REMOTE SENSING APPLICATIONS FOR ONLINE MAPPING OF AGRICULTURAL VEGETATION

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ABSTRACT
Automated recognition of agricultural crops on multispectral images is proposed. The results of efficiency analysis of spectral transformations (using the method of principal component, transformation Tasseled Cap, normalized difference vegetation index NDVI) are provided in the article. The map generated as a result of remote sensing imagery interpretation is outlined.

1. INTRODUCTION

Artificially created and regulated by people biotic communities of cultivated plants with their ecotopes (locations) in order to get agricultural products are defined as agroecosystems. Availability of reliable and timely information on the main agroecosystem component, that is agricultural crops, is an important constituent of efficient agricultural policy. However, analysis and mapping of agroecosystems is particularly difficult process because the latter are characterized by highly dynamic agricultural vegetation due to annual crop-rotation.

The so-called "history books of the fields" represent the main source of information on cultivated crops in Belarusian agricultural organizations. However, the information provided by these sources may not be highly reliable due to these books are based on the data produced by agronomists and different distortions may occur for a variety of reasons. In order to create an adequate system for estimating the agricultural policy efficiency, it is necessary to develop a number of methods for independent and efficient interpretation of crop types.

2. RESEARCH AREA AND INITIAL DATA

The results of experimental analysis of automated crop type recognition (winter rye, winter wheat, spring wheat, winter triticale, winter rape, barley, oats, buckwheat, corn, perennial grasses and legumes) are described in the article. Analysis was based on remote sensing data using GIS technologies.

Landsat 8 satellite imagery is the main source of information. The fields being tested are located within the territory of agricultural company 'Smolevichsky district' (Minsk Region). The total area divided on 257 fields is about 9799 hectares. During the period from 23 March to 30 August 2014 the archive of 8 scenes was compiled for the tested area.

3. METHODOLOGY OF AUTOMATED CROPS RECOGNITION

While pre-processing, all images have undergone radiometric and atmospheric corrections (extraction of absolutely black bodies). In order to improve the quality of subsequent thematic processing the vector layer of fields was used as a mask for interpretation (Fig. 1.) [Myshlyakov 2012].

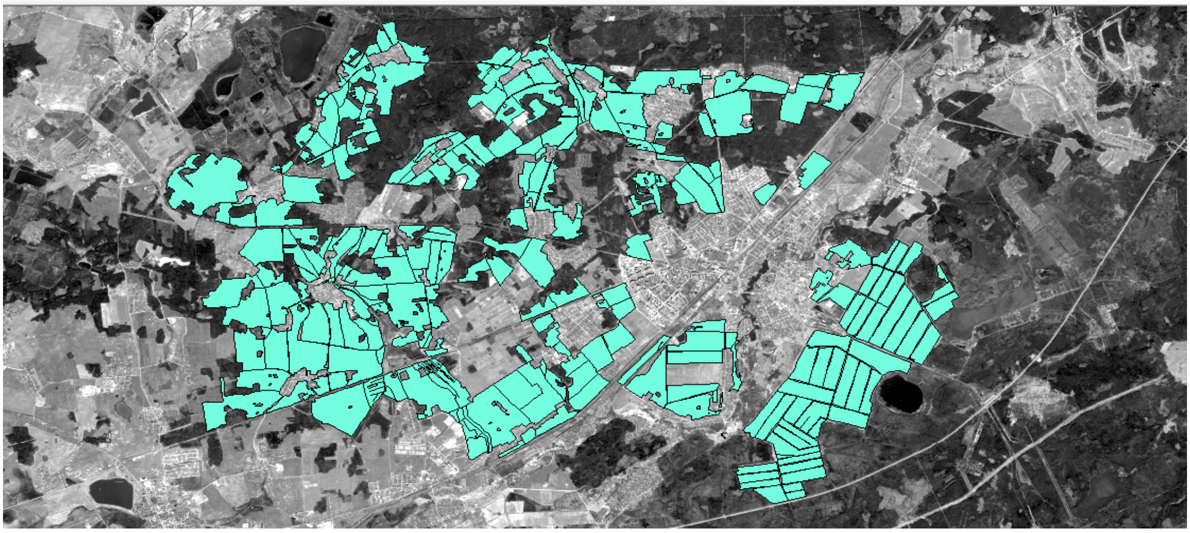

Figure 1: Vector map of observed field area

The key element of analysis is application of different spectral transformations of multispectral images in order to enhance the efficiency when recognizing the results. Spectral transformations include algebraic transformations of intensity, or reflection coefficients of multispectral satellite channels (Table 1). Three spectral indices (method of principal component, transformation Tasseled Cap, normalized difference vegetation index NDVI) were calculated in ENVI 5.2 software for three cloudless scenes of Landsat 8 (19.05, 29.07 and 14.08.2014)

