

Analysis and study of water resources management system at home and abroad

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Abstract. In order to enhance the effectiveness of China's water resources management, China has implemented the most stringent policies in recent years, such as the most stringent water resources management system, the full implementation of the "River Administrator" system, and the "Lake Administrator" system. In this article, we studied the water management systems of six foreign countries, including United States, Canada, Japan, the United of Kingdom, France, and Australia, with exploring and analyzing the operating modes of their management system, to summarize their distinct advantages and common problems, provide reference for the development and perfection of China's water resources management system, and to better support the sustainable management of China's water resources and water environment to support the sustainable economic development of the basin and strict water resources management systems and water Implementation of pollution prevention action plans.

1 Preface

Water is the cornerstone for maintaining the stability and healthy operation of natural ecosystems, and it is also an important strategic resource that supports the sustainable development of the national economy. The importance to humanity and even the entire ecosystem of the earth is self-evident [1]. Water's natural and social dual properties determine the nature of its limited resources and prone to pollution. With the increasing pressure from the economic and social development on the water resources system, the impact of climate change on water resources, shortage of water resources, ecological damage to water, and pollution of the water environment have become more prominent, and have become major bottlenecks restricting sustainable economic and social development [2-3]. Establishing an appropriate water resources management system to guide, organize, coordinate, supervise and manage the water activities of the entire society is the key to achieving the sustainable use of water resources. Therefore, domestic experts and scholars have studied the successful experience of foreign water resources management, and combined with their national conditions, they hope to provide reference for the promotion of China's water resources management. In 2001, Zheng Yong et al [4] concluded that the UK implemented a management system that combines watershed unified management and water privatization. In France, the "parliamentary" basin committee and its basin water bureau are used to centrally manage water resources in the basin; In 2013, Hu Desheng et al [5] expounded the water resources management responsibility assessment system and its implementation effects in China, the United States

and Australia, and pointed out that China needs to learn from the successful experiences of the United States and Australia in terms of assessment form, institution construction and public participation; In 2016, Dong Shitao et al [6] pointed out that Japan's central water resources management is based on the Ministry of Land, Infrastructure, Transport and Tourism, and the four departments coordinate and cooperate. The local water resources management is based on the basin level classification, and the water resources operation mechanism with clear division of labor at all levels of government. The above comparative studies included fewer countries and did not reflect the characteristics of national water resources management in different regions.

In view of this, the author analyzes the representative national water resources management system in different regions of the world, and analyzes in depth the problems of different systems of water resources management, administrative regions, and the establishment and function division of water resources institutions in river basins. Summarize the characteristics of different management systems, sum up their common problems and their respective advantages, and analyze the enlightenment of water resources management systems in various countries on China's water resources management system, with a view to contribute to the realization of integrated water resources management in China.

2 China's water resources management system

In 1988, China's "Water Law" established the principle of unified management and grading of water resources,

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combined with sub-sector management. The multi-sectoral management of the rivers and the administrative management of multiple water departments in the provinces along the river prompted the water resources management system to form a “multi-dragon water control [7]” pattern. Such overlap of property rights and scope and the overlapping of water resources management and disposal rights make it difficult to unify and coordinate the functions of multiple “dragons” and the relationship between departments.

In 2002, the State made a comprehensive amendment to it. In the new “Water Law,” it established a river basin management system that combines river basin management and administrative regional management, and defined the management authority of river basin management agencies and local water administrative authorities. The water administrative department of the State Council is responsible for the unified management and supervision of water resources throughout the country. The river basin management agencies (hereinafter referred to as the river basin management agencies) established by the water administrative department of the State Council in important rivers and lakes determined by the State. To exercise the water resource management and supervision duties as stipulated by laws and administrative regulations and the water administrative department of the State Council within the scope of its jurisdiction. The water administrative department of the local people’s government at or above the county level shall be responsible for the unified management and supervision of water resources within its own administrative area in accordance with the stipulated authority.

Subsequently, according to the natural and social nature of water resources, scientifically and reasonably divide water function areas, and implement a management system combining watershed management and administrative area management.

