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A new methodology for quantifying the impact of water repellency on the filtering function of soils

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Soils deliver a range of ecosystem services, and some of the most valuable relate to the regulating services resulting from the buffering and filtering of solutes by soil. However, it is commonly accepted that soil water repellency (SWR) can lead to finger flow and preferential flow. Yet, there have been few attempts to quantify the impact of such flow phenomena on the buffering and filtering of solutes. No method is available to quantify directly how SWR affects the transport of reactive solutes. We have closed this gap and developed a new method for quantifying solute transport by novel experiments with water-repellent soils. It involves sequentially applying two liquids, one water, and the other a reference fully wetting liquid, namely, aqueous ethanol, to the same intact soil core with air-drying between the application of the two liquids. Our results highlight that sorption experiments are necessary to complement our new method to ascertain directly the impact of SWR on the filtering of a solute. We conducted transport and sorption experiments, by applying our new method, with the herbicide 2,4-Dichlorophenoxyacetic acid and two Andosol top-soils; one from Japan and the other one from New Zealand. Breakthrough curves from the water experiments were characterized by preferential flow with high initial concentrations, tailing and a long prevalence of solutes remaining in the soil. Our results clearly demonstrate and quantify the impact of SWR on the leaching of this herbicide. This technique for quantifying the reduction of the soil's filtering efficiency by SWR enables assessment of the increased risk of groundwater contamination by solutes exogenously applied to water-repellent soils.