MODEL FOR EXTRACTING GEOSPATIAL INFORMATION FOR GRASSLANDS. CASE STUDY

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Abstract. *Geomatic means and methods are increasingly applied in the agricultural and environmental fields, in the analysis of land use, for the identification and delimitation of grassland areas, in the assessment of biodiversity or in the mapping and estimation of degradation processesIn this context, the aim of this study is to create an operational flow, applicable to geospatial data, which reduces processing time and includes all the tools necessary for the geoprocessing of data acquired through UAV equipment, to provide viable and usable data sets in pratological research. The working methodology was applied on a grassland located in Brebu commune from Caraş-Severin county. The research is based on data acquired with UAV equipment, DJI Phantome 4, respectively aerial images, orthophotoplan and Digital Elevation Model. The photogrammetric flight was performed in October at an altitude of 60 m. The geospatial data sets were processed with ArcGIS 10.4 software in which Model Builder was used to automate the data processing process. The data purchased with UAV equipment are particularly useful in the characterization of grassland surfaces, both by the high degree of detail and by the possibility of flying over the surfaces in different temporal moments. These data provide information on relief, altimetry, data on the slope, useful in characterizing vegetation or identifying environmental factors that may intervene as restrictive elements. By the spectral classification of the orthophotoplan, the useful surface of the grassland can be delimited and by the application of some calculation algorithms, maps of some vegetation indices can be generated. The inclusion of data sets in Model Builder offers the advantage of fast processing, in a single work sequence and is a useful tool in pratological research.*

Keywords: *Geographic Information Systems, ModelBuilder, grasslands, aerial imagery, drones.*

INTRODUCTION

The literature outlines the concept of "geointelligence" which includes means of satellite remote sensing, aerial photogrammetry, respectively Unmanned Aerial Vehicle (UAV), Geographic Information Systems (GIS) and implicitly the products obtained by automated exploitation of satellite and/or aerial images (SIMON ET AL, 2018; GEOSPATIAL WORLD, 2021). All these means, products and methods of investigation are increasingly involved and applied in the fields of agriculture and the environment, in the analysis of land use (BĂLTEANU, POPOVICI, 2010; EASTMAN, 2016; COPĂCEAN ET AL, 2019; KHOSHNOOD MOTLAGH ET AL, 2021), for the identification and delimitation of grassland areas (HE ET AL, 2005; SHALABY, TATEISHI, 2007; COJOCARIU ET AL, 2015; HOANCEA ET AL, 2017; SIMON ET AL, 2017; MEHRABI ET AL, 2019), in biodiversity assessment (ROBINSON, SUTHERLAND, 2002; SMITH ET AL, 2003; COJOCARIU ET AL, 2018; COJOCARIU ET AL, 2019) or in the mapping of grasslands and estimating the processes of degradation of agricultural spaces (WANG ET AL, 2003; STENSEKE, 2006; FU ET AL, 2007; BÂRLIBA, COJOCARIU, 2010; TARANTINO ET AL, 2016; ZARE ET AL, 2017; VOGT, 2021).

"Classical" research methods use point measurements and observations, selected according to an experimental device, to determine the vegetation of grasslands (MOISUC ET AL, 1997; MOISUC ET AL, 1998; IMBREA ET AL, 2010) and forage crops (COJOCARIU ET AL, 2008;

RADU ET AL, 2010; MAZĂRE ET AL, 2019). To complete them, UAV technology can be applied which offers the advantage of acquiring data on the whole surface, taken from low altitudes which means high spatial resolution images and allows the repetition of acquisition sessions at short time intervals, planned as needed (HUNT ET AL, 2008; LEBOURGEOIS ET AL, 2008; RANGO ET AL, 2009).

The aim of this study is to create an operational flow, applicable to geospatial data, which will reduce processing time and include all the tools needed to geoprocess data purchased via UAV equipment, to provide viable and usable data sets in pratological research.

MATERIALS AND METHODS

1. Study area

The grassland that is constituted as a case study in this article is located in the Brebu administrative-territorial unit, Caraş-Severin county (Figure 1).

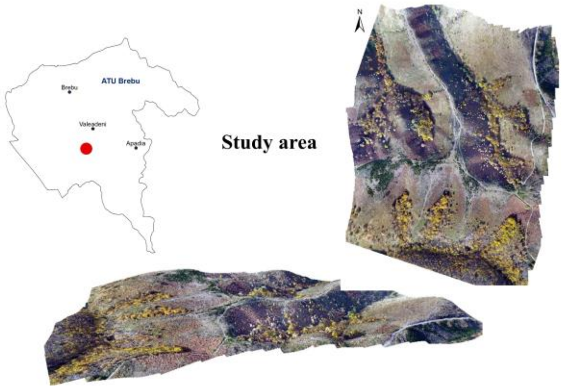

Fig. 1. Location of the study area (processing after GEOSPATIAL, ANCPI)

The analyzed grassland has an area of 58.2 ha and represents a part of a surface unit cadastrally classified as "pasture". The relief is marked by a succession of valleys and interviews, with altitudes between 287 - 405 m.

