

RESEARCH INTO OPTIMIZING THE PROCESS OF ASSESING THE DEGREE OF DESTRUCTION OF RAPESEED CULTURES AFTER WINTER USING IMAGE PROCESSING

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Abstract

Increasingly often we hear the terms “precision agriculture” and “modern monitoring tools”. Thus, we wish to bring to the fore the drone, as an agricultural tool which can be used to take pictures of crops and to help determine the degree of destruction of rapeseed cultures during the end of winter and in the beginning of spring. To achieve this, we want to determine what is the optimal flight altitude of a drone for taking pictures of the ground and of the rapeseed cultures. The pictures from the drone are processed with modern methods of pixel classification, in order to obtain the most accurate percentage of vegetation. We will use GIS instruments, GPS measuring tools, custom Python scripts for pixel classification and the LeoWorks software.

Key words: affected area, drone, GIS instruments, GPS measuring, pixel classification.

INTRODUCTION

Over the years, Romania faced some harsh winters, with blizzards and cold temperatures. Following the winter of 2015, the research area of “Moara Domnească” had an affected area of 4300m² of the rapeseed cultures that were planted at different epochs. Thus, we want to determine the degree of destruction caused by external meteorological factors during the winter. We will identify the patches without rapeseed and they will be expressed as a percentage: the surface with vegetation out of the total analyzed surface. (Sandino et al, 2016) We will use drones to capture images at different altitudes to determine the optimal altitude that will produce the best image. (Fu et al., 2012)

This method will be compared against the classic method that involves digitizing the field with the help of GIS instruments.

MATERIALS AND METHODS

First, we used the classic method of determination of affected areas in percentages, with the help of a 50x50 cm wooden frame.

Then, we used the Phantom 3 Professional Drone to capture images of the culture at different altitudes: 50m, 150m, 250m and 500m. (Figure 1). The sensor on the camera is a 1/2.3”CMOS, with 20mm lens and f/2.8 focus. The ISO range is 100-1600.



Figure 1. Drone Phantom 3 Professional

The images were taken after fixing the milestones to serve as landmarks, which are used to determine the coordinates in the Stereo 1970 system. (Karl et al., 2014). (Figure 2)



Figure 2. Control Points + GPS Trimble

The results can be observed in the following figures. The first picture, taken at an altitude of 50m, captures an area of 4500m². The second picture, taken at 150m, captures an area of 13,500m². The third picture, taken at 250m, captures an area of 22,500m². And lastly, the last picture, taken at 500m, captures an area of 45,500m². (Figures 3, 4, 5, 6)



Figure 3. Drone image taken at 50m



Figure 4. Drone image taken at 150m



Figure 5. Drone image taken at 250m



Figure 6. Drone image taken at 500m

RESULTS AND DISCUSSIONS

We started the analysis by determining the NDVI index with the help of the LeoWorks software and calculated it for all 4 images.

The NDVI index is used to aid the photo-interpreter in the visual analysis and the process of determining the percent of healthy vegetation. The NDVI index is usually defined by the following formula:

$$NDVI = \frac{(NIR - VIS)}{(NIR + VIS)}$$

where VIS and NIR stand for the spectral reflectance measurements acquired in the visible (red) and near-infrared regions. (Karthika et al, 2014). In this case, we used the following adapted formula:

$NVDI = (G-B)/(G+B)$, where G is the green band of the images and represents to the spectral reflectance measurements in the near-infrared regions (NIR), and B is the blue band in the images and represents the spectral reflectance measurements in the visible regions (VIS).

