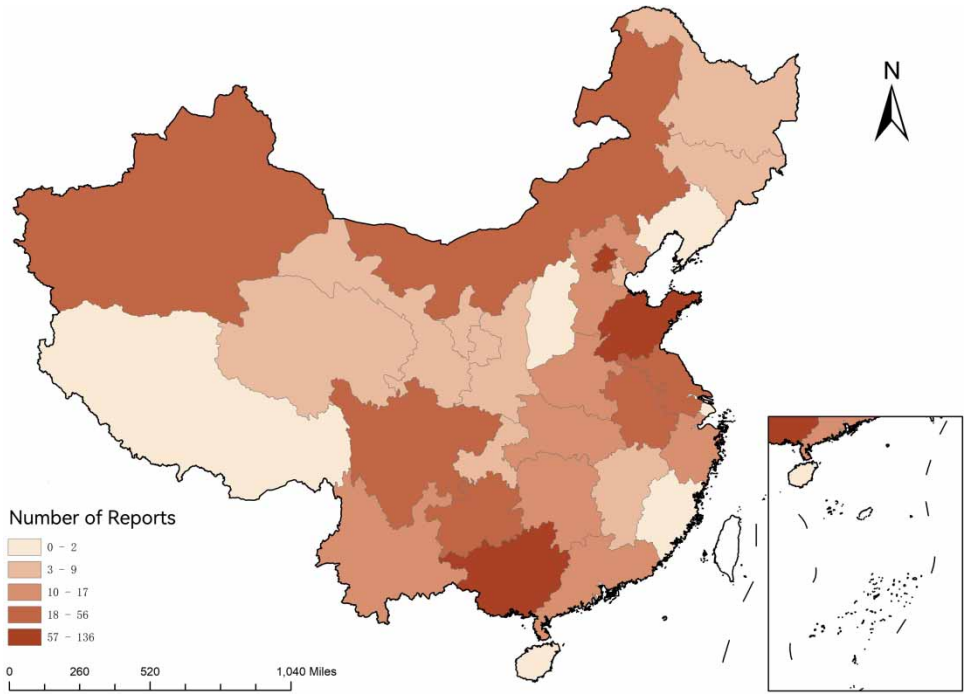


Figure 4 | Spatial distribution of the WDUA-CP reports.

steadily increasing, the number is relatively small compared with those of Eastern and Western China (Figure 5). The reason may be that, on the one hand, there are only eight provinces in Central China, whereas Eastern and Western China have 12 and 11 provinces, respectively, which are smaller regions and correspondingly have fewer reports. On the other hand, compared with Western China, Central China has fewer water resources. Compared with Eastern China, Central China is economically underdeveloped, and the demand for and attention to water resources are not enough. From 2014 to 2015, the number of WDUA-CP reports in Eastern China was lower than that in Western China, and from 2016, the number of WDUA-CP reports in Eastern China began to surpass that of Western China. The main reason is that Eastern China is economically developed; therefore, the population continues to flow to Eastern China, the urbanization rate is high, the demand for water resources is large, and water resources management is more normalized.

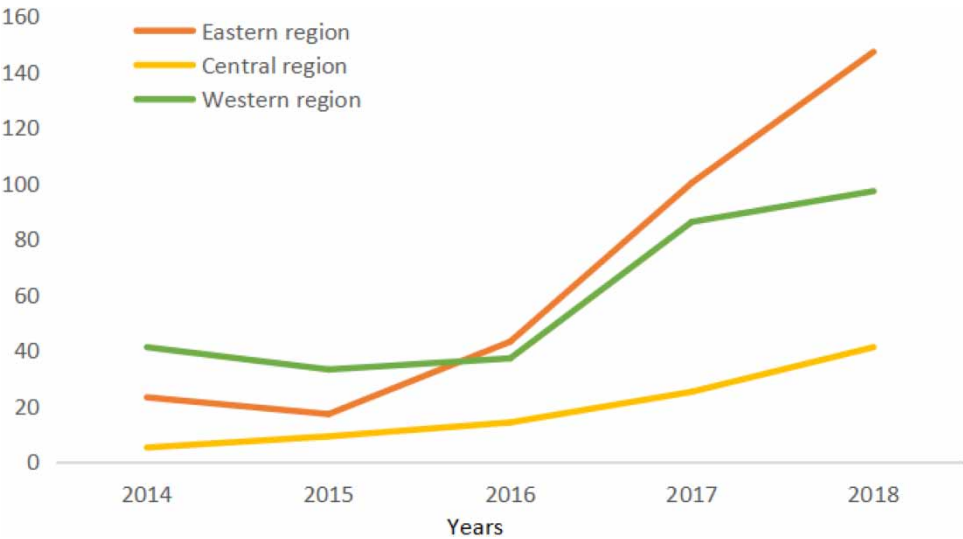


Figure 5 | Growth of the WDUA-CP reports, 2014–2018.

