REMOTE SENSING AS A TREND IN AGRICULTURE

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Abstract: *Remote sensing are widely used in the field of agriculture, forests, urbanism, transport and other fields for better performance and results. The aim of this paper is to show small part possibility of using remote sensing in the area of agriculture. Main part of this research is to show the process of classification and mapping of agriculture crops using satellite images from Rapideye satellite platform. These satellite images were used for the classification of three basic crops: corn, beet and soybean. Satellite images and basic concepts and techniques of classification are presented in order to emphasize benefits of classification of satellite imagery for presented classification methods.*

Key words: *Remote sensing, GIS, Agriculture, Classification, Rapideye*

INTRODUCTION

Agricultural goods belong to the most important renewable, natural resources. It is very important to have accurate and timely information about agricultural resources. Due to the increased needs for agricultural products (as a side effect of population growth) there is a need for improvement in management of agricultural resources, i.e. increasing crop yields. Because of that, it is necessary to get valid data about crop types their quality, quantity and location of these resources. Remote sensing techniques were, and have an upward trend to continue to be, an important factor in the improvement of existing systems for data acquisition and data processing in agriculture

Remote sensing is defined as the acquisition of data using a remotely located sensing device, and the extraction of information from the data. The increasing use of remote sensing in agriculture is visible in growing researches in crops (production, crop types, harvest, crop yield), lands (land condition, parcel area, location), forest types, quality of water bodies, types of irrigation systems etc.

Progress in agricultural production mostly depends on the improvement of existing and development of new and appropriate technical solutions. There is a lot of emphasis on environmental protection, production of quality, healthy food, without neglecting the reduction of production costs with respect to profit and yield increase and improvement of working conditions.

MATERIAL AND METHODS

RapidEye AG, Germany, successfully launched its own satellite system, satellite constellation which is comprised of five identical satellites, in August 2008. RapidEye constellation is shown in Figure 1. RapidEye was first commercial operative satellite with the capability of large-area coverage, frequent revisit intervals, high resolution and multispectral imagery. With the ability to produce 5m spatial resolution imagery in five spectral channels, Rapideye represents an excellent source of data for the monitoring in ecology, environmental protection, agriculture and forestry.

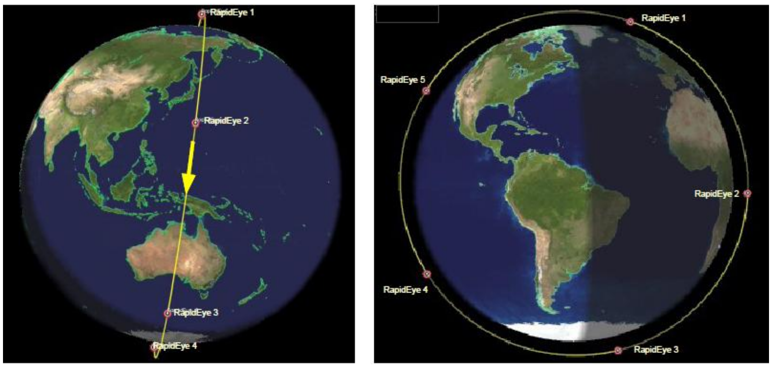

Figure 1 RapidEye constellation of five satellites

Each of five satellites is equipped with one JSS-56 camera, which weights approximately 150 kg. A seven-year operational lifetime is predicted for RapidEye satellite constellation. The primary applications of RapidEye imagery are agricultural mapping, growth monitoring, damage assessment, yield prediction and cartography.

Each of the multispectral sensors collects data in five different wavelength channels: blue, green, red, red edge and near infrared, as illustrated in Figure 2. RapidEye is the first commercial sensor which the ability to collect data in the red-edge band, which is useful for detecting changes in chlorophyll content. It could allow better estimation of the ground cover and chlorophyll content of the vegetation.

The significance of red-edge band is that it provides measurements of changes and differences in vegetation, providing the distinguishing and monitoring of vegetation spieces.

