

Using electrical resistivity tomography (ERT) to evaluate water flow in a vertical flow constructed wetland

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Introduction

- Flow constructed wetlands (CW) is a wastewater treatment technology based on water flows through a porous material where biological and inorganic reactions transform and remove pollutants from the water



- Common problem in CW: Non-homogeneous flow distribution defined by the installation of preferential flow paths produces a considerable variability of the hydraulic residence time, which in turn is affecting the treatment efficiency

- ❑ Information of water flow variations may be obtained by tracking the changes of resistivity, since the resistivity is function of water content, water conductivity and type of material
- ❑ If water conductivity variation is low and type of material does not vary, changes of resistivity represent water content variations
- ❑ This scenario can be found in a vertical flow CW

Aim

- To study the distribution of water flow in a vertical flow CW, for the identification of preferential flow paths and stagnant or dry zones with no water flow

- A vertical flow CW located at the Experimental Wastewater Treatment Plant of Carrión de los Céspedes (PECC) (Seville – Spain), managed by the CENTA Foundation



- The studied vertical flow CW consists of a substrate composed of gravel beds and isolated from the ground by an impermeable PVC liner membrane.
- Wastewater input is done by a distribution system consisting of 7 longitudinal pipes with holes regularly spaced



- A geophysical technique, Electric Resistivity Tomography (ERT) has been applied to obtain a 2-D image (profile) of the resistivity distribution in the CW substrate
- The ERT equipment used in this work was a Syscal Junior 48 resistivitymeter



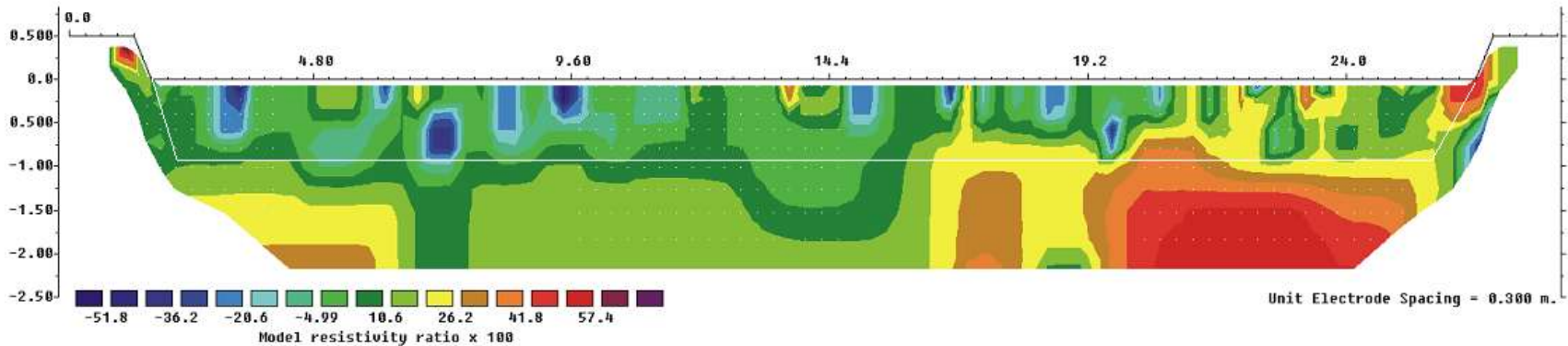
- A line of electrodes with a total length of 28.2 m was installed in the CW, parallel to a irrigation pipe, consisting of 48 electrodes spaced 0.6 m apart. A Dipole-Dipole array was selected to get the best lateral resolution



- To compare the spatial and temporal water content changes, a first resistivity profile prior to any water discharge (i.g. dry conditions during the previous 2 weeks) was obtained as reference profile. Afterwards, 7 successive ERT lapse-time profiles were acquired (7 discharges x 400 litres each, mean time interval of 45 min) in 5h 55'. Data analysis and modelling were carried out by using the geophysical inversion program Res2dinv