Bounded by the Qinling Mountain and Huai River, China is generally divided into north and south regions. The development difference between the north and south areas of China has been a hot topic in recent years. In the field of the WDUA, the number of reports is higher in the north than in the south for both the WDUA-CP and WDUA-UP (Figures 6 and 7). From 2013 to 2016, there were 12,607 reports of the WDUA-CP in the north and 9,579 in the south. From 2014 to 2018, the number of the WDUA-UP reports in the north totaled 418, and the number in the south totaled 300. This is the opposite of water resources endowments. Southern China is rich in water resources, whereas the north is short of water resources. Long-distance water diversion through mega water projects is an important means to solving this dilemma. It is because of this situation that the governments in Northern China are stricter in water resources management, intending to strengthen water saving and efficient use of water resources through policy intervention and strict management.

4.2.2. Characteristics of the WDUA policy

4.2.2.1. Analysis based on the sectors. Industrial structure refers to the proportion of agriculture, industry, and services in a country's economic structure. The industrial structure reflects a country's degree of economic development. Analyzing the

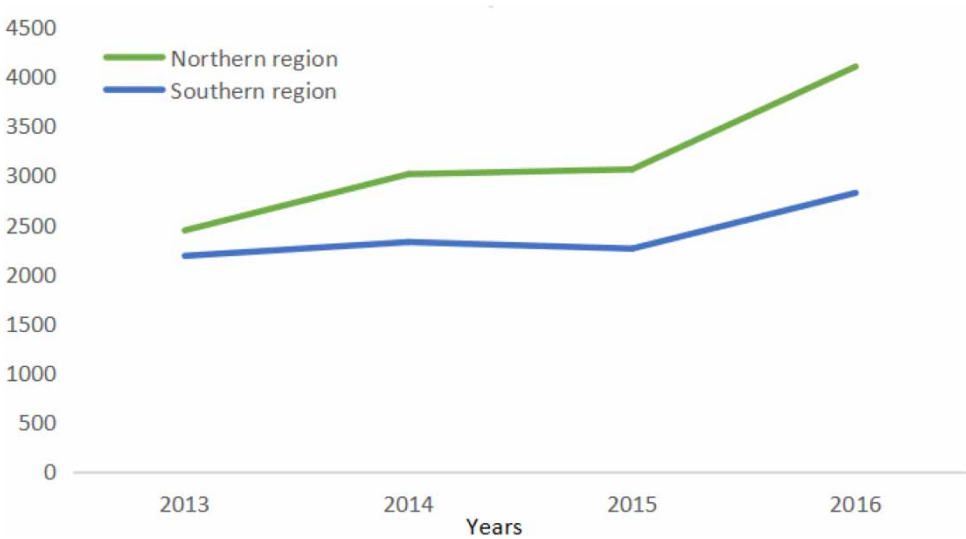


Figure 6 | Distribution of the WDUA-CP reports in the Northern and Southern China.