In the following figures you can observe the results and see that the images captured at 50m and 150m are optimal for photo-interpretation (Figures 7, 8, 9, 10)

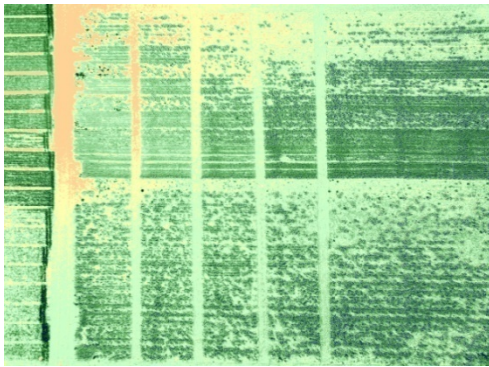


Figure 7. NVDI index at 50m

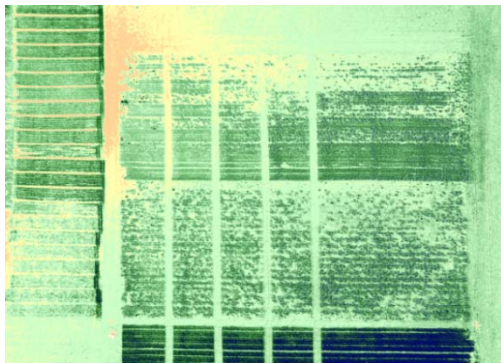


Figure 8. NVDI index 150m

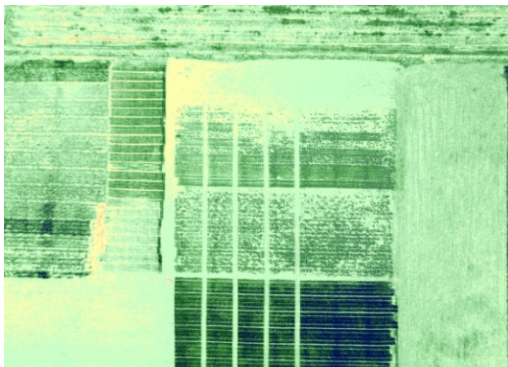


Figure 9. NVDI index 250m

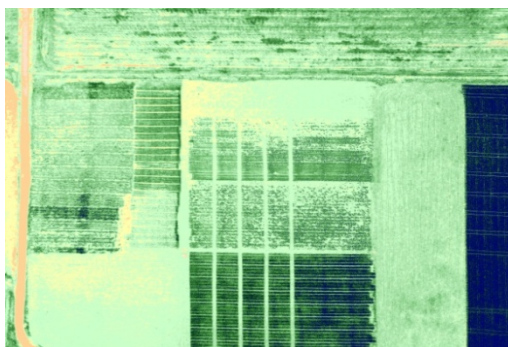


Figure 10. Indice NVDI 500m

Next, we performed an unsupervised classification with 2 classes and 12 iterations for each photograph. All green hues were included in a single color class, which will result in the most exact calculation. To do this we used a custom Python script. The results presented in the following figures are processed in the professional LeoWorks 4.0 software.

