Study on Water Distribution Scheme Across Regions

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Abstract. For a long time, water conservancy projects across administrative region is mostly invest in the construction by superior government, each side unconditional benefit, this is difficult to arouse the enthusiasm of benefited party to investment, and makes the government faces a great financial pressure, at the same time, it is easy to produce regional imbalance and contradiction of water resources. Finally, it will affect the resource efficiency and investment efficiency of the project. The transregional water allocation is an important basis for implementing the total water use control system in drainage basin and regions and an important content for implementing tough water management measures. This article summarily analyses the typical engineering way of water allocation, and the basic principle of the water allocation, takes Qingxi Reservoir water allocation on concrete analysis, puts forward the main factors of Qingxi Reservoir water allocation, including the area of the Qingxi river basin in each administrative regions, water resources, effect of reservoir engineering constructions, the water demand and water deficit in each administrative regions, input factors, and then puts forward proposals on water allocation. Based on two water allocation proposals, this article puts forward proportion and recommended of water allocation in each administrative region. Each administrative region should own the same right to use water resources and shoulder the same responsibility based on the same proportion, same right , same profit and same responsibility. The water allocation plan can be used as reference for Qingxi Reservoir water allocation.

1. Foreword
Water is the valuable natural resources for mankind's survival and development. Water is used for human production and life. Water resources have been considered inexhaustible since ancient times. With the growth of population, the development of economy and society, the acceleration of urbanization process and the improvement of people's living standard, water resource shortage, water pollution and water ecological deterioration become one of the main factors which restrict sustainable development of social economy and ecological environment. Water resources have become economic resources from public resources. People improve the utilization efficiency of water resources by saving water and building reservoirs. For a long time, water conservancy projects across administrative region is mostly invest in the construction by superior government, each place unconditional benefit, this is difficult to arouse the enthusiasm of benefited party to investment, and makes the government faces a great financial pressure, at the same time, it is easy to produce regional imbalance and contradiction of water resources. Finally, it will affect the resource efficiency and investment efficiency of the project. The transregional water allocation is an important basis for implementing the total water use control system in drainage basin and regions and an important content for implementing tough water management measures. It is necessary to determine the right of
each party to use water and make a reasonable water allocation plan in order to reduce conflicts among all parties and ensure the benefits of all water users.

2. Basic principles of water distribution

Water allocation is one of the basic works for implementing tough water management measures, and the centralized allocation of water resources is to pursue the maximization of the whole society's water use efficiency. Different administrative regions have different levels of economic, social development and water demand, so they have different expectations for water resource management strategies and have preferences for water allocation methods. At the same time, water allocation belongs to the redistribution of benefits, which involves the vital interests of relevant regions. Therefore, differences and disputes must be properly resolved on the basis of democratic consultation. In general, water allocation consists of the following three basic principles[1][2][3]:

First, the principle of equity. Equity means everyone has the right to use water, and every region has the right to use water. On the basis of equality between everyone and all regions, the distribution of water should follow equity principle to ensure that each region and everyone's demand for water is met. As a natural resource, water has special commercial value. On this level, the principle of equality has two other connotations: first, water priority can be obtained in the area where water is produced; second, priority can be obtained in the area where water is taken.

Second, the principle of sustainable development. Water is an indispensable resource for human survival. Only sustainable development can balance the ecological environment and meet the water needs of contemporary and future generations. Therefore, on the basis of the principle of sustainable development, water is not inexhaustible, and a certain amount of water must be left for future generations. At the same time, water is not only satisfy the needs of human beings, but also all physical heritage, and the basic water should be left to maintain the ecological environment.

Third, the principle of efficient use of water, which advocates that areas, departments and users with high water efficiency can be given priority for distribution, but it must be based on the principle of fairness.

In case of severe water shortage, domestic water should be ranked first; In the principle of fairness, people and livestock should have priority in drinking water. In industrial water use, the principle of fairness should be followed within the quota, and the principle of efficiency should be followed outside the quota[4].

