PROCESSING AND INTERPRETATION OF SATELLITE IMAGES – LANDSAT

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Abstract:

The Geographic Information System is a collection of located, collected, stored and managed geographic data with the use of the computer, data which can be used to perform various spatial analyses. The special GIS operations over the spatial information make from these instruments more than just efficacy instruments for making maps, but especially, irreplaceable instruments for analyzing the information that refer to the terrestrial surfaces. GIS maps must be made exploiting all available resources based on rigorous analysis of their content and the costs involved, seeking assurance required with maximum efficiency. The information obtained from remote sensing is contained by the cosmic or aerial images, which can be interpreted for 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 response of the objects from nature to various wavelengths of electromagnetic radiation is different, depending on their physical and chemical properties, configuration and surface roughness, its illumination intensity and angle of incidence. These responses recorded via sensors translate the image by the emergence of patterns (features), based on which objects can be distinguished and identified. The remote sensing data is public, meaning it can be acquired from any area of the world and by anyone, with some restriction. The images used in this study were taken from Landsat 8 satellites.Landsat 8 consists of three key mission and science objectives:Collect and archive medium resolution (30-meter spatial resolution) multispectral image data affording seasonal coverage of the global landmasses for a period of no less than 5 years;Ensure that Landsat 8 data are sufficiently consistent with data from the earlier Landsat missions in terms of acquisition geometry, calibration, coverage characteristics, spectral characteristics, output product quality, and data availability to permit studies of landcover and land-use change over time;Distribute Landsat 8 data products to the general public on a nondiscriminatory basis at no cost to the user.

Key words : *GIS, Landsat, bands, combination, band*

INTRODUCTION

Landsat 8 is an American Earth observation satellite launched on February 11, 2013. It is the eighth satellite in the Landsat program; the seventh to reach orbit successfully. Originally called the **Landsat Data Continuity Mission** (LDCM), it is a collaboration between NASA and the United States Geological Survey (USGS). NASA Goddard Space Flight Center_provided development, mission systems engineering, and acquisition of the launch vehicle while the USGS provided for development of the ground systems and will conduct on-going mission operations.

The satellite was launched aboard an Atlas V 401 carrier rocket with an Extended Payload Fairing. The launch took place at 18:02 UTC (10:02 PST) on 11 February 2013, from

Space Launch Complex 3E at Vandenberg Air Force Base. Seventy eight minutes and thirty seconds later, the spacecraft separated from the upper stage of its carrier rocket, successfully completing the launch. Landsat 8 joins Landsat 7 on-orbit, providing increased coverage of the Earth's surface.

Figure 1: Landsat 8 satellite

MATHERIAL AND METHODS

Providing moderate-resolution imagery, from 15 meters to 100 meters, of Earth's land surface and polar regions, Landsat 8 will operate in the visible, near-infrared, short wave infrared, and thermal infrared spectrums. Landsat 8 will capture approximately 400 scenes a day, an increase from the 250 scenes a day on Landsat 7. The Operational Land Imager - OLI and Thermal Infrared Sensor - TIRS sensors will see improved signal to noise (SNR) radiometric performance, enabling 12-bit quantization of data allowing for more bits for better land-cover characterization.

Planned parameters for Landsat 8 standard products:

- Product type: Level 1T (terrain corrected)
- Output format: GeoTIFF
- Pixel size: 15 meters/30 meters/100 meters (panchromatic/multispectral/thermal)
- Map projection: UTM (Polar Stereographic for Antarctica)
- Datum: WGS 84
- Orientation: North-up (map)
- Resampling: Cubic convolution
- Accuracy:
- OLI: 12 meters circular error, 90-percent confidence
- TIRS: 41 meters circular error, 90-percent confidence

