REMOTE SENSING METHODS FOR ANALYZING VEGETATION AND URBAN EXPANSION

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Abstract. *The specific means and methods of remote sensing, based on specialized softwares, can make comparative analysis of satellite images and can thus highlighting quantitative changes in the structure of geographical space, in a given territory. The main purpose of this study is to analyze the space-time evolution of Lugoj Municipality and the surrounding area, in a temporal interval of approx. 25 years, from 1985 to 2011. To achieve the proposed analysis, Landsat TM satellite images were used, purchased in 1985 and 2011, images were processed with Idrisi Selva software. Using the methodology described in the literature, were calculated two indices, Normalized Difference Vegetation Index (NDVI) and Normalized Difference Building Index (NDBI) for the two time points, and the results were analyzed comparatively in order to identify possible amendments products in this temporal interval (Change Detection function). Validation of the results was done by comparison with topographic maps, cadastral maps and ortophotoplans for the area of interest. To calculate areas, raster maps obtained were reclassified and converted into vector format, making it possible to "quantify" the changes.In the region under study, in the aforementioned time interval, changes are noted, both in the spatial distribution of vegetation and as regards the areas covered by the construction. Socio-economic and political changes that occurred during the analyzed time, is reflected in the use of land in crops structure and terms of use non-agricultural areas (construction, water-covered surfaces). In the case of Lugoj Municipality, the phenomenon of "urban growth" is not one of scale, as in the case of large cities, the most significant changes noticed in other components of the environment.*

Key words: *satellite images, comparison, change, expansion*

INTRODUCTION

The dynamics of urban and suburban area is one of several topics addressed in all areas of research, this phenomenon has implications for ecological, economic, landscape, architecture, etc.

Starting from the idea that one of the most important features of geographic information is *spaciousness*, temporal variability of objects and/or phenomena (in terms of location, size, shape, etc.) facilitates the identification and configuration dynamics (MĂRGĂRINT M, 2010).

Progress in science and technique, imposed a rapidly changing of specific means and methods of remote sensing, from desire to know, as thoroughly, environmental components situation and the temporal and/or spatial evolution of them. The specialized programs have been developed and have developed methods of analysis for the use of satellite images to extract information particularly useful in quantitative analysis of vegetation and other components of the geographic space.

MATERIALS AND METHODS

The main purpose of this study is to analyze the spatial-temporal evolution of vegetation and the built space of Lugoj Municipality between 1985-2011.

In order to achieve the proposed analysis, were used:

- Landsat TM satellite images acquired in different time periods, namely June and August 1985 and 2011, based downloaded free of Earth Explorer database [9]
- Orthophotoplans for Lugoj area [7]
- Cadastral maps at scale 1:5000 and 1:10,000 [8].

Based on the two Landsat TM images, using Idrisi Selva software, were calculated:

- Normalized Difference Vegetation Index (NDVI) using the relation [10]:

$$NDVI = (NIR - R) / (NIR + R) \quad (1)$$

where: NIR - near infrared band (band 4), R - red band (band 3)

- Normalized Difference Building Index (NDBI) using the relation [10]:

$$NDBI = (IR - NIR) / (IR + NIR) \quad (2)$$

where: IR - middle infrared band (band 5), NIR - near infrared band (band 4).

With Idrisi Selva software *(application Change Detection*) on the two pictures/maps NDBI the changes were highlighted during the time from 1985 to 2011.

The data and information extracted during the processing of satellite images were analyzed together with other cartographic materials (cadastral maps, thematic maps) using ArcGIS 10.0 software (HERBEI M, 2013).

RESULTS AND DISCUSSIONS

For this study were used three of the bands of Landsat TM images:

- ***Band 3*** - because the vegetation absorbs most of the red light, thus are sometimes called "absorption band of chlorophyll" (HORNING N, 2004), band useful to distinguish vegetation from the ground (POPESCU C, şi colab, 2015)
- ***Band 4*** - in this band bodies of water appear very dark because water absorbs almost all the light in this wavelength so reflectivity contrasts with "light" soil and vegetation so it is a good band for differentiating water – land
- ***Band 5*** - is very sensitive to moisture and therefore, is particularly useful for monitoring vegetation and soil moisture status.

The analysis of changes in terms of vegetation coverage in Lugoj area, between 1985 - 2011, started with NDVI calculation and representation.

Normalized Difference Vegetation Index (NDVI) was first introduced in 1969, by Kriegler. It is particularly useful in: mapping areas covered with vegetation in determining the vegetation typology, but also its health (LEWIN K, 2012).

