USE OF SPECIFIC MEANS AND METHODS OF AERIAL PHOTOGRAMMETRY IN PAYRIST ANALYSIS

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Abstract

The grasslands in Romania are spread mainly in the hilly and mountainous regions, in different environmental conditions and often on hard to reach lands. In this context, "remote" investigation, through aerial photogrammetry methods and techniques, is very useful. By involving drones, as investigative tools, precision agriculture is supported and at the same time provides grassland owners and users with access to a wide range of data. In addition to assessing the current situation, it is also possible to monitor, through consecutive data sets, both the grassland area and the grazing animals. The research presented in this article, has as main purpose the use of means and methods specific to aerial photogrammetry, respectively UAV systems, for the analysis of grasslands under different aspects. The research presented in this case study was carried out in Zăvoi commune, located in the northeast of Caraş-Severin county. The grassland considered a case study was flown over with WingtraOne equipment, in the technical conditions imposed by the legislation in force. By processing the aerial images and the point clouds obtained during the flight, we obtained: two- and three-dimensional models of the grass surface and the orthophotoplan that provides both qualitative and quantitative information.

Keywords: grasslands, drones, surfaces, altitudes, orthophotoplan.

INTRODUCTION

Grasslands cover about 40.5% of the earth's surface and spread to all continents (White *et al*, 2000). Satellite coverage maps created by NASA (National Aeronautics and Space Administration) provide scientists with a detailed picture of the distribution of ecosystems and the use of land and grasslands around the world. (NASA, 2022).

The surface of grasslands, related to the total agricultural lands, places Romania on the fifth place, at the level of Europe (Sima and Popa, 2014).

Zăvoi commune, located in the northeast of Caraş-Severin county, with a total area of 38920 ha, has a wide range of natural resources, from those related to land, to tourism and geology, included in five geographical units: Muntele Mic, Ţarcu Massif, Godeanu Massif, Bistra Corridor and Poiana-Ruscă Mountains.

Of the area of the Zăvoi territorial administrative unit, 60%

is declared a Natura 2000 site, respectively ROSCI0126 Țarcu Mountains. In the reference perimeter, the grassland habitats are distinguished at altitudes of 500 - 800 m (Poiana Mărului) and over 1400 - 1600 m on Muntele Mic and 1800 m altitude on Godeanu and Țarcu Mountains (Planul de management al Sitului Natura 2000 Munţii Ţarcu).

The alpine grasslands extend on the highest heights of the mountains in the reference perimeter, on flat or slightly inclined surfaces, but also on the slopes. The subalpine pastures are found in an altitudinal range between 1600 - 1800 m and are presented in the form of a transition floor between the alpine floor and that of the coniferous forests.

Grasslands have been studied for biodiversity and conservation (Akeroyd and Page, 2001; Cojocariu *et al*, 2018; Cojocariu *et al*, 2019; Moisuc *et al*, 2000), of invasive species (Sărăţeanu *et al*, 2021) or medicines (Imbrea *et al*, 2010), of optimizing the application of nutrients (Moisuc *et al*, 1997, Ranta *et al*., 2021; Samfira *et al*, 2021) and sustainable use (Hoancea *et al*, 2017; Marusca *et al*, 2016; Moisuc *et al*, 1998; Samuil *et al*, 2018; Vidican *et al*, 2020), but less by modern means of aerial photogrammetry and satellite imagery.

Sometimes in the conditions of a rugged relief, difficult to access, the grasslands become "objectives" difficult to investigate, without the support of drones or satellite images, technical fields increasingly involved in the study of pratological (Capolupo *et al*, 2015; Cojocariu *et al*, 2015; Von Bueren *et al*, 2015; Wu *et al*, 2019).

Unmanned aerial vehicle (UAV) platforms are today a valuable source of data for investigation, surveillance, mapping (Bârliba and Cojocariu, 2010; Simon *et al*, 2017), monitoring and 3D modeling (Casian *et al*, 2019, Simon *et al*, 2018). Another major advantage is that UAVs can be considered as a low-cost alternative to conventional aerial photogrammetry, and with the increasing "demands" for this equipment, new applications are introduced in various fields.

