A non-stationary analysis on runoff data using GAMLSS. An application to Sicily, Italy.

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Climate change affects all the components of the hydrological cycle. Starting from precipitation distribution, climate alterations have a direct effect on both surface water and groundwater, in terms of their quantity and quality. This aspect leads to a modification in water supply, urban water disposal, water availability for agriculture, ecology and other social aspects.

A change in rainfall patterns also affects the runoff of natural rivers. For this reason, studying runoff data through classical approaches of hydrology, i.e., statistical inference methods that exploit stationary probability distributions, might result in missing some important information in this perspective. From this point of view, it is necessary to find a new approach in the study of this type of data considering a non-stationary frequency analysis (Nasri et al., 2017).

The tool used in this study, known as Generalized Additive Models for Location, Scale and Shape (GAMLSS) (Rigby and Stasinopoulos, 2005) is a statistical framework which allows to carry out also non-stationary statistical analysis. In this study, an application of GAMLSS to runoff data collected by four gauges widely distributed across Sicily (Italy) in the period 1916-1998 is presented.

At first, a classical stationary frequency analysis of these runoff data was performed while, successively, non-stationary frequency analysis was carried out in order to compare the two methodologies. While the first analysis was made using as covariate the annual precipitation, in order to understand how some runoff statistical parameters of runoff distribution vary with changes of precipitation, the second one derived some information about the temporal variability of runoff frequencies by considering the time (years) as covariate.

Through the GAMLSS approach, it was possible to investigate different probability distributions for runoff in both stationary and non-stationary statistical analysis, identifying which one shows the best fit for each examined data sample using the Akaike Information Criterion (AIC) (Akaike H., 1974) as performance metrics.

References

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