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MONITORING THE VEGETATION OF AGRICULTURAL CROPS USING DRONES AND REMOTE SENSING - COMPARATIVE PRESENTATION

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Abstract

Precision farming is agricultural land management, involving the introduction of efficient technologies and machinery to make farming more efficient and ensure production control. Thus, through the measurements in the field and the analysis of environmental factors (weather, quality and soil properties, seasonality, stage of plant development), farmers obtain the information needed to manage resources and culture efficiently. This study presented the results of the measurements in the field, using unmanned aerial vehicle (UAV) with specific topography, with the precision of multispectral camera technology. The Article includes a comparative presentation between multistructural images obtained by a type of unmanned aerial vehicle (UAV) with multi-rotor configuration and multistructural analysis performed by remote sensing by satellites on the same agricultural surface in the Baragan plain.

Key words: *unmanned aerial vehicle (UAV), precision agriculture, normalized difference vegetation index (NDVI), green normalized difference vegetation index (GNDVI)*

INTRODUCTION

Over the last decade, the unmanned or uncrewed aerial vehicles - UAVs have proven to be applicable in many technological areas. The increasing number of the world's population and rapid industrial development tend to overexpose arable soils and fields. In order to meet production expectations, agriculture can even be a threat to the environment.

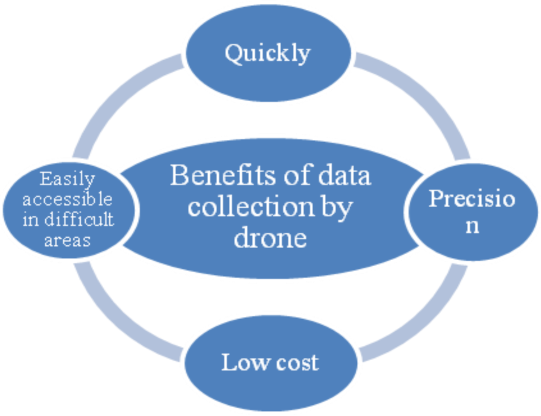

Fig.1.Scheme of drone use in agriculture
Source: Authors Contribution.

In this respect, the use of drones eloquently leads scientists to seek better solutions and reliable techniques to preserve the environment and, in addition, to increase the potential of agriculture in a sustainable way [1, 2, 8, 10, 13, 14].

The benefits of data collection from UAVs are presented in Fig. 1.

Intensive use of remote sensing is justified according to Fig. 2 as a first advantage, large area that can be covered in a shorter time than drones.

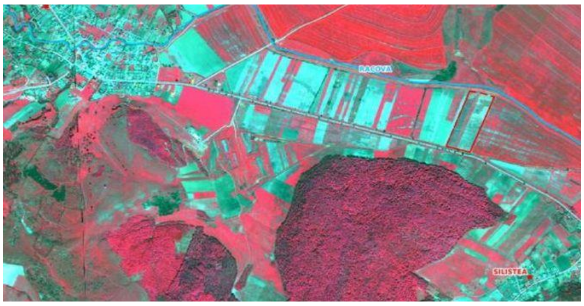

Fig. 2. Satellite image of agricultural parcels, Source:Agrointel.ro, 2017 [1].

Another major advantage is the accuracy of the information that this technology delivers on the location of agricultural parcels declared by farmers and on the types of crops existing on the land (each plant emits specific electromagnetic radiation in the visible and invisible spectrum in several spectral bands, this allows for rapid identification of existing crops on the area concerned [5].

Data on the use of drones

A UAV drone assembly is composed of an aeromodel, designed according to a particular design, with dedicated systems dedicated to remotensing (multi-spectral sensors from HD video photons to thermal and IR), launch/landing system and ground control station. (HD = high definition, IR = infrared).research data can be collected via multi-spectral sensors, by processing the information obtained by drones. The use of drones in research has the following advantages:

-detailed analyzes of concentrations of water and useful substances in soil and plants;

-evaluation of the level of infestation of crops with diseases and/or pests, with delimitation of infestation levels;

-assessment of the state of agricultural vegetation using specific vegetation indicators;

-detailed farm maps, for which important crop and soil parameters can be seen and monitored.

