IDENTIFICATION AND ANALYSIS BY GRADIENT OF GRASSLANDS FROM THE ALMĂJULUI MOUNTAINS

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Abstract. *In Banat Montains, the grasslands have a significant influence, on the one hand by the size of the surfaces and implicitly the weight in the structure of the land fund, and on the other hand, by the role they have in the regional economy. Through classical working methods, locating and mapping grassland areas is a complicated process, requiring very large human and time resources, but supplemented by geomatic methods, which offers the possibility of a computerized and "remote" territorial analysis using geospatial data, simplifies this process and further provides significantly superior results. In this context, the purpose of this study can be divided into two research directions: on the one hand, the identification and location of grasslands areas in the Almajului Mountains, and on the other hand, their analysis on the altitudinal gradient, with direct and indirect implications on genesis and evolution of grassland areas. To achieve the objectives of the study, techniques and methods specific to the GIS environment and implicitly geospatial data sets were used. The identification and location of the grasslands surfaces was done by processing the Corine Land Cover database, 2018 edition, and the analysis of the relief of the area, by processing the Digital Elevation Model. The analysis of the grasslands on altitudinal gradient resulted from the spatial, statistical "crossings" between the grassland surfaces and the altitude map. The researches showed that the grasslands are distributed in all subzones of the considered area, an area of great physical-geographical complexity, which also determines differentiations in the structure of the vegetal cover and implicitly in the typology of the grasslands. The gradient analysis showed a slightly higher percentage of grasslands in the hill area (approx. 43%), between 301 - 600 m. The use of geomatic techniques in the analysis of pastoral space allowed both the identification and spatial location of grassland areas, as well and their complex analysis in correlation with relief factors. Therefore, the approach of the grasslands through the GIS technique allows the analysis of discrete processes, difficult to quantify by classical methods.*

Keywords*: grasslands, location, quantification, analysis, geomatics.*

INTRODUCTION

According to data from the literature, grasslands are considered to be some of the largest ecosystems in the world and according to FAO research, contribute and/or support the existence of over 800 million people ((SIEGMUND, R., et al, 2016).

According to the National Institute of Statistics (INS), in Romania the grasslands occupy approx. 20% of the total area and approx. 33% of the agricultural area, which emphasizes their importance as a component of the geographical area. Equally important is their quality as a multifunctional natural resource: economic (KNOWLES, 2011), social (GARDE ET AL, 2014, MOGA ET AL, 2016) and cultural (BUCUR ET AL, 2014, ZANDEN. ET AL, 2018).

In the Banat Mountains, the grasslands have a significant influence, on the one hand by the size of the surfaces and implicitly the weight in the structure of the land fund, and on the other hand, by the role they have in the economy of the area (IANĂŞ, 2010), rural areas are dependent on agriculture.

Although mountain areas have large and compact grassland areas, their exploitation is conditioned by depopulation phenomena, produced by different mechanisms (SĂGEATĂ, 2008, COJOCARIU ET AL, 2014, VERT, ANCUTA, 2011), the population of a territory being considered one of the the most important resources (PLĂIAŞ, 2014) and which dictate the meaning of exploitation. For this reason, in the pastoral landscape there are obvious signs of abandonment

phenomena, a situation present both in the mountains of Banat and in other hilly and mountainous areas in Romania (TÖRÖK - OANCE RODICA, TÖRÖK – OANCE M., 2012).

Given, on the one hand, the large territorial expansion and the low degree of accessibility of mountain areas, and on the other hand the total or partial lack of cartographic materials and cadastral documents, locating and mapping grassland areas is a difficult process that requires very large human and time resources. To remove this impediment, classical pratological and cadastral research can be supplemented by geomatic methods, which offer the possibility of a computerized and "remote" territorial analysis by using geospatial data, which means saving human resources and time but also the superiority of results, both as a way of representation and in terms of consistency of analysis, by the number of variables involved and the technique of interpretation (HOANCEA, 2020).

