USING SATELLITE IMAGES LANDSAT TM FOR CALCULATING NORMALIZED DIFFERENCE INDEXES FOR THE LANDSCAPE OF PARÂNG MOUNTAINS

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***Abstract**: The information obtained from remote sensing is contained by the cosmic or aerial images which can be interpreted in many purposes. Building these images is based on detection and registering of electromagnetic energy reflected or issued by the surface of the objects present on the visual field of the sensors, which interacted with the electromagnetic energy issued by a natural source (e.g. Sun, Moon) or an artificial one (e.g. radar). The remote sensing data is public, meaning it can be acquired from any area of the world and by anyone, with some restriction.*

***Keywords:** Landsat, remote sensing, vegetation index, NDVI.*

1. Introduction

The electromagnetic radiation spectrum unites all the length waves that are detectable and measurable by humans using various resources. The spectrum presents a series of areas where the electromagnetic radiation is bound based on wave length. The feedback representing the objects from nature is different according to the various wave lengths of the electromagnetic radiation, based on their physical and chemical properties, configuration and roughness of the surface, the light intensity and the angle of incidence.

These responses registered by the sensors are translated in images by forming models (features) based on which they can be distinguished and identified as the corresponding objects. The satellite images are important sources for extracting geographic information, and one of the ways to analyze them is based on defining the normalized difference indexes of the landscape elements.

The presence of LANDSAT images in the civil domain has brought the possibility to vary the exploitation method of satellite information. In the next table there are presented the LANDSAT bands and their usability.

Table 1. The LANDSAT bands and their usability

Band no.	***Spectral band***	***Length waves***	***Spatial resolution (m)***	***Usability***
1	B - Blue	0.45 - 0.52 μm	30	• Interpretation of the water occupied areas • Analysis of soil characteristic, vegetation and land use • Identification of anthropic elements
2	G- Green	0.52 - 0.60 μm	30	• Achieving a qualitative dissociation of the vegetation (identifying healthy vegetation) • Identification of anthropic elements

3	R - Red	0.63 - 0.69 μm	30	• Distinguishing of plant species • Determining of pedological and geological limits
4	NIR – Near Infra Red	0.76 - 0.90 μm	30	• Determining the vegetation type • Determining the biomass quantity • Identifying the cultures • Precise mapping of the water front • High contrast soil – vegetation and water - land
5	MIR – Medium Infra Red	1.55 - 1.75 μm	30	• Identifying the excess humidity • The study of the cultures in dryness conditions • Investigating the plants' strengths • Distinguishing the snow from the muddy areas
6	TIR – Thermal Infra Red	10.4 - 12.5 μm	90	• Presenting thermal properties of the bodies at intervals of every 2^0 • Classifying the vegetation, analysis of the vegetation stress and studies of soil humidity • Analysis of water pollution
7	MIR – Medium Infra Red	2.08 - 2.35 μm	30	• Discrimination of geological formation • Identifying of areas with hydro – thermal alterations

In theory there are many possible combinations of these bands (6 bands considered 3 times in the 3 areas of the visible spectrum: blue, green, red) but practically only a small part of these combination can be useful. Choosing the optimal combination depends on: the characteristics of the land, climate, the type of the application, the moment of data acquisition, azimuth and elevation of the Sun in the moment of acquisition or spatial dimension of the elements.

2. Additions

The vegetal coverage can be characterized not only by its spectral reflectance and emittance, but also by different indexes which are calculating the radiometric response in different spectral bands. The vegetation reflectance in the visible spectrum is very small due to the radiation absorption by the photosynthetic active pigments. Maximum levels of absorption exist for wave lengths from the Blue band and Red band. Instead in Near Infra Red the vegetation reflectance is high.

A large part of radiation in this domain is reflected or transmitted, depending on the structure of the coverage and the cellular structure of the leaves. The contrast between the reflectance in Red and the reflectance in Near Infra Red can be a method of the vegetation quantity.

The vegetation indexes represent types of measure for this contrast, being defined by empirical functions which integrate the structure of vegetation coverage and the physiological parameters associated with photosynthesis.

Below there are presented the most important vegetation indexes and the method of mapping them. The study area is Parang Mountain.