In this context, the main objective of the research was the evaluation of an agricultural plot located in the north of Braila county, Salcia Tudor, grown with maize, and the culture was established in spring 2020.

MATERIALS AND METHODS

For this purpose, a drona Parrot Bluegass with the Sequoia spectral chamber (Fig. 3) was used. Parrot Bluegass fields is a quadricopter made for multiple uses in agriculture, being an accessible and able tool justify the investment of farmers through the results obtained.

Parrot Bluegers fields incorporates two cameras:

-Front camera, full HD, through which you can monitor: Farm infrastructure, cropped terrain, orchard, vineyard or livestock herd;

-The Parrot Sequoia multispectral camera, which captures images that are processed using the Pix4DFields software [7], and immediate steps can be taken based on the results to save or improve crops.

Fig. 3. The Sequoia multispectral chamber
Source: Parrot Bluegrass Fields Drone [9].

Technical specifications of Parrot Bluegers drone

Dimensions: Lxlxh355.0 x 140.0 x 407.0 mm; maximum take-off weight below 500g;

Propeller number: 4; GPS Yes; maximum altitude 120 m; weight (with accumulator):1.81 kg;

Collision sensors: Sensor positioning (drone body): bottom, front, angle ofgrasping (front) 64° (horizontal), 62° (horizontal), 50° (vertical), 49° (vertical).

Fig. 4. Parrot Bluegrass Drone
Source: Agricultural Drones [9].

Remote control: Integrated display No; operating frequency: 2.4 GHz, 5.8 GHz; maximum operating distance 2 km remote; full HD video resolution; Integrated camera, Yes; resolution: 14MP;

Power and charge: Baterry, Li-polimer battery capacity 6,700 mAh/99 Wh;

Autonomy 25 minutes. The multi-spectral sensor on the Parrot Sequoia camera provides a complete and adaptable solution, analyzing plant vitality by capturing the amount of light it absorbs and reflects the collected data will help to map crops and analyze NDVI indications, GNDVI by obtaining maps that can be transferred to farmers' work machinery, contributing to an excellent optimization in agricultural work (fertilization, treatments with plant protection products and not least irrigation).

Data on the use of remote sensing

Using satellite images and/or air (provided by aircraft), the following shall be determined:

- the areas and locations of agricultural parcels;
- the types of agricultural area;
- the crops on those parcels and the stage of farming vegetation;
- how cross-compliance rules are complied with;
- the existence of ineligible elements (buildings, water, forests) on agricultural land for which payment applications are submitted.

Irregularities detected

The most common types of irregularities identified by remote sensing in accordance with Figure 5 are those related to the location and areas of agricultural land declared to be in use by farmers. Minor discrepancies between topographic maps and orthophotonels obtained by remote sensing are compensated, and for differences of no more than 3% between the area declared and that identified by remote sensing farmers are not penalized.

Fig. 5. Satellite used for remote sensing
Source: Geocledian.com [4].

Above this threshold penalties apply progressively, above 20% the payment is suspended for that year and above 50% is suspended it applies not only suspension, but also multiannual sanctions, for a duration of up to 3 years.

Regarding this aspect, the provisions of Final OTSC Guidelines of the EU Commission have been respected [3].

Other types of irregularities, equally common to the situation, are the absence or misclassification of crops covered by payment applications and the failure to comply with the requirements for obtaining a certain type of aid, such as for example, orchards, traditionally operated, where the main production is hay. But if the maximum number of 240 trees per hectare is exceeded, the main yield is not hay, but fruit. This is therefore another classification both in the categories of grants granted by the APIA [Agricultural paying and intervention Agency] and in respect of the levies and taxes to be paid by the farmer [6].

Calculation of the vegetation index

The vegetation Index is an indicator that is calculated as a result of operations with different spectral ranges of remote sensing data and is related to the vegetation parameters in a given image pixel. The effectiveness of the vegetation index is determined by the characteristics of the reflection. The calculation of most vegetation indices is based on two more stable sections of the spectral reflection of the plant curve.