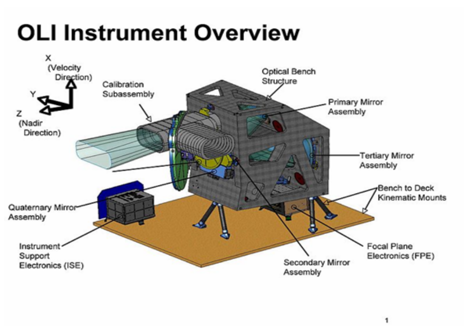


Fig. 2 Operational Land Imager

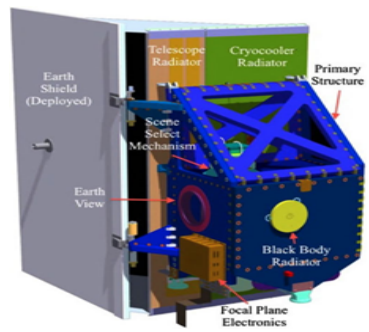


Fig. 3 Thermal InfraRed Sensor

Table 1

OLI Spectral Bands

Spectral Band	**Wavelength**	**Resolution**
Band 1 - Coastal / Aerosol	0.433 - 0.453 µm	30 m
Band 2 – Blue	0.450 - 0.515 µm	30 m
Band 3 – Green	0.525 - 0.600 µm	30 m
Band 4 – Red	0.630 - 0.680 µm	30 m
Band 5 - Near Infrared	0.845 - 0.885 µm	30 m
Band 6 - Short Wavelength Infrared	1.560 - 1.660 µm	30 m
Band 7 - Short Wavelength Infrared	2.100 - 2.300 µm	30 m
Band 8 – Panchromatic	0.500 - 0.680 µm	15 m
Band 9 – Cirrus	1.360 - 1.390 µm	30 m

Table 2

TIRS Spectral Bands

Spectral Band	**Wavelength**	**Resolution**
Band 10 - Long Wavelength Infrared	10.30 - 11.30 µm	100 m
Band 11 - Long Wavelength Infrared	11.50 - 12.50 µm	100 m

In the following paragraphs are listed normalized differentiation indexes with their interpretation:

1 Normalized difference vegetation index – NDVI

Interpretation: NDVI values vary depending on the radiation absorption by chlorophyll in the red spectral reflectance in the near infrared region. These values are between -1 and +1, expressing consistency of green vegetation. The closer to 1 (light colors) is a high consistency of specific vegetation and hardwood. Values close to -1 (dark tones) are barren land, with soil

or rock to date. A value of 0 (midtones) is associated lands meadows. It is useful in areas with vegetation mapping, vegetation typology, health of vegetation, land use patterns.
It is given by: NDVI = (NIR – R)/(NIR + R) = (B5 – B4) / (B5 + B4)

2 Normalized difference water index - NDWI

Interpretation: It is useful in mapping water bodies, views of the differences of turbidity and vegetation water content, alluvial soils or where differentiation of vegetation water content. It uses green spectral bands (electromagnetic radiation penetrates the water) and near infrared (increase the spectral response of moisture in soils, rocks and plants, and the water starts to absorb radiation in the surface layers). Dark tones express water surface. Light tones ,dry land. Midtones, land with intermediate moisture content.
It is given by: NDWI=(NIR-G)/(NIR+G)=(B5-B3)/(B5+B3)

3 Normalized difference snow index - NDSI

Interpretation: Light tones (land with snow), dark tones (land without snow). Use green spectral bands (high reflectance of snow) and middle infrared (low reflectance). In general, snow is characterized by high values of NDSI (over 0.4) and is expressed in tones of light (almost white). Useful for mapping snow covered areas, or assessment processes nivatie effective potential surfaces planning ski areas.
It is given by: NDSI=(G-IR)/(G+IR)=(B3-B6)/(B3+B6)

4 Normalized difference soil and vegetation humidity index - NDMI

Interpretation: Light tones (humidity excess), dark tones (small humidity). Humidity content differentially express the landscape elements and particularly of soils, rocks and vegetation (good indicator of the occurrence of droughts). Values greater than 0.1 symbolized by light tones express a high humidity. Small values (close to -1) indicated by dark tones express a low humidity. It is useful in mapping water potential.
It is given by: NDMI=(NIR-IR)/(NIR+IR)=(B5-B6)/(B5+B6)

5 Normalized difference burn ratio - NDBR

Interpretation: Uses bands in the spectral response of vegetation unburned (near infrared) and burned (medium infrared) are the strongest. Differences present chlorophyll reflectance means before burning , or lack of it after the burning. Light tones (values above 0.1) symbolizes the land with a high risk of catching fire (s). Dark tones symbolizes the land without taking the risk of fire (concrete buildings, highways and roads).
It is given by: NDBR=(NIR-MIR)/(NIR+MIR)=(B4-B7)/(B4+B7)

6 Normalized difference built-up index - NDBI

Interpretation: Calling open (showing land and buildings occupied), dark tones (land occupied by forests). NDBI values vary depending on the spectral signatures of middle infrared band (high reflectance of soil moisture, vegetation, rocks, including construction materials) and near infrared band (high reflectance of chlorophyll). Paler tones (positive values) symbolizes the land covered by buildings. Dark tones (negative values) symbolizes other elements of landscape (forests, agricultural land). It is useful in automatic mapping of human settlements, as well as some elements of the space arranged (dams, canals, railways, roads).
It is given by: NDBI=(IR-NIR)/(IR+NIR)=(B5-B4)/(B5+B4)

RESULTS AND DICUSSIONS

For this application was used a Landsat TM satellite image of 2013 covering Timişoara metropolitan area.

