INFOSOIL – AN INFORMATION-REFERENCE SYSTEM FOR SOIL RECOGNITION AND CLASSIFICATION IN RUSSIA

V. A. Rozhkov[1], S. V. Rozhkova[1], P. V. Kravets[2], D. E. Konyushkov[1]

[1]V.V. Dokuchaev Soil Science Institute, Russia, 119017 Moscow, Pyzhevskii 7, bld.2 e-mail: rva39@mail.ru

[2]National University of Bioresources and Environment Conservation, Ukraine, 03041, Kiev, Geroev Oborony str. 15

INFOSOIL is a new information-reference system aimed at elaborating purposeful classifications of soils by using a definite set of soil features. The stages and procedures of this system permit to determine the maximum number of objects taking into complete account their most informative features, the method and quality of objects grouping into classes as well as to recognize newly presented soils to be classified. This system should be named as a generator or engine of soil classifications developed for different purposes; it is based on the concept of enumeration classification, thus connecting a totality of soil features to meet requirements of the soil classification. The amount of features (classifier positions) determines the maximum number of objects and brings them in correspondence. It is shown how is realized the suggested approach in practice; the position of soils in the classification system is indicated. In this paper the first INFOSOIL version (www.infosoil) is presented to show the development of its real possibilities and accessibility for users and classification authors. In the system the interfaces are envisaged with the soil-geographical database, the State register of soil resources and the Soil map 1: 2.5 MIn its essence the system contains the soil classification system widely adopted now (2004), the automated guide to determine the soils (2008) and creates all the conditions for its further development. INFOSOIL has being elaborated as an intellectual information system that includes the MERON system, algorithm means to create new enumeration classifications as well as to use and study the available classifications.

Keywords: classification theory, enumeration classification, classification generator.

INTRODUCTION

INFOSOIL as an information-reference system is aimed to create the tools for elaborating purposeful classifications and soil recognition. To describe the most representative soils, a definite set of soil indices was taken in the “Program of Soil Map” (1972) and “Classification and Diagnostics of Soils in Russia” (1977). The system has three blocks of soil description: enumeration of all the indices for soil genetic horizons, the distribution types of substances and properties along the soil profiles and the block of soil-forming factors.

The profile-genetic principle is of major importance in this system. The first attempt in this direction which was rather new for elaborating the soil classification was made by V. M. Fridland in his publication of 1982 (Fig. 1). The list of soil indices was subjected to changes and generalized in “Methodical Guide” (1986). The total amount of soil indices, presented in corresponding classifiers served as an information base for soil classification [16, 21].

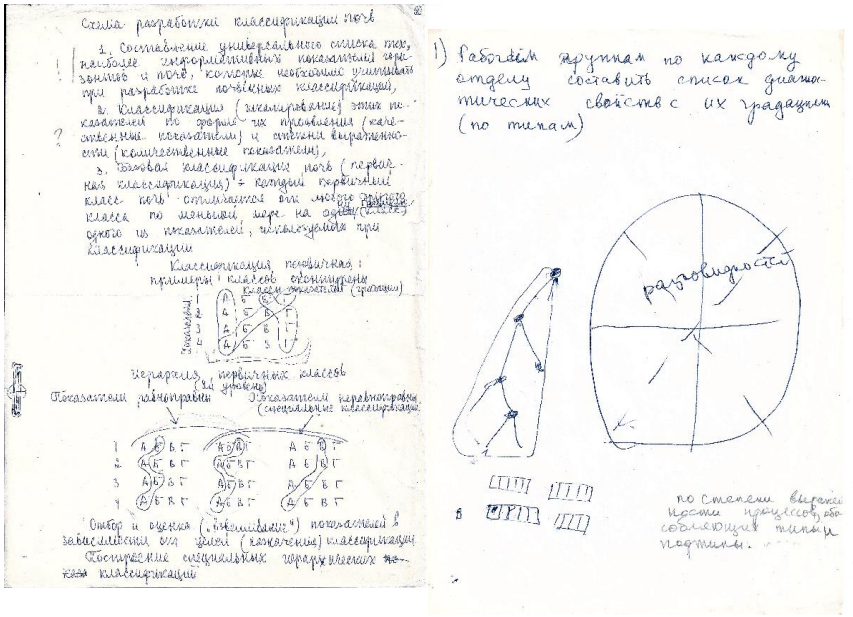


Fig. 1. Fragment of a manuscript V.M. Friedland.

