

The soil bank models for information support for the training of agrarian specialists

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Abstract— Agricultural establishment requires information on a complex natural object – the soil, which is the main productive force of agricultural production, and the information must be timely available. The experience of creating material and virtual soil bank models, attracting its funds for educational activities, is proposed. The scientific concept of creating soil bank models reflects the processes of formation, development and evolution of soil, depending on the natural and environmental factors of soil formation. The methodology of assemblage, processing of stock materials, the stages of the formation process, the design of exposure and collections of soils of the world, of Russia, of the flat and mountainous territory of the Southern Ural, of individual enterprises of the agricultural sector; and their translation into 3D models are revealed. Biological, technological, aesthetic and other aspects of the soil cover, the factors of its formation and degradation are shown using systematic, thematic, integrated and landscape methods of forming exposures. The methods and principles used to create a soil bank make it possible to study the processes and phenomena occurring in soils in an environment of increased anthropogenic impact and to scientifically answer the questions of the current state of the soil cover. This makes it possible to conduct an educational process at two levels of communication. The use of the proposed soil models emphasizes the specificity, uniqueness, importance of the soil on a regional and global scale, provides additional research and practical experience in the training of specialists in the agricultural sector, conducts educational activities at a higher level of scientific generalization unlimited in time and space, conduct monitoring research and predict the state of the soil.

Keywords—digital education, soil, museum, soil bank, virtual model, material model.

I. INTRODUCTION

Digital technology today is the basis of economic development. However, the beginning of the digital economy is digital education. For the agricultural sector, it is necessary, first of all, to have complete and accessible in time and space information about the main productive force, the means of production and the product of labor - the soil.

The soil body, as an ecological object, has essential features, which are hidden from visual perception. Soil properties change in the vertical direction, reflecting the regular transformations and movements of substances during soil formation, and their change occurs in the horizontal direction. Change of soil occurs gradually, expressed in the

disappearance of some properties and accumulation of others.

Misunderstanding of this complex natural object is reflected in the violation of its use and brings enormous economic and environmental damage [1; 2].

A soil specialist can spend only about thirty field periods for his entire working life during annual field trips. It is not much for finding a qualified solution of modern problems of soil degradation. The problem of agricultural education today is the separation of fundamental scientific knowledge of the soil from environmental and industrial tasks.

Soil science in the third millennium has the task of promoting and disseminating soil knowledge among young people, as well as among policy makers and decision makers in the field of environmental management [3].

The transformations in agriculture and education, outlined today by the Russian Government, force us to carry out an innovative educational process.

To understand the soil ability to degradation because of intensive use, it is necessary to improve education through the creation of real and virtual models of landscape objects.

Therefore, the creation of natural historical soil museums and their modeling in three-dimensional images provides a visual spatial representation of real soils, indicator plants, their location in landscapes, readability, recognizability of individual elements and an assessment of the relative position of objects.

II. LITTERATURE REVIEW

The soil is one of the most valuable natural formations worthy of being represented in museums. However, as an object of exposure, it is one of the most complex among other known formations of nature due to the specific features of its structure and properties, as well as the traditional concept of "earth".

For the first time, the soil was exhibited in the museum thanks to the activities of the founder of scientific soil science, V.V. Dokuchaev. On his initiative, the first soil museums were created in Nizhny Novgorod and Poltava. The soil, as an exhibit, received, together with the soil map of the European part of Russia, the Grand Gold Medal at the World Exhibition in Paris in 1900.

Currently in Russia there are museums in which stationary material models of soils are presented that are widely used in educational and outreach activities.

The Central Museum of Soil Science named after Dokuchaev is of particular historical importance (St. Petersburg).

Currently, due to the land resources crisis, the importance and role of soil museums has greatly increased, but these museums are limited in space use [4; 5; 6 and others].

The World Soil Museum in the Netherlands (WORLD SOIL MUSEUM Wageningen The Netherlands) has a great importance in information activities, where since 2014 the world soil reference collection has been presented. Information about global soil resources comes to the museum through multimedia tools, which include pads, touch screens and a large digital tablet for viewing maps [7].

This World Data Center for Soil (WDC-Soils) contains soil samples, country documentation, and a number of geo-referenced databases. They can be used to support a wide range of studies of environmental, social and economic sustainability [8]. However, a virtual soil museum in 3D models, possessing the most significant educational opportunities, has not yet been created.