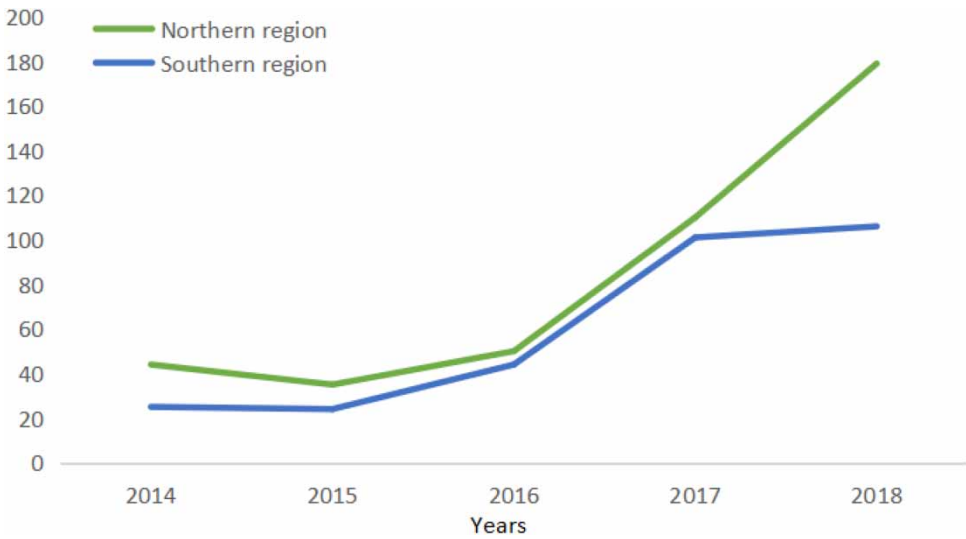


Figure 7 | Distribution of the WDUA-UP reports in the Northern and Southern China.

distribution of the WDUA reports across various industrial sectors can identify the importance of water resources in different sectors, and the extent to which each sector contributes to water conservation and water use efficiency.

From 2013 to 2016, the number of WDUA-CP reports in the primary industry was about 1,400, the number of WDUA-CP reports in the secondary industry was about 16,603, and the number of WDUA-CP reports in the tertiary industry was about 3,201 (Figure 8). The WDUA-CP reports are mainly concentrated in the secondary industry. Industrial water demand is the largest. In 2022, China's industrial water was 96.84 billion m^3, occupying 16.2% of the total water use. As a result, WDUAs are generally required for projects in the industrial sector.

Regarding specific industries, the scale of water intake in petrochemical and chemical industries has decreased year by year, and the scale of water intake in agriculture has changed greatly (Figure 9). The petrochemical and chemical industries are heavy water users and also key industries with water-saving potential. Long-term imperfection in China's industrial water price creation system has resulted in a typically low price and large industrial water consumption, which also has a negative impact on sewage treatment and reuse rates. With the optimization of the industrial structure of the petrochemical and chemical industry, we can see improvement in the cleaner production level of enterprises and continuous progress of sewage treatment technology. The government and businesses in China have made the reuse of reclaimed water their top priority as a result of the country's dual challenges of water pollution and a lack of water resources. Therefore, the petrochemical and chemical industries have seen a major improvement in the water-saving effect, constant improvement in water efficiency,

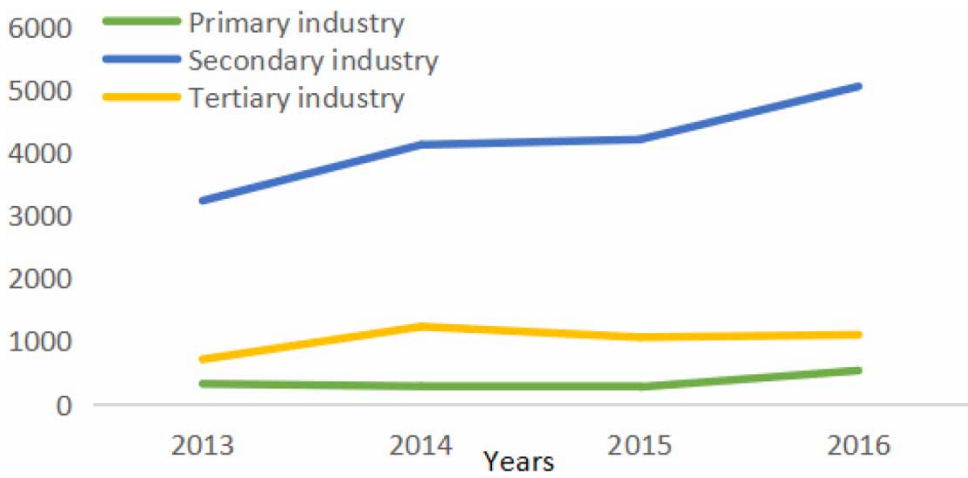


Figure 8 | Distribution of the WDUA reports based on the sectors.

