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Analysis of annual-averaged water level changes at the tail of Fuhe River, inflow of Poyang Lake

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Abstract. The area at the tail end of Fuhe River has an important economic and social status and ecological protection needs. Its water level change is directly related to the water security of this region. Based on the daily average water level observation data of three hydrologic stations in the end of Fuhe River in the past 70 years, the change trend of annual average water level was analysed by using Mann-Kendall and moving average methods. The results show that there has been a continuous downward trend of water level at the tail end of Fuhe River. The water level drop along the river was 1.3m to 3.5m, and abrupt changes had occurred in the 1990s and early 20th century.

1 Introduction

Fuhe River is one of the five major water inflow systems of Poyang Lake, and its annual-averaged runoff accounts for more than 11% of the total annual runoff of Poyang Lake [1]. The tail of Fuhe River is located in Nanchang, Yichun and Fuzhou, Jiangxi Province, with dense population, rich land resources, prosperous economy, convenient transportation, advanced science and technology and culture. Its location advantage is very prominent. At the same time, there is a Jiangxi Provincial Ecological Protection Area - an important spawning ground of silver carp - Qinglan Lake. Therefore, this region is an important part of the construction of Poyang Lake ecological economic zone, and its water level change law and trend have a very important impact on the economy, society and ecological environment of the region. In recent years, with the influence of climate changes and human activities, the water level at the tail end of Fuhe River has changed significantly both affected by the water level in the lower reaches of Poyang Lake and the changes of river channel itself. The annual-averaged water level has continued to drop, which has brought very adverse effects on the economic development and the water ecological security in this region. In this paper, based on the observed water level data of three control water level stations in the tail of Fuhe River, the Mann Kendall method is used to analyse the trend of water level change in the region, so as to provide a technical support for the comprehensive river regulation in this area.

2 Study area, data and method

2.1 Study area and data

The area studied in this paper is about 80 km from Jiaoshi dam to Sanyang bridge. There are three water level observation and control stations along the river in the study area, namely Lijiadu, Wenzhen and Sanyang. The study area is shown in Figure 1. The above three stations have long-term daily average water level observation data, and the observation data date in this paper is shown in Table 1. The trend analysis in this paper is mainly based on the daily average water level observation data of the above three stations, and the analysis content is the annual average water level change trend.

Table 1. Observation data date.

Station	Date (year)
Lijiadu	1953~2019
Wenzhen	1950~2018
Sanyang	1973~2018

2.2 Method

In this paper, the research object is the annual-averaged water level change trend at the tail of Fuhe River, and the analysis method to be adopted is Mann-Kendall test method. This method has been widely used in the trend and mutation test of climatology [2], and has been recommended and widely used by the World Meteorological Organization. Since Mann-Kendall test method is a nonparametric method, it does not require samples to follow a certain distribution and is not disturbed by a small number of outliers, so the method is more and more used in the analysis of runoff and water level trend and abrupt change of hydrological stations in river system [3-7].

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The statistical value *Z* in this method has a standard normal distribution. If $Z > 0$, it indicates that the sequence has an upward trend, otherwise, it indicates a downward trend. At the same time, UF and UB are used to draw curves in this method, and the time corresponding to the intersection point of UF and UB lines is the start time of mutation.

At the same time, the moving average method [8] is used to analyse the change trend of the annual average water level in this paper. The moving average method is based on the simple average method. It calculates the moving average value by increasing and decreasing the old and new data in order to eliminate the accidental change factors, find out the development trend of things, and make prediction accordingly. The moving average period is 5 years in this paper.

