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From flood to low flow: analysis of recession processes

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Context

Floods and droughts are mostly independently analysed. Flood analysis focuses on rising process whereas drought is related to recession periods. The analysis of recession processes usually concerns the baseflow recession whereas flood recession curves are in most cases discarded.

The understanding of recession processes is useful to manage water resource but their analysis has a lot of shortcomings related to the high variability in recession behaviours and in recession coefficients. Furthermore it is difficult to find a consistent method to select recessions from a hydrograph especially in a humid climate because the process is frequently interrupted by rainfall.

The aim of this study is to analyse both flood and base flow recessions observed in an annual chronological way. The methodology gives consistent results and makes the interpretation of the variability of recessions easier.

Methodology

An automatic procedure is applied to select decreasing discharges, from the maximum annual flow until the minimum annual flow. Between these two extremes the aim is to select only decreasing discharges by eliminating rainfall influences and floods: i) the maximum annual flow is selected ii) from then, only discharges that are lower than the previous one are kept until the minimum annual discharge iii) the result is an annual recession curve which represents the recession from the maximum to the minimum discharge of the considered year.

Results

The curve shows a regular behaviour: from the maximum discharge (in the winter) until the minimum discharge (in the summer) the recession process follows different rates that decrease regularly. This annual recession curve can be interpreted in terms of processes by dividing it in several homogeneous segments:

- The first part of the curve shows a fast decrease related to flood recession widely influenced by overland flow. The next segments have a slower slope and represent different stages in the groundwater outflow process. The last part of the curve can show very constant flows. Lower recessions in autumn than in summer can be interpreted by lower evapotranspiration.

- The recession coefficients of the different segments are correlated to the initial discharges of the concerned segments: we observe high correlations between these two variables for the first part of the curve; on the contrary these variables are independent for the last part of the curve. No relation proves the quantification of the outflow of a linear aquifer.

- The recession segments can be classified according to their rates and behaviours. On a semi-logarithmic scale the last part of the curve shows a series of straight lines which is not true for the first part. Flood and baseflow recessions do not follow the same pattern and it is interesting to derive quantitative expressions for this two processes.

Benefits for hydrological extremes

The variability of the recession coefficient should be included in low flow forecast but its interpretation is hard to understand. In involving the flood recession period in the analysis of recession curves we enhance the understanding of these processes. Furthermore, by plotting decreasing discharges in a chronological way the recession processes seem consistent.

Finally the comparison of recession processes between several basins is interesting and shows different behaviours depending on geological characteristics: for impervious basins the recession process seems simple and can be expressed by a simple equation; on the contrary basins with important groundwater resources need several expressions to represent the different stages in the groundwater outflow process. These observations can be introduced in hydrological models to improve the simulation of the transition from flood recession to baseflow recession.