Multicomponent solute transport in soil lysimeters irrigated with waters of different quality

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[1] A variety of analytical and numerical models have been developed during the past several decades to predict water and solute transfer processes between the soil surface and the groundwater table. While many models quantifying solute transport in soils usually consider only one solute and severely simplify various chemical interactions, others such as the geochemical module of HYDRUS-1D consider multiple solutes and their mutual interactions. In this study we use HYDRUS-1D to analyze water flow and solute transport in three soil lysimeters (1.2 m^2 × 1 m) irrigated during the summer months with waters of different quality that were used to evaluate salinization and alkalization hazards. The soil monoliths were constructed in a Eutric Fluvisol in Alentejo, Portugal. The electrical conductivity (EC) of irrigation water varied between 0.4 and 3.2 dS m^{-1}, and the sodium adsorption ratio (SAR) varied between 1 and 6 $(mmol_{(c)} L^{-1})^{0.5}$, while maintaining a ratio of Ca:Mg equal to 1:2. The soil monoliths were subjected to regular rainfall and leaching during the rest of the year. Water contents and fluxes, concentrations of individual ions (Na^+, Ca^{2+}, and Mg^{2+}), electrical conductivity of the soil solution, SAR, and exchangeable sodium percentage (ESP) indices were monitored from May 2001 to September 2004 at four depths (10, 30, 50, and 70 cm) in all three soil monoliths. Irrigation water with EC up to 1.6 dS m^{-1} did not cause salinization or alkalization hazards. The rainfall water leached the salts accumulated during the irrigation period down to a depth of 100 cm. Rainfall, however, did not restore the salinity and sodicity of the soil to its original values below a depth of 60 cm for the lysimeter irrigated with water having an EC equal to 3.2 dS m^{-1}. HYDRUS-1D successfully described field measurements of the water content (R^2 = 0.60), overall salinity (R^2 = 0.65), and the concentration of individual soluble cations (R^2 ranged between 0.62 and 0.78) as well as the sodium adsorption ratio (R^2 = 0.87) and the exchangeable sodium percentage (R^2 = 0.76).

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