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"UKRAINIAN SOIL PROPERTIES" DATABASE AND ITS APPLICATION

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The structure and the main characteristics of the multi-purpose soil database "Ukrainian Soil Properties", designed on the basis of the data of long-term soil studies comprisin, analysis of the samples and mapping of the soils are presented. The attributive data for the 2,075 soil profiles are ranked and grouped into nine separate thematic tables. The key field of each table is the indexing number for the soil profile. It ensures a genuine link between the profile sets of attributive data and the cartographic units on the soil maps in the different scales, on the map chart of economic and agricultural zoning and the administrative map of Ukraine. The main indicators of the soil properties were determined; the legends of both Ukrainian and the WRB classifications were used to code the names of soils. The main results of scientific research were listed, including the ones, obtained in the framework of international projects, implemented using the mentioned database.

Keywords: database, soil, attributive data, soil properties, profile.

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INTRODUCTION

The "Ukrainian Soil Properties" Database was designed using the data of the field studies of agricultural soil properties, which were carried out by the specialists of the National Scientific Center "Institute for Soil Science and Agrochemistry Research named after O. N. Sokolovsky" (NSC ISSAR, Kharkiv, Ukraine), and the numerous publications of scientific reports of soil scientists of other institutions (total of 60 references) were used.

The first generalization of the field research results (for 300 soil profiles) was completed in the mid 1980s and published (Reference book of soil agrophysical properties the Steppe zone of Ukraine), under the editorship of P. A. Gavrik) [1]. This book stimulated and initiated creation of the electronic database of soils in the 1990s.

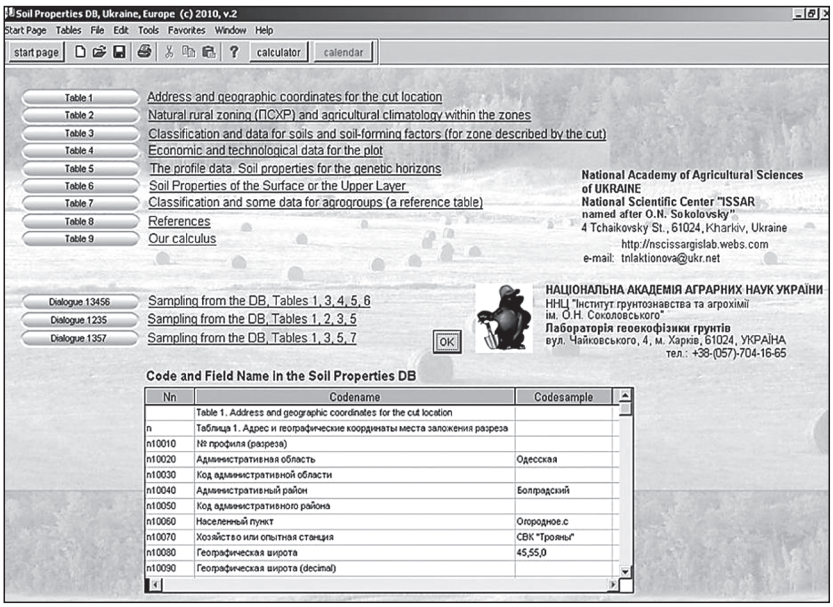
In the course of several years a great amount of archive and published materials were collected, processed and transformed into electronic tables of the database. In addition to scientific reports, the data ware also obtained from soil outlines, and were composed using the results of mapping in the administrative district scale. The original protocols of laboratory analyses and other related materials from the Institute archive were used.

Now the database contains 2,075 (the number is constantly growing) described soil profiles, located at the territory of Ukraine, as well as all the necessary characteristics of soil forming factors and other environmental properties. Today it is a digital multipurpose soil database of attributive information with the management system (DBMS) of the relational type. The object-oriented visually programmed language VisualFoxPro of Microsoft with rushmore-technology of inquiry optimization was used as an instrument for DBMS creation [2].

