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Anisotropy of permeability and its effect on the water movement in hillslopes

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Modelling the water movement in soils normally assumes that the water conductivity presents an isotropic behaviour, in spite of the fact that several authors demonstrated an anisotropy in hydraulic conductivity (Zaslavsky and Rogowsky, 1969; Mualem, 1984; Hartge, 1984; Dabney et al, 1987; Tigges, 2000; Ursino, 2001). The anisotropic behaviour of soils depends on the scale (Mualem, 1984). Some authors (Zaslavsky and Rogowky, 1969; Mualem, 1984) mentioned that soils consisting of fine layers parallel to the surface, like the stratified soils, have a horizontal component of the saturated water conductivity (ksh) higher than its vertical component (ksv). In this case the complete soil behaves anisotropically. Single soil horizons present also anisotropy (Childs et al, 1957; Hartge, 1984; Dabney et al, 1987; Tigges, 2000). At this scale, anisotropy is due to soil structure, which may be laminar, platy, or columnar, thus presenting a pattern of pores with a distinct directional bias (Hillel, 1998). Hartge und Horn (1991) mentioned as well, that soils present anisotropy due to the dependency between conductivity and the form and continuity of the pore passages. Therefore the aim of this work is to show some results about anisotropy of permeability and the effect of the anisotropy of the saturated water conductivity in plough layers on the water movement in a hillslope in northern Germany.

The development of the matrix potential in three sites (S1, S2, S3) of one soil catena (Catena II) in Ritzerau (Schleswig Holstein, Germany) was measured with tensiometers in different depths. Undisturbed soil samples were taken at angles of 0°, 45° and 90° from the different horizons from S1, S2 and S3. The soil is a Stagnic Luvisol in S1 and S2 and Cumulic Anthrosol in S3. The water retention curve, saturated water conductivity, air permeability and shear strength parameters were measured. Continuity factors proposed by Ball (1988) to describe the geometry of the pore system were

determined.

The parameters of van Genuchten were determined for each soil horizon with RETC v 6.0 (van Genuchten et al, 1991). The two dimensional water movement was modelled with Hydrus 2D (Simunek, et al, 2003). The Anisotropy of the saturated water conductivity was considered in the model, and the matrix potential data were used to estimate the goodness of the fitting.

The results shows that the water conductivity and air permeability present anisotropy, which are related to the continuity of the pores. The parallel orientation of soil aggregates (i.e. platy structure in the plough pan) leads to a higher continuity in the horizontal direction. The blocked porosity plays also a role in the anisotropy of the air permeability. Due to the anisotropy of the saturated water conductivity the hydraulic gradient and water flow are not parallel, which leads to a deviation of the water movement in the direction of the higher water conductivity, and consequently, parallel flow along the hillslope took place.

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