SOME CONSIDERATIONS REGARDING THE USAGE OF MULTISPECTRAL REMOTE SENSING IMAGES IN AGRICULTURAL CROP ANALYSIS

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Abstract. The article includes some considerations regarding the usage of multispectral remote sensing imagery in agricultural crops analysis. Several aspects regarding the *Landsat* multispectral remote sensing image processing are taken into account, in order to perform the quantitative and qualitative anlysis on the cultivated vegetation.

Keywords: Remote sensing, multispectral images, agricultural crops, quantitative and qualitative analysis

INTRODUCTION

Objectives: Two objectives were aimed: the *efficiency* and *precision* in identifying the agricultural crops classes from the researched area, as well as their qualitative analysis level. The precision in identifying the classification of the topographic details in a multispectral remote sensing image depends on the image's *spectral and spatial resolution*.

The spectral resolution refers to the spectral interval (wavelength interval) where an image was recorded and allows an object or phenomenon in the area to be identified through the electromagnectic radiation, reflected within an atmospheric window. [Jensen, J. R., 2005; Vlaicu Aurel**,** 1997]. In multispectral images, the spectral resolution is expressed through the number of bands (spectral intervals), where images of the same land surface were taken simultaneously. The spectral resolution depends on the spectral behavior of the topographic details in relation to the wavelength of the reflected electromagnetic radiation and the sensor's sensitivity in relation to different spectral intervals.

The spatial resolution refers to the linear dimension of the smallest topographic land detail that can be recorded in a remote sensing image. This corresponds as dimmension in land to the pixel edge of the image and depends on the performance of the remote sensing sensor [Vlaicu Aurel**,** 1997].

MATERIALS AND METHODS

For the multispectral analysis of the vegetation from the researched area, *Landsat* multispectral images were used, especially those from the red (R) and near-infrared (NIR) bands. In the case study, three areas from the Landsat multispectral images were chosen, in June 2011, areas located in the unincorporated area of Câmpia Turzii locality. The image analysis process implied the image georeferencing process, then a quantitative and qualitative thematic analysis. The quantitative analysis was made through a thematic classification (both supervised and unsupervised), and for the qualitative analysis difference vegetation indices were used.

The georeferencing was performed by means of photogrammetric points, identifiable both on image and in land, whose rectangular geodetic coordinates were determined in land through GPS measurements [Vertan Constantin, 1999; Toderaş Teodor, 2002].

The thematic qualitative anlysis of the multispectral images' informational code was made through a spectral (static) classification. *Supervised classification* (assisted by operator) was used, where image spectral classes are associated to the topographic details through the image photo-interpretation, as well and *the unsupervised classification* (unassisted by an operator), where targeted spectral classes are automatically identified by statistical means. LEOWorks Software was used, as a multispectral image processing tool, developed for EDUSPACE by The European Space Agency and The Romanian Space Agency.

In *supervised classification,* cultivated vegetation classes searched in images' informational content are priorly known on certain small areas from the image, the areas from the image, specific to each agricultural crop category being identified (using the polygon selection), then through the image analysis process, each image pixel is classified into one of these categories. The supervised classification of the digital images implies the following operations:

- *the selection of characteristics*, that supposes to select the useful information (of the vegetation area), used in order to classify the content of the image;
- *the selection of the classification type*, which consists in decomposing the characteristics space into subspaces, so that any pixel belong to one of the categories. The software used allows options for three supervised classification types: *geometric*, which depends on measuring the distance between the unknown pixel and a halfway vector, *parallelepipedal,* where a rectangular-shaped field is being set and each pixel is tested if it belongs to the field and *probabilistic*, relying on the probability of a pixel to belong to a specific category [Bogdan M., 2009].

In *unsupervised classification*, cultivated vegetation classes are made by creating pixel groups that represent characteristics of the cultivated vegetation without priorly knowing what it's being classified. In fact, pixels are distributed in classes and grouped in clusters, depending on the characteristics of reflected radiation (recorded in gray shades) of the analysed vegetation [Bogdan M., 2009].