STRUCTURE AND SPECIFICITIES OF DATABASE CONSTRUCTION

All the attributive data are grouped according to four spatial levels:

– Units of administrative division of the country (region, district, settlement);



Starting page of "Ukrainian Soil Properties" database (UkrSPDB)

– Spatial units of Nature-agricultural zoning (NACZ) (zone, province, okrug, district);

– Soil polygons on the maps of small (1:1,500,000) and medium (1:750,000; 1:200,000) scales;

– Genetic horizons (with individual indexing number, upper and lower horizon boundaries in the profile framework) and layers of sampling (with individual indexing number, upper and lower layer boundaries in the horizon framework).

Therefore, one or several soil profiles in the database may present soil properties in a soil polygon on the map. The number of soil profiles in the testing area of a small scale map will be higher than that in a medium scale.

The taxonomic units of Ukrainian soil classification are used in the procedure of registering the profile information (type, subtype, sort, kind, parent material, texture) [3]. All the data are collected into nine two-dimensional tables. Each table contains a thematically selected group of parameters. A starting page of the database is presented in Figure.

TABLES: CONTENTS AND PURPOSE

Table 1. Address and geographic coordinates of the soil profile location. Table contains 21 fields with the information about the administrative region, area, geographic coordinates, place in the system of Nature-agricultural zoning (zone, province, county and district) *etc*.

Table 2. Natural and agricultural zoning and climate. It contains the main data about climate, landscape and specificities of soil cover structure (total 55 fields), presented in the section of each spatial unit of NAZ. The Table also contains the data regarding almost all the major criteria, used in SOTER-methodology of zoning territories (climate, parent materials, landscape, vegetation, soil cover) [4, 5].

Table 3. Classification of soils and main characteristics of soil-forming factors. 25 digital fields with attributes to define the place of a soil profile in the Ukrainian system of soil classification; normative reference books are used to code the soil morphological features [3].

Table 4. Economic and technological characteristics of a plot. 10 fields with the information about the yield of the main agricultural crops, the rating of locality quality within the limits of a soil polygon, about economic and technological characteristics of the field or a land plot with the profile section slit.

Table 5. Profile data. Soil properties in genetic horizons. 112 fields of the Table contain information about the parameters of soil properties within the limits of each genetic horizon, the layout of sampling or measurements *in situ*. The measurements in the upper genetic horizon were usually carried out in 2–3 layers at the specific depths.

The information for most studied profiles is presented by the following indices:

– index of soil horizon, upper and lower boundaries of the horizon and the layer of sampling;

– general physical properties (bulk density, solid phase density, total porosity, *etc*.);

– water and physical properties (field water capacity, permanent wilting point, water holding capacity, soil permeability, *etc.*);

– particle size distribution by Kachinsky's method and the class of the particle size according to USDA/ FAO classification, calculated using a specially developed method [6];

– microaggregate composition (by Kachinsky's method);

– structure composition (percentage of macroaggregates of different size – from 0.25 mm to 10.0 mm);

– stability of aggregates in water (percentage of water-resistant aggregates of > 0.25 and > 1.0 mm);

– physical and chemical properties (pH H_2O and pH KCl, exchange acidity, exchangeable cations, organic carbon, humus);

– toxicological characteristics (percentage of heavy me-tals of mobile forms).

Table 6. Soil properties in the surface layer. It consists of 10 fields with the data related to water-permeability of soil, stoniness and other properties.

Table 7. Agrogroups of soils. The averaged data, characterizing the soil properties of the agrogroup, which includes the studied profile in the framework of each map-unit of NAZ are presented (profile capacity, humus horizon capacity, humus content in the upper layer of soil, area of soil, used in agriculture within the province, *etc*.)

Table 8. Sources of information and methods of analysis. The Table contains data about the sources of relevant information on soil profiles: type of information, place of publication, name of the publishing house, name of the author, methods of estimation each property, and references to the sources, where the methods of analyses are described.

Table 9. Estimated parameters. The Table is intended for keeping of previously calculated data, including the information, obtained using the methods of pedotransfer models.

