USABILITY OF UAV (TRIMBLE UX5 HP) AND SENTINEL 2 REMOTE SENSING IMAGERY FOR MAPPING OF AGRICULTURAL AREAS

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ABSTRACT

Nowadays due to climate change, the agriculture has new challenges to product same quality and yield of different crops. At field crop production, plants are exposed for many kinds of natural impacts called stress factors, which can be determined by the yield of the crop per annum. In the last decades, crop producers could experience, how the climate change vary the yields, so they have realized, that the monitoring of the stress response of the grown plants is essential to provide crop production safety. The main goal of our research is to compare the applicability of the satellite and UAV data to be able to calculate NDVI maps and define stress factors on crops.

METHODS-UAV WORKFLOW

The presented method specified on Trimble Ux5 HP system. The photos have taken by two Sony Alpha ILCE-7R (36.4 Megapixels) full-frame digital cameras. Both cameras have CMOS sensor (RGB true color, and NIR false color). For the NIR camera we applied LP550 Orange Longpass filter (Figure 1). We processed the photos with Trimble Business Center photogrammetry software. The workflow began with image matching and generating sparse point cloud. Then, the software generated the dense point cloud which contains more than 143 million points in case of the larger area. The next step was building of the mesh (3D model of the scene with more than 14 million vertices). After that we generated the orthophoto mosaic of the area.

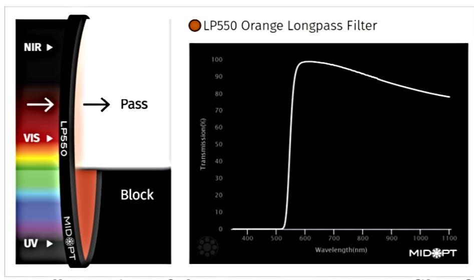

Figure 1: Illustration of the Orange550 Longpass filter function.

Considering that we have two ortophoto mosaic per each experiment, we applied georeferencing method to get perfect matching. After this step we made band composite because we needed the red band from RGB mosaic, and the near infrared band from the NIR mosaic. Then we generated the NDVI maps with the formula: NDVI = ((IR - R)/(IR + R)) (Figure 2-5)

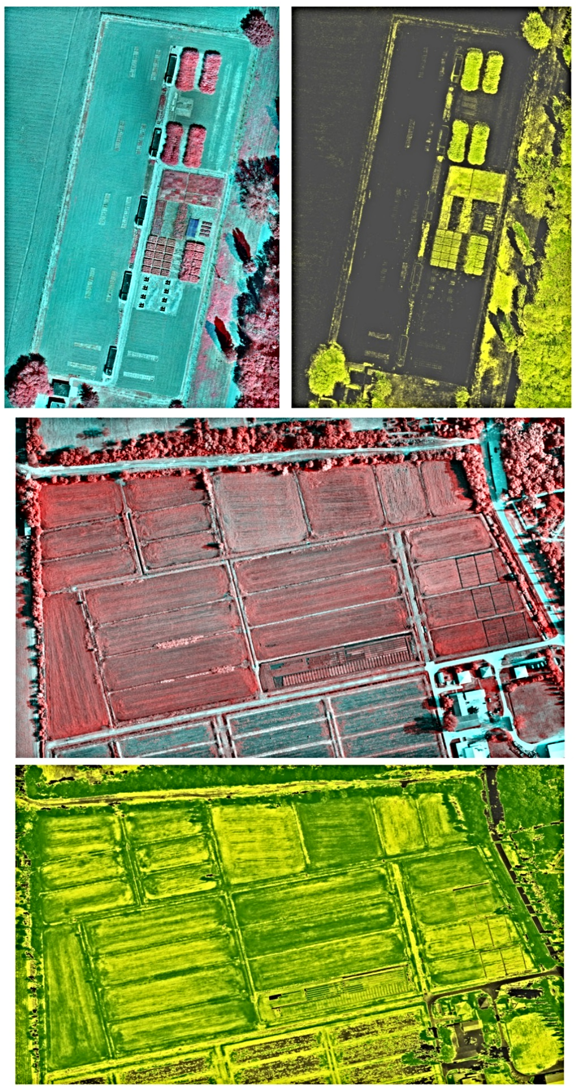

Figure 2-5: Images show the false coloured orthophoto mosaic, and the generated NDVI maps of the National Agricultural Research and Innovation Center, Research Department of Irrigation and Water Management - Lysimeter Research Station, and Rice Research Station. UAV photos taken 16-17th of August 2017.

