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Preferential flow effects on transport and fate of chemicals and microorganisms in soils irrigated with wastewater

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This work is part of a multidisciplinary research properly planned by the ENAS (Cagliari-Sardinia–Italy) to verify the consequences of urban wastewater reuse in irrigation practices on chemical, biological and hydrological behavior of agricultural soils of the Had as Soualem area (Morocco). The area consists of Fluventic Haploxerept soils, according to USDA Soil Taxonomy. Undisturbed large soil columns, 70 cm height and 20 cm diameter, were collected from plots, the locations of which were preliminarily individuated through a prior pedological study. The soils are characterized by an apparent structure, suggesting that preferential flow processes may occur in the study area, which may impact usable groundwater at depth.

Wastewater reuse for irrigation simultaneously solves water shortage and wastewater disposal problems. Unfortunately, wastewaters generally contain high concentrations of suspended and dissolved solids, both organic and inorganic, and microbial contaminants (virus and bacteria) added to wastewater during domestic and industrial usage. Most of these contaminants are only partially removed during conventional sewage treatment so they remain in the irrigation water.

Although adsorbing ions and microbes are relatively immobile within porous media, preferential flow and adsorption to mobile colloids can enhance their transport. There is limited knowledge regarding the role of preferential flow and colloidal transport on adsorbing contaminants. The main aim of this research is to determine the influence of preferential flow and colloids on wastewater contaminant transport. Leaching rates and arrival time of wastewater contaminants will be determined using field and laboratory measurements at the study sites in combination with preferential flow numerical modeling. To achieve these objectives the soil columns were analyzed for physical, chemical, and microbial characterization. At the laboratory, an experimental facility was set up and sensors for monitoring soil water and contaminants concentrations during infiltration experiments were inserted horizontally in each column at different depths.

To measure initial distribution of water content in soil columns, as well as water content changes during infiltration, TDR probes were inserted horizontally at 10 cm intervals from the soil surface starting from a depth of 5 cm. Pressure heads were measured by tensiometer cups at the same depths of TDR probes. For monitoring solute and microbial composition of soil water, soil solution extractors were also installed at the same depths on a different vertical line.

This work details the initial data collection and analysis during the 1st year of this project and outlines the ongoing modeling and other analysis steps.