2.1. Normalized Difference Vegetation Index – NDVI

Interpretation: The NDVI values vary according to the radiation absorption by the chlorophyll in the red spectral area and its reflectance in the near infra red spectrum. These values are between -1 and +1, corresponding to the consistency of the green vegetation. The ones close to +1 (light color) represent a higher consistency of the vegetation and are specific to the dense broadleaf forest. The ones close to -1 (dark color) represent the land with lack of vegetation, having visible soil or rock surface. The 0 value (intermediate color) is associated with grass lands. It is useful in mapping of vegetation areas, vegetation types, vegetation health status, the land use etc. The formula for calculating this index is:

$$\mathrm{NDVI} = (\mathrm{NIR} - \mathrm{R}) / (\mathrm{NIR} + \mathrm{R}) = (\mathrm{B4} - \mathrm{B3}) / (\mathrm{B4} + \mathrm{B3}) \quad (1)$$

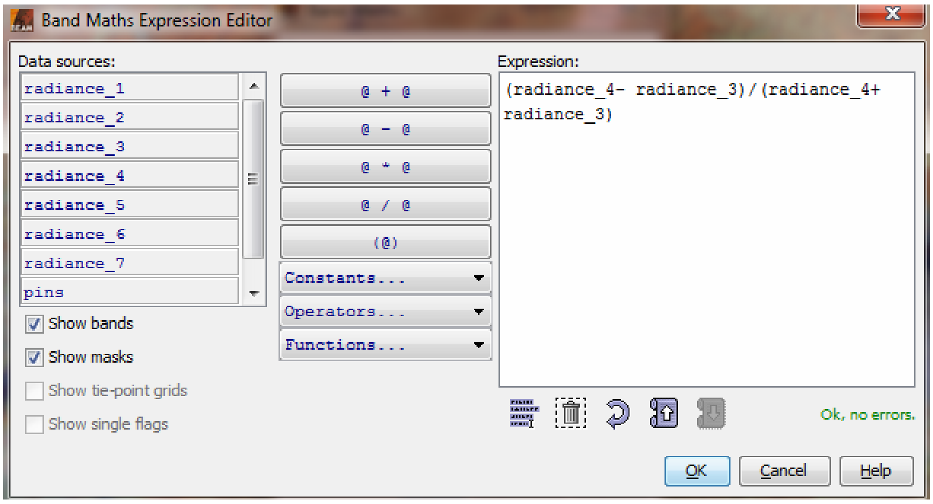

Fig. 1. The NDVI Band Math

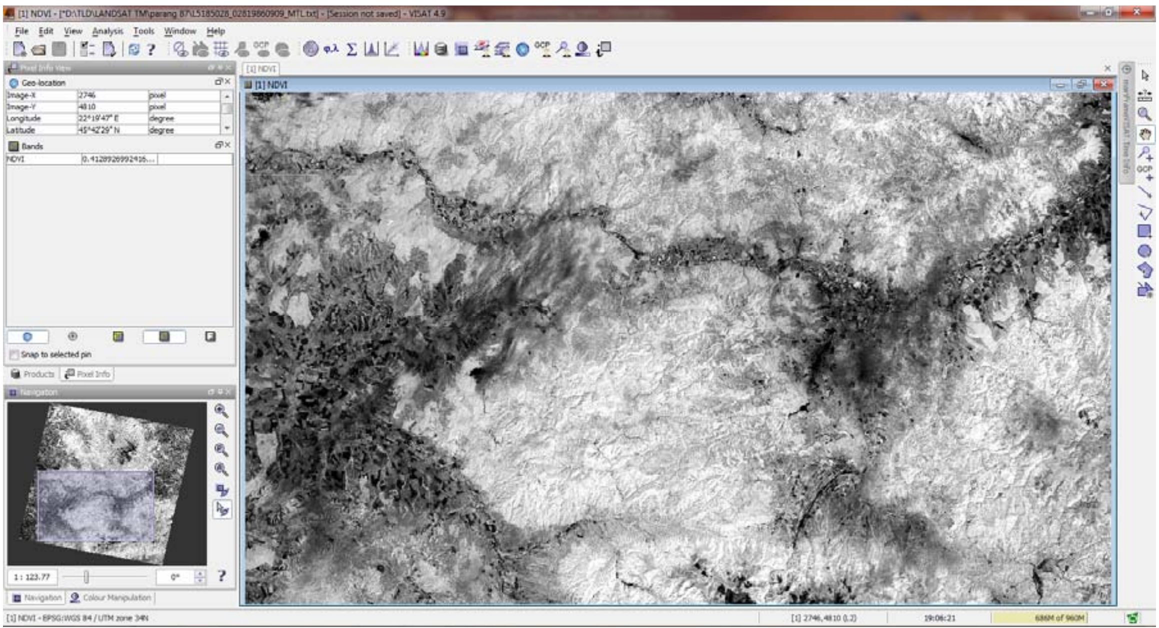

Fig. 2. NDVI map

The software enables to create also some statistical reports, NDVI histogram for the whole studied area, to create the profile for a certain assign area or to display the NDVI coordinates and values.

