USE OF SENTINEL 2 IMAGES IN LAND MANAGEMENT

Milena VOINOV, A. ISFAN, V. URSIC, R. BERTICI, M. V. HERBEI
Banat University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Timisoara, 300645, Romania
Corresponding author: Mihai-Valentin HERBEI

Abstract. *Remote sensing is the technology through which objects can be measured, identified, and analyze remotely, without the need for direct contact. For analysis of satellite images, we used the data obtained from Copernicus Sentinel-2. Sentinel-2 is used for plant growth monitoring, but it can be also used for supervision changes in the terrain, as well as forest changes. The images obtained by Sentinel-2 are given by a constellation of two identical satellites in the same orbit, with a high spatial resolution in the optical field. Sentinel-2 offers good quality high quality images as well as multispectral images, observation of changes in land. Each Sentinel-2 satellite weighs about 1.2 tons and has been built to be compatible with small launchers, as VEGA and ROCKOT. Sentinel-2 satellites are 180 degrees apart in the same orbit. Copernicus Sentinel-2 uses 13 spectral bands, and the spatial resolution depends on the particular spectral band: 4 bands at 10m: blue (480nm), green (560nm), red (665nm) and almost infrared (842nm); 6 bands at 20m: 4 narrow bands for characterizing vegetation (705nm, 740nm, 783nm and 865nm) and 2 large SWIR bands (1,610nm and 2,190nm) for applications such as snow detection, frost or moisture in vegetation; 3 bands at 60m: mainly for atmospheric corrections and cloud detection (443nm for aerosols, 945nm for water vapor and 1375nm for Cirrus cloud detection).*

Keywords*: Remote sensing, satellite images, Sentinel-2, satellites, spectral bands.*

INTRODUCTION

The use of imagistic methods (DOBREI ET AL., 2010; LALU ET AL., 2020; BREBU ET AL., 2012) and remote sensing images in monitoring processes has proven to be a very efficient and successful technique in various fields such as: agriculture, forestry, infrastructure, hydrography (PETRESCU AND SMULEAC, 2019). Remote sensing systems are in continuous progress, with numerous remote sensing imaging solutions available. Among the systems that offer open source satellite images can be listed: Sentinel 2, Landsat 7, Landsat 8, Landsat 9, RapidEye (HERBEI ET AL., 2015B).

Sentinel 2A is equipped with a multispectral optoelectronic sensor for surveillance with a resolution between 10-60m in the visible infrared (VNIR) and short-wave infrared (SWIR) visible spectral areas. It contains 13 spectral bands that ensure the capture of differences in the state of vegetation and minimize the impact on the quality of atmospheric photography (DRUSCH ET AL., 2012). Moreover, it can monitor terrestrial ecosystems, agriculture, islands, cartographic disasters, and civil security (https://www.esa.int/). The mission's primary goal is to disseminate information on agricultural methods and to address the worldwide issue of food security. For example, images can be utilized to calculate leaf area chlorophyll and water content indexes. These data are crucial for accurate yield prediction and applications involving the Earth's vegetation (https://earthobservatory.nasa.gov).

However, the mission's data has been used to track changes in ice sheets and glaciers, coastal erosion, deforestation, burned land from wildfires, pollution in lakes and coastal waters, and more over the last six years. For optimal coverage and data delivery, the mission relies on a constellation of two identical satellites in the same orbit, 180 degrees apart. As a result, when Sentinel-2A retires, Sentinel-2C will take its position, and Sentinel-2D will eventually replace Sentinel-2B.

MATERIAL AND METHODS

Sentinel 2A is the first optical observation satellite in the European Copernicus program, developed and built under the leadership of Airbus Defense and Space for the European Space Agency (ESA). Sentinel 2A was launched on 23 June 2015 in a Vega rocket from spaceport Kourou, French Guiana, Sentinel 2B on 7 March 2017. (SHOKO ET AL., 2017).

Table 1.

