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Filling, storing and draining. Three key aspects of landslide hydrology

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Rainfall-triggered landslides are among the most widespread hazards in the world. The hydrology in and around a landslide area is key to pore pressure build-up in the soil skeleton which reduces shear strength due to the buoyancy force exerted by water in a saturated soil and to soil suction in an unsaturated soil. Extraordinary precipitation events trigger most of the landslides, but, at the same time, the vast majority of slopes do not fail. The intriguing question is: 'When and where exactly can a slope become triggered to slide and flow downwards?' The objective of this article is to present and discuss landslide hydrology at three scales—pore, hillslope, and catchment— which, taken together, give an overview of this interdisciplinary science. In fact, for rainfall-triggered landslides to occur, an unfavourable hydrological interplay should exist between fast and/or prolonged infiltration, and a relatively 'slow' drainage. The competition of water storage, pressure build-up and the subsequently induced drainage contains the importance of the timing, which is indisputably one of the more delicate but relevant aspects of landslide modelling, the overlay of hydrological processes with different time scales. As slopes generally remain stable, we can argue that effective drainage mechanisms spontaneously develop, as the best for a slope to stay stable is getting rid of the overload of water (above field capacity), either vertically or laterally. So, landslide hydrology could be framed as 'Filling-Storing-Draining'. Obviously, 'Storing' is added to stress the importance of dynamic pressure build-up for slope stability. 'Draining' includes all removal of water from the system (vertical and lateral flow, evaporation and transpiration) and thus pore water pressure release.
Furthermore, by addressing landslide hydrology from both earth sciences and soil mechanics perspectives, we aim to manifest the hydrological processes in hillslopes and their influence on behaviour and triggering of landslides and vice versa. The challenge of landslide hydrological research is matching, at hillslope scale, causal hydrological processes, often conceptually described, with detailed physical models of triggering mechanisms. Interdisciplinarity is key in advancing our knowledge on water flows in (un)stable slopes.