Predicting catchment runoff: Trivial, challenging or impossible in principle?

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Modelling the rainfall runoff relationship of catchments at daily resolution usually requires not more than 2-3 parameters when calibration is allowed for any specific data set. The resulting models are purely empirical and do not provide options for a (unique) interpretation of internal runoff generating processes (e.g. flowpaths reconstruction). The smallest process-based hydrological models, however, supporting such interpretations typically involve 10-12 parameter, of which only some can independently be observed. This leaves hydrology in a dilemma when seeking predictions outside the range of past observations. Models which work best in practice are not those that have the highest scientific reputation. These difficulties are usually attributed to the complexity of ecosystems, the heterogeneity of flow regions, etc. Here we discuss an alternate option, in which this dilemma results from inappropriate abstractions within catchment models. We use information content and complexity measures of runoff time series and from artificially generated data sets to demonstrate that the encountered difficulties may be the result of the interactive nature of ecosystems rather than their apparent complexity.