Bands of Sentinel-2

Sentinel 2-Bands	Central Wavelenght	Resolution
Bans 1- Coastal aerosol	0.443	60
Band 2- Blue	0.490	10
Band 3- Green	0.560	10
Band 4- Red	0.665	10
Band 5- Vegetation Red Edge	0.705	20
Band 6- Vegetation Red Edge	0.740	20
Band 7- Vegetation Red Edge	0.783	20
Band 8- NIR	0.842	10
Band 8A- Vegetation Red Edge	0.865	20
Band 9- Water vapour	0.945	60
Band 10- SWIR- Cirrus	1.375	60
Band 11- SWIR	1.610	20
Band 12SWIR	2.190	20

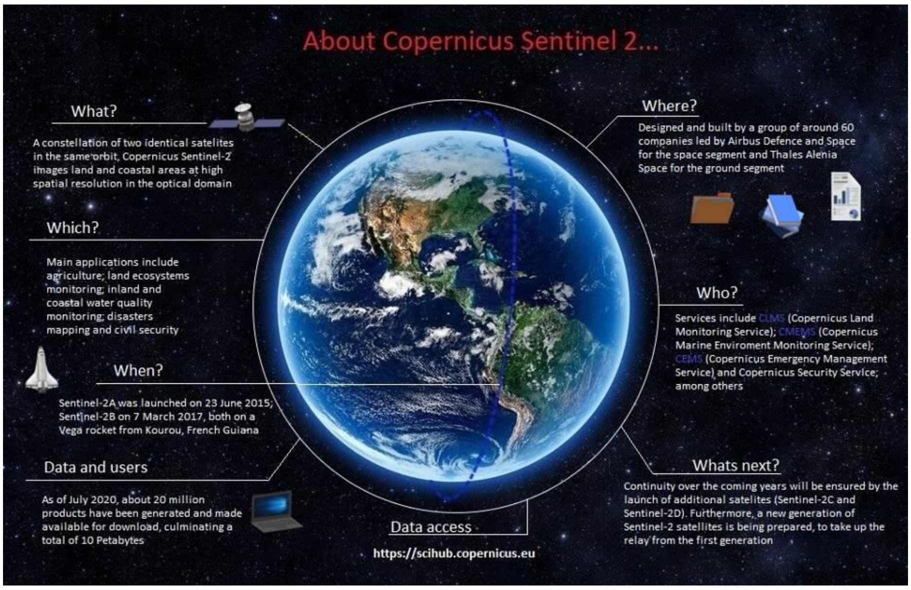

Fig. 1. Details about Sentinel-2

The software that we used is SNAP, which is developed by European Space Agency (ESA), under open-source licence, being designed for the processing of satellite data from the Sentinel-2, as well as other contributing missions (Landsat (HERBEI AND SALA, 2015), SPOT, TerraSAR-X, etc.). It can be installed on Windows, Linux or MacOS. ESA is the space agency of Europe, with activities in all areas of the space sector, offering benefits both in life daily as well as the environment business. (https://esamultimedia.esa.int)

To better analyze the features in pictures, we use band combinations. We accomplish this by creatively rearranging the available channels.

We can extract specific information from an image by employing band combinations. Band combinations, for example, might be used to highlight geology, agricultural, or vegetative aspects in an image.

