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Statistical analysis of low-flow based on short time series. The case of Wallonia

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The floods have always been the main concern resulting of extreme weather conditions. Now droughts and low flows are more and more recognized as risk situations due to the huge consequences of water shortage. Furthermore, the changing climate context constitutes a new threat even if the uncertainty in low-flows evolution remains high. In Wallonia (Southern part of Belgium), a knowledge gap remains on statistical analysis of low-flows. In this paper, we present a study of historical data in Walloon Region and the first steps of their statistical analysis.

Wallonia is one of the three regions of Belgian federal state. It covers an area of 17000 km^2 and spreads on 4 districts (Meuse, Escaut, Rhin, Senne). The watercourses are divided in navigable watercourses (700km), not navigable watercourses that are listed in 3 categories (14300km) and streams that are not navigable and not listed (4000km).

Hydrological monitoring has a short history in Wallonia. The first monitoring site was installed in 1960. It consisted in a limnimetric scale and daily manual readings. Since 1974, hourly data are recorded. The number of measurement sites reached 244 stations in 2011. About 60 % of the monitoring sites have less than 20 years of hourly data.

A qualitative analysis of monitoring stations led us to disregard 184 stations. The main quality problems were important discharge rating curve extrapolation, algae development in summer or low flow inferior to 5l/s.

In preparation for a statistical analysis of low-flows, the old manual daily readings were analyzed. Unusable in high flow situations, they still hold practical and usable information during drought. This analysis allowed us to extend the registration period up of 7 stations and to recover 16 stations.

There were lots of missing data during the 1960-1994 period, due to a poor management of the monitoring network. A yearly hydrograph analysis leads us to keep years of partial measurement when the gaps were found to be out of the low-flow period. The monitoring sites presenting more than 20 years of readings were selected for the statistical analysis. A homogeneity test was performed.

Finally 64 out of 244 monitoring sites are kept for the frequency analysis.

The indicators used to characterize low-flows are the popular Q95 and MAM7. Five below bounded distributions are tested with the HYFRAN software: Weibull (2 parameters), log-normal 2 parameters and 3 parameters, Gamma and Pearson type III. The parameters of the laws are estimated by the maximum likelihood estimation. The selection of the three best laws is performed for each site thanks to three Bayesian criterions proposed by HYFRAN. Then the distribution that fits the best the data is visually chosen. The results of the adjustment method are the same for the two indicators. The Gamma distribution is the most used followed by the lognormal with 2 parameters. However in some cases a law of three parameters is more appropriate.

This preliminary work gives a first analysis of low-flows statistics in Wallonia. Yet a lot of missing data or short recording duration still limits our knowledge, this analysis allows us to progress towards best management practices in rivers and watersheds.