"The concept" of NDVI is based on the fact that if vegetation pigment in plant leaves or chlorophyll strongly absorbs visible light (0.4 - 0.7 μm) its use in photosynthesis.

The cellular structure of the leaves, on the other hand, strongly reflect near infrared light (0.7 - 1.1 μm). So NDVI values expresses consistency varies depending on the vegetation and absorption of radiation in the spectral reflectance its red and near infrared spectral area (MIHAI B, 2007).

Initially, the NDVI calculation based on the relation (1) were used of Landsat TM images acquired in August, 1985 and 2011 (Figure 1).

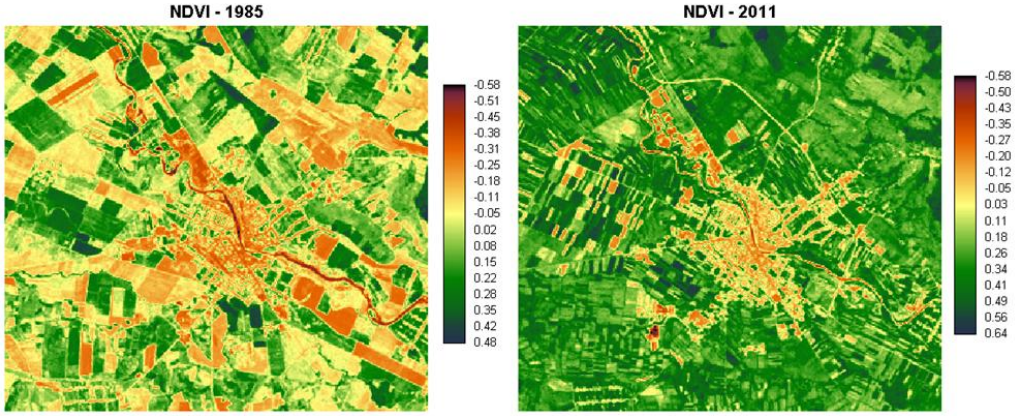

Figure 1 NDVI map – August 1985 and 2011

Simple visual analysis of both NDVI images suggest major differences in terms of spatial distribution of vegetation, but these differences are not related to the use of the land, but the structure of crops. It is known that, under socialism, agricultural land were fully exploited, so it can not be considered exploitation only partial or use agricultural land to another destination so that in 2011 the areas with vegetation to hold larger areas than in 1985. This is explained by the fact that the grain-growing land in 1985 after harvesting them, was removed "green table" and thus reflectance is reduced.

To prevent such situations can have a negative influence on the final result of the analysis of changes, they were used two of Landsat images acquired in June over the same period, 1985 - 2011 (Figure 2).

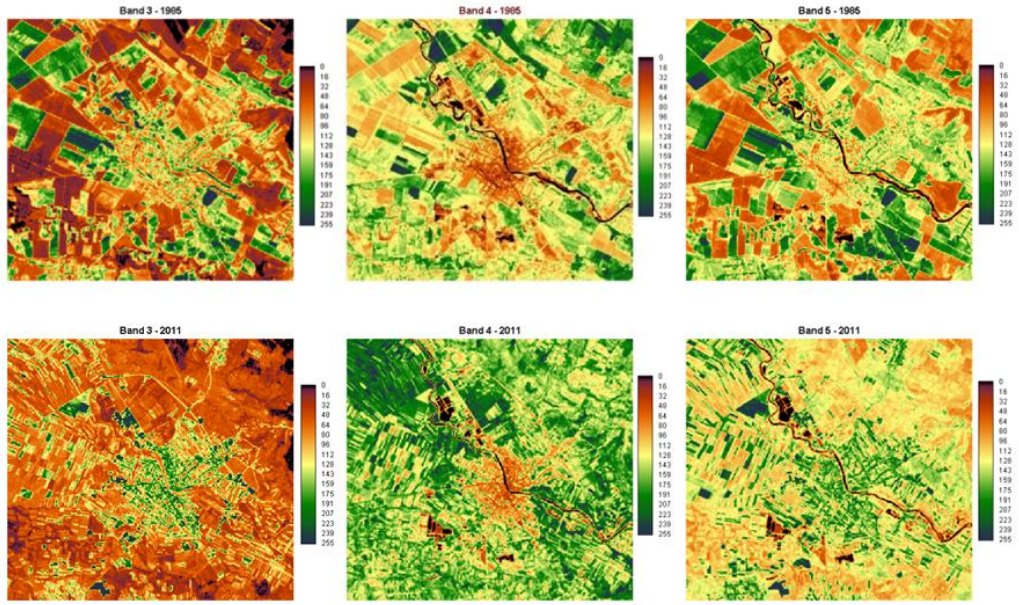

Figure 2 Spectral bands of Landsat TM images displayed by Idrisi Selva

From the two satellite images has extracted area of of interest (Figure 2) and bands 3, 4 and 5, which participate in the subsequent tests, were processed in order to improve the contrast.

