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Quantification of three dimensional characteristics of macrofauna macropores and their effects on soil hydraulic conductivity in northern Vietnam

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Soil bioturbation is associated with the production of soil macropores that influence numerous ecological functions such as those associated with water infiltration and the generation of runoff water. This impact is especially important on sloping lands in the tropics that are highly susceptible to erosion. In this study, we questioned the influence of soil biodiversity on soil macropore properties (> 20 mm3) and saturated hydraulic conductivity (Ksat) on sloping land in northern Vietnam. Biostructures found at the soil surface (casts, sheetings and soil excavated on the ground) were used to identify areas colonized either by earthworms, termites or dung beetles, respectively. The influence of soil macrofauna on Ksat was measured in situ using the Beerkan method below bioturbated zones and compared to the surrounding soil without visible biostructures at the soil surface. Undisturbed soil columns were afterwards sampled and scanned by X-ray computed tomography (X-CT). Properties of macropores below each biostructure depicted a large variability, revealing the complexity of the macropore network. Further, galleries made by termites, dung beetles and earthworms were manually isolated from the rest of macroporosity. Galleries made by beetles, termites and earthworms were clearly differentiated on the basis of their diameter, verticality, sphericity, tortuosity, length and number of branches and the fraction of galleries in the top part of the column and. Ksat was most increased by dung beetles (45-fold), then by termites (30-fold) and to a lesser extent by earthworms (16-fold). Relationships between total macropore properties and Ksat showed that the most important properties explaining Ksat were (i) the volume of percolating macropores, (ii) the diameter, (iii) the critical macropore diameter and (iv) the number of macropores. In conclusion, this study confirmed not only the interest in using X-CT for the quantification of macroporosity but also the absence of a clear relationship between aboveground biostructures and macropore properties and functional impacts.
Keywords: soil; X-ray computed tomography; soil macrofauna; galleries networks; saturated hydraulic conductivity