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Investigating hydropedological relations using quantified morphological data under banana plants on a transect in Guadeloupe

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Due to its limited surface and contamination through chemicals, subsurface water resources in Guadeloupe are under pressure. Banana plantations on highly conductive soils, in particular Andisols represent a large source of nonpoint-source pollution. The proper characterization of the soil transfer properties are therefore needed to sustainably manage groundwater. Hydropedology can help understand the links between the soil hydraulic behaviour and its pedology. The aim of this study was to assess the key parameters controlling the hydraulic properties of these soils.

Fifteen sites were chosen along a climatic transect in the South East of Guadeloupe, going from lower to higher altitudes associated with a rainfall gradient and with a pedological differentiation, to investigate the effects of soil type and soil structure on the hydraulic properties. At each site, a structural description of the profile (Manichon technique) was realised and samples were taken for chemical and mineral characterization. The root density was also assessed. In situ suction infitrometer measurements were realised at the soil surface. Undisturbed 1 L soil cores were extracted in the A (10-20 cm) and B (40-60 cm) horizons for Multistep outflow (MSO) measurements. The experiments were simulated with Hydrus-1D parameterised with the Mualem-van Genuchten (MV) model for which the parameters were optimised with the inversion algorithm AMALGAM-SO.

Links between the hydraulic characteristics (infiltration rates and MV parameters) and soil profile information were obtained using a stepwise procedure. Infiltration rates at -1 and 0 cm of pressure head were satisfactorily described based on the root density, the contents of fine earth and easily discernible clods. All these explanatory variables contain information on the structural state of the soil. The MV parameters optimised from the MSO experiments were not well described with the available predictors. However, points of the hydraulic conductivity curves at h=-1, -5, -10 and -100 cm were acceptably predicted with a blend of variables associated with structure and pedology. These promising preliminary results suggest that structure and pedology related information can explain part of the hydraulic behaviour of tropical volcanic soils. A larger database is needed to support the conclusions of this study.