Geophysical Research Abstracts
Vol. 14, EGU2012-14044, 2012
EGU General Assembly 2012

Evolution of the poral structure of a constructed Technosol during its early pedogenesis

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Soil structure, through the architecture of soil pore system, influences water infiltration and retention, hence the preservation of groundwater resources and the development of a sustainable vegetation cover. Our study confronts two distinct approaches to quantify soil macroporosity in order to evaluate the capacity of a constructed Technosol to meet its buffering/filtering function as well as “natural” soils.

An in situ 1 hectare plot of constructed Technosol was set up in 2007 on the experimental station of the French Scientific Interest Group - Industrial Wasteland, in Homécourt, North-Eastern France. This station was divided in 24 plots of 20m x 20m (Program Biotechnosol-Gessol). In situ soil samples were collected in Kubiena boxes in 2008 and 2010 in each plot and impregnated under vacuum with a polyester resin for thin section preparation. Soil macroporosity (pore diameter>25μm) was directly quantified by analyzing thin sections images prepared on undisturbed soil. Pores were classified according to their diameter (five classes: >2000μm, 500-2000μm; 200-500μm; 50-200μm; 25-50μm) and their shape (three classes: channels, cracks, packing voids). Channels, cracks and packing voids are respectively pores with a shape factor larger than 10; between 5 and 10; smaller than 5. Seven parameters were calculated for each pore diameter/shape class: number, area, Crofton perimeter, distance, volume, eccentricity, connectivity and shape/diameter. The macroporosity (percentage of voids surface) slightly decreased from 2008 (21.0% $\pm$ 9.2) to 2010 (15.2% $\pm$ 5.3%). However, there was in both cases a prevalence of channels and capillary pores (pore diameter between 25 and 200μm). These voids were more homogeneously distributed in the soil, compared to gravitational ones (pore diameter larger than 200μm). Soil pits were opened and undisturbed 250 cm3 soil-cores were sampled for hydraulic property measurements. Physical parameters were analyzed including bulk density, solid density (helium pycnometer) and total porosity. Complementary, saturated hydraulic conductivity was measured using the constant head method and water retention data were determined using the drying method on a pressure plate apparatus. In 2010, the total porosity - estimated with bulk and solid densities - was 63.1% $\pm$ 9.2%. Within that poral system, 25.1% corresponded to pores below the permanent wilting point, 22.8% was considered as available water for plant and 15.2% as macropores. The porosity parameters (area, shape, and connectivity) and the hydraulic properties (saturated hydraulic conductivity Ksat) were related taking into account the huge spatial variations of this last parameter. There is a very strong correlation between the proportions of macroporosity determined by the two methods. The great proportion of capillary pores denotes that this Technosol has a very high water retention capacity. The outlooks of this work suggest that, through soil construction, pedological engineering brings solution for water management. Applications could be developed in water stressed areas such as derelict lands in urban and industrial areas or under dry climates. Further developments could even lead to an alternative way to mitigate the adverse effects of climate change by an adapted management of soil and waste resources.