Relevance of using soil moisture simulation for farming decision support

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S07.H.03
Field scale variability of measured and estimated hydraulic properties: stochastic analysis of hydraulic behaviour sensitivity and investigation on spatial structures of the data

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Flux and storage of soil water in the unsaturated zone is adequately described by the classical Richards equation. Extrapolating the theory to a larger-scale system is ordinary practice (scale-invariant equation) but its application in modeling field-scale water flow set the following major and strictly related problems; namely (i) the characterization and parameterization of soil hydraulic properties and (ii) their variability, precisely sample and spatial variability.
In order to address (i) the characterization issue, the soil hydraulic properties are typically derived either through expensive laboratory and/or field experiments or with alternative approaches like pedotranfer functions, in order to increase cost effectiveness.
On the other side (ii) the variability of soil hydraulic properties can be treated by studying both data and spatial variability. In the former case a simple approach, considering soils in the field as an ensemble of parallel and statistically independent tubes. Then we used the Monte Carlo technique, for analyzing soil hydraulic properties probabilistic uncertainty.
Moreover the stochastic analysis of the data does not tell us anything about how soil hydraulic properties vary in space. Spatial variability was studied aiming to define spatial structure of the measured data and to perform estimates of some important hydraulic parameters. We used geostatistical approach for data analysis and applied different Kriging methods as interpolation techniques.
The goals of this work, placed at the core of the issues (i) and (ii), are the following:
- recognize the sensitivity of a Richard-based model to the measured variability of $\theta(h)$ and $k(\theta)$ parameters;
- establish the predictive capability of PTF in term of a simple comparison with measured data taking into account the results of point (i);
- establish the effectiveness of using PTF by using as data quality control an independent and spatially distributed information (NDVI).
- study the spatial variability of some hydraulic parameters and interpret their spatial patterns by means of comparison with soil and topographic characteristic of the study area.
The study area is located in the Po plain (Lodi) in Northern Italy and it has an extension of approximately 2000 hectares; most of the area has corn land use.

S07.H.04
Relevance of using soil moisture simulation for farming decision support

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Many decisions in agriculture are conditional to soil moisture. For instance in wet conditions, farming operations as soil tillage, organic waste spreading or harvesting may lead to degraded results and/or induce soil compaction. The development of a tool that allows the estimation of soil moisture is useful to help farmers to organize their field work in a context where farm size tends to increase as well as the need to optimize the use of expensive equipments.
Soil water transfer models simulate soil moisture vertical profile evolution. These models are highly sensitive to site dependant parameters. A methodology to implement the mechanistic soil water and heat flow model (the TEC model) in a context of limited information (soil texture, climatic data, soil organic carbon) is proposed. The obtained accuracy in surface soil moisture (0-30 cm) was 0.04 m3/m3. When a few soil moisture measurements are available (collected for instance by the farmer using a portable moisture sensor) a significant improvement in soil moisture accuracy is obtained by assimilating the results into the model. To meet the decision support context, we evaluated the model ability of evaluating the soil moisture level in comparison to a moisture threshold that splits soil conditions into desirable and undesirable cases. This threshold depends on soil properties, the farming operation and equipment characteristics. We evaluate the rate of making good decisions using either the TEC model with and without soil moisture measurements or an empirical algorithm that simulate the decision processes followed by farmers, currently. This later is a reference case that allows appreciating the adding value of using soil water transfer models. We found a significant improvement with a rate of success, which increases from 65% with the reference case to 90% when using the model with soil moisture assimilation.

S07.I.01
Using randomised moving plots to quantify the spatial variability of soil water dynamics in small forest areas

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Observations of the soil water status are usually restricted to few selected positions, due to the costs and equipment requirements. A common measuring design is to stratify the area under investigation into more or less homogeneous sub-areas and to measure soil moisture/tension at a “representative” position within each sub-area. This approach neglects any spatial variability of the flow dynamics within the sub-areas, caused e.g., by varying soil-hydraulic properties.
As an alternative to the stratified measuring approach, we present the concept of randomised moving plots (RMPs) which allows observing both the long-term soil moisture regime and its spatio-temporal variability. We applied the RMP concept to the mapping of the soil moisture dynamics of two forest areas (80 m × 1000 m) in Southwest Germany. The RMP concept is based on the fact that the typical seasonality of the soil moisture regime is governed by some (easily measurable) climatic driving variables. Describing the seasonality of the soil moisture by climatic variables renders it unnecessary to measure soil moisture at the same position over a long period. The thus saved measuring equipment can be beneficially used to observe the spatial variability of the soil moisture. For this, we carry out short-term continuous soil moisture measurements within an RMP with 31 FDR probes at random positions. Both, the RMP centres and the FDR positions are moved randomly in two-week intervals. Thus, within one year of measurements, $26 \cdot 31 = 806$ short soil moisture time series are obtained. These data are used to (i) relate the seasonality of the proxy variables (climate) with that of the soil moisture and (ii) to quantify the variability around the mean seasonal development.
Combining the seasonal development (derived from the proxy variables) and the spatial patterns (observed in the RMPs) results in a space-time-model of the soil moisture.

S07.I.02
Database of soil-hydraulic properties of forest soils in Baden-Württemberg/Germany

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Forest soils are under-represented throughout the existing soil databases, although they evidently differ in their hydraulic