FEATURES OF RECOGNITION AND MAPPING OF SOILS BY METHODS OF DIGITAL PROCESSING OF AERIAL PHOTOGRAPHS

V.V. Konakh*, A.A. Topaz**

*Faculty of Applied Mathematics and Informatics, **Geographical Faculty, Belarus State University, Skorina av., 4, Minsk, 220050, Belarus, e-mails: *Konakh@bsu.by*, *Topaz@bsu.by*

Abstract. In the article the methodical approaches and technological methods of a decoding of soils are explained on the basis of digital processing of materials of air photography. As object of research the soils and top-soil of Polessje province alluvial terracing, marsh and secondary water-glacier of landscapes of Belarusian Polessje are considered.

Introduction

The soil map represents the main fundamental scientific document on the ground, which contains the fullest and the most objective information on the properties and structure of top-soil. Therefore for the effective quantitative and qualitative registration of soils it is necessary to have soil-cartographical materials of high quality. For the obtaining of such soil maps it is required the implantation of new progressive methods of research for soil cartography. The most perspective and effective method consists of application of materials of air photography. Now it is widely applied in domestic and foreign cartography of soils.

When using the materials of air photography there is a chance to study the relief, vegetative cover and other signs of cartography territory, which even at cameral decoding allow in general to map the character of the top-soil. Therefore the most precise and detailed compilation of maps of a top-soil and mapping of its features is reached when using the materials of air photography.

Until recently the most widespread methods of image analysis of snapshots were the visual and visibly-instrument methods. However visual methods have particular limitations. They do not allow to change the quality of basic material, to analyze simultaneously series of the multizonal and non-simultaneous images, they have restricted capabilities of obtaining of the quantitative characteristics of objects. These tasks can be decided with the usage of digital processing techniques of snapshots.

The digital image processing is a new and perspective direction at remote learning of a top-soil. The primal problem of digital images processing at soil mapping is a thematic interpretation of allocated contours that is decoding. The physical basis of recognition of soils is their spectral reflecting capacity [1]. Therefore automated methods of soils decoding are based on the differences of a spectral reflecting capacity of soils depending on its physical, chemical, biological and other properties, which manifest on pictures in different brightness of soil image.

Result of research

The purpose of our work is the development of the methodical approaches and technological methods of soil decoding on the basis of digital processing of materials of air photography. As an object of research the soils and top-soil of Polessje province alluvial terracing, marsh and secondary water-glacier of landscapes of Belarusian Polessje were selected.

To study the features of a decoding of a soil-vegetative cover of different landscapes the materials of air photography were used introduced. They were black-white panchromatic snapshots of optimum terms flight (vernal and autumnal), large-scale topographical maps, and also soil maps of economy of a scale 1:10 000. The identification of outcomes of digital image processing was grounded on the morphological and analytical parameters of soils obtained at research of soils from the key sites.

With reference to the tasks of soil decoding it is possible to conduct method classification of digital processing of the picture as follows:

– methods of geometrical correction of picture ensuring creation of a photo-basis for a further procedure of the automated decoding;
– methods of pretreatment of the image ensuring an increase in objectivity and reliability of a decoding;
– methods of the automated allocation and classifications of objects on the pictures.

These methods (photogrammetric, photometric and automated decoding) were put in the base of the designed technological scheme and techniques of digital processing of aerial photographs with the purpose of a decoding of a top-soil.

At realization of computer processing of pictures the following software were used: for geometrical transformations – digital photogrammetric system «Realistic-Map» (development of scientific-industrial firm «MediaScan», Minsk), for theme processing – system «MDW» (joint development of faculty of a software of a management information system of faculty of applied mathematics and informatics and development of a geodesy and cartography of geographical faculty BSU) [3].

Due to the of properties of a central projection, the picture differs in the geometrical characteristics from of a map by distribution of distortions, by scale in different parts and on different directions. Besides the relief of terrain introduces considerable distortions to the map. Therefore to make the picture geometrically precise as an inspection tool it is necessary to transform it the modern geometrical technologies of a digital photogrammetry solve this task with the help of digital photogrammetric systems.

