The first Hungarian Detailed Soil Hydrophysical Database (MARTHA)

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Abstract
The soil hydrophysical properties determine how the water demand of the natural vegetation and harvested plant can be satisfied. The direct measurement of these properties is labor intensive, time consuming and costly therefore these are rarely determined soil characteristics. Most of the hydraulic data that already exists is poorly documented. The Hungarian Detailed Soil Hydrophysical Database (MARTHA) was developed to collect all the information about measured soil hydraulic and physical characteristics in Hungary. Recently this is the largest detailed hydrophysical database available in Hungary. It contains information on basic and hydrophysical soil properties, including measured water retention values, physical and chemical characteristics. The database can be used besides others to develop pedotransfer functions and to evaluate the difference between the laboratory measurement methods.

Introduction

A number of hydrophysical soil databases have been developed in the last two decades worldwide. The UNSODA (Unsaturated Soil Hydraulic Database) is a database of unsaturated soil hydraulic properties. It has information about the water retention, hydraulic conductivity, soil water diffusivity and basic soil properties. It contains approximately 800 data sets (Leij et al., 1996). The HYPRES (Hydraulic Properties of European Soils) database was developed by 20 institutions from 12 countries of Europe (Wösten et al., 1999), and holds measured soil hydraulic characteristics for 4030 soil horizons of those countries. On the database class pedotransfer function were developed to predict the moisture availability of soils in Europe. The pedotransfer functions can be applied for 1 : 1 000 000 scale.

In Hungary two databases exist which can be used to develop methods to estimate soil hydrophysical characteristics. One of them is the dataset of the Research Institute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Science (RISSAC). It contains information about 270 soil samples, mainly from the Hungarian Great Plain. The pedotransfer functions developed on this dataset can be well applied for the chernozems soil type. The other hydrophysical dataset is the Unsaturated Soil Hydraulic Database of Hungary (HUNSODA) having information about 840 soil samples and holding soil water retention characteristics for 576 soil horizons (Nemes, 2002). Both of these databases are very useful but their disadvantage is that they have information about only narrow groups of soils. The measurement of these soil hydraulic properties is difficult and time consuming and there is an interest to predict them from more easily measured soil properties. For these reasons there was a great need to collect the existing soil hydraulic data and integrate to one unique database. With the National Scientific Research Fund (OTKA) under grant No. T048302 we had the opportunity to develop the Hungarian Detailed Soil Hydrophysical Database (MARTHA) with the collaborations of the County Offices of the Hungarian Plant and Soil Protection Service.

The description of the database

Our aim is to collect all the measured soil hydrophysical data available in Hungary and to harmonize into one uniform database, called MARTHA (acronym of the Hungarian name of the database), the Hungarian Detailed Soil Hydrophysical Database. Since we receive data about the agricultural areas from all over the country this database is representative for the Hungarian soils, which are under cultivation. It was applied on a database server of SQL platform (Firebird 2.0), the selected program language is Delphi. To visualize the locations of the soil profiles the GoogleMap connection was used.

The source of the data

The MARTHA database includes existing smaller datasets: the above mentioned dataset of the RISSAC (270 soil samples) and HUNSODA (576 horizons). Further to these basic datasets, we included the data of the Hungarian Soil Information and Monitoring System (TIM) and data hold by the University of Pannonia (UP). The first (TIM) contains field and laboratory data for soils in Hungary, the soil-physical data on about 1023 profiles are ready for processing. Measured values of water retention curves are available for 3115 horizons (Várallyay, 1995). The second (UP) has information about 150 soil samples. These samples are originated mainly from county Zala and Somogy (South-west Hungary). The third main additional data source is that from the Plant and Soil Protection Services of the Hungarian Counties, which produce various purpose soil assessments (e.g. for irrigation planning) and collect data for these needs. In addition to the above data sources, data were obtained from scientists as well through personal request. The first period of the data collection has been closed. The MARTHA database currently contains the soil physical, chemical data of approximately 5000 soil horizons.

Database contents

The MARTHA database currently contains information about 5416 soil horizons belonging to 1358 soil profiles. Figure 1 outlines the location of the MARTHA's soil profiles on the topographical map of Hungary.

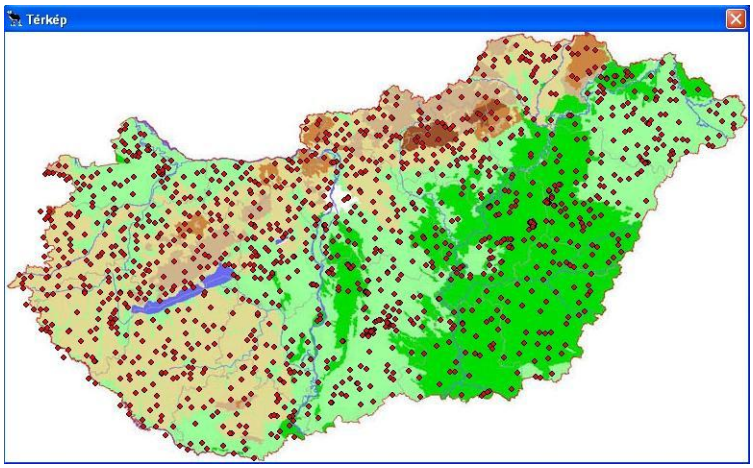

Fig. 1. Locations of soil profiles in the MARTHA (visualized by the program).

