EAGE

21134

Differences in the assessment of vegetation indexes in the EO-Browser and EOS landviewer services (on the example of Lutsk district lands)

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Summary

The paper considers the differences in the display of vegetation indices in the services EO-Browser and EOS LandViewer for selected key areas in the Lutsk district (Volyn Upland, NW Ukraine). A sample of satellite images with different cloud filters was evaluated for the period 2019-2020. The number of images acceptable for analysis in different months of the year is determined.

The difference between the maximum, minimum and average NDVI values, which are calculated by both services, is determined. In most cases, smaller values are typical for calculated indexes by EOS LandViewer. Despite the significant difference in individual unit values (up to 30-50%), the averaged deviations were predominantly less than 10%. For plains with flat terrain, the difference between NDVI values for both services is much smaller than for areas with complex topography. The combined use of both services will create the most effective analysis of vegetation indexes. Effective analysis is possible by using the features identified in this study.

Introduction

Estimation of vegetation indices (vegetation indexes, VI) according to remote sensing data has been widely used in various fields of research, primarily agriculture, forestry and environmental monitoring. Today, more than 500 different spectral indices are known, many of which are focused on assessing the state of vegetation cover, and in at least 65 of them the term "vegetation" is present in the very name of the indices (List of available Indices, 2021).
The most popular is the NDVI index and its modifications. As of today, there are several publicly accessible online services that allow to analyze vegetation indices in real time (Kovalchuk and Kovalchuk, 2019; Mimenbayeva and Zhukabayeva, 2020), even without using specialized desktop programs. Of course, this does not provide the full range of opportunities that can be implemented in GIS packages, but enough for a significant number of users, including owners of small and medium farms.
However, even when using the same input data from the same sources, each of these services reveals certain differences that may affect the quality and end result of the analysis of vegetation indices. This is mainly due to the use of various image post-processing algorithms and interpolation methods.
In addition, certain differences may be due to the peculiarities of the topography of a particular study area, the manifestations of erosion processes, etc. (Lukyanchuk et al., 2020; Kokhan, 2012; Fedoniuk et al., 2020). Therefore, we decided to conduct a comparative assessment of the determination of vegetation indices in the two most common remote data processing services (EO Browser from Sentinel HUB and LandViewer from EOS Data Analytics) on the examples of specific agricultural fields in the Volyn Upland.

Method and/or Theory

In the first stage, we selected the key areas for the study: 4 different plots (with known crop rotation in recent years), with an area of 40 to 200 ha (field 1-191 ha, field 2-43 ha, field 3 - 70.9 ha, field 4-98.7 ha) in the Lutsk district of Volyn region. Geomorphologically, it is part of the Volyn Upland with absolute heights from 190 to 245 m and a vertical dissection of 15-35 m. Fields with different orographic conditions were selected - both with a relatively flat area (height difference up to 2 m) and with the presence of a system of erosion forms and height differences up to 15 m.
Each field was first outlined in GoogleEarth in high-resolution images, and outline files were saved in kml format. The resulting files were then uploaded as an area of interest (AOI) to the EOS Land Viewer (eos.com/lv) and EO Browser (apps.sentinel-hub.com/eo-browser) satellite image analysis services.
At the next stage, a database of images for these fields for the period 2019-2020 was formed. Sentinel-2 and Landsat-8 satellite images with cloud filters were used. The found images were stored in the optical range (natural color) and various combinations of VI. Database tables were created based on NDVI numerical values and their ratios.
After that, we compared the obtained VIs on the same date from the same satellite, as well as graphs of the dynamics of VIs in fields with different conditions in 2 different services.

Results

In both of these services there is a function of time series analysis by selected indices (NDVI, NDSI, NDWI, and in EO-Browser also by Moisture Index-NDMI, and thermal TIR for Landsat-8). When selecting the area of interest and the corresponding index, a statistical series is generated for a certain period of time. The information is displayed on the screen in the form of a graph. In addition, it is possible to download the source file in CSV format. This operation has the following differences in the considered services (as of February 2021):
- in LandViewer it is possible to set any time interval (custom), in EO-Browser - only fixed (1,3,6 months or 1,3,5 years, counting is taken from the date of the current image viewed on the screen);
- In both services, you can select the point of a single image from the graphs and view statistics on the index, but LandViewer additionally displays a preview of the satellite image itself;

- LandViewer also offers a function of dividing the schedule by year, which allows you to compare the vegetation indices of crops in the same periods (Figure 1);

