Simulation of Br movement in disturbed columns of soil by HYDRUS-ID model

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Abstract
Water and contaminants moving through the vadose zone are often subject to a large number of simultaneous physical and chemical nonequilibrium processes. Modification the transport of one component is difficult, time consuming and expensive, therefore its important to simulate this movement. In the present article our purpose was study Br movement and its simulations by HYDRUS-ID model for soil columns. For this, we used 2 soil textures (Sandy loam and Loamy sand), 3 Br doses (10, 20 and 30 mg/kg soil) were added to columns then we made saturated columns by a leaching process. After that we measured Br concentration in output leachates and after leaching for different depths in columns, then compared observations with data estimated by the model. Results show that the model could efficiently predict the time of reaching maximum concentration and the extent of maximum concentration.

Key Words
Nonequilibrium, Br, simulation, leachate.

Introduction
Amount of leaching is related to the velocity of water movement in soil and the conservation potential of solutes by soil. The most important things that affect solute movement include: texture, structure and capillary conductivity that are influenced by management and tillage (Agus *et al.* 1992). Usual anions in soil also have a particular importance and this is because of their importance for salinity, productivity and groundwater pollution. Most anions are inactive and do not adsorb at adsorption sites, and that is why they are important to study because they can be leached easily from profiles and add to groundwaters. Many researches use Br as a tracer and this is because of its low concentration in most soils, it is a conservative tracer that is not subject to microbial transformation and gaseous losses. By defining types of tracer movement in soil, modeling it, and obtaining some coefficients and changes we can predict movements of other solutes and use such models in other situations (Bowmas 1984).

Methods
Soil columns were constructed from sandy loam and loamy sand soils with 10.17 cm diameter and 25 cm height. Bulk density was similar to the field situation. At the end of columns closed 5 cm sand washed with acid was placed to inhibit soil loss, and end parts of columns closed using aluminum net, experiments were done in 18 columns with 3 replications. Three different doses of Br (10, 20 and 30 mg Br/kg dry soil) were dissolved in 250 ml distilled water, after applied solute pulse treatments to columns, leaching them in saturated situation with 5 cm constant head. With the end of leaching, we sectioned columns and took samples at every 2 cm for 0-12 centimeters depth, at every 4 cm for 12-20 centimeters depth and every 5cm for 20-25 centimeters depth so that there was one sample for this depth. Then Br concentration was measured with a Br selective electrode. Bulk densities were determined by a core method (Klute 1986), saturated hydraulic conductivity determination was made by constant head method (Klute 1986), texture with pipette method (Klute 1986). Electric conductivity of soil extracts and cation exchange capacity was determined by an ammonium acetate method.

Results
After measurement of Br concentration, all necessary data for modeling were collected from columns and were compared with leachate concentrations predicted by the model. As we can see in Figure 1, most of output leachate concentration of Loamy sand soils was within 100 to 120 minutes after starting leaching whereas this time for Sandy loam texture was 150 minutes after starting leaching. Due to the finer texture of loamy sand compared with sandy loam, water and solute movement were slower and the time of reaching maximum output leachate concentration was longer. In the case of prediction of leachate concentration, model could efficiently determine time of reaching maximum concentration and measure the extent of

maximum concentration for the two studied textures. End of leaching is after the exit of four pore volume of leachate from columns and because pore volume of loamy sand texture is less than of Sandy loam textures the speed of water movement in pores is more than in sandy loam. Thus loamy sand reach the end of leaching sooner, as is clear in the diagram.

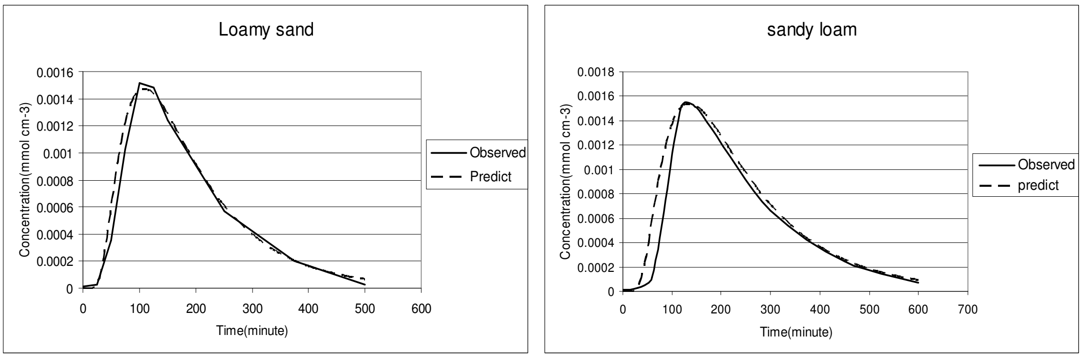

Figure1. Simulation of output leachate concentration for the third level of Br treatment on sandy loam and loamy sand textures.

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