In 2017, the Ministry of Water Resources issued the “Supervision and management of water function zones” to make more detailed provisions. The water administrative department of the State Council implements unified supervision and management of the national water function zones coordination of the supervision and management of important rivers and lakes water function zones within the river basin, as well as the rivers (river sections), lakes, and rivers that contain provincial boundary water function zones (including the provincial buffer zone) and river basin management agencies. The water function area of the reservoir shall be supervised and managed. Other water functional areas shall be supervised and managed according to the administrative authority determined by the water administrative department of the people’s government of the province, autonomous region and municipality directly under the Central Government.

The Chinese government attaches great importance to the management of water resources. In recent years, it has proposed a series of policies such as building a water-saving society, implementing the most stringent water resources management system, implementing water pollution prevention and control action plans, and

implementing the “River Administrator” system and the “Lake Administrator” system. The implementation of the “River Administrator” system, and the “Lake Administrator” system are an institutional innovation embedded in China’s existing water resources management mechanism system, effectively improving the capacity and level of water resources management, and effectively guaranteeing economic and social development.

3 Foreign water resources management status

According to geographical location, climatic conditions, hydrological characteristics and water resources endowments, selected representative countries of the Americas, Asia, Europe, and Oceania, such as the United States and Canada, Japan, the United Kingdom, France, and Australia. A comparative analysis of water resources management and its characteristics was conducted.

3.1 Water resources management system in the United States

The U.S. water resources management is basically carried out by the state as a unit. Each state has its own functional department to manage water resources, and it exercises equal legislative authority with the federal government [5,8-9]. The management of U.S. water resources involves three levels of organization: federal government agencies, state government agencies, and local government agencies. In the United States, water resources management is provided by the Department of Natural Resources Protection of the Ministry of Agriculture, the Water Resources Department of the National Geographic Survey, the Bureau of Reclamation (USBR) under the Ministry of Internal Affairs, the Army Corps of Engineers under the Ministry of National Defense, and the National Environmental Protection Agency.

The National Environmental Protection Agency is located at the highest level and has the highest power of control and final decision power. Under the same leadership of the federal government, each department has a clear job function and can perform division of labor and cooperation very well. It can also be very good at mutual restraint and cooperation and form an efficient management system. The Natural Resources Environmental Protection Agency is affiliated with the Ministry of Agriculture and is responsible for the development and protection of water resources. The Water Resources Department under the jurisdiction of the National Geographic Survey Bureau is responsible for collecting, monitoring, and profiling various hydrological and informational materials within the country, and at the same time providing policy advice on the development and utilization of water resources. The Bureau of Reclamation under the Ministry of the Interior is responsible for planning hydropower initiatives and maintenance of water quality and quantity. The Army Corps of Engineers under the Ministry of Defense is

primarily responsible for the planning and start-up of large-scale water projects supported by the government.

The development of U.S. water resources management has gone through four stages, including the single-target development stage (before 1930), multi-objective development and comprehensive watershed management stage (1930-1970), water quality optimization development stage (1970-1990), and Persistence and return to the natural stage of redevelopment (after 1990). The development of U.S. water resources management has gone through four stages, including the single-target development stage (before 1930), multi-objective development and comprehensive watershed management stage (1930-1970), water quality optimization development stage (1970-1990), and Persistence and return to the natural stage of redevelopment (after 1990).

The history of water resources management in the United States can be traced back to after the war of independence. In 1901, the United States promulgated the first federal water law; in 1902, it established the United States Bureau of Reclamation (USBR) and promulgated the "Regulations Act", which declared that water resources belong to the state; and the "Flood Prevention Act" promulgated in 1928 marked the beginning of multi-purpose development of U.S. water resources. In 1933, the Tennessee Valley Institution (TVA) was established, mainly adopting the following measures: through legislation, providing legal guarantee for the unified management of natural resources in the basin; the Tennessee Basin Administration for unified management of water resources in the basin; establishing a benign operational mechanism and management Institutions; watershed management to promote regional economic and social development. After years of practice, the development and management of the Tennessee Valley has achieved brilliant achievements, and the management of TVA has become a unique and successful example of watershed management and has attracted worldwide attention. In 1965, the US government began implementing the water quality law. Since 1970, the EPA (United States Federal Environmental Protection Agency) has made a more gradual deployment of water environmental protection and management, and stricter requirements for water environmental protection objectives, in order to achieve a more comprehensive and effective goal of water environment management. In 1987, its water ecological zoning scheme was proposed. The method mentioned in the scheme is based on the difference of different shapes, different types of landforms, vegetation, soil and land use indicators to implement functional zoning. In 2005, the United States launched a pilot study in the great lakes basin. In 2007, the US Geological Survey (USGS) released the 10-year science strategy (2007-2017), which faces the challenge of tomorrow, and uses the US Water Resources Census as the six strategic scientific directions of the United States. Nowadays, water management in the United States is developing towards the complex ecological environment of the team. The estuarine protection plan and the river restoration movement are being implemented, emphasizing not only improving the

