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Hydrology and Earth System Sciences Discussions

Interactive comment on "Catchment classification based on characterisation of streamflow and precipitation time-series" *by* E. Toth

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I would like to warmly thank Referee # 1 for his/her time and consideration and especially for so valid and pertinent comments, that prompt me to integrate and improve the work and its presentation. I have a couple of doubts on the interpretation of the Comments (see Comments 3 and 4) and I will consider with particular care any additional suggestion that the Referee may offer either in the remaining of the Discussion Phase or through the Editor.

REPLY TO REFEREE 1'S COMMENTS

"1.The authors used the SOM neural network for the classification of streamflow signa-

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tures? How about the K-Means or Fuzzy C-Means methods?"

R. The Referee is certainly right and other clustering techniques (for example K-Means or Fuzzy C-Means or hierarchical clustering) may certainly be used for this classification and have been successfully applied - and compared with SOM - in hydrological applications (see, e.g. Hall and Minns, 1999; Chang et al., 2008; Ley et al., 2011). The SOM is only one of the possible classification methods, with the advantages exposed in the paper (mainly the ability to preserve the topological structure of the data, thus allowing also an evaluation of the affinity between the clusters), but I believe that a different method for the partitioning of the streamflow properties would probably provide analogous results. I will explicitly mention the possibility to use alternative classification methods in the revised version.

"2. Figure 1 shows the closure sections of the catchments associated to the three clusters obtained from the streamflow signatures. This figure is interesting and able to capture the meaningful input-output pattern; while the output layer of the SOM only consists of 3 nodes (one dimension only), which might not fully explore a meaningful topological map. If it is feasible, it would be interesting to learn the result if the number of nodes increase, such as 2x2, 2x3. This can be referred from Chang et al. (2010), where they stated that the spatial location of an output (evaporation) in the SOM would correspond to a particular feature of data drawn from the input space (meteorological variables) and thus gain ideas over the formulated map of input-output patterns."

R. This is a very useful suggestion; I had chosen a small number of nodes given the limited amount of records to be classified, but a larger output layer (corresponding to more classes and therefore to a more detailed classification) may be able present, as the Referee highlights, a more complete topological map and it would – nonetheless – still provide the possibility to identify also a smaller number of broader classes. In fact, given that similar input patterns activate units that are close together, a SOM produces a topologically ordered output that displays the similarity between the different classes (Foody, 1999; Chang et al., 2007; Chang et al., 2010). Given such topological prop-

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erties, nodes that are nearby may be considered representative of akin classes, and it would be possible to analyse, on the higher-dimension output map, the relationship of such more refined classification with the original partitions in 3 clusters. Following the Referee's suggestion I will carry out a clustering of the streamflow attributes with a SOM formed by a larger output layer, highlighting the differences/similarity with the original 3-class approach.

"3. It would be easier to catch the idea if the component of classes in SOM could be presented in a figure not just in text."

R. If possible, I would need a clarification on what you exactly mean with "component of classes in SOM": maybe it is related to the points raised by the other Referees, on the need to add one or more maps of the main climatic and topographical attributes? I will certainly add such figures in the revised version.

"4. It would be good to address the reason for calculating the error rate of the discriminant analysis through the result of SOM. If there is some expert knowledge, a supervise learning strategy, such as Learning Vector Quantization (LVQ), couple with the SOM might enhance the classification result of the SOM."

R. I confess that I do not fully understand this suggestion and, given that also Referee #3 found the unsupervised/supervised approach confusing, it is evident that the paper is not clear in its description. It is assumed to have no previous expert knowledge on the hydrological similarity among the catchments and the SOM is first applied as an unsupervised methodology for grouping catchments that are similar from the hydrometric point of view. (and it should be noted that, in such conditions, the PCA+ Discriminant analysis approach can not be applied, since the Discriminant Analysis is a supervised learning technique, that assign each record to predefined groups that here are not available). Successively, aiming at assigning to such classes also any new watershed where hydrometric measures are not available, the Discriminant Analysis is applied (in the leave-one-out validation framework), constructing a classification rule based on the

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knowledge of i) the morpho-pluviometric attributes and ii) the hydrometric classification of the gauged watersheds (such classification, obtained by the unsupervised SOM based on streamflow indexes, becomes, in this second analysis, our predefined grouping). For this reason I calculate the goodness of the Discriminant Analysis through the capability of assigning a catchment, on the basis of the morpho-pluviometric attributes only, to the same class to which it would be assigned if we knew its streamflow attributes. I will try to better describe these steps in the revised paper, hoping that the methodology may result clearer.

"5. Adding more recent publications relevant to this research topic will enrich this manuscript, such as Chang, F.J., Tsai, M.J., Tsai, W.P., Herricks, E.E., Assessing the Ecological Hydrology of Natural Flow Conditions in Taiwan, Journal of Hydrology, Vol. 354 pp.75-89, 2008. Thomas B., Lischeid G., Steidl J., and Dannowski R., Regional catchment classification with respect to low flow risk in a Pleistocene landscape, Journal of Hydrology, 2012."

R. I thank the Referee for having signalled these interesting works, certainly pertinent to the present work, which will be added in the References.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 10805, 2012.