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Application of a fully integrated surface-subsurface physically based flow model for evaluating groundwater recharge from a flash flood event

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In many arid regions around the world groundwater recharge occurs during flash floods. This transient spatially and temporally concentrated flood-recharge process takes place through the variably saturated zone between surface and usually the deep groundwater table. These flood events are characterized by rapid and extreme changes in surface flow depth and velocity and soil moisture conditions. Infiltration rates change over time controlled by the hydraulic gradients and the unsaturated hydraulic conductivity at the surface-subsurface interface. Today is a challenge to assess the spatial and temporal distribution of groundwater recharge from flash flood events under real field conditions at different scales in arid areas.

We apply an integrated surface-subsurface variably saturated physically-based flow model at the watershed scale to assess the recharge process during and after a flash flood event registered in an arid fluvial valley in Northern Chile. We are able to reproduce reasonably well observed groundwater levels and surface flow discharges during and after the flood with a calibrated model. We also investigate the magnitude and spatio-temporal distribution of recharge and the response of the system to variations of different surface and subsurface parameters, initial soil moisture content and groundwater table depths and surface flow conditions. We demonstrate how an integrated physically based model allows the exploration of different spatial and temporal system states, and that the analysis of the results of the simulations help us to improve our understanding of the recharge processes in similar type of systems that are common to many arid areas around the world.