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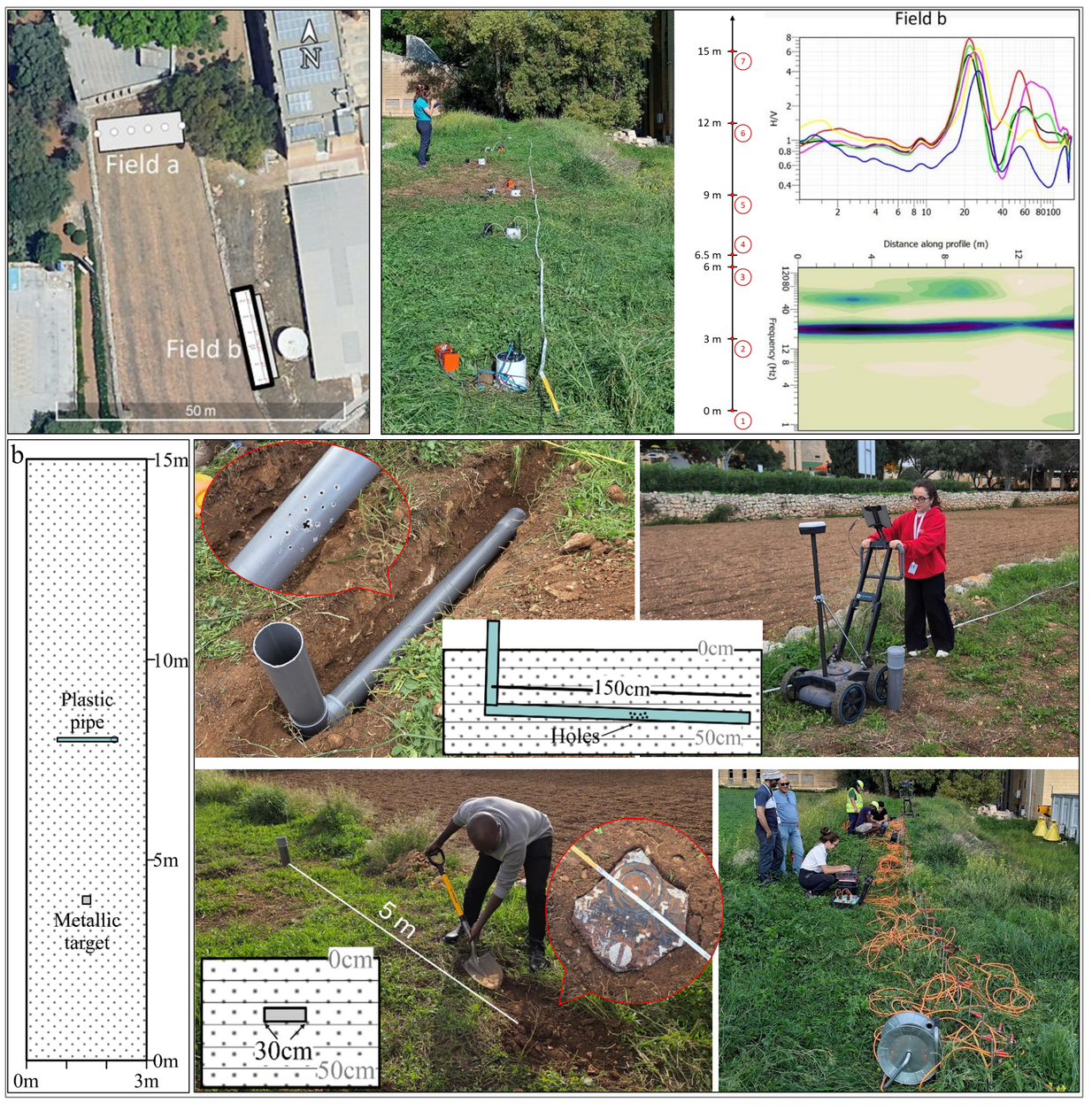
Towards More Resilient Water Distribution Networks Through Integrated and Non-Invasive Monitoring Technologies: The TEAMWIRE Project