UAV flight plans offer a high operational variety in terms of cost, time and repeatability (Haarbrink, 2012; Nex *et al*, 2014).

Using data obtained by UAV technology as a basis for high-resolution spatial imaging (Javernick *et al*, 2014; Tripolitsiotis *et al*, 2017), users can make reliable and fast decisions in case of risk situations or for assessing damage, calamities from agriculture (Newcombe, 2007). UAV systems also provide access to areas of risk or inaccessible areas (Ferrer-Gonzalez *et al*, 2020).

In the theoretical and practical context presented, the paper aims to use the means and methods specific to aerial photogrammetry, respectively UAV systems, in the detailed analysis of grasslands, under different aspects.

MATERIAL AND METHOD

The research presented in this case study was carried out in Zăvoi commune, located in the northeast of Caraş-Severin county (figure 1). From a biogeographical point of view, the area of interest in this study is included in the Alpine bioregion, of Romania, and as a geographical settlement, in the Southern Carpathians. According to the territorial statistical data, Zăvoi commune owns 21642 ha of agricultural land, of which 20560 ha of grasslands (INS, 2022).

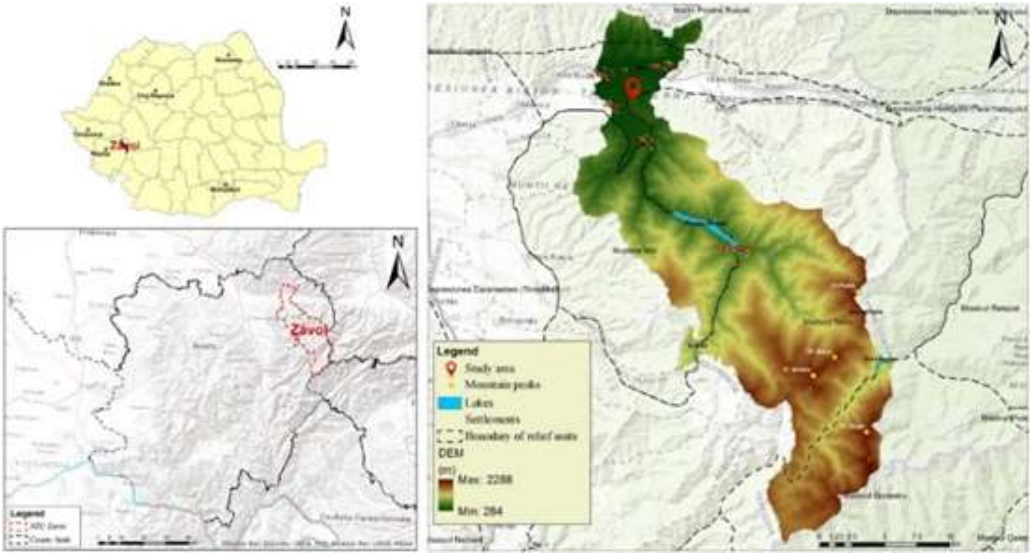

Figure 1. Location of the study area
(processing after EEA-EU-DEM, Geospatial, ArcGIS Documentation, ANCPI)

The working methodology applied in the research involves several steps, summarized in figure 2: data acquisition, data processing and analysis. The products obtained are: aerial images, 3D models of the surface and the orthophotoplan.

In the case of the research presented in this article, a WingtraOne fixed wing drone (WingtraPilot User Manual) was used to map a pasture in the suburbs of Zăvoi locality, Caraş-Severin county, with an area of approx. 300 ha (figure 3).