The thematic qualitative analysis of the informational content in multispectral images implies a qualitative analysis of the cultivated vegetation, based on the NDVI index (Normalized Difference Vegetation Index). This is a normalized spectral vegetation index, which can separate the vegetation from the uncovered soil by combining spectral bands: 3 in red (R) on the visible spectrum and 4 in near-infrared bands (NIR). Through this comparative analysis of the pixels from the two-spectral bands, the chlorophyll activity can be highlighted, by means of which vigorous plants (healthy, high-quality) and weak plants (affected by drought, diseases and pests) are separated[Badea A., 2011; Bogdan M., 1999]. *The Normalized Difference Vegetation Index* ***(NDVI)*** was used to highlight the quality of the vegetation areas based on vegetation spectral signatures in *near-infrared* (spectral area where the chlorophyll reflectance index is the highest), compared to the one from the *red area* (where chlorophyll absorbs light radiations, giving to the healthy vegetation a green colour). The calulation relationship of the vegetation index is based on the pixels analysis of the spectral red (R) and near-infrared bands (NIR – *Near Infra Red*).

$$NDVI = \frac{NIR - R}{NIR + R}$$

where: NDVI – is the normalized difference vegetation index;
NIR – pixel value on the near-infrared spectral band (e.g.: 4th band);
R – pixel value on the red spectral band (e.g. visible, Red – 3rd band)

The NDVI index can take values between -l and 1, representing the consistency of the cultivated vegetation. Thus, value 1 represents the maximum consistency vegetation, specific to dense and healthy vegetation. Value zero corresponds to the low consistency vegetation, affected by drought or diseases and -1 represents the land with no vegetation.

RESULTS

Based on the thematic classification, class types that include agricultural crops were identified and extracted. By *supervised* classification (assisted by operator) of the informational content of the area selected in the multispectral images that include the unincorporated area of Câmpia Turzii locality, 4 categories of agricultural crops were identified and extracted (wheat, canola, potato and rice), conventionally materialized by colours (fig. 1).

