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Regional flood frequency analysis in Slovenia

Katarina Kavcic, Mitja Brilly, and Mojca Sraj
University of Ljubljana, Faculty of Civil and Geodetic Engineering, Chair of Hydraulic Engineering, Slovenia (katarina.kavcic@fgg.uni-lj.si)

The regional flood frequency analysis is mainly used for purposes of improving flood prediction. There are many examples of its application in different countries but it hasn't been used in Slovenia yet. So our main goal was to use different approaches to perform regional flood frequency analysis of maximum annual discharges for hydrological stations in Slovenia.

Regional flood frequency analysis usually involves four steps. For each one there are different methods that can be used. At first, accuracy and discordance of data has to be checked. The second and also the most important step is identification of regions and checking their homogeneity. The last two steps are the choice of an appropriate frequency distribution for a region and estimation of the parameters and quantiles of the selected distribution, respectively.

Maximum annual discharges for 112 hydrological stations in Slovenia that satisfied required conditions about measurement performance were considered for analysis. Time series were first checked for missing data, outliers, normality and linearity. The discordancy measure was also used.

The regionalization was performed using two different approaches. The first method used was subjective partioning where the regions are formed with the goal to get concluded groups in which hydrological stations lay geographically close to each other. The second used method was cluster analysis within which two algorithms were tested (Ward method and K-means). Three data sets with different number of attributes were used for each one. The homogeneity of the regions was tested using the heterogeneity measure H.

The result of the subjective partioning were 10 regions, 8 of them were acceptably homogeneous ($H < 1$), one was possibly heterogeneous ($1 \leq H < 2$) and one was definitely heterogeneous ($H \leq 2$). Among Ward method and K-means we decided to use the results of the latter one based on the data set with 4 attributes (catchment area, longitude, latitude, elevation). After some adjustments we defined 9 acceptably homogeneous regions.

The best frequency distribution was estimated according to K-means adjusted regions. Different goodness-of-fit tests were used. For the whole region data the L-moment ratio diagram and the goodness-of-fit measure Z were performed. For the single station data the QQ diagram, Kolmogorov-Smirnov test, PPCC (probability plot correlation coefficient) and RMSE (root mean square error) were used.

After analysing different results we decided to estimate the final frequency distribution of the regions using L-moment ratio diagram, goodness-of-fit measure Z and the RMSE test. At the end we estimated also the quantiles for chosen frequency distributions using the regional L-moment algorithm based on the index-flood procedure.