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Understanding what to account for and what to ignore in the design of distributed hydrological models

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Designing a distributed rainfall-runoff model requires many not obvious decisions, such as whether to include regional groundwater flow, whether to account for the spatial variability of topography, geology, soils and vegetation, and at which spatial resolution to resolve model inputs. Typically, the effect of such decisions is determined a posteriori, for example based on sensitivity analyses, with the disadvantage that if a decision is poorly made, it is necessary to restart the model development from the conceptualization stage, which is a time consuming process. We here show that a more effective strategy is to base such decisions on a preliminary analysis of the available data, hence by "looking at data first". In particular, similarly to what done in catchment classification studies, we start by identifying potential climatic and landscape controls on streamflow signatures. These insights are subsequently used to inform model decisions such as the ones above described. This approach is illustrated in the Thur catchment in Switzerland (1702 km^2), with 10 sub-catchments. The catchment shows a large variability in streamflow, climatic, and landscape characteristics. Results demonstrate that precipitation (quantity and type) is the main control of the water balance and of streamflow seasonality; geological features control the partition of the fluxes between baseflow and quick flow; other catchment characteristics are not of primary importance in determining streamflow variability. The present study, that conjugates some aspects of catchment classification with hydrological modelling, represents a step forward in understanding catchment dominant processes at the large scale and in designing a procedure for constructing distributed hydrological models with limited complexity.