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From aquifers' and rivers' memory to a better low-flow forecasting model

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The 2019 major drought in northern France highlighted the necessity to design an efficient and reliable low-flow forecasting system. Most forecasting tools, based on rainfall-runoff surface models, could benefit from an utilization of piezometric data, broadly available over the French metropolitan territory: obviously, surface water/groundwater interaction are a key process to explain low-flow dynamics.

Indeed, aquifers carry most of the hydroclimatic memory of a catchment, which determines the intensity and duration of droughts: a catchment beginning summer with empty aquifers will not have the same trajectory as the same catchment with higher than average piezometric levels. However, the piezometric data itself is not straightforward to use in a hydrological model, since aquifer-river connexions are often equivocal. Thus, a prior analysis of available data is necessary.

In this work, using 100 catchments of the national French hydroclimatic database and available piezometric data from the national aquifer monitoring network, we performed a comparative memory analysis of piezometry and streamflow, through a simple convolution function. The results were then compared to the behaviour of GR6J, a conceptual lumped rainfall-runoff model. For each catchment of the dataset, a selection of relevant piezometers was made, in the perspective of developing a model incorporating their levels as input data.