water quality of the estuary, but also paying more attention to restoring the natural ecological environment, and some of the dams that affect the ecological environment have been or will be demolished.

3.2 Water resources management system in Canada

The transformation of water management concept is a sign that Canada's water resources management has entered the stage of "sustainable water management". The realization of sustainable use of water resources is the basic tenet of water resources management in Canada.

Canada is based on national and local administrative agencies, but does not exclude watershed management systems. The federal government basin water resources management agency is responsible for the comprehensive management of water as a basic resource, and its functions are mainly undertaken by the Ministry of Environment, the Ministry of Fisheries and Oceans, and the Ministry of Agriculture. The Canadian Department of the Environment is a water resources management agency at the federal level. Its main responsibility is to combine the management of natural resources with the protection of environmental quality and to study them to promote rational development and utilization.

The provincial government is the institution that link between the preceding and the following. Therefore, the provincial government has set up a special agency responsible for river basin water resources management, and centralized water management rights that are scattered among many government agencies in water management institutions or companies. Saskatchewan has established Saskatchewan Water Company to assign the water supply plants and sewage treatment plants owned by the provincial government to the company's operations and management, and the company is also responsible for the various administrative tasks of water resources and water environment. In order to adapt to the reform of the water resources management institutions of the federal and provincial governments, local governments have also made major adjustments to the basin water resources management institutions, so that the adjusted local governments can more effectively implement various policies and laws of federal and provincial government watershed management agencies.

3.3 Water resources management system in Japan

Japan's water resources management has formed a water resources operation mechanism in which the central government is led by the Ministry of Land, Infrastructure, Transport and Tourism, and the four departments coordinate and cooperate, and the localities are divided according to the basin level.

Japan's central water resources management agencies mainly include the Ministry of Land, Infrastructure, Transport and Tourism, the Ministry of Environment, the

Ministry of Health, Labour and Welfare, the Ministry of economy, trade and industry, and the Ministry of Agriculture, Forestry and Fisheries.

The Ministry of Land, Infrastructure, Transport and Tourism is mainly responsible for the long-term planning of water resources development and utilization. The Ministry of Environment is mainly responsible for water pollution and environmental management. The Ministry of Health, Labour and Welfare is mainly responsible for the management of residential water supply. The Ministry of Economy, Trade and Industry is mainly responsible for industrial water supply management. The Ministry of Agriculture, Forestry and Fisheries is mainly responsible for agricultural water supply management. There are divisions of labor and cooperation between the five water resources management departments, which on the one hand bear different specific functions related to their respective fields; on the other hand, they cooperate with each other in the form of inter-provincial associations and formulate comprehensive policies related to water resources.

In addition, Japan has a semi-official water conservancy institution, the Water Resources Development Corporation. The basic task is to follow the country's long-term planning and local government's long-term planning for the seven major water systems in Japan (ie, Ligenchuan, Arakawa, Toyokawa, Kisokawa, Yodogawa, Yoshinokawa and Chikugo River) Unified development, management, adjustment of various aspects, raising funds, and coordinating water resources development projects across the country.

Japan has formulated a relatively complete water resources legal system to restrict and regulate water activities throughout the country [10]. Although Japan is "multi-dragon water management", it is "administrative by law, multiple management, and methodical". It can be seen that although Japan manages water resources according to the statutory functions of the department, in essence, the water rights are uniformly managed by the state to strengthen the unified management of river water systems for development and to ensure the realization of river basin planning.