One of the most cost-effective professional drones is the ability of WingtraOne to capture large amounts of high-precision data in a short period of time on difficult terrain. Compared to traditional topography and cartography techniques, the use of UAV-specific means and methods provides a wealth of information (Sasi and Yakar, 2018; Turner, 2011) and offers new ways of analyzing, measuring and monitoring pastoral space.

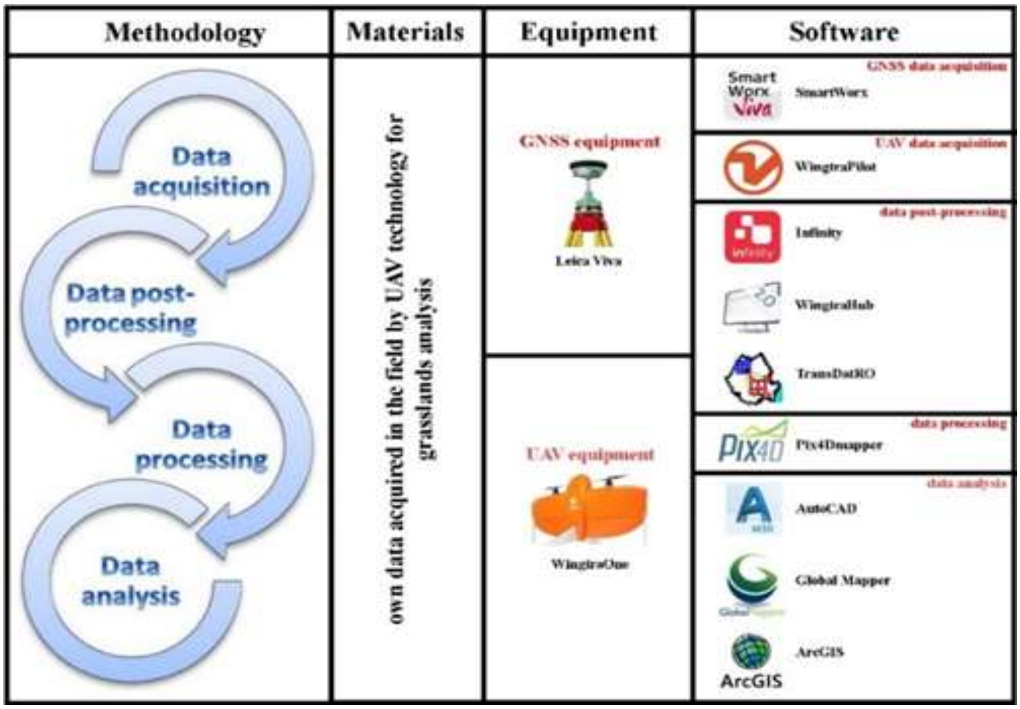

Figure 2. Working methodology

Figure 3. Presentation of the investigated grassland

RESULTS AND DISCUSSION

Agricultural space investigation and drone mapping open up opportunities to generate high-precision data and map the various components of the environment (Lalak *et al*, 2020; Laliberte *et al*, 2011; Turner, 2011; WU *et al*, 2019).

In order to demonstrate the applicability of modern photogrammetry methods in grasslands, we chose a grassland from Zăvoi locality from Caraș-Severin county. The flight over this grassland was made with the help of the WingtraOne drone (Figure 4) through the WintraPilot application.

The flight plan (Figure 4) was made in Google Earth and then exported as a .kml file which was copied to the tablet.

Figure 4. Equipment and flight plan

The flight took place from a height of 300 m in 33 minutes, during which time the drone traveled a distance of 31 km above the area of interest. During this time, 372 images were purchased along with the GNSS records for each image. GNSS data along with images stored on the SD card were copied to the laptop along with the observations recorded by the reference station (Leica Viva GS16) during the flight.

Post-processing was done using WingtraHub software. At the end of the process a report is generated where we can check the average accuracy.

Image processing was done using Pix4Dmapper software. Processing WingtraOne datasets into Pix4Dmapper is a few simple steps that only need to be completed at the beginning of the project. Once these steps are completed, image processing can be done.

