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Inferring Aquifer Transmissivity from River Flow Data

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Daily streamflow data is the measurable result of many different hydrological processes within a basin; therefore, it includes information about all these processes. In this work, recession analysis applied to a pan-European dataset of measured streamflow was used to estimate hydrogeological parameters of the aquifers that contribute to the stream flow. Under the assumption that base-flow in times of no precipitation is mainly due to groundwater, we estimated parameters of European shallow aquifers connected with the stream network, and identified on the basis of the 1:1,500,000 scale Hydrogeological map of Europe.

To this end, Master recession curves (MRCs) were constructed based on the RECESS model of the USGS for 1601 stream gauge stations across Europe. The process consists of three stages. Firstly, the model analyses the stream flow time-series. Then, it uses regression to calculate the recession index. Finally, it infers characteristics of the aquifer from the recession index. During time-series analysis, the model identifies those segments, where the number of successive recession days is above a certain threshold. The reason for this pre-processing lies in the necessity for an adequate number of points when performing regression at a later stage. The recession index derives from the semi-logarithmic plot of stream flow over time, and the post processing involves the calculation of geometrical parameters of the watershed through a GIS platform.

The program scans the full stream flow dataset of all the stations. For each station, it identifies the segments with continuous recession that exceed a predefined number of days. When the algorithm finds all the segments of a certain station, it analyses them and calculates the best linear fit between time and the logarithm of flow. The algorithm repeats this procedure for the full number of segments, thus it calculates many different values of recession index for each station. After the program has found all the recession segments, it performs calculations to determine the expression for the MRC.

Further processing of the MRCs can yield estimates of transmissivity or response time representative of the aquifers upstream of the station. These estimates can be useful for large scale (e.g. continental) groundwater modelling. The above procedure allowed calculating values of transmissivity for a large share of European aquifers, ranging from Tmin = 4.13E-04 m^2/d to Tmax = 8.12E+03 m^2/d, with an average value Taverage = 9.65E+01 m^2/d. These results are in line with the literature, indicating that the procedure may provide realistic results for large-scale groundwater modelling.

In this contribution we present the results in the perspective of their application for the parameterization of a pan-European bi-dimensional shallow groundwater flow model.