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Numerical Simulations for Below Ground Nitrate Dynamics in Soil Columns Subject to Reclaimed Water

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A mathematical model was developed to simulate nitrate mass transport and transformations in soil during continuous application of reclaimed water in a laboratory scale soil column. The coupled material balance equations for both ammonia nitrogen *(NH_3-N)* and nitrate nitrogen *(NO_3^--N)* on the total soil volume were solved to simulate the NO_3^--N concentrations with time along the soil depth. The model is one-dimensional and based on the Galerkin technique of the Finite Element Method. It incorporates convection-dispersion processes of NH_3-N and NO_3^--N, nitrification, denitrification and adsorption of ammonium on to soil grains. The adsorption of ammonium was assumed to be represented by the linear form of Freundlich isotherm. The accuracy and validity of the developed model were examined by comparing the simulated data with the experimental data. Optimization of the first order rate constants for nitrification *(k_1)* and denitrification *(k_2)* was conducted by varying both k_1 and k_2 within a wide range until the simulated NO_3^--N concentrations fit properly with the corresponding measured values. The optimum k_1 and k_2 are 0.188 d^{-1} and 0.0248 d^{-1}, respectively. A sensitivity analysis on the kinetics of nitrate dynamics showed that the concentration of belowground nitrate is largely affected by the flow velocity *(v)*, D, k_1 and k_2.