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In situ spatiotemporal monitoring of saline vertic paddy soils from niger by subsurface geophysics during a desalinization experiment

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Salinization of irrigated paddy fields threatens large areas of the world, particularly in irrigation perimeters along major rivers of western Africa. Desalinization of these heavy clay vertisols is hampered by low infiltration rates and difficulties in monitoring the salt content in soil over time. The aim of this study was to assess the ability of a non-destructive electrical resistivity method to monitor spatially and temporally the salinity changes of an acid saline vertisol from Kollo (Niger) during a desalinization experiment. In an experimental plot of 100 m^2 inside an irrigated paddy field, 7 data acquisition campaigns were performed from 13 July to 24 September 2009. During this period, 12 consecutive irrigations of 60 mm each were applied. At the initial state, and after two consecutive irrigations, 281 apparent electrical conductivity (EC_a) measurements were collected in water-saturated soil conditions according to a systematic sampling strategy using a Wenner electrode array with two electrode spacings (10 and 30 cm). Simultaneously, soil samples were collected at 28 locations at 3 soil depths (0-10, 10-20, and 20-40 cm) to measure: i) electrical conductivity of 1/5 diluted aqueous soil extract (EC) and ii) total salinity (dry residue of the water extract). Water and salt balances were estimated during the experiment. Salinity remediation by flood irrigation and consecutive water removal was more efficient for the topsoil layer than for deeper horizons. During the monitoring period, we measured a significant decrease of EC, with a mean of 0.73dS.m^{-1}, 0.63dS.m^{-1} and 0.34dS.m^{-1}, and a removal of salt stocks of 40.4 kg, 35.6 kg and 38.0 kg in the 0-10, 10-20 and 20-40 cm soil layers, respectively,. EC_a measurements were correlated to EC of soil-water extracts and salt stocks with no significant influence on the soil water content. The highest correlation (R=0.57) was observed between EC_a measured with an electrode spacing of 30 cm and EC of 1/5 diluted aqueous extract from the upper soil layer (0-10 cm). More effective than other methods, the EC_a survey used in saturated conditions allowed the detection of spatial and temporal salinity changes of the shallow layer (0-10 cm) during the experiment with a high spatial resolution. Nevertheless, its limited investigation depth in the presence of a conductive layer on the topsoil, was a limit to monitoring salinity changes in the entire soil profile in the presence of deep saline vertisols located in irrigated paddy fields.

Keywords: soil salinity, electrical resistivity method, spatio-temporal analysis, vertisol, paddy fields, Niger.