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The limits of splitting: a framework to test model spatial distribution

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When it comes to deciding of the necessary spatial representation of a catchment, hydrologists need to choose between spatially lumped and spatially distributed approaches. This decision is not trivial: on the one hand, lumped models have proved both efficient and robust over the years (moreover their relatively low number of parameters limits the numerical problems such as secondary optima, parameter interaction, poor sensitivity); on the other hand many hydrologists believe that distributed models could potentially have a greater ability to take into account the spatial heterogeneity of both rainfall and land surface. Few attempts have been made to test rigorously alternative distributed schemes (see the discussion of semi-lumped and semi-distributed alternatives in Andréassian et al. (2004)).

The purpose of our work was to identify whether an optimum level of spatialisation exists: to investigate "the limits of splitting" (Beven, 1996). We propose a framework to evaluate the effect of the distribution over a large set of 181 French catchments, using a newly available high resolution rainfall product of Météo France, combining radar data and raingage measurements. Five grid sizes are studied, as catchments are splitted into 1, 2, 4, 8 and 16 sub-catchments and streamflow simulation results are analysed in validation mode.

For each type of basin, we study the trend of model efficiency with the number of sub-catchments. We find paradoxical results: while some catchments clearly benefit from the distribution, others show opposite trends. The large variability between basins underlines the necessity to have enough case studies to reach a robust conclusion.

Andréassian, V. et al., 2004. Impact of spatial aggregation of inputs and parameters on the efficiency of rainfall-runoff models: a theoretical study using chimera watersheds. Water Resour. Res., 40(5): W05209, doi: 10.1029/2003WR002854.
Beven, K., 1996. The limits of splitting: hydrology. The Science of the Total Environment, 183: 89-97.