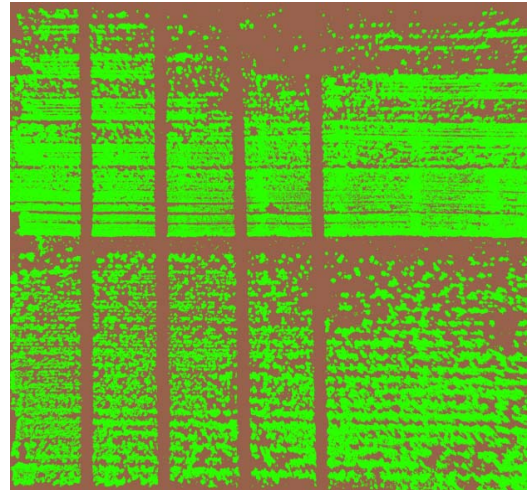


Figure 11. Image after classification, 50m

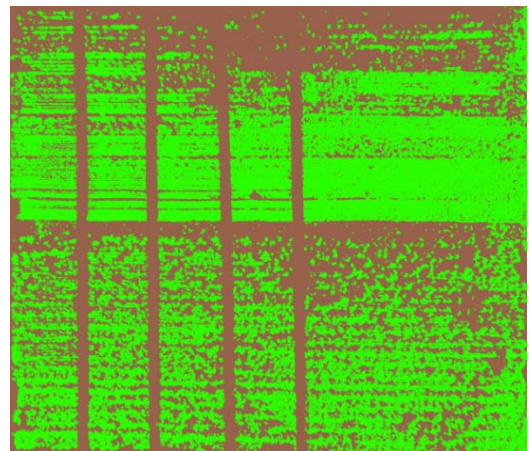


Figure 12. Image after classification, 150m

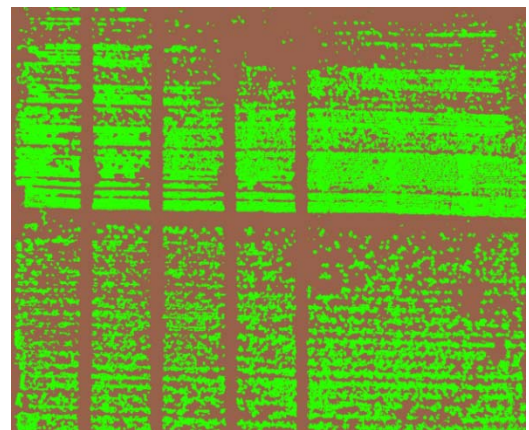


Figure 13. Image after classification, 250m

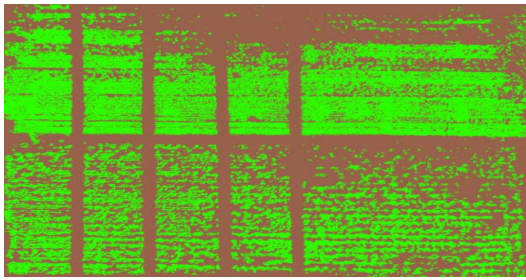


Figure 14. Image after classification, 500m

The graph below compares the percentages of affected area for each image taken at different altitudes, with the result obtained by using the classic method. We can see that the best results were given by the images taken at 50m and 150m, which have the smallest difference between their results and the 49,9% that was obtained using the classic method (Figure 15).

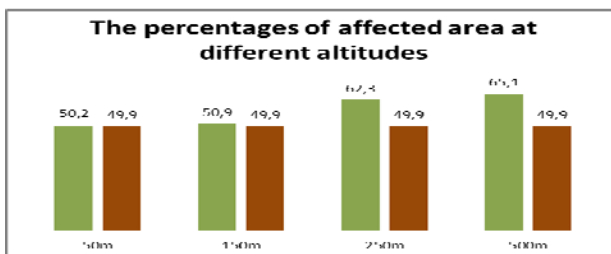


Figure 15. The percentages of affected area at different altitudes, compared to the percentage obtained by using the classic method

In the following figure it can be seen that 50m is the altitude that provides the most exact measurement, following the outline of the plants the best and excluding shadows. However, the picture taken at 50m provides a very good result, the difference being only 0.3%. Depending of the desired accuracy, the best altitudes are 50m, 100, and 150m. We can state for certain that as the altitude at which the pictures are taken increases, the accuracy of the measurements decrease (Figure 16).

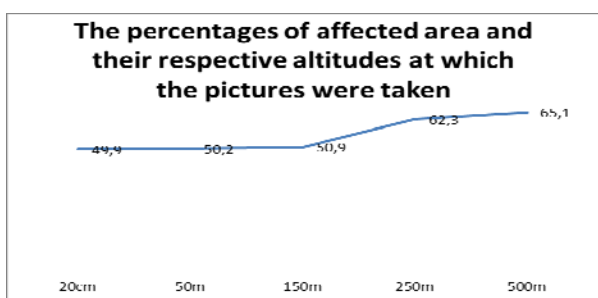


Figure 16. The percentages of affected area and their respective altitudes at which the pictures were taken.

CONCLUSIONS

We recommend taking your images as close to the ground as possible for the best accuracy, and if the land area is over 4500m² we recommend taking multiple images and moving the center of projection.

The classic method requires a lot of time in the field, but the method which involves taking and processing images with a drone has a lowest time investment compared with all the available existing methods.

In conclusion, modern processing instruments are recommended for this kind of studies, as well as advanced drones that take pictures at high resolutions.

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