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Temporal stability of the infiltration pattern and the role of soil hydrophobicity

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For a period of three years, soil moisture distribution was monitored within a 50 cm $\times$ 50 cm transect on a forested hill-slope (Fudoji experimental watershed of Kyoto University, Japan). The aim of the study was to assess temporal stability/variability of the infiltration process under natural conditions. Initial analysis of the data revealed changes of the infiltration pattern in the region close to the soil surface that appeared influenced not only by the initial moisture conditions but also by the history of wetting. Therefore, soil hydrophobicity measurements were conducted to test the extent of that phenomenon and its possible effect on the infiltration process.

Soil moisture was monitored using 25 probes (CS615 Water Content Reflectometer, Campbell Scientific, Inc.) arranged in a 5$\times$5 matrix spaced by 10 cm. The readings were collected in 5-minute intervals. To facilitate installation, the probes were shortened to the 10-cm length. Case specific calibration curves between the probe reading and the soil volumetric water content were determined after the end of the monitoring.

During the three years of monitoring, very dry conditions were observed in summer 2002. As the soil became extremely dry, the pattern of the moisture increase during infiltration became distinctly different than the pattern observed before the dry period; instead of retaining water from precipitation, the top layer resisted wetting, the water entered the soil profile along separate pathways, bypassing large portion of the upper profile, which stayed relatively dry long after the moisture content of the deeper parts of the profile returned to the original level. This “bypass” pattern persisted until March 2003, after which the behaviour observed before the dry period re-established.

To asses the hydrophobicity of the soil, the Water Drop Penetration Time test (WDPT) was used. The test was applied to both, the naturally moist and the air-dried soil. Soil

samples were taken in three layers within the top 18 cm of the soil profile (5 samples in each layer). Testing was repeated 10 times between spring 2003 and summer 2004. Generally, the results show a decrease of hydrophobicity between spring and autumn 2003 and then an increase between spring and summer 2004. It is possible that the hydrophobicity observed in spring 2003 was established during the dry summer 2002, persisted to a large extent untill the spring 2003 and then gradually deteriorated throughout the year 2003, during which no severely dry period was observed.

The distinct infiltration pattern change was detected after dry summer 2002; the pattern, characterized by bypassing of the upper layer, persisted throughout the following half a year. The soil hydrophobicity measurements, started in spring 2003, showed that the soil hydrophobicity changes gradually in time and can potentially become severe, particularly in the surface layer of the soil profile. It is possible that the detected "bypass" infiltration pattern was related to the hydrophobic conditions in the upper soil layer, as the soil hydrophobicity is known to be initiated by dry and hot conditions.

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