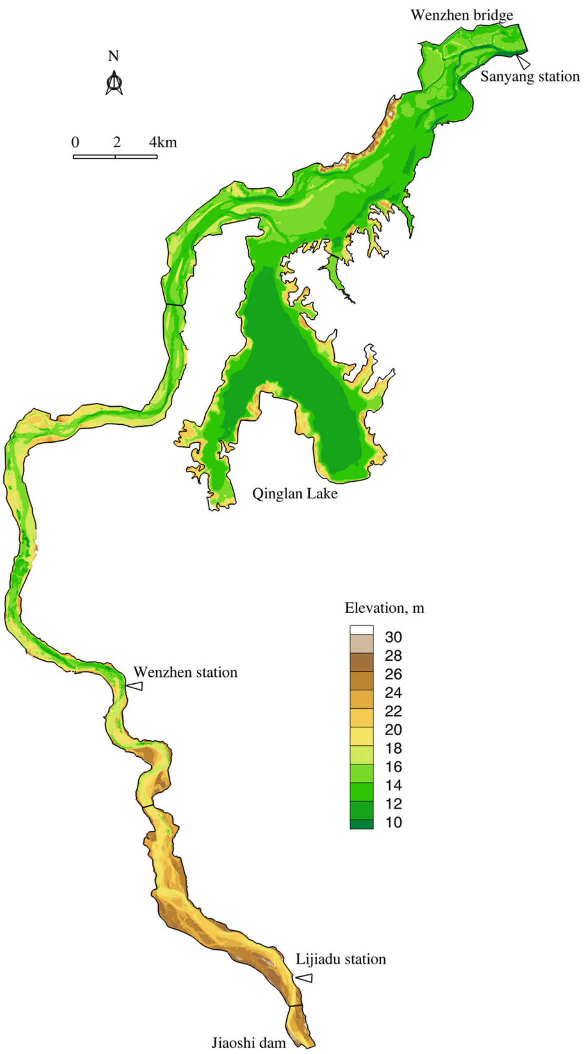

Fig. 1. Map of the study area.

3 Results and discussion

3.1 Trend analysis

Table 2 shows the statistical value Z of annual average water level of each station according to Mann-Kendall method. It can be seen from the table that the Z value of each station is less than 0, which indicates that the annual average water level at the end of Fuhe River shows an obvious downward trend.

Figure 2 shows the moving average variation of annual average water level at each water level station in the tail of Fuhe River. It can be seen from the figure that the moving average line of each station has a downward trend. The water level of Lijiadu, Wenzhen and Sanyang is about3.5m, 1.3m and 3.3m, respectively.

According to the trend analysis results of the moving average method and Mann-Kendall method, it can be seen that the annual average water level in the tail area of Fuhe River has shown an obvious downward trend since the 1950s.

Table 2. Statistical value of Z in Mann-Kendall method.

Station	Z-stat	trend
Lijiadu	-8.32	yes
Wenzhen	-9.39	yes
Sanyang	-3.07	yes

3.2 Mutation analysis

Figure 3~5 shows the variation of UF and UB curves of each station. It can be seen from the figures that there is an intersection point between the UF and UB curves of the three stations, which indicates that the annual average water level of the three water level stations has abrupt changes. The abrupt changes of Lijiadu, Wenzhen and Sanyang stations occurred between 1998~1999, 1988~1989 and 2002~2003, respectively.

3.3 Discussion

The above analysis results show that the annual average water level in the tail of Fuhe River has an obvious downward trend and a mutation change time point. The Enlightenment from the above results is that we must pay enough attention to the problem of water level drop at the end of Fuhe River. On the one hand, the decline of water level will bring obvious adverse effects on water intake and navigation in the area along the river, which will cause water intake difficulties and navigation obstacles. On the other hand, the wetland area decreases after the water level drops, which brings great challenges to the survival of migratory birds and zooplankton. The adverse effects of water level drop must be considered in the comprehensive river regulation in this area.

In order to better carry out a comprehensive river regulation, further research should clarify the internal causes of water level changes in this region, and remedy specific problems to ensure the water safety of the region.