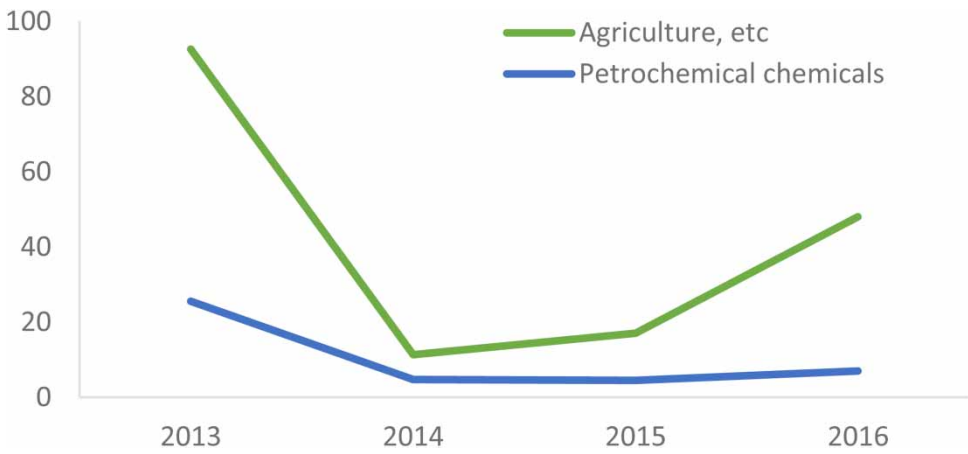


Figure 9 | Changes in water intake in agriculture and petrochemical chemicals industry.

and continual decrease in water consumption. Agriculture has been the largest user of water. Agricultural water use is mainly affected by agricultural production, technology, climate, soil, crop types, and many other factors. Therefore, changes in water use in agriculture are a dynamic and complex process, as illustrated by 2013–2016 data. Overall, China's agricultural water use efficiency is improving and water use is declining.

4.2.2.2. Analysis based on the types. There are various types of urban and town planning, including master planning, detailed planning, urban system planning, city planning, town planning, village planning, and park planning. In the current practice of the WDUA, the WDUA of industrial park planning is the most common (Figure 10). Industrial parks have played a key role in China's rapid urbanization. On the one hand, as the frontier of urban spatial sprawl, industrial parks promote urban spatial reconstruction. On the other hand, as a spatial carrier of emerging industries, industrial parks facilitate the transition development of industries. In addition, industrial parks are also the main space for population mobility and social change. The types of industrial parks are various, including high-tech development parks, economic and technological development parks, science and technology parks, industrial parks, cultural and creative industry parks, logistics industry parks, and industrial new town parks. Various local governments in China are actively developing industrial parks as a driving force for urban development and economic growth. Therefore, a lot of industrial park planning has emerged in China.

From 2014 to 2016, the number of WDUA reports in industrial park planning increased slightly, but from 2016, the number of reports increased sharply and remained at a high level from 2017 to 2018. This is due to the large amount of industrial park planning in China. However, after the issue of the WDUA-CP policy, the WDUA-CP policy was gradually recognized by local governments, and more and more projects were conducted under the WDUA.

From the perspective of the total amount of reports of the WDUA, from 2014 to 2018, the total reports have increased year by year. The reasons are as follows. First, driven by the strong promotion of China's government, the capacity and system of water governance are constantly improving. Second, the importance of water resources and awareness of saving water has been widely recognized in society. Finally, the policy of the WDUA has been effective, and the policy has been paid attention to and applied.

4.2.3. Implementation effect of the WDUA policy

The reports of the WDUA-CP and WDUA-UP also directly reflect the implementation effect of the WDUA policy. The number of the WDUA-CP reports increased from 4,622 in 2013 to 6,919 in 2016, and the number of the WDUA-UP reports increased from 69 in 2014 to 285 in 2018. This demonstrates that, on the one hand, the standardization, modernization, and legalization of integrated water resources management continue to improve, and on the other hand, it shows that the WDUA policy is scientific and has been seriously implemented.