RESOLUTION ISSUES OF CALCULATING NDVI

Comparing the resolution of the Sentinel 2 (20m) and the UAV (centimeter accuracy) images, we assume that the high resolution of images serve more potencial on NDVI calculation and mapping. The location of the study area is in western Hungary. The area is a wheat experimental area of the University of Pannonia, Georgikon Faculty (Figure 6). In our experiment we checked the usability of UAV images in different resolution to generate NDVI maps.

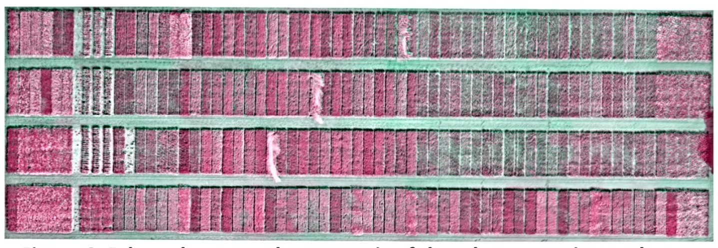

Figure 6: False colour ortophoto mosaic of the wheat experimental area.

During the calculation, we realized that the high resolution images give us some undesirable details as shadow and leaf movements near the plants. Figure 7-8 show that the mean NDVI values do not change too much while the resolution gets lower, so we can state that UAV-s with lower resolution sensors are suitable to serve usable images for satisfying NDVI calculation.

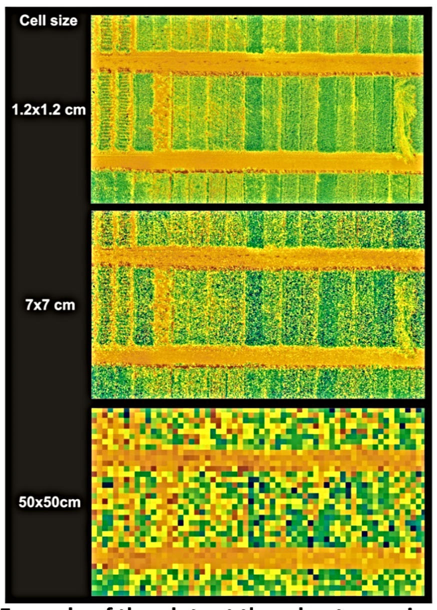

Figure 7: Example of the plots at the wheat experimental area in different resolutions.

plot number	NDVI value		
	Cell size 50x50 cm	Cell size 7x7 cm	Cell size 1.2x1.2 cm
73	0,222	0,266	0,262
74	0,298	0,351	0,343
75	0,159	0,255	0,130
76	0,315	0,289	0,290
77	0,369	0,307	0,315
78	0,240	0,290	0,299
79	0,299	0,319	0,319
80	0,511	0,474	0,472
81	0,300	0,335	0,348
82	0,445	0,408	0,414
83	0,351	0,339	0,336
84	0,439	0,446	0,452
85	0,402	0,364	0,362
86	0,392	0,380	0,384
87	0,438	0,4494	0,4446

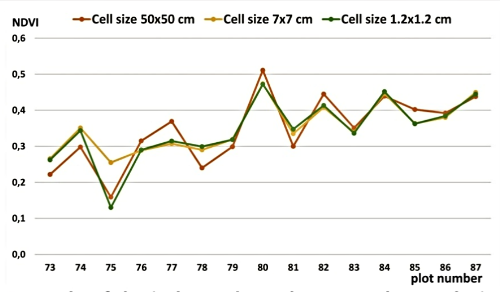

Figure 8: Example of the independency between the resolution and the NDVI values.