Results and discussion

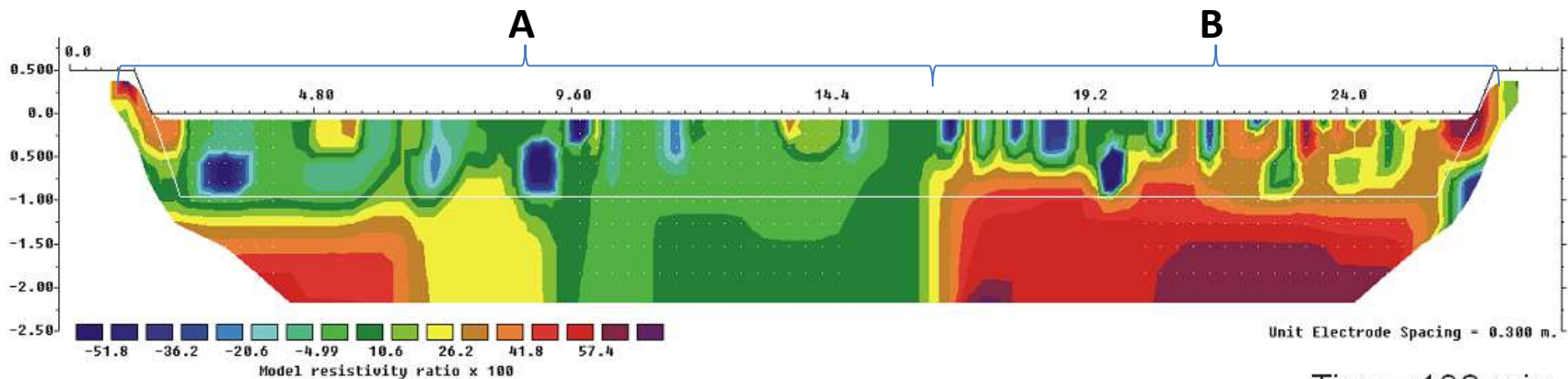
- The successive ERT lapse-time profiles display a similar resistivity pattern which is characterised by a large heterogeneity in water content along the line



Time=5 min
1 discharge

Results and discussion

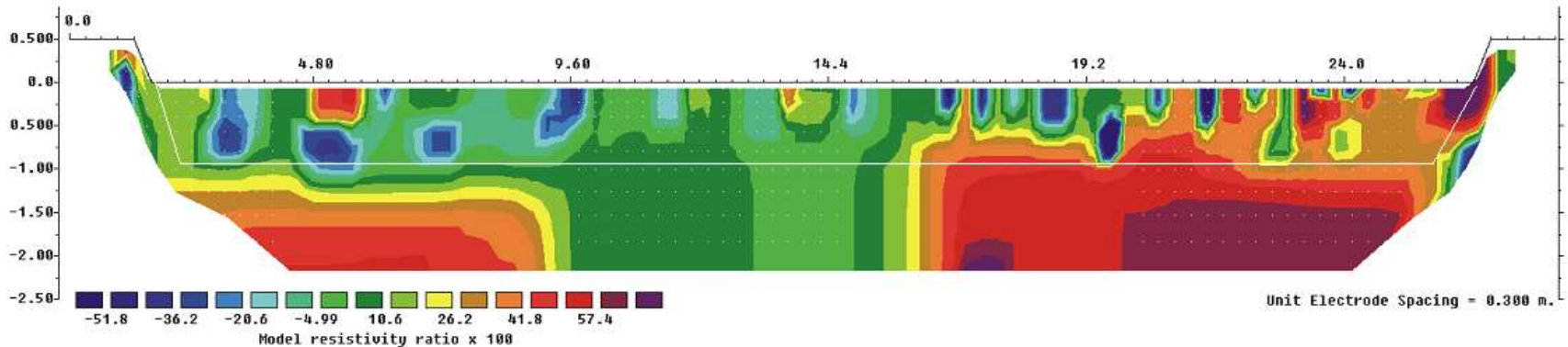
- The profiles show two distinct parts. The largest one (A) is characterized by an average lower resistivity and a more homogeneous water distribution compared to the other part of the CW (B) which displays a more heterogeneous water distribution and contrasted resistivity values



Time=182 min
4 discharges

Results and discussion

- In both sectors, there are regularly distributed discrete zones with more water content (i.e. lower resistivity) defining preferential vertical flow paths



Time=333 min
7 discharges

- The non-homogeneous flow distribution in a CW may be due to: a) changes in porosity (e.g. related to size distribution, bed compaction, etc), b) presence of rhizomes and plant roots, c) biological, physical and chemical clogging, and d) system of water input
- In the studied case, field observations reject the causes b) and c)

- The discontinuous system of water input (i.g. point-to-point irrigation system) fits well to the pattern defining the zones where preferential vertical flow paths occur
- The heterogeneity at larger scale in the CW and identified by the contrast in sectors A and B could be due to the changes in porosity related to textural and fabric gravel variations in the beds

- ❑ Water is not homogenously distributed along the CW
- ❑ A distinct pattern is marked by regularly distributed discrete zones with lower resistivity, that are defining preferential vertical flow paths controlled by the point-to-point irrigation system on which is based the wastewater input to the CW

- ❑ Water flow heterogeneity at larger scale in the CW seems to be due to the changes in porosity related to textural and fabric gravel variations
- ❑ The similarity of the resistivity/water content pattern in all lapse-time profiles indicates that in each pulse the profile departs from similar water content conditions, and therefore is no significant water accumulation along the pulses

Thank you for your attention

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