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Time-lapse ERT of water infiltration in the context of soil aquifer treatment

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Global concerns such as climate change and population growth make soil aquifer treatment (SAT) an important and likely increasingly used technology for water and wastewater purification and storage. SAT means the cyclic infiltration of pre-treated wastewater in ponds for further treatment within the vadose zone. The Shafdan site in Israel is one of the largest SAT facilities in the world. However, it is approaching its limits due to increasing amounts of wastewater. Our study investigates the infiltration process in association with SAT with regard to improving its efficiency using time-lapse electrical resistivity tomography (ERT) in combination with hydrological methods. Therefore, we equipped one selected infiltration pond close to the city of Yavneh, south of Tel Aviv, with three ERT lines, each containing 96 electrodes. The electrodes are separated by 0.5 m in two of the profiles and 2 m in another profile. ERT monitoring was performed every hour over a time period of almost two month in spring/summer 2014 for different infiltration scenarios. The averaged apparent resistivity data show a clear response over time which can be related to the overall water content dynamics in the vadose zone. Already the raw data shows that ERT is able to track the water infiltration under very high fluxes. The inverted difference images of the electrical conductivity show nicely the spatial water movement close to the surface and with increasing depth of the profiles. They indicate that the infiltration is affected by subsurface heterogeneity. By analyzing the transient behavior of the drying curves derived from the time-lapse ERT images, we are able to characterize the heterogeneity in a hydraulic manner. The study shows that time-lapse ERT helps to better understand the dynamics of water infiltration processes in the context of SAT.