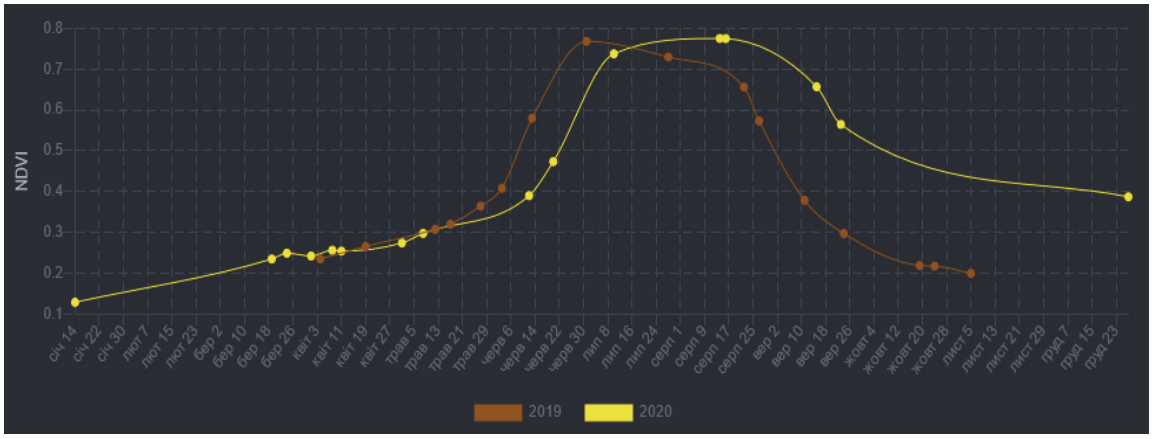

Figure 1 *Automatic division of the NDVI series by individual years in EOS LandViewer (field with rugged topography, 2019 – sunflower crops, 2020 – corn crops)*

- when analyzing NDVI according to Landsat, EO-Browser does not provide a standard scale from -1 to 1, but modified with multiple magnification. This provides more opportunities to visualize the VI difference, but creates difficulties when compared to other data sources;
- in LandViewer, the series is now built only on zero cloud images (originally it was on all images of the selected period). Instead, the EO-Browser has a dynamic cloud filter that allows you to select data in increments of 1% (Figure 2).

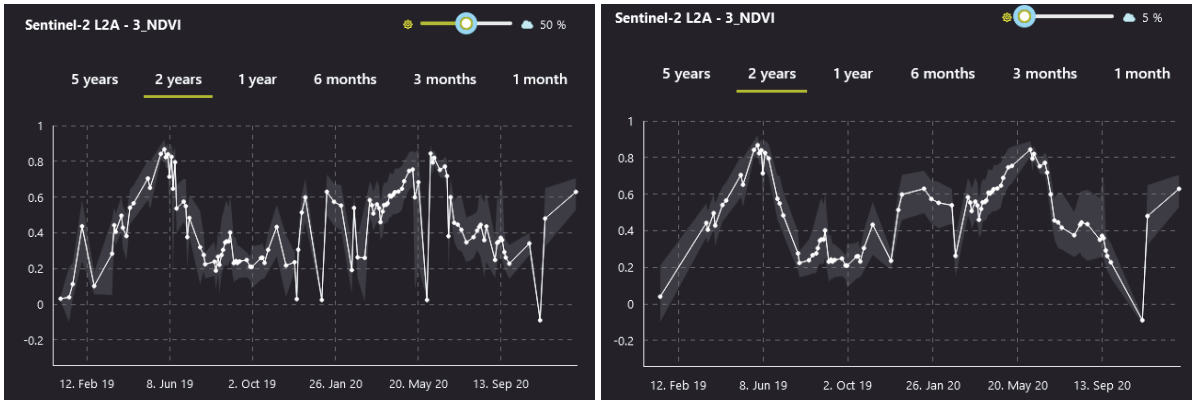

Figure 2 *Graphical display of NDVI dynamics in EO-Browser for 2 years with different cloud filters (50% - left image, 5% - right image)*

In fact, due to such differences in filtering, the size of the sample of images and, accordingly, the amount of data obtained differs significantly. Thus, when constructing the NDVI statistical series for 2019-2020 for different fields within the Lutsk district, according to Sentinel-2 LandViewer used 32-35 images, while EO-Browser - 285-292 images, with about 80 of them - from zero cloud cover, 105 - with cloud cover less than 20% (Figure 3).

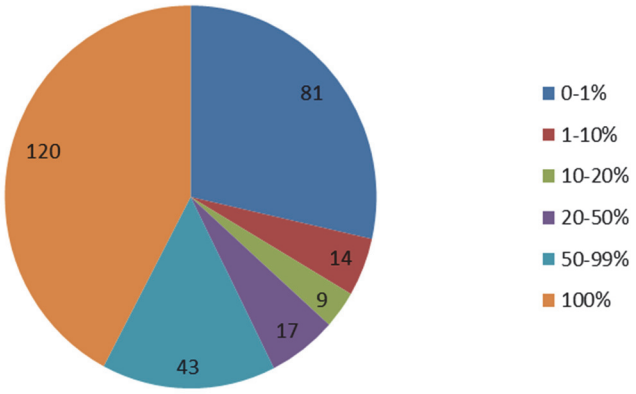

Figure 3 *Distribution of Sentinel-2 images by the percentage of clouds for key areas of Lutsk district during 2019-2020*

Thus, EO-Browser operates with a much larger number of original images, which sometimes allows you to detect differences in VI in a relatively short period, which is very important for agricultural practices. If we analyze the number of images available for analysis with minimal cloudiness (Figure 4), there is a significant predominance in the EO-Browser, including directly in the growing season.

