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# Laboratory determination of soil hydraulic conductivity for paddy soils: effects of different soil sample saturation methods

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Saturated soil hydraulic conductivity (Ks) is a key factor in predicting vertical percolation fluxes, especially in paddy areas, where the peculiar agricultural practices adopted (especially flooding) lead to the formation of a dense and low permeable layer below the ploughed horizon. The core method, reproducing the Darcy's experiment over large undisturbed soil samples, is considered the reference method for Ks determination. To prepare soil samples for the analysis, two different soil saturation procedures can be adopted: vessel (AtmSat) and under-vacuum saturation (VacSat). A comparison between Ks values obtained by the core method after applying the two procedures is still missing in the literature, and is presented in this work.

Five soil profiles were opened in three paddy fields located close to Pavia (Northern Italy) in the context of the WATPAD project (Fondazione Cariplo, grant n° 2014-1260). In particular, five couples (replicates) of large undisturbed soil samples (H 15.0 cm, ø 14.6 cm) were collected from the less conductive layer (LCL) of each profile. Ks was determined by the core method after the saturation of soil samples with the two procedures (AtmSat and VacSat). To assess the reliability of the resulting Ks values, vertical percolation fluxes estimated by the Darcy's law (applied by considering lab-measured Ks) for the three paddy fields were compared to the same fluxes obtained as residual terms in the water balance equation applied to the fields. The main outcomes of the study, probably justified by the peculiar characteristics of the analysed soils (low-permeability layers of paddy soils), are the following: (1) the duration of flux experiments to reach the steady-state flux at which the convergence Ks value is obtained was generally very long (up to 25 days in the case of VacSat); (2) also the time needed to reach an evident trend in the measured flux was often long (even more than 20 hours); (3) AtmSat was found to provide reasonable results only for samples with a higher sand content, while, in case of low Ks, the underestimation was found to be up to 10 fold (probably because of air entrapment); (4) when vacuum was applied slowly, VacSat provided accurate estimations of Ks at the steady-state, while a fast vacuum application may produce a relevant hydraulic gradient within the core that can lead to damaging the sample; (5) when applying VacSat, the initial estimation of Ks was misleading (often more than 10 times higher than the convergence value), which can be explained by changes in the electrical diffuse layer (EDL) due to interactions between pore water and within-aggregate water, and/or to the release of biological gasses due to vacuum conditions; (6) in case of VacSat, pouring water under vacuum (instead of before the vacuum application) increased the time needed to reach the steady-state flux, but allowed a smoother convergence to the final Ks value and an earlier evidence of the trend. Due to the low number of samples analysed, outcomes need to be further investigated by considering a larger number of samples and other soil types.