3.4 Water resources management system in Britain

In the 20th century, British water resources experienced a historical evolution from local decentralized management to unified management of watersheds. At present, the central management system for water resources is managed by the unified management of watersheds and the privatization of water resources [4]. The central government shall carry out macroeconomic regulation and control of water resources according to law, issue water permit and discharge permit through the UNEP, implement water rights allocation, water intake management, sewage discharge and river water quality control; and issue water rate standards through water service offices to determine water prices; Develop drinking water quality standards and implement water quality supervision through the Drinking Water

Supervision Committee. On the basis of the distribution of water rights and water quantity, the private water supply company implements integrated water management and management within the scope of services under the guidance and supervision of the government and relevant social departments.

In the UK, the central government departments related to water resources management are: Ministry of Agriculture, Fisheries and Food, Ministry of Environment, Transport and Regions, Ministry of Science and Technology. The Ministry of Agriculture, Fisheries and Food is mainly responsible for agricultural irrigation and drainage, and is responsible for providing central flood control funds. The Ministry of Environment, Transport and Regional Affairs is mainly responsible for formulating national water policies, laws and regulations, protecting and improving water resources, and finally ruling on water conflicts and supervising the implementation of the water permit system. The Ministry of Science and Technology and Education is mainly responsible for research and education activities related to water conservancy.

The government water resources management executive departments mainly include the National Environment Agency, the Drinking Water Supervision Committee, the Water Service Office, and the Water Conflict Arbitration Committee. The National Environment Agency has the functions of issuing water and sewage discharge permits, formulating and implementing water and sewage discharge and environmental protection policies and plans, formulating national flood control plans, organizing flood control projects, and interpreting relevant laws; the Water Service Office represents the government in the macroeconomic regulation and control of the water supply enterprises by controlling the upper limit of income of the water company, and supervises the water supply company to perform various duties assigned by the water law; the Drinking Water Oversight Committee is a functional department of the Ministry of Environment, Transport and Regional Affairs, which behalf of the government to propose water quality parameters of drinking water, formulate drinking water quality policy and testing standards, check the water supply company's water quality testing system, provide technical advice and negotiations with the European Community.

The British privatized water supply company, after the reform of the British water system in 1989, privatized the top ten water bureaus and established ten large-scale water supply companies. The water management areas of the top ten water supply companies are basically divided by watersheds and are responsible for water supply and sewage treatment in this basin.

3.5 Water resources management system in France

France has used "parliament" river basin commission and its executive arm, the unified management of river basin water pipe bureau to river basin water resources, urban

water does not like the British make full privatization, but transfers the ownership of the assets to private enterprise, the planned entrusted management [4].

Historically, France has implemented user-based, district-based water management. From the post-World War II to the 1969 period, France was rapidly transformed from an agricultural country to an industrial country. Rapid industrial development and urbanization led to rapid growth in water demand and a sharp deterioration in water pollution. In response to this situation, France enacted a revised water law in 1964 to reform the water resources management system. Its main contents are as follows: First, it has legally strengthened the governance of water pollution in the whole society, and determined the time target for pollution control; secondly, established a watershed-based mechanism for solving water problems; and third, established a basin committee and a river basin authority. As the main financing institution for comprehensive river basin management, under the premise of environmental protection, the efficient development and utilization of water resources in the basin will be realized. After 1964, France divided the country into six major river basins according to the water system. The respective river basin committees and river basin administrations are responsible for the unified planning and unified management of water resources in the basin. The goal is to meet the water demand of users and meet the needs of environmental protection. The new Water Law in 1992 further strengthened this management system.

At present, the French water management institutions are mainly divided into several levels, such as national level, river basin level and local level [4, 11].

State-level government agencies mainly include the Ministry of Environment, the Ministry of Agriculture, and the Ministry of Equipment (construction, transportation, and housing). The Ministry of the Environment is mainly responsible for formulating water regulations, water policies and supervision, monitoring and analyzing water pollution, formulating national standards related to water, coordinating various water relations, and participating in the formulation of water resources planning in river basins. The Ministry of Agriculture is mainly responsible for water supply, farmland irrigation and agricultural waste-water treatment in agriculture and villages. The water-related duties of the equipment department (construction, transportation, and housing) are mainly flood control, and management branches with water management are provided in each area. In addition to these functional departments of the central government departments, an inter-ministerial joint meeting on water resources management was established at the central level, with representatives from 13 departments related to water resources management, mainly discussing national water resources management policies and regulations.

