Non-linear scaling characteristics of solute transport in a small catchment

PERNILLA ÖHRSTRÖM[1], JONAS OLSSON[1], JEAN ALBERGEL[2], PATRICK ZANTE[2], SLAH NASRI[3], MAGNUS PERSSON[1], RONNY BERNDTSSON[1]

ABSTRACT

Growing concern about water resources has increased the importance of understanding solute transport in soils. It has been known for a long time that the heterogeneity of soil properties influence solutes to take preferential pathways. Field investigations regarding preferential flow were conducted in the catchment M'Richet el Anze within the EU cooperation HYDROMED to reveal consequences of this phenomenon. A 20-year rainstorm was simulated using a rainfall simulator and water mixed with dye. Vertical sections of 2.5-cm thickness were excavated and photographed. Image analysis and statistical results showed that different physiographical areas (nose, slope, and hollow) of the catchment displayed significantly different response to the infiltrating dye. Nose and hollow areas exhibited largest susceptibility to preferential flow. Here, infiltrated dye was transported to the greatest depths. Slope showed a more even horizontal dye distribution with less deep cracks and fissures.

The infiltration data from the image analysis have been used for analyzing scaling properties by studying power spectrum and statistical moments. Preliminary results based on 5% of the available data show that the dataset exhibits scale invariance. The power law behavior suggests that the spectral component is in the range 0.98 to 1.3. Power spectrum analyses performed by Harris et al (1996) on rainfall data resulted in a range 0.95 to 1.68 of the spectral component. The analyses of statistical moments imply that nose and hollow exhibits scale invariance within a micro and a macro scale. The micro scale ranges from below 2 cm and the macro scale from 2 cm and above. The slope seems to be scale invariant over the whole range.

1. Department of Water Resources Engineering, Lund University, Box 118, S-221 00 Lund, Sweden
2. IRD, Mission IRD, BP 434, 1004 Tunis el Menzah, Tunisia
3. INGREF, B.P. 10, 2080 Ariana, Tunis, Tunisia