Table 1: Formulae of spectral indices under analysis

Principal component	1	0,054TM2+0,130TM3+0,143TM4+0,595TM5+0,709TM6+0,321TM7
	2	-0,079TM2+0,121TM3+0,212TM4+0,787TM5+0,421TM6+0,372TM7
	3	0,230TM2+0,504TM3+0,616TM4+0,140TM5+0472TM6+0,266TM7
Tasseled Cup	1	0,304TM2+0,279TM3+0,474TM4+0,599TM5+0,508TM6+0,186TM7
	2	-0,285TM2-0,244TM3-0,544TM4+0,704TM5+0,084TM6-0,180TM7
	3	0,151TM2+0,197TM3+0,328TM4+0,341TM5-0,711TM6-0,457TM7
NDVI		(TM5-TM4)/(TM5+TM4)

Original image and spectral indices cartograms were considered as the basis for the supervised agricultural vegetation classification. For this purpose several testing sites were created for each crop. Testing sites are areas representing each known crop type that appear fairly homogeneous on the image (as determined by similarity in spectral values). They was located and circumscribed with polygonal boundaries drawn using the computer mouse on the image (Fig.2).

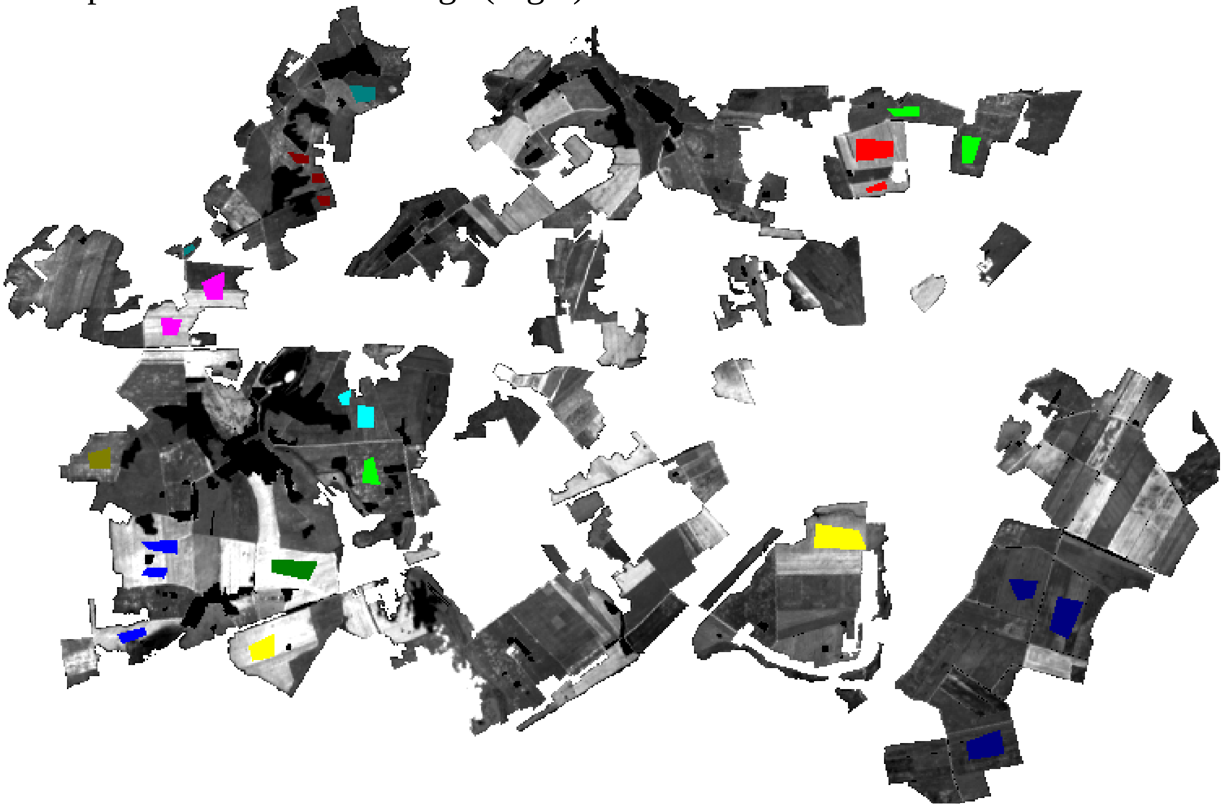

Figure 2: Testing sites location

Then three original images and indexed images were exposed to supervised classification and after that the verification of its accuracy was carried out. For the reliable comparison of index efficiency it was necessary to apply for all analyzed images the same testing sites and classification rules [Terechin 2012]. In this case the classification was carried out according to the maximum likelihood rule.

