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Soil column tomography – Combined geoelectrical and hydrochemical investigations in laboratory scale to characterize tropical soils in their potential for artificial groundwater recharge

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The controlled percolation of pre-treated municipal wastewater is a simple and economic treatment technique. One target of this method besides natural wastewater treatment is groundwater recharge by percolating water though the unsaturated zone to the groundwater table.
Hydraulic conductivity, grain size distribution and composition are important parameters and have major impact on the infiltration process and the retardation potential of the soil.
Geoelectrical measurements can be applied as a non destructive survey method for subsurface characterisation, e.g. investigation of depth to water table and monitoring of subsurface contamination. Other applications, especially for hydrological studies, are investigation of groundwater mineralisation and soil moisture.
This project aims on the development of a quick and easy tool to approximate the percolation process in a party saturated soil in focus of treatment of wastewater and artificial groundwater recharge.
This work deals in detail with a combined method of geoelectrical measurements and hydrochemical balancing in laboratory scale. Therefore a device for tomographic geoelectrical measurements on soil columns has been constructed. The measurement device is cylinder-shaped (diameter: 10 cm; height: 20 cm) and fitted with 48 electrodes which are installed in six layers with equidistant electrode spacing. Each electrode ring contains eight electrodes also in equidistant spacing. The electrodes are controlled by three decoder units which are connected to a RESECS® earth resistivity meter. To gain high resolution results a measurements sequence with 246 single measurements is applied. The monitoring measurements are first done along each electrode ring individually with a dipole-dipole electrode configuration. This method, also well known from geoelectrical tree trunk tomography, produces 2-D, horizontal and equidistant information about the electrical resistivity distribution in the soil column. As a second step of the geoelectrical monitoring a vertical series of measurements using all six electrode rings is conducted. All geoelectrical data are processed and analysed using an inversion software to get a detailed 3-D image of the electrical resistivity distribution in the soil column.
Following the measurements on the unsaturated soil column (background measurements) an artificial wastewater with defined mineralisation is percolated through the soil column while the tomographic measurements described above are continuously running.
The main objective of this investigation is to evaluate relationships between infiltration of wastewater with known composition and changes of electrical resistivity in the soil column going along with the infiltration, by observing it with geoelectrical and hydrochemical measurements. Ultimately, the high resolution geoelectrical measurements provide a detailed picture of the infiltration process in a soil column experiment under partly saturated conditions.
The eight different soils used in this investigation represent typical tropical soils from Distrito Federal, Brazil.
These investigations will be combined with multiple field, climate and hydrological data to estimate the potential for artificial groundwater recharge for the different soils.