NDVI- vegetation index normalized difference. Most commonly known in agriculture, characterizes the density of vegetation and allows farmers to assess germination, growth, the presence of weeds or diseases, and to predict field productivity. Index indicators are generated by green table satellite images that absorb electromagnetic waves in the visible red domain and reflect them in the near infrared domain. The red region of the spectrum (0.62 to 0.75 μm) represents the maximum absorption of solar radiation by chlorophyll and the near infrared area (0.75 to 1.3 μm) has the maximum energy reflection from the leaf cell structure. That is, high synthetic activity results in lower reflectivity values in the red spectrum region and high values in the near infrared region of the spectrum. The ratio of these indicators to each other allows you to clearly separate vegetation from other natural objects. As a result, it is possible to obtain a full spectrum analysis and to identify areas requiring re-seeding, application of plant protection products or fertilizers. NDVI is recommended when looking for differences in surface biomass over time or in space. NDVI is most effective when portraying the density variation of the canopy during the early and medium development stages, but tends to lose sensitivity to high density levels [11].

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

GNDVI - vegetation index difference normalized green. It is similar to NDVI, except that instead of red, it measures green spectrum in the range from 0.54 to 0.57 microns. This is an indicator of the photosynthetic activity of the plant shell; it is most commonly used in assessing the moisture content and nitrogen concentration of plant leaves according to multispectral data that do not have an extreme red channel [11].
Compared to the NDVI index, it is more sensitive to chlorophyll concentration. It is used in the assessment of the depressed and aging vegetation.

$$GNDVI = \frac{(NIR - Green)}{(NIR + Green)}$$

The Earth Observation satellites (EOS) are intended to obtain information about the surface and atmosphere of the Earth from a distance of a few tens to 36,000 km in space. The derived information does not come from a single satellite, but from a whole series of satellites with different instruments and observation missions. The "civilian" observation satellites have been orbit since the early '70, and the resolution and the level at which the details of the earth's surface can be described is now in the orders of the centimeters. Satellites that offer free images generally have a resolution of about 10 meters.

RESULTS AND DISCUSSIONS

Processing of information obtained through the drone

The software for the creation and analysis of multispectral images in the Parrot Bluegass drone is from Pix4Dfields.com, as shown:
(1)Example of using the GNDVI index for the study of photosynthesis activity as shown in Figures 6 and 7.

Fig. 6. Zoning map for differentiated application of agro-technical measures, obtained from analysis of GNDVI
Source: Pix4Dfields Software [7].

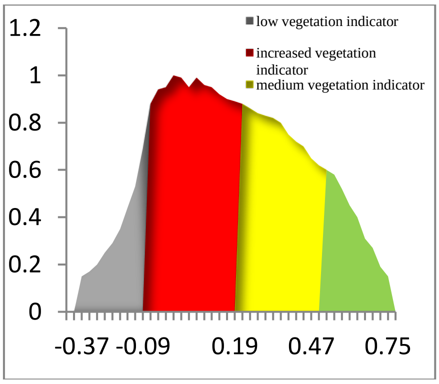

Fig. 7. GNDVI - Boundary legend
Source: Pix4Dfields Software [7].

(2)Example of using the NDVI indexto study the development of foliar mass as shown in Figures 8 and 9.

Satellite image processing was carried out but the assistance of the Solorrow application

After processing satellite images, the same plots, grown with maize in the area of Salcia Tudor, were obtained the zoning map according to Fig.10.

