Study on water level correlation of key nodes in the north line of East Zhejiang Water Diversion Project

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Abstract. Eastern Zhejiang is an important area for the economic development of Zhejiang Province. However, water resources in eastern Zhejiang are relatively poor. After the completion of the north line of East Zhejiang Water Diversion Project, the catchment and drainage connecting rivers of all counties and cities have been dredged, the flood control and drainage capacity of all counties and cities has been improved, the river channels along the line have also been comprehensively renovated, the river network water environment of Shangyu City, Yuyao City and Cixi City along the water diversion line has been significantly improved, and the environmental quality of the area around Hangzhou Bay on the South Bank of Qiantang River has been improved. In order to find out the correlation between the water levels of key nodes of the project and provide more targeted guidance for future scheduling, this paper uses the partial least square method to calculate the relationship between the water levels of each node. It is found that there is a significant correlation between the upper water level of Sanxing sluice and the water level under Xinsan sluice and Mashan sluice, and there is a certain correlation with the upper water level of xinsanjiang sluice and Mashan sluice. The correlation between the upstream water level of Xiaoshan hydroproject and the water levels under xinsanjiang sluice, Heshan sluice and Mashan sluice is obvious; There is the most significant linear correlation between the water level of Hengjiang River in xisantang and the water level of Lingshan, Lingshan, Qitang, Sitou and Sitou. The correlation between the water level of Yangxun bridge, Puqian gate and Qitang gate is also significant, and the correlation of other water level stations is poor. In addition, there is a great correlation between the water level of Yangxun bridge and the downstream water level. Attention should be paid to observing the water level of Yangxun bridge during the dispatching process.

1. Introduction

East Zhejiang is located on the South Bank of Hangzhou Bay, including Hangzhou, Shaoxing, Ningbo and Zhoushan. It has a very superior geographical location and convenient water, land and air transportation. It is an integral part of the Yangtze River Delta economic zone and plays an important role in the economic development of Zhejiang Province. Shangyu, Yuyao and Cixi in the region are among the top 100 counties in China. The Yangtze River Delta will become an important growth point of China's economic development in the 21st century. As a regional city on the south wing of the "Yangtze River Delta", it is facing historic development opportunities and unavoidable strong challenges. In order to seize opportunities and meet challenges, we must strengthen the supporting work of infrastructure. However, at present, the whole eastern Zhejiang region is relatively poor in water resources. In case of severe drought, it is seriously short of water.The north line project of East Zhejiang water diversion project can alleviate this situation.The north line project of East Zhejiang water diversion project is also known as East Zhejiang Water Diversion Project (Xiaoshan junction Cixi section). After the completion of the water diversion project from Cao'e River to Cixi River, the catchment and drainage connecting rivers of all counties and cities have been dredged, and the flood control and drainage capacity of all counties and cities has been improved. The water diversion project from Cao'e River to Cixi River mainly adopts the water conveyance mode of backbone river. After the project is completed, the river channels along the water conveyance line will also be regulated. After the completion of the project, the river network water environment of Shangyu City, Yuyao City and Cixi City along the water diversion line has been significantly improved, the environmental quality of the area around Hangzhou Bay on the South Bank of Qiantang River has been improved, and the flood control and drainage capacity along the line has been improved. Since the water diversion test in eastern Zhejiang in 2013, while some achievements have been made along the water diversion project in eastern Zhejiang, there are also some problems, such as uneven distribution of drought and flood, conflict between upstream drainage and downstream flood control. In order to find out the correlation between the key water level nodes of the project and solve the contradiction between the upstream and downstream "water problems",

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this paper uses the partial least square method to establish the direct relationship between the key water level nodes, so as to obtain the correlation between the water levels of each key node, so as to provide reference for the accurate dispatching of water diversion in eastern Zhejiang.