By combining pratological research with geospatial methods and data, the present study pursues two major objectives: on the one hand, the identification and location of grassland areas in the Almajului Mountains, and on the other hand, their analysis on the altitudinal gradient, in correlation with the conditions of relief, this being the determining factor, directly and/or indirectly, regarding the composition and structure of the vegetal cover of the meadows.

MATERIAL AND METHODS

Study area

From an administrative point of view, the grasslands that are the object of this study are located within six administrative-territorial units (ATU): Eftimie Murgu, Bănia, Dalboşeţ, Şopotu Nou, Sicheviţa and Berzasca (Figure 1). The total area of the study area is 85837.70 ha.

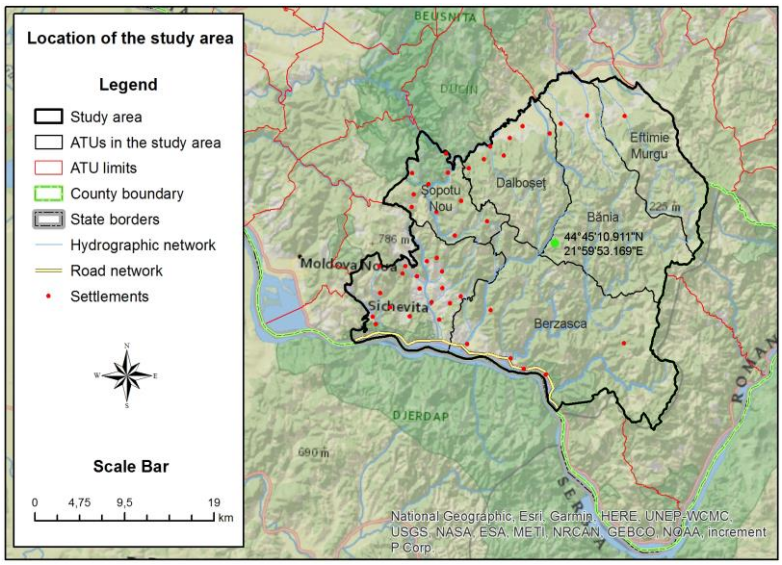


Figure 1. Location of the study area
(processing after: ANCPI, www.geospatial.org, Eurostat, ABA Banat)

As a geographical location, the grasslands analyzed in this study partially overlap the territory of the Almajului Mountains and the Almajului Depression (subunits of the Banat Mountains), in the southeastern area of Caraş-Severin County.

Research methodology

The research presented in this study was performed in two main stages, according to the general objectives, divided into several sub-stages, presented in Figure 2.

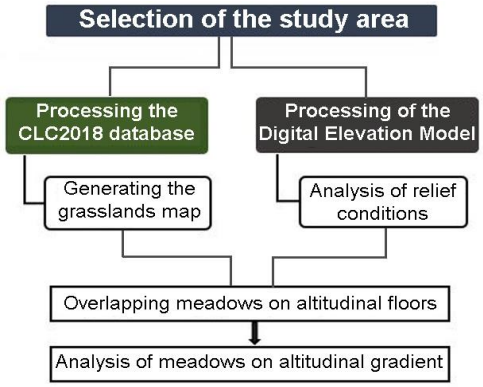


Figure 2. Research methodology

The first step in developing the research was to select and extract the study area. The boundaries of the ATU taken in vectorial format from the archive of the National Agency for Cadastre and Real Estate Advertising were used. In establishing the study area, the condition was met that it be located in the mountainous area of Banat, where the grasslands are representative.

To identify the land used as grasslands, the 2018 Corine Land Cover geospatial database was used, in vectorial format, taken from the European Environment Agency (EEA) website. By overlapping with the area of interest, in the GIS environment, the map of the land use/coverage was obtained, as well as the map of the distribution of the grassland surfaces.

The analysis of the relief of the area of interest, determining factor of the distribution and properties of the grasslands, was performed based on the Digital Elevation Model, with the spatial resolution at 25 m, available in raster format, on the portal of the European Environment Agency. Following the processing of this model, the altitude map and implicitly the general character of the analyzed geographical space resulted.

