P067 Infiltration process in heterogeneous forest soil – long-term TDR monitoring

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Soil moisture distribution within a 50 cm × 50 cm transect of soil on a forested hill slope has been monitored over last 2 years. The aim of the study is to assess temporal stability/variability of the infiltration process under natural conditions. The results show changes of the infiltration pattern in the region close to the soil surface, whereas the position of the preferred flow path at the bottom of the monitored transect appears stable.

1. Site characteristics

The site is located in Fudoji watershed in southern part of Shiga prefecture (experimental site of the Kyoto University Department of Forest Science). The slope is forested by Hinoki (Japanese cypress), Sugi (Japanese Cedar), and Konara (Oak). The monitored transect is situated on a hilslope of about 35º slope, perpendicular to the slope, about 20 m from the top. The depth of the brown forest soil is approx. 75 cm.

2. Monitoring and data specifications

The transect was instrumented with 25 soil-moisture TDR probes (CS615 Water Content Reflectometer, Campbell Scientific, Inc.) arranged in a 5×5 matrix with 10-cm separation distance. The probes are connected to a datalogger (CR10, Campbell Scientific, Inc.), and the readings are collected in 5-minute intervals. The probes were installed at the end of year 2000. Data collected during years 2001 and 2002 were analysed.

The original probes were shortened to 10 cm to facilitate installation. Therefore, the calibration provided by manufacturer is not applicable. Moreover, in a preceding laboratory study, soil-layer specific calibration curves were found for the TDR probes employed and the soil from the same location. However, that calibration was conducted for the probe being inserted through a 1-cm acrylic wall, and thus it is not valid for the in-situ measurement. Therefore, the raw TDR data have been processed. As for those, an increase or decrease of the TDR-output value signals an increase or decrease of the soil water content, respectively. However, considering the results of the laboratory calibration, the relative difference between read-out from different probes can not be interpreted as a difference in water content.

3. Long-term soil-moisture variations

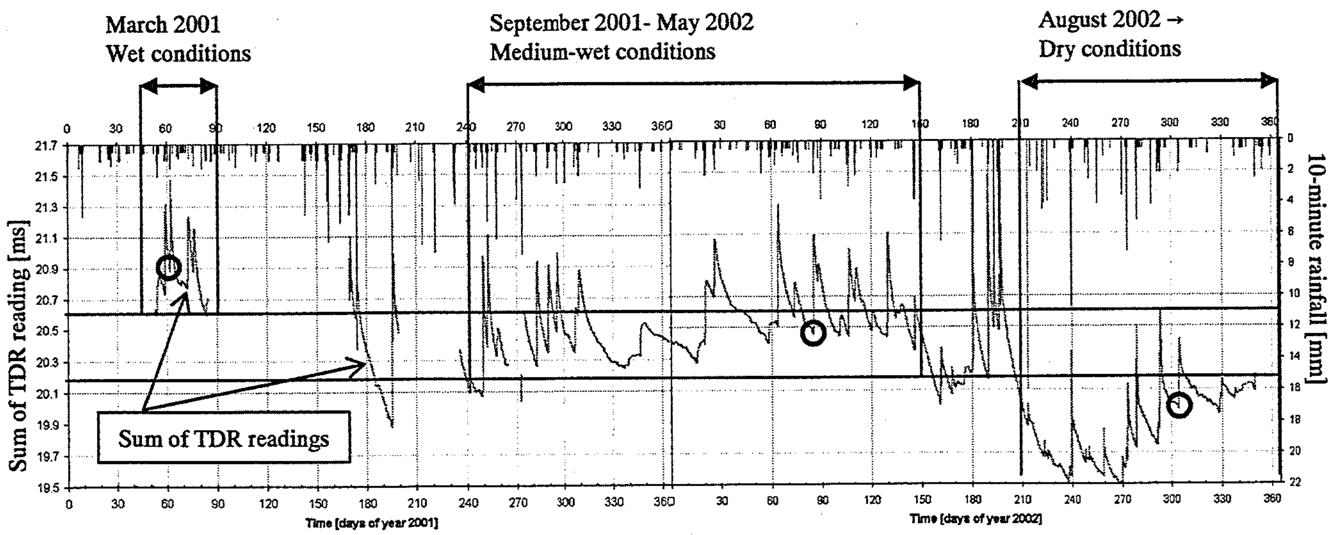

Figure 1. Time development of the total sum of the reading from all 25 TDR probes (represents changes of the transect total water content). The circles mark infiltration events presented in Figure 2.