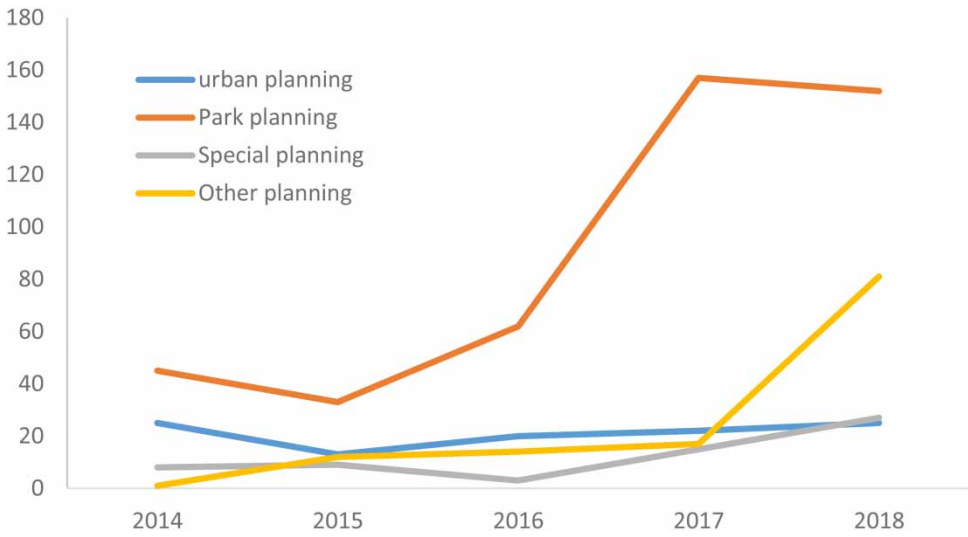


Figure 10 | Distribution of reports based on the planning types.

In China, groundwater and surface water are the primary sources of urban water supply. In China's cities, there is no significant water shortage, but there are issues with the water environment, water ecology, and water security. In the past, insufficient planning and management of water resources in Northern China has resulted in excessive groundwater extraction, which has caused significant declines in urban groundwater levels and even geological catastrophes like seawater inwelling and land subsidence. Additionally, both surface and groundwater are severely polluted, and the environment surrounding water resources has rapidly deteriorated, necessitating high costs for sewage treatment and rehabilitation.

With the attention and promotion of integrated water resources management and water governance in the past two decades, especially the implementation of the WDUA policy, China's water resources management has reached a certain achievement. The key performance is that the scale of groundwater use decreases and the utilization rate of recycled water increases. From 2014 to 2016, the amount of surface water supply dropped from 111.7 billion m^3 in 2014 to 105.7 billion m^3 in 2016. The amount of recycled water resources increased from 360 million m^3 in 2013 to 4.53 billion m^3 in 2016, and recycled water is mainly used in landscape environments, industrial production, agriculture, forestry and animal husbandry, urban non-drinking water, and groundwater recharge. This shows that, on the one hand, water resources management has achieved initial results, water-saving awareness has been strengthened, and the scale and structure of water use have been continuously optimized. On the other hand, water use efficiency has increased and sustainable water development has significantly improved.

5. DISCUSSION

The formulation and implementation of the WDUA policy is a dynamic and complex process. The current work proves that the policy has achieved initial success, but it needs further improvement. There are a number of key factors that must be addressed.

The development of the WDUA from construction projects to urban planning is not only the expansion of the scope of work, but also the deepening of integrated water resources management in the Chinese context, which is conducive to the construction of a Chinese-type water governance system, and helps to promote sustainable water development and the realization of SDG6 (Koop *et al.* 2017; Chang *et al.* 2020).

The results reveal that the WDUA policies are mainly affected by economic development and governance capacity, which is verified by the previous studies (Hanjra *et al.* 2012; Hasselman & Stoker 2017; Nykvist *et al.* 2017; Bromley & Anderson 2018). In developed Eastern China, the government has high governance ability and pays more attention to the rule of law and the standardization and legalization of water resources management, so more WDUA has been carried out. With the development of the economy, the WDUA in the Central and Western China, both construction projects and urban planning, are growing rapidly. Therefore, developing the economy and improving the governance capacity of governments are key to water governance and sustainable water development (Grigg 2023). At present, the primary problem faced in the improvement of the WDUA policy is ministry coordination. The WDUA is a significant contribution to integrated water resources management and a significant policy that the MWR offered following years of experience (Liu *et al.* 2020). Other ministries are also involved in the WDUA, including the National Development and Reform Commission, the Ministry of Housing and Urban-Rural Development, which is in charge of construction, and the Ministry of Natural Resources, which is in charge of urban and town planning. However, the current coordination of the ministries has not reached the expected goal, which is the main reason for the delay in the *Administrative Measures for the Water-draw and Utilization Assessment in Urban Planning*, which is also a key task that must be addressed in the future.

