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Realistic prediction of infiltration-excess overland flow occurrence under contrasting land cover conditions in the Nepalese Middle Hills

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Abstract:
Rainfall partitioning into infiltration-excess overland flow (IOF) and water infiltrating into the soil to sustain vegetation and groundwater recharge is a key ecohydrological process. A widely used approach to predict IOF occurrence as a function of land cover involves comparing top-soil saturated hydraulic conductivities (K_{sat}) and rainfall intensities of specific recurrence intervals. Comparisons against measured IOF are rare, however, while infiltration tests involving ponding may overestimate actual infiltration. This contribution presents data on rainfall intensity, surface- and sub-soil K_{sat} (disk permeameter and constant-head well permeameter, resp.), wet-season soil moisture levels as well as measured (75 m^2 plots) and modelled IOF (Spatially Variable Infiltration model, SVIM) for a highly degraded pasture (DP) and a natural mixed broad-leaved forest (NF) in the Middle Hills of Central Nepal. About 80% of annual rainfall occurs within the four- month monsoon rendering soil water retention key to hillslope hydrological functioning and maintenance of springs and rain-fed river discharges. Median surface K_{sat} in the DP and NF were 18 and 232 mm h^{-1}, respectively, vs. 39 and 82 mm h^{-1} for the 0.05–0.15 m layer. The upper quartile and 95% percentile of the maximum 5-min rainfall intensity (I_{5max}) were 43 and 72 mm h^{-1}, respectively. Wet-season IOF was 187 mm (21.3% of *P*) in the DP vs. 18 mm (2.5% of *P,* 3.3% of throughfall) in the NF even though surface K_{sat} in the forest exceeded I_{5max} at all times. Inserting measured IOF and rainfall intensity data in the SVIM model gave plot-scale weighted average surface K_{sat} values of 10 and 119 mm h^{-1} for the DP and NF, respectively, implying a reduction of 45–49% relative to infiltrometer-based values. Actual K_{sat} during the rainy season thus seems reduced compared to test results during the dry season. To also examine the possibility of saturation-excess overland flow (SOF) occurrence in the NF, soil water dynamics in the top 15 cm layer were considered. Peak volumetric moisture contents in the NF remained constant at high values (up to 43%) close to soil porosity (i.e. saturation) values (45.3 ± 3.4%) during periods with prolonged rainfall suggesting occasional SOF at the height of the rainy season is a distinct possibility.

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