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Impact of sample uncertainty of inflows to stochastic simulation of reservoirs

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Design and management of water resource systems are arguably challenging tasks, as they are mainly driven by hydrological processes that are dominated by “structured” randomness. In this vein, the stochastic simulation of the input processes is regarded an essential component for such studies. Typically, the objective of stochastic models is the generation of long synthetic time series that reproduce the statistical and dependence properties of the historical data, ideally at multiple time scales (including long-term changes, such as those induced by the Hurst-Kolmogorov behavior). However, the sample statistical characteristics that are forced to be reproduced entail an inherent uncertainty, due to the generally short length of historical data. This key shortcoming is not typically accounted for within the current practices. This work is an attempt to investigate and quantify the input uncertainty within stochastic models, and eventually assess its impact on reservoir systems. Towards this, we establish a methodology for the quantification of the sample uncertainty, involving the essential statistical characteristics of historical inflows in a multiscale context, by using as background stochastic simulator the CastaliaR model. Initially, this model is employed for the generation of a large set of synthetic time series with the same length with the historical sample, and thus provide multiple “pseudo-historic” realizations. Subsequently, the statistical properties of the ensemble of pseudo-historic data are extracted and employed to generate long synthetic time series, which are finally used as inputs to a reservoir simulation model. In this context, the above procedure is demonstrated for the derivation of ensembles of storage-yield-reliability relationships. Furthermore, multiple analyses for different sample sizes and Hurst coefficients are performed, aiming to investigate the uncertainty imposed by the sample size and the long-term persistence of the inflow processes.