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Quantifying Water Infiltration through the Preferential Passages in the Forest Soil

Liqin Qu (1), Ping Chen (2), Ping Gan (1), and Tingwu Lei (2)

(1) China Institute of Water Resources and Hydropower Research, International Research and Training Center on Erosion and Sedimentation, Beijing, China (liqin.qu@iwhr.com), (2) College of Water Resources and Civil Engineering, China Agricultural Univerity Beijing 100083

Infiltration of water into soil commonly involves infiltration through the matrix body and preferential passages. Quantifying the contribution of preferential flow is important to evaluate the effects of land use and land cover changes on hillslope hydrology and watershed sedimentation. A new procedure was applied in this study to estimate the water infiltration into the soil through the soil body and macrospores. Field experiments were conducted in a forest field on the Loess Plateau at Tianshui Soil and Water Conservation Experimental Station, Gansu Province, China. The experiment implements a double-ring infiltrometer and involves two measuring phases. Firstly, a thin layer sieved soil collected on site was sprinkled on the nylon cloth to shelter the macrospores and to ensure that water infiltrates the soil through the matrix only. The infiltration process was measured, computed, and recorded. Secondly, immediately after the first phase, the nylon cloth and layered soil above the soil surface was removed from the double ring infiltrometer carefully, and the infiltration process was measured for 30 mins in which water infiltration through both soil body impacted by the preferential passages in the soil body. There were three treatments according to the measured infiltration periods in the first phase of 30, 60, 90 mins, respectively, and two replicates for each treatment were conducted. The measured soil infiltration curves in the first phase explained the transient process of soil matrix infiltration well. The measured date were fitted by Kostiako models fitted measured data well with all coefficients of determination greater than 0.9. The constant infiltration rates from the second phase were at least 2 times larger than the estimates from the first phase. In other words, the results indicated that more than 60% of water infiltration was through the preferential passages in the forest soil. The result also shows that durations in the first phase affect the trends of the infiltration curve in the second phase. The result from this study is helpful to understand the mechanism of hydrological response to different land covers.