Classification accuracy was estimated as a percentage of correctly recognized fields for a particular crop. In addition, overall classification accuracy of crops shown on a picture and the value of each index were estimated according to the results of interpretation (Table 2).

As can be seen from Table 2, the overall interpretation accuracy is very high. The usage of vegetation index NDVI reduces the recognition reliability of agricultural crops. It should be noted that the classification accuracy greatly depends not only on the chosen method for spectral transformations but also on the date when satellite imagery was taken. 19/05/2014 was noted for the highest accuracy value. This is due to the fact that during this period (usually it's late May – early June) the reflective characteristics of crops differ one from the other to the greatest extent. The imagery taken in August showed lower results. It is explained by the fact that the crop had already been gathered from the fields and soil reflective properties began to change the reflection spectrum by introducing to the spectrum their peculiarities.

Table 2: The interpretation accuracy of crops on the original picture and its spectral index cartograms (%)

index / crops	19.05.2014				29.07.2014				14.08.2014			
	Original image	NDVI	Tasseled Cup	Principal component	Original image	NDVI	Tasseled Cup	Principal component	Original image	NDVI	Tasseled Cup	Principal component
winter wheat	100	38.9	100	100	100	38.9	100	100	73.4	46.1	70.6	73.4
winter rye	100	31.5	100	100	100	31.5	100	100	85.6	25.7	84.4	85.6
triticale	99.7	32,0	99,3	99.6	99	31.9	99,3	99,6	74.0	9.76	71.7	74.0
rape	100	82.9	100	100	100	82.8	100	100	100	38.9	100	100
spring wheat	98.8	43.1	97,6	98.8	97	43.0	97,0	98,8	90.5	33.1	89.8	90.6
barley	99.6	81.4	99,6	99.6	96	81.3	98,1	99,6	69.9	22.9	69.6	70,0
oats	100	53.4	98,7	100	100	53.4	98,6	100	82.0	15.8	76.2	82.0
buckwheat	94,9	65,1	96,2	94,9	94,9	65.1	96,2	94,9	82.5	8.98	68.4	82.6
legumes	95,5	35,5	96,4	95,6	95,6	35.4	96,4	95,6	32.4	0.00	33.7	32.5
corn	100.	87.7	99,7	100	100	87.7	99,7	100	83.2	26.8	79.9	83.3
Perennial herbs	100.	93.0	100	100	100	93.0	100	100	88.2	78.2	84.3	88.3
total accuracy	93.2	64.9	94,4	94,0	90,2	62.8	91,4	91,9	77.0	35.5	75.7	77.4

Combined analysis of images in ENVI using GIS technology allowed us to get the original map of crops (based on data provided by agronomists) and a map showing the real structure of agroecosystems vegetation (Fig.3).

The variances revealed from GIS analysis are shown in Fig. 4. In this case it can be assumed that introducing crop information into “the book of history of fields” was not done accurate.