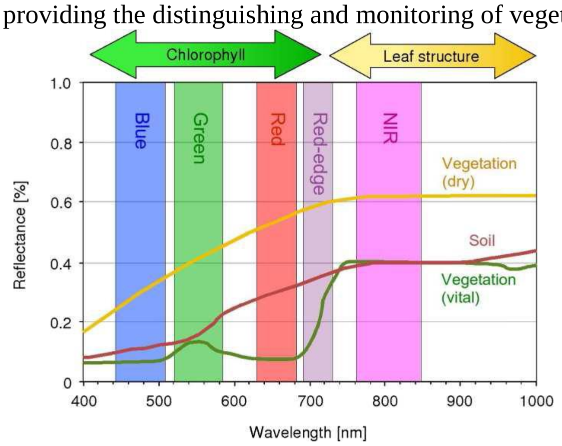

Figure 2 RapidEye wavelength bands

Rapideye wavelengths are given in the *Table 1*.below.

Table 1.

RapidEye basic characteristics

Band No	Band	Wavelength	Spatial resolution
1	Blue	(440 – 510µm)	5m
2	Green	(520 – 590µm)	5m
3	Red	(630 – 685µm))	5m

4	Red-edge	(690 – 730μm)	5m
5	NIR	(760 – 850μm)	5m

Agricultural enterprise "Sava Kovačević" A.D. was founded in 1946 (Figure 3). Today, the company possess 3.880ha of soil of its own property and 750ha of state soil, which is taken as a permanent rent. Out of total arable land (4.600ha), 40% is under the irrigation system, with a tendency of continuing growth. Industrial crops are presented in 40% whereas grains and forage crops are presented in 55% of the area.

The classification was performed in satellite images from August in 2009. The most abundant crops in that time period, in the agricultural area "Sava Kovačević", were: corn, sugar beet and soya bean, which was the reason why those crops were chosen for the classification. These crops are presented in most agricultural areas in the Republic of Serbia, especially in this time period (August), which confirms selected crops for the process of classification. Furthermore, soil areas in which there were not any crops sowed in August, or harvest had already been done, were mapped. Such soils were introduced as a background training sample, as practice has shown that this provides better results of classification.

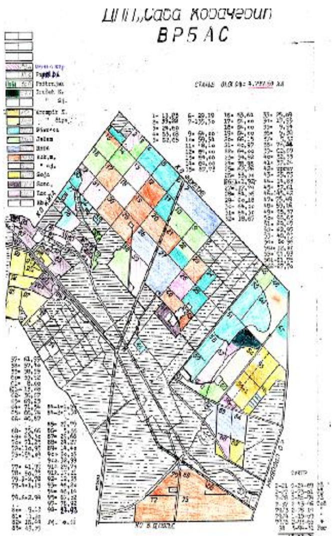

Figure 3 Agricultural enterprise "Sava Kovačević"

Supervised classification (classification with supervision) requires *a priori* (already known) information such as what type of classes are needed to be recognized and extracted (soil types, vegetation, or something else). Using this type of classification, in order to select the appropriate samples for classification, it is necessary to have the information about pixels which fall into some of the classes. In the supervised approach, the system must learn from a training sample (TS): a collection of examples previously analysed and identified by a human expert. Those training samples represent a set of pixels which represent what is identified, chosen as a representative of the class. It is important to choose representative TS of the class that is needed to be identified and isolate in a certain area. These TS was create by information from the employees from Agricultural enterprise "Sava Kovačević" (Figure 3).

Supervised classification is quite accurate for mapping classes, but depends heavily on the cognition and skills of the image specialist. The strategy is simple: the specialist must recognize conventional or meaningful classes in a scene from prior knowledge, such as personal experience with what is present in the scene, or more generally, the region it is located in, by experience with thematic maps, or by on-site visits. As a rule, the classifying person locates specific training sites on the image - either a print or a monitor display - to identify the classes**.**

RESULTS AND DISCUSSIONS

Classification, as a way of automatic mapping of agricultural crops, represents one way to get the information about exact situation in the field, without on-site (on-the-spot) visits or at least to a lesser extent. It implies the analysis of multispectral satellite imagery and usage of statistically based conclusion rules for determination of the land cover identity for every pixel of the scene.

