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## Comprehensive analysis and separation of river hydrograph using the GrWat R package

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River hydrograph analysis provides valuable information about temporal and spatial variability of the river discharge. One of the most important operations is separation of hydrograph, which aims at decomposing the total streamflow into components. Numerous approaches for hydrograph separation have been developed to date. Most of them traditionally separate the streamflow into general quickflow and baseflow components, but it is also possible to obtain more specific quickflow separation with subdivision into genetic components, such as seasonal snowmelt, rain, thaw etc. We present the general framework for river hydrograph analysis and separation provided by newly released GrWat package, which has been developed during several years. The framework includes a simple tabular data model for representation of hydrograph and climatic (temperature and precipitation) daily data needed for separation of the quickflow into genetic components; spatial analysis operations for automatic extraction of climatic data from reanalysis datasets covering the river basin; automated interpolation of missing data considering the autocorrelation; fast implementation of multiple algorithms for hydrograph separation; computation of more than 30 interannual and long-term characteristics of separated hydrograph components; scale-space transformation for hierarchical decomposition of the hydrograph; high-quality plotting and reporting of the results of analysis. One of the prominent features of the framework is a powerful algorithm for genetic hydrograph separation, which is capable of not only extracting the baseflow, seasonal, thaw and rain flood components, but also to cut the short-time rain floods which complicate the shape of the seasonal flood. The baseflow separation is performed on the first stage and can be initialized by any of the baseflow separation algorithms available in the package. On the second stage the quickflow is separated into genetic components. Such modular structure provides the flexible way to experiment with different combinations of algorithms and to select the approach which serves best to the goal of the analysis and specific features of the hydrograph.

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