The description of the most distributed soil types was presented by competent researchers (V.D. Tonkonogov, I.I. Lebedeva, N.I. Belousova, V.S. Stolbovoy and others) and used as standards for recognizing new soils to be described by indices enumerated in INFOSOIL.

The methods of digital classification permit to create automatized groupings of soils with description of their profiles [18, 22, 23]. In dependence on the amount of initial data it is possible to give the required assessment of informative features and to formalize the rules for recognition of new soils.

The present version of this information-reference system should be considered as the first stage of elaborating Web-portal – generator of soil classifications for definite purposes. Two approaches found an application. The first approach includes the concept of the information base for classifications realized in the MERON system [16, 27, 28, 30, 31]. This concept is a key for elaborating the information system. The second approach is oriented to use the data taken in available soil classifications, to analyze and generalize them by means of the MERON system and methods of digital classification. The first approach makes it possible to visualize the classification structure using the expert descriptions of soil types, classifiers of features and the recognition procedure of new soils. In this case the soil to be recognized is described by using the indices of soil horizons, profile distribution of soil properties and/or soil-forming factors included into the system. The comparison with the expert descriptions of soils allows recognizing their similar features or properties to find an analogue and synonyms in the other classifications [6, 7, 32]. As was said above, the second approach is based upon the profile-genetic characteristics of soils given in the soil classification of 2004, the latter being used as an initial material for the information base for classifications created by formal methods.

It has been noted that the scientific principles of soil classifications are urgently required, because the classification can be changed but the principles of its elaboration remain unchanged. However, the soil classification of 2004 is an expert work reflecting the experience and knowledge of the authors. The amount of indices for genetic horizons is insufficient and needs to be supplemented by definite indices of properties and composition of soil. Thus, the soil classification elaborated in 2004 should be subjected to revision towards the unification of

principles and formalization. It serves only as a source of data for elaborating the INFOSOIL system.

THE THEORY OF PROBLEM

Classification is a method to apprehend the objective reality. This is a process, a process result and a procedure for recognizing any object or situation. The aim of soil classification is determined by the amount of definite features and their gradation [19, 20]. It can be exemplified in the following way: gradation according to the humus content in soil: 1- weakly humus, 2 – moderately humus and 3 – highly humus; the gradation according to the oxidation degree: 1 – low, 2 – moderate, 3 – high or according to the third soil feature 1 – base-saturated, 2 – unsaturated. In this case the classification-enumeration has 18 possible objects (Fig. 2) and the other combination of gradations and properties cannot be in the given classification [1]. On the contrary, there are the other combinations, for instance the saturation of highly acidic soils. Such a surplus of gradations doesn't hinder the organization and analysis of data but keeps the balance of classification. The rearrangement of soil properties doesn't change a number of the described objects. At the same time it is feasible to see that a new feature is capable to change the classification. For example, the fourth feature in Fig.2 shows that this classification contains already 54 objects instead of 18[1].

A very simple and correct procedure to elaborate any classification is the following: the soil features are taken in ordinal or nominal scale, the classification-enumeration determines a number of all possible objects among these features, their description and coding [18]. These descriptions prove to be the most representative images for soil scientists. The soils newly presented and described by features that are similar to the representative ones will form empiric classes of soils*. Of course, when they are far from representative features there will be

[1] There is a computer program permitting to give a number for the soil according to the enumeration of its features in classifiers or this number helps find the soil description. For instance, the soil under number 6 has description 1-3-2, the soil under number 18 – 3-3-2.

no possibility to avoid a subjective description of these soils. With accumulating the vast volume of data some classes can be combined into one class. The selection of similar features and criteria for the quality of classes are determined by known formal methods [18, 20, 25].

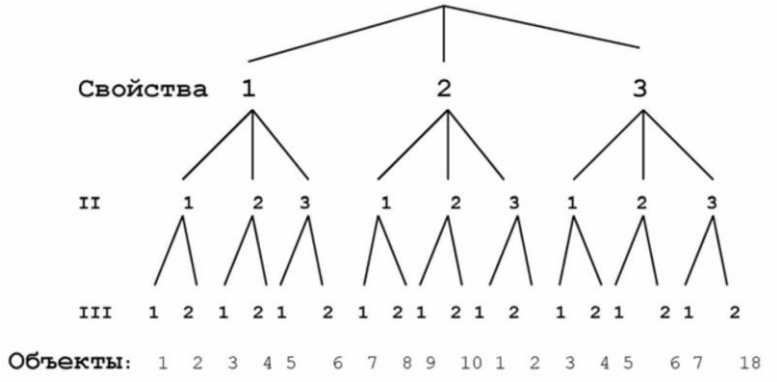


Fig. 2. Example of the classification-listing.