3. Typical water distribution mode of the project

At present, there is no fixed or unified regulation or calculation method for water allocation. Especially with the development of economy and society, all parties have a relatively large demand for water resources, so it is very difficult to make water allocation plans without any dispute in water shortage areas. Although the parties consider it necessary to carry out water distribution, it is difficult to reach an agreement on the water distribution share, which is usually determined by the higher government through consultation. Water allocation schemes have been studied in many regions. According to the principle of giving priority to local runoff and ensuring insufficient water diversion projects, water resources in the Qiantang River estuary are allocated in accordance with the existing water resources, and the priority supply right and water supply order are divided according to the social and economic status of water users. Qiandao Lake water distribution project allocates the water consumption of different areas according to the principle of fixed supply on demand. The distribution of water rights in Taihu Lake basin mainly takes into account 47 indexes of 6 major and 13 subsystems, including water resources, society, economy, ecological environment, engineering and technology, and policy and management. Zhanghe Reservoir in Hubei province is under the guidance of total volume control and efficiency control of water, and two calculation methods including quota allocation method and classification weight method are adopted.
3.1. Allocation of water resources in the Qiantang River estuary

Qiantang River estuary water distribution involves living, production and ecological environment, etc., involving the main area of Hangzhou, Jiaxing, Shaoxing, Ningbo and Zhoushan, therefore the river outside the water distribution in the river estuary under the premise of ecological environmental water, must be coordinated, configured according to certain principles, in order to achieve reasonable exploitation and utilization of water resources, to support the purpose of the regional social and economic sustainable development.

The analysis principles of supply and demand balance are as follows:

(1) Take the 40 years of the hydrological long series (1961~2000) as the calculation sequence, take the day as the calculation period, and calculate the supply and demand balance respectively for the current working condition and the planning working condition. (2) Within the scope of supply and demand, unified allocation of existing water resources should be made according to the practical and feasible dispatching principle. Priority should be given to the right of supply and the order of water supply according to the social and economic status of water users, so as to give priority to the supply of high-quality water for daily use and give consideration to agriculture, general industry and other water. (3) In general, water use in jiangnan section of Hangzhou urban area should be firstly considered by making use of the local river network, and water intake from the Qiantang River estuary should be considered for the insufficient part. (4) On the premise of making full use of local runoff, the eastern Zhejiang region should consider supplemental water shortage through the water diversion project of Fuchun River.

The control and scheduling principles of water intake engineering are as follows:

(1) Principle of sequential control. Water supply from public waterworks, landscape water supply from West Lake, agricultural water supply from jiangnan and general industrial water supply from non-public waterworks, water diversion from Fuchun River, water diversion from Fuchun River to the city and other environmental water supply are controlled. (2) Installment scheduling principle. According to the runoff and tidal characteristics of the Qiantang River estuary, the annual schedule is divided into the following three periods: from April 1 to July 15, there is a wet season; from July 16 to November 15, there is a dry spring tide; from November 16 to March 31, the following year, there is a dry neap tide. (3) The dual control principle of annual total water withdrawal and daily maximum water intake flow. The annual total water withdrawal is controlled according to the annual average annual total water allocation of no more than 4.29 billion cubic meters, and the daily maximum water intake flow is regulated according to the average discharge volume of two days before Fuchun River hydropower station and the chlorinity value of river water at high tide the day before the gate station.

3.2. Water distribution of Qiantao Lake water distribution project

The water supply scope of the Qiantao Lake water distribution project, is mainly for the urban area of Hangzhou (the main urban area of Hangzhou, Xiaoshan district and the east area of East Tiaoxi River in Yuhang) and some areas of Jiande, Tonglu and Fuyang along the route of the project. It adopts the large-quality water supply mode, using high-quality and stable water from Qiandao Lake as high-quality water for urban and rural living in water demand areas, keeping the existing water sources as general industrial water, and realizing the optimal allocation of water resources by complementing the quantity and quality of multiple water sources and optimizing the use of water. The comprehensive domestic water quota method is used to predict the future water demand of the large-quality water supply mode, including the urban comprehensive domestic water consumption and part of the industrial water that requires high water quality. The water amount is distributed according to the actual water demand of each zone.

3.3. Water rights distribution model in Taihu Lake basin

Water rights distribution in the Taihu Lake basin mainly considers six indicators, including water resources, society, economy, ecological environment, engineering and technology, and policy and management, which basically cover all aspects affecting interregional distribution. Water resources
include regional present situation with the amount of water resources, water resources development and utilization status of resource factors, such as social refers to the land area, including regional people's life and social factors such as population, economic means including regional industrial economic development situation and the development prospects of economic factors, such as ecological environment refers to the region's ecological environment, engineering and technology embodies the region in the development and utilization of water resources guarantee the rational utilization of water resources, water saving, improve the ecological aspects in water conservancy engineering facilities and technical input, etc., and water management policy and management reflects the regional government department importance of water resource management, configuration and administration.