The data are grouped into tables either in the original form (for instance, measured parameters) or in the form of codes and classes in accordance with the national system of soil classification. 38 special directories are used to code the data. The records are mainly in Russian, but the names of tables, fields and legends in the references are duplicated in English. The profiles are related to the maps of Ukrainian soils of different scales. It ensures the possibilities for detailed and integrated estimation of soil cover quality.

THE AREA OF DATA APPLICATION

The data are used in scientific research of NSC ISSAR, conducted in several main trends:

Analysis and rating of spatially distributed specificities of physical properties of soils. Several scientific monographs, describing the main physical characteristics of Ukrainian soils, were prepared using the database.

The description of the structure of Ukrainian soil cover and the characteristic of the main soil properties were first presented in English publication. The results of the estimation of the degree and distribution of soil degradation have also been demonstrated [7].

The information on the bulk density of Ukrainian soils, *i. e.* composition – geography, profile distribution for dominant soils, model and modal parameters for virgin soils and ploughed soils, were presented. The analysis and mapping of the data allowed us to suggest the approaches to the diagnostics of soil quality and estimation of its current condition [8].

The comparison of the structure of main Ukrainian soils in the arable layer and deeper layers allowed us to suggest original indicators for the monitoring of structural condition of soils [9].

The data about granulometric composition of soils and parent materials in Ukraine have been generalized. Different aspects of their using have been described, in particular, interpretation, simulation and forecast of the soil properties and migration processes, estimation of soil inclination to aggregation/deaggregation, sorption/ desorption, deformation, abrasion and other phenomena, to develop the different types of zoning [10].

The parameters of the soil water-physical properties were as a subject for the cartographic-analytical estimation both for the whole territory of Ukraine and the specific natural zones. The comparison of the soil and climatic characte-ristics yielded the information about the water capacity of soils (including the content of plant available moisture) while growing the winter wheat, barley and sugar beets. The analysis has shown nature-agricultural provinces with the most and the least favorable conditions of water supply for agricultural crops [11].

The index of soil physical quality for any region of Ukraine may be calculated with the help of the database. The laboratory of geoecophysics of soils suggested using the database to search for reference indices of soil physical quality (for specific type and granulometric composition) [12]. The comparison of the quality of any soil and its reference serves as an efficient instrument of objective estimation of agronomic suitability of soil.

The cartographic analysis of all the main soil physical characteristics has been collected in one monograph for practical application of this information while justifying the ways of soil tillage [13].

Search for statistical regularities in the interrelations of soil properties. The use of a large amount of data related to the granulometric composition allowed us to carry out the study and to prove the possibility of the transition (re-calculation the data) from the results of the analysis of the particle size distribution according to Kachinsky to texture classes according to FAO-USDA. The coefficients of variation of soil physical parameters in selections for close texture classes are similar for both classifications, the same is true for the correlation coefficients of the content of key fractions with physical properties [6].

Due to the statistical study of the relations of the soil hydrophysical constants and physical soil properties it is possible to determine the relative availability of the moisture for plants in soils of different texture. It was revealed that a considerably larger part of water capacity in light soils belongs to available moisture compared to heavy soils [14].

The hypothetic areas of distribution for degraded chernozem have been defined using the database. The maps of Ukraine's soil susceptibility to physical degradation have been created [15].

Pedotransfer simulation. The regulation of the collected data was used to develop the pedotransfer models to estimate the different physical properties. The example may be found in the calculation of permanent wilting point for chernozem soils using the data about the content of three granulometric fractions − 0.01−0.005, 0.005−0.001 and < 0.001 mm (using Kachinsky's classification) [16].

The data, collected in the "Ukrainian soil properties" database, were used to create several pedotransfer models (linear and quadratic) to forecast different soil properties using the data processing for fraction content of under 0.01 mm and percentage of humus [17].

Mapping of properties and regimes of soils. The map of Ukrainian soils (S 1:1,500,000) was used to develop a series of thematic maps, related to the properties of soils and lands, combined in the electronic Atlas [18].

The researchers of NSC ISSAR prepared several maps for the National Atlas of Ukraine using the collected data [19].

The data were transferred to the compiled European soil database to create the Soil Atlas of Europe [20].