Basin water resources management. The River Basin Committee is an authority for river basin water administration. Its functions include the formulation and release of water management policies, the approval of river basin planning, the review of project investment budgets, and the implementation of supervision projects.

Municipal water management. Water management in France is implemented within the boundaries of the town. French law stipulates that water supply and sewage treatment are the responsibility of local governments.

3.6 Water resources management system in Australia

Australia's water resources management system combines administrative management and watershed management. The water management is divided into three levels: federal, state and local, but it is mainly based on the state. The combination of watershed and regional management, unified management and comprehensive management of water resources (including groundwater), water environment and water rights market [5,12-13].

The Federal Government Water Resources Council is the nation's water advisory body and the country's leading agency for the management of surface water and groundwater, responsible for organizing and coordinating nationwide water resources research and planning. The federal government level provides policy guidance for water resources information and management, and coordinates the development and utilization of water resources in the various states within the basin. The State Department's Ministry of Water and Soil on behalf of the state government implements water resources management, development and water distribution, and according to the state's water resources allocation determined by the federal government, the state users are issued a water permit for a certain number of years, and charges are charged. The local government is the executive agency, which mainly implements water laws and regulations promulgated by the state government. The local water department is responsible for water supply, drainage and water environmental protection. The division of labor at all levels of government is clear, and the water resources are graded and managed, and good results have been achieved.

In the central government agencies in 2015, the core structure of "two departments + two bureaus + two committees" was adopted for water resources management. "Two departments" means that the Ministry of Agriculture and Water Resources is responsible for water resources policy management on behalf of the federal government, and the Ministry of Environment is responsible for water environment management. The "two bureaus" refer to the Murray-Darling Basin Authority (MDBA) as the executing agency responsible for formulating policies and plans for water resources management within the basin. The Meteorological Administration is responsible for collecting and disseminating water and water information. "Two Committees" means that the Australian Competition and Consumer Commission (ACCC) is the executive body responsible for water market competition and consumer protection. The National Water Resources Commission (NWC) is the executive agency responsible for water supply and waste-water treatment.

4 Classification of water resources management system

4.1 Regional water resources management system based on local administrative areas

The United States, Canada, and Australia are typical countries that conduct water management based on national and local administrative agencies. They also attach great importance to the management of water resources by basin to compensate for the deficiencies of local administrative agencies. The water resources management in these three countries tends to be based on the comprehensive management of water resources in the river basin and a management system combining the supervision and coordination of state functional departments and local governments. The following aspects are introduced for the commonality: the trend is to take the whole basin as the management object; the cooperation between the river basin management organization and the regional department; the management method is diverse and reasonable; and the important role of the public participation mechanism is emphasized.

4.2 Watershed water resources management system based on natural watershed

The United Kingdom and France are typical representatives of a comprehensive watershed management system. In this watershed management system based on natural watersheds, water resources management agencies have a wide range of control water pollution and manage the water resources such as multi-level rights and duties. Through the research on the operation of water resources management system organizations and watershed management institutions in these two countries, we can find that they have some outstanding features in the construction of water resources management system: water resources management based on natural watershed; Pay attention to the guarantee role of the law on the operation of the river basin management system; attach importance to public participation.

4.3 Water management system based on the function of water

The water resource management system based on the function of water mainly refers to the multi-level of the establishment of water resources management institutions. Unlike the centralized water resource management system, there are several water resources management departments in the water resource management system based on the function of water. Therefore, the water resource management system based on the function of water presents the characteristics of "Separate management of water and use of water, multiple 'dragons' management of water".

The characteristics of Japan's water resources management system: showing a clear multi-sector

multi-level management and achieving hierarchical management of sub-sectors; in order to solve the inherent drawbacks of this "multi-dragon water management system", Japan has also established corresponding coordination agencies. the Water Resources Bureau within the Ministry of Land, Infrastructure, Transport and Tourism is responsible for the coordination of the daily management of water resources, and has established a departmental coordination system between the administrative departments of water resources; according to the water resources management system of the River Law, the first is to emphasize the unified management of water resources in the basin, and the second is to emphasize the coordination of flood control and water resource utilization.

