REMOTE SENSING MATERIALS PROCESSING IN SOIL CARTOGRAPHY

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Abstract. In the article the methods of topsoil humus content measuring by means of the remote sensing are being developed are researched. The classification of "Tulgovichi" key area topsoil is given.

Introduction

Application of aerospace materials in top-soil studies embraces two main task groups: the first task is connected with the soil cartography, working out and making maps, top-soil structure studying and mapping; the second one is connected with studying soil dynamics, humus content, humidity, salinity and erosion.

Soil humus study is the main objective of the modern soil science. Quantity and the nature of humus substances in the soil are closely connected with the soil formation process direction, biological, chemical characteristics of the soil, its fertility, since the most important elements of plants nutrition (nitrogen, phosphorus, potassium, sulfur etc.) are accumulated in humus. That's why soil scientists use such definitions as gross content of humus, its structure, reserve and type distribution to determine their genetic belonging and for early detection of erosion processes etc.

Laboratory methods reliable enough are developed which allow determining the content and the structure of the humus substances in the soil. However these methods are labor-intensive and practicable only in the laboratory environment. That's why the research of the remote sensing methods of indicating humus in soils is so important.

Analysis and problem statement

One of the main indications good for remote sensing of soils is spectral reflectance and color of soils.

Soil is a complex mixture of mineral and organic substances of various physical and chemical characteristics, which may influence absorbent and reflectance of soil. Main characteristics influencing the reflectance of soils are:

- permanently acting factors: content and condition of organic substances (humus); mineral and granulometric soil content;
- temporarily acting factors: humidity, structure of the surface layer (degree of processing); presence of erosion and salinity processes.

As a rule, spectral factors of soils' luminosity are influenced by several rather different, but closely interrelated soils characteristics simultaneously. Above all it has to do with the content of the organic substances, oxide iron, carbonates, freely soluble salts in the soil, its humidity, granulometric content, structure and composition [2].

It has been stated that there is a steady correlative dependence between spectral reflectivity of soils and humus content. However there are certain difficulties by generalization of research results, connected with the fact that in some works humus content is summed up with other pigments content, mainly with iron content [7], in other works over-all content of organic substance or organic carbon is determined [5]. Optic characteristics of remote indication of humus in soils also differ: reflectance, relative zonal brightnesses, integral reflection and optic density of negative image [1, 6].

According to the data of the visible and near IR spectrum area studies, spectral reflectance of soils including reflectance and spectral coefficients of brightness correlate well and nonlinearly decreasing with the increasing of humus content in soils.

Remote indication of humus content in soils is essentially influenced by the layers on which soils were developed; it can lead to great errors in determining humus content in soils. It is known [1, 3], that soil forming layers influence essentially the developing of spectral coefficients of reflection in the system "humus – soil forming layer" with the little humus content in soils (0.3 – 0.5%). Henceforth by increasing of the humus content in soil in the system "humus – soil forming layer" it will to a greater extent depend on spectral coefficients of the humus reflection.

Therefore, by studying the areas of soil forming layers one may exclude one of the factors influencing the reflectance – mechanic content –. In this case the spectral brightness of soils will mainly be influenced by humidity and humus content.

Application of remote materials in soil map-making using the results of air photography is based on the differences of soil reflectance depending on its physical, chemical, biological and other characteristics, which are reflected in photographs with different brightness of soils reflection.

Experimental results

The aim of our research is to study the peculiarities of the topsoil deciphering using methods of digital processing of images, to determine the influence of certain soil characteristics on the changes of the image photo tone in air photos, their correlative dependence, and also to study the possibility of the interpreting these characteristics by air photos in the conditions of Belarusian Polessje.

For that purpose there were synchronously taken samples from the key site with homogeneous soil forming layers in 26 soil spots for determining the humus content, physical clay and humidity (Table No.1). On the grounds of the analytical data humus content and humidity maps of the key area were made.

Analysis of the data of the percentage of humus and moisture in the samples showed that increasing of the moisture content in the soil causes decreasing of the reflectance. Similar decreasing of reflectance causes increasing of the organic substance content. In a fig. 1 are shown correlations of photo tone of the image of soils on aerial photographs and humus, humidity, quantity of physical clay and average spectral coefficient of reflection.

The air photo interpretation on the territory of the given key area was performed with the help of methods of the digital processing of the image. Software of the developed computer-aided interpreting system [4] allows rendering the process of decoding partially automatic: noise elimination, edge enhancement, preliminary contour decoding (segmentation of an image), geometrics measurement (length of the contour borders, area etc.).