Zoning of agrotechnologies, ways and instruments of soil tillage. Spatially oriented parameters of soil physical properties were used to determine optimal sets of soil-tillage equipment with specific weight and pressure on the soil surface. The databases were used to develop the legends of maps of the compliance of Ukrainian soils to the method and depth of tillage as well as to the types of equipment and maximal intensity of pressure upon soil, which were used as a basis for the Soil Technological Zoning of Agricultural Land [21].

The analysis of a considerable amount of data was used to suggest the list of key criteria for the determination of agronomic quality of lands using the method of monofactor and integrated estimates for land zoning. The system of rating parameters for the classification of land quality using the criteria of complex agronomically oriented zoning was developed [22].

The distribution of plough soils of Ukraine by the parameters of the main physical characteristics (in % and ha) was completed and used as a basis for the development of the concept of the transition of Ukrainian agriculture to soil-protecting systems of soil tillage with the consideration of their suitability [13].

Estimation of soil quality and forecast of the investment attraction of plough lands. The resources of the soil database are efficiently used to search for new approaches to the estimation and scientific interpretation of soil properties to solve practical tasks.

A new modern approach to the evaluation of soils taking into account their properties, specificities of land use and climate was successfully implemented using the multifunctional soil database [23].

The integrated estimation of soil fertility, climatic and agroindustrial specificities of land was used to determine the comparative agroinvestment attraction of

agricultural land of Ukraine [24] within the framework of natural zones.

The data have been included into several integrated databases, created during the realization of international scientific projects, for instance:

− The Project of Mapping the Soil and Terrain Vulnerability in Central and Eastern Europe (SOVEUR) [25];

– INCO-Copernicus Concerted Actions on Subsoil Compaction [26];

– Integrated database of soil resources of Russia, Ukraine and Belarus [27];

– European Hydro-Pedological Data Inventory (EU-HYDI) [28].

Therefore, the database of the soil profile characteristics, developed in the laboratory of geoecophysics of the soils in NSC ISSAR, is an important source of information both for scientific research and for tsolutions of practical tasks, related to spatial specificities of the soil cover of Ukraine.

База даних «Властивості ґрунтів України» та її використання

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Представлено структуру й основні характеристики багатоцільової ґрунтової бази даних «Властивості ґрунтів України», створеної на основі матеріалів багаторічних ґрунтових обстежень, аналізу зразків і картографування ґрунтів в Україні. Атрибутивні дані для 2075 ґрунтових профілів упорядковано і розміщено в дев’яти окремих тематичних таблицях. У кожній таблиці ключовим полем є порядковий номер ґрунтового профілю, чим забезпечується стійкий зв’язок профільних наборів атрибутивних даних з картографічними одиницями в картах ґрунтів різних масштабів, картосхемі природно-сільськогосподарського районування і в адміністративній карті України. Визначено основні індикатори ґрунтових властивостей; для кодування назв ґрунтів використано символи української класифікації, а також класифікації WRB. Перелічено основні результати наукових досліджень, у тому числі в рамках міжнародних проектів, виконаних із застосуванням бази даних.

Ключові слова: база даних, ґрунт, атрибутивні дані, властивості ґрунтів, профіль.

База данных «Свойства почв Украины» и ее использование

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Представлены структура и основные характеристики многоцелевой почвенной базы данных «Свойства почв Украины», созданной на основании материалов многолетних почвенных обследований, анализа образцов и картографирования почв в Украине. Атрибутивные данные для 2075 почвенных профилей упорядочены и размещены в девяти отдельных тематических таблицах. В каждой таблице ключевым полем является порядковый номер почвенного профиля, чем обеспечивается устойчивая связь профильных наборов атрибутивных данных с картографическими единицами в картах почв разных масштабов, картосхеме природно-сельскохозяйственного районирования и в административной карте Украины. Обозначены основные индикаторы почвенных свойств; для кодирования названий почв использованы символы украинской классификации а также классификации WRB. Перечислены основные результаты научных исследований, в том числе в рамках международных проектов, выполненных с применением базы данных.

Ключевые слова: база данных, почва, атрибутивные данные, свойства почв, профиль.

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