ISSN 2616-5872 Vol.3, Issue 3: 28-32, DOI: 10.25236/AJEE.2021.030307

A Probe into Ecological Base Flow of the Intersection of Qianhe-Weihe River in Baoji City, China

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Abstract: *The prior remediation of the Baoji section of the Weihe River has significantly improved the river's flood control and drainage, water and soil pollution control, and wetland environment. However, the uneven distribution of water resources in time has led to the inability to effectively guarantee the ecological base flow of the river during dry season, which has affected the ecological and social functions of the intersection of Qianhe-Weihe River. The maintenance of the ecological base flow of the intersection of Qianhe-Weihe River is to ensure the ecological health of the river, the function of the wetland ecosystem and the basic flow of the social and economic development of Baoji City. It should start from saving water resources, improving water use efficiency, strengthening water distribution and management, and construction of water conservancy control projects. Improve.*

Keywords: *Qianhe River, Weihe River, ecological base flow*

1. Introduction

Rivers are of great significance for promoting the social and economic development of river basins, especially cities, and ensuring ecological service functions. The scientific allocation and utilization of the limited water resources of rivers is particularly important for the basic ecological environment protection of the river basin, especially in areas with water shortages during the dry season. The ecological base flow of the river course is to maintain the basic ecological environment functions of the river, and a certain basic flow in the river course should be maintained throughout the year to prevent the dry flow from shrinking [1]. However, in social and economic development, industrial and agricultural production water often squeezes the ecological base flow of the river, which greatly reduces the river flow, especially when the river is interrupted during the dry period, which directly causes the river's basic service functions to be lost, and the river has dried up and shrunk, etc. The irreversible situation will disappear even further. The shrinking, dry-flow, or disappearance of rivers will, to a certain extent, in turn affect the water use of agricultural irrigation or other production sectors, making the water demand of the production sector unsatisfactory. In view of this, whether it is to promote the economic development of the river basin or maintain its own health, there is an urgent need to reserve a certain amount of water resources to meet the water demand of the ecological base flow of the river in water shortage areas. With the development of regional social economy and the quantitative development of ecological environmental value, the research on river ecological base flow is becoming more and more urgent.

2. Ecological base flow

2.1 The concept of ecological base flow

There are many definitions for river ecological base flow at home and abroad, such as basic water ecological water demand, minimum acceptable flow, minimum environmental flow, environmental flow, ecological environmental water demand, river ecological base flow, minimum ecological water level and

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many other definitions. Regarding ecological flow, my country's Liu Changming proposed that ecological flow is the amount of water provided by rivers, wetlands or estuaries to achieve certain goals, under natural conditions, to maintain the function of the ecosystem. Chen proposed that ecological flow is the minimum flow needed to maintain the ecological environment and environment of a river, mainly for the most basic needs of maintaining the natural ecosystem of the river. Zhou [2] believes that Ecological base flow is a component of ecological environmental water demand, and is the appropriate amount of water under certain water quality requirements required to maintain the healthy development of the basic functions of the regional ecosystem or improve the quality of the ecological environment. In actual work, it is often determined as the minimum flow.

In view of the inconsistencies in the understanding of the ecological base flow of rivers and lakes, and the inconsistent definition of ecological base flow, the Ministry of Water Resources issued the "Guiding Opinions on Doing a Good Job in the Determination and Guarantee of the Ecological Flow of Rivers and Lakes" in 2020. The ecological flow of rivers and lakes refers to the flow (water volume, water level) and processes that need to be retained in the rivers and lakes to meet the water quality requirements in order to maintain the structure and functions of the water ecosystems such as rivers and lakes. The guidance points out that the ecological flow should be determined to ensure basic ecological protection objects such as the basic form of rivers and lakes, basic habitats, and basic self-purification capabilities, as well as important ecologically sensitive areas with clear protection requirements, aquatic biodiversity, sand transportation, and estuary pressures. The water demand of ecological protection objects is the starting point.