METHODS-SENTINEL WORKFLOW

The Sentinel-2 imagery (taken on 3th of August 2017) has been downloaded from the ESA Copernicus Access Hub using Qgis with Semi Automatic Classification plugin. This plugin also done the preprocessing of the images. We made a real-colour composite using band 4,3 and 2. (Table 1)

The Normalized Differential Vegetation Index (NDVI) calculated using this formula: (B8-B4)/(B8+B4) figure 9.

The Normalized Differential Water Index (NDWI) calculated using this formula: (B3-B8)/(B3+B8) figure 10.

The Soil Moisture Index calculated using this formula: (B8A-B11)/(B8A+B11) figure 11.

Sentinel-2 Bands	Central Wavelength (µm)	Resolution (m)
Band 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 12 - SWIR	2.190	20

Table 1: Sentinel-2 MSI bands

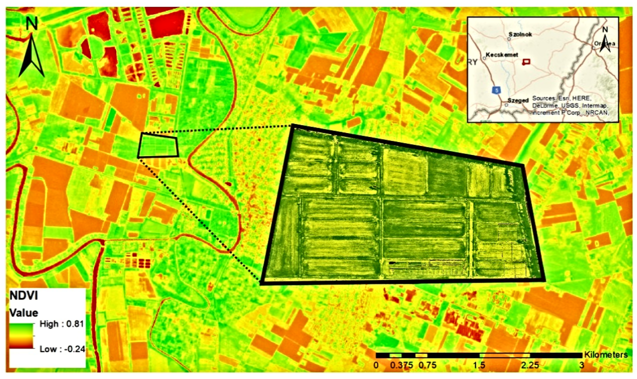

Figure 9: Town of Szarvas on NDVI map derived from Sentinel-2 imagery 03 of August 2017. Figure also shows the Rice Research Station NDVI map calculated from UAV images.

Figure 10: Town of Szarvas on NDWI map derived from Sentinel-2 imagery 03 of August 2017.

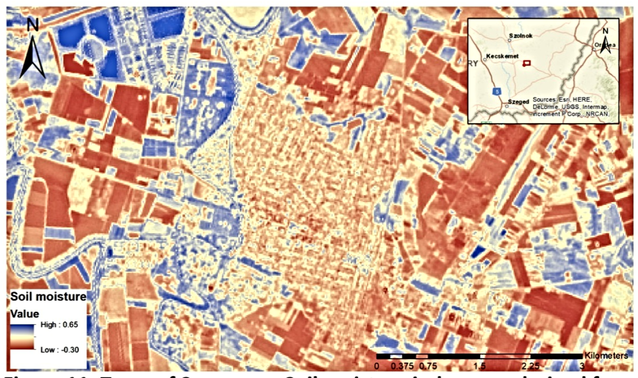

Figure 11: Town of Szarvas on Soil moisture index map derived from Sentinel-2 imagery 03 of August 2017.

RESULTS, CONCLUSION

As our result shows the NDVI calculation by using UAV imagery could give more accuracy in different plant experiments and provides opportunities to make local survey. While using Sentinel 2 imagery (due we have 12 bands) we could distinguish the plant and non plant areas then give them a wide interpretable value (NDVI), and make regional research. We could also calculate The Soil moisture index, and Normalized Differential Water Index. Using UAV photos we can make research on plot level and give differentiated NDVI values inside a plot, while validate and specify our results of Sentinel imagery process.

It should be noted as the resolution is high, errors could appear during the UAV data processing for example the shadow between the plants make the NDVI values overrated. Applying the RGB and NIR sensors in time difference (Trimble Ux5 HP) during the survey, the plant leaves and shadows could move by time and weather conditions, and give inaccuracy for our success.

MAJOR REFERENCES

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