Soil varieties and soil characteristics were identified in those parts of the photo, which corresponded to the ploughed territories. Tone of the photo image was the main decoding basis.

Sample №	Soil variety names	Quantity of physical clay, %	Humus, %	Humidity, %	Image photo tone	Average spectral coefficient of reflection, %
1	1. Sod-podzol light-sandy and gley from below	4,8	0,5	0,6	Light	23,6
2		5,0	0,5	0,9		
3	2. Sod-podzol temporarily over wetted linked-sandy	5,0	0,7	0,9	Light gray	18,1
4		5,2	0,6	0,9		
5		4,8	0,7	0,5		
6		3,2	0,8	0,9		
7		5,6	0,8	1,0		
8		4,8	0,6	1,3		
9	3. Sod-podzol slightly gley linked-sandy	6,0	1,2	1,4	Gray	15,1
10		8,8	2,8	3,3		
11		7,0	2,7	3,5		
12		4,8	1,1	1,5		
13	4. Sod-podzol gley linked-sandy	9,2	3,5	15,0	Dark gray	13
14		6,8	2,9	10,3		
15		5,6	2,4	11,2		
16		7,6	2,8	6,6		
17		6,4	3,4	10,6		
18		10,8	3,2	9,5		
19		8,6	5,7	26,6		
20		6,0	3,4	18,7		
21		10,6	7,8	27,7		
22	5. Sod-gley and sod-humus gley	9,6	6,6	19,2	Dark	9,2
23		9,8	7,4	19,7		
24		10,0	5,7	16,4		
25		6,8	2,9	9,2		
26		5,6	4,5	15,2		

Table 1. *Mechanical content and agrochemical characteristics of soils*

The results of the research showed that there exists a close correlative connection between the tone of the photo image of the soils developing on the basis of homogeneous sand mother layers and the content of humus, moisture and granulometric fractions.

At the same time the main components, which determine the tone of the photo image of soils are humus and moisture. A certain content of humus, correlating with the coefficients of the spectral reflectance of sand soils corresponds to each of the sand soils contour groups, which differ in the tone of the image.

After a cluster analysis of the ploughed territories tree contour groups were defined, which differed on their decoding characteristics. The analysis of the humus percentage of

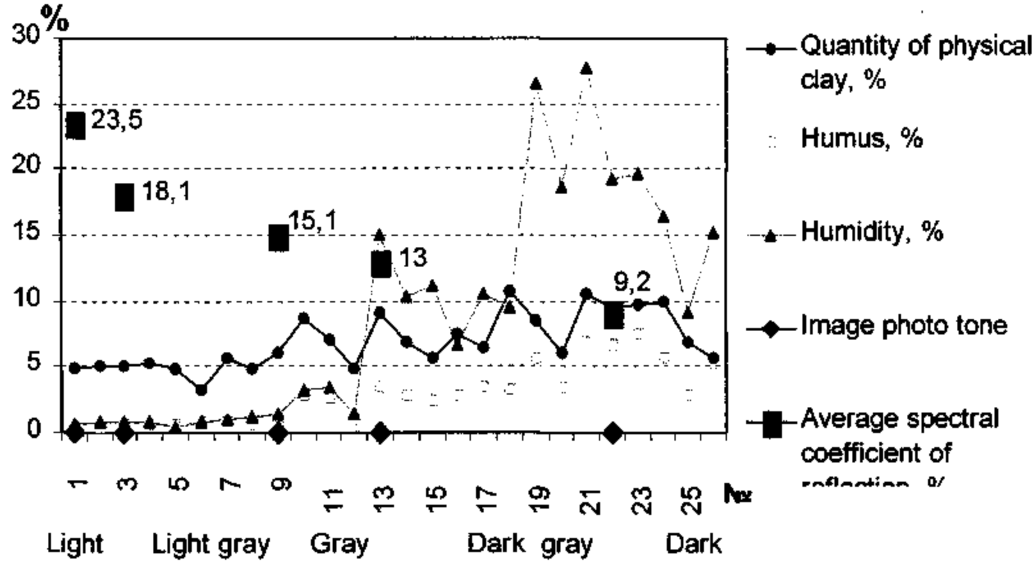

Fig. 1 Correlations between photo tone of the soils image on aerial photographs and humus, humidity, quantity of physical clay and average spectral coefficient of reflection

each contour and the tone of the image made it possible to group the homogeneous image contours and contours similar in humus content:

- Light gray tone of the photo image – temporarily over wetted linked-sandy **soils**. Humus percentage is from 0,6% up to 1,0%. Average coefficient of the spectral reflection of these soils is 18,1% (Table No.1, 2-th soil variety);
- Gray tone of the photo image – sod-podzol slightly gley linked-sandy soils. Humus percentage is from 1,1% up to 2,2%. Average coefficient of the spectral reflection of these soils is 15,1% (Table No.1, 3-th soil variety);
- Dark gray tone of the photo image – sod-podzol gley linked-sandy soils. Humus percentage is from 2,3% up to 3,4%. Average coefficient of the spectral reflection of these soils is 13% (Table No.1, 4-th soil variety).

In a fig. 2 the outcome of classification пахотных of soils of "Tulgovichi" key area is given for matching: a fragment of a cartogram of the contents of humus (a), composed by a conventional way, and result of a segmentation of an aerial photograph on the same region (b).

Conclusion

Usage of digital processing techniques for decoding remote sensing materials diminishes the labor-consuming character and increases decoding objectivity as compared with purely visual-tool methods and also allows to obtain additional information for separating decoding signs.

The results of the digital image processing aiming at interpreting the topsoil and definite soil characteristics lead to a conclusion of a high efficiency of this research line. However the determining of the real humus content of broke territories by means of remote sensing is much more complicated than classification. That's why the humus content evaluation technique needs to be developed and thoroughly approved. There are definite positive results; still it will take a lot to accomplish this task.

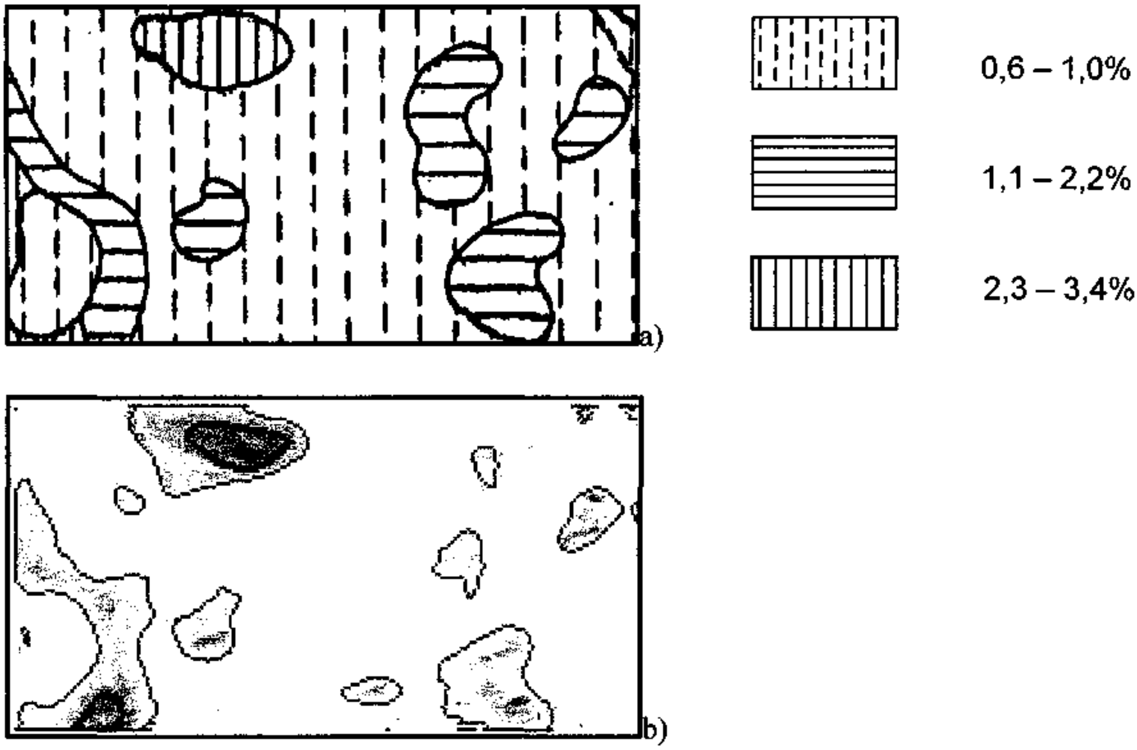

Fig. 2 Fragment of the cartogram of the humus contents (a), composed by a conventional way, and result of the aerial photograph segmentation on the same region (b)

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