The non-rhetorical question is arisen: why does everybody think that the classification must be elaborated as based upon the features but doesn't use their total amount for all the soils. Obviously, it happens due to disregard of logic and formal judgments. The classification authors have the idea about the content and structure of the future classification and adjust the features and taxonomic levels to it. The approach of classification-enumeration permits to group the soil features according to different kinds of classification including substantive, factorial, etc. The essence of such a grouping will be discussed in terms of the composition of soil features evidenced by experiments. The description of this approach was exemplified in publications about the theory of soil classification [17, 19].

The mathematical apparatus of digital classification permits to assess quantitatively the classification results [18, 20, 21]. Particularly, it makes possible to find combinations of the most informative soil features, to assess the quality of classification, to compare the features between each other and to formulate the rules for soils to be recognized.

The qualitative and well organized information base is required to realize the described approaches for soil classification. A new ver-

sion of the information system accessible on site www.infosoil.ru is a stage in creating this information base.

CONTENT AND STRUCTURE OF THE SYSTEM

The figures presented in this paper demonstrate some examples how to use the possibilities of the information-reference system in interactive regime. They need no special explanation and the further text is designed for those who don't use Internet.

The menu structure. In the upper part of the site page there are references for transition in the other sections. They are accessible for any user. In the left part of the page the section "Thematic maps" contains references to Soil classification of 2004, Soil-geographical database [26] and State register of soil resources in Russia (2014). The references to papers containing the information on this system are given in the lower part of the page.

The structure of the thematic part. The thematic part is divided into several information blocks.

– visualization of the list of soils in alphabetical order;

– total and unified description of soil types in the system of classifiers.

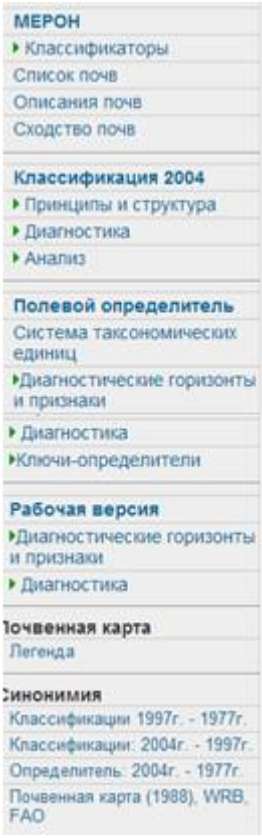
The classifiers in the MERON system have three groups: Factors, Profile and Horizon.

General information. A list of soil types according to trunk and order is presented which have been described by the other authors. There is a list of authors as well. Having chosen a soil type, it is possible to find its description in the MERON system.

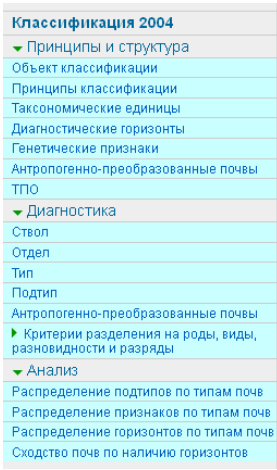
Description of soils. The soil description is taken in menu indicating the author described this soil. The most representative soil properties are blue-colored in table.

Comparison of soils in the database. It is possible to find a similarity level for the chosen soil and horizon. There is a list of soils, the description of which well agrees with the selected soil. The soils are compared according to horizons and a definite set of features. The red-colored values are given to compare the soils. For instance, in table of properties – Factor – polar climate is indicated. As a comparison result – a list of soils developed under conditions of the polar climate.

Soil study according to horizons. In this section the soil can be studied by the presence of horizons. Soil analysis – horizons, horizon analysis – soils



Block – Soil classification of 2004. The soil classification of 2004 and "Field Determinant" of 2008 serve as a basis for this block. The structure is the following: – general description,



principles and structure
system of taxonomic units
diagnostic horizons
genetic features
human-modified soils
technogenic superficial formations (TSF)

Diagnostics

Trunk – its description is given together with a list of orders within this trunk.