In Pix4Dmapper it is possible to view the selected locations in detail: when positioning at a point on point clouds, the photo from that location will also open at the same time (figure 5).

For research in pratology, this way of viewing is particularly important: on the one hand, the entire investigated area can be analyzed, and on the other hand, specific information can be extracted regarding the vegetation, areas without vegetation, etc., at a very high resolution (Simon *et al*, 2020).

Another product generated based on UAV data, is the 3D model of grassland surfaces (figure 6).

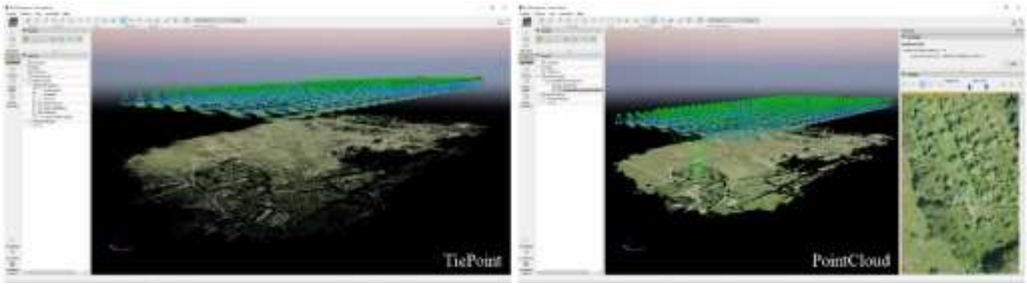

Figure 5. Detail analysis on point clouds and images

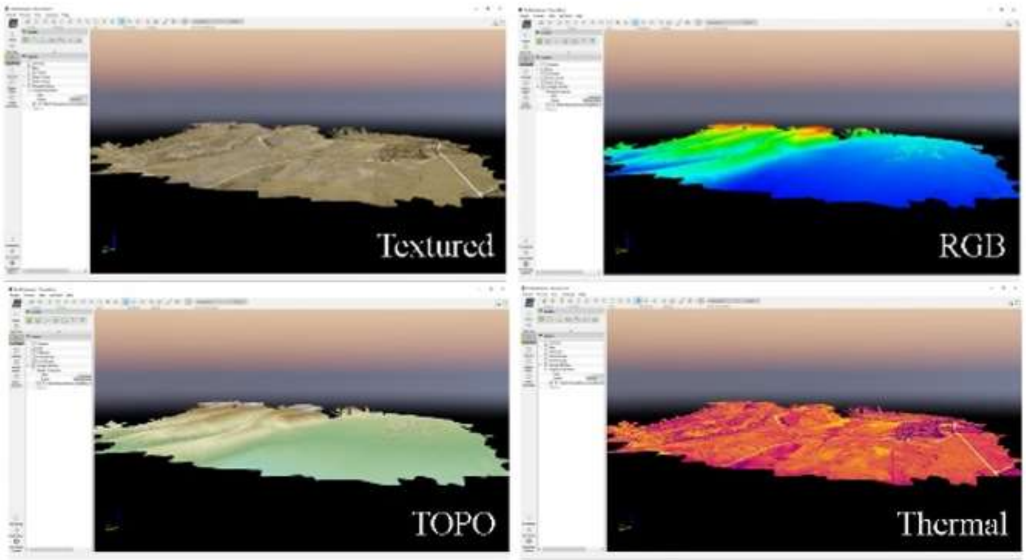

Figure 6. Types of 3D model views

Analyzing the 3D model of the pasture, a faithful copy of reality, we can establish the slope of the terrain, but also the creation of contours. In the case of the analyzed pasture, there is a level difference of 93 m, the minimum altitude being 321 m and the maximum 414 m (figure 7).

Another way to analyze the shape of the land in the analyzed grasslands is to view the orthophotoplan or "surface models": the Digital Elevation Model (DEM), the Digital Surface Model (DSM) and the Digital Terrain Model (DTM), shown in figure 8.

