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Analysis of landslide hydrology with a distributed process-based model: calibration strategies and multi-objective evaluation procedures.

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The objective of this study is to analyse the hydrology of an unstable slope by using a physically based spatially distributed model, incorporating Darcian saturated flow in the matrix, fissure flow and meltwater flow. The focus is more particularly to discuss the calibration strategy and the evaluation procedures used to test the performance of the model. The model is successively calibrated on one or a combination of groundwater level time series observed in different piezometric tubes located in contrasting hydro-geomorphomogical units of the landslide. It is demonstrated that calibration of the model on a single observed response (e.g., one piezometric tube) may lead to several possible combinations of parameter optimization, while a calibration on more than three observed responses lead to a single solution and thus to a better predictive capability of the model. The paper discusses the multiple fitting criteria used in the modelling exercise, and proposes a strategy for model calibration using a multiobjective method that allows to take into account the uncertainties inherent to the representation of the hydrological process, the observation errors and the parameter estimation. Moreover, the best fitted simulation indicates that the incorporation of an additional water flux is needed to represent the observed hydrology; this hydrological flux is also observed from a detailed hydrochemical survey of the site. The model and the calibration strategy are applied on the distributed groundwater and soil moisture times series acquired on the Super-Sauze mudslide in Southeast France.