2.2 Ecological base flow calculation

The relatively mature theoretical system of river ecological base flow calculation was formed in the 1970s. With the development of ecological base flow research, more than 200 methods have been developed for the quantitative calculation of river ecological base flow. The calculation of ecological base flow mainly includes hydrology, hydraulics, habitat method, etc. Among them, hydrological methods mainly include Tennant method, 7Q10 method, Texas method, flow history curve method, etc., which are mainly expressed by the percentage of the average flow rate of a certain section of the river for many years and the minimum flow rate in a certain period of time and other related flow indicators. In other words, the method mainly uses the multi-year historical flow of a certain section of the river as the basic data to calculate the ecological base flow of a certain section of the river. The hydraulic method is based on Manning's formula, and determines the ecological base flow of the river by constructing the hydraulic relationship between the river flow and the hydraulic elements of the corresponding river section, such as wet cycle method (river bed stability), R2-CROSS method (river width less than 30 m) and the average water depth method. The habitat method uses the main environmental elements and corresponding flow conditions and hydraulic conditions in the habitat of typical river species as data and theoretical basis, and uses related calculation models to establish the correlation between the three to determine the ecological base flow of the river in the research basin, such as the IFMI method, CASIMIR method and PHABSIM method. At present, the research focus and mainstream research direction are the holistic approach. It is not only necessary to ensure the ecological base flow of the river channel with the minimum discharge flow of the reservoir, but also the most important thing is to realize the ecological environment flow and process of the river's multiple ecosystem service functions, mainly including flow events. Method, hydrological response method, overall analysis method, etc.

2.3 Ecological Base Flow Accounting of the intersection of Qianhe-Weihe River in Baoji City

The intersection of Qianhe-Weihe River is the confluence of the Weihe River and its tributaries Qianhe River in Baoji City. It is also the location of the the intersection of Qianhe-Weihe River National Wetland Park in Shanxi. The wetland park involves Fengxiang County, Chencang District, and High-tech Zone. It starts from Wolongsi Bridge on the Weihe River in the west, Phoenix Bridge on the Weihe River in the east, Wangjiaya Reservoir on the Qianhe River in the north, and Binhe South Road on the Weihe River in the south. It has a total area of 17km from north to south and 7km from east to west. 1864ha, of which the wetland area is 1737ha, accounting for 93.2% of the total area of the park. Qianhe River is a primary tributary on the left bank of Weihe River, with a geographical position of 34°21′-35°10′N, 106°15′-107°22′E, about 138 km from north to south, 50 km from east to west, and an altitude of 55-2428 m, The total area is 3493 km^2.

According to existing studies, the total ecological water demand in Baoji City of the Weihe River is calculated to be 10.01×10^8 m^3 under the premise of considering the ecological base flow of the river, the

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transportation of sediment and the self-purification capacity of the water body. The basic ecological water requirement of the Linjiacun section in Baoji is 2.7×10^8 m^3, and the water requirement for sediment transport is 3.01×10^8 m^3, which can meet the basic ecological functions of the river and the balance of river erosion and deposition. In addition, the Comprehensive Management Plan for the Weihe River Basin in Shaanxi Province clarified that the minimum flow of Linjia Village in non-flood season should be above 10 m^3/s, and the base flow of the main Weihe River below Baoji in 2020 will reach 12-35 m^3/s [3]. On the other hand, some researchers have calculated that the ecological base flow of the Baoji section of the Weihe River is 18.8 m^3/s according to the minimum monthly average flow method, 13.99 m^3/s according to the velocity method, 12.34 m^3/s according to the Tennant method, and according to the section head control method. (Self-purification method) is 16.4 m^3/s, that is, the ecological base flow of Baoji City shall not be less than 10 m^3/s.

3. Ecological base flow problems of the intersection of Qianhe-Weihe River

3.1 Unbalanced supply and demand of urban river water resources

The hydrological data of the Linjiacun Hydrological Station in the Weihe River Basin shows that the average annual runoff of the Weihe River since 2000 is 11.49×10^8 m^3, and the minimum runoff is 5.06×10^8 m^3 (in 2002), while the annual water diversion volume of the Baojixia Water Diversion Project is about 7.6×10^8 m^3. The head of the diversion canal in the Baoji Gorge Irrigation District is near the hydrological section of Linjia Village in the Baoji section of the Weihe River. It is mainly used to divert water from the Weihe River to irrigate the upper irrigation area of the Baoji Gorge plateau. The extent of reduction, especially in dry years and non-flood seasons, requires a large amount of water for agricultural irrigation. Sometimes, the amount of water diversion for irrigation can reach more than 90% of the total inflow of the Baoji section of the main stream of the Weihe River.

The intersection of Qianhe-Weihe River is located in a water shortage area. The limited water resources are unevenly distributed over time. The runoff in the dry season is much smaller than in the wet season. The annual runoff changes in a "V" shape. The average flow in the wet season (June to October) 51.65 m^3/s, while the average flow during the dry season is only 17.81 m^3/s. In recent years, the annual runoff in the river has been less than 3×10^8 m^3, and the time distribution during the year is uneven, mainly in the wet period [4]. According to the "Statistical Yearbook of Shaanxi Province", the total amount of water resources in the Baoji section of the Weihe River in 2015 was 34.90×10^8 m^3, of which the total amount of surface water resources was 29.20×10^8 m^3, the total amount of groundwater resources was 16.96×108m3, and the total amount of repeated water resources was 11.27×10^8 m^3.