For the grouping and characterization of the grasslands according to the altitudinal gradient, statistical analysis and multilayer analysis were applied in the GIS environment (*Tabulate Area*, *Zonal Statistics as Table*).

RESULTS AND DISCUSSIONS

The technical and technological progress of the last decades, driven by more and more diverse requirements, has made possible the analysis of grasslands in a multidisciplinary context, analysis with an increasing degree of complexity and precision (HOANCEA, 2020).

As the study area is inhomogeneous in terms of phyto-ecological and physical-geographical, but also in terms of land use, it was necessary to approach a research methodology with techniques and geomatic methods, capable of providing complex spatial analyzes, with unitary character, over the entire study area.

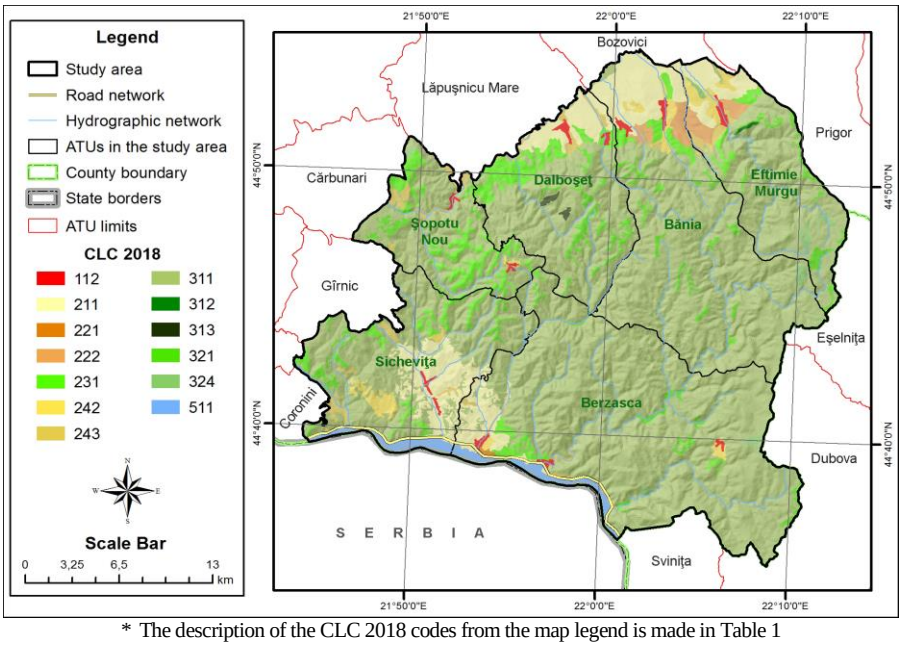
Identification and location of grassland areas

The specialized literature presents numerous studies that have as object the mapping, management and monitoring of the grasslands surfaces (COJOCARIU ET AL, 2017, GOLDEWIJK, ET

AL, 2007, IFTIKHAR, ET AL, 2016, JADHA ET AL, 2007, SCHUSTER ET AL, 2015), using different procedures, sensors, satellite or aerial images of different resolutions.

In the case of the present study, the identification and location of grassland areas was done using the Corine Land Cover geospatial database, 2018 edition (CLC 2018). The "operation" Corine Land Cover was initiated in 1985 and is based on satellite images: Landsat 5 - MSS7TM, Landsat 7 - ETM, SPOT 4-5 and IRS P6 LISS III, RapidEye, Sentinel-2 and Landsat 8.

At the level of the study area, out of the 44 classes of CLC 2018, there are 13 classes, distributed territorially according to Figure 3. The largest areas are covered by deciduous forests (approx. 75%), given the location of the area in the mountainous area of Banat (Figure 3, Table 1).