Currently, the WDUA-CP is mandatory, whereas the WDUA-UP is optional. The question of when to conduct a WDUA-UP is contentious because there are no clear regulations. The WDUA-UP should be coordinated with urban planning compilation and should be a requirement for urban planning approval (Vinagre *et al.* 2023). The WDUA-UP actually occurs either too early or too late. If the WDUA-UP is carried out prior to the plan's creation, the plan's goal and specific details are not yet apparent, making it easy to veer off course. It is challenging to perform the constraining role of the WDUA-UP in urban planning if the WDUA-UP is undertaken after the plan has been prepared. In the current practice, local governments and planning authorities have not embedded the WDUA-UP into the urban planning process, and water resources departments generally carry out the WDUA-UP after the preparation of the urban planning is completed, and it is difficult for the WDUA-UP to affect the layout, scale, and water consumption scheme of the urban planning.

Inadequate public participation systems are also a deficiency in the current WDUA policy. Public participation is an effective tool to avoid decision-making errors and an important instrument of the WDUA (Carlander *et al.* 2016). At present, the

public participation in the WDUA is not wide, and the participation methods must be further expanded, which are limited to inquiry, investigation, and expert review, and the effect is also limited. The lack of clear and specific regulations and procedures for public participation, as well as the lack of constraints, has led to inadequate or even formalized efforts.

Therefore, building a collaborative governance between multiple actors is crucial in the WDUA (Wang & Ran 2021). The current leading thinking in the WDUA is still top-down within the administrative level, with the government playing a leading role, which leads to insufficient attention to stakeholders, low levels of public participation, and policy implementation that is reactive and costly. In addition to the public, businesses, NGOs, and other stakeholders currently have a limited role in the WDUA. The next step must be to stimulate the participation of the stakeholders and increase transparency.

6. CONCLUSION

The WDUA, including project construction and urban planning, is a critical policy in China's integrated water resources management. Evaluating the WDUA policy will not only help improve the policy but also contribute to strengthening water governance and sustainable water development. This study conducted a policy evaluation from the dimensions of policy text and implementation effectiveness through text-mining and statistical analysis methods based on a review of the WDUA policy.

The results show that the WDUA policy is generally successful and has progressed across all regions in China, with documented benefits and varying effectiveness. Despite existing gaps, effectiveness will continue to grow in the current situation of implementation. The WDUA policy has been formulated scientifically and its implementation has been effective, but there are also some problems. Limitations to the implementation and improvement of the WDUA policy, especially in urban planning, have appeared in some sectors and regions. For example, the current collaboration between multiple sectors for the WDUA is insufficient for and constrains the implementation of, water governance. In addition, the contents and provisions of saving water and ecological water in the WDUA policy are not enough, and the economic measures of water resources, such as water prices and water resources taxes and fees, also need to be improved.

China is a country with serious water shortage and outstanding water ecology, water safety, and water environment problems, which have seriously constrained economic growth and sustainable urban development in China. It is urgent to strengthen integrated water resources management and water governance. The WDUA, as an extremely important but easily neglected water resources policy, plays a key role in water governance and sustainable water development. The WDUA policy still requires some improvement. On the one hand, there is a need to improve the policy system, strengthening ministries cooperation. On the other hand, a lot of technical work must be clarified and deepened, such as the rationality of water demand prediction, the problem of sharing water sources between the planning area and other regions, and the cumulative impact of water drainage from the planning area and other regions. In addition, public awareness of the importance of the water-draw and utilization needs to be raised. The government needs to further enrich technical standards and promote standardization and institutionalization. These are also the directions of the follow-up research.

There are some limitations in this study. First, due to the limitation of data sources, the data sample of this study was only from 2013 to 2018, and further expansion of the data is needed for subsequent studies with longer time series. Second, a more diversified and quantitative method can be used in the future research. Finally, a multi-country comparative study should follow.

ETHICAL APPROVAL

All authors committed that the manuscript is original and has not been published elsewhere in any form, nor is it being currently considered for publication by another journal.

CONSENT TO PARTICIPATE

All authors agreed with the content and consent to submit and have obtained consent from the responsible authorities at the institute/organization.

CONSENT TO PUBLISH

All authors approved the manuscript to be published and agreed to be accountable for all aspects of the manuscript.

AUTHOR CONTRIBUTIONS

Z. C. conceptualized the whole article, developed the methodology, funded the project, and wrote and edited the article. Y. X. developed the methodology, arranged the software, and wrote the original draft. Y. L. supervised the work, rendered support in data acquisition, and wrote the original draft. Y. Z. supervised the work and arranged the software. L. G. supervised the work, dealt with project administration, and wrote the review and edited the article. All authors read and approved the final manuscript.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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