ORIGINAL PAPER

ECO-PRACT: A PROJECT FOR DEVELOPING THE RESEARCH COMPETENCES OF STUDENTS REGARDING THE MONITORING OF FLORISTIC COMPOSITION IN MOUNTAIN GRASSLANDS

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Abstract. *A project called ECO-PRACT was implemented in 2017 to familiarize the students with several methods and techniques that are used to identify and classify species, monitor biological efficiency of the canopy in correlation with meteorological parameters, and map the mountain grasslands in the administrative territory of Fundata Village, Romania. Based on the field surveys, three groups of zonal grassland types were identified as follows: Agrostis capillaris with mesophilic character near villages, Agrostis capillaris with meso-xerophilic species on slopes, and Agrostis capillaris and other eutrophic grasses. Their forage potential varies from 1.7-2.1 t DM/ha (grasslands on slope and steep) to 5.7-6.2 t DM/ha (grasslands on quasi-flat lands used as hayfields). Consequently, the estimated grazing capacity ranges from 0.8-1.1 to 2.4-2.8 LSU/ha, respectively.*

Keywords: *grassland typology, pastoral value, specific quality index, ecological indicator, GIS mapping.*

1. INTRODUCTION

Grasslands are important ecosystems, which together with forests and shrublands represent valuable terrestrial biomes that own increased diversity and a complex interrelation between biocoenosis and abiotic factors [1]. Mountain grasslands contain valuable species of plants and animals, as well as microorganisms that often have valuable ecological plasticity. Conversely, grasslands having canopies formed by species with high phenotypic plasticity show a better multifunctional utilization potential starting from valuable fodder production to areas of ecological compensation (reservations of biodiversity) for the flora and fauna potentially affected by inadequate cropping practices, environmental issues, and climate change [2]. Consequently, there is a stringent need for specialists and proper strategies to ensure an adequate grassland management especially in the mountain and alpine areas of Romania [3]. Such specialists must know the best practices in monitoring of floristic composition from grasslands' canopy to evaluate their pastoral value, as well as their potential multifunctional value.

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In this context, a project called ECO-PRACT was implemented in 2017 to familiarize the students from Mountain Agriculture, Environmental Engineering, and Geography study programs with several methods and techniques that are used to inventorize species, monitor biological efficiency of the canopy in correlation with meteorological parameters, and map the representative phytosociological associations in the study region. The practical applications involving students were performed in Fundata Village (Rucar-Bran Corridor), Romania, where Valahia University has a research and didactic base for mountain studies (45°42424N; 25°29272E; altitude 1190 m - Fundatica).

1.1 ECO-PRACT PROJECT

The objectives of the ECO-PRACT Project were as follows:

- Development of some experimental facilities for the study of mountain ecosystems at Fundatica didactic base (Brasov County, Romania), respectively the use of instruments for the quantification of growth and development of the canopy, and the mapping of the existing grassland types, as well as the establishment of an experimental site for the determination of the bio-meteorological parameters, including the solar radiation fluxes in the mixed canopy.
- Achieving of an experimental protocol to familiarize students with research methods applied in grassland ecology and management, forestry, biogeography and hydro-geomorphology, respectively in an interdisciplinary team work. It is a prerequisite for developing a scientific background, which will enable the professional training of several generations of students. In addition, the tested and validated protocol will allow the multi-annual study of the grasslands' canopy and the influence of climate change on the growth of selected plant species as ecological indicators (species with increased phenotypic plasticity) in the study region.
- Improvement of the practical skills of the enrolled students to enable the application of the theoretical knowledge acquired from the curricular disciplines related to the ECO-PRACT project and to use the database obtained for the completion of their graduation theses.

1.2 PARTICULARITIES OF THE MOUNTAIN GRASSLANDS IN FUNDATA AREA

In this area, the vegetation of grasslands is relatively rich and varied. Due to the uneven orography of the land, with varying altitudes and exposition of slopes corroborated with uncontrolled deforestations in significant areas, the microclimatic conditions are very variated, especially on the sunlit slopes, where the herbaceous steppe vegetation penetrates, forming grasslands that are close to the silvo-steppe type. Generally, vegetation has the characteristics of high hills and mountainous areas, being very rich in species [4].