2. Used materials

The research is based on data purchased with DJI Phantome 4 UAV equipment. Following the photogrammetric flight, aerial images and point clouds were purchased, based on which the orthophotoplan and the Digital Elevation Model (DEM) with a spatial resolution of 0.8 m were obtained. The flight was performed in October, at an altitude of 60 m.

3. Research methodology

The first stage of the research is related to the acquisition of photogrammetric data. After establishing the flight plan and acquiring the data in the field (SIMON ET AL, 2018; RODER ET AL, 2018; EWERTOWSKI ET AL, 2019; PEACOCK, CORKE, 2020; DJI GO Manual, 2021), the processing protocol was applied, with the help of PhotoScan Professional and Pix4Dmapper software, the result obtained being the orthophotoplan and the surface models (TAVANI ET AL, 2014; SIMON ET AL, 2018; PIX4D DOCUMENTATION, 2021).

The second stage involved the introduction of data obtained by aerial photogrammetry an alternative to classical photogrammetry (VOROVENCII, 2010), in ArcGIS 10.4 software (ARCGIS DOCUMENTATION, 2021). From this program, Model Builder was used to automate the data processing process, according to Figure 2.

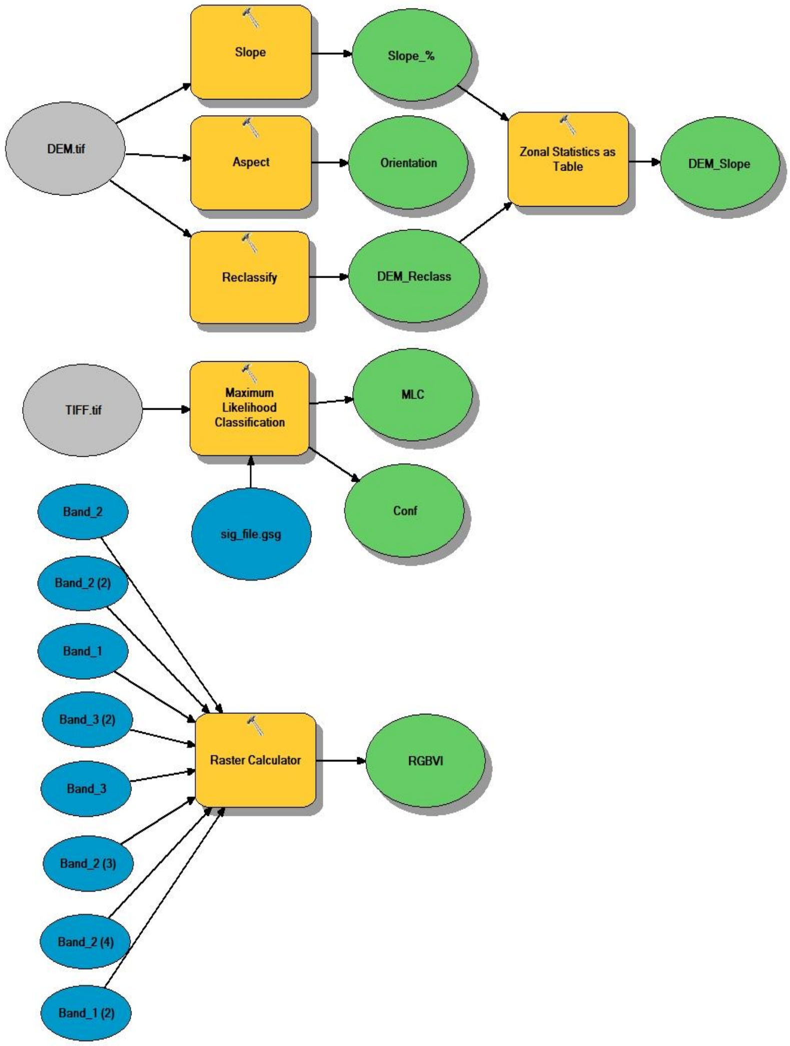

Fig. 2. Geospatial data processing workflow

Model Builder can be seen as a visual programming language for building workflows; was used to create, edit, and manage a model that aims to extract geospatial data that can be used in pratological research. This model combines several sequences of geoprocessing tools. Once the data and functions/applications with which they are processed are entered, the model automatically generates the results in the form of maps or tabular data.