Using relation (1) was calculated and mapped NDVI (Figure 3).

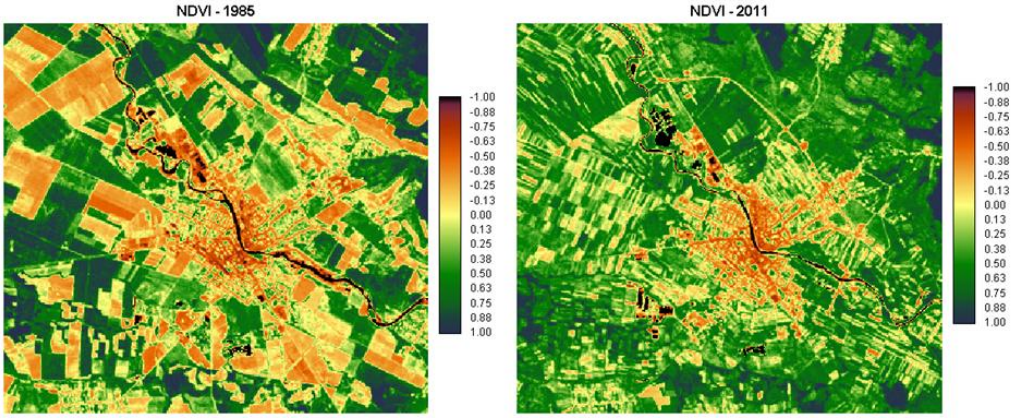

Figure 3 NDVI map in the Lugoj area – June 1985 nad 2011

Unlike the previous case, the quantitative differences between the two time points are lower, but in this case may receive an "abundance" bigger vegetation at end considered also linked to the crop structure.

To analyze the change in the "territorial expansion" of Lugoj Municipality, was calculated and plotted the **Normalized Difference Building Index (NDBI)** using the relation (2), to highlight the built environment (human settlements, road networks, bridges, dams).

Relation for calculation of NDBI involves spectral signatures of objects in the middle infrared bands (reflectance high humidity, including construction materials) and near infrared (with maximum reflection vegetation) - so it is used to differentiate the spectra of vegetation and building materials (MIHAI B, 2007).

NDBI map for the two time points indicating quantitative changes in the structure and organization of built space (Figure 4).

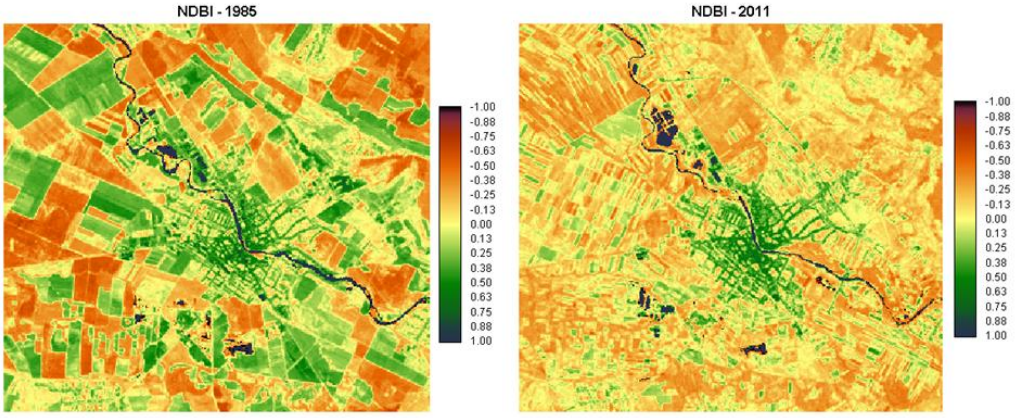

Figure 4 NDBI map in the Lugoj area

Visual analysis, qualitative, of the two NDBI maps does not allow "quantification" of changes between 1985 - 2011, which calls their digital processing. The two images were "compared" using Idrisi Selva follows: execute drop images, being obtained as a new image from of histogram were extracted the mean and standard deviation, based on which, with reclassification, it obtained a map changes in the interval 1985 - 2011 (Figure 5).

