A Comparison of Parameter Estimation Methods Using Typical Precipitation Data in Plain River Networks: Case Study in Taihu Basin, China

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ABSTRACT

As one of the most developed regions in China, precipitation frequency analysis is of great necessity to Taihu Basin for flood disaster prediction and prevention. In this study, four parameter estimation methods of probability distribution functions, namely conventional moments method, curve fitting method, maximum likelihood method and L-moments method are used to estimate parameters of Pearson III distribution models to fit these sets of data collected from four stations in Taihu Basin. The performance of the four parameter estimation methods is tested by K-S test and is also compared by weighted least squares (WLS) criterion. This study can provide a reference for the selection of parameter estimation methods while using Pearson III distribution model in Taihu Basin.

KEY WORDS: precipitation frequency analysis; Pearson III; parameter estimation methods; K-S test; WLS criterion; data samples; Taihu Basin.

INTRODUCTION

Due to recent global warming, extreme rainfall events are remarkably increasing in both frequency and intensity. Accordingly, rainfall induced flooding in urban areas occurs more and more frequently and seriously. Taihu Basin is one of the most developed regions in China, and also suffers from rainfall induced flooding in the past decades, which causes a great loss of properties as well as threats to human lives (Yu, Yan and Zou, 2012). Moreover, the serious non-point source pollution during flood rooting leads to problems of environmental pollution and environmental safety in Taihu Basin. Therefore, as a basic work for flood design, precipitation frequency analysis is of great importance and necessity to Taihu Basin for flood disaster prediction and prevention.

The main contents of precipitation frequency analysis are selecting sample series from existing hydrologic data, choosing a frequency distribution fitting to sample series, estimating the parameters of the frequency distribution and calculating design rainfall corresponding to various frequencies according to the drawn frequency curve (Wan, Gao, Fu and Ji, 2009). In China, based on analysis results of a lot of precipitation data and years of practical experience, “Regulation for Calculating Design Flood of Water Resources and Hydropower Projects” (Ministry of Water Resources, P.R.C., 2006) defines that the linetype of frequency curve should use Pearson III curve, and other linetypes can be adopted for the special case after analysis and demonstration. In addition, some other distribution curves are also widely used, such as Generalized Extreme Value distribution and Weibull distribution.

After selecting the distribution curve, better parameter estimation of the frequency distribution function is important for precipitation frequency analysis. In the current study, the common parameter estimation methods includes conventional moments method, curve fitting method, maximum likelihood method, L-moments method, probability weighted moments method, weight function method and so on (Liang, Liu, Zhong, Zhou and Hu, 2013). In China, conventional moments method has been applied for many years. However, the estimated parameters calculated by this method have a certain deviation from population parameters, which will affect the accuracy of the estimation of design rainfall (Lin, Bonnin, Martin, Parzybok, Yekta, and Riley, 2006). Curve fitting method is simple and convenient, but it is greatly influenced by man-made factors. Maximum likelihood method is considered as the best method in theory in the sense that it produces the most efficient parameter estimates (Strupczewski, Singh and Weglarczyk, 2002, Mahdi and Ashkar, 2004). However, to ensure the existence of the solution, it is required that the value of skewness coefficient ranges from 0 to 2. L-moments method as a new parameter estimation method is now being adopted worldwide (Parida, Kachroo and Shrestha, 1998, Atiern and Harmancio, 2006, Liu, Zhu and Ma, 2007). And L-moments is less influenced by extreme value in the sample series. These parameter estimation methods with different advantages and disadvantages apply to different regions and different data samples. In view of the data samples with different features in Taihu Basin, the research of comparison of parameter estimation methods is insufficient.

In this paper, the precipitation frequency analysis using the rainfall data from four stations in Taihu Basin is investigated. The four sets of data samples have their own features. As the most widely used distribution model in China, Pearson III is employed. Four parameter estimation methods of probability distribution functions, namely conventional moments method, curve fitting method, maximum likelihood method and L-moments method are used to estimate parameters of Pearson III