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# Analysis of scale effect of surface runoff on steep forested hillslopes

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Scale effect of surface runoff, by which surface runoff per unit area (i.e., runoff coefficient) decreases as slope length increases, has been demonstrated in gentle slopes of agricultural lands and grasslands. This study aimed to examine the scale effect of surface runoff and its mechanisms on steep forested hillslopes with slope gradient ranging from 35 to 43°. We conducted (1) monitoring surface runoff at small and large plots (2 and 20 m in slope lengths, respectively) for 19 months; (2) in-situ artificial rainfall experiments for different slope lengths (0.5 – 5 m); and (3) a dye tracer experiment for examining runoff and infiltration processes. Surface runoff per unit width in the large plot was at the same level as the surface runoff estimated for the small plots, considering spatial distribution of throughfall. As a result, runoff coefficient in the large plot was ten times smaller than ones in the small plot under typical rainfall. However, under high rainfall intensity ($> 5$ mm 5min$^{-1}$) the large plot produced 2.5 times greater surface runoff per unit width than the small plots. Results of the artificial rainfall experiment showed that surface runoff per unit width increased as the slope from 0.5 to 2 m in length and remained constant on slopes longer than 2 m under 4 mm 5min$^{-1}$rainfall. However, in the case of heavy rainfall (12 mm 5min$^{-1}$), the surface runoff per unit width increased as the slope length increased. The dye tracer experiment revealed that infiltration occurred preferentially when run-on length exceeded 1 m. Our findings suggest that (1) certain height of water depth need to be developed for initiating vertical infiltration; and (2) the relationship between the water depth of surface runoff and an equilibrium depth, at which the infiltration amount

becomes equal to the rainfall intensity, along the hillslope plays an important role in surface runoff and run-on infiltration processes; surface runoff per unit width increases as run-on length increases and finally becomes constant when the water depth attains the equilibrium depth.