3.2 Insufficient ecological base flow affects the wetland environment

Ensuring the basic ecological base flow is the basic condition for realizing the natural and social functions of the river. The shortage of water resources and water for industrial and agricultural production in the intersection of Qianhe-Weihe River section have continuously reduced the water environmental carrying capacity of the river, and the river's self-purification capacity has been impaired, which cannot better meet the needs of biodiversity, ecological, pollution-receiving, self-purification, and sediment transport. The water utilization coefficient of the canal system in the upper irrigation area of Baoji Gorge is 0.52, and the waste of water resources is relatively serious [3]. In addition, the population increase in the administrative area of the Baoji section of the Weihe River and the drastic climate change will further squeeze the ecological base flow of the river for agricultural irrigation water. River water quality has deteriorated, and aquatic biodiversity has declined, especially fishes with economic value, important ecological indicators and ornamental value; it may also cause potential safety hazards to the imbalance of river water and sand, and the ecological security of river water environment has been seriously affected. threat. Insufficient ecological flow has a profound impact on the realization of the natural and social functions of the Weihe River in Baoji, especially in the urban area.

4. Strategies for the ecological base flow of the intersection of Qianhe-Weihe River

4.1 Save water and increase the ecological flow of the Weihe River

Reducing water waste in agricultural irrigation areas through water-saving reconstruction and channel dredging in irrigation areas has a very important contribution to ensuring the ecological base flow of the

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Weihe River. It is necessary to increase water-saving publicity in the whole society, accelerate the use of water-saving technologies, continuously improve the efficiency of water delivery in the water supply pipe network, comprehensively promote the technology of reclaimed water reuse, and promote water-saving in production and life, so as to reduce the amount of water taken from other tributaries of the Weihe River.

4.2 Strengthen river ecological base flow control and keep the bottom line of 10 m3/s flow

In 2015, the Shaanxi Provincial Government pointed out that the Baoji Gorge Hub gave a constant flow of 10 m^3/s to the middle reaches of the Weihe River in Baoji, and the daily discharge flow at the Linjiacun section during non-flood seasons should not be less than 8 m^3/s. The water diversion from the Linjiacun channel of the Baojixia Highland Power Station is an important reason for the insufficient ecological base flow in the Baoji section of the main stream of the Weihe River. The amount of water used in the Baoji Gorge Irrigation District directly affects the ecological base flow of the Weihe River. When the inflow of the Weihe River is generally insufficient, it is necessary to solve the problem of insufficient ecological flow in the middle reaches of the Weihe River. It is necessary to strengthen the management of ecological flow discharge and implement the established flow.

4.3 Construction of ecological base flow compensation project

Through Yindongxia Reservoir water diversion project and Tongguanhe Reservoir construction, while giving full play to the benefits of water supply, flood control, power generation, tourism, etc., it can play a certain role in guaranteeing the ecological water demand of the Weihe River. In particular, the Tongguan River Reservoir stores the flood resources of the Tongguan River and replenishes the tributaries of the Weihe River in the northern bank of the Weihe River, which directly increases the ecological flow of the Weihe River by 1×10^8 m^3 each year [5]. The construction of Tongguan River Reservoir and Water Delivery Project will effectively increase the ecological flow of the Weihe River and greatly improve the ecological environment of the Weihe River and its tributaries.

5. Conclusion

According to the concept and calculation method of the ecological flow of rivers and lakes, as well as the related research results of the water resources of the Baoji section of the Weihe River, the ecological base flow of the intersection of Qianhe-Weihe River in Baoji City was calculated, and the problems in the maintenance and management of the ecological base flow were analyzed. It is proposed to improve the efficiency of water resources utilization, strengthen the management and control of river water resources utilization to maintain the base flow and the construction of water conservancy projects to effectively guarantee the ecological flow of the intersection of Qianhe-Weihe River, maintain the health of the river and the ecological safety of the wetland.

Acknowledgements

Foundation: Funded by Shaanxi Province Enterprise Innovation Striving for the First Young Talents Support Program Project(202041);Technology Innovation Center for Land Engineering and Human Settlements, Shaanxi Land Engineering Construction Group Co., Ltd and Xi'an Jiaotong University (2021WHZ0094); Shananxi Provincial Land Engineering Construction Group internal research project (DJNY2021-24, DJNY2021-20).

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