Our objective is to create a bank of material and virtual soil models, which reflects the features of natural and anthropogenic modified soils, for training specialists in the agricultural sector.

We are aiming at developing a scientific concept, methodology and design of the material and virtual models of the world's, Russian, the flat and mountainous territory of the Southern Ural's soils; studying the processes and phenomena occurring in the soils in the environment of increased anthropogenic impact; attracting the funds of the collected soil bank for educational activities.

The scientific concept of this museum is based on the Dokuchaev provisions on the creation of a soil museum [9].

The scientific concept: a presentation of the processes of formation, development and evolution of soil, depending on the natural and environmental factors of soil formation through the creation of material and virtual soil bank models.

The modern soil bank, presented first in the material, then in virtual models is a comprehensive scientific knowledge base in which the interrelated and interdependent components of the biosphere are selected, studied, and selected according to criteria that take into account geographic location, the problems of use and protection of the natural environment.

The implementation of the scientific idea of the museum is carried out through expositions and collections, decoration and determination of the place in the museum for exhibits of soil, plants, rocks, minerals in accordance with modern classifications.

III. METHODS

The collection of a museum fund with a soil bank began in 2001 in the Russian Federation in accordance with the scientific concept and includes the study of the processes and phenomena of soil formation and development, their composition and properties according to the laws of

horizontal and latitudinal zones of their distribution using general scientific and special research methods.

The main method of research in soil science is used – the expeditionary along routes that meet the requirements of the scientific concept of the museum and provides for the collection of exhibits in the field.

The purpose of the expeditions is to study the soil change over the period of land exploitation under the influence of anthropogenic impact on the natural reference areas of nature and to show how high the natural productivity of land can be.

For the knowledge of the geographical distribution of soil cover, a system of methods using the achievements of the natural sciences was used, which are comparative geographical and comparative analytical methods.

On the flat territory, the method of laying soil-geomorphological profiles through characteristic elements of the landscape was used, which allows to reduce the research time.

In difficult conditions of mountainous terrain, the “loop” method was used.

Such a complex system of research organization identified three phases of work: preparatory, field and office work. The most difficult and responsible is the field period.

The result of the expeditions was the creation of the main raw materials, auxiliary and duplicate funds for the formation of a soil museum.

The peculiarity of these museum funds is their raw material base, which requires additional diagnostics by standard laboratory methods of research and development of special types of preparation for visual attractive and expressive perception of the features of soil-forming processes, soil composition and properties.

The collected and processed material was packaged in the exposition and collection of the soil museum using methods that correspond to the developed concept.

The applied systematic method includes the selection, placement and interpretation of homogeneous objects in accordance with the classification systems in soil science and related sciences. It allows to regularly replenishing the museum with similar exhibits and showing biological, technological, aesthetic and other aspects of the soil cover, factors of its formation and degradation. The structural unit of a systematic exposition is a systemic or typological series of soils, plants, and other objects of nature that affect soil formation processes.

The thematic method of collecting and completing exposures is aimed at collecting different types of exhibits, which are connected by one theme and problem. Such an exposition is a system of interrelated sections and topics whose content is due to the developed concept. For example, the collection of soil, plants, soil-forming rocks contributes to the disclosure of the essence of soil-forming processes.

A complex method combining systematic and thematic methods was used in the early stages of the formation of a soil museum for educational purposes. Complex collections of exhibits of the museum have certain content and clearly confirm conceptual plans for building expositions (mountain igneous, metamorphic and sedimentary rocks, soil-forming

rocks, soil-forming processes in the morphological features of the soil, fossils and imprints, minerals, history of the planet).

The use of the landscape method contributed to the re-creation of interrelations and interdependencies of natural components: climate, vegetation and soil-forming rocks. Soil subzones are taken as the basic structural units. Panoramic image of landscapes combined with monoliths and plants-indicators of soil located in front of it.

The construction of a virtual soil bank is based on the organization of new expeditions and the adaptation of expositions, collections of the created Natural History Soil Museum to the construction of its 3D model. The 3d Max Studio, Unity 3d and Photoshop are used in the basic model of creating such a soil bank [10; 11].

IV. RESEARCH RESULTS

A soil bank was created at the Soil Museum of the Institute of Agroecology, a branch of the South Ural State Agrarian University (Chelyabinsk, Russia), whose expositions and collections were adapted to create its virtual 3D model.

