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Modelling the impact of land use change on drinking water supply in a karstic system

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Hydrological models are valuable and commonly used tools to investigate the impacts of land use changes on water resources. Most commonly, distributed, physically-based models are applied for land use change impact studies in hydrology. However, providing a physically-based and detailed description of subsurface flows in karst systems is challenging. Lumped models, in contrast, are easy to implement and widely used in karst hydrological research, albeit not applicable for land use change impact studies. To overcome these limitations, we developed a new semi-distributed model that lumps the predominant hydrotopes (i.e. areas characterized by homogeneous hydrophysical properties such as land use and soil type) present in a catchment as stand-alone units. From our conceptual perspective, each hydrotope represents a specific response of the vadose zone in the catchment and it is modelled as a non-linear storage. The saturated zone consists of a single linear storage unit recharged by each hydrotope independently. The main goal of this approach was to investigate land use change impacts by changing the area covered by each hydrotope. We validated our model for the area of Waidhofen a.d. Ybbs (Austria), a dolomite karst system used for municipal water supply. This pre-alpine catchment, located in the south of the city of Waidhofen a.d. Ybbs, is mostly forested and it is affected by land use change in the form of increasing area used for mining activities. Such land use change was suspected to have an effect on water resources availability for the municipality. The model was able i) to reproduce the discharge observed in the largest spring of the Waidhofen karst system during the period 2006-2013, in which the area of the stone quarries almost doubled and ii) to reproduce the discharge observed in two smaller springs with different catchment areas and not affected by land use change, while maintaining the parameterization of the hydrotopes storage parameters. Our modelling approach represents a promising framework for land use change impact studies on water resources in karstic environments.