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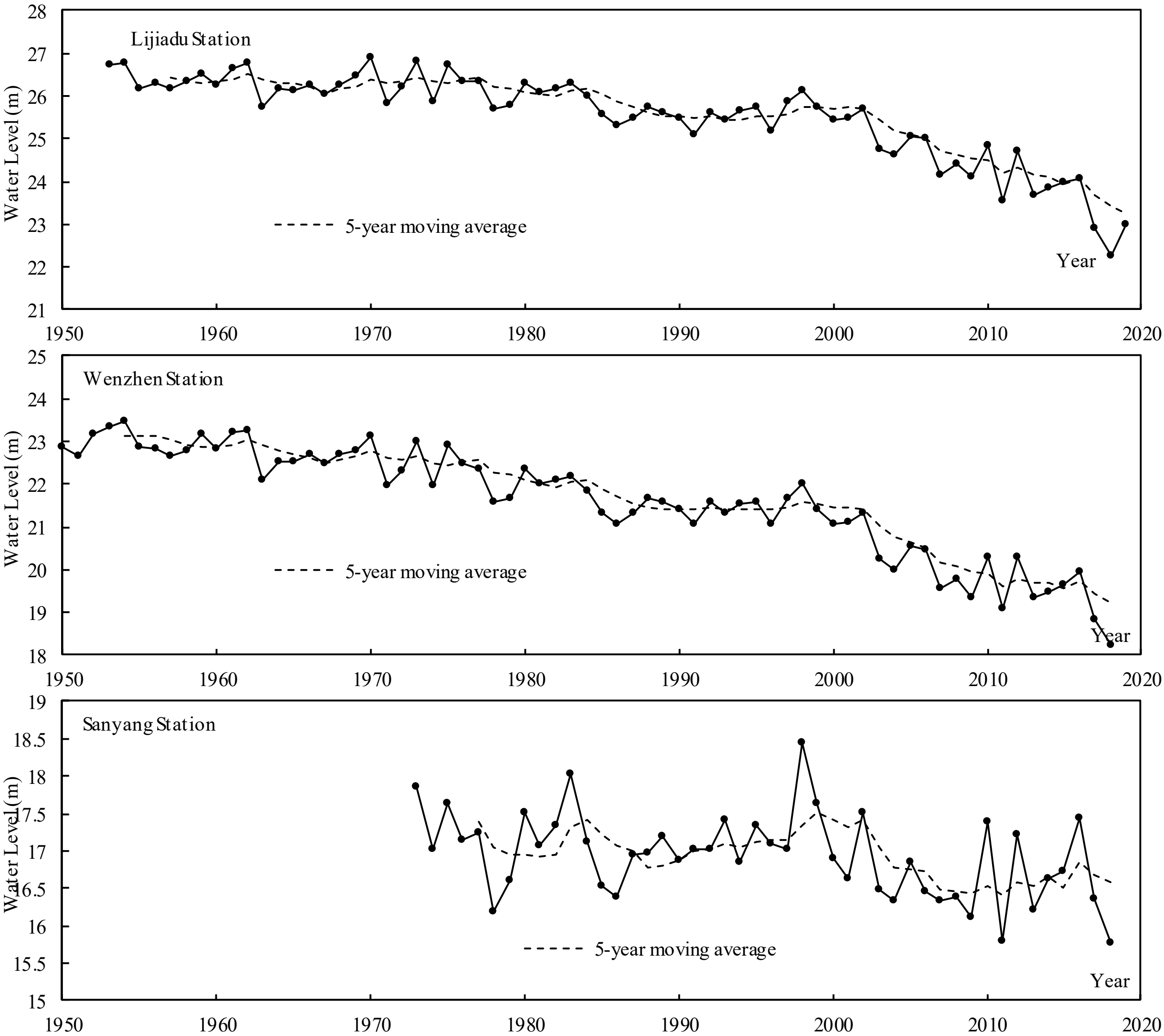

Fig. 2. Map of moving average trend.

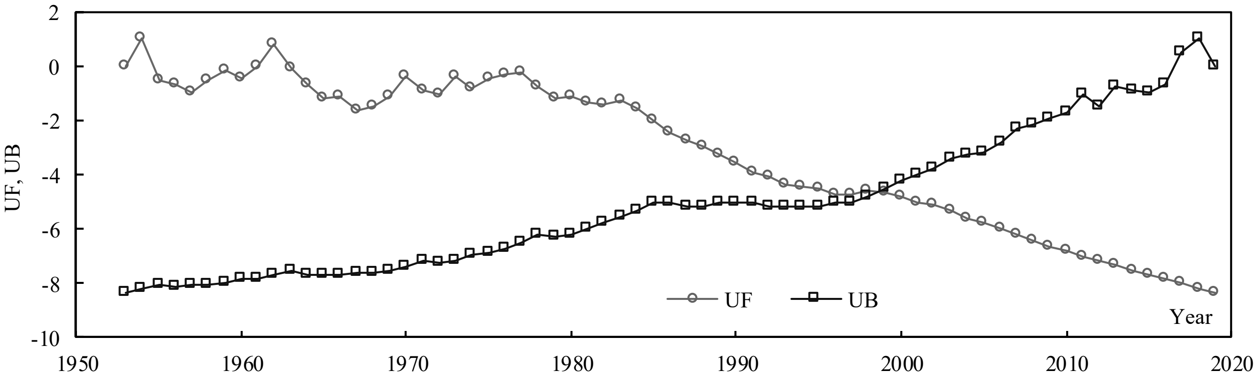

Fig. 3. UF and UB curves of Lijiadu station.

