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A high-density wireless underground sensor network (WUSN) to quantify hydro-ecological interactions for a UK floodplain; project background and initial results

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Floodplain meadows support some of the most diverse vegetation in the UK, and also perform key ecosystem services, such as flood storage and sediment retention. However, the UK now has less than 1500 ha of this unique habitat remaining. In order to conserve and better exploit the services provided by this grassland, an improved understanding of its functioning is essential. Vegetation functioning and species composition are known to be tightly correlated to the hydrological regime, and related temperature and nutrient regime, but the mechanisms controlling these relationships are not well established.

The FUSE* project aims to investigate the spatiotemporal variability in vegetation functioning (e.g. photosynthesis and transpiration) and plant community composition in a floodplain meadow near Oxford, UK (Yarnton Mead), and their relationship to key soil physical variables (soil temperature and moisture content), soil nutrient levels and the water- and energy-balance.

A distributed high density Wireless Underground Sensor Network (WUSN) is in the process of being established on Yarnton Mead. The majority, or ideally all, of the sensing and transmitting components will be installed below-ground because Yarnton Mead is a SSSI (Site of Special Scientific Interest, due to its unique plant community) and because occasionally sheep or cattle are grazing on it, and that could damage the nodes. This prerequisite has implications for the maximum spacing between UG nodes and their communications technologies; in terms of signal strength, path losses and requirements for battery life.
The success of underground wireless communication is highly dependent on the soil type and water content. This floodplain environment is particularly challenging in this context because the soil contains a large amount of clay near the surface and is therefore less favourable to EM wave propagation than sandy soils. Furthermore, due to high relative saturation levels (as a result of high groundwater levels and occasional overland flooding) considerable path losses are expected. Finally, the long-term below-ground installation of the nodes means that batteries cannot be replaced easily, therefore energy conservation schemes are required to be deployed on the nodes.

We present a brief overview of the project and initial findings of the approach we have adopted to address these wireless communication issues. This involves tests covering a range of transmission frequencies, antennae types, and node placements.

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