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Subsurface storm flow - the crucial role of interaction

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The intensity of subsurface storm flow is affected by site characteristics, initial soil water content and precipitation characteristics. This interdependency of temporally and spatially variable factors is not yet fully understood. However, a better understanding of the influence and relevance of each particular factor would help to assess subsurface flow intensities and to model subsurface flow more reliably.

To this purpose, sprinkling experiments were made and natural rainfall events were monitored on hill slopes in four different catchments in Switzerland. Highly resolved measurements of soil moisture and soil suction, surface runoff and subsurface runoff were made. Event and pre-event water fractions were determined in the different flow components using artificially traced sprinkling water and 222Rn as natural tracer. Instantaneous tracer injections during steady state conditions were used to estimate flow velocities.

The subsurface flow intensity varied substantially on the different hill slopes depending on how the flow was fed. When the soil characteristics favoured a low degree of interaction between preferential flow and the soil matrix, subsurface flow was fed directly from precipitation by bypass flow resulting in a quick subsurface flow response. In contrast, when high interaction occurred, subsurface flow was fed indirectly from saturated parts of the soil and the intensity was much lower. The fraction of pre-event water in subsurface flow responded extremely sensitive to the rate of direct or indirect feeding of lateral preferential flow. Fast subsurface flow in the soil consists therefore of event water flowing through preferential flow paths and of pre-event water mobilised in saturated zones in the soil matrix. The extent of these saturated zones and the degree of interaction between the saturated soil matrix and preferential flow paths determine the amount of pre-event water in the subsurface flow as well as the intensity of the flow.