Download satellite images were achieved on the NASA portal www.usgs.gov

Image used LC81860282013221LGN00

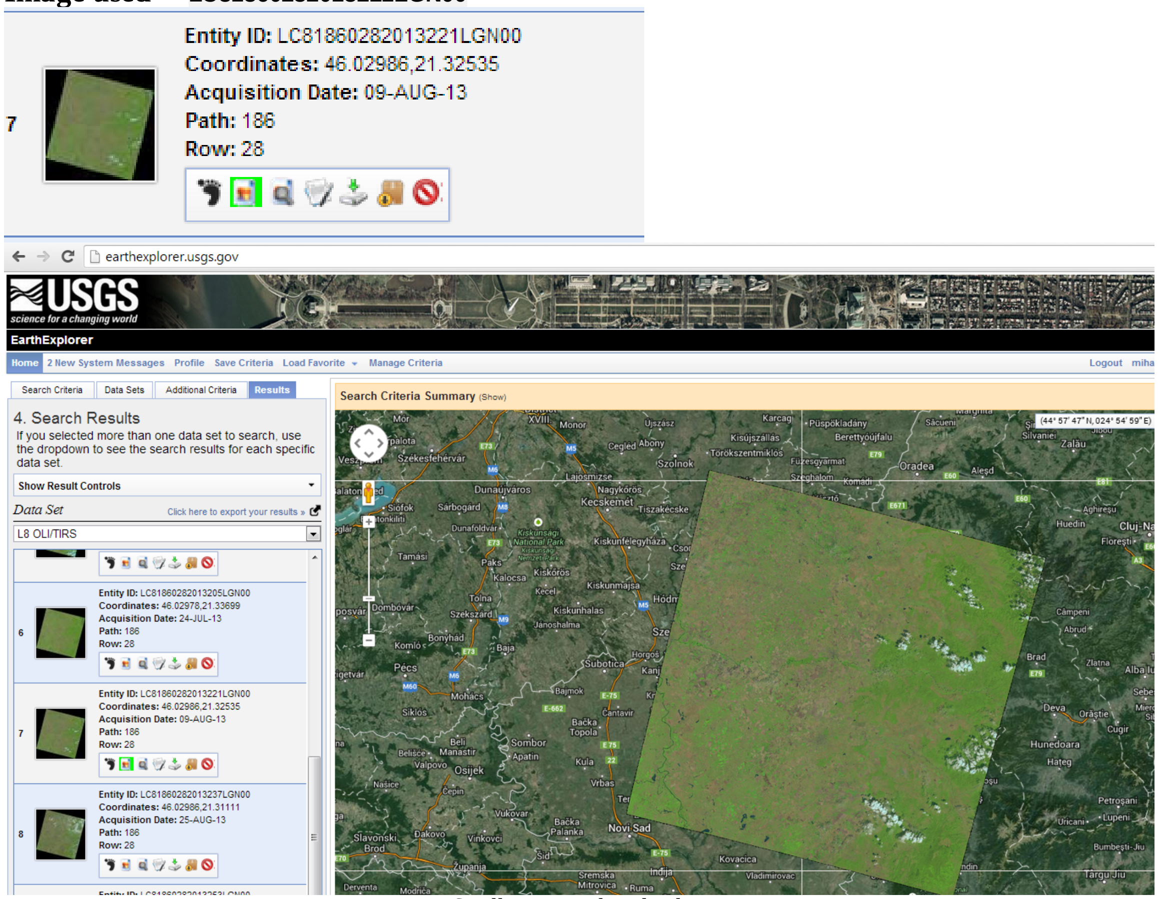


Figure 5 Satellite image downloading

Image used parameters are:

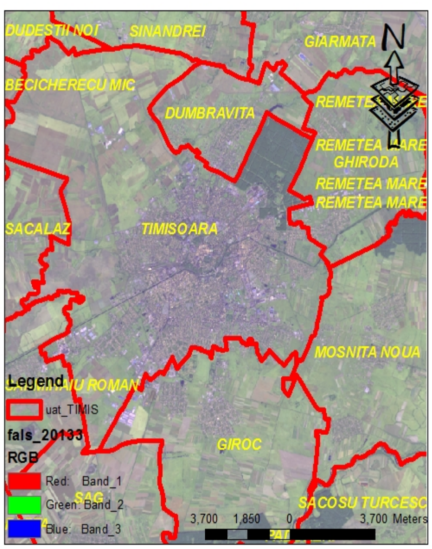
- Entity ID: LC81860282013221LGN00
- Coordinates: 46.02986,21.32535
- Acquisition Date: 09-AUG-13
- LC8 : Landsat 8 satellite and sensor
- Path: 186
- Row: 028
- Registration year : 2013
- Number of days of year 2013 : 221
- Land station capturing the signal and creating the image : LGN00

Below are two combinations of spectral bands, which were processed from Landsat TM satellite image of Timişoara metropolitan area, processing performed using ArcGIS software v10, Raster Processing module - Composite Bands. There is also presented the interpretation of results for the combinations:

Landsat 8 Band Combination 764 – False Color This band combination also provides a "natural-like" rendition while also penetrating atmospheric particles, smoke and haze. Vegetation appears in shades of dark and light green during the growing season, urban features are white, gray, cyan or purple, sands, soils and minerals appear in a variety of colors. The almost complete absorption of Mid-IR bands in water, ice and snow provides well defined coast lines and highlighted sources of water within the image. Snow and ice appear as dark blue, water is black or dark blue. Hot surfaces such as forest fires and volcano calderas saturate the Mid-IR bands and appear in shades of red or yellow. One particular application for this combination is monitoring forest fires.

Landsat 8 Band Combination 432 – Natural Color is used to represent an image in natural colour and therefore best approaches the appearance of the landscape in reality. Band 3 detects chlorophyll absorption in vegetation (thus low reflection). Band 2 detects the green reflectance from vegetation. Band 1 is more suited for penetration in water, in clear water this can be some 25 meters. On the other hand one can also derive information about sediment transportation in water from this band. Band 1 also differentiates between soil and vegetation and distinguishes forest types.

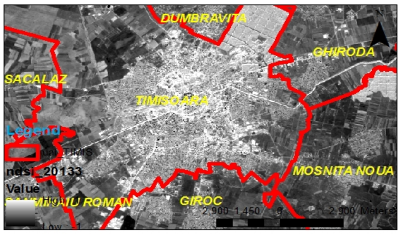
Landsat 8 Band Combination 764 - False Color



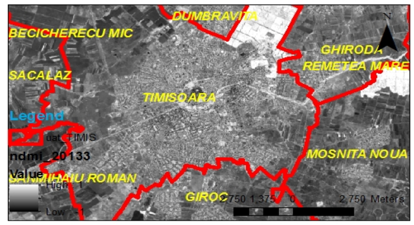
Lansat8 Band Combination 432 - Natural Color

Below are four normalized difference indexes which were processed from Landsat TM satellite image of Timişoara metropolitan area, processing performed using ArcGIS software v10, Map Algebra - Raster Calculator.

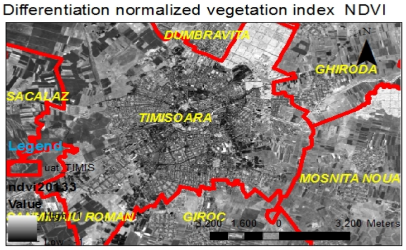
Normalized difference water index - NDWI



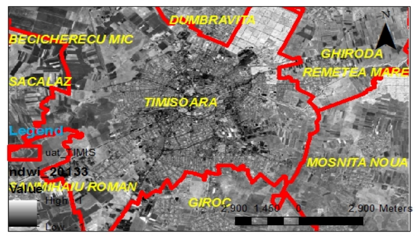
Normalized difference soil and vegetation humidity index - NDMI



Differentiation normalized vegetation index NDVI



Normalized difference snow index - NDSI



CONCLUSIONS

Landsat 8 (formerly called the Landsat Data Continuity Mission, or LDCM) is NASA's eighth satellite in the Landsat series and continues the Landsat program's critical role in monitoring, understanding and managing the resources needed for human sustainment such as food, water and forests. As our population surpasses seven billion people, the impact of human society on the planet will increase, and Landsat monitors those impacts as well as environmental changes.

Research of land area from airspace and outer space using remote sensing techniques delivers valuable information for many industries, among which: agriculture, forestry, geology, soil, hydrology, cartography, exploration and evaluation natural resources, environmental monitoring (soil, water and air) and others.

Landsat images can be used successfully in a number of scientific applications and practical problems: global urbanization, wetland delineation, detecting changes.

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