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Simulated Mountain Block Hydrology's Sensitivity to Subsurface

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Editorial

Mountain block systems are important for water supplies, and they've been studied and modelled extensively in recent decades. Due to a lack of field evidence, however, there is little clarity about how models reflect the subsurface of mountain blocks. Although there is a lot of research on subsurface heterogeneity, few studies have looked at the impact of modelers' typical conceptual choices in mountainous systems on simulated hydrology. We use six typical conceptual models of the mountain block subsurface to simulate the hydrology of a semi idealized headwater catchment. Multiple representations of hydraulic conductivity decaying with depth, changes in soil depth with topography, and anisotropy are included in these scenarios. To measure the effect of subsurface conceptualization on hydrologic activity in three dimensions, we analyse flow paths, discharge, and water tables. For most of the world's population, mountain regions are vital water sources, and understanding headwater hydrology is crucial for forecasting the impact of human activity and climate change on these resources. Because of their geologic complexity, mountain systems vary from other forms of watersheds, restricting our ability to apply lessons learned in other ecosystems to mountainous watersheds. Runoff and infiltration processes in the mountain block are influenced by thinly layered soils, steep topography, and complex folded and faulted geology, which drives the storage-discharge activity of these systems in specific ways.

Accessible observations constrain our existing conceptual models of mountain hydrogeology. Field measurements with adequate spatial and temporal resolution to help watershed scale subsurface characterization are difficult to come by. Drilling into the mountain block to collect subsurface data can be costly, and the hydrologic properties that hydrogeologists must infer and extrapolate from geologic measurements can be speculative. Because of these drawbacks, computer models are often used to investigate mountain groundwater hydrology. Early studies on regional groundwater systems helped to shape our current understanding of mountain groundwater systems. The effects of topography on groundwater table configuration were investigated in some of the first regional groundwater models, which assumed the water table's shape in advance. Within a regional groundwater system, he demonstrated the presence of nested flow paths, which he classified as local, intermediate, and regional flow paths. Shallow flank slopes, negligible longitudinal flow (justifying the use of a two-dimensional domain), an isotropic, heterogeneous subsurface, and, most importantly, that the water table was a subdued replica of topography were all assumptions he made in his numerical experiments. Tooth’s nested flow path model remains the basis for many of our groundwater conceptualizations today, despite the somewhat simplistic nature of his theoretical research. Hydrogeologists have since investigated the drivers of regional groundwater flow, building on Tóth's pioneering work. Many of Tóth's assumptions were relaxed, including the form of the water table, the thickness of the active aquifer, and topographic variability.

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