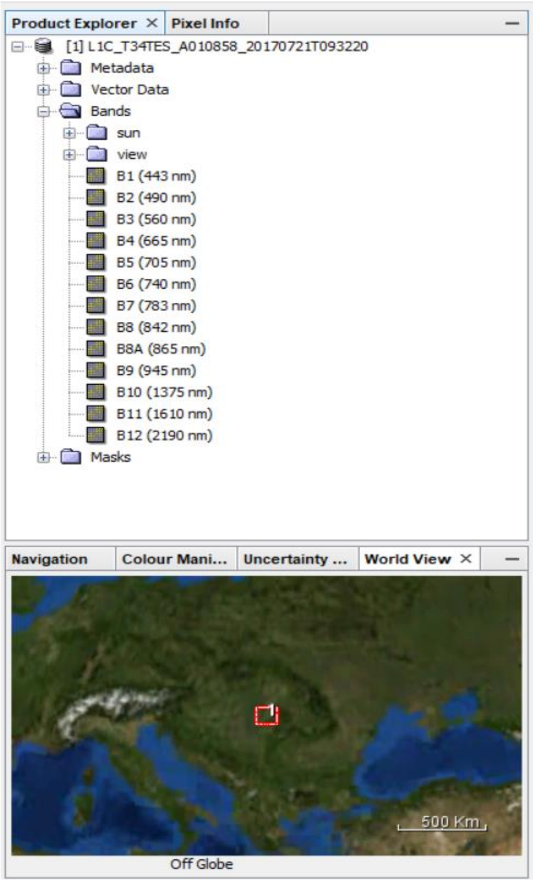

Fig. 2. Spectral Bands

Sentinel-2 has 13 spectral bands, and each is used for different purposes.. Band 1 is used for aerosol detection. Band 2 is beneficial for distinguishing soil and plants, charting forest types, and detecting man-made objects. It is diffused by the atmosphere, lights shadowed things more effectively than longer wavelengths, and penetrates clear water more effectively than other hues. Chlorophyll absorbs it, causing plants to become darker. Band 3 has a good contrast between clear and turbid (muddy) water, and it penetrates clear water well. It aids in the identification of oil on water surfaces and in plants. Green light is reflected more strongly than any other visible color. The presence of man-made features can still be seen. Band 4 is important for detecting vegetation types, soils, and urban (city and town) environments since it is highly reflected by dead foliage. It has a low water penetration rate and does not reflect effectively from chlorophyll-rich living vegetation. Bands 5, 6, 7 and 8A are used for classifying vegetation. Band 8 is a near-infrared band that may be used to map shorelines and biomass content, as well as detect and analyze vegetation. Band 9 is good for detecting water vapours. Band 10 is used for cirrus cloud detection. Band 11 is effective for determining the moisture content of soil and vegetation, as well as providing a nice contrast between different vegetation kinds. It aids in distinguishing between snow and clouds. On the other hand, cloud penetration is restricted. Band 12 is excellent for determining the moisture content of soil and vegetation, as well as providing a nice contrast between different vegetation kinds. It aids in distinguishing between snow and clouds. On the other hand, cloud penetration is restricted. (https://custom-scripts.sentinel-hub.com/)

RESULTS AND DISCUSSIONS

Sentinel-2 is a satellite dedicated to land surfaces, so it is easy to apply in agriculture (D'ODORICO ET AL., 2013).

In this study we used a Sentinel 2 remote sensing scene taken from the portal https://scihub.copernicus.eu/ since 21.07.2017 Level 1C.

Based on the satellite scene and using the open source SNAP program we made a series of combinations of spectral bands and we calculated vegetation indices useful in monitoring real estate properties. (HERBEI ET AL., 2014; HERBEI ET AL., 2015A;)

- Spectral bands combinations:

- **Natural Color (B4, B3, B2)**

The red (B4), green (B3), and blue (B2) channels are used in the natural color band combination. Its goal is to display imagery in the same way that our eyes do. Healthy vegetation is green, just as we perceive it. Following that, urban features are frequently white and grey. Finally, the color of water varies depending on how clean it is. (https://gisgeography.com)

Fig. 3. The combination of spectral bands B4, B3, B2

- **Color Infrared (B8, B4, B3)**

The mix of color infrared bands is intended to highlight healthy and sick vegetation. It's especially good at reflecting chlorophyll since it uses the near-infrared (B8) band. Denser vegetation appears red in a color infrared picture. However, metropolitan areas are predominantly white. (https://gisgeography.com)

