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Regional statistical analysis of rivers low flow

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Estimates of river low flow characteristics are needed for several purposes in water resources and environmental management, including water supply planning, river basin management, drought mitigation, hydropower development and environmental flow definition.
Low flow regime is closely dependent on the catchment hydrogeological features and for its characterization a detailed surface and groundwater catchment analysis is necessary. However, from an operational but scientifically founded point of view, statistical analysis is widely applied to derive indices to characterize low flow regimes and as a measure of environmental minimum flow. With these indices it is possible to identify the occurrence, the extent and magnitude of the hydrological droughts. Low flow indices are commonly evaluated at gauged sites from observed streamflow time series. Their reliability can be affected by the lack of observed streamflow data, a diffuse problem in the real world. In order to overcome these problems and to estimate low flow statistics in ungauged sites it is possible to refer to a regional statistical analysis, widely used since log time and in different disciplines. The methods employ catchment and climatic characteristics, supposed to be measured over the investigated area, as independent variables, and data from other catchments where stream flow data are recorded.
The analysis of low flow indices is carried out on the discharge data of 65 consistent hydrometric stations located in Tuscany region, in Central Italy, from 1949 to 2008. The area is subdivided into different regions using the L-moments method applied to the 7-day annual minima and to the Q70 annual series. The division into subregions is tested using discordancy and heterogeneity statistics. A unique region and a subdivision into three different subregions, following previous studies on rainfall extreme values, are preliminary considered. The use of five subregions, starting from the previous subdivisions and taking into account some hydrological features, is also tested. For each river section the catchment area is identified and an appropriate set of catchment physiographic and climatic characteristics is defined. A physiographical space-based method is used to relate the duration and annual minimum indices of low flow to the investigated territory characteristics. The new space is built as a power combination of the catchment geomorphologic and climatic characteristics. In this space several interpolation techniques, either deterministic or geostatistical, such as Inverse Distance, Thiessen polygon methods and Kriging, are applied. The results are valuated using the jack-knife method. Different error measurement (mean square error, mean relative error...) are also assessed to compare the results, to quantify the accuracy of the different techniques and to define the most suitable procedure for low flow regionalization.