APPLICATION OF SENTINEL 2 IMAGERY FOR YIELD ANALYSIS

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ABSTRACT

Sentinel-2 satellite's optical remote-sensed data provide significant potential in precision agriculture applications, due to its outstanding spatial resolution related to other data sources widely used for the same purposes. We used various bands of the sensor to calculate vegetation indices and to determine the correlation between them and yield data from a specific study site by various statistical methods. We set up a group of indices which can be helpful in analyzing different status of vegetation.

INTRODUCTION

Remote sensing is a really easy and cost-efficient way to examine the health status of vegetation, and to obtain the necessary information which can be a basis for any intervention in order to increase the final yield in a damaged or problematic area. Remote-sensing can be regarded as a collection of various types of data that are derived from different sensors. One of them is optical imagery which has become a widely popular data source for a number of applications ranging from the field of forestry to military appication, etc. The first Earth observation programmes originate from the 1970-80's and since then more and more observation programmes have started to distribute images of various resolution and revisit time characteristics. Different spectral bands make it possible to calculate spectral indices. In terms of agriculture, these indices are useful and popular for the purpose of e.g. monitoring the changes in vegetation health status, estimating yields and assigning management zones in order to achieve the highest yield possible.

OBJECTIVE

In this research our objective was to examine which popular spectral vegetation indices are the most capable of estimating the yield in a corn parcel, by analyzing the correlation between each index and the yield, and between each pair of indices. The analysis was conducted in a single corn parcel near Mosonmagyaróvár, NW Hungary. We aimed to select indices which strongly correlates with yield, while eliminating those which provide redundant information.

METHODS

Due to the fact we analyzed a corn parcel, we used Sentinel 2 images throughout the vegetation period of 2017. With a special attention to the growing season of corn, four cloud-free images between May and August were downloaded from Copernicus Open Hub (28 May, 17 July, 16 August, 26 August). After performing atmospheric correction, various spectral indices were calculated for every pixel of the parcel in all the four images, and the results were imported to R software for further analysis. We applied linear regression to analyze the correlation between the calculated indices, and between each index and the yield data of 2017, on a pixel-by-pixel basis. In order to avoid the effect of spatial autocorrelation – which can be interpreted as the influence of the values of neighbouring units – we created a 10% random sample of each dataset, and the correlation analysis was performed on these random samples. In order to investigate the correlation between the indices, we used the hierarchical clustering method.

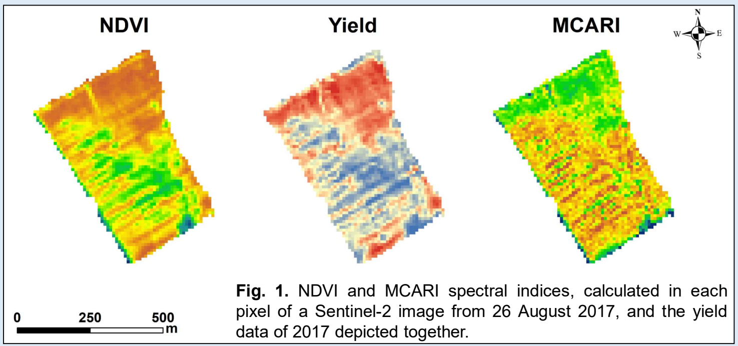
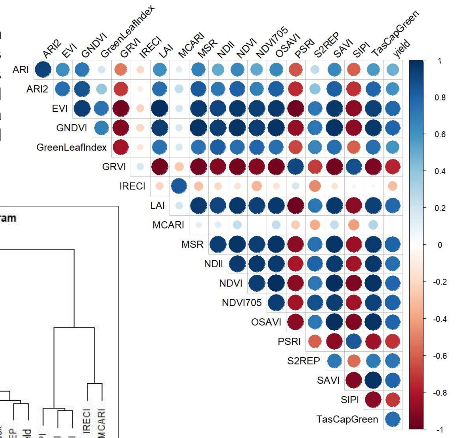


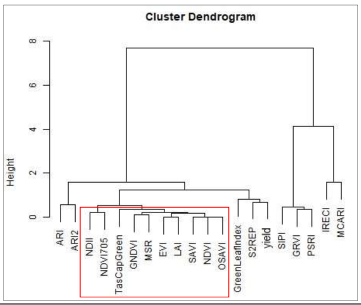
Fig. 1. NDVI and MCARI spectral indices, calculated in each pixel of a Sentinel-2 image from 26 August 2017, and the yield data of 2017 depicted together.

RESULTS

Among the four images, the last image – from 26 August – showed the highest correlation with the yield data in case of the most indices. There are indices which consistently show low correlation with the yield data (like IRECI and MCARI, as depicted in Fig. 1.), hence they did not prove to be useful for this purpose. The result of hierarchical clustering can be depicted in a dendrogram, where indices with practically the most similar information content belong to the same groups or sub-groups („clusters"). The more similar (correlated) the data of a pair of indices are, the more possibility they belong to the same group. The indices in the similar clusters (in red frame in the bottom left of Fig. 2.) were correlated to the yield data to the largest extent, but they were also highly correlated to each other – meaning they carry similar information content, thus they are not worth being calculated for the same purposes.

Fig. 2. The correlation between spectral index pairs (upper right; coloured circles indicates the value of R) and dendrogram (bottom left), in a 10% random sample of all pixels.





CONCLUSIONS

Most indices showed increasing correlation with the yield data throughout the growing season, which had been presumed, since the vegetation indices are mainly designed for monitoring this development. For instance, if the corn was planted in May, the image from 28 May cannot show any development of the vegetation at that time. When the corn grows and converges to the harvest period (end of September – beginning of October), the heterogeneity of the vegetation can be visually identified, and we can even see which part of the vegetation is under the parcel average. Vegetation indices support this analysis.

In our research, we tested various widely used indices. We identified the ones which provided redundant information for monitoring vegetation in our case, and determined a group of indices by which we can achieve the analogous results in further estimation (like GNDVI, EVI or LAI). The correlation of these indices to each other can be the result of the fact that they are calculated from partly similar band combinations, focusing on similar characteristics of the vegetation.

References

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