In the case of the present study, the Model Builder integrated the grassland DEM and the orthophotoplan, images on which six geoprocessing operations were applied (Figure 2). All these operations have concrete results that can be used in pratological research and will be presented in detail in the section "Results and discussions".

RESULTS AND DISCUSSION

According to the working methodology (Figure 2), the first dataset included in the Model Builder was the Digital Elevation Model (DEM), obtained by UAV equipment, by processing point clouds. In order to obtain the useful geospatial information in the study of the grasslands, the following functions were applied on the DEM: "*Slope*", through which the slope map expressed in percentages was obtained; "*Aspect*" by which the slope orientation map was generated and "*Reclassify*" for the reclassification of the DEM on altitudinal stages (Figure 3), to be analyzed in correlation with the slope values, through the function "*Zonal Statistics as Table*" (Figure 4). In this way, continuous thematic maps were obtained for the analyzed grassland, thus the information being available at any point on the respective surface.

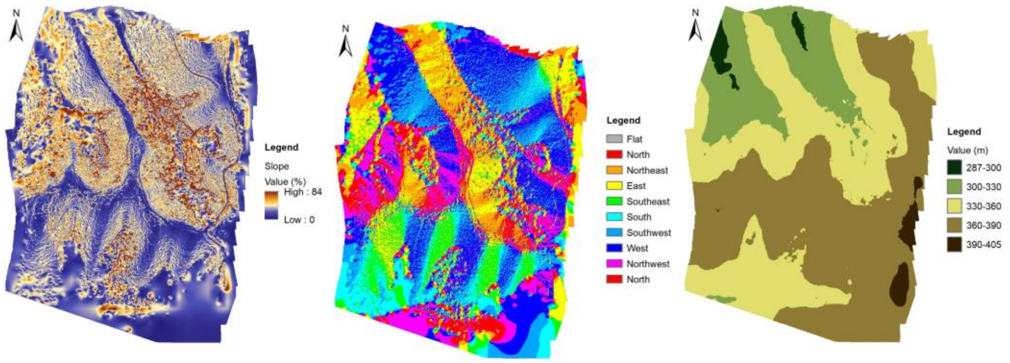

Fig. 3. Slope map (%), slope exposure map and Digital Elevation Model

Rowid	ALTITUDE	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
1	287-300	8565	0.09	54.98	54.89	16.23	9.46	173726.09
2	300-330	97410	0	84.23	84.23	25.91	11.37	3153004.49
3	330-360	218871	0	84.35	84.35	22.35	12.26	6110253.65
4	360-390	268374	0	76.71	76.71	16.72	10.57	5605090.66
5	390-405	11143	0.01	73.7	73.69	14.95	10.79	208163.05

Fig. 4. Altitude-slope correlation

DEMs, some of the most commonly used bases for landform analysis, are needed in other types of analysis that can influence grassland vegetation, such as water runoff or drainage modeling, geological and geomorphological studies, land use research, and more (LI ET AL, 2004; BALASUBRAMANIAN, 2017; WILSON, 2018). Also, through the photointerpretation of the DEM, information can be extracted regarding the conformation of the relief, direct and/or indirect factor of some geomorphological processes that can affect the respective surface (erosion, landslides, water runoff and so on).

For the pratological researches, the slope of the land and the orientation of the slopes are important both by the influence they have on the vegetation and as physical-geographical elements. For example, they influence the amount of radiation, humidity and soil temperature, which are reflected in the growth and development of plants (LIEFFERING ET AL, 2019). Also, the orientation and slope of the land have a direct and/or indirect influence on productivity (GONGA ET AL, 2008), but also on the distribution of species (MOISUC ET AL, 1997; BENNIE, 2003; LIEFFERS, LARKIN-LIEFFERS, 2011).

The second geomatic product included in the working model was the orthophotoplan which is considered a scaled aerophotogrammetric product that represents the physical environment photographically (SEINIC, 2019). Because it is a high spatial resolution image with a high degree of detail, by simple photointerpretation it is possible to identify aspects related to grassland vegetation, the presence of invasive species or the identification of elements related to environmental conditions (Figure 5).