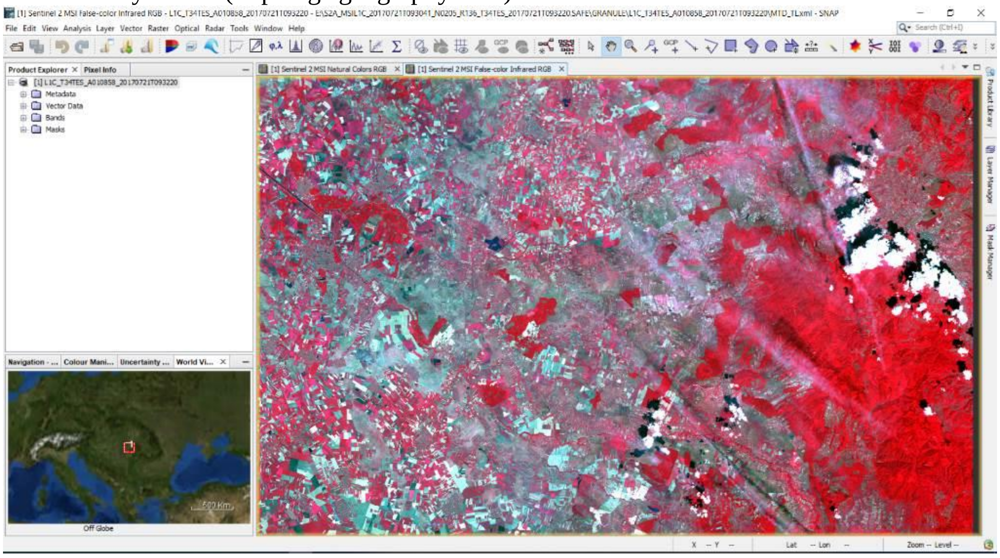

Fig. 4. The combination of spectral bands B8, B4, B3

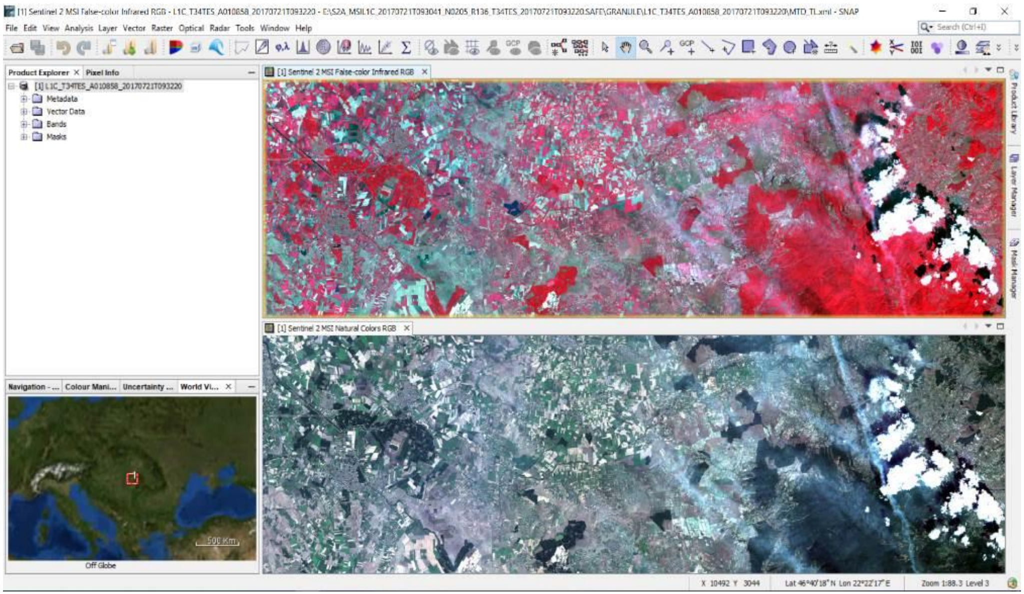

Fig. 5. Parallel between the two combinations

- **Atmospheric penetration (B12, B11, B8A)**

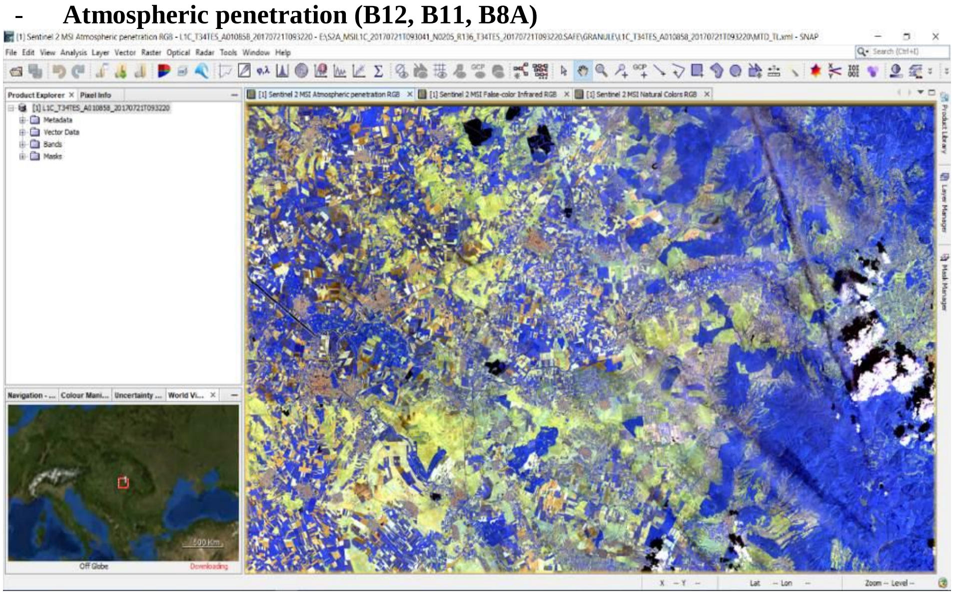

Fig. 6. The combination of spectral bands B12, B11, B8A

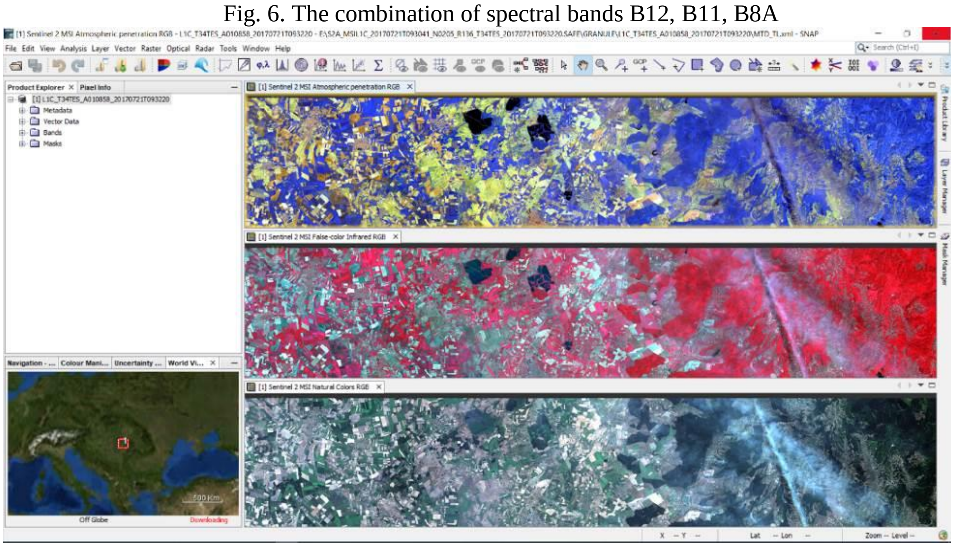

Fig. 7. Parallel between the three combinations

The NDVI (Rouse et al., 1973) index is calculated with the formula:

$$NDVI = \frac{NIR - Red}{NIR + Red} \qquad (1)$$

Researchers must monitor the varied colors (wavelengths) of visible and near-infrared sunlight reflected by the plants to calculate the density of green on a patch of land. The spectrum of sunshine is made up of many various wavelengths, as seen via a prism. Certain wavelengths of the spectrum are absorbed while others are reflected when sunlight strikes objects. Chlorophyll, a substance found in plant leaves, absorbs a lot of visible light (between 0.4 and 0.7 m) for photosynthesis.

