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MONITORING OF WINTER RAPESEED CROPS IN NORTHEAST BULGARIA THROUGH SATELLITE AND TERRESTRIAL DATA

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ABSTRACT

The study aims to develop a methodology for assessing the condition of winter rapeseed (Brassica napus) crops on the basis of experimental studies, theoretical analyzes and satellite data. It is based on the hypothesis that there is a correlation between, satellite vegetation index images and phenological, biometric and physiological indicators of winter rapeseed crops. The existence of such a dependency makes it possible to propose a methodology for assessing the condition of winter rapeseed crops only by land remote sensing methods and to avoid labor-intensive classical methods and therefore to be able to monitor rapeseed crops on a regional and national level. The results of the survey will help improve farming practices in winter rapeseed. The study will also contribute to the more efficient use of data provided by Sentinel-2 missions.

INTRODUCTION

The of winter rapeseed (*Brassica napus)* is relatively new crop for Bulgaria. The Ministry of agriculture, food and forestry of Republic of Bulgaria included it for the first time in the 2001 statistics. Even if a numerous studies and recommendations are given for the winter rapeseed growing in Bulgaria, often there are planted plots that are destroyed and replanted with spring crops because it did not germinate or did not withstand the winter. For 2016/2017, the Ministry of agriculture, food and forestry publishes data for 18300 hectares planted with winter rapeseed and only 16800 hectares harvested.

Improving farming practices in growing winter rapeseed through satellite data and products will reduce the losses from planted but unharvested areas, will increase the environmental impact of avoiding unnecessary fertilized and herbicide-insecticide-scattered areas. The implementation of the project will contribute to the more efficient use of the services provided by the Sentinel-2 missions for the agriculture.

Different canopy morphologies influence differently how solar radiation is intercepted and therefore spectral-temporal variability at a canopy level of the rapeseed crop will be studied. The winter rapeseed crop undergoes tree main canopy morphologies during development. The first is characterized by the development of green leaves and biomass, the second by yellow flowering and the third by formation of pods. This study will concentrate on the first and the second morphology development: 1. Status of the crop before and after winter, 2. Duration of the flowering period.

The vegetative growth, before anthesis, will be monitored with Vegetation Indices (VI) that evaluate the foliage (biomass, LAI and photosynthetically active radiation). However for the flowering stage, the VI should evaluation the density of yellow flowers and therefore the duration of flowering.

For the study, a remote sensing data from Sentinel-2 S2A and S2B will be used as well as field data (phenological phase, dry and fresh biomass) and data from unmanned aerial vehicle (UAV).

This project is supported by Research Grant Award № ДФНП-17-43/26.07.2017 from the Bulgarian Academy of Sciences. It starts from 2017 August 1st and goes for 18 months. The field data for the campaign 2016-2017 started 2017 March 22nd. Therefore, this poster will concentrate mainly on part of the project that deals with the duration of the flowering period.

OBJECTIVE

For rapeseed crops, the yield per unit area depends on stand density, the number of pods per plant, the number of seeds per pod, and seed weight (Diepenbrock, 2000). Even if the objective of this study is not the yield estimation, but the monitoring of rapeseed crop condition, the monitoring periods will correspond with the periods that are important for the yield formation. As the number of flowers per plant increases, the number of pods increases if no high stress impacts occurred at this stage. Therefore there are more opportunities for seed to set. This is why the objective of the study for the flowering stage is to determine its beginning and end of the flowering stage and calculate its duration. (Sulik and Long, 2015) found that an index of green to blue wavebands positively correlates with the number of flowers per plant. (Sulik and Long, 2016) stats that a VI from green and blue wavebands may be used to monitor the duration and intensity of flowering. (Fang *et al.*, 2016) created a model that estimates the Flower Fraction based on Vis.

The study area is the Bulgarian part of the Sentinel-2 TNJ tile. The test site for the flowering stage 2017 of the winter rapeseed a rapeseed s a trial field for Pioneer™ of 24 hectares where 11 different Pioneer hybrids are planted. Figure1 shows the study area for the project, the test site and the hybrids that are flowering early, late and mixed.

