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Monitoring soil to groundwater preferential flow during border irrigation using time-lapse ERT

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In the Crau region of southern France, the border system , where water derived from canals floods the field, is used to irrigate large grassland fields. This results in an application of 1500 to 2000 mm/year of water of which 60-70% is lost to groundwater, and thus contributes to the aquifer recharge which is further used for drinking/industrial water production. Understanding how water flows from soil surface down to groundwater table is important in such a setting where irrigation practices could be changed because of possible lower water supply in the future, in relation with climate change. In particular, estimating the preferential/heterogeneous flow component to the recharge process is of prime importance. In this study, we used electrical resistivity tomography (ERT) to delineate soil and subsoil units down to the aquifer and to monitor water infiltration at different scales (plot to field scale: metric to hectometric horizontally and m to $\sim$10 m vertically). ERT, as non-intrusive method, is here useful because the stony soil and hard-pan layers make difficult the installation of classical techniques (e.g. neutron probe, minilysimeters…) and give a spatial view of variations and heterogeneity of flow process not amenable with these classical techniques.

ERT monitoring shows the development of heterogeneous flow patterns which develop mainly at the interface between the stony soil layer and a hard-pan made of cemented stones. This highly resistive hard-pan is well evidenced by the ERT survey. However, results obtained from ERT are obtained from the inversion of electrical current flow equation (with Res2Dinv software here) and a sensitivity analysis shows that inversion parameters shall be correctly defined in the time-lapse inversion to get ERT derived infiltration results without artefacts. Finally, coupling a soil hydrodynamic model and time-lapse electrical results can help in estimating variability of hydrodynamic properties/fluxes in the soil and subsoil by an inversion process.