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## Variation characteristics of runoff and sediment in the middle reaches of the Yellow River based on Copula function

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**Abstract:** In order to grasp the temporal and spatial variation of runoff and sediment transport and the relationship between runoff and sediment in the Yellow River, the Mann-Kendall test was used to analyze the trend of runoff and sediment load based on the data of runoff and sediment load from 1950 to 2020 at Tongguan station. This paper adopted a method based on moving correlation coefficient to diagnose the variation of watershed runoff and sediment, which was verified with cumulative curve method and regression analysis method. The Pearson III distribution was selected to fit the runoff and sediment distribution before and after the variation, and the combined runoff and sediment distribution was established based on Copula function. The variation characteristics of runoff and sediment at Tongguan station were compared and analyzed to study the wetness-dryness encountering of runoff and sediment at different times. Results show that: (1) The annual runoff at Tongguan station underwent a stepwise decrease until about 1990, and the amount of sediment load continued to decrease after 1983. (2) Taking 1985 as the segmentation point, the mean value of runoff and sediment decreased from 1986 to 2020 compared with that from 1956 to 1985. When the design frequency  $P \leq 90\%$ , the runoff and sediment load decreased, while when  $P > 90\%$ , the runoff decreased and sediment load increased. (3) In both time periods, the synchronous frequency of runoff and sediment load wetness-dryness was greater than the asynchronous frequency of wetness-dryness, and the probability of wetness-dryness combination was the smallest, and the frequency of each combination was more uniform after the variation period. The implementation of soil and water conservation measures and the control of water and sediment by large-scale water conservancy projects were the main reasons that led to the change of the wetness-dryness of water and sediment. This work was supported by the National Key Research and Development Program [grant number 2016YFC0500802].

**Keywords:** runoff; sediment load; Copula function; the Yellow River Basin