5 Conclusion

In summary, different water management systems have been adopted by different countries, to adjust to the different regional condition, water condition, and economic situations. The United States, Canada, and Australia, which have large country land, adopt the combination of the administrative regional stratification and integrated river basin management, for better information exchange and water resources control. In Japan, the water resources management system belongs to the "multi-dragon water management, collaborative management" model, in which the central government is led by MLIT (Ministry of Land, Infrastructure, Transport and Tourism), with the coordination and cooperation by four departments, and the localities are divided according to the basin level. In Britain and France, the management of river basin water resources belongs to resource management, which is dominated by government behavior, and urban water management is dominated by market behavior.

While, currently in China, the water function zone is set as the basic unit, and the management system is adopted with combining watershed management and administrative district management in the water function zone, and the assistance of the "River Administrator" system^[14] and "Lake Administrator" system^[15], which can effectively protect the water resources, ensure a sustainable employment, promote the construction of ecological civilization, and form a harmonious developing pattern between human and nature.

According to the characteristics and advantages of international water resources management, for learning from the international advanced experience in water resources management, with considering the current problems of China, several points are implied for further improving China's water resources management.

(1)Legal norm: to further improve the water-related laws and regulations to prepare better environment for water resources management. The Chinese wading laws and regulations system still exist some defects, and the issued laws also have been executed poorly [16-17]. Since the reform and opening up, China has successively promulgated the water law, the law on soil and water conservation, the law on the prevention and control of

water pollution, the law on the prevention and control of water pollution, the flood prevention and control, and the measures on the supervision and management of water functional areas, which provide the basis for water resources management. Under the practice and theoretical exploration, the insufficient water-related laws and regulations need to be filled, for further improving the water law system, at the same time, clarifying the internal relationship between laws and regulations, and activating the supervision and law enforcement by people congress at all level; the government need to guide the establishment of stakeholder participation mechanisms to promote the implementation and supervision of water related laws and regulations.

(2) Management system: to further improve the water resources management system combining river basin management with administrative regional management [18-19]. In 2002, the Water Law established a watershed management system that combines river basin management with administrative regional management. In 2003, the “Water Function Zone Management Measures” promulgated by the ministry of water resources used the water function zone as an important platform for various water management and water-related activities, and clarified the relevant management measures for water function zones. In 2017, the “Measures for the Supervision and Administration of Water Functional Zones” further clarified the authority for the supervision and management of water functional zones between river basin management agencies and local water administrative authorities. However, there will be new problems in the implementation of the “Water Function Area Supervision and Management Measures” and there are no clear details in the implementation process. Therefore, we need to continue to be guided by practical problems, and further clarify the division of water rights in China’s seven major river basins and regions, central and local. Clearly clarify the functions of river basin management agencies and local water administrative departments, and give play to the functions and functions of river basin institutions in river basin planning and management, flood control and water resources unified dispatching, river and lake management, and supervision and assessment.

(3) Departmental coordination: strengthen cross-sectoral coordination to resolve local water-related issues. Taking the opportunity of implementing the “River Administrator” system and “Lake Administrator” system as opportunity, the cooperation, coordination and linkage mechanism between four levels of river length and lake length in provinces, cities, counties and townships, as well as different departments involved in local water-related issues, shall be established, and the interests and responsibilities related to water resources protection, shoreline management of water areas, water pollution prevention and control, water environment management and water ecological restoration shall be coordinated [19-20]. We will implement the responsibilities of the chiefs of the rivers and lakes in accordance with the law, coordinate and integrate the

forces of all parties, and promote the management and protection of rivers and lakes resources.

(4) Public participation: to further improvement of the public participation mechanism is a useful supervision of China’s water resources protection work. China should also further improve the corresponding policies to support and guide the public to participate in water resources management. The government should introduce specific implementation measures to make specific provisions on the scope, methods and ways of information disclosure involving water resources. In addition, it is necessary to form a corresponding accountability mechanism for responsibility, and make specific provisions on issues such as responsibility and accountability for the subject of information disclosure, and effectively implement water resources management and protection.

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