* The description of the CLC 2018 codes from the map legend is made in Table 1

Figure 3. Land use at the level of the study area
(processing after: ANCPI, www.geospatial.org, Eurostat, ABA Banat, EEA-CLC 2018)

Table 1

Land use categories according to the Corine Land Cover database, 2018

CLC 2018 Code	Legend code*	Land use/land coverage	Surface (ha)
112		Discontinuous urban fabric	622,64
211		Non-irrigated arable land	7365,28
221		Vineyards	50,01
222		Fruit trees and berry plantations	858,74
231		**Pastures**	**4587,22**
242		Complex cultivation patterns	1368,26
243		Land by agriculture, with natural vegetation	1575,51
311		Broad-leaved forest	64529,86
312		Coniferous forest	40,85
313		Mixed forest	96,51
321		**Natural grasslands**	**2861,09**
324		Transitional woodland-shrub	486,82
511		Water courses	1233,44

Also as a consequence of the geographical location of the study area, the arable lands and those destined for complex crops occupy approx. 10% of the territory, being located in the depression areas or in the river meadows (Figure 3).

The representative grasslands in terms of surfaces (categories of pastures and natural grasslands), have a differentiated spatial distribution (Figure 3, Figure 4):

- in meadow areas, isolated in low mountain areas or as a strip at the contact with the forest area and arable lands, in case of pastures;
- dispersed, inside the forest "massif", on smaller surfaces, at higher altitudes, in the case of natural grasslands.

Given that the CLC 2018 database resulted from the processing of satellite images or as a result of classification procedures, it is possible that some grasslands, especially forested and smaller in size, may be classified in other categories (e.g. agricultural land with natural vegetation). Their "recovery" and transfer to the category of "grasslands" can be done by comparison with cadastral maps or high-resolution aerial imagery.

Because the central objective of this study concerns grasslands, from the CLC 2018 database, only these spatial entities were selected and spatially analyzed (Figure 4).

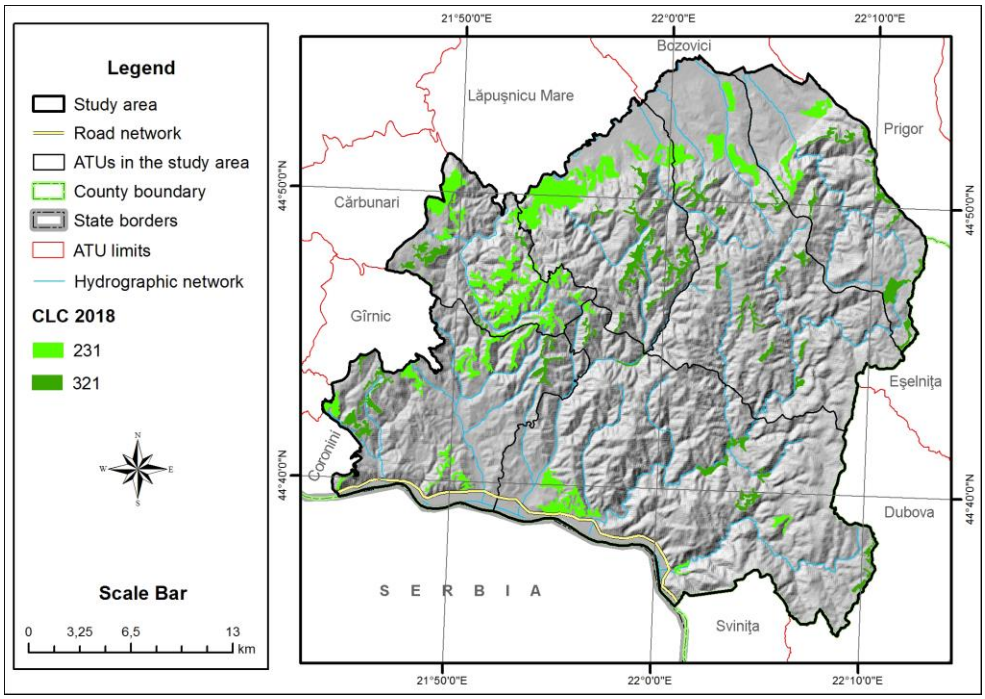


Figure 4. Representative areas of grasslands in the study area
(processing after: ANCPI, www.geospatial.org, Eurostat, ABA Banat, EEA-CLC 2018, EEA-EU-DEM)

As a share in the structure of the land fund of the study area, the grasslands (pastures and natural grasslands) represent approx. 9% (Table 1), the largest areas being located in areas with low altitudes in depressions (Figure 4).

