

Study on ecological flow accounting of high stress rivers

Yu Xiao, Zhuge Yisi, Li Guoqiang, Du Qiang, Tan Hongwu
China Institute of Water Resources and Hydropower Research, Beijing 100038, China

Objectives

High-stress rivers are usually characterized by over-exploitation of water resources, high regulation of water engineering, high variability of river hydrological processes, and serious damage to water ecological integrity. The ecosystem structure and function of such rivers undergo a series of changes, leading to the degradation of the river water ecosystem. In the context of high stress, the hydrological process of rivers is difficult to guarantee. The issue of ensuring ecological flow has become a significant weakness in the protection and management of ecological environment in high stress rivers.

The upstream drainage area of Yongding River (above Guanting Reservoir) is 92.3% of the total basin area. It is the main runoff

and water use area, with high water resource development and utilization rate. This paper takes the restoration of the green corridor in upper Yongding River as the main objective to carry out the ecological flow accounting research.

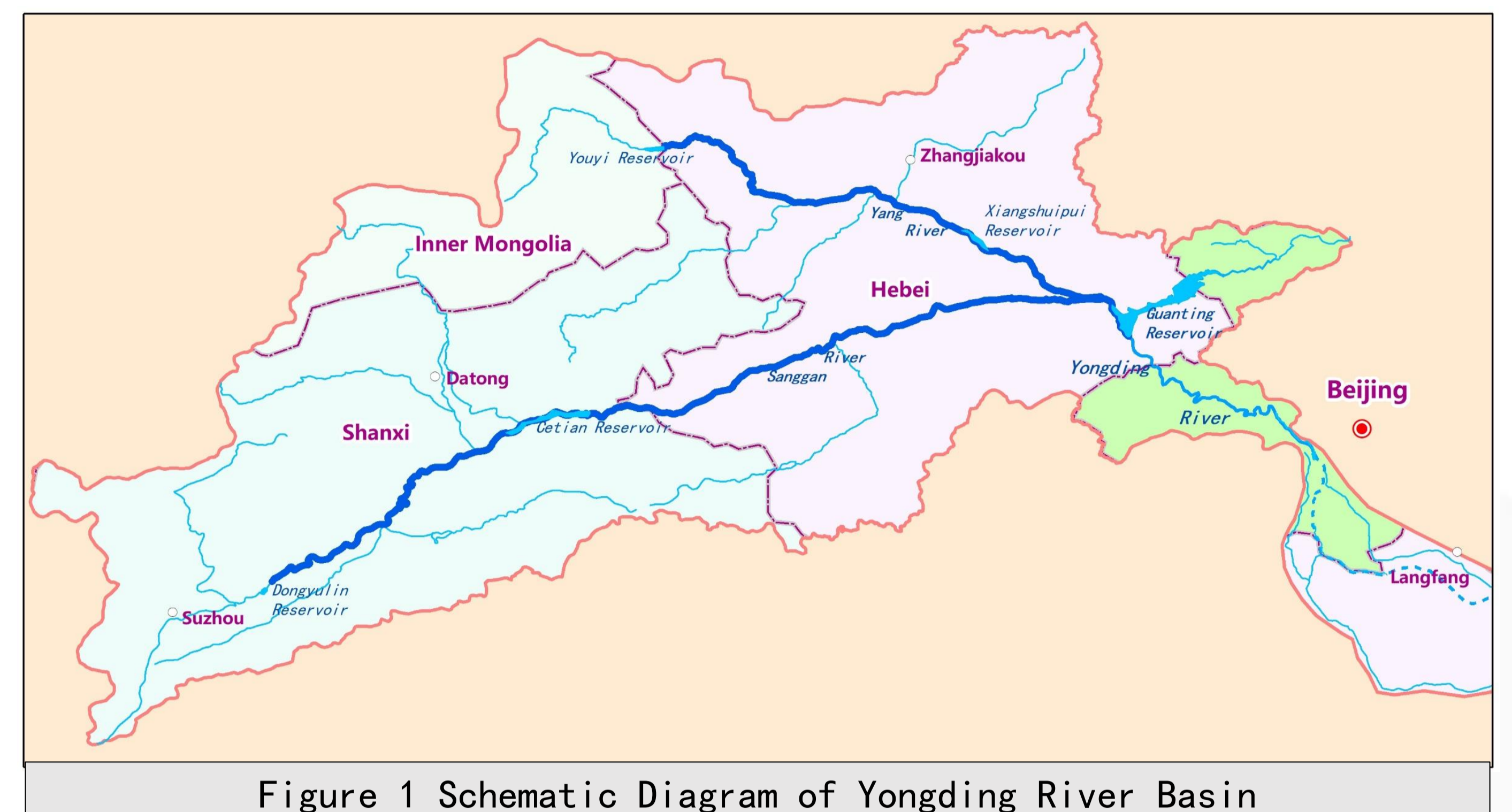


Figure 1 Schematic Diagram of Yongding River Basin

Methods

- Through the investigation of terrestrial and aquatic ecosystems in upper Yongding River, the health status of the river ecosystem was assessed.
- The "4-components" ecological flow calculation method is constructed (Table 1~2), including the management division of ecological flow, the classification of ecological protection objectives, the stages of different water periods and level years, and the early warning classification of the implementation degree. This method was used to determine the threshold and composition of ecological flow at each typical section of upper Yongding River (Table 3).
- The overall coordination analysis model of ecological flow is built to balance the ecological recovery demand, social and economic affordability, and the range of ecological flow control in the basin. This model was used to analyze the accessibility of ecological flow in upper Yongding River.
- Based on the above analysis, the ecological flow standard scheme for upper Yongding River was formulated. This scheme considered the basic coordination of production water, domestic water and ecological water in upper Yongding River.

