Geophysical Research Abstracts
Vol. 19, EGU2017-1223, 2017
EGU General Assembly 2017

Water and salt dynamics and the hydraulic conductivity feedback: irreversible soil degradation and reclamation opportunities

Yair Mau (1) and Amilcare Porporato (2)

(1) Department of Soil and Water Sciences, The Hebrew University of Jerusalem, Rehovot, Israel (yair.mau@mail.huji.ac.il), (2) Civil and Environmental Engineering, Duke University, Durham, NC, USA (amilcare.porporato@duke.edu)

We present a model for the dynamics of soil water, salt concentration and exchangeable sodium fraction in the root zone, driven by irrigation water of various qualities and stochastic rainfall. The main nonlinear feedback is the decrease in hydraulic conductivity for low salinity and/or high sodicity levels. The three variables have quite disparate characteristic time scales: soil water can vary two or three orders of magnitude faster than the exchangeable sodium fraction. In certain limiting cases in which the input of water is constant, the system can be simplified by eliminating the equation for soil water, allowing a full description of the dynamics in the two-dimensional salinity–sodicity phase space. We estimate soil structure degradation time scales for high sodium-adsorption-ratio irrigation water, and delineate the regions in the salinity–sodicity phase space where sodium-induced degradation is effectively irreversible. This apparent irreversibility is the result of relatively long evolution time scales with respect to human activity. When we take into account stochastic rainfall—and the accompanying wetting and drying cycles—the system produces a myriad of statistical steady states. This means that equal environmental conditions can produce different outcomes, accessible to each other only by large interventions, such as temporary changes in the quality of irrigation water or one-time amendment use. Our characterization of the dynamics of water and salt in the root zone, and how it depends on environmental parameters, offers us opportunities to control and reclaim degraded states making optimal resource use. We show an example of sodic soil reclamation through calcium-based fertigation, with minimal time (and applied water) expenditure.