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Evaluation of three regionalization approaches for continuous streamflow simulation.

The Water Framework Directive (Commission of the European Communities, 2000) requires that an integrated monitoring programme be established within each river basin district. This monitoring programme enable collection of the physical, chemical and biological data which is necessary to assess the status of surface and groundwater bodies in each river basin district.

In the French part of the Rhine-Meuse basin, monitoring networks include 468 sites. Most of these pollution-control sites are ungauged. Therefore, when reanalysing the quality measurements through data mining methods, it is somewhat difficult to interpret ground data and trends on pollutants indicators without any information on the hydrological context of measurements. Continuous streamflow data (hydrographs) could indeed give valuable information on the overall types of water pathways, processes and sources in a basin. This will contribute to the understanding of the processes responsible for pollution and detecting areas of concern.

In the framework of a research project funded by the French Water Agency, three regionalization approaches has been evaluated for continuous flow simulation at pollution-control ungauged sites. The objectives were to produce daily flow data with uncertainty and predict the main stages of the hydrograph (rising limb, falling limb, recession) over the two last decades.

The hydro-meteorological dataset refers to the period 1990-2009. Daily unregulated streamflow time series (104 stations) were collected within the study area (French part of the Rhine-Meuse basin). In addition to the streamflow data, we also collected daily precipitation and evapotranspiration time series from the SAFRAN analysis (Quintana-Segui et al., 2008), so that a daily lumped parsimonious rainfall–runoff (RR) model (Perrin et al., 2003) could be calibrated. The efficiency of the RR model has been estimated through the « split sample test » and a regional parameters set was built up for the study area.

Continuous flow simulation in ungauged basins has been performed by regionalizing the RR model. The transfer of parameters from neighboring gauged basins (i.e. donor basins) was implemented through : i) spatial proximity, ii) georegression, iii) Top-kriging (Skøien et al., 2006). For regionalization strategy assessment we use the leave-one-out cross validation procedure as well as the Nash and Sutcliffe criterion computed on the square root of the discharge.

Evaluation of the three regionalization approaches allows verifying the coherence of flow predictions and to determine which method is performing the best in view of producing daily flow simulation at pollution-control site. Whereas for most of ungauged sites, predictions are similar, for some of them, significant differences has been found. This result rises the question why one method performs better than an other for certain basins. On the other hand, « hydrological monsters » (i.e. outliers for whom the 3 methods fail) has been identified.

This study rises the challenging question of searching or applying a « monoregionalization » strategy for continuous flow simulation in ungauged basins. It

seems obvious that some basins require to improve behaviour understanding and to develop site-specific approach for estimating hydrographs. Last, areas of contradictions between constraints imposed in an operational context and a rigorous scientific approach in prediction of discharge are discussed.