3.4. Water distribution plan of Zhanghe Reservoir in Hubei Province[5]
Zhanghe Reservoir was built in 1966, it is located at Zhanghe River which is a tributary of the Yangtze River, and is the largest reservoir under the jurisdiction of Hubei Province. Affected by natural geographical factors and water conservancy construction, Zhanghe Reservoir control catchment area and the scope of water supply involved in the administrative region (prefecture-level city) is different, from the catchment area to the water supply area involving four cities in Hubei province. The reservoir catchment area covers Yichang, Xiangyang and Jingmen. The water supply scope of the reservoir involves Yichang, Xiangyang and Jingmen, while parts of Jingmen city and Jingzhou city are beyond the scope of the river basin.

In the dry season of Zhanghe river basin, the water demand of each water area is large, but the water supply is limited, and the water supply contradiction is prominent. According to the water supply and use situation of Zhanghe Reservoir, the water distribution research focuses on the water distribution in dry years, and the selected water inflow frequency is P=50%, P=75% and P=85%. According to the basic principles of basin conditions and water allocation, the priority of water use is determined as follows: (1) Domestic water (including some important industrial water, water for flood control, drought relief and power generation), and water for minimum river ecological environment; (2) Water for agricultural irrigation; (3) Water for the secondary and tertiary industries; (4) Water for power generation other than flood control and drought relief; (5) Other types of water use, such as the addition of water users for external diversion (such as the replenishment of ecological environment caused by flushing of river courses outside the basin).

In terms of water allocation method, two calculation methods, quota allocation method and classification weight method, are adopted. The quota allocation method is to use the quota method to predict the demand for water, and then analyze the balance of supply and demand between users and regions. Classification weighting method for watershed water user, on the basis of statistical analysis to quantitative distribution principle, water distribution, water of different categories of (life, agriculture and industry) give different weights and priority sequence respectively, by calculating the weights of all kinds of water water area, it is concluded that the weight of the water area of water allocation.

4. Water distribution of Qingxi Reservoir

4.1. Overview of Qingxi Reservoir
Qingxi is located in the east coast of Zhejiang Province, with Qimen port in the east, Haiyou river in the south, Jiaojiang river basin in the west and Baixi river basin in the north. Qingxi river basin belongs to two cities and three counties, the upper and lower reaches of the basin belong to Tiantai and Sanmen of Taizhou, and the middle reaches belong to Ninghai county of Ningbo. Qingxi river basin is a river flowing into the sea alone. The main stream Yongxi river originates from Yangjia’ao village at the north foot of Cangshan in Tiantai county. It flows southward through Fengjia, Sanwangling and Liangkeng in the southeast. The total area of Qingxi river basin is 157 km², the mainstream river is 39km long, and the average slope is 5.93‰. It is divided into Tiantai county, Ninghai county and
Sanmen county, with an area of 81.0 km², 49.4 km², and 26.6 km² respectively. Qingxi Reservoir is a comprehensive utilization of water supply, flood control, water environment improvement and power generation. The construction of Qingxi Reservoir can meet the annual demand of Sanzhou and Shaliu in the lower reaches of the reservoir. On the premise of meeting the requirements of flood control safety, water ecological security and sustainable utilization of water resources in the basin, it can also provide high-quality water to the downstream Sanmenwan economic zone.

4.2 The main problem of Qingxi Reservoir water distribution
Qingxi Reservoir in the basin, on the basis of water demand, mainly supply water to the Sanmen bay economic zone of Qingxi river downstream. Water supply to distinguish two major parts: Sanmen bay piece in Ninghai (covers the Ningbo south seashore city, Changjie, Liyang, Chayuan, Hu Chen, Yishi and Yuexi) and Sanmen bay in Sanmen county(covers Sanmen county and Tingpang).

The water distribution of Qingxi Reservoir mainly depends on the water distribution proportion of Sanmen county and Ninghai county. Ninghai county believes that the local area is the location of Qingxi Reservoir dam, and is the main influent of reservoir inundation, and has done a lot of work in the early stage of the project, resettlement, land acquisition and other aspects, so it should take a large proportion in the water allocation. However, Sanmen county believes that the water allocation ratio proposed by Ninghai county is unreasonable considering the respective basin area and water resources proportion.

