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Downward approach at the catchment scale or at the catchment set scale?

C. Perrin, V. Andréassian, and N. Le Moine
Cemagref, UR HBAN, Antony Cedex, France (charles.perrin@cemagref.fr)

The downward approach that learns from observations the main features of the catchment hydrological response has long been recognized as a way to develop hydrological models for the catchment scale (Klemes, 1983). In this approach, a link is made between rainfall inputs and flow outputs using the mathematical tools found the most efficient to reproduce catchment behaviour. This approach received recently more attention, as some limitations of the upward approach were identified (Sivapalan et al., 2003).
However model structures developed with this downward approach at the catchment scale are often difficult to generalize, i.e. difficult to transpose to other catchments. Indeed they are often over-adapted to the specific features of the catchment on which they were developed. Generalization is a major problem in current hydrological modelling (Sivakumar, 2008). This is potentially a major drawback for the application of such models to the case of ungauged catchments.
We argue that a better way to develop the structure of hydrological models following a downward approach is to place model development at the level of large set of catchments and not only at the level of a single catchment. This way of developing models will force them to be general, i.e. more transposable in space. They will capture the essential features of the rainfall-runoff transformation common between catchments. This way of developing models also gives the opportunity to analyse the spatial patterns of model failures, therefore providing more robust sources of explanations and more convincing ways to improve models. We do not believe that we could develop a single model that fit all conditions, but models developed with this approach are likely to be better starting points to get general models. Then we have to find ways to make them more appropriate to specific conditions without losing their generality.
We will illustrate the advantages (and possible limitations) of this approach using examples drawn from our past and current research activities based on large data sets. Surprisingly, the level of model complexity that could be achieved following this approach is quite low, which may indicate that the current understanding of the main features of hydrological catchment behaviour is not as good as many models may suggest (Michel et al., 2006).
We hope that this communication will stimulate discussion on this issue and encourage more hydrologists to work on large sets of catchments (Andréassian et al., 2006).

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