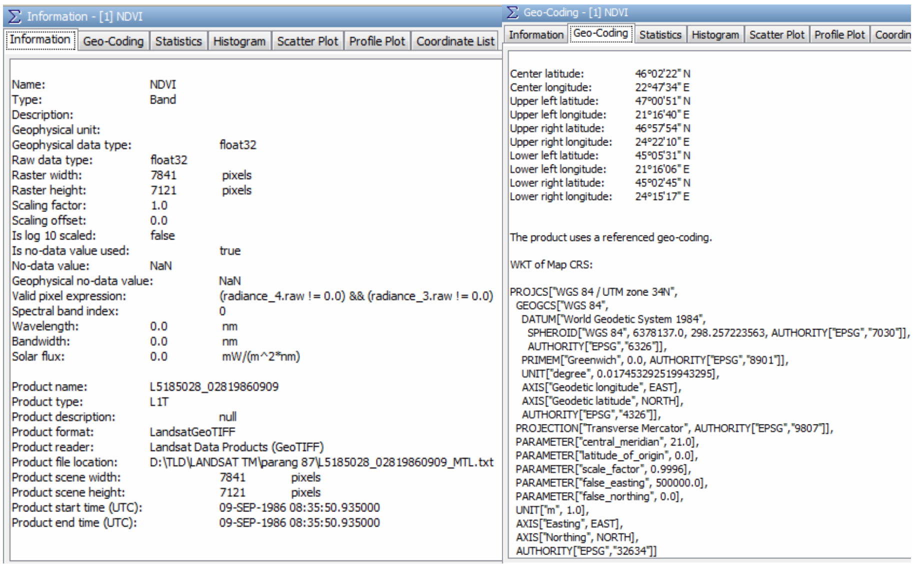

Fig. 3. Informal and statistical report of NDVI map

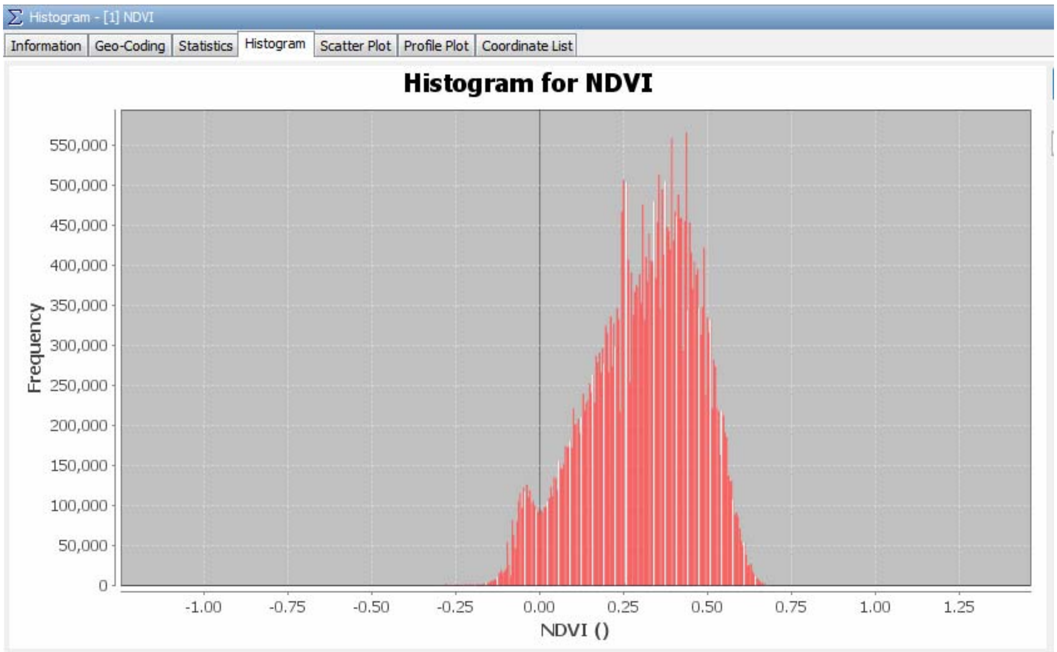

Fig. 4. Histogram of NDVI map

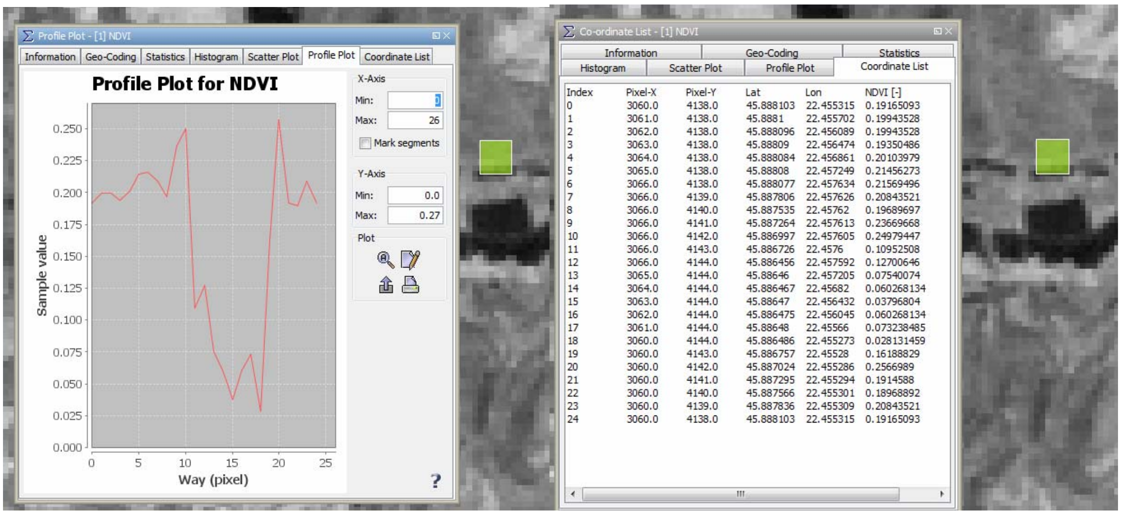

Fig.5. Profile of a NDVI map

2.2. Normalized Difference Water Index – NDWI

Interpretation: This index is useful in mapping the water areas, displaying the differences in turbidity and vegetal content of the water, erratic soil or in measuring the water content of the vegetation. This index uses green spectral bands and near infra red (increases the spectral feedback of the soil humidity, of the rocks and plants and the water begins to absorb radiation from the surface layer). The dark color (values close to -1) represent the water crystal, the light color (values close to +1) represent dry land and