4.3 Main factors and schemes of water distribution
(1) According to the area and water resources of Qingxi river basin where Ninghai county and Sanmen county are located.

According to the proportion of surface water resources of Ninghai and Sanmen counties in Qingxi river basin, the area of Ninghai and Sanmen Qingxi river basin is respectively 49.4 km and 26.6 km. The runoff ratio of Ninghai and Sanmen was 6.5:3.5. This index reflects the contribution of water resource availability in the two counties and gives consideration to fairness.

(2) Considering the influence of reservoir construction

The index reflects the direct and indirect influence of Qingxi Reservoir construction and operation on the two counties. Among them:

The reservoir dam site of Ninghai county is located in Ninghai, and the reservoir area involves Ninghai and Tiantai. The policy treatment of land expropriation and resettlement for reservoir construction mainly involves two counties. It is the direct influence area of Qingxi Reservoir construction. Submerged 1347 acres of arable land, including 854 acres of Ninghai county.

The downstream of Sanmen county reservoir involves Ninghai county and Sanmen county, which is the indirect influence area of Qingxi Reservoir construction. It has the favorable influence of flood control. After the completion of the reservoir, the flood control standard of Sangzhou town and Shaliu street reaches once every 20 years, and that of rural area reaches once every 10 years. There are also adverse effects after water intake, mainly the impact of water diversion outside the basin on the lower reaches of the reservoir.

In general, Ninghai county is not only the direct influence area of reservoir construction, but also the indirect influence area of reservoir construction. Therefore, the influence degree of Qingxi Reservoir construction is higher in Ninghai county than in Sanmen county.

(3) According to the planned total population water demand and water shortage of Sanmenwan water supply area of Qingxi Reservoir

Sanmen bay, Ninghai county (including changjie, liyang, tea house, huchen, yishi and yuexi), which is supplied by the outer drainage area of Qingxi Reservoir, has a total population of 542,000 in 2020 and 989,000 in 2030. The total population of Sanmen bay area in Sanmen county (including Sanmen county town and tingbang town) was 277,000 in 2020 and 350,000 in 2030. In 2030, the population ratio of Sanmen bay area in Ninghai county and Sanmen bay area in Sanmen county was 7.4:2.6.
(4) Construction investment
This index reflects the unity of rights and interests. At present, the preliminary work of reservoir project is mainly carried out in Ninghai county. At present, Ninghai county has done a lot of work. The project investment of project construction, resettlement and other aspects of the investment by Ninghai county, Sanmen county water than undertake.

5. Suggestions on water distribution

5.1 proposed distribution plan I
Ninghai and Sanmen Qingxi river basin area ratio was 6.5:3.5, Qingxi river basin water resources quantity ratio was 6.6:3.4, sea county and the county of Sanmen county population ratio of 6:4, at the same time considering the reservoir dam site is located in Ninghai, and the influence degree of the reservoir construction in the two counties, Suggestions to watershed Qingxi Reservoir water supply (multi-year average is 51.8 million tons), Ninghai and Sanmen water distribution ratio of 7:3 (among them, 36.26 million tons to Ninghai and 15.54 million tons to Sanmen).

5.2 proposed distribution plan II
Sanmen bay area of Ninghai and Sanmen county (Qingxi Reservoir basin water supply range), water deficit in 2030 is 119.95 million tons and 31.33 million tons, water deficit ratio of 7.9:2.1, according to the proportion as the basis of Qingxi outside water supply reservoir basin water allocation proportion, considering the reservoir dam site is located in Ninghai, it is suggested that water quantity allocation proportion of Ninghai and Sanmen should ratio of 8:2 (among them, 41.44 million tons to Ninghai and 10.36 million tons to Sanmen).

Based on the above two water allocation proposals, it is recommended that the water allocation ratio of Ninghai and Sanmen should be between 7:3 and 8:2. Among them, Ninghai county water content is 3626~4144 million tons, Sanmen county water content is 10.36 to 15.54 million tons.

6. Conclusions
With the improvement of economic and social development level in various regions, water shortage has been continuously intensified, and the demand for water resources in various regions is increasing day by day. Taking all factors into consideration, reasonable water allocation can help to solve the differences in water demand among different regions. When carrying out water distribution work, we should take into account the basin area, water demand, contribution to the relevant water source projects and other factors, so as to better solve the water distribution contradictions in the basin.

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