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EXPERIENCES WITH A TDR-MOISTURE-METER IN LABORATORY INVESTIGATIONS*

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A b s t r a c t. In a laboratory experiment, soil moisture was measured by means of a TDR-moisture-meter. Corresponding water content values were available from measurements of the gravimetric water content and the bulk density of the soils. Results for the period 1995-2000 confirmed the factory installed calibration functions and indicated that there was no long term drift of the TDR-system used.

Keywords: TDR, water content, soil, laboratory investigations

INTRODUCTION

For the assessment of soil water dynamics and in the case of many hydrological and environmental questions the water retention characteristics and the hydraulic conductivity function of soils have to be known. These soil parameters can be estimated in the field as well as in the laboratory. Since TDR (Time-Domain Reflectometry) technology became a common method for the estimation of soil moisture, it was also applied to laboratory investigations [1-3]. In the laboratory of the Institute for Soil and Water Management at Petzenkirchen such measurements have been in progress since 1995 and the soil moisture of the samples has been estimated with the EASY TEST LOM/RS system all the time. Based on the results of these investigations some experiences are summarised in the present paper.

MATERIALS AND METHODS

The principles of the investigations and the approach used in our laboratory to determine the water retention characteristics and the hydraulic conductivity function of soil are described by Plagge, 1991. Our tested samples have a diameter of 98 mm and a height of 150 mm. At the depth of 15, 45, 75, 100 and 135 mm above the

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bottom of the soil sample, the soil water potential and the soil moisture are measured simultaneously. The water potential is estimated by tensiometers and the soil moisture with the EASY TEST LOM/RS system (Fig. 1).

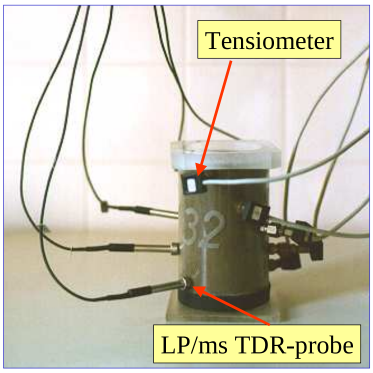

Fig. 1. Equipment for simultaneous measurement of soil water potential and soil moisture

The TDR-sensors used are the LP/ms miniprobes with two, 53 mm long, parallel stainless steel rods and data acquisition is controlled by a PC. Soil moisture is measured at five depths during a drying cycle periodically (interval: 0,5-4 hours). At the end of this procedure the soil sample is divided into five equal subsamples (0-30, 30-60, 60-90, 90-120 and 120-150 mm), at which the gravimetric water content and the bulk density is determined and the calculated volumetric water content is used to check the final TDR-readings. Such investigations had been done for about 160 soil samples (~800 subsamples) during the period of 1995-2000. The texture and the organic matter content of the tested material and the results for bulk density of the subsamples are summarized in Figure 2.

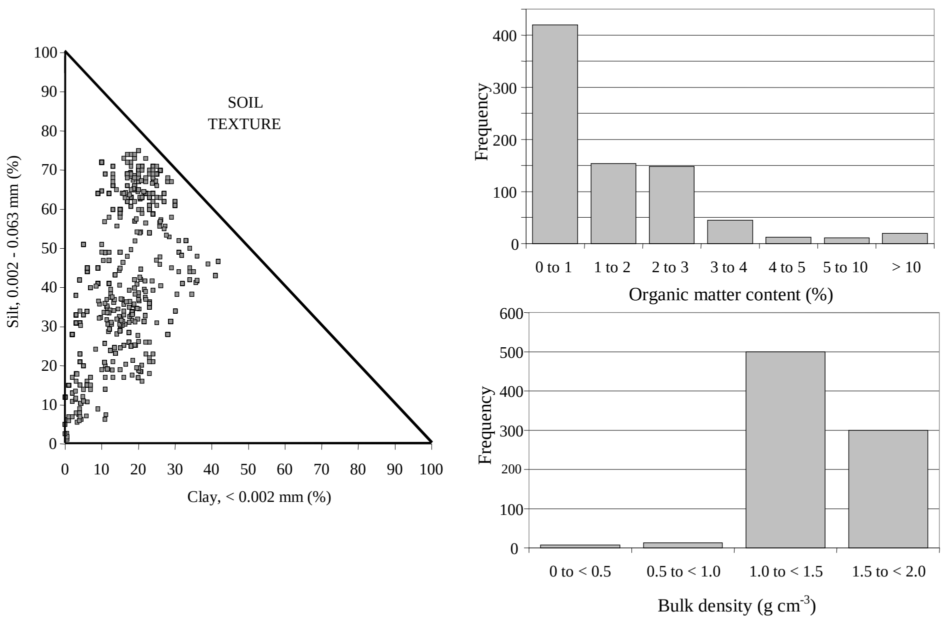

Fig. 2. Texture, organic matter content and bulk density of the tested soils

On the assumption that the last TDR-reading of our laboratory procedure should match the calculated water content of the corresponding subsample, we have a lot reference data of the dielectric constant and the water content. Based on these data the reliability of the factory installed calibration functions and a long term drift of the LOM system can be checked.

RESULTS

The simultaneous data of the volumetric water content, calculated using the finally measured gravimetric water content and the bulk density, and of the square of the dielectric constant from TDR-measurements, are compared in Figure 3 and the third order polynomial regression of these data is added. The factory installed calibration function for the conversion between these two parameters is also illustrated there.