The area of interest for the agricultural enterprise “Sava Kovačević” was drawn over the satellite image, with the difference of 52.46ha (2.87%), compared to the real situation in the field. Only those parcels which were sown with the crops of interest (crops which are used in classification) in time of the imagery acquisition were included into the area of interest.

For every chosen area of interest, first step in the classification was mapping and classification of single crops using Maximum likelihood algorithm in Erdas Imagine software tool. The choice of pixels of interest, as the representatives of the classes, was done randomly. During this process, different parameters were set for Euclidean distance and the number of observed pixels in that distance. The results of classification of four crops simultaneously (sugar beet, corn, soya, land background), by using maximum 10% of sampled area of every class, are shown in Table 2.

Table 2.

The results of classification of four crops simultaneously

Area	Sugar beet	Corn	Soya	Background class (land)	Total	Classified area [ha]
Truth area [ha]	203,49	339,89	272,59	1006,95	1822,92	1875,38
Classified area [ha]	196,68	322,75	271,74	1057,58	1848,75	
Classification error [%]	**3.35**	**5.04**	**0.31**	**-5.03**	**-1.4**	

The results of Rapideye image classification are illustrated in the Figure 4 **The results of Rapideye image classification**shown below. There are visually visible the results of individual classification of agricultural crops: Corn is maroon, sugar beet is blue, soya is yellow and land are represented light brown, respectively. There is also visible the simultaneous classification of all of these crops in the first part of the picture.

Expanding the training set and the classification of four crop types simultaneously, instead of the classification of individual crops by four runs, increased the accuracy of the results. An Red-edge Band (705 – 745nm) significantly helps in the analyses of vegetation conditions; Red-edge band is sensitive to chlorophyll and carry important information about the content of chlorophyll in vegetation. It helps in mapping, identification and detection of vegetation age, health and vegetation types.

Red-edge band is the transition between red and NIR band of electromagnetic spectrum. In healthy plants with a high content of chlorophyll, REP position (REP Red Edge Position) moves to the NIR and when plants are suffering from any illness, the REP is moved towards the green band of the electromagnetic spectrum. Red edge band in RapidEye satellite was created in order to capture the dynamic of REP. It is important to understand the phenomenon of plants in order to get more precise information by analysing the satellite images.

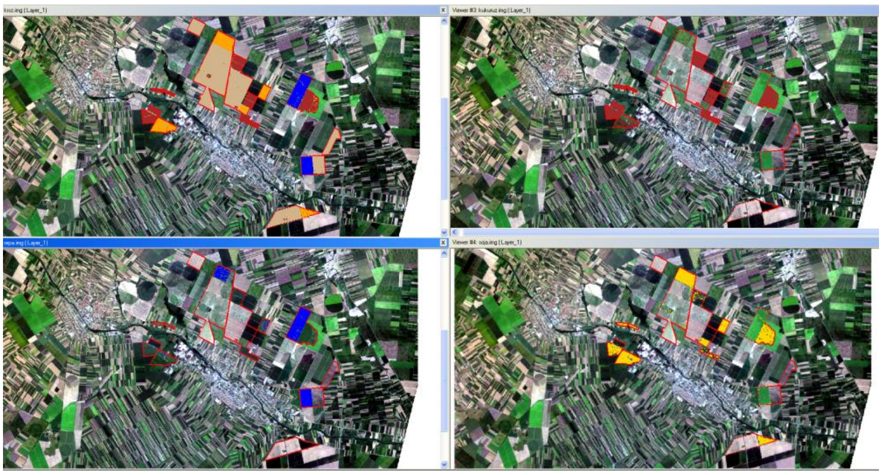

Figure 4 The results of Rapideye image classification

CONCLUSIONS

The accuracy of over 90% which was achieved by processing of Rapideye image, basically is because of radiometric resolution of 16-bit and red-edge band with all benefits that come with red-edge band. Red-edge band has proved to be responsive to the amount of vegetation biomass presented in a scene. It is obviously very useful for crop identification, for distinguishing between crops and soil, and for seeing the boundaries of agricultural parcels. Since there have been major new developments in satellite technology, RapidEye imagery (in terms of information content) and all other satellite images with high spatial and spectral resolution seems to be particularly suitable for feature detection and land cover mapping of agriculture landscapes.

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