Table 1 Identification of Ecological Protection Objectives and Analysis of Ecological Hydrological Needs

Protected object	Description	Flow component	Period	River
Wetland vegetation	Maintain a certain water level to ensure that the roots of the plant absorb water.	low flow	April to October	Sanggan River
	The river water can flood the beach, replenishing wetland vegetation growth in the spring.	High flow pulse	spring	
	The river water can flood the beach, replenishing wetland vegetation growth and maintaining the lateral connectivity of the river channel.	flat flow (Once every two years)	Flood season	
	Supplementing freeze-thaw water for wetland in winter	High flow pulse (Once every two years)	October, November	
Fish	Habitat maintenance	low flow	All the year round	Sanggan River, Yang River
	Fish spawning	High flow pulse	Spring and summer	
Urban landscape	Meet the water demand for urban landscapes and maintain a certain level of river water surface.	low flow	All the year round	Yang River
	Meet the ecological water demand of Constructed wetland and downstream rivers	low flow	All the year round	Yongding River

River	Method	Sanggan River			Yang River		Yongding River
		Dongyulin-Cetan	Cetian-Shixiali	Downstream of Shixiali	Upstream of Xiangshuipu	Downstream of Xiangshuipu	Upstream of Guanting
Ecological base flow (m ³ /s)	Tennant method (10%)	1.69	2.34	1.14	1.56	3.9	
	Flow duration curve method (95%)	1.02	2.23	2.16	0	0.36	2.52
Water demand during sensitive periods	Biological water demand in spring (m ³ /s)	10.83	12.57	24.81	8.54	10.93	22.08
	Wetland water demand in autumn (m ³ /s)	8.80	12.57	24.81			11.43
	2.5-year flood in summer (10 ⁶ m ³)	1952	2360	3518	—	—	
Water demand for evaporation on the surface of Yanghe River (10 ⁶ m ³)				1631	390		

Month	Sanggan River			Yang River	Yongding River
	Dongyulin Reservoir	Cetian Reservoir	Shixiali	Xiangshuipu Reservoir	Bridge 8
Jan	1.0	1.7	2.3	1.8	3.9
Feb	1.0	1.7	2.3	1.9	3.9
Mar	1.0	1.7	2.3	2.3	3.9
Apr	5.9	7.1	17.7	7.6	23.5
May	1.0	1.7	2.3	2.8	3.9
Jun	2.0	3.4	4.7	4.1	7.8
Jul	5.7	10.5	15.5	3.8	19.3
Aug	2.0	3.4	4.7	3.7	7.8
Sept	2.0	3.4	4.7	3.7	7.8
Oct	4.9	7.1	13.6	4.9	16.6
Nov	1.0	1.7	2.3	2.0	3.9
Dec	1.0	1.7	2.3	1.8	3.9
Annual water demand (10 ⁶ m ³)	0.75	1.19	1.97	1.06	2.80

River	Sanggan River			Yang River		Yongding River	
	Dongyulin-Cetan	Cetian-Shixiali	Downstream of Shixiali	Upstream of Xiangshuipu	Downstream of Xiangshuipu	Upstream of Guanting	
Ecological base flow (m ³ /s) (ensuring rate: 100%)		1.02	1.69	2.34	1.14	1.56	3.9
Water demand during sensitive periods	Biological water demand in spring (m ³ /s) (ensuring rate: 50%)	10.83	12.57	24.81	8.54	10.93	22.08
	Wetland water demand in autumn (m ³ /s) (ensuring rate: 50%)	8.80	12.57	24.81			11.43
	flood in summer (10 ⁶ m ³)	1952	2360	3518	—	—	
Water demand for evaporation on the surface of Yanghe River (10 ⁶ m ³) (ensuring rate: 100%)				1631	390		

Results

Through this study, a recommended ecological water quantity plan was obtained (Table 4), including the recommended ecological water volume of typical sections in upper Yongding River, of which the recommended values of Dongyulin, Cetian, Shixiali, Youyi, Xiangshuibao and No.8 Bridge are 75 million m³, 79 million m³, 133 million m³, 20 million m³, 89 million m³, 244 million m³.

This study solved the problem that the previous ecological flow scheme was out of touch with reality, and fully considered the current water resource shortage and management situation. The research results can promote the coordinated development of economic society and water ecological environment protection in upper Yongding River.