Physical-geographical context and analysis on altitudinal gradient

The Almajului Mountains, which occupy most of the study area, are in the form of long, branched peaks, with rounded interfluves (in areas with crystalline schists), but also in the form of

high ridges, separated by deep valleys (in areas dominated by calcareous formations). The slopes are mostly steep. In the southern area, towards the Danube Gorge, the relief is fragmented. Under the climatic aspect, in the vegetation of the area, the sub-mediterranean influences are felt (POSEA, 2005, MUNTEANU, 2001).

Figure 5 shows that the study area extends over an altitudinal range between 60 - 1198 m (so with the amplitude of the relief of 1138 m), which suggests the complexity of environmental conditions (relief, temperatures, precipitation, soils), which it is also reflected on the vegetal cover and implicitly on the typology of the grasslands.

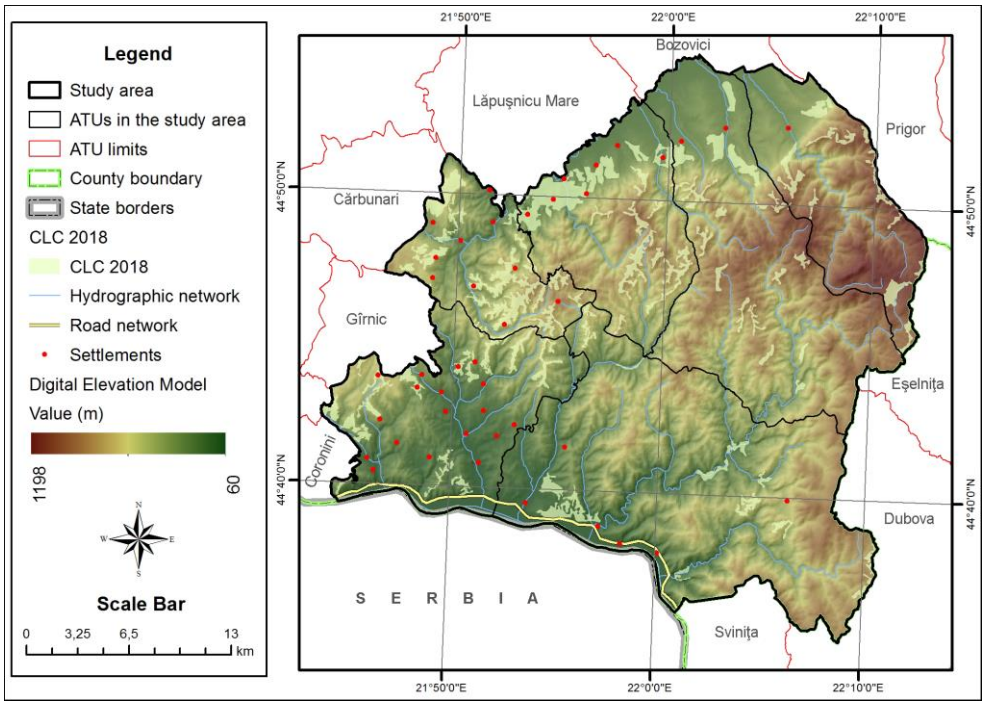


Figure 5. Physical-geographical characteristics of the grasslands in the study area
(processing after: ANCPI, www.geospatial.org, Eurostat, ABA Banat, EEA-CLC 2018, EEA-EU-DEM)

For the analysis of the grasslands in accordance with the environmental factors, especially with the relief, they were superimposed over the Digital Elevation Model (Figure 5). Thus, it can be observed, in the first expeditious stage, the location on the altimetric gradient of the surfaces used as grasslands and at the same time the overall image on their general characteristics is outlined.