intermediate colors (values close to 0) represent lands with intermediate humidity content. The formula for calculating this index is:

$$NDWI = (NIR - G)/(NIR + G) = (B4 - B2)/(B4 + B2) \qquad (2)$$

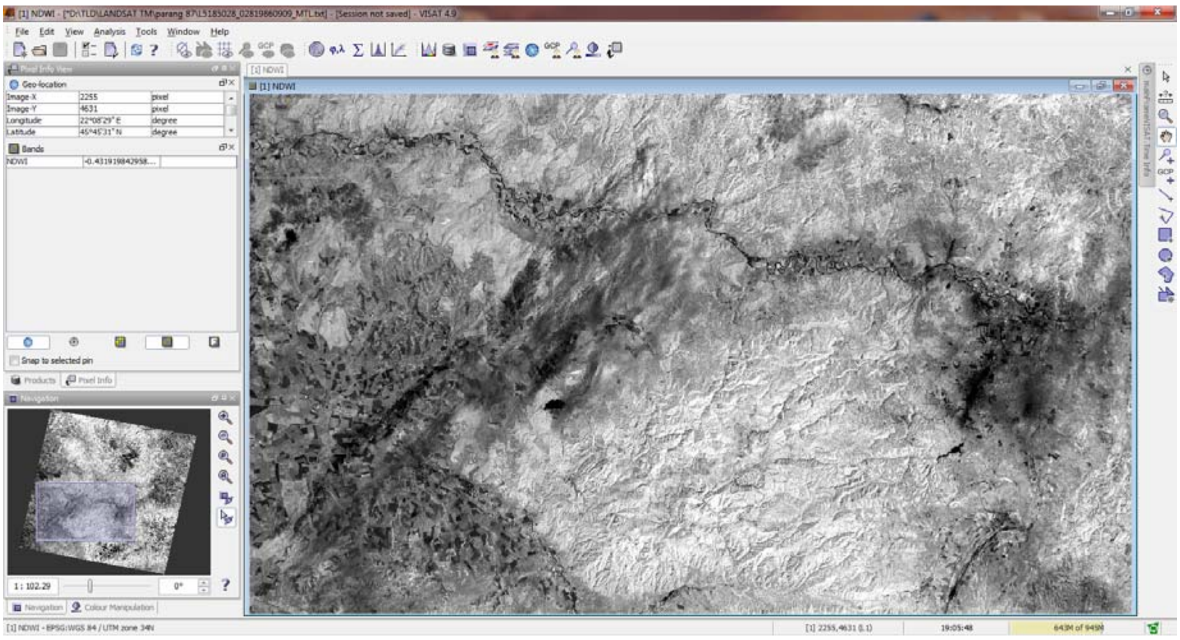

Fig. 6. NDWI map

2.3. Normalized Difference Snow Index – NDSI

Interpretation: Using this index the light colors represent land covered in snow, the dark color represent land without snow. It uses green spectral bands (high reflectance of the snow) and medium infra red (low reflectance). Generally, the snow is characterized by high values of NDSI (above 0.4) and it is represented in light color shades (close to white). This index is useful in mapping snow covered areas or in efficient evaluation of the possible new skiing domains. The formula for calculating this index is:

$$NDSI = (G - IR)/(G + IR) = (B2 - B5)/(B2 + B5) \quad (3)$$

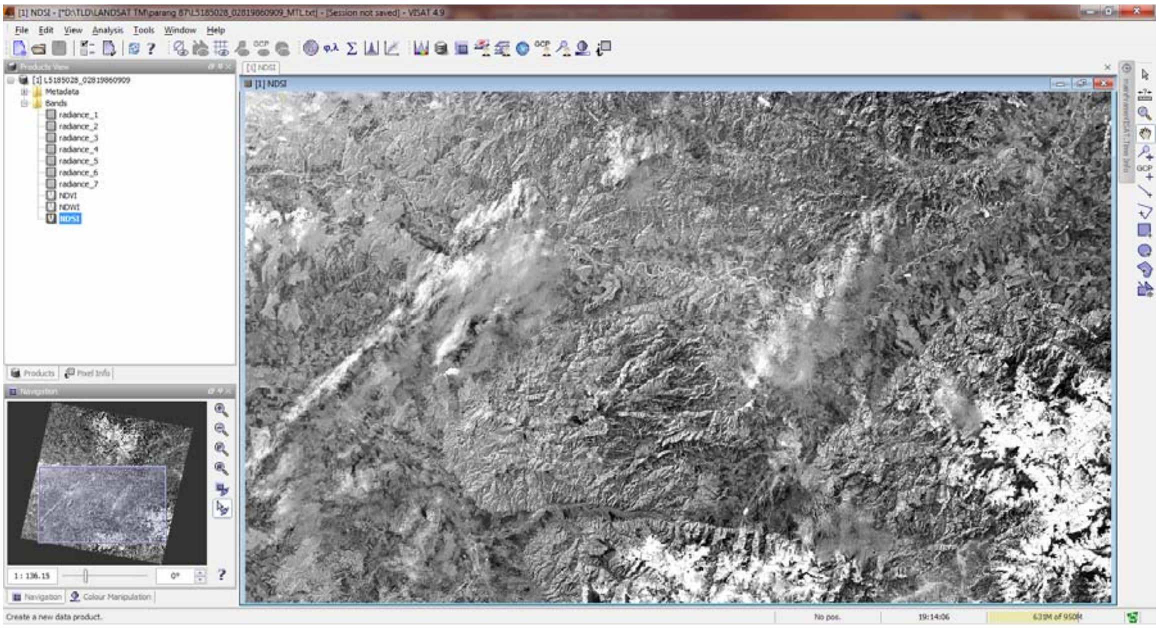

Fig. 7. NDSI map

2.4. Normalized Difference Moisture Index – NDMI

Interpretation: Using this index the light colors represent excess of humidity and dark colors represent low humidity. It evaluates the different content of humidity from the landscape elements, especially for soils, rocks and vegetations (excellent indicator for dryness). Values higher than 0.1 are symbolized by light colors and they signal high humidity level. Low values (close to -1) symbolized by dark colors represent low humidity level. The formula for calculating this index is:

$$NDMI = (NIR - IR)/(NIR + IR) = (B4 - B5)/(B4 + B5) \quad (4)$$

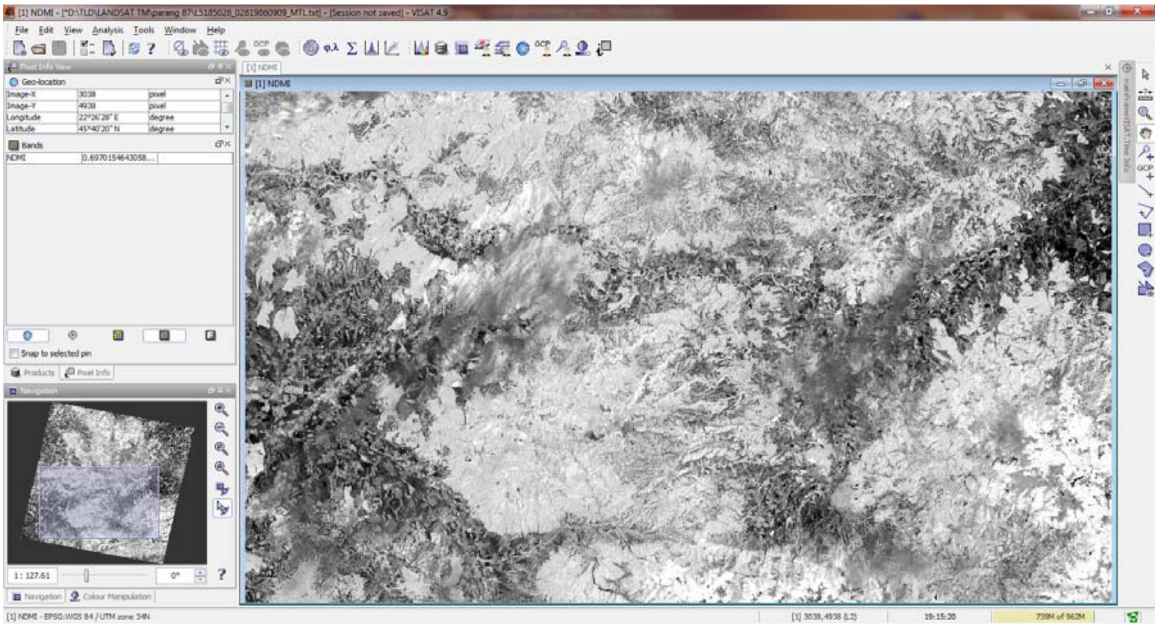

Fig. 8. NDMI map

2.5. Normalized Difference Burning Ratio – NDBR

Interpretation: This index uses the bands where the spectral answer of non incendiary vegetation (near infra red) and incendiary ones (medium infra red) are the most visible. The difference in reflectance symbolizes the presence of chlorophyll before arson, and the lack of it after arson. The light colors (above 0.1) represent the lands with high risk of arson (woods, dry bushes) and the dark colors represent the lands without risk of arson (buildings made of stone or concrete, highways or roads, railroads etc.). The formula for calculating this index is:

$$\mathrm{NDBR} = (\mathrm{NIR} - \mathrm{MIR}) / (\mathrm{NIR} + \mathrm{MIR}) = (\mathrm{B4} - \mathrm{B7}) / (\mathrm{B4} + \mathrm{B7}) \qquad (5)$$

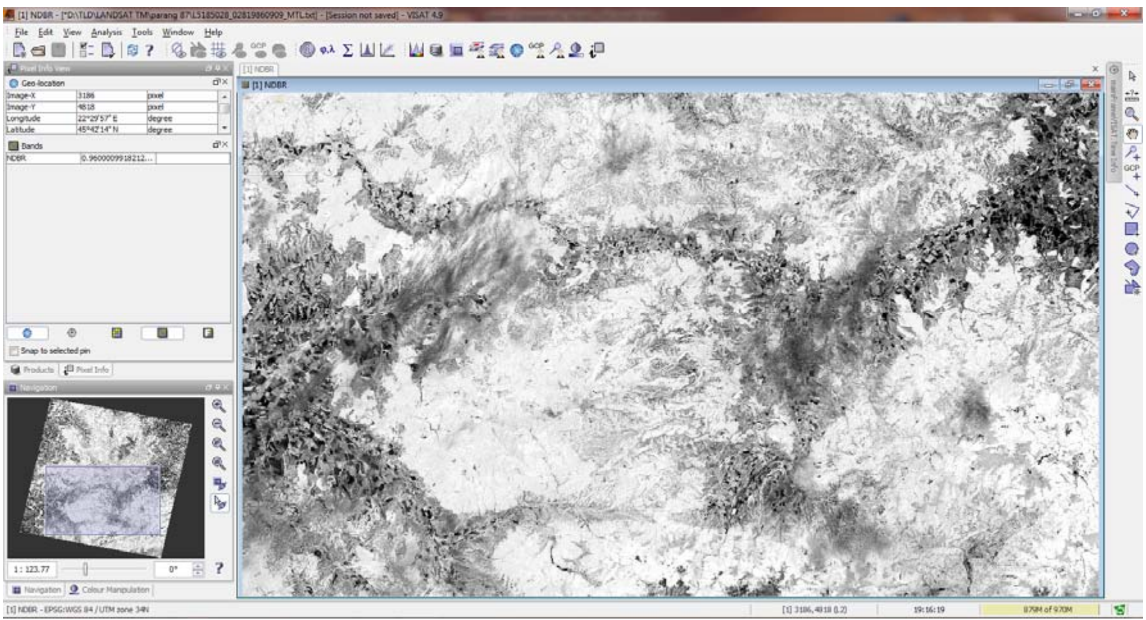

Fig. 9. NDBR map

2.6. Normalized Difference Building Index – NDBI

Interpretation: Using this index the light colors represent tilled land and building areas and dark colors represent forests. The values of NDBI vary according to the spectral signature from medium infra red and near infra red band. Light colors (positive values) symbolize lands with buildings and dark colors (negative values) symbolize other landscape elements. It is useful in mapping human settlements but also some elements of surrounding constructions. The formula for calculating this index is:

$$\mathrm{NDBI} = (\mathrm{IR} - \mathrm{NIR}) / (\mathrm{IR} + \mathrm{NIR}) = (\mathrm{B5} - \mathrm{B4}) / (\mathrm{B5} + \mathrm{B4}) \tag{6}$$

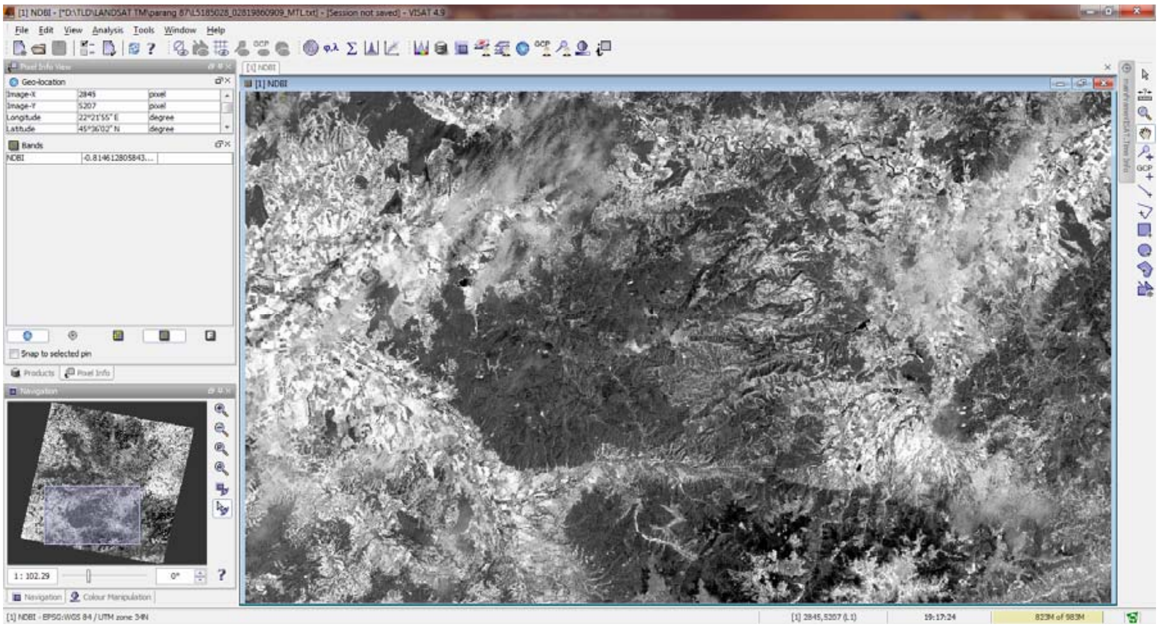

Fig. 10. NDBI map

2.7. Enhanced Vegetation Index EVI (Enhanced Vegetation Index)

Interpretation: EVI index is dedicated to optimizing the vegetation signal by increasing sensitivity in regions rich in biomass. The formula for calculating this index is:

$$\begin{aligned} \mathrm{EVI} &= \mathrm{G} \cdot (\mathrm{NIR} - \mathrm{R}) / (\mathrm{NIR} + \mathrm{C1} \cdot \mathrm{R} - \mathrm{C2} \cdot \mathrm{B} + \mathrm{L}) \\ \mathrm{EVI} &= \mathrm{G} \cdot (\mathrm{B4} - \mathrm{B3}) / (\mathrm{B4} + \mathrm{C1} \cdot \mathrm{B3} - \mathrm{C2} \cdot \mathrm{B1} + \mathrm{L}) \end{aligned} \tag{7}$$

Where C1, C2 – resistance coefficients of aerosols, L – adjustment factor, G – multiplication factor; for MODIS sensor: L=1, C1=6, C2 =7.5 and G=2.5.

