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Developing Novel Geophysical Tools to Investigate Urban Vegetated Soil Moisture Dynamics

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Vegetation is an important tool for managing urban surface water and shallow geotechnical assets. However, root water uptake driven changes in slope hydrology (soil water content, matric suction, and hydraulic conductivity) are poorly understood in heterogeneous soils and under extreme climatic conditions. Slope stability is affected by intrinsic factors, including geometry, soil properties, groundwater and vegetation driven matric suction. Field evidence indicates that engineered slopes are susceptible to hydrometeorological slope instability mechanisms and that these pose a potential failure hazard to asset operation and public safety. The UK hosts 15,800 km of railway network and 7100 km of strategic road network, accounting for 49,000 slopes. This is a significant portfolio of slopes that must be managed and maintained at considerable expense.

To better understand the influence of vegetation on soil water dynamics in geotechnical infrastructure, Electrical Resistivity Tomography (ERT) is being used. ERT is a non-invasive tool for measuring and imaging subsurface soil moisture dynamics volumetrically. ERT can be used to quantitatively establish how the presence of roots influences transient soil moisture content and suction to assess the effectiveness of vegetation in managing slope hydrology and excess surface water issues in the built environment. This research aims to use 4-D ERT to determine the impact of vegetation on the hydrological behaviour of a high plasticity clay derived sub-soil used in the construction of infrastructure slopes in the southern half of the UK. Laboratory-scale experiments are underway at the UK National Green Infrastructure Facility, Newcastle, using a controlled environment chamber. A suite of soil columns is planted with vegetation, False Oat Grass (Arrhenatherum elatius) and Common Bent (Agrostis capillaris) and feature a 3D ERT electrode array and point sensors for measurement of volumetric water content, matric suction, and electrical conductivity throughout the profile. Through frequent imaging of soil-water-plant interactions and correlation with destructive root architecture imaging, this research aims to highlight how these relationships change over time and respond to extreme weather conditions (drought/inundation) to better predict, manage, and mitigate the occurrence of slope failure. Furthermore, the work aims to improve understanding of vegetation-driven soil moisture movement in the near-surface to better assess seasonal and longer-term slope stability to inform asset management strategies.