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Soil properties and preferential solute transport at the field scale

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An important fraction of water flow and solute transport through soil takes place through preferential flow paths. Although this had been already observed in the nineteenth century, it had been forgotten by the scientific community until it was rediscovered during the 1970s. The awareness of the relevance of preferential flow was broadly re-established in the community by the early 1990s. However, since then, the notion remains widespread among soil scientists that the occurrence and strength of preferential flow cannot be predicted from measurable proxy variables such as soil properties or land management practices (e.g. Beven, K., 1991, Modeling preferential flow - an uncertain future, Preferential Flow, 1-11). In our study, we present evidence that disproves this notion. We evaluated breakthrough curve experiments under a constant irrigation rate of 1 cm/h conducted on 65 soil columns (20 cm diameter and 20 height) which had been sampled from an approximately 1 ha large loamy field-site in Silstrup, Denmark. We show that the holdback factor, which is an indicator for the strength of preferential transport, is strongly correlated to the bulk density, which in turn is correlated to the organic matter content. By applying multiple linear regression in a bootstrapping framework, we could estimate the holdback factor from the bulk density and the very fine sand fraction with a coefficient of determination of 0.65. Our results raise hopes that it is indeed possible to establish pedotransfer functions for soil susceptibility to preferential flow and transport.