The paired study of soil formation factors, the virgin soils, pasture, arable and degraded areas of Russia allowed us to collect, study and present the material in the form of exhibits in accordance with the geographical and topographical distribution of soils.

The specificity of the museum fund is the raw material stock of nature objects, which requires additional processing, preparation, installation, as well as laboratory tests to determine the classification of belonging and the state of nature objects. For the formation of the Soil Museum we used the main, auxiliary and duplicate funds, which are the basis of the museum collection. The total fund of the museum is more than 3000 exhibits on an area of 500 square meters.

The main fund of the museum is authentic natural science expositions and collections of soil monoliths, indicator plants, agronomic ores, crafted landscape panels reproducing the natural environment, own research materials of the museum's exhibits, scientific materials of different periods of nature research by the founders of soil science and compatriots. Rocks and minerals are presented as a natural basis for soil formation.

The support fund is represented by materials that perform an additional function. These are photographs, video films, soil samples, maps, cartograms, field descriptions of soil, laboratory results.

Soil monoliths, samples of rocks and minerals, agronomic ores, plants that can be used for restoration of exposures, exchange or transfer, are assigned to the duplicate fund.

The collections include exhibits related to the geological and biological basis of soils (rocks and minerals, life forms), the evolution of the soil-forming process, cartographic and historical materials of soil studies.

There were created expositions with landscape binding, which give various information about the soil cover of the world and Russia in particular, of individual regions in

accordance with the laws of the horizontal and vertical zones of the distribution of soils.

A separate large section presents work on the study of the soils of the Southern Ural. The soil map was created and located there. Panoramic landscape exposition with soil monoliths at all taxonomic levels in natural areas and subzones is provided with diagnostic data of soils and plant associations.

Exposure of unique soils of relict forests and buried soils of Arkaim is widely represented. Global soil degradation as a result of anthropogenic impact led to the demonstration of reclaimed dumps of the Korkinsky coal mine and the Molodezhny mine for copper ore mining, degraded black soil as a result of irregular irrigation and environmentally unfounded processing technologies.

Soil monoliths are provided with specialized loose "shows" in which the morphological features of the soil are visible along the horizons. 180 monoliths of soils are presented as expositions.

Currently, the activities of the museum are: the continuation of systematic and thematic acquisition with the attraction of museum objects to the funds and the creation of a 3D model of a soil bank; educational and cultural activities; storage, study and scientific processing of stock materials; popularization of museum expositions and collections; exhibition activities; publication of research results.

The following topics are proposed in the excursion theme:

- introductory tour;
- soil - the basis of life on Earth, its functions in the biosphere;
- basis of the soil - rocks and minerals;
- precious and ornamental stones, bioliths;
- healing stones;
- morphological features of the soil;
- genesis, composition and properties of soils;
- soils of the world;
- soil cover in Russia, modern soil-environmental problems;
- black soil as a soil standard;
- soil cover of the flat part of the Southern Ural, environmental problems;
- mountain soils of the Ural;
- soils of Krasnoarmeysky district;
- land use problems;
- genesis, evolution and soil degradation;
- technogenesis and soil recultivation in the Chelyabinsk region;

Excursions in the soil museum are accompanied by audiovisual demonstrations.

V. DISCUSSION OF THE RESULTS

Due to the special geographical position, Russia has a wide variety of soils. The extensive development of black soil here has educational and historical aspects, and needs to be promoted through knowledge of the soil when training agrarian specialists, biologists, scholars and the public.

When selecting exhibits for the Soil Museum, the principles of scientific, informative, authenticity of samples were used, taking into account the landscape features of soil formation, typical morphological features. The developed types of preparation of monoliths and the design of exposures made it possible to transmit the expressiveness and attractiveness of the soil cut of highly fertile zonal and specific intrazonal soils that need to be land developed.

Special attention was paid to landscapes reflecting the use of the soil. Therefore, soils degraded by irrational use and man-made impact are of particular interest in the museum.

The process of organizing work on a natural historical soil exposition is very complex and time consuming. It was carried out in two stages: design and implementation of the plan.

The specificity of the soil museum requires some adjustments to the design of expositions to reflect individuality, educational features and the diversity of its exhibits.

The design of soil expositions took place in three stages: scientific, crafting and technical.

The scientific stage included preparatory work: study of scientific literature and creation of a scientific concept, consisting of setting the relevance of the creation, formulation of goals and objectives, plans for creating museum exhibits, the choice of methods for their implementation, themes and issues. The themes of the expositions are determined taking into account the crafting means and material capabilities of the institute.