Project brief

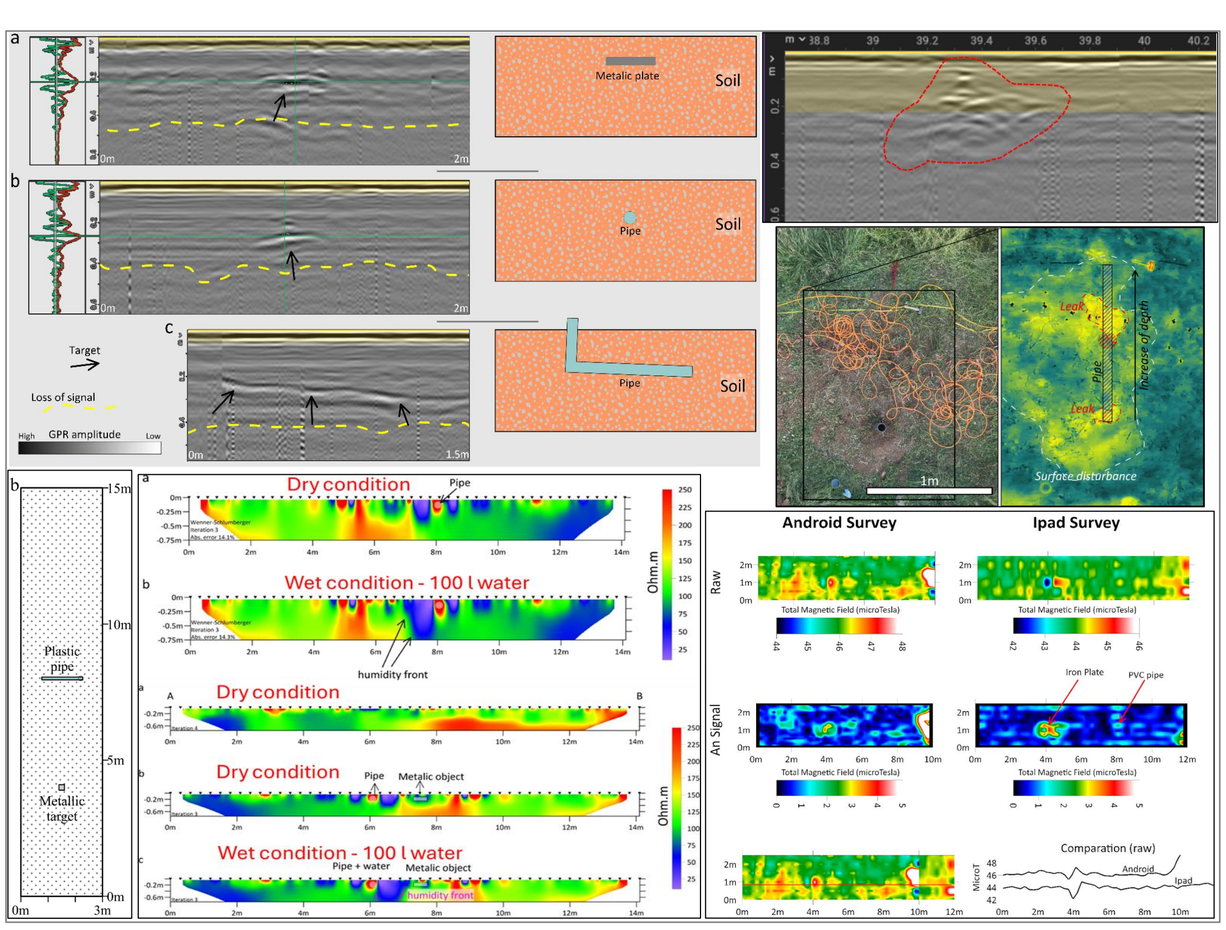
The TEAMWIRE (TEchnologies and Advanced Monitoring for Water Infrastructure and Resource Efficiency) project is a multidisciplinary research initiative aimed at improving the resilience and efficiency of water distribution networks through non-invasive monitoring technologies. Addressing the major challenge of hidden leaks—which cause significant water losses and waste, increased operational costs, and infrastructure degradation—the project supports proactive asset management through early leak detection. To this end, TEAMWIRE proposes an integrated monitoring strategy combining Time Domain Reflectometry (TDR), Ground Penetrating Radar (GPR), and high-precision Global Navigation Satellite System (GNSS) technologies.

Methodology

A controlled field experiment was carried out under realistic conditions, including soil physical characterization and the simulation of a localized water leak using a perforated PVC pipe buried at shallow depth. In addition, a metallic objects was installed at the same depth and positioned approximately 5 m from the pipe to serve as reference targets for known subsurface anomalies. GPR surveys were performed before, during, and after the simulated leakage conditions in order to evaluate the detectability of moisture variations and buried features. To support data interpretation and improve the reliability of the results, complementary geophysical and remote sensing methods were also employed, including Electrical Resistivity Tomography (ERT), magnetometry, and thermal imaging.



Results & conclusions



The integrated dataset enabled cross-validation of detected anomalies and assessment of the experimental setup; the collected data revealed clear geophysical signatures of buried metallic objects, empty pipes, and moisture variations induced by simulated leakage.

Overall, the results demonstrate the effectiveness of integrated non-invasive geophysical approaches for characterizing subsurface anomalies in water distribution systems. In particular, the combined use of GPR and complementary techniques, supported by accurate georeferencing, shows strong potential for improving early leak detection and infrastructure monitoring.