Also, the analysis of Figure 5 shows the hypothesis that the grasslands, regardless of their characteristics, are located in all subunits of the study area and therefore in distinct physical-geographical and socio-human conditions.

For a detailed analysis of the relationship between grassland and altitude, we proceeded to the spatial "crossing" of the data (*Tabulate Area* function), through which the grassland entities were "fixed" on predetermined altitude levels.

In accordance with the geomorphological thresholds and the behavioral patterns of the vegetation of the grasslands in altitude, at the level of the study area three altitudinal floors

were established, as follows: 60-300 m (corresponding to meadow and low areas), 301-600 m (corresponding to the hilly areas), 601-1196 m (includes the pre-mountain and mountain areas).

Within the altitude levels previously established, the grasslands have a differentiated distribution (Figure 6):

- in the low areas, under 300 m from the south and northwest of the territory (Danube Gorge and Nera's meadow), are located approx. 20% of the grassland areas, with specific characteristics of these areas;
- in the altitudinal interval 301 - 600 m, corresponding to the hill areas (the slopes of the depressions and the peaks that make the transition to the mountain area), are located approx. 43% of the grasslands of the study area; at the specified altitudes, they constitute one of the most important categories of land use;

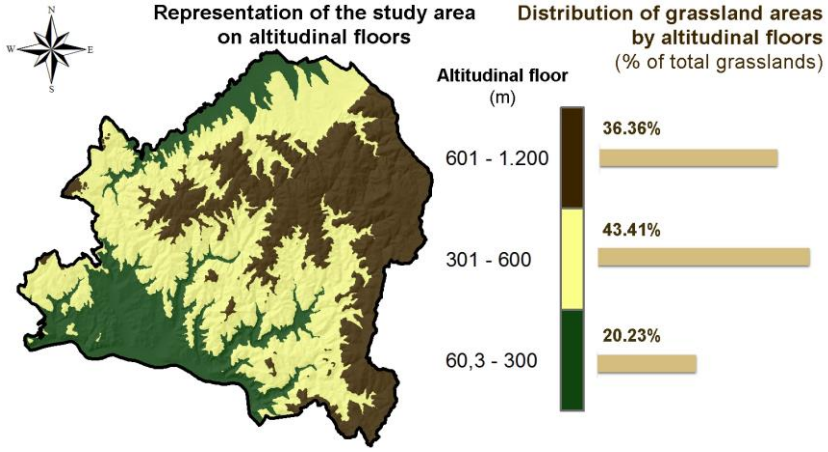


Figure 6. Distribution of grassland areas on altitudinal floors
(prelucrare după EEA-CLC 2018, EEA-EU-DEM)

- in the submountain and mountain floor, at altitudes over 600 m, are approx. 36% of the grasslands of the study area, generally as small areas, insular, inside the forests.

The relief conditions and therefore the vertical distribution of the environmental factors are also reflected on the vegetation of the grasslands. In the grasslands from the hills are specific: *Festuca pseudovina, Festuca vallesiaca*, *Festuca sulcata*, *Andropogon*, *Stipa* sp., and in the mountainous areas, species such as: *Agrostis tenuis*, *Cynosurus cristatus*, *Arrhenatherum elatius*, etc. (PUŞCARU-SOROCEANU, ET AL, 1963).

CONCLUSIONS

Due to the physical-geographical complexity of the study area, the grasslands have distinct spatial characteristics and "behaviors" from one subregion to another, both in terms of occupied areas and in terms of typology.

The grassland surfaces, regardless of the exploitation mode, are located in all the subzones of the researched territory, a slightly higher percentage returning to the hill areas, with altitudes between 301 - 600 m.

The use of geomatic techniques in the analysis of the pastoral space allowed both the identification and spatial location of the grassland surfaces, as well as their complex analysis in

correlation with the relief factors. Therefore, the approach of the grasslands through the GIS technique allows the analysis of discrete processes, difficult to quantify by classical methods.

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