Four groups of zonal grasslands exist in the Rucar-Bran Corridor: *Agrostis capillaris* with mesophilic character on flat surfaces, *Agrostis capillaris* with meso-xerophilic on slopes, *Festuca rubra* and *Agrostis capillaris,* and *Festuca rubra and Nardus stricta grasslands.*

Agrostis capillaris grasslands with good productivity have pastoral values of 50-60 and a natural production potential of 2-3 tons Dry Matter (DM)/ ha (10-15 tons green fodder (GV)/ ha and 200-400 kg Crude Protein (CP)/ ha [5]. At this level of production, the grazing capacity is 1-1.2 LSU/ha. Application of proper surface works on these grasslands may increase the forage yields up to 7-8 t DM/ ha, the pastoral value up to 70-80, respectively the grazing capacity at 1.6-2.4 LSU/ha [5].

The highest quality of forage is produced on the *Agrostis capillaris* subtypes with *Festuca pratensis*, *Dactylis glomerata* and *Trisetum flavescens*. Maintaining such floristic composition is conditioned by rational fertilization and utilization through mowing and grazing [6]. Regarding the latter aspect, in practice, the *Agrostis capillaris* grasslands are usually used as hayfields with 1 cutting cycle, being grazed very intensely in the early spring and then in autumn. However, to be successful, this cropping practice requires the application of modern principles of grassland management [7].

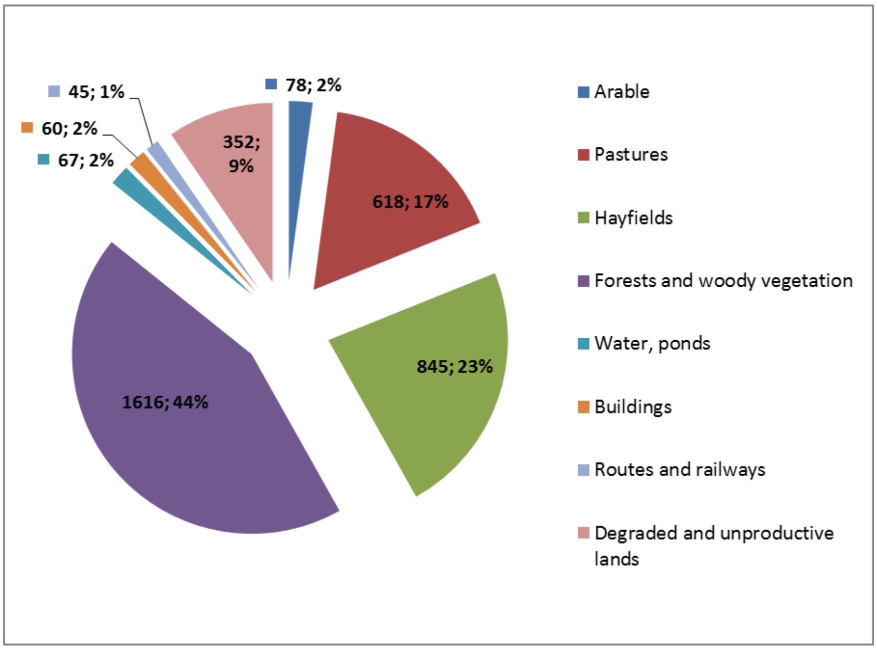

Figure 1. Land cover in Fundata village [ha; %][8].

The latest official data presenting the land cover in Fundata Village [8] showed that grasslands occupy 1463 ha (40%) divided in 845 ha pastures (23%) and 618 ha hayfields (17%) – Fig. 1. Consequently, Fundata Village detains significant areas for studying grassland ecology in the context of climate change and anthropogenic impact. Here, a WMO meteorological station for monitoring background air pollution is also located at 1380 m altitude on Bacârcea Ridge [9].

1.3 THE CONCEPT OF MULTIFUNCTIONAL UTILIZATION VALUE OF PERENNIAL CANOPY IN GRASSLANDS

According to the concept of grassland multifunctional utilization [10, 11] concomitant with the primary use of grasslands as a food source for livestock, either mowed or grazed, the valorization of the secondary potentials of floristic composition needs to be addressed, namely: melliferous [12], medicinal [13, 14], tourism-related, protection of the environment [15, 16], biodiversity [17] and soil conservation [18-21], and landscaping potentials [22]. Therefore, grassland maintains sustainable economic outputs for farmers and provides ecosystem services [11].

For a sustainable grassland management in mountain areas, the role of perennial canopy amplifies, acquiring the valences of multifunctional utilization and requiring reliable methods for environmental protection and enhancing of the natural specific landscape.

The content of a synthetic indicator for perennial canopy multifunctional utilization must include:

- efficiency of canopy to produce vital nutrients for animals;
- conversion of forage production in animal production;
- recycling degree of the substances in the food chain;

- capacity of ecological compensation, and
- economic efficiency of multifunctional utilization.