However, in some cases, images with poor image quality in the local key areas are not eliminated. Therefore, the statistical series may contain almost zero NDVI values in the middle of the growing season. During the study period, 2 such cases were detected for the Sentinel-2 series and 1 for the Landsat-8 series. In LandViewer, such images are eliminated.

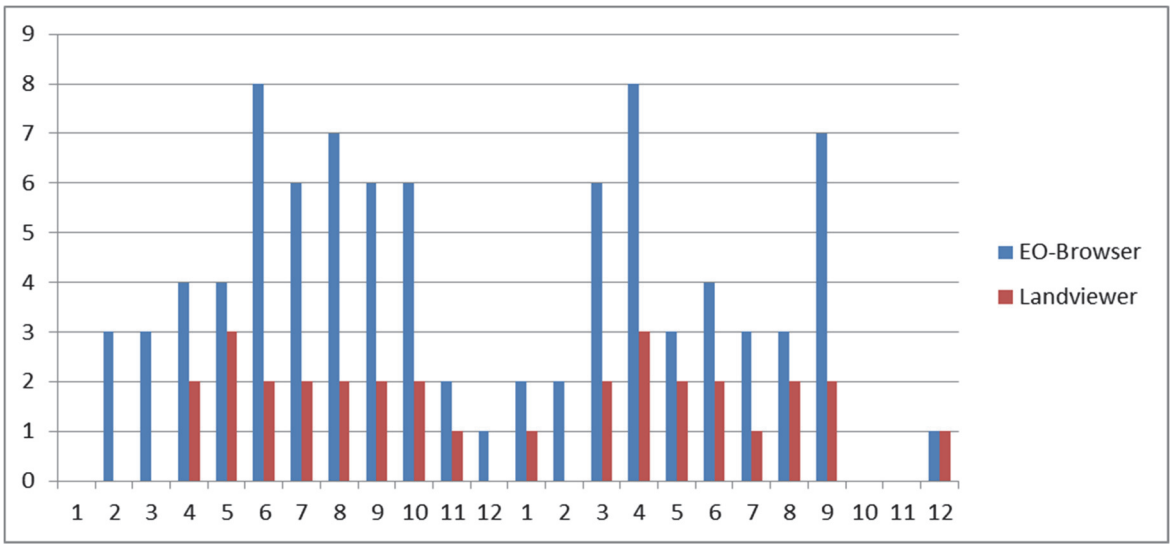

Figure 4 *The ratio of the number of original images of Sentinel-2 with minimal cloudiness by months (for key areas of Lutsk region during 2019-2020)*

Having made a sample of statistical indicators of a number of NDVI from both services for the common dates of receipt of images, we found differences in the obtained values, which also depended in part on the complexity of the topography of the studied fields (table 1).

Thus, in areas with rugged topography, the differences in individual unit values were up to 59.3% for maximum values, up to 30.8% for minimum values, up to 24.5% for median values. The largest deviations were observed in the period June-July 2019 and June-September 2020. In areas with smooth relief, the number of cases of significant (more than 10%) deviations was much smaller and was observed mainly in the autumn of 2019, and during 2020 there were only 3 such deviations.

In both areas, the average values were mostly higher according to data from EO-Browser.

Table 1. *The average difference (%) between the indicators of the NDVI statistical series obtained in LandViewer and EO-Browser*

Area type / indicator	min	max	std	average	median	p10	p90
Areas with smooth relief	0,68	-12,05	-2,54	-6,26	-6,69	-3,52	-9,03
Areas with rugged topography	-7,16	-29,96	22,83	-8,01	-3,59	-25,56	-12,55

In general, the deviations for a number of indicators were not critically significant, but in some periods they were of great importance, which may indicate the quality of the analysis of the composition and the adoption of appropriate agronomic decisions. Therefore, in this case it is advisable to combine data from both services, as well as use the analysis of additional indexes (SAVI, EVI, ARVI, etc.) and perform automatic classification (clustering), which is available in LandViewer or in accordance with GIS applications.

Conclusions

A comparative analysis of vegetation indices obtained in the tested services showed a generally acceptable similarity of these data, but with differences in individual indicators. EO-Browser uses a much larger sample through a dynamic cloud filter, but sometimes does not filter out low-quality images. On average, NDVI values for the studied areas within the Volyn Upland were slightly lower in LandViewer, with the most significant difference recorded for fields with rugged topography.
The largest deviations were observed in the values of max, min and p10. LandViewer uses several different color palettes for NDVI, and also offers a mechanism for clustering images by any number of classes, which greatly increases the ability to visualize the spatial differences of VI in the fields.
In fact, both services have a number of advantages and certain disadvantages, taking into account which combination of use allows to get the most effective results.

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