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Open-Access Soil Information and Soil Classifier System

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***Abstract* — The aim of the study is to introduce the establishment of a public web based soil information and classification system and to describe its current status. The classification is based on the WRB (World Reference Base for Soil Resources), the correlation system of the International Union of Soil Sciences (IUSS). Users with various authorizations are able to gain access to the web-based portal and system providing them different kinds of activities. The visual representation of soil data is geovisualized with the help of KML (Keyhole Markup Language) files by WMS (Web Map Service) for every user. The algorithm of the WRB classification has been coded and implemented into the system according to the following groups: Cryosol, Solonetz, Vertisol, and Solonchak.**

***Key Words* — WRB, kml, soil classification, open-access, soil parameters, information system**

I. Introduction

The need for soil information has increased significantly in recent years [8]. Web-based environmental information systems and soil databases (global and regional) have been established with the purpose of satisfying these requirements. While most of the data of the global systems are accessible, in several cases users still cannot gain access to numerous (primarily regional) soil data [5], [11]. Furthermore, soil classification is not based on consistent principles. The main reason for this is the difficult assimilation and harmonization of the various classification systems of countries with the international systems [3], [9], [10]. The requirements of the rapidly evolving global infrastructure for spatial information cannot be met even by the developed countries regarding soil data [14]. For the above listed access restrictions, it became necessary to establish a public based, freely accessible and useable web-based soil database and automated classification system [12]. Furthermore, we aim to establish an innovative classification mechanism which would meet the data-information requirements and use a pedagogical parameter list. The classification is based on the WRB, the official correlation system of the International Union of Soil Sciences (IUSS). The soil classification system uses quantitative and qualitative data as well. Therefore, we are able to represent the process of classification and to optimize the result with decision processes. This requires the algorithmization of the reference groups according to the previously defined parameter list [6], [11]. Instead of the harmonization of national soil classification units, it uses the original soil survey data for the identification of different WRB units, according to the method proposed by Waltner (2010) and Michéli (2006). The disadvantages of the method are that the establishment of the algorithm is time-consuming and the errors emerging from the different methods can be eliminated only to a certain degree. Its advantage is that after having established a system, practically unlimited number of soil units can be classified automatically, therefore the analysis of large data bases is not a challenge any more.

II. Methods

The basic function of a web-based soil classification system is to provide digital access to the data stored in it [1]. According to the previous statement our main purpose is to store soil data in a soil database, and also to display and classify them by a service catalogue. The reasonable way to achieve this task is to establish user groups having different authorizations. Since our data have geospatial components, it is a natural requirement to geovisualize them for example, with the help of a web map service. During the selection process of developing tools, we attempted to prefer open-source, cost-effective therefore widely used software products. The free access and downloading were also important aspects. The application has been developed by using PHP (PHP Hypertext Preprocessor), JavaScript programming and HTML (Hyper Text Markup Language) languages. The user interface is provided by the free web template of Medialoot, which was modified in accordance with the requirements. The database is hosted by the database management system of the MySQL Databases. The visual representation of the soil sections are based on KML (Keyhole Markup Language) files. As a result, our system supports the geovisualization and sharing of soil profiles with other users in a web map (Google Maps) [15].

III. Actors and Process of Development

The system currently serves 3 actors: *Administrator*, *Classifier* and *Guest* (Figure 1). The common function of the above three groups is the access of data. The *Administrator* and the *Classifier* are both able to upload/classify data, however, the last one can only classify and update their own data. The *Administrator* has additional two privileges including the user management (creating new users with *Classifer* access right) and database maintaining with full access. This last one is necessary for creating new fields in the case of integration of further reference groups.