Order- its description is given together with a list of soils within thin order; there are also a scheme of profiles and a list of subtypes and features of these soils.

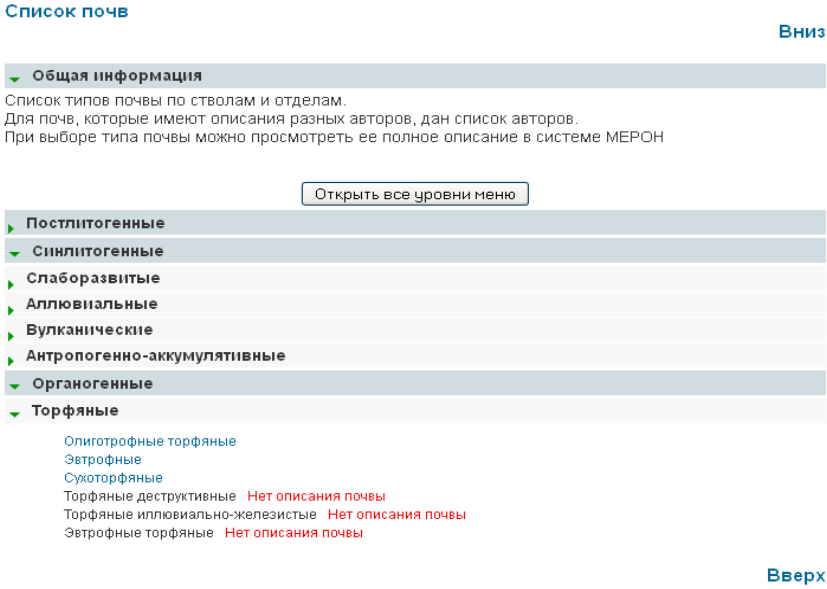
Human-modified soils – their description and a list of orders are presented.

Criteria for distinguishing genera, species, varieties and phases of soils

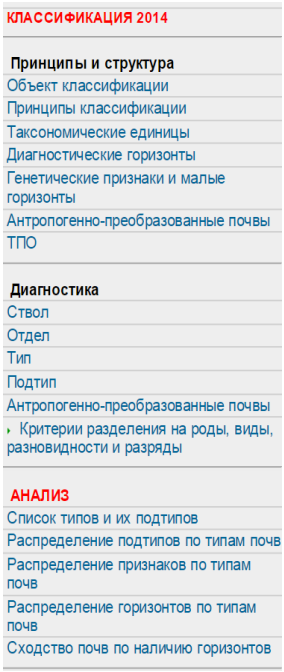
Key-determinant of soils – it is possible to diagnose the trunk, order, type or horizon using a system of keys-determinants. Having answering the question, the user obtains the results.

Description

Diagnostic horizons



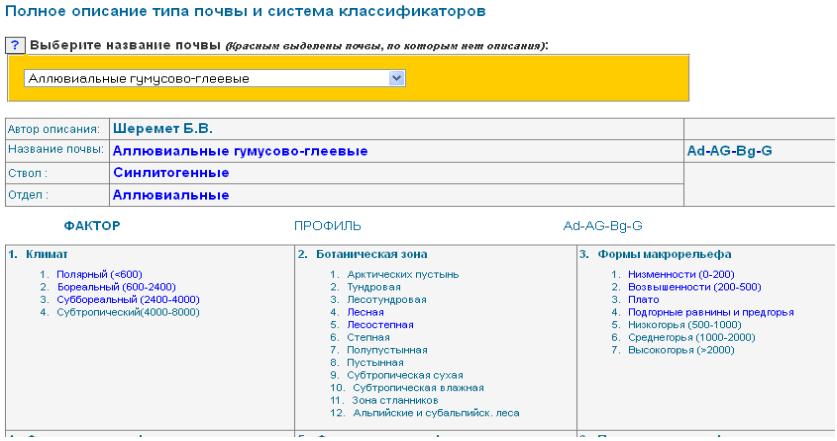
Block – the working version – at present, a version of 2014 has being elaborated to combine the information of previous versions; it will contain the newly obtained data about the soil classification. The aim is to maintain the version of 2004 and new data presented in version of 2008. The Infosoil system contains the information on the correspond-



ence between different versions, thus keeping their succession. It is constantly added by new specified data. The programs are optimized with the view of improving interface and their code. In contrast to the main menu where the point Analysis was referred to the classification of 2004 in the working version we regarded this point to the combined version of soil classification of 2014, where it will be feasible to see the distribution of horizons in soil types. Having chosen a horizon, the user obtains its description and a list of soils with this horizon.