As a cartographical base for the purposes of the automated decoding of soils the separate photosnapshots of key sites were used. The photogrammetric data processing of photosnapshots was implemented with the help of a program module of a system "Realistic-Map", intended for processing of single (mono) photosnapshots. As a result the digital photomaps of a scale 1:10 000, suitable for realization of a further procedure of the automated decoding and calculation of quantitative parameters (indexes) were created.

For the purposes of the automated decoding of soils the separate photosnapshots of key sites were used as a cartographical base. Photogrammetric processing of these photosnapshots executed with the help of a program module of a system "Realistic-Map", intended for processing of single (mono) photosnapshots. In outcome the digital photomaps of a scale 1:10 000, suitable for realization of a further procedure of the automated decoding and calculation of quantitative parameters were created.

The productivity of the automated decoding essentially depends on availability of the programs oriented to problem solving in particular area, i.e. from appropriate software. To automaze the process of decoding on materials of air photography the version of the automated system («MDW») is created. The system works in an interactive mode. The given system allows to conduct preprocessing of the images and to select the image of homogeneous areas and to conduct classification of isolated segments. For the solution of the above mentioned tasks in a system the algorithms of histogram transformations, of filtration, of edge enhancement and of cluster analysis are realized. It is likely to obtain quantitative parameters, input data for which are: the length of the contour borders, area of contours, quantity of contours. The system has also capability of training.

The preprocessing of the digital images in a direction of convenience of a decoding (suppression of a noise, edge enhancement etc.) and also theme processing was executed with the help of software "MDW". The technology used at an automated decoding, has included splitting (segmentation) of the digital image on the statistically homogeneous area in the photo tone and the classification of defined contours (areas) too. The obtained color code image of clusters is shown a figure 1.

The analysis of result of the automated decoding (fig. 1) has shown that at segmentation those areas are selected which have the homogeneous image photo tone and which can correspond to different soils genetically and classifically. This problem was considered in [4].

In this case the first cluster (light image photo tone) has got sod-podzol light-sandy fly-away by a wind soils and sod-podzol slightly temporarily over wetted linked-sandy soils in cropland.

The second cluster (light grey image photo tone) has got sod-podzol slightly gley mellow-sandy soils of cropland and sod-podzol mellow-sandy gley from below soils under natural vegetation.

The third cluster (grey image photo tone) has got sod-podzol mellow-sandy gley from below soils under natural vegetation and sod-podzol gley mellow -sandy soils sod-podzol gley mellow -sandy soils.

The fourth cluster (dark gray image photo tone) has got, in general, sod-gley soils under natural vegetation.

The fifth cluster (dark image photo tone) has got sod-gley soils and sod-humus gley soils under natural vegetation.

Thus, the application of cluster analysis to whole image, without taking into account the characteristics and the type of ground, under which there is this or that soil, does not give acceptable outcomes for interpretation of soils, owing to the mixture of different soil varieties within the limits of one cluster. It is explained by the factor that the same soil located in tillage and under natural vegetation can have a different image photo tone on a snapshot.

More correct outcomes can be received if to conduct cluster analysis separately for different kinds of cropland (fig. 3). So, for the ploughed up territories after realization of cluster analysis three clusters corresponding to particular soil varieties are distinguished in their interpretation characteristics (fig. 4).

1-st cluster – light grey image photo tone – sod-podzol slightly temporarily over wetted linked-sandy soils in cropland. The contents of humus oscillates from 0,6 up to 1,0 %. The mean factor of spectral reflection of these soils at field moisture capacity makes 9,1 %.

2-nd cluster – grey image photo tone – sod-podzol slightly gley linked-sandy soils. The contents of humus oscillates from 1,1 up to 2,2 %. The mean factor of spectral reflection of these soils at field moisture capacity makes 6,4 %.

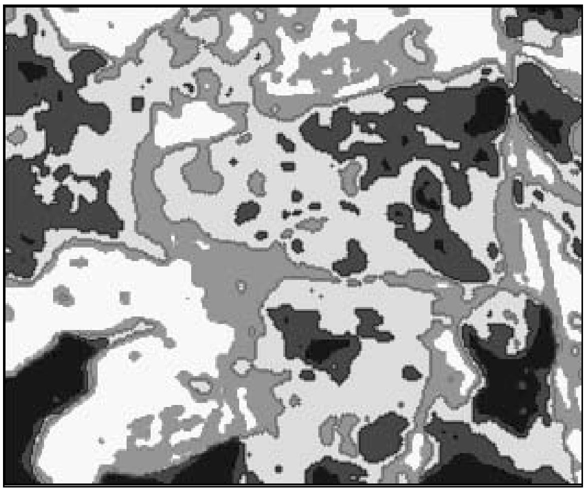

Fig.1. Result of cluster analysis (5 clusters).