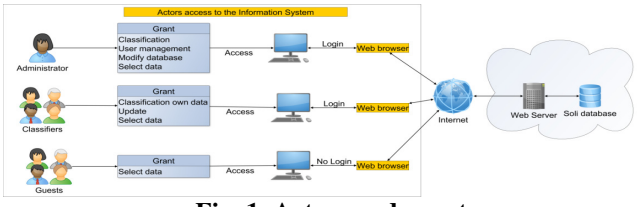

Fig. 1. Actors and grants

The process of development

Step 1: Pseudocoding of the classification processes of WRB (main groups, diagnostic levels, soil materials, properties, soil parameters)
Step 2: Planning and building the soil database
Step 3: Establishing the user groups and authorizations
Step 4: Planning and devising the user interface (forms, functions, actors, design)
Step 5: Implementation of the classification algorithm into the information system
Step 6: Database management (insert data into the uploading interface, update)
Step 7: Testing
Step 8: Identification of further development aims

IV. PROCESS OF CLASSIFICATION

For the identification of FAOs and different soil types, the system uses a three-level hierarchy. In the first level, the reference group has to be selected according to a (usually complex) criteria system (Figure 2). The evaluation of the conditions, based on the first reference group (Histosol), decides whether the soil sections could be classified among the given group or, if the conditions are not met, the next group will be tested. If the soil section does not meet the criteria of any of the reference groups, then it will be classified among the last Regosol group. After the identification of the appropriate reference group, in the next hierarchy level of the classification, the qualifiers applicable to the examined soil are chosen according to the properties associated with the group. The qualifiers are listed by reference groups in priority order. The range of qualifiers applicable to different soil groups is limited, since the occurrence of several properties can be excluded in certain soil groups in the first place, and using other properties are unnecessary because they are characteristic of every soil type. The list of the qualifiers applicable in different reference groups can be found in the tables containing the definitions of the reference groups. In each group so-called principal qualifiers and supplementary qualifiers can be determined. The principal qualifiers are indicated before the description of the reference group separated by hyphen, while the supplementary qualifiers are indicated after the description of the reference group in brackets, separated by comas.
The qualitative and quantitative parameters are required by the classification process [2], [4]. Parameters are determined during the field work; while the other ones are measured in the laboratory. We have to remark that the list of parameters cannot be considered definitive at the moment since only the Cryosol, Solonetz, Vertisol and Solonchak main groups have been involved into the algorithmization yet [7].

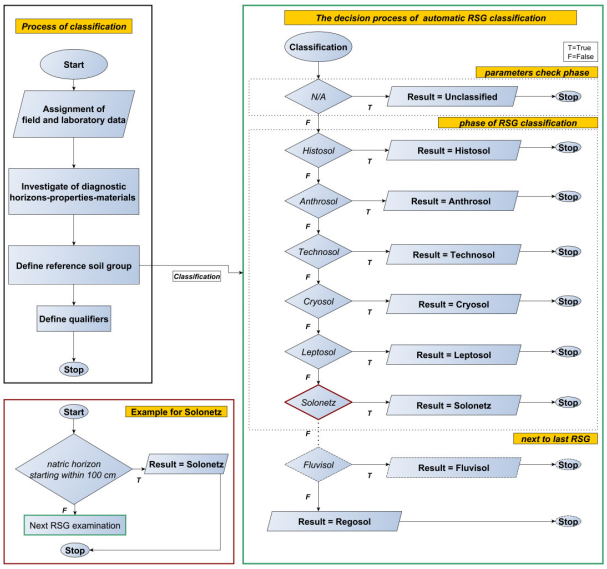

Fig. 2. Process of classification

V. RESULTS AND DISCUSSION

Based on the original concept, the beta version of a task-specific soil information system has been established, which is applicable in multipurpose digital soil mapping methods as well. The structure of the user interface is different depending on the current user type. The ones with Guest authorization are able to gain access to the information system via a web browser. All of the actors can browse the soil data and the geovisualized sections. The entire database (Figure 3) can be queried and displayed without logging in it. Every user with Classifier authorization has to be registered, when a user name and password are set for them. At this level the uploading of soil sections and automated WRB main group classification are allowed through a form (Figure 4). If a user would like to share his results, then the recorded data can be saved/updated expanding the point database. The spatial data and soil section databases can be uploaded independently of each other. Every uploaded and classified reference section and previously dedicated sampling place can be searched, reedited and replaced by cross-referencing the real-time spatial and the field data. In addition, this information allows the examination of spatial expansion, the reambulation of spatial data and the dedication of monitoring points based on the conclusion, if necessary. Therefore, a consistent data system is available for further research, which has a maximized data content, a unified methodology background and some metadata have been added as well.

