A novel LoRa based soil sensor network for real-time monitoring of soil moisture in the landscape laboratory patchCROP

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Sustainable agricultural systems of the future should be driven by an optimized use of resources, including water and soil. The landscape laboratory patchCROP aims at achieving this through diversified agricultural landscapes in space and time by reducing the field size and by introducing site-specific, diverse crop rotations that are adapted to heterogeneous soil conditions. It offers the opportunity to assess the functioning of innovative field technologies and monitoring networks combined with multiple scientific measurements of sustainability. As monitoring and automation play an increasingly important role in agriculture, a wide set of data is continuously collected and connected to an Internet Of Underground Things (IOUT) by using, for example Long-Range-Wide-Area Network (LoRa WAN).

The objective of this study was to investigate the real-time dynamics of soil water content at four different depths under differing soil texture and crop regimes using LoRa WAN. The experiment was conducted in newly designed field arrangements within a 70 ha large field whereas experimental units comprise 30 patches with a size of 0.5 ha each, following two different yield potential zones with varying soil conditions and site-specific five-year crop rotations.

Sensors were installed at 7 cm, 30 cm, 60 cm, and 90 cm depth in each patch to monitor the volumetric water content, soil temperature and soil electrical conductivity every 20 minutes. The user-friendly online visualization tool developed by the technology partner of patchCROP enables real-time monitoring of raw and processed data. Using LoRa WAN offers further advantages for field monitoring, such as low power consumption and high communication distances under adaptive data rate. Since the experimental set-up of patchCROP is implemented on-farm, routine field traffic and activities like reduced tillage or mechanical weed control are conducted constantly. This demands technical data collection solutions which do not disturb normal field traffic. All components of the underground soil sensor network are deployed wireless and are equipped with batteries with approximately one year lifetime. The LoRa network in patchCROP was additionally equipped with two weather stations and mobile sensors measuring soil moisture in the top soil.

By September 2021, the results will consist of a yearlong time series of water content, soil temperature and electrical conductivity data. The high temporal resolution provides an excellent basis for comprehending the behavior of soil moisture under different local conditions within the field, such as different crops and soil characteristics. The high spatial resolution will enable the predication of drought stress for different crops in different growth stages at the specific sites. In this way, findings on the impact of differences in soil characteristics and resulting plant water stress on yield can be obtained. Furthermore, when coupled to climate data and vegetation cover, the measurements of soil moisture at different depths will allow new insights in the percolation behavior of soil water at the field scale. This large set of objectives shows how the use of LoRa technology can support to optimize crop production schemes and the management of resources as well as strengthen drought risk management at the agricultural landscape level.