At the end of scientific design, it became possible to develop a theme-exposition plan, in which themes, texts were alternately highlighted, exhibits were listed, including authentic ones and plaster casts, and the relative position of the exhibits in the expositions was determined.

The second stage, crafting, is the creation of an artistic project. It sets the spatial, color and light solution, and the scientific concept is embodied in the crafting ideas and images of the expositions. The result of this joint work of a soil scientist and a designer was a museum project and exhibition sketches. The decoration of the museum was achieved by compact placement of exhibits, design of expositions and the creation of labeling.

The third stage, technical design, determined the location of each exhibit, text, landscape panels.

Pedagogical and psychological factors influencing the perception of information were taken into account in the author's design development of special furniture. Taken engineering solutions for general lighting and exposure lighting.

Craft techniques and technical tools support the scientific content of the museum. The final stage of the formation of the museum was the implementation of the plan – the

installation of expositions in accordance with the scientific concept.

The principles and methods of exposition construction allowed us to create a museum of specific acquisition, show typological series of soils, features of their formation and evolution, morphology and technological properties, reveal various themes and problems of both local, regional and global scale.

The basis of the acquisition of the museum is a complete and objective understanding of the biosphere, its main component – the soil. Therefore, the applied principle of science reflects modern concepts, attitudes, classifications in soil science and related sciences.

The observance of the educational principle of communicativeness in the creation and use of a soil bank made it possible to single out publicly accessible elements and elements of an in-depth scientific character. Most of the constituent elements of a soil bank have two levels of communicativeness – information is available on the external features of the model and on the features that are hidden from perception, soil properties, and other components of landscapes (graphs, soil maps, etc.).

At the first communication level, the natural and environmental components are easily perceived: mountain and soil-forming rocks, their constituent minerals, soil-indicator plants. The system of thematically interrelated and coordinated expositions and collections is presented at a more complex second communication level.

Based on the functions of the museum, its activity has the main forms of educational activities: excursion, competition, meetings and conferences. Educational activity begins during the collection of exhibits and forms a biosphere ecological outlook. Expeditionary studies of the soil provide a visual representation of the specifics of natural conditions, where an extensive process of change and degradation of nature is observed.

The initial information about the soils is given by the material (soil bank) and descriptive (features) ecological-soil models of landscapes.

The methodology of creating and displaying expositions has made it possible to comprehensively reflect the diversity of objective human relations with nature, economic processes in society, leading to depletion of the soil cover, which was suppressed earlier.

Expositions that have cross-cutting themes, tracing time, the life of society, the relationship between man and nature are currently relevant and are becoming leading in a modern exposition display. Such stock material is Arkaim's soils, initial soils, agricultural soils, urban soils.

Currently, there is an increasing need for a comparative demonstration of the use of regional nature resources in Russia and global. This allows you to highlight the specificity, uniqueness, significance of objects of nature on a regional and global scale. The presence in the exhibitions of the soil museum of such a synthesis material on the soils of the world, Russia, the Southern Ural, individual enterprises of the agricultural sector helps to determine the place and importance of the country in global history.

Video information on electronic media contributes to an increase in the emotional, scientific and informational levels of the expositions of the soil museum.

A descriptive ecological-soil model of landscapes with a complete description of the modern soil cover of the Southern Ural is presented in the scientific works of the Soil Museum, which can concretize the museum's exhibits, be used in the educational process and in soil monitoring [14].

At an unlimited level of time and space, information about soils is provided by a model of a virtual soil bank built in a three-dimensional visualization of the initial information of the Soil Museum.

In the basic 3D model of the technology of creating a virtual soil bank, the following stages of work are provided (Fig. 1).

