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Conceptual modelling to predict groundwater flooding in Chalk regions

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Chalk aquifers represent an important source of drinking water in Europe. Due to their fractured-porous structure, Chalk aquifers are characterized by highly dynamic groundwater fluctuations that enhance the risk of groundwater flooding. The risk of groundwater flooding can be assessed by physically-based groundwater models. But for reliable results, a-priori information about the distribution of hydraulic conductivities and porosities is necessary, which is often not available. For that reason, conceptual simulation models are often used to predict groundwater behaviour. They commonly require calibration by historic observations of groundwater and discharge. Consequently, their prediction performance may reduce significantly, when it comes to system states that did not occur within the calibration time series. In this study, we calibrate a conceptual model to the observed groundwater level observations and discharge at a Chalk system in Southern England. During the calibration period, no groundwater flooding occurred. We then apply our model to predict the groundwater dynamics of the system at a time that includes a groundwater flooding event. We show that the calibrated model provides reasonable predictions before and after the flooding event but it over-estimates groundwater levels during the event. After modifying the model structure to include topographic information, the model is capable of prediction the groundwater flooding event even though groundwater flooding never occurred in the calibration period. Although straight forward, our approach shows how conceptual process-based models can be applied to predict system states and dynamics that did not occur in the calibration period. We believe such an approach can be transferred to similar cases, especially to regions where environmental changes are expected to alter groundwater dynamics but where also data is too scarce to apply physically-based groundwater models.