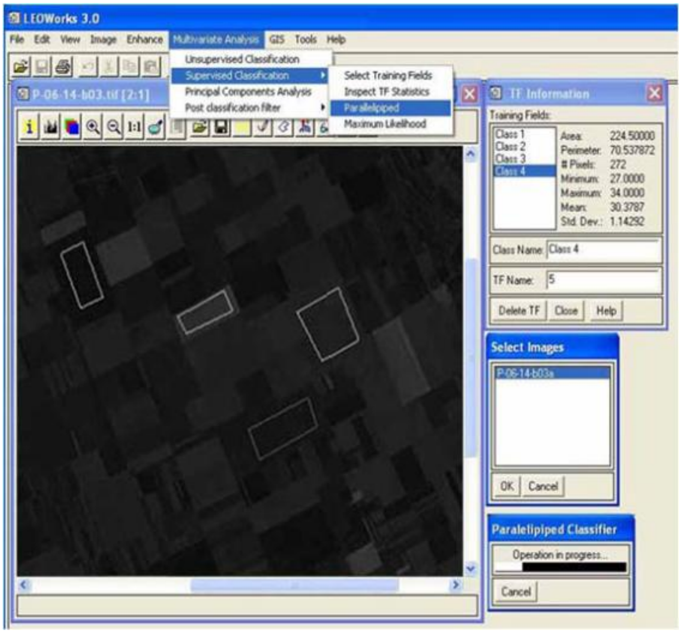


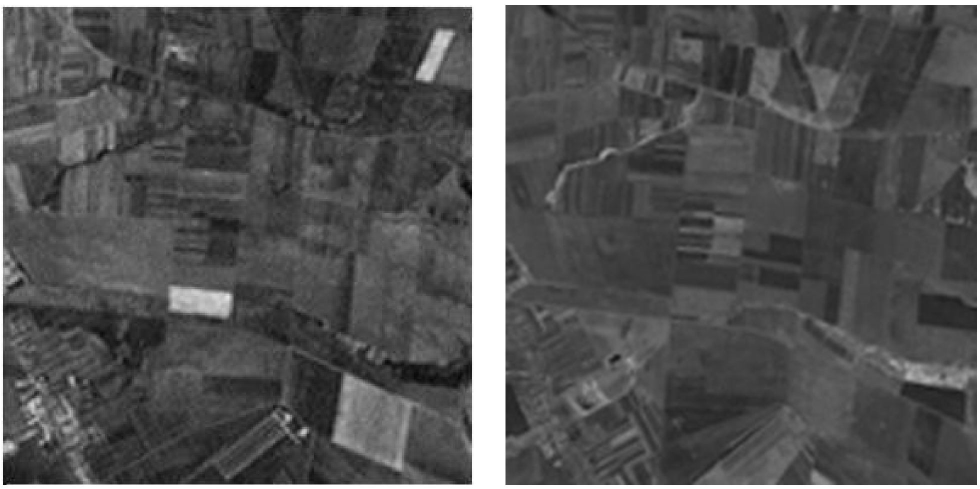
Fig. 1. Supervised classification. Multispectral image (3rd Landsat band) (section of the unincorporated area of Câmpia Turzii)

The result of the supervised classification of the researched area is shown in figure 2. As can be seen, on the analysed area the following agricultural crops are selected: wheat 25.53%, canola 12.20%, potatoes 3.51% and barley 26.03%.

Fig. 2. The result of the supervised classification (section of the unincorporated area of Câmpia Turzii)

The supervised classification method implies priorly identifying on the image the areas and classes that would be researched along the multispectral image.

For the *unsupervised* classification (unassistated by an operator) of the multispectral image informational content, an area selected on the multispectral images was used, in the south-western part of Câmpia Turzii locality, in its unincorporated area (fig. 3).



a b

Fig. 3. Unsupervised classification (section of the 3rd and 4th multispectral bands) a – image of the 3rd band (R); b – image of the 4th band (NIR).

Following the unsupervised classification of the image content from the researched area, the next classes were selected, being depicted in coventional colors: barley 2.04%; canola 16.02%; wheat barley 13.76%; potatoes 26.03%; corn, barley 9.17 %; beet 2.04%;

lucerne 13.37 % and rye 17.45%. It can be seen that in this area the largest crop is the potato one and the smallest one, the barley and beet crops (fig. 4).

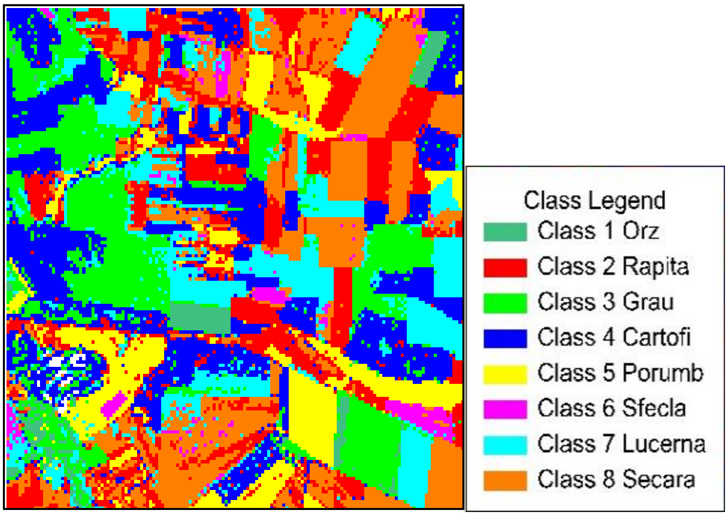


Fig. 4. Result of the unsupervised classification
(Section of the unincoroporated area of Câmpia Turzii, south-west from the locality)

For the ***qualitative analysis*** of the cultivated agricultural vegetation the same unincorporated, south-western area from Câmpia Turzii locality was selected and processed, as for the unsupervised classification, the area registered on the 3rd red spectral band (R) and 4th near-infrared spectral band (NIR), (fig. 5).

