Modeling the impact of solute recycling on groundwater salinization under irrigated lands: A study of the Alto Piura aquifer, Peru.

AUTORES:

Yakirevich, A., Weisbrod, N., Kuznetsov, M., Rivera C., Benavent, I., Chavez, A., Ferrando, D.

RESUMEN:

Studies of groundwater quality in arid and semi-arid lands show that irrigation return flow is one of major factors contributing to aquifer salinization. Existing mathematical models do not account explicitly for solute recycling during irrigation on a daily scale, which is considered as an important salinization input. The main objective of this research was to develop a mathematical numerical model that can simulate impact of irrigation return flow by coupling water and solute fluxes at the soil surface with quality of water pumped from the aquifer. This was obtained with a Quasi-3D model representing flow in the vadose zone-aquifer system by series of 1D Richards’ equations in a variably-saturated zone and by a 3D flow equation in groundwater. The 3D advection-dispersion equation is solved in the entire domain. Concentration of irrigation water is calculated at each time step as a function of concentration of both surface water and groundwater extracted at specific locations.

The model was applied to simulate the impact of irrigation on groundwater salinization of Alto Piura aquifer (Northern Peru) over thirty years. Three scenarios were considered: (i) use of flood irrigation and groundwater extraction (the present situation); (ii) increase of groundwater pumping by 50% compared to the first scenario; and (iii) transition from flood irrigation to drip irrigation, thus decreasing irrigation volume by around 60% compared to the first scenario. Results indicate that in different irrigation areas, the simulated increase rates of total dissolved solids in groundwater vary from 3-5 to 15-17 mg/L/year, depending on hydrogeological and hydrochemical conditions, volumes of water extracted, and proportion between surface water and groundwater applied. The transition from flood irrigation to drip irrigation decreases the negative impact of return flow on groundwater quality; however drip irrigation causes faster soil salinization compared to flood irrigation. Irrigation return coefficients were calculated in the order of 21-23% and 22-24% for the first and second scenarios, respectively.

Key words:

Flow and transport modeling; Phreatic aquifer; Irrigation; Salt recycling; Peru.