Menu structure

Language of the program is Hungarian. The management program is executed with the help of menus (Figure 2.). The user can do selection via the screen in the right-hand upper box, where the identifiers of the soil profiles, the number of their horizons and the year of the survey are displayed. The general, chemical and physical parameters of the soil profiles can be reached from the overlapping sheets.

The *General parameters* sheet contains basic information about the soil profile (identifier; origin of the sample; name of the county, where the soil profile is; EOV coordinates; GPS coordinates; soil type

and subtype), picture of the selected soil profile (this option has not been activated yet), location of the selected soil profile on the map (it is possible to visualize the position of the soil profiles on the Google Map), horizons of the selected soil profile (name of the horizon, depth of the horizon).

The *Chemical parameters* sheet stores data about the pH_{H2O}, pH_{KCl}, calcium-carbonate (%), salt content (%), changeable Na (S%), humus content (%) and the CEC.

The *Physical parameters* sheet holds the following parameters: pF values (vol %) (pF 0, pF 2.5, pF 4.2, pF 6.2); particle size distribution (mass %) (0.25-2 mm; 0.05-0.25 mm; 0.02-0.05 mm, 0.01-0.02 mm; 0.005-0.01 mm; 0.002-0.005 mm; < 0.002 mm); bulk density (g/cm3); Liquid limit (according to Arany); higroscopicity (vol %); hydraulic conductivity (cm/day).

The measurement of the parameters were executed according to the Hungarian standards (Búzás, 1993).

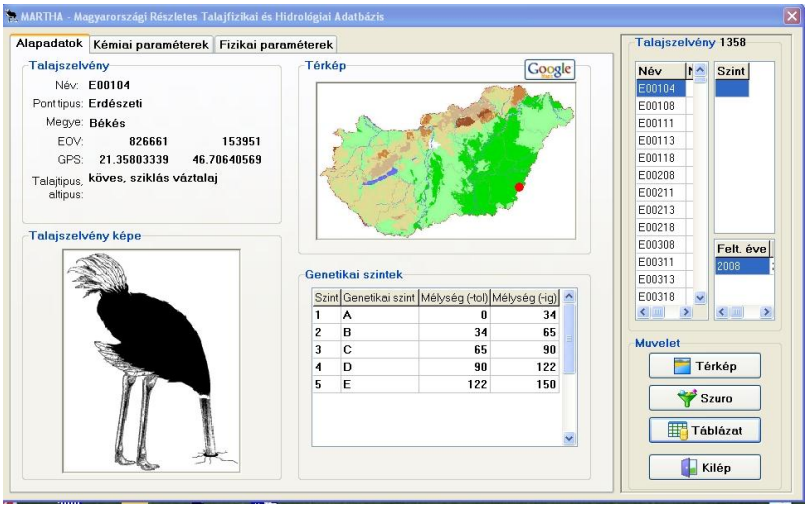

Fig. 2. Example of MARTHA menu screen.

The right-hand bottom box contains the following four modules:
Display on map. Show all the soil profiles of the MARTHA on the topographic map of Hungary.
Filter data. Choosing this option a new menu screen comes up where for all the parameters – contained in the database – can be obtained selection by giving the criteria. After selection just profiles fulfilling the given criteria are displayed in the main menu.
Show Table. By this option as well a new menu screen is displayed. The center box shows the table of the whole database containing the general characteristics of the soil profile. In the bottom part of the screen other parameters of the database can be added to the above basic table. This menu has three sub-modules: Statistical analysis; Export to MSExcel; Export to SPSS. The analysis gives a basic statistical analysis for the chosen parameters and the report can be saved to MSExcel. By the two export options the query can be saved into the above mentioned two program.
Exit. Logout from the MARTHA program.

Application

One of the potential applications of MARTHA is to develop and apply methods to estimate water retention from more easily measured data (e.g., particle-size distribution, organic matter content, bulk density).
We already used the previous version of MARTHA – containing less data – for our former research works. It has been applied to calculate soil hydrophysical properties (Tóth et al., 2006) on the basis of the soil information available from detailed soil maps. In an other study we prepared a category matrix

to classify the soil water regime statistically characterising the hydrophysical properties of soils (Makó, Tóth, 2007). Later on the same database we worked on to create soil groups according to their soil water retention characteristics (Tóth et al., 2008).
MARTHA has sub-modules as well, for instance one special section of it can be suitable to analyse the difference between the diverse determinations of the particle-size distribution. On other sub-module has information about the air permeability providing possibility to include this information in the estimation of the water retention.

Perspectives of database development

The next step of the database development will be to enlarge the MARTHA dataset with new measured data. The user interface of the database needs to be further developed as well. One of the plan is to connect the digital topographical model of Hungary with the soil parameters so as to add topographical parameters to the data.
In the future we plan to combine the database with the TALAJTANonc 1.0 program which contains different estimation methods to calculate soil hydrophysical properties (Fodor, Rajkai, 2005).
We would like to develop and test pedotransfer functions on the database to predict soil hydraulic properties from easily available soil data for national and local use as well. It would become a useful resource for the national researches of soil science, agricultural chemistry, environment protection and to further develop the D-e-Meter land evaluation system (Tóth 2001). Finally we would like to connect the MARTHA with the Europen soil hydrophysical database (HYPRESS).

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