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Factor analysis and cluster analysis applied to assess the water quality of middle and lower Han River in Central China

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The Han River basin is one of the most important industrial and grain production bases in the central China. A lot of factories and towns have been established along the river where large farmlands are located nearby. In the last few decades the water quality of the Han River, specifically in middle and lower reaches, has gradually declined. The agricultural nonpoint pollution and municipal and industrial point pollution significantly degrade the water quality of the Han River. Factor analysis can be applied to reduce the dimensionality of a data set consisting of a large number of inter-related variables. Cluster analysis can classify the samples according to their similar characters. In this study, factor analysis is used to identify major pollution indicators, and cluster analysis is employed to classify the samples based on the sample locations and hydrochemical variables. Water samples were collected from 12 sample sites collected from Xiangyang City (middle Han River) to Wuhan City (lower Han River). Correlations among 25 hydrochemical variables are statistically examined. The important pollutants are determined by factor analysis. A three-factor model is determined and explains over 85% of the total river water quality variation. Factor 1, including SS, Chl-a, TN and TP, can be considered as the nonpoint source pollution. Factor 2, including Cl^-, Br^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, K^+, Fe^{2+} and PO_4^{3-}, can be treated as the industrial pollutant pollution. Factor 3, including F^- and NO_3^-, reflects the influence of the groundwater or self-purification capability of the river water. The various land uses along the Han River correlate well with the pollution types. In addition, the result showed that the water quality of Han River deteriorated gradually from middle to lower Han River. Some tributaries have been seriously polluted and significantly influence the mainstream water quality of the Han River. Finally, the result showed that the nonpoint pollution and the point pollution both significantly influence water quality in the middle and lower Han River. This study provides an effective method for watershed management and pollution control in Han River.