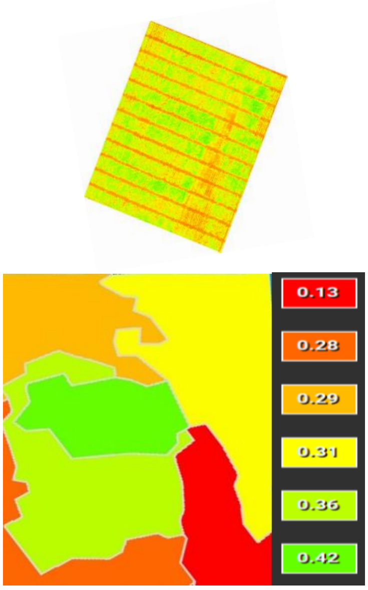

Fig. 8. Zoning map for differentiated application of agro-technical measures, obtained from analysis of the NDVI

Source index: Pix4fields program [7].

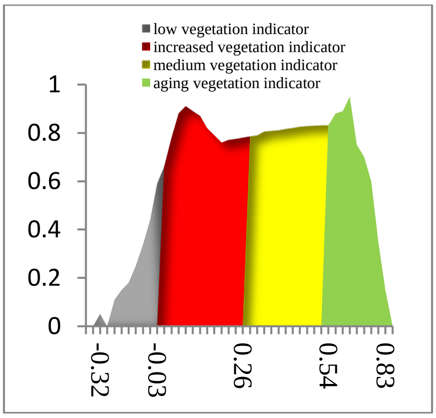

Fig. 9. NDVI - Boundary.legend

Source: Pix4fields program [11].

Benefits of Solorrow application

The result of the analysis strictly reflects soil heterogeneity, since by mediating values over a longer period of time, errors are eliminated either from the technology used, from the special annual environmental conditions, from crop rotations or from other specific causes,The application creates the plot potential map, and this is used to generate the prescription map. The analysis obtained may be used for variable-rate agricultural sowing or for the differentiated application of solid or liquid fertilizers.

Vă rog sa căutaţi parcela dvs. pe hartă sau să introduceţi adresa.

Diferenţa de potenţial de la o zonă la alta este de 3%

Maşină de împrăştiat — Tipul de utilaj

ø 200 kg/ha

% 3 Diferenţa de dozare la zona următoare (bazată pe diferenţa de potenţial)

Strategia de aplicare

● Dozare mare în zonele cu o biomasă medie mai mare

○ Dozare mare în zonele cu o biomasă medie mai mică

Dozaj (kg/ha)	Suprafaţă	Cantitate
187	1,26	236
192,61	2,59	500
198,39	2,20	437
204,34	3,29	672
ø 200	Σ 11,71	Σ 2,34k

UTILIZAŢI HARTA DE PRESCRIPŢIE

Pentru a aplica harta de prescripţie, aveţi următoarele opţiuni:

- PORNIŢI APLICAŢIA SOLORROW DE GHIDAJ: MOD CONDUCERE
- TRIMITEŢI CA ISO-XML ŞI FIŞIER PDF PRIN E-MAIL
- TRIMITEŢI CA SHAPE ŞI FIŞIER PDF PRIN E-MAIL
- CONECTARE CU JOHN DEERE OP. CENTER
- CONECTARE CU AGRIROUTER

ÎNAPOI LA HARTA DE POTENŢIAL

Fig. 10. Map with productive potential depending on the distribution of biomass in the last 5 years; prescription map as well as export options

Source: Solorrow application [12].

CONCLUSIONS

Satellite images reflect the distribution of vegetative mass in the field, making it possible to identify areas with low vegetation and develop agro-technical measures to improve them. NDVI-per-year analysis will help determine productive and non-productive fields, and this information will help to achieve optimal crop rotation. For example, an NDVI index analysis will reveal fields where there has never been a high yield of five years, and you can decide whether to invest in fertilizers or to sow perennial herbs for food.

The availability of such spatial and temporal data obtained using drones, linked to the use of field sensor networks, which provide real-time measurements, is a change in the way farmers implement the benefits of precision farming, as well as farm-level decision management. A great advantage is that low-cost solutions can be achieved by using drones for small areas for small farmers as well as satellite images for large areas for large farmers:

-Photogrics and architectural heritage relevance;

-Monitoring in agriculture and forestry, natural disasters;

-Biodiversity and monitoring of communication routes;

-Acquire recent and prior satellite images;

-Orthophotlan, multispectral, interferometric.

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