Another stage of the workflow is the creation of the orthophotoplan which is a very valuable "piece" from which can be extracted a series of data and information quantitative, quantifiable, but also qualitative, respectively attributes, of some registered land areas.

The orthophotoplan in digital format is a scale aerophotogrammetric product that photographically represents a portion of the earth's surface. Made from a mosaic of orthophotoimages partially overlapping partially longitudinally and transversely, the orthophotoplan is actually a photo map that provides accurate visual information on the analyzed grassland surfaces.

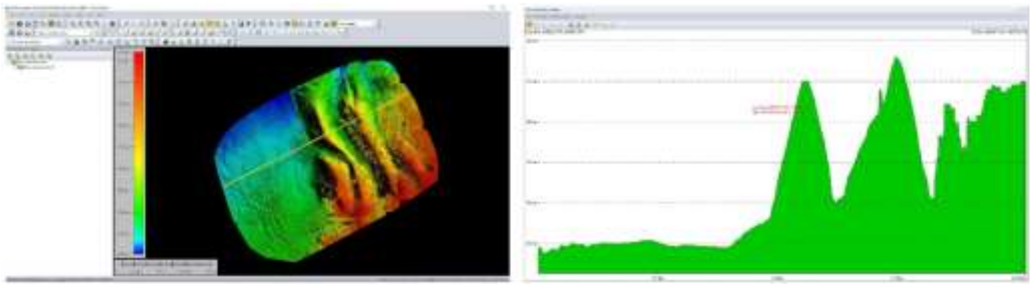

Figure 7. Representation of the relief in longitudinal profile

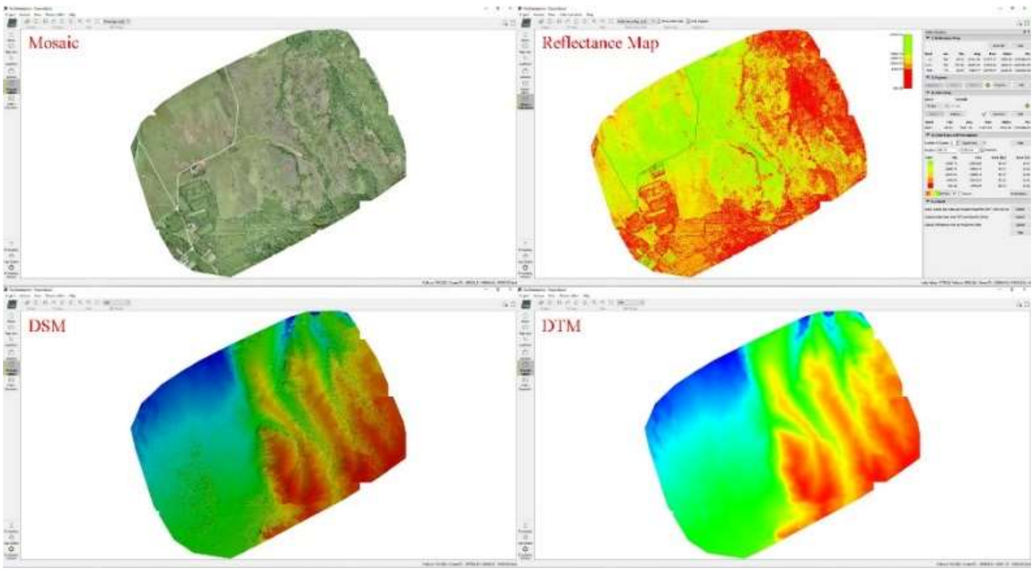

Figure 8. Possibilities to view the obtained data

For a complex analysis of the grassland, after obtaining the orthophotoplan with a resolution of 4 cm/pixel, followed the transposition of the information in vector format. In this way, all the elements on the surface of the grassland were vectorized (figure 9).

