



Are physiographic and hydrological similarity indices as equivalent as we think? Insights from a Scottish wide data set

Genevieve Ali (1), Doerthe Tetzlaff (1), Jeff McDonnell (1,2), Rene Capell (1), and Chris Soulsby (1)

(1) Northern Rivers Institute, University of Aberdeen, School of Geosciences, Aberdeen, United Kingdom, (2) Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, Oregon, USA

Given the rationale that catchments with analogous physical characteristics share a comparable hydrological behaviour, the concept of similarity has emerged as a key notion in order to transfer information from gauged to ungauged locations. Recent scientific contributions have however questioned whether all approaches to defining catchment similarity are indeed equivalent as there is no agreement on which physiographic or flow characteristics are best suited to such an exercise and could serve as universally accepted metrics. We here wish to contribute to the debate by (1) introducing a relatively new algorithm especially designed for clustering purposes but not yet exploited in hydrology, and (2) testing various catchment characteristics so as to quantify catchment similarity.

We focus on 36 catchments, some of them partly nested, ranging in size and spread over seven different regions of Scotland. A whole suite of characteristics was compiled for each catchment, including climatic indices (e.g. mean annual precipitation), topographic properties (e.g. elevation, slope, drainage density, mean flow path length, topographic index), soil cover proportions, flow indices (e.g. Q5, Q95), mean transit times and storage estimates. The chosen algorithm, termed affinity propagation and developed by Frey and Dueck (2007), is a low error and high speed graph theoretic clustering method which has the compelling advantage of identifying which object is the most representative exemplar of each group. Several combinations of catchment characteristics were fed into the algorithm so as to assess the difference between climatic, topographic, pedologic and hydrologic similarity.

Results show that neighbouring catchments are usually but not always more similar than distant catchments. Besides, catchment groupings obtained on the basis of topographic properties do not match those obtained using flow indices, mean transit times or storage estimates, thus implying that physiographically similar catchments are not necessarily hydrologically similar. This conclusion stresses the importance of including as many catchment characteristics as possible in regionalisation studies so as to capture the combined physiographic and hydrological variability of the landscape. Our approach is also an interesting one to build upon as the identification of representative catchments may help rationalize sampling efforts and serve as a basis for international intercomparison studies.