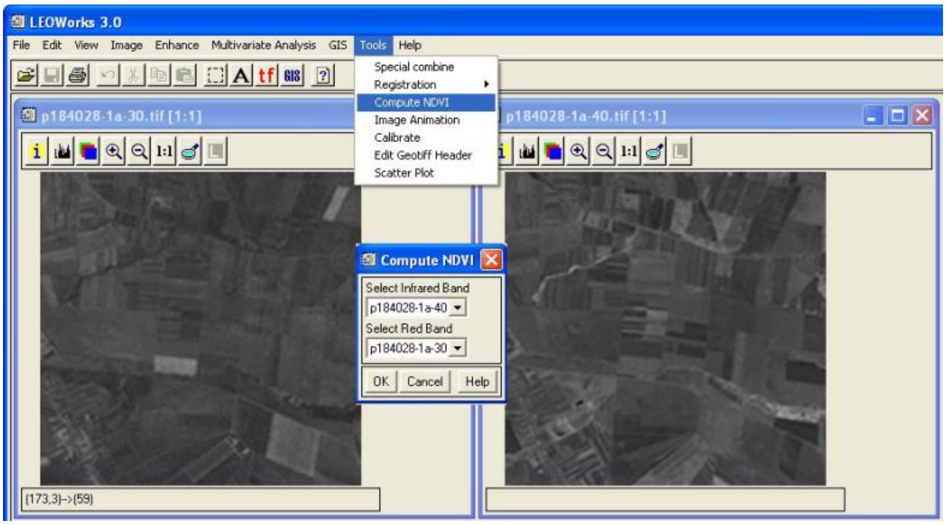


Fig. 5. The qualitative analysis of the cultivated vegetation based on NDVI index calculation (image sequence from the 3rd and 4th spectral bands)

After NDVI index processed the multispectral images from the 3rd red spectral band (R) and 4th near-infrared spectral band (NIR) of the researched area, 5 high-quality classes of the cultivated agricultural crop emerged, depicted in conventional colors: dense vegetation (healthy); moderate vegetation (moderate density); rare vegetation (lack of water); low vegetation (dry, with diseases) and lands with lack of vegetation (fig. 3).

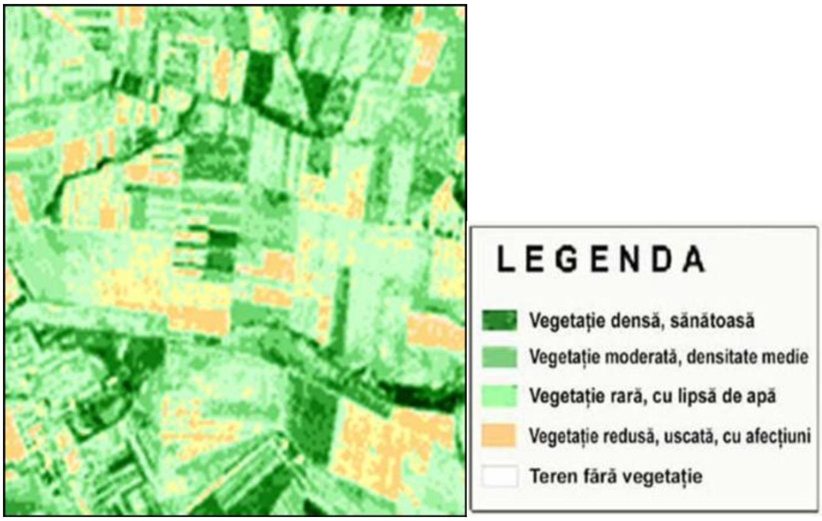


Fig. 3. The result of the qualitative classification of the cultivated vegetation, based on NDVI index (Normalized Difference Vegetation Index)

As can be seen from the results, after processing the images, high NDVI values got closer to 0.70 (representing dense vegetation, marked in dark green colour shades), and moderate vegetation in light green. Also, lands with low vegetation are characterised by values lower than 0.25.

CONCLUSION

For a good theme processing, on qualitative and quantitative analysis of the cultivated vegetation, the multispectral images used must be georeferenced. The georeferencing precision of the images is given by the precision in determining the aiming points and identifying them on the image. For a high-quality vegetation classification, high and moderate resolution multispectral images must be used and choosing the difference vegetation indices depends on the vegetation type to which they are sensitive.

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