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Time Series Analysis of Flow and Sediment Discharge in Yellow River Estuary

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ABSTRACT

The runoff and sediment in the Yellow River Delta is significant to the continuous economic development and ecological environment evolution. The analysis of the flow and sediment can provide an important basis for the future control of the River Delta. According to the survey data from 1950~2007 of Linjin hydrologic station, probability statistics and time series method such as Kendall method, order clustering method are applied to analyze the runoff and sediment discharge. The results show that the flow and sediment have been declining obviously over the past 60 years, and the change decreases mainly in the form of jumping. The reasons of the variations of flow and sediment are also discussed in this paper.

KEY WORDS: Flow and Sediment; kendall method; order clustering method.

INTRODUCTION

Nowadays, as the change of natural factors and human activities, the flow and sediment of Yellow River Estuary has been affected dramatically in recent years. Flow and sediment, which are significant to the ecological environment and economic development of the delta, has become a hotspot for governments and scientists in the whole world Watson R T et.al, 1996).

In this paper, according to the data from 1950~2007, the stochastic hyrology method is applied to analyze the annual runoff and sediment discharge of Lijin hydrologic station. The results show that the flow and sediment has reduced in recent years. The reasons caused the variations are also analyzed in the paper. There are three main factors that inflect the flow and discharge, which are reduce of the rainfall, reservoir filling and increase of water and sand diversion.

ANALYSIS OF FLOW AND SEDIMENT

Linjin hydrological station is a key station of Yellow River located in the delta, which can well reflect the change of runoff and sediment of the delta. The data from 1950~2007 is used for the analysis.

A. TREND ANALYSIS

The Kendall method is employed for the trend analysis of the runoff and sediment. For the time series x1, x2, ... , xn, P is defined as the occurrence number of allelomorph (xi<xj, i<j). The statistic value U is defined as follows (Ying M. et.al, 2005; Khistofrov A. V.,1998):

$$U = t\sqrt{\frac{9n(n-1)}{2(2n+5)}}, \left(t = \frac{4P}{n(n-1)} - 1\right) \quad (1)$$

Where n is sample size. E(P) is the mathematical expectation as $E(P)=n(n-1)/4$, if P<E(P), it shows there is a downward trend, while if P>E(P), there is a rising trend. The results are in table 1.

Table 1. Results of Kendall method of Linjin Station (1950~2007)

Parameters	n	n(n-1)/4	P	U
Runoff	58	826.5	360	-6.259
Sediment	58	826.5	373	-6.048

In the analysis, the confidence levels are set to $\alpha = 0.05$ and $\alpha = 0.01$, from the table of normal distribution, the critical value can be got as U0.05/2=1.96 and U0.01/2=2.575. From table 1, |U|> U0.05/2 and |U|> U0.01/2, as a result, the hypothesis of no trend turned to be wrong. As P<E(P), there is a reduce trend of annual flow and sediment of Linjin Station.

B. LINEAR REGRESSION FITTING

The regression test of linear trend is employed to justify whether the downward trend is linear. The detail of equations can be found in the references. The test results are in table 2.

Table 2. Results of linear regression test of Lijin Station (1950~2007)

Parameters	A	b	T
Runoff	554.5476	-8.0876	-7.6816
Sediment	14.4416	-0.2283	-7.4933

In this analysis, the confidence levels are set to α =0.05 and α =0.01, from the T distribution table, T0.05/2=2.004 and T0.01/2=2.667. From table 2, |T|> T0.05/2 and |T|> T0.05/2, as a result, the null hypothesis