# The Population Index Flood Method for Regional Frequency Analysis

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**Abstract.** The population index flood (PIF) method has recently been suggested as an alternative to the traditional index flood procedures for regional frequency analyses of extreme hydrologic events. In the PIF method the index flood (or the indexing function) at each site is taken to be a function of the unknown at-site population quantities and, as a result, the homogeneity of the region is embedded in the structure of the parameter space of the underlying distribution model. More precisely, depending on the regional distribution model and the type of the indexing function, some of the distribution parameters are site-specific, while others are common for all sites within the statistically homogeneous region. Because of the analytical framework of the PIF regional method, the method of maximum likelihood can be used for parameter estimation and in addition when regularity conditions are satisfied the variance-covariance matrix of the maximum likelihood estimators can be used to estimate the standard error of estimated quantiles.

Asymptotic and sample variances of quantile estimators are estimated for the PIF method based on the general extreme value (GEV) distribution with maximum likelihood estimation. This is done using a formula for the Cramer Rao lower bound (CRLB) of variance of unbiased estimators and the estimated asymptotic and observed variance-covariance information matrix of the maximum likelihood GEV parameter estimators. The estimated asymptotic and sample variances of the quantile estimators are compared using simulation experiments for different sized regions and two types of indexing functions: (1) the sample data at each site are indexed by dividing them by the at-site population mean, and (2) the sample data at each site are indexed by standardizing them using at-site population statistics. In addition, the PIF regional method is compared with the well-known Hosking and Wallis regional estimation scheme (HW scheme), where the uncertainty of at-site quantile estimators is quantified using methods and procedures recently suggested by De Michele and Rosso. The proposed PIF regional method is compared with the HW scheme using extreme precipitation data from northeastern Colorado. The results of this study show that the new PIF models are a useful addition to existing regional frequency analysis models, and that their analytic structure, which is not present in other regional models, have important theoretical and practical implications.

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