Figure1: Study area for the project and test site for the flowering stage 2017

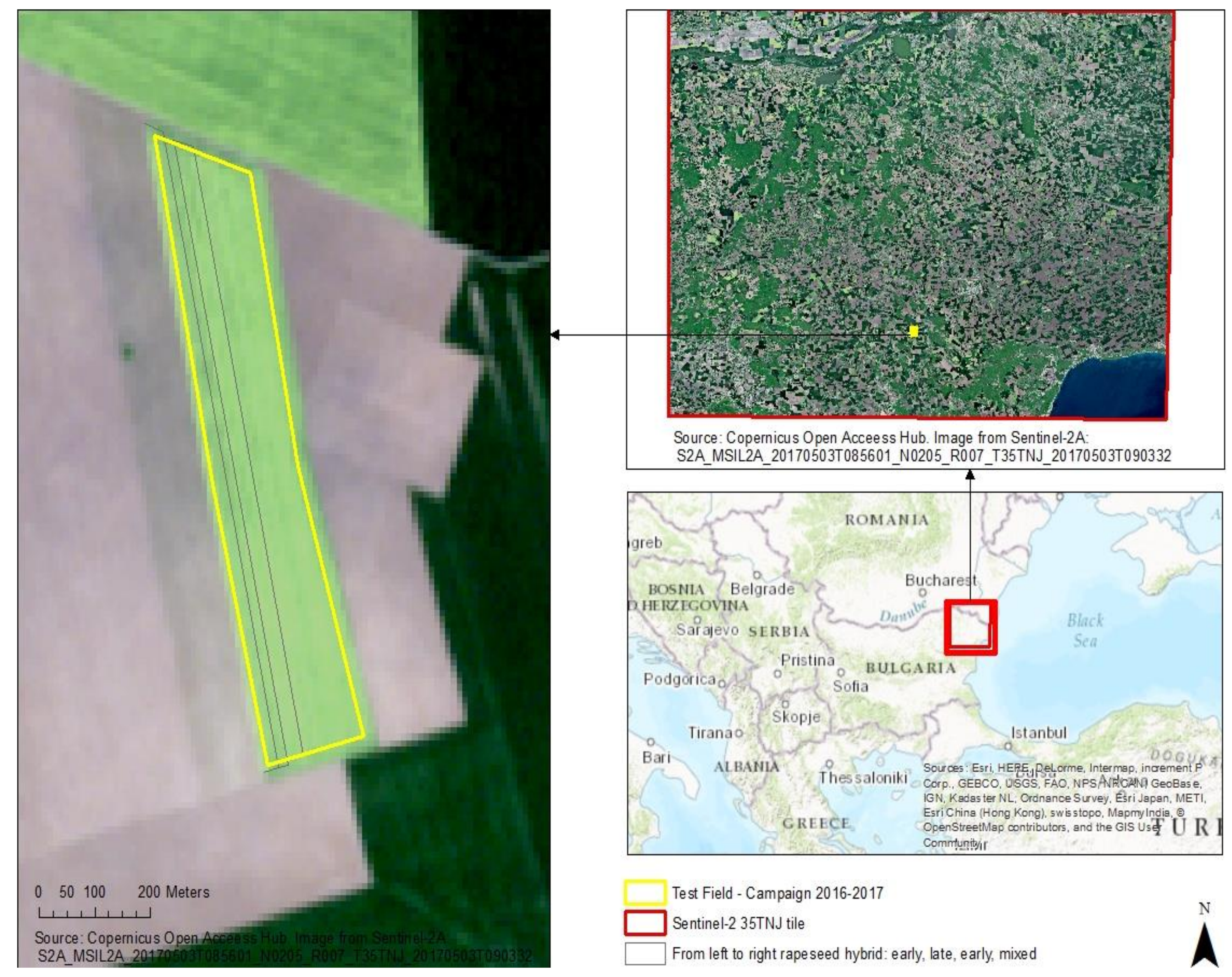