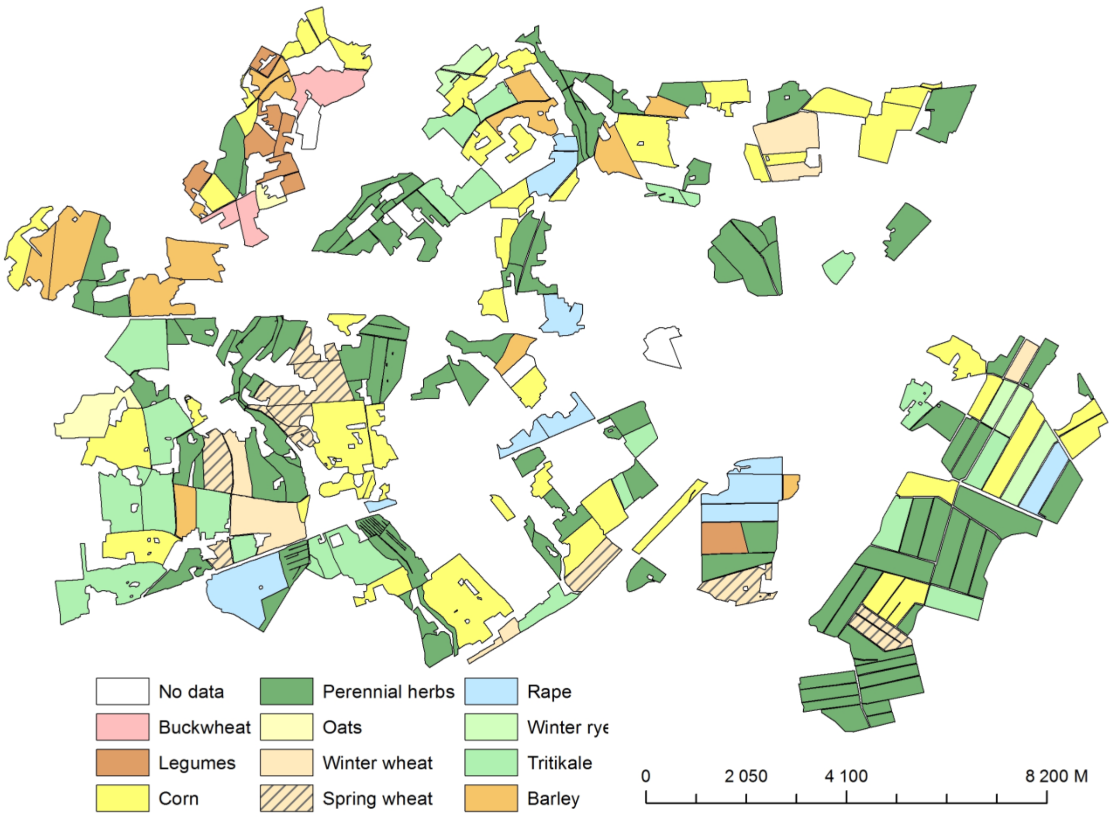

Figure 3: The map of real agroecosystem vegetation structure (based on remote sensing data)

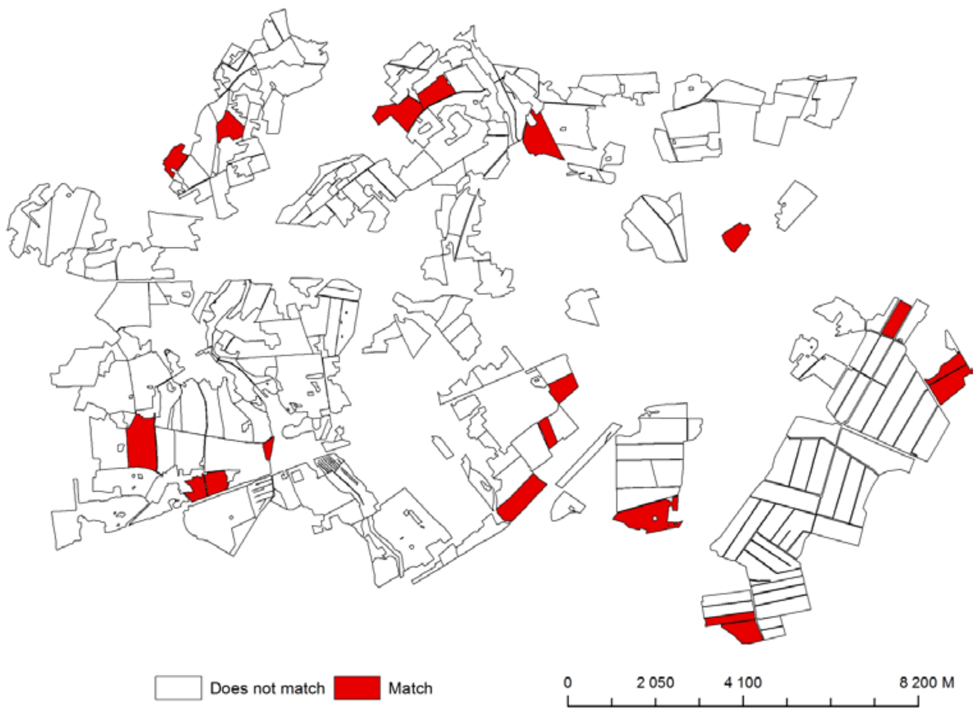

Figure 3: The map of differences between interpretation results and data provided by agronomists

CONCLUSION

Analysis confirmed that remote sensing data are the most reliable source of unbiased and objective information on agroecosystem vegetation structure. The developed approach and agroecosystem recognition peculiarities can be used for detailed interpretation of crops and analyzing the seasonal reflectance curves of vegetation indices. The availability of a series of such maps created for different years will allow providing a qualitative analysis of agroecosystems, to carry out efficient planning and land use control.

REFERENCES

Myshlyakov, S. 2012. Mapping of the agricultural crops using satellite images and author's observation. Research and industry magazine «The Land of Belarus». № 1. Pages 52-56. Minsk.

Terechin, E. 2012. The information capability of spectral vegetation indices in the process of agricultural vegetation interpretation. Topical problems or remote sensing of the Earth from space. T.9. № 4. – Pages 243-248. Moscow.

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