Block Soil Map - a systematical list and cartographical indices of the main types and subtypes of soils in Russia are present.

Block Synonymy – comparison of soil classifications elaborated in different years. There is a possibility to see the available information on orders, types of soils.

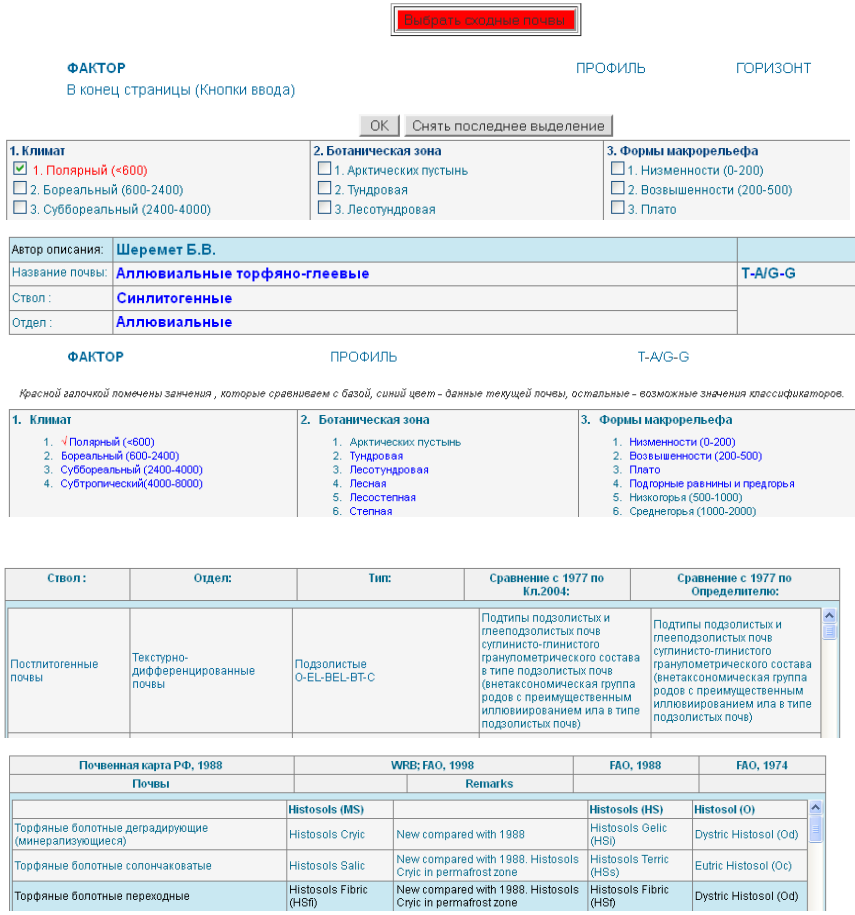


Comparison between soil classifications of 1997 and 1977 – the review of similarity and differences between these versions of soil classification.

Comparison between soil classifications of 2004 and 1997 – having selected a soil type, it is possible to find its correlation with the other classifications.

Correlation of terms – in Field Determinant of 2008 and Soil Classification of 1977.

Correlation between the Soil Map of Russia, M 2.5, WRB and FAO.



INFOSOIL doesn't exhaust its possibilities. The information base of soil classifications and the author's classification of 2004 are used as an information basis and program-algorithmic apparatus of generator for diverse purposeful classifications according to soil indices.

CONCLUSION

INFOSOIL should be considered as an information base for the knowledge with its possibilities to recognize new soils and synonymy of available soil classifications. The acceptable cheep program means were used to elaborate this system. Domen http://infosoil.ru in site of hosting company http://timeweb.ru., that provided technical and program support required to realize the concrete task: MySQL, 5, PHP 4/5, Zend, phpMyAdmin, etc. The program language is HTMLPHP5 and JAVAscipt are tested now. Under consideration is also the use of Open Source CMS, but it is necessary to approbate and correlate the databases and program solutions. It can be added by photos of described soils and banks of attributive data.

INFOSOIL is the second stage in elaborating the information basis of generator (machine) of classifications and will be integrated with the Soil Map at a scale of 1 : 2500000 and the State register of soil resources in Russia.

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