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Automation of hydrological drought typology to study drought propagation in a tropical catchment

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Understanding different types of droughts and how they propagate through the hydrological cycle from precipitation, to streamflow and groundwater deficit, is important for improving water and risk management policies. Drought in the tropics is a recurrent phenomenon, but there is a lack of knowledge regarding drought severity and duration as well as the processes that cause different types of hydrological drought. At the catchment scale, the analysis of drought propagation is usually done manually. This can be time consuming (e.g. when dealing with long time series or many catchments) and may introduce subjective elements into the analysis that affect the comparability between catchments and studies. In this study, we develop a methodology to provide an automated, objective procedure for drought typology to study hydrological drought propagation in the tropics. We selected the Savegre catchment in Costa Rica as a proof-of-concept pilot study. The first step was to analyse if the types of hydrological drought affecting this catchment could be explained in terms of the process-based typology available in the literature: classical rainfall deficit drought, wet-to-dry season drought, and composite drought. Then, based on the manual typology, we defined different criteria for the hydrological drought types to make the typology automated and objective. Finally, we analysed drought propagation using a set of duration, timing and deficit indicators. We found that the process-based hydrological typology available in the literature is suitable to describe the different drought processes occurring in Savegre. The classification obtained with the automated typology was highly similar to the manual typology, with the exception of three events. We found that most of the detected droughts (80% and 76% from all river-discharge and base-flow droughts, respectively) were classical rainfall deficits droughts, which suggests that hydrological droughts in this catchment are highly climate dominated. However, the importance of catchment characteristics was revealed by the presence of highly severe composite drought events. Our results can potentially be applied to the wider tropics facilitating automatic drought classification using process-based selection criteria. Our study contributes to the overall knowledge of drought propagation in tropical catchments and is useful for supporting drought monitoring and forecasting, which is a much-needed tool for water and drought-related disaster management in the tropics.