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# Evaluating the Available Water Content of soils at large scale to improve the estimation of soil services

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**Abstract:** Pedotransfer functions used to evaluate the Available Water Content (AWC), a key soil parameter for the description of soil-plant-atmosphere transfer are compared. We demonstrate that the functions using soil granulometry data are not more precise than functions using only textural classes, which can pilot the choice of a function for estimation of AWC over large territories.

**AWC, a main soil characteristic.** To evaluate the contribution of soils to ecosystem services at large scale, soil-plant-atmosphere models are commonly used. The latter usually represent water fluxes through soil by a water balance model, mainly parameterized by the soil Available Water Content (AWC), which assesses the water content stored in soil and available for plant biomass production (the so-called “green water”). AWC is then considered as one of the most important soil parameter to be estimated at large scale. Nevertheless, its direct measurements in the field, by soil water content monitoring during several winter months, or its laboratory evaluation, by soil water content measurements on soil clods equilibrated at given water potentials, are time-consuming and quite expensive. Evaluating AWC by using indirect methods is then of great interest. The objectives of this study was then to compare the ability of different pedotransfer functions (PTF) often used in France to calculate AWC, given the precision of available soil data.

**A methodology based on the comparison of commonly used pedotransfer functions.** A large database containing measurements of available water content values from 761 soil horizons in various agro-pedo-climatic contexts over France has been firstly built, by gathering AWC measured (field or laboratory) data and common soil characteristics including texture granulometry, organic carbon content and bulk density. Five pedotransfer functions<sup>1 to 6</sup> allowing the evaluation of AWC from legacy data were then selected according to different criteria: i) their frequent use by technical institutes<sup>1,2</sup>, ii) their type (continuous pedotransfer functions<sup>4,5,6</sup> vs class pedotransfer functions<sup>1,2,3</sup>), iii) the level of stratification of the data that must be used, iv) their development from French data or European data. The performance of the selected PTFs was analysed for different levels of stratifications of the database: stratification between topsoil and subsoil horizons, stratification according to 5 or 15 textural classes, stratification according to the bulk density value.

**An equivalent performance of continuous and class pedotransfer functions.** Counter to results of the literature, continuous pedotransfer functions do not lead to better estimations of AWC than class pedotransfer functions. Among continuous pedotransfer functions, the Toth *et al.* PTF<sup>4</sup> leads to general better of the water content whatever the water potential, whereas it usually strongly overestimates the water content at -100hPa, considered here as the potential at field capacity. As far as class pedotransfer functions are concerned, the AlMajou *et al.*<sup>3</sup> PTF leads to general better water content estimates for a given water potential than the others. But when the validation database is stratified according to soil texture, the use of the Bruand *et al.*<sup>2</sup> PTF (using 15 textural classes) is better than the AlMajou *et al.*<sup>3</sup> PTF (using 5 textural classes) for silty and loamy textural classes, but equivalent for clay textural classes. At large scale, the use of the bulk density as an argument of the PTF improves only slightly the evaluation of AWC, except for subsoil clay horizons, where the improvement is significant.

**Toward an aware selection of PTF used for the evaluation of Available Water Content.** The choice of a pedotransfer function for the evaluation of AWC has to be thought depending of the

objective. As far as local evaluations of AWC are concerned, the use of a continuous pedotransfer function has to be recommended whereas it requires quite expensive soil measurements like the determination of the granulometry in each layer. Anyway, a direct measurement would still be preferable. As far as spatial evaluations of AWC are concerned over large territories, continuous pedotransfer functions are not better than class pedotransfer functions, the latter using class textural classes instead of granulometry measurements, which can be less expensive. The knowledge of the bulk density, which is considered to be the main determinant of stock calculations in soil does not improve significantly the evaluation of AWC, except for deep clayey horizons. Our results, which compare the efficiency of pedotransfer functions as a function of the price or availability of soil legacy data, can then be used for a fair selection of PTF to evaluate AWC as a key parameter of soil-plant-atmosphere models.

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