2. Overview of the study area

2.1 overview of East Zhejiang Water Diversion Project

East Zhejiang water diversion project is a major water resource allocation project recommended by [1] the general plan for the protection, development and utilization of water resources in Zhejiang Province, the Qiantang River Estuary resource allocation plan and other relevant plans to ensure the sustainable economic and social development of xiaoshaoningzhou area in East Zhejiang. It was listed in the "five ten billion" project and "ten billion water resource guarantee project" in our province in 2006, Project task [2] It is to introduce Fuchun River water to supplement water for industrial and agricultural production in xiaoshaoningzhou area, taking into account the improvement of regional water environment. East Zhejiang water diversion project connects the river networks of Qiantang River, Cao'e River, Yongjiang River and xiaoshaoning plain through Xiaoshan hub (built), Cao'e River Sluice hub (built), Cao'e River Cixi water diversion (built), Cao'e River Ningbo water diversion, Zhoushan continental water diversion (phase I has been built, phase II is under construction, phase III is proposed), etc, The Xiaoshan junction diverts Fuchun River water through the Xiaoshao plain river network into the upper reservoir of the grand sluice of Cao'e River, and then diverts water from the Sanxing sluice (built) and Dashe sluice (proposed) on the right bank of Cao'e River to Yuci and ningzhou areas respectively. Eastern Zhejiang water diversion project also includes Qincun reservoir water diversion project, which is an important water resource allocation project focusing on providing high-quality water supply in eastern Zhejiang.

2.2 Introduction to Caoejiang Cixi Water Diversion Project

Cao'e River Cixi water diversion project [3],it spans Shaoxing and Ningbo, and is mainly composed of water intake hub (intake gate) and water conveyance system (water conveyance channel, regulating metering gate, river crossing bridge and other supporting buildings). Intake Sanxing gate (3 holes) × 6m) located near Sanxing village on the right bank of Cao'e River in Shangyu, the designed diversion flow is 60m3 / s and the designed annual diversion volume is 420 million m3. Along the way, Yubei River, Yudong River, Qitang Hengjiang River, Sitang Hengjiang River, Batang Hengjiang River and Santang Hengjiang River in the Northern Plain of Yuci are mainly used to transport water to Cixi, mainly to solve the general water and river network environmental water along the line, especially Cixi, The main river for water conveyance is 85km long. The estimated investment of the project is 843 million yuan. The Caoe River Cixi water diversion project has been completed, including Cixi section in September 2008, Yuyao section in March 2010 and Shangyu section in November 2011.

3. Correlation coefficient analysis

3.1 Correlation calculation method

This time, by establishing the correlation between the water levels of key nodes along the water diversion line, the correlation coefficient of each key node is obtained to obtain the relationship between each node. Partial least square method [4,5] is a principal component analysis. Set the upstream water level of Xiaoshan hydroproject as the dependent variable $Y=\{y_1,y_2,\cdots,y_n\}$ (n is the total number of selected data), where y_i ($i=1,2,\cdots,n$) is the water level of a certain day. Set the water level of other key nodes as the independent variable, then:

$$X=\begin{pmatrix} x_{11},x_{12},\cdots x_{1p} \\ x_{21},x_{22},\cdots x_{2p} \\ \vdots \quad \vdots \quad \vdots \\ x_{n1},x_{n2},\cdots x_{np} \end{pmatrix} \tag{1}$$

Where $x_{i,j}$ is the water level factor of key nodes, $i=1,2,\cdots n$, $j=1,2,\cdots p$,and p is the number of key nodes. Note that the key node water level matrix $X_{n\times p}$ is the independent variable matrix, andThe horizontal river level Y_n of xisantang is the dependent variable matrix, where n is the number of years and p is the number of independent variables.