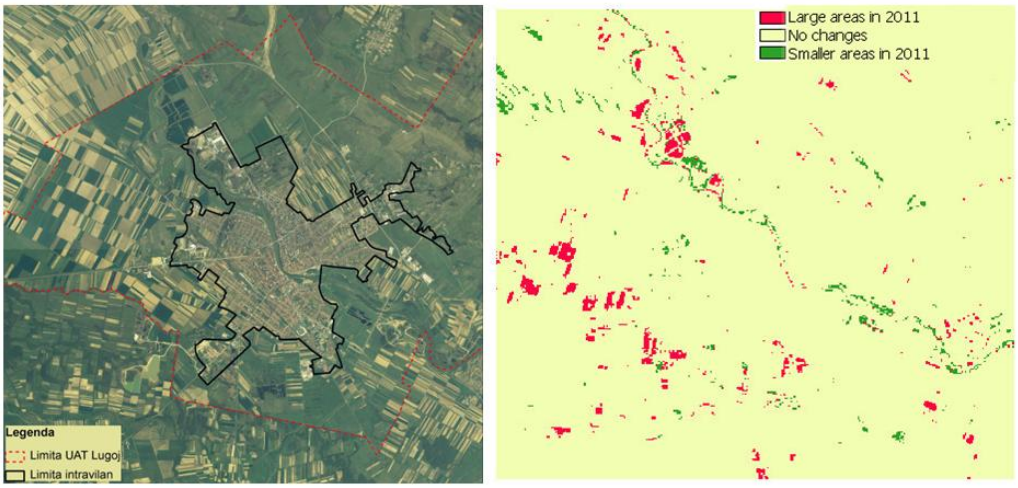

Figure 5 Orthophotoplan from Lugoj area [7] and changes map between 1985-2011

For guidance, on the changes map were superimposed roadways and Timis River using ArcGIS 10.0 software (Figure 6).

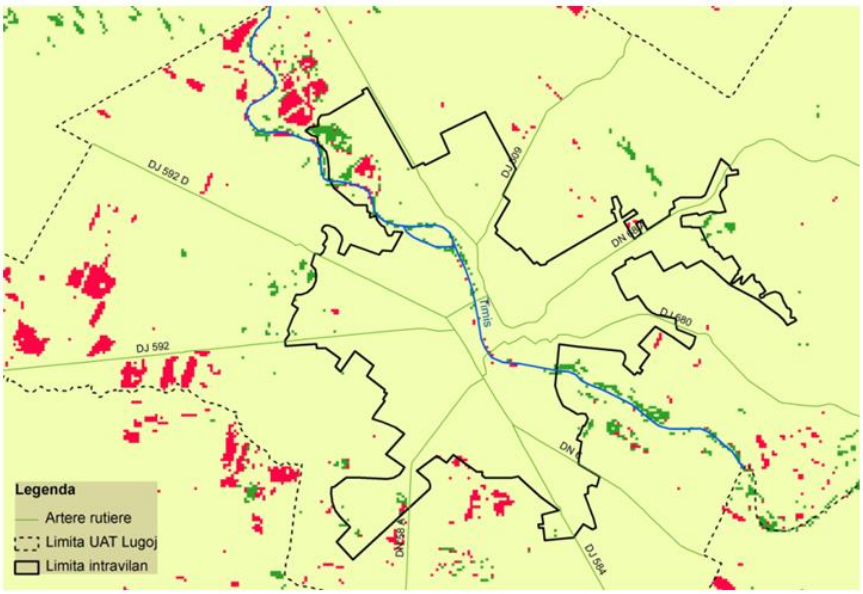

Figure 6 Result of changes analysis

As shown in Figure 5 and Figure 6, during 1985 - 2011, in the town area have not produced major changes, except the area of the north-west.

To validate the results, the data were compared to other cartographic materials being emphasized is this: larger areas in 2011 are actually covered by surfaces with water (lakes, ponds) - in changes analyzing being involved spectral bands 4 and 5 - and do not belong on category "constructions", so the phenomenon of „urban expansion" has occurred with low intensity.

CONCLUSIONS

Using satellite images to analyze the geographical space offers many advantages: large volume of information, reusability of data in subsequent analyzes, getting information from remote areas, the possibility of integrating the results with other GIS-specific data, etc.

Of particular importance is the stage of choosing imagery involved in spatial-temporal analysis, of this step depends on compliance outcome.

In the case of Lugoj area, in the temporal interval 1985 - 2011, no major changes are outlined in terms of built space, which means that "urban expansion" occurred at minimum.

Further differentiating notified in the case of areas covered with water so in the north-west and south-west, these areas are more extensive in 2011 compared with 1985. It also notes changes in the meadow Timişului in this case water covered areas were limited to the end of the period of time the use of space is different.

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