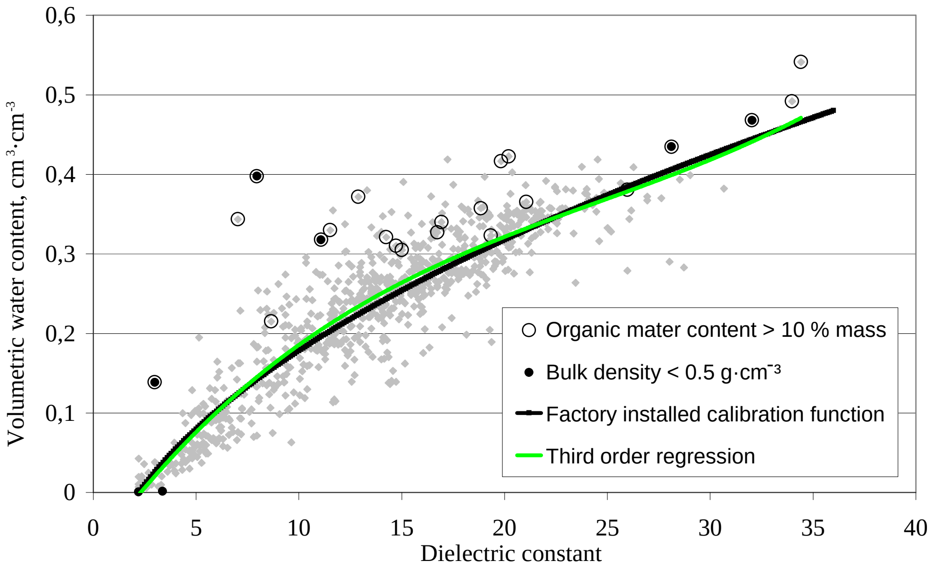

Fig. 3. Measurements compared with the factory installed calibration function concerning the dielectric constant and the water content of the

For the soils tested, the factory installed calibration function can be assessed as an appropriate tool to convert the measured dielectric constant to volumetric water content, especially taking into account the certainly existing, but in that case unknown deviation of the parameters considered. The third order regression is in accordance with the factory installed calibration function. It can also be seen that the greatest differences from this function are very often linked with extreme values of organic matter content and/or bulk density.

A check regarding a long term drift of the LOM system was done by dividing the whole data set into three periods. In Figure 4 the comparison of the square of the dielectric constant and the volumetric water content is shown for the periods 1995/1996, 1997/1998 and 1999/2000.

Obviously, there is no indication of a long term drift of the LOM system during the period of 1995-2000.

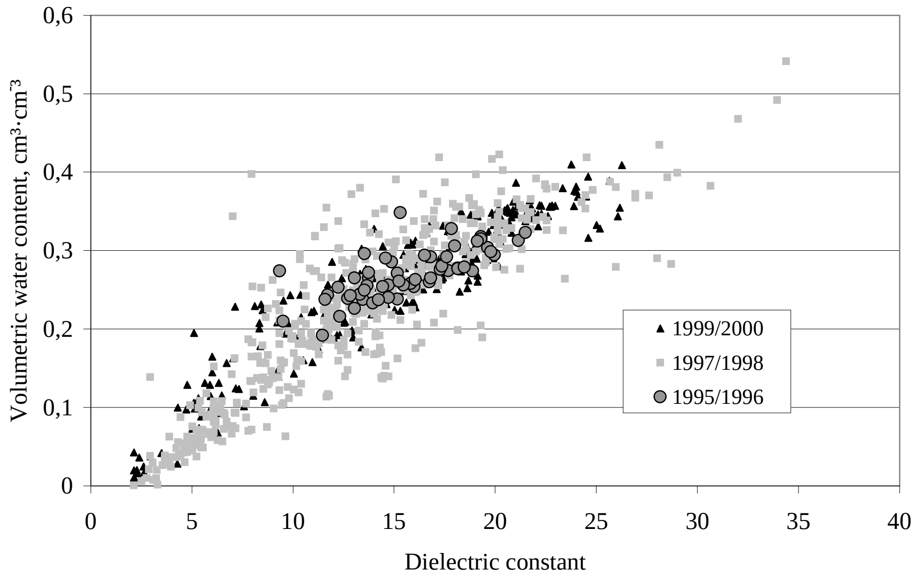

Fig. 4. Dielectric constant and the water content of the soil for the periods 1995/1996, 1997/1998 and 1999/2000

CONCLUSIONS

During the period 1995-2000 the water content of soils was measured in the laboratory by means of the EASY TEST LOM/RS system based on TDR technology. Simultaneously the gravimetric water content and the bulk density were measured and the volumetric water content was calculated. The correspon-ding data of the dielectric constant of soils and their volumetric water content can be summarized in the following way:

1. The factory installed calibration function is an appropriate tool to convert the measured dielectric constant to volumetric water content.
2. There is no indication of a long term drift of the TDR-system used.

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DOŚWIADCZENIA ZE STOSOWANIA MIERNIKA WILGOTNOŚCI TDR W BADANIACH LABORATORYJNYCH

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Streszczenie. W doświadczeniu laboratoryjnym prowadzono pomiar wilgotności gleby za pomocą miernika wilgotności TDR. Odpowiednie wartości zawartości wody w glebie były dostępne z pomiarów grawimetrycznej zawartości wody oraz gęstości objętościowej gleb. Wyniki uzyskane za okres 1995-2000 potwierdziły fabrycznie zainstalowane funkcje kalibracyjne miernika oraz wykazały brak przesunięcia czasowego w zastosowanym systemie TDR.

Słowa kluczowe: TDR, wilgotność, gleba, badania laboratoryjne