3.2 Analysis of calculation results

See Table 1 and table 2 for the relationship of various indexes along the East Zhejiang diversion line (Xiaoshan junction to Cixi point) calculated by partial least square method:

Table 1: Correlation between main upstream representative stations and key stations

x1	x2	x3	x4	x5	x6	x7	x8	
1	0.49	-0.23	-0.19	-0.54	-0.69	-0.53	-0.5	x1
	1	0.46	-0.05	-0.46	-0.25	-0.44	-0.37	x2
		1	0.53	0.06	0.39	0.16	0.27	x3
			1	0.58	0.2	0.66	0.67	x4
				1	0.66	0.98	0.91	x5
					1	0.67	0.69	x6
						1	0.96	x7
							1	x8

It can be seen from the above table that the relationship between the upper water level of Sanxing sluice and the water levels under Xinsan sluice and Mashan sluice is significant, and there is a certain correlation with the upper water level of xinsanjiang sluice and Mashan sluice. The correlation between the upstream water level of Xiaoshan hydroproject and the water levels under xinsanjiang sluice, Heshan sluice and Mashan sluice is obvious.

Table 2: Correlation between downstream main representative stations and key stations

x12	x13	x14	x15	x16	x17	y	
-0.02	0.1	-0.06	0.03	-0.15	-0.03	-0.03	x1
0.48	0.48	0.27	0.5	0.34	0.47	0.45	x2
0.77	0.59	0.56	0.75	0.73	0.75	0.74	x3
0.34	0.23	0.32	0.39	0.38	0.38	0.41	x4
-0.06	-0.05	0.04	0.06	0.13	0.09	0.14	x5
0.21	0.17	0.17	0.25	0.35	0.31	0.33	x6
-0.03	-0.02	0.06	0.1	0.17	0.13	0.18	x7
0.01	0	0.05	0.16	0.2	0.19	0.24	x8
-0.38	-0.23	-0.07	-0.46	-0.25	-0.42	-0.41	x9
0.5	0.41	0.58	0.18	0.45	0.24	0.21	x10
0.66	0.76	0.52	0.58	0.46	0.57	0.54	x11
1	0.91	0.84	0.91	0.91	0.92	0.9	x12
	1	0.76	0.88	0.82	0.89	0.88	x13
		1	0.69	0.93	0.73	0.73	x14
			1	0.84	0.99	0.99	x15
				1	0.88	0.89	x16
					1	0.99	x17
						1	y

It can be seen from the above table that the linear correlation between the water level of the Hengjiang River in xisantang is the most significant. The correlation between the water level of Yangxun bridge, Puqian gate and Qitang gate is also significant, and the correlation of other water level stations is poor. In addition, there is a great correlation between the water level of Yangxun bridge and the downstream water level. Attention should be paid to observing the water level of Yangxun bridge during the dispatching process.

4. Conclusion

After the completion of the Caoe River Cixi water diversion project, the catchment and drainage connecting rivers of all counties and cities have been dredged, the flood control and drainage capacity of all counties and cities has been improved, the river channels along the line have also been comprehensively renovated, the river network water environment of Shangyu City, Yuyao City and Cixi City along the water diversion line has been significantly improved, and the environmental quality of the area around Hangzhou Bay on the South Bank of Qiantang River has been improved. In order to find out the correlation between the water levels of key nodes of the project and provide more targeted guidance for future scheduling, this paper uses the partial least square method to calculate the relationship between the water levels of each node. It is found that there is a significant correlation between the upper water level of Sanxing sluice and the water level under Xinsan sluice and Mashan sluice, and there is a certain correlation with the upper water level of xinsanjiang sluice and Mashan sluice. The correlation between the upstream water level of Xiaoshan hydroproject and the water levels under xinsanjiang sluice, Heshan sluice and Mashan sluice is obvious; There is the most significant linear correlation between the water level of Hengjiang River in xisantang and the water level of Lingshan, Lingshan, Qitang, Sitou and Sitou. The correlation between the water level of Yangxun bridge, Puqian gate and Qitang gate is also significant, and the correlation of other water level stations is poor. In addition, there is a great correlation between the water level of Yangxun bridge and the downstream water level. Attention should be paid to observing the water level of Yangxun bridge during the dispatching process.

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