Geoelectric monitoring of irrigation experiments at the Rautenweg landfill (Vienna)

Scholger, Robert[1]; Sarc, Renato[2]; Lorber, Karl[2]; Reiselhuber, Karl[3]

1 Chair of Applied Geophysics, Montanuniversität Leoben, Peter-Tunner-Straße 25, A-8700 Leoben, Austria; 2 Chair of Waste Processing Technology and Waste Management, Montanuniversität Leoben, A-8700 Leoben, Austria; 3 Municipal Department 48 of the City of Vienna, Rautenweg 83, Vienna, Austria.

In the period from 06.07.2020 to 16.09.2020, a geoelectrical monitoring along 6 profiles with a length of up to 204 meters was carried out in the Rautenweg landfill to investigate the changes in the water content in areas with household waste during the implementation of irrigation. The conditions for monitoring the relative increase in water saturation during irrigation are favorable if the irrigation water has a significant contrast in terms of electrical conductivity to the landfill contents. Monitoring comprised 7 phases of investigation: (1) Construction of profiles, geoelectric “zero” measurements (state before irrigation), temperature measurements in gas wells and inclinometers with infrared thermometry and testing the suitability of the landfill water from an extraction well, which yielded an extremely high conductivity of 0.55 S/m at a temperature of 22 °C. (2) to (6) irrigation experiments employing different gas wells and irrigation lances with accompanying geoelectric monitoring along one profile during the irrigation (e.g. 1, 3, 5 and 19 hours after the start) and measurement of all 6 profiles after the end of irrigation. (7) Final ERT-measurements and temperature determinations in gas wells 1 month after the last irrigation experiment. All electrical resistivity tomography measurements were carried out with a LGM 4point light 10W Earth resistivity meter with up to 69 steel electrodes and a constant electrode spacing of 3 meters. At profile positions, where the deposited waste material formed a concrete surface, pre-drilling of mounting holes for the electrodes was required. Where necessary, the electrical ground contacts were improved by means of watering the electrodes before and throughout the measurements. The time needed for a complete ERT measurement was 60 to 90 minutes, depending on the array type and profile length. Measurement errors were consistently very small, and the best results were achieved with the Wenner array. Time-lapse inversion of the measured data was carried out with RES2DINVx64 (Geotomo Software SDN BHD, Malaysia) and the inversion models were exported to Surfer (Golden Software LLC, Colorado) for advanced grid operations and plotting. The top layer and large parts of the landfill body has a very low electrical conductivity and the contrast to the conductivity of the irrigation water is sufficiently large. The household waste in the investigated area yields strongly anisotropic water flow paths. Horizontal and vertical barriers within the waste volume limit the spread of the water introduced. Iron pipes of the gas wells act as electrical conductors, and they are displayed in the profiles as conductive structures. However, in geoelectric monitoring, the changes in electrical conductivity caused by irrigation are evaluated. In the immediate vicinity of the wells, these changes are not completely masked, but are less significant than at a sufficient distance (a few meters) from the gas wells. There was no loss of water due to discharge into the landfill subsoil. The final measurement 4 weeks after the end of the irrigation shows no or only minor changes in the conductivity distribution. The geoelectric method is generally very well suited for monitoring the water saturation in the Rautenweg landfill.