Figure3: Sentinel-2 image, UAV data and result from the classification

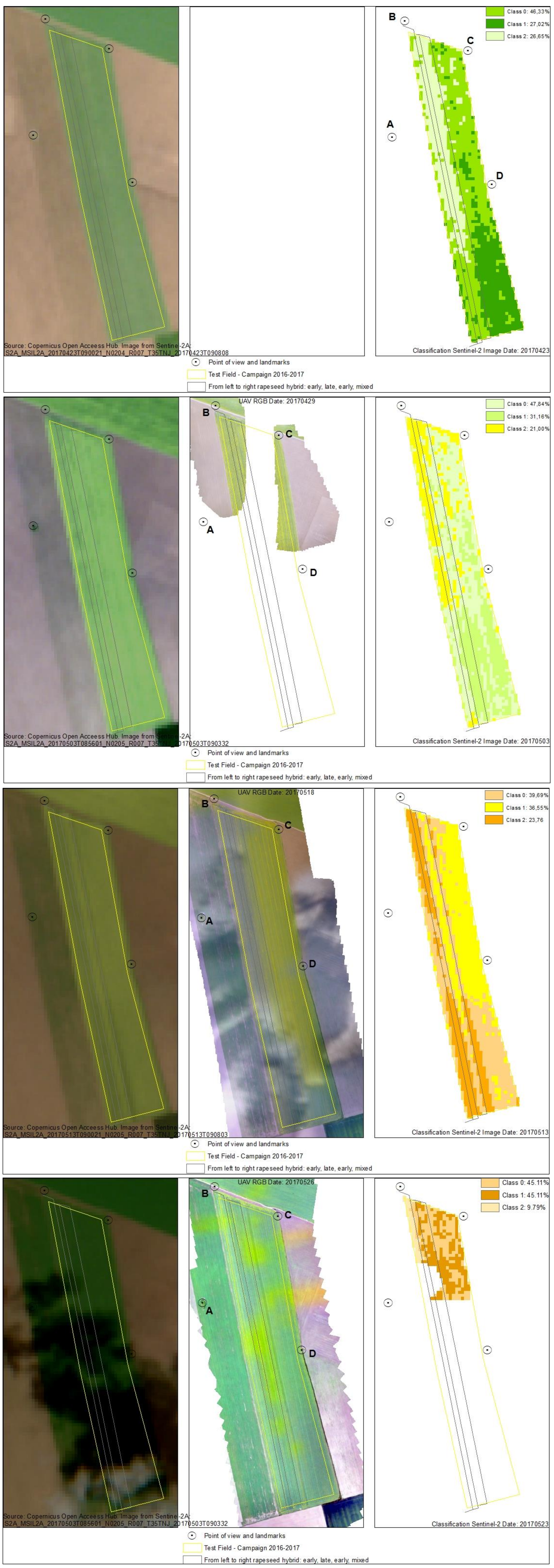
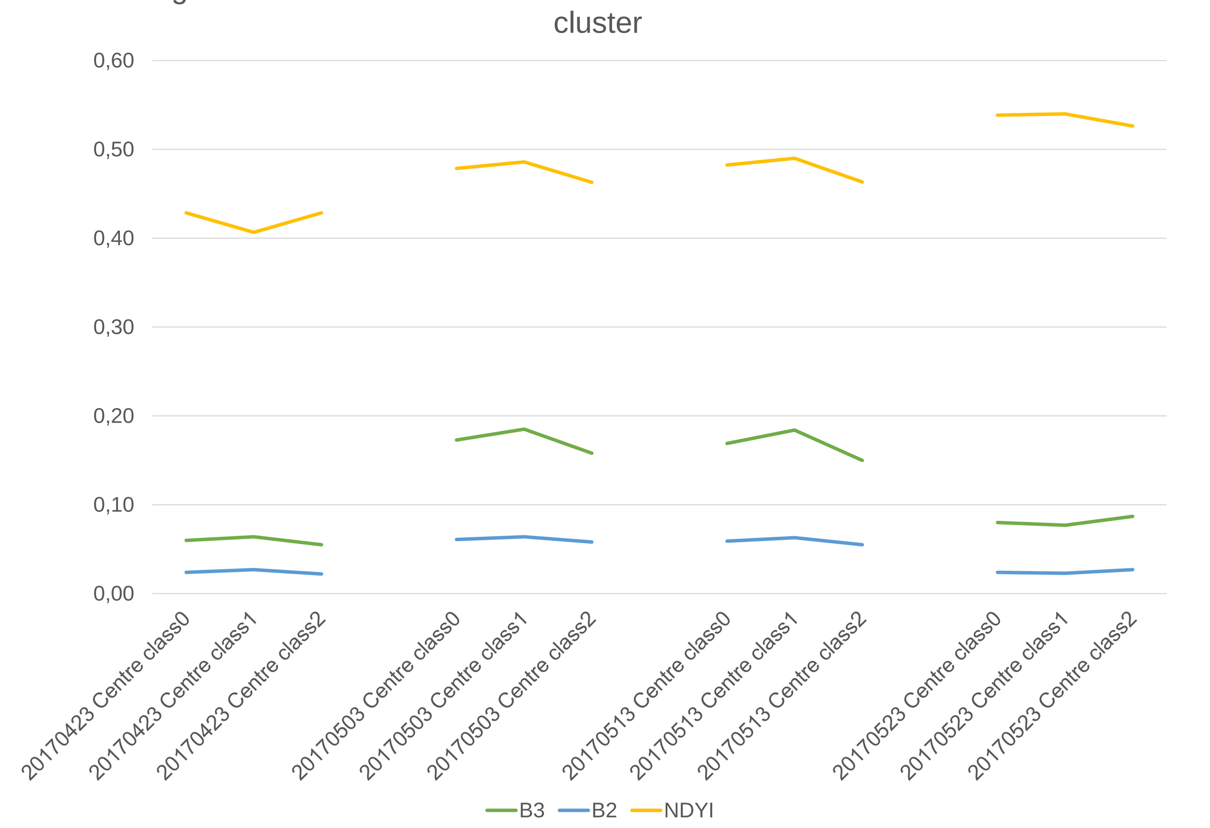


