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Impacts of rainfall features and antecedent soil moisture on occurrence of preferential flow: A study at hillslopes using high-frequency monitoring

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In order to evaluate influences of rainfall features and antecedent soil moisture on occurrence of preferential flow, a more than 2 years observation was conducted at 12 sites within a 7-km^2 catchment, by applying the high-frequency monitoring approach. Totally 65 rainfall events were selected to compare among sites, and preferential flow was inferred when (i) responses of soil moisture did not follow a linear sequence with depth, and (ii) penetration velocity of wetting front in at least one horizon exceeded the threshold, which was set to be 5-10 times of the saturated hydraulic conductivity of soil matrix at different depths. Results showed that frequency of preferential flow was 40.7% in average, but varied from 17.9% to 74.3% among the sites. Correlations between the frequency and rainfall features, i.e. rainfall amount, duration, maximum and average intensity, were well fitted by logarithmic curves. Rainfall amount, which was most prominently correlated with frequency (R^2=0.93), was regarded as the dominant driving factor of preferential flow, while average intensity was in second (R^2=0.90). Antecedent soil moisture was also significantly correlated with the frequency. However, this should largely be attributed to the differences of soil moisture among sites, since varying range of soil moisture at a specific site was not wide enough to influence the frequency significantly. Further examination suggested that topography and surface cover (dead leaves and humus) were the controlling factors of both infiltration amount and occurrence of preferential flow, as water was more readily to infiltrate into soils and preferential flow was more readily to occur when slope gradient was small and surface cover was thick, while soil moisture was more likely to be a consequence of water storage capacity, rather than an inducer of preferential flow. This knowledge could be helpful in understanding the partitioning of surface runoff and infiltration, as well as runoff processes in catchments with complex topography and underlying conditions.