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Changes of pore systems and infiltration analysis in two degraded soils after rock fragment addition

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Many soils in arid and semi-arid environments contain high amounts of rock fragments as a result of both natural soil forming processes and human activities. The amount, dimension and shape of rock fragment strongly influence soil structure development and therefore many soil processes (e.g. infiltration, water storage, solute transport, etc.).
The aim of this work was to test the effects on both infiltration process and soil pore formation following an addition of rock fragments.
The test was performed on two different soils: a clayey soil (Alfisol) and a clay loamy soil (Entisol) showing both a natural compact structure and water stagnation problems in field.
Three concentrations of 4-8mm rock fragments (15%, 25% and 35%) were added to air-dried soils and the repacked samples have been subject to nine wet/dry cycles in order to induce soil structure formation and its stabilization.
The process of infiltration was monitored at -12 cm of pressure heads imposed at the soil surface and kept constant for a certain time by a tension infiltrometer. Moreover, k(h) was determined imposing -9, -6,-3 and -1 cm at soil surface and applying a steady-state solution.
After the hydrological measurements the soil samples were resin-impregnated and images of vertical sections of the samples, acquired at 20μm resolution, were analyzed in order to quantify the pore size distribution. This latter was calculated using the "successive opening" approach.
The Entisol samples showed similar infiltration curves I(t) among the 4 treatments, with higher percentage of stones (i.e. 25 and 35%) showing a faster rising in the early-time (< 2 min) infiltration; the Alfisol samples are spread, showing a higher variability: limiting the analysis to the first three, despite they show a similar shape, the higher the stones content the lower the cumulated infiltration. The behavior of the 35% sample diverges from the others: it shows a fast rising step at the very early time (< 2 min) followed by a rather flat infiltration curve.
Hydraulic conductivity decreases with the rock fragment addition till 25% for the Entisol and 35% for the Alfisol; then an increase of hydraulic conductivity was observed. The same trend was observed in the Sorptivity values obtained by the early-time (< 3 min) analysis.
Image analysis showed in both soils first a decrease of porosity at 15% RF concentration and then an increase of porosity at increasing RF concentration. Such an increase respect to the control was evident starting from 25% RF concentration in the Entisol and at 35% in the Alfisol. Comparison of Pore size distributions showed in both soils an increase of larger pores in a range starting from 150μm to 300μm, more evident in the Entisol samples which showed also a reduction of porosity in the smaller pore size classes.
Overall, the results showed that only after addition of 35% of rock fragments to the Alfisols and 25% to the Entisol a physical restoration was reached.