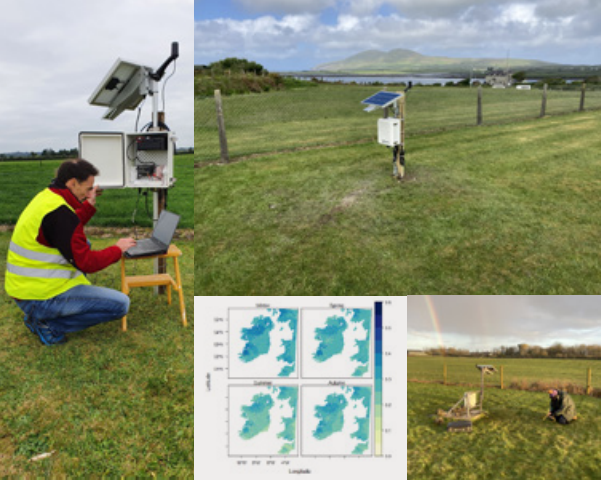

epa Research

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SoMoSAT – Soil Moisture Estimates from Satellite-based Earth Observations

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Identifying pressures

In spite of the recognised importance of soil moisture interactions for climate, and their relevance for understanding hydrological, agricultural and ecological processes, there is a paucity of soil water observations globally. Even at the regional and country scale, only limited observations are available, and many of these are limited in duration and/or extent. As a consequence, alternative techniques have been developed to derive estimates of soil moisture, including water balance-based approaches, the use of remotely sensed information and the application of land surface modelling techniques. Water balance-based approaches are typical at the catchment scale, while remote sensing and land surface modelling techniques have been employed to generate global/regional soil moisture estimates. While remote sensing-based methods offer potential for monitoring, significant uncertainties remain concerning retrieval algorithms and monitoring locations with dense vegetation cover and organic soils. At present, they are also limited to a daily temporal resolution. Machine learning techniques, which can address issues around the use of single sensor-based approaches, have been successfully employed to derive high-resolution soil moisture estimates and represent a novel approach to complement existing techniques.

Informing policy

Soil moisture is classified as an essential climate variable and is an essential parameter for use in a range of applications, including groundwater resource estimation, catchment-scale rainfall run-off and flood estimation/management, ecosystem productivity, nutrient transport management and modelling, crop production, and land surface and climate modelling. Nationally, this research will inform policy development and implementation in support of catchment monitoring and management, groundwater resource estimation and catchment-scale nutrient or contaminant modelling. More broadly, the research will also support the wider research and stakeholder community through the provision of a gridded soil moisture product for Ireland. A key output from the research was the deployment of a number of *in situ* soil moisture sensors, which will support a national initiative to deploy an integrated network of soil moisture sensors across Ireland – coordinated through the Irish Soil Moisture Observation Network.

Developing solutions

The research addresses a number of shortcomings associated with the use of existing remote sensing derived soil moisture estimates. A machine learning technique, random forest, was employed to downscale the European Space Agency's Climate Change Initiative combined data product, representing both active and passive sensors, to derive a harmonised soil moisture product for Ireland. While the combined global soil moisture product represents the current state of the art in generating a global-scale soil moisture product, the resolution of the data, ~25 km, is too coarse for most applications. The machine learning model was found to largely reproduce the available soil moisture measurements, based on independent tests of the model. A land surface model was also employed to generate estimates of soil moisture for Ireland, using forcing data obtained from the European Centre for Medium-Range Weather Forecast. A key advantage of the land surface model is its ability to generate model estimates of soil moisture over various soil depths, in contrast to satellite-derived estimates, which are limited to the top 2–5 cm. Consideration should be given to the operational deployment of both models for use in generating soil moisture estimates in near real time.

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