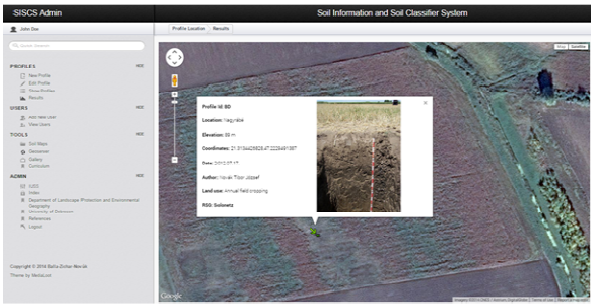

Fig. 3. Map view of Guest Interface

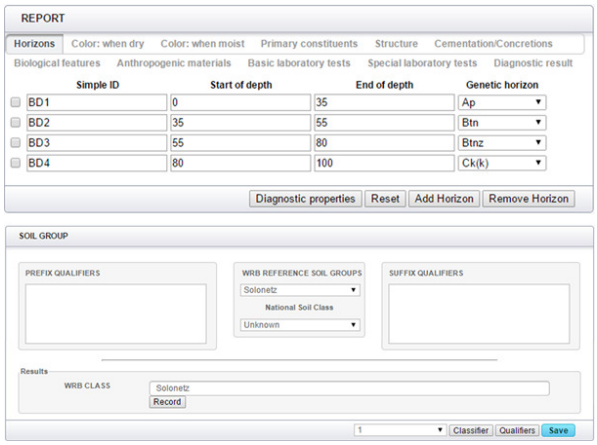

Fig. 4. Classification interface of SISCS

In 2010 Eberhardt and Waltner proposed an automatable methodology, which was different from the previous primarily correlation and harmonization based national systems. The main characteristics of the proposed method are that instead of the harmonization of the national soil classification units, it uses the original soil survey data for the identification of different WRB units. In order to achieve this, the necessary algorithms need to be established separately for each database with different methods. The disadvantages of the method are that the establishment of the algorithms is time-consuming and the errors emerging from the different methods can be eliminated only to a certain degree. Its advantage is that after having established a system practically unlimited number of soil units can be classified automatically, therefore making possible the analysis of larger data bases. In accordance with this, using the list of parameters proposed by the FAOs, it is possible to enter the WRB classification criteria by the best effort method and to pseudocode the main groups. Originally, the beta version of the system has been coded to the Cryosol, Solonetz Vertisol and Solonchak groups, however, due to the great data requirements of WRB, the algorithmization works are currently still in progress. The correlation system of the WRB, the parameter list of the FAO integrated into the SISCS (Soil Information and Soil Classifier System) makes the sampling and the classification purpose-directed and therefore making the field and laboratory work fast and effective. Relatively large areas can be (re)surveyed and characterized by the updated soil properties, which were defined in the revisited or replaced representative soil sections, the representativeness of which can be verified based on the SISCS as well. On the other hand, if a detailed soil survey is conducted in a given area and the collected data are thematically compatible with the SISCS, its result can also be integrated.

Reflecting to the needs of users, the established soil database and information portal is a continuously developing data warehouse. The pseudocoding and the implementation of the classification algorithms - expanding the database and the list of parameters - are in progress.

In the future, we attempt to make the uploading of the sampling record available by tables for the offline application. Our further aim is to allow the users to query and display dynamically the most important field-laboratory results in the case of each section with diagrams. The system is currently being tested in the intranet network of the Centre of Earth Sciences at the University of Debrecen. From December 31, 2015 the system will be publicly accessible for the internet community at the website of university.

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