Geophysical Research Abstracts, Vol. 8, 10361, 2006
SRef-ID: 1607-7962/gra/EGU06-A-10361

Hydraulic characterisation of soil surface crusts by pore image analysis

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Use of saline water for irrigation is a widely diffused practice in the whole Mediterranean area and crust formation on soil surface is an unavoidable consequence which affects more or less negatively many agricultural systems in such area. Crust-like soil structure is very difficult to be characterized with only hydrological approach. This is mainly related to i) the size and shape of the crust samples which do not fit well with lab methods and ii) the expected anisotropy in the horizon after the crusting which generates a lot of uncertainties in hydraulic properties measurements. In order to find relationships between pore geometry and unsaturated water conductivity, field measurement on plots irrigated with saline and plain water were carried out in a Vertic Xerochrept soil from South Italy by means of a disk tension infiltrometer. After the measurements, first 15 cm of undisturbed soil under the disk and 2 cm thick isolated crusts have been sampled for pore image analysis. New image analysis procedures, based on mathematical morphology algorithms, have allowed a detailed quantitative description of the soil pore space in terms of both shape and size distribution at a pixel resolution of 10 microns. The pore-size distribution of the 15 cm thick samples has been used to calculate the unsaturated hydraulic conductivity applying a series-parallel model based on water flow through capillary tubes (Childs and Collis-George model-type) where the power factor encompassing the effects of pores shape and tortuosity has been calibrated on the k(h) measured curve. Once calibrated, the computational model has then been applied on the pore size distribution obtained from the soil crusts. The segmentation of the sample, because of the crusting in two distinct horizontal layers (the crusted and the original), produced two very dissimilar k(h). The different behaviour has been confirmed also in terms of sorptivity which was measured on the

crusts by a lab device and on the uncrusted soil by the tension infiltrometer data in the field. The quantitative analyses performed on soil microfabrics combined with soil the hydrology measurements have showed to be very useful i) to interpret the physical behaviour of soil surface crusts allowing partial reformulation of the current reference models and ii) to give more reliability to otherwise uncertain field measurement results.