The leaf cell structure, on the other hand, reflects near-infrared light well (from 0.7 to 1.1 m). These wavelengths of light are influenced more by the number of leaves a plant has. The NDVI value for a specific pixel is always in the range of minus one (-1) to plus one (+1); however, there are no green leaves, therefore the value is near to zero. A zero denotes no vegetation, whereas a value close to +1 (0.8-0.9) suggests the highest density of green leaves conceivable.

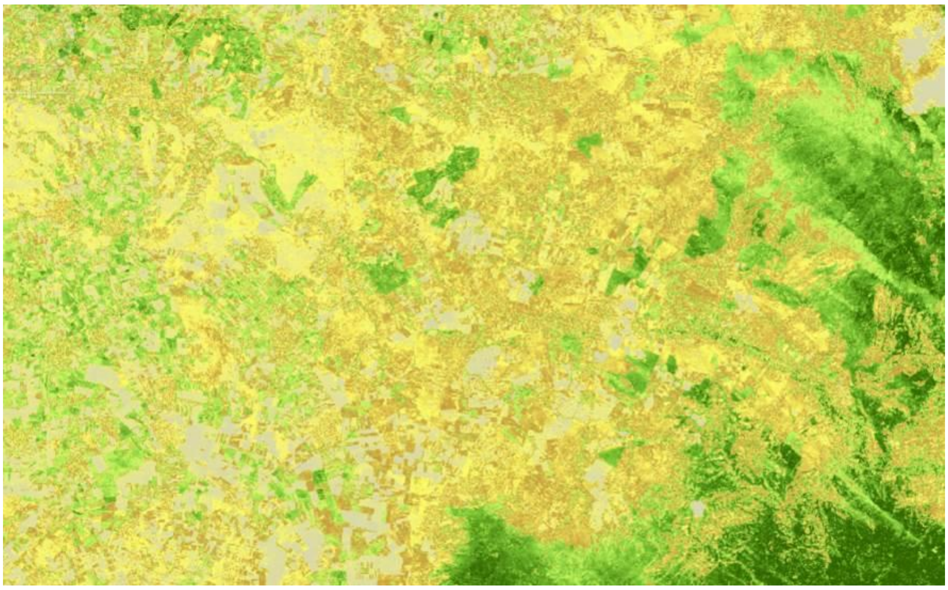

Fig. 8. Tha Map of NDVI index

CONCLUSIONS

Sentinel-2 is a unique mission to service Copernicus because it combines a huge swath, frequent revisit, and systematic capture of all land surfaces at high spatial resolution and with a large number of spectral bands.

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