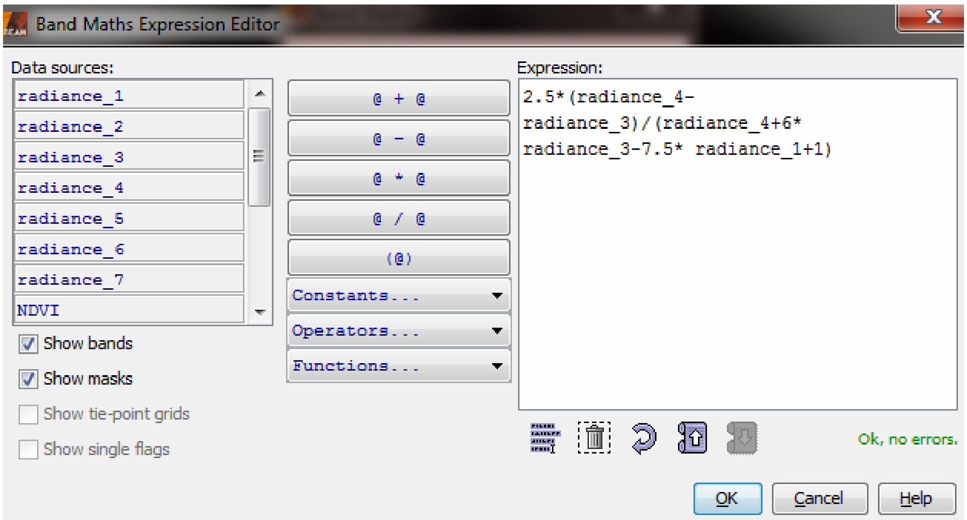

Fig. 11. The EVI Band Math

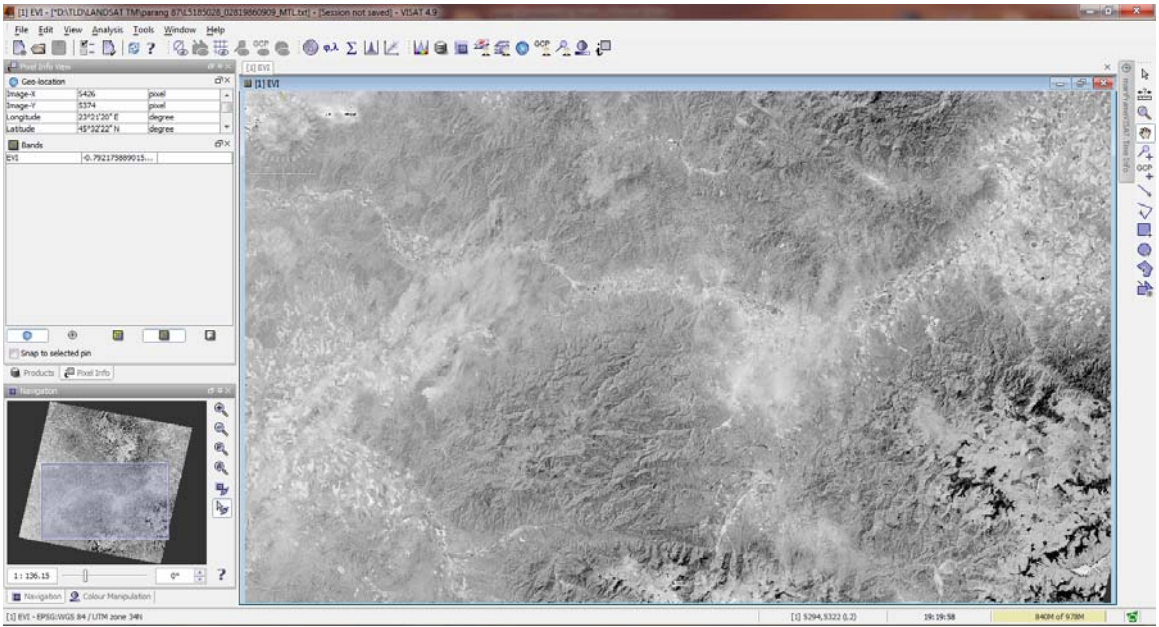

Fig. 12. EVI map

3. Conclusions

These indexes are the result of some mathematical algorithms which have the purpose of accentuating some characteristics of the environment using two spectral bands, where the subject receives opposite responses. In this paper there have been determined, using an open source platform called BEAM: Normalized Difference Vegetation Index – NDVI, Normalized Difference Water Index – NDWI, Normalized Difference Snow Index – NDSI, Normalized Difference Moisture Index – NDMI, Normalized Difference Burning Ratio – NDBR, Normalized Difference Building Index – NDBI, Enhanced Vegetation Index – EVI.

4. References

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