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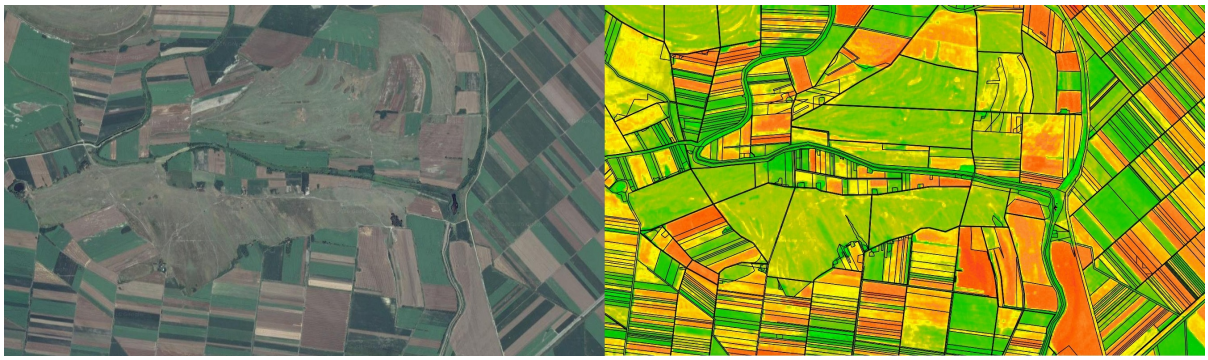
A Novel Low-Cost Open-Hardware Platform for Monitoring Soil Water Content and Multiple Soil-Air-Vegetation Parameters



Title	A Novel Low-Cost Open-Hardware Platform for Monitoring Soil Water Content and Multiple Soil-Air-Vegetation Parameters
Title (native language)	
Category	• Recording or mapping technology
Short summary for practitioners (Practice abstract) in English)	Monitoring soil water content at high spatio-temporal resolution and coupled to other sensor data is crucial for applications oriented towards water sustainability in agriculture, such as precision irrigation or phenotyping root traits for drought tolerance. The system is based on an open-source ARDUINO microcontroller-board, programmed in a simple integrated development environment (IDE). Low cost high-frequency dielectric probes were used in the platform and lab tested on three non-saline soils (ECe1: 2.5 < 0.1 mS/cm). Empirical calibration curves were subjected to cross-validation (leave-one-out method), and normalized root mean square error (NRMSE) were respectively 0.09 for the overall model, 0.09 for the sandy soil, 0.07 for the clay loam and 0.08 for the sandy loam. The overall model (pooled soil data) fitted the data very well (R2 = 0.89) showing a high stability, being able to generate very similar RMSEs during training and validation (RMSEtraining = 2.63; RMSEvalidation = 2.61). Data recorded on the card were automatically sent to a remote server allowing repeated field-data quality checks. This work provides a framework for the replication and upgrading of a customized low cost platform, consistent with the open source approach whereby sharing information on equipment design and software facilitates the adoption and continuous improvement of existing technologies.
Short summary for practitioners	
Website	
Audiovisual material	
Links to other websites	
Additional comments	
Keywords	Soil management / functionality | Water management
Additional keywords	Multi-sensor platform; Soil water content; Contactless temperature sensor; Infrared thermometry; Wireless data
Geographical location (NUTS)	EU
Other geographical location	
Cropping systems	
Field operations	Irrigation | Crop and soil scouting

SFT users	Farmer | Contractor
Education level of users	Secondary education | Apprenticeship or technical school education | University education
Farm size (ha)	0-2 | 2-10 | 10-50 | 50-100 | 100-200 | 200-500

Scientific article

Title	A novel low-cost open-hardware platform for monitoring soil water content and multiple soil-air-vegetation parameters
Full citation	Bitella, G.; Rossi, R.; Bochicchio, R.; Perniola, M.; Amato, M. (2014). Sensors (Switzerland), DOI:10.3390/s141019639

Effects of this SFT

Productivity (crop yield per ha)	Some increase
Quality of product	No effect
Revenue profit farm income	Some increase
Soil biodiversity	No effect
Biodiversity (other than soil)	No effect
Input costs	No effect
Variable costs	No effect
Post-harvest crop wastage	No effect
Energy use	Some decrease
CH4 (methane) emission	No effect
CO2 (carbon dioxide) emission	No effect
N2O (nitrous oxide) emission	No effect
NH3 (ammonia) emission	No effect
NO3 (nitrate) leaching	No effect
Fertilizer use	No effect
Pesticide use	No effect
Irrigation water use	Some decrease
Labor time	Some decrease
Stress or fatigue for farmer	No effect
Amount of heavy physical labour	No effect
Number and/or severity of personal injury accidents	No effect
Number and/or severity of accidents resulting in spills property damage incorrect application of fertiliser/pesticides etc.	No effect
Pesticide residue on product	No effect
Weed pressure	No effect
Pest pressure (insects etc.)	No effect
Disease pressure (bacterial fungal viral etc.)	No effect

Information related to how easy it is to start using the SFT

This SFT replaces a tool or technology that is currently used. The SFT is better than the current tool	agree
The SFT can be used without making major changes to the existing system	agree
The SFT does not require significant learning before the farmer can use it	disagree
The SFT can be used in other useful ways than intended by the inventor	no opinion
The SFT has effects that can be directly observed by the farmer	no opinion
Using the SFT requires a large time investment by farmer	no opinion
The SFT produces information that can be interpreted directly	disagree

View this technology on the Smart-AKIS platform

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