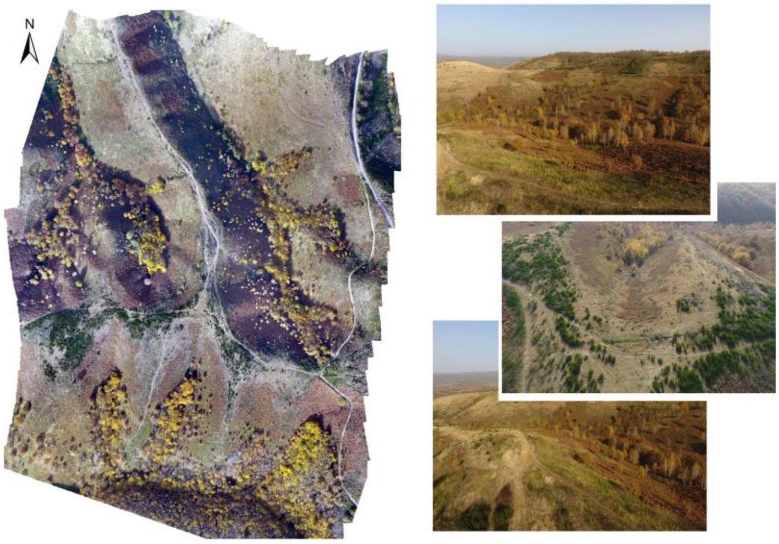

Fig. 5. The orthophotoplan for the analyzed grassland

According to the workflow (Figure 2), in the case of the analyzed grassland, the orthophotoplan was a support for two types of analyzes: spectral classification and RGBVI map generation.

For the spectral classification of the orthophotoplan, the "*Maximum Likelihood Classification*" method was implemented in the working model, method based on probabilities in clasterization, a method applied on multispectral images, in different research directions, such as statistical studies, land use, forestry research, but also in agriculture (HAGNER, REESE, 2007; OTUKEI, BLASCHKE, 2010; AHMAD, QUEGAN, 2012; NITZE ET AL, 2012; SISODIA ET AL, 2014; LIANG ET AL, 2022).

By spectral classification on orthophotoplan (RGB image), according to the training areas implemented a priori, the useful surface of the analyzed grassland was separated (Figure 6), thus being possible to calculate the surface and its spatial location.

To obtain the RGBVI map, the "*Raster Calculator*" function and the RGBVI calculation formula (BENDIG ET AL, 2015) have been implemented in Model Builder:

$$RGBVI = (R_G * R_G) - (R_R * R_B) / (R_G * R_G) + (R_R * R_B)$$

in which RR = red, RG = green, RB = blue

RGBVI (BENDIG ET AL, 2015) was designed to characterize vegetation and can be applied to high-resolution spatial RGB images purchased with UAV equipment. This index is used for different crops, both compared to other vegetation indices and experimental, for the improvement of the method (BARETH ET AL, 2016; POSSOC ET AL, 2016; LUSSEM ET AL, 2018).

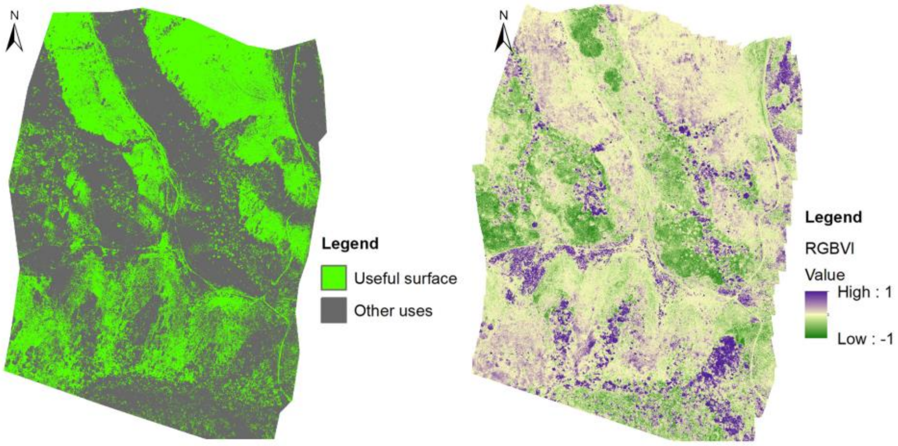

Fig. 6. Useful area map of the grassland and RGBVI map

In the case of the analyzed grassland, the RGBVI map, presented in Figure 6, suggests the characteristics of the vegetation at the time of data acquisition, respectively October and highlights the uneven distribution, in accordance with the specific conditions of each subzone.

CONCLUSIONS

The data acquired with the drone are particularly useful in characterizing the grassland surfaces, both by the high degree of detail and by the possibility of "flying" over the surfaces at different time points, selected according to the evolution of vegetation.

The processing of surface models (DTM, DSM, DEM) extracts information on relief, altimetric data, data on the slope or exposure of slopes, useful in characterizing vegetation or identifying environmental factors that may occur as restrictive elements.

By processing the orthophotoplan (RGB image) the spectral classification can be made which highlights the useful surface of the grassland. By applying calculation algorithms, maps of vegetation indices can be generated, used to characterize the vegetation.

Including all datasets in ArcGIS Model Builder offers the advantage of fast, in a single work sequence and is a useful tool in pratological research.

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