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Geoelectrical Imaging of Moisture Dynamics in Engineered Slopes

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Understanding construction quality and state of embankments used for road and rail infrastructure is critical in the effective management and maintenance of our transport network. Future climatic changes are predicted to lead to up to 20% more precipitation (with strong increases in winter), more flash floods, and drier summers. These environmental changes will have inevitable consequences for the serviceability and maintenance of our engineered infrastructure. Yet, current assessment of asset condition is mainly informed by failure events and remediation measures initiated in response to emergencies. New intelligent platforms and science to monitor current embankment state and risk are required, to enable proactive remediation before failure occurs.

Electrical resistivity tomography (ERT) is a geophysical technique that is sensitive to lithological and mineralogical heterogeneity and changes in ground temperature and soil moisture content. When corrected for temperature changes, repeated resistivity measurements employing permanently installed electrodes will highlight changes in moisture content over time.

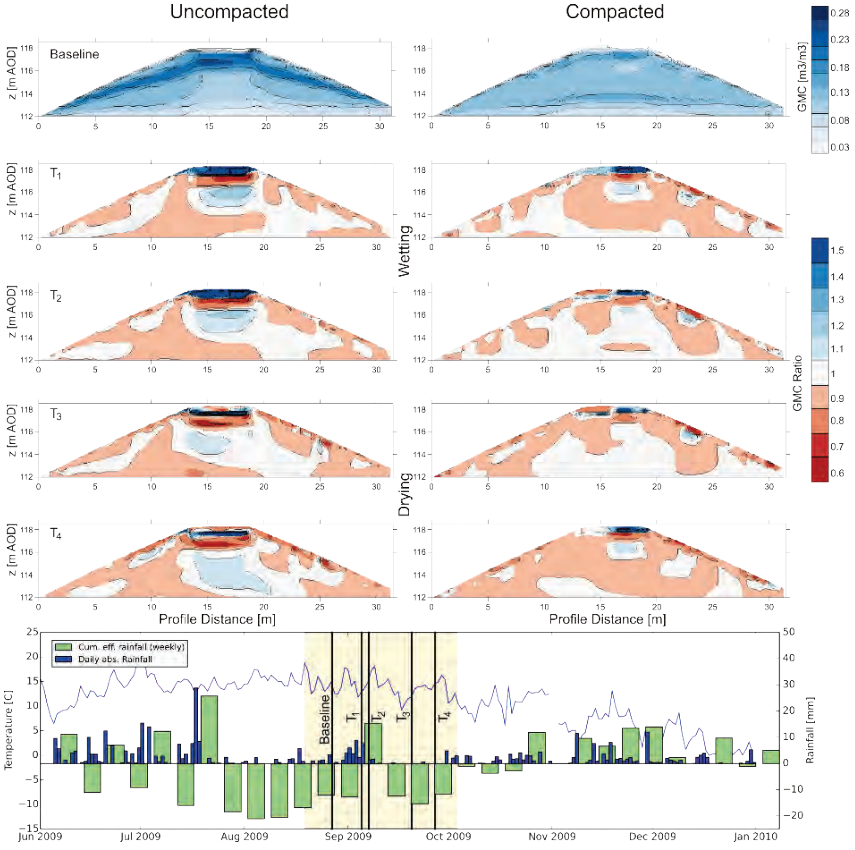

Figure 1 (Top) Baseline GMC data sets for the compacted (left) and (right) uncompacted panel. Below, images of GMC ratio between data sets acquired at different dates and the baseline data set. Note the deeper moisture penetration in the uncompacted panel.

Therefore, ERT monitoring can be used to image moisture movements in slopes, giving information about accumulation and drainage areas, as well as preferential flow paths. This provides a tool to assess the hydrological state of an embankment, which can be used as an indicator for its geotechnical state.

We compare ERT monitoring data acquired on a section of the BIONICS research embankment, which was built according to modern Highways England specifications, with data from a section representing the building standards of Victorian railway embankments (i.e. poor compaction). These sections show distinct differences in moisture movements and penetration, highlighting an accelerated weathering impact for the poorly compacted section. Thus, the embankment compacted to standard levels will show slower deterioration than historic structures, resulting in a longer life time and lower whole-life-costs.