Table1: Sentinel-2 images used in the study

Sentinel-2 images	Available product level	Sen2Cor transformation
S2A_MSIL1C_20170423T090021_N0204_R007_T35TNJ_20170423T090808	1C	YES
S2A_MSIL2A_20170503T085601_N0205_R007_T35TNJ_20170503T090332	2A	NO
S2A_MSIL2A_20170513T090021_N0205_R007_T35TNJ_20170513T090803	2A	NO
S2A_MSIL2A_20170523T085601_N0205_R007_T35TNJ_20170523T090333	2A	NO

Figure2: Field data, where “A” is a bush used as landmark

Figure4: Classification k-mean cluster: values of the centers of each cluster



METHODS

The flowering period of the winter rapeseed crop in North East Bulgaria is usually between the end of April and the end of May. The onset of flowering of rapeseed was determined as the date of flowering of approximately 10% of plants in a field. The end of flowering was recorded when all flowers in more than 90% of plants faded.

At this stage of the project to determine the flowering onset and end date we performed a classification using blue and green band and compared it with the normalized difference yellowness index (NDYI).

NDYI = $\frac{(Rgreen - Rblue)}{(Rgreen + Rblue)}$ (eq. 1) (Sulik and Long, 2016)

The preliminary classification process with the blue and green bands was performed by Sentinel Application Platform SNAP5.0 Desktop and Sen2Cor version2.3.1. The unsupervised classification was K-mean cluster analysis with 3 classes. In this study only B2 band was used as a blue band. The same process will be executed using the B1 band because (Sulik and Long, 2015) and (Sulik and Long, 2016) used narrow band products with a central wavelength at 450nm.

Data from campaign 2016/2017

Satellite remote sensing data

A time series of Sentinel-2 2SA Level-2A images were used for this study from mid-April 2017 to end of May 2017. Most of the images were downloaded on a local disk from the Copernicus Open Access Hub (https://scihub.copernicus.eu/) directly as Level-2A products. Those that were in Level-1C products were transformed via the Sen2Cor processor available as a third-party plug-in for SNAP, see Table1.

Field Data

Field data was collected during the flowering stage 2017 of the winter rapeseed test field. The field data consists in assessment of the “Biologische Bundesanstalt, Bundessortenamt und CHemische Industrie” (BBCH) stage of the studied plot. See Figure2.

UAV remote sensing data

Digital aerial images were acquired by a standard DJI Phantom 3 Advanced UAV and its RGB digital camera, graciously provided by Pioneer™. The UAV was also equipped by a Sentera NDVI single sensor. See Figure3.

RESULTS

The results of the classification are in Figure4.

The field visit from 2017 April 22nd showed a test field just before the flowering stage. The observations were made from view point D, once looking toward the bush (view point A) and another time looking southwest. Therefore, the class 0 is in BBCH59, class 1 is before this stage and class 2 is after

The field visit from 2017 April 29th showed a test field in full blossom. The difference in the reflectance and classification is probably due to the difference in the flower density compare to the green mass of the plant visible between the flowers. Also, the classification was done on an image taken 4 days latter which is quite a long time considering the flowering period.

The field visit from 2017 May 18th showed a test field at the end of the flowering period. The difference in the reflectance and classification is probably due to the difference in the flower density compare to the beginning of the ripening of the plant visible between the flowers. Also, the classification was done on an image taken 3 days before the visit time.

The field visit from 2017 May 26th showed a test field at the beginning of ripening. The classification, however, could be done only on the northern part of the field because the rest is in a shadow of clouds. The difference in the reflectance and classification is probably due to the difference in the ripening of the plant visible between the last flowers.

DISCUSSION

The first assessment of the K-means Cluster Analysis with 3 Classes and Blue and Green bands shows a coherent behavior in view of the field data used. No accuracy assessment of the classification is yet carried out. The accuracy assessment will be carried out latter on, including several other test sites that were monitored during the flowering period 2017 of the winter rapeseed in the same region. The studied period should be enlarged to include the stage before the flowering and after all the flowers are gone. Additionally, in the next steps of the study, the morphology of the plant in terms of green biomass should be included into the evaluation of the results.

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CONCLUSIONS

The first preliminary results give encouraging sign in using wavebands from green and blue and a VI with them as a good indicator for estimating the onset and end of flowering.

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