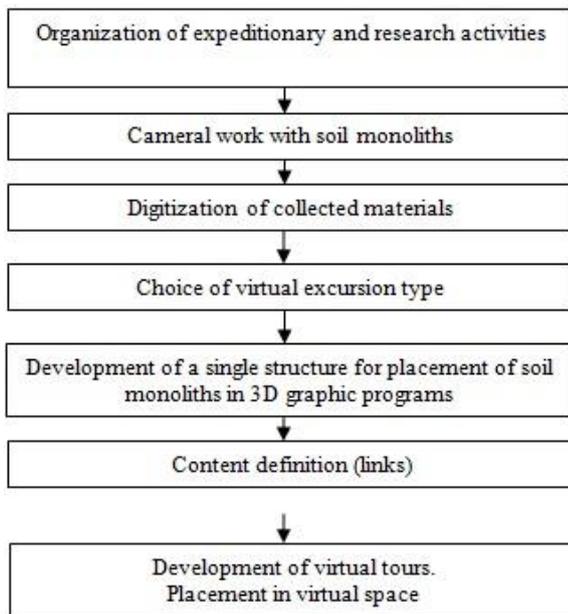


Fig. 1. The basic model of the creation of a virtual soil bank

The technology of creating a virtual soil bank using the 3d Max Studio, Unity 3d, Photoshop takes into account the main characteristics: consistency, efficiency, functionality. These principles are aimed at the implementation of the following functions: organizational, system-forming, resource-intensive, informational, clustering for combining old and new informational replenishment.

This technology allows you to structure materials, to create an extensive soil storage bank, to combine various informational data over time. The criterion of its adaptability is the consistency. The components of this criterion are:

- open virtual space, providing the possibility of continuous updating, replenishment and improvement for communication and interaction of different generations of participants in the educational process - students, teachers through distance learning;
- a subject-activity and continuous process, focused not only on getting the final product, but also discussion, preparation of objects of the virtual soil bank, joint creative search;
- creative groups of teachers with the delegation of authority to administrators (leaders of these groups)

for organizing and conducting expeditionary, excursion and other types of work;

- creative groups of students for research and design work;
- a portfolio of creative and design projects of students. Creation of a photo report in the virtual space, as a reflection of the results of educational and research activities aimed at disseminating the experience of the activity and indicating effective work with information technologies.

VI. SCIENTIFIC RELEVANCE

The soils will not remain the same state in the future; therefore the presented soil bank has enormous opportunities and prospects in creating a scientific picture of soil evolution, revealing the essence of global problems of their degradation in an environment of increased anthropogenic load.

A comparative presentation of the soils of a particular region, Russia and the world in the material and virtual image allows highlighting the specificity, uniqueness, and significance of these objects on a regional and global scale, and to reach a higher level of scientific synthesis.

VII. THE PRACTICAL SIGNIFICANCE AND RESULTS OF IMPLEMENTATIONS

Creating material and virtual soil bank models and using them as an educational tool in preparing highly qualified personnel for agriculture and educating the environmentally erudite population now and in the future makes it possible to transfer the learning process to a higher scientific and methodical level, which allows getting research experience and practical activities faster.

Carrying out various forms of excursions in order to promote knowledge of the biosphere, the ecological functions of the soil is one of the most important educational forms of activity of the created soil models [12].

In the economy of the country, in the agricultural sector, the use of soil bank materials helps determine the place and importance of a region or a separate agricultural enterprise in their historical development.

For a short period of its formation, the Soil Museum of the Institute of Agroecology in the museum competitions became the winner in the nominations "The best use of museum exhibits in educational and research work" and "The best museum of natural sciences".

VIII. SUGGESTION

The scientific concept, principles and methods that are used to create the Soil Museum, as a material and virtual soil bank model, are aimed at providing methodological support for regional agro-ecological monitoring [13].

A descriptive model can provide initial information about the soil [14].

The most typical soil monoliths can be clearly used as standards for multi-purpose mapping of soil cover. The reference ecological and soil models with reference to the terrain should be used as a guide, when doing the morphological description of the soil of landscapes; highlighting the changes that have occurred in the external

features of the soil, which are available to various enterprises. Comparison of changes with the existing verbal model will allow determining the change of soil parameters of landscapes over time and forecasting their future state. The created soil museum with unique soils of the Southern Ural, provided with a verbal model, can become a prerequisite for the creation of the IUCN Red List of soils of the Chelyabinsk region.

IX. CONCLUSION

The Soil Museum of the Institute of Agroecology and the Soil Bank of Russian and world's soils meet the requirements of natural history museums [9], and has been introduced into educational and outreach activities and is a promising methodological and practical tool for conducting regional agro-ecological monitoring, which is the basis of its Joint Center.

The information of the material and virtual soil bank models allows it to be used in the training of specialists of the agricultural sector through innovative education for unlimited time and to obtain quality indicators in mastering the fundamental interdisciplinary knowledge of the biosphere.

ACKNOWLEDGMENT

The work on creating a material model of a soil bank was carried out with the support of the Director of the Institute of Agroecology, Professor V.A. Lippa.

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