Based on the data exported from the CAD environment and implemented in GIS for the entire analyzed area, descriptive databases, 2D situation plans and qualitative and quantitative representations can be created (Jianlong and Tiangang, 1998).

Using drones saves time and raises awareness of ownership. UAV technology supports precision farming (Seelan *et al*, 2003; Seinic, 2019; Shannon *et al*, 2020; Sona *et al*, 2016; Zhang and Kovacs, 2012) and gives grassland owners and users access to a vast set of data.

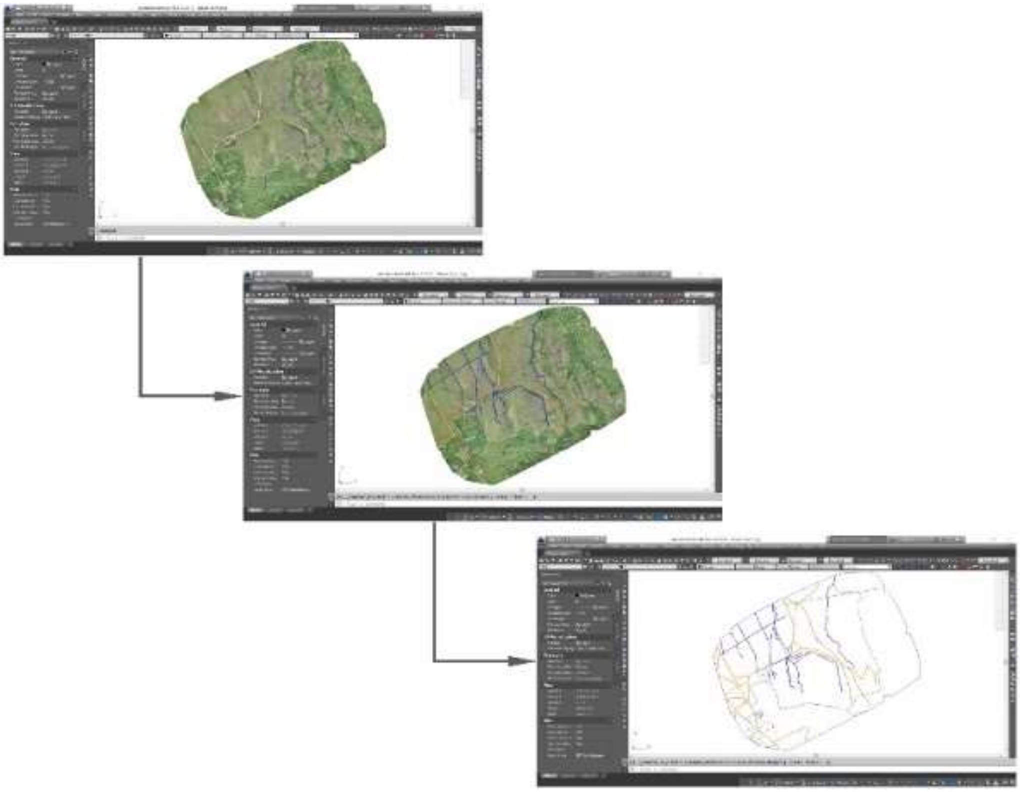

Figure 9. Transposing information into vector format

CONCLUSIONS

Based on the purpose of this case study, to use UAV technology in pratological research, in this article were created models for using the WingtraOne drone as well as working schemes that reduce working time in this dynamic field.

Aerial photogrammetry, through UAV technology, offers several products that are very useful in pratological research: aerial photography, Digital Elevation Models and orthophotoplan.

With the help of aerial images, acquired by flying over the grasslands with UAV equipment, information can be extracted regarding the vegetation carpet, the condition of the grasslands, the mode of exploitation, etc. Because the images are purchased at a very high resolution, the default level of detail is very high.

Based on point clouds obtained by UAV technology, two- and three-dimensional representations of grassland areas can be created, very high-precision measurements and complex analyzes that include both quantitative and qualitative elements.

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