Fig.2. Joint mapping of the vectorial data and rastrer.

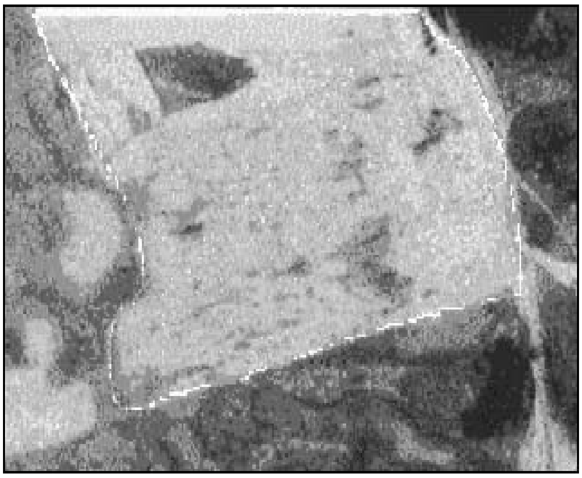

Fig.3. Fragment of a photosnapshot with isolated by the ploughed up territory.

Fig.4. Result of cluster analysis of this fragment.

3-rd cluster – dark grey image photo tone – sod-podzol slightly gley mellow-sandy soils. The contents of humus oscillates from 2,3 up to 3,4 %. The mean factor of spectral reflection of these soils at field moisture capacity makes 5,6 %.

It is necessary to mark, that the problem of authentic interpretation of the data of remote sensing is one of most composite problems arising at development of methods of remote sensing of a soil cover. Obviously, the similar task can not be saved fully by au automated system. A reason to that is multiformity of a top-soil, and also the limit of capabilities of remote methods of researches. In our system for classification of soil varieties as direct characteristic of interpretation the image photo tone is used. This characteristic is conveniently formalized for perception by the automated system of processing.

However straight characteristics of a decoding allow to recognize not all objects (in our case, soil varieties), which are necessary to single out at theme mapping. The mechanical method does not allow to take into account the factors of agricultural activity (ploughing up, stubble, vegetative cover etc.), to characterize which it is necessary to use the indirect indications. In this connection at interpretation of results of digital processing as indirect characteristic of interpretation the relief being the indicator of a top-soil was used.

As it is known, often boundaries of units of a soil cover coincide with the boundaries of units and forms of a relief, which can be selected on a topographical map using figure of horizontals [2]. This important feature - correlation of units of a top-soil and of relief - can be traced directly on the photo image. For this purpose the superposition of the digital image and topographical map with horizontals is necessary. The joint mapping of the vectorial data and raster was executed by tools of system "Realistic-Map".

As it is visible from a figure 2, on this image with the help of straight characteristics of a decoding (image photo tone) the micro relief (local closed downturns, rises) is well decoded. It is possible to say that on considered territory there is enough conformity of soil varieties and relief. The negative ground features with higher contents of humus and greater degree of humidifying are represented by a darker tone.

Thus, the application of computer technologies has allowed to combine two processes necessary for a decoding of soils on aerial photographs: the analysis of a relief on a figure of horizontals and the analysis of tones of the photomap on an aerial photograph, i.e. two cartographical bases necessary for a decoding and studying of a top-soil structure. Furthermore the engaging of the data about a relief allows conduct interpretation of the cluster image and recognition of soil varieties with allowance for existing correlations of a system a soil - relief.

Conclusion

The comparison of results of the automated decoding and before the composed soil map testifies to possibility of using of the automated processing of aerial photographs for refinement of boundaries and areas of different soils. The digital processing of images has advantages before visual at definition brightness decipher characteristic. The boundaries of segments with an identical optical density are precisely established, and the separation of soils on a spectral image is found.

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