Gradual change of the prevailing soil-moisture conditions was detected over the 2 years of monitoring. In Figure 1, temporal development of the sum of the readings of all 25 TDR probes is presented (the value is related to the water content of the whole transect). Separate peaks represent the soil response to rain events. Considering moisture conditions prior to each rain event, three distinct periods were identified. The first period, in spring 2001, is characterised by high moisture content. During the second period, between September 2001 and May 2002, the prevailing moisture content varied within an intermediate range. The soil profile became even more dry during the summer 2002, and thus during the third period after August 2002 driest conditions prevailed, while the soil moisture content was gradually increasing.

4. Typical infiltration patterns observed for the three different moisture conditions

Figure 2 shows three infiltration patterns, each typical for one of the distinct moisture-condition periods introduced in Figure 1. The presented plots are interpolated images either of the actual TDR readings (two columns on the left showing the initial conditions and the peak of the total TDR reading) or of the TDR readings change relative to the initial conditions (difference between the readings at a selected time along the infiltration and the readings before the infiltration started). Thus the rightmost plots show difference between the plots in the second and first columns.

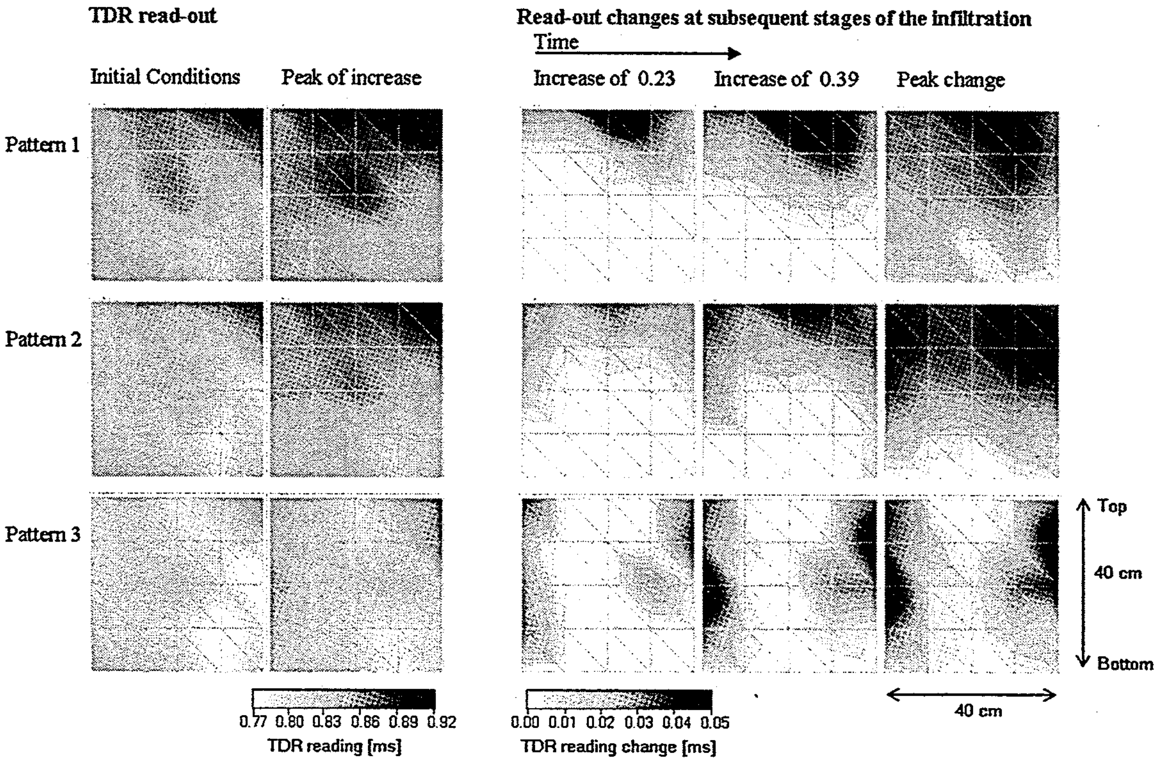

Figure 2. Infiltration patterns characteristic for the three distinct period of different moisture conditions.

The difference between Pattern 1 and Pattern 2 is pronounced mainly during the initial stages of infiltration, when the moisture changes in Pattern 1 are more limited to the central part of the transect, whereas in Pattern 2 the changes along the sides become more important. Distinctly different is Pattern 3, in which the central part of the transect remains dry. The position of most intensive moisture changes at the bottom of the transect did not change significantly; under any initial conditions, the left side of the transect appeared a preferred pathway for water transport to deeper layers. Moreover, during heavy rainstorms in summer periods, the moisture changes in the bottom layer were limited to the left side of the transect (results are not presented here).

5. Conclusions

The infiltration pattern is influenced not only by the initial moisture conditions but also by the history of wetting. The response of the uppermost layer appears crucial for the development of the profile wetting. It is hypothesized, that hydrophobicity of the soil and its changes due to temperature, wetting, and vegetation may be the governing factor of the infiltration pattern changes observed.