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An analysis of watershed hydrological double mass curve based on elasticity index

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The method of double mass curve (DMC) is often used in the analysis of the consistency of hydro-meteorological factors and their inter-annual variations. The trend and slope of DMC are the focus of general concern. By taking the DMC of annual precipitation-runoff in a watershed as an example, this paper analyzed the characteristics of DMC variations by means of the elasticity index obtained by the curve slope divided by the ratio of accumulated runoff to accumulated precipitation at corresponding location. Using a year as a time step, the index was further simplified to be the ratio of annual runoff coefficient to the runoff coefficient averaged over the period from starting year to computing year. An elasticity index greater than, less than, or equal to one indicated rising, decline, or stability of average annual runoff coefficient, respectively. Variation trend of elasticity index was analyzed to extract the information on the years with significant change and then, dominant factors and their impacts could be enquired further. The Jinghe River is located in the middle reaches of the Yellow River, being the largest tributary of the Weihe River. The elasticity index was used to analyze the DMC of annual precipitation-runoff on the scale of water year for the Jinghe River watershed from 1961 to 2012 and the two years of 1971 and 1997 were first chosen as the years showing abrupt changes. The elasticity indices in three periods separated by the two years in the past 50 years averaged 1.08, 0.89 and 0.64 and annual runoff coefficients, 0.08, 0.07 and 0.05, respectively. The human activities disturbing underlying surface were found to be the important factor responsible for the remarkable decline of runoff coefficient. The large-scale comprehensive control of soil erosion and the adjustment of landuse structure had made some achievements in the recent twenty years. However, their disturbing effects on underlying surface interacted with the impacts of climate change, which led to intensified evapotranspiration and reduced runoff and thus had some significant impacts on hydrological cycles in the Jinghe River watershed. The elasticity index can not only be used to illustrate the trend and characteristics of precipitation–runoff DMCs, but also applied to the analysis of all kinds of watershed hydro-meteorological DMCs.