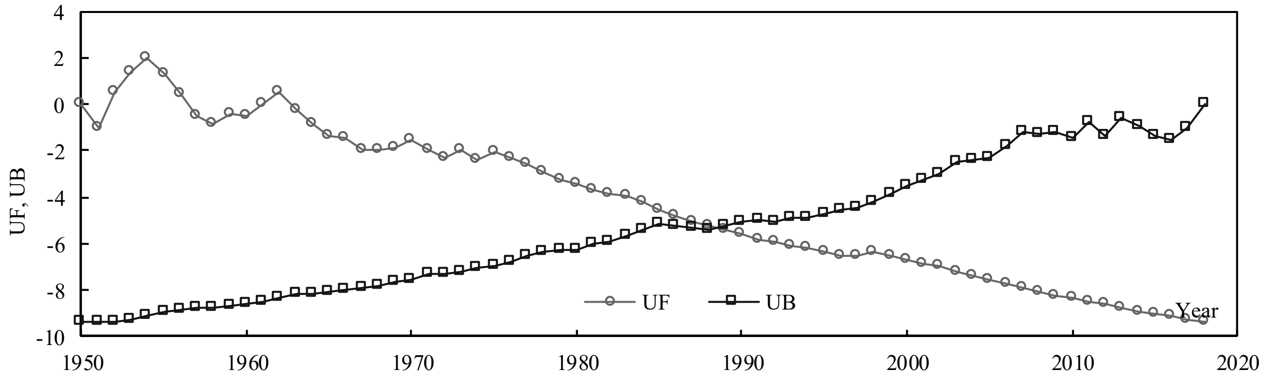

Fig. 4. UF and UB curves of Wenzhen station.

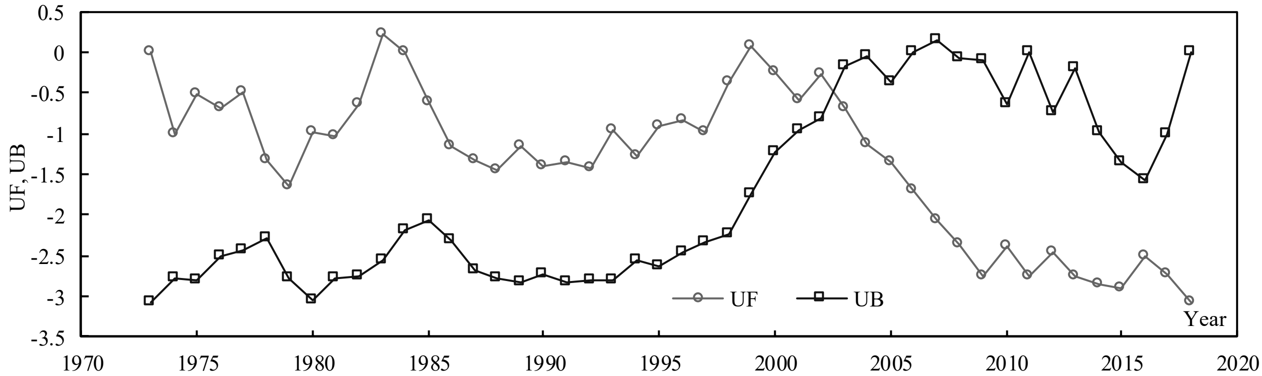

Fig. 5. UF and UB curves of Sanyang station.

4 Conclusions

In the past 70 years, the water level in the lower reaches of Fuhe River has obviously been declined. The water level drops are from 1.3 m to 3.5 m, and the sudden change of water level occurred in 1990s and the early 20th century.

Acknowledgments

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