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Regional Hydrological Extremes Frequency Analysis Based on Statistical and Hydrological Models

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Abstract : The hydrological extremes frequency analysis is the foundation for the hydraulic engineering design, flood protection, drought management and water resources management and planning to utilize the available water resource to meet the desired objectives of different organizations and sectors in a country. This spatial variation of the statistical characteristics of the extreme flood and drought events are key practice for regional flood and drought analysis and mitigation management. For different hydro-climate of the regions, where the data set is short, scarcity, poor quality and insufficient, the regionalization methods are applied to transfer at-site data to a region. This study aims in regional high and low flow frequency analysis for Poland River Basins. Due to high frequent occurring of hydrological extremes in the region and rapid water resources development in this basin have caused serious concerns over the flood and drought magnitude and frequencies of the river in Poland. The magnitude and frequency result of high and low flows in the basin is needed for flood and drought planning, management and protection at present and future. Hydrological homogeneous high and low flow regions are formed by the cluster analysis of site characteristics, using the hierarchical and C- mean clustering and PCA method. Statistical tests for regional homogeneity are utilized, by Discordancy and Heterogeneity measure tests. In compliance with results of the tests, the region river basin has been divided into ten homogeneous regions. In this study, frequency analysis of high and low flows using AM for high flow and 7-day minimum low flow series is conducted using six statistical distributions. The use of L-moment and LL-moment method showed a homogeneous region over entire province with Generalized logistic (GLOG), Generalized extreme value (GEV), Pearson type III (P-III), Generalized Pareto (GPAR), Weibull (WEI) and Power (PR) distributions as the regional drought and flood frequency distributions. The 95% percentile and Flow duration curves of 1, 7, 10, 30 days have been plotted for 10 stations. However, the cluster analysis performed two regions in west and east of the province where L-moment and LL-moment method demonstrated the homogeneity of the regions and GLOG and Pearson Type III (PIII) distributions as regional frequency distributions for each region, respectively. The spatial variation and regional frequency distribution of flood and drought characteristics for 10 best catchment from the whole region was selected and beside the main variable (streamflow: high and low) we used variables which are more related to physiographic and drainage characteristics for identify and delineate homogeneous pools and to derive best regression models for ungauged sites. Those are mean annual rainfall, seasonal flow, average slope, NDVI, aspect, flow length, flow direction, maximum soil moisture, elevation, and drainage order. The regional high-flow or low-flow relationship among one streamflow characteristics with (AM or 7-day mean annual low flows) some basin characteristics is developed using Generalized Linear Mixed Model (GLMM) and Generalized Least Square (GLS) regression model, providing a simple and effective method for estimation of flood and drought of desired return periods for ungauged catchments.

Keywords : flood , drought, frequency, magnitude, regionalization, stochastic, ungauged, Poland
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