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Variability of surface runoff and infiltration rate under a tree canopy: indoor rainfall experiment using a stand of Japanese cypress

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To estimate the variability of surface runoff generation and infiltration rate at a bare surface in a forested area, indoor experiments were conducted using 13 runoff boxes and a single transplanted Japanese cypress tree 9.8 m in height in a large-scale rainfall simulator with spray nozzles at a height of 16 m. Surface runoff was measured for throughfall and for rainfall applied at different rainfall rates and kinetic energies among measurement points and canopy structures. While no surface runoff was observed for the applied rainfall, surface runoff was observed for throughfall in each runoff box. The drop size of throughfall was larger due to canopy drip generation and thus had higher kinetic energy, which decreased the infiltration capacity. The maximum stable infiltration rate (IR_{MAX}) was lowest for throughfall (46 mm h^{-1}). Surface runoff generation and infiltration rates varied greatly under the canopy, even though the rainfall applications were identical and the runoff boxes had identical initial soil properties. The variability of IR_{MAX}, ranging from 46–105 mm h^{-1}, was caused by the variabilities of the rainfall rate and kinetic energy. The rainfall index with the best correlation to IR_{MAX} was the effective unit kinetic energy ($KE_{0.mm}$: J m^{-2} mm^{-1}). Prediction of surface runoff generation in a forested area requires estimations of the spatial variations of the amount and kinetic energy of throughfall.