The existing database of experimental data and original scientific information is sufficiently rich to allow the underlining of the most important indicators of multifunctional utilization as follows:

- annual average yield of dry matter per unit of area;
- elementary yield of dry matter:

- *daily accumulation during the growth season* [23];
- *per unit of biologically active temperature* [24];
- *per unit of rainfall during the growth season* [25];
- *per unit of solar radiation captured by the canopy (either energetic or quantic units)* [26];

- indices of plant nutrition with N P K [27];
- intake of biological nitrogen from legumes of the canopy [28];
- pastoral value [5];
- indices of conversion for plant production to animal production [29, 30];
- the recovery degree of extracted nutrients from the soil [21].

The values of these indicators show more or less variability depending on the natural conditions and the improvement of technological and operational requirements. Characterization of each canopy type (customized by the structure of grasses and legumes that form the canopy) based on multifunctional utilization value, allows the differentiated application of multifunctional specialized cropping practices adapted for mountain grassland management [10].

In this context, the paper presents some of the results of training and research activities performed with students i.e., mapping of grasslands distribution in Fundata Village administrative territory, floristic composition evaluation of the main type of grasslands from this area, and assessment of the ecological traits of the main species of predominant phytosociological associations.

2. MATERIALS AND METHODS

Several steps were performed to characterize the grassland typology and its potential forage value in the study region, Fundata Village (Rucar-Bran Corridor, Brasov County) as follows:

- Assessment of the spatial distribution of grasslands, density of predominant species, architecture of heterogeneous canopy, and periods of grazing / grazing capacity (animals' loading on the pasture expressed in livestock units - LSU);
- Selection of the experimental protocol to allow the testing and critical analysis of the forage system based on the initial objectives - establishing the sampling areas, detailed planning of the sampling interval, planning of the biometric and radiometric measurements and floristic surveys sequence in relation to the availability of satellite images providing the vegetation index (NDVI).
- Rigorous identification of species in the phytosociological association to update the typology of existing grasslands and the associated floristic composition as a potential action of climate change and anthropogenic actions;
- Estimation of the forage value of the species and the pastoral value of the relevant grasslands.

2.1. MATERIALS

During the field surveys performed in 2017, assessments of floristic composition were conducted by recording specific quality index (fodder value), ecological indicators related to soil conditions of canopy component species, stationary conditions for each survey, plant phenological stage, canopy height and other descriptive biological characteristics [31]. Locations of each field assessment were established using Garmin GPS receivers and a total station. Biometeorological measurements were performed using a Delta-T Devices Beam Fraction Sensor (measurements of radiation fluxes in μmol m^{-2} s^{-1}) connected to a field laptop, a Greisinger multiparameter for relative humidity, temperature and atmospheric pressure, an anemometer for wind, a rainfall gauge and soil thermometers (Fig. 2).

Figure 2. Instrumentation used for measurements of solar radiation fluxes, relative humidity, temperature, rainfall and wind parameters during floristic surveys performed in Fundata, Romania – year 2017.

Radiometric information from the PROBA-V satellite images provided the *Normalized Difference Vegetation Index* (NDVI) time series of the grasslands located in the envisaged area. The NDVI provides an index to present the vitality of the vegetation on the earth’s surface being a measure of the photosynthetic activity within the area covered by a pixel of image. The algorithm uses the abrupt rise of the reflection level of 0.7 μm [32]. Both ground and satellite radiation data were correlated (not shown in this paper).

The average annual temperature at Fundata meteorological station is 4.1 °C and the annual average rainfall is 1020 mm. Based on the monthly multiannual average values of temperature and precipitations, excepting July, August and September, which are considered temperate months, all other months are characterized as cold and wet months.

2.2. METHODS

Evaluation of floristic composition and pastoral value of the permanent grasslands

The floristic composition of permanent grasslands and the estimation of the species participation in the phytosociological associations were obtained using the Daget-Poissonet double-meter method, also known as the linear method [3]. Each sampling point was located using WGS84 coordinates obtained with Garmin Oregon 650t GPS receivers (Fig. 3).

The contribution of the floristic composition to the forage yield formation was expressed by using the *specific contribution* (*C.s.*).

The Daget-Poissonet method consists in marking the presence of species on the length of a double meter in 100 points. Readings were carried out from 4 to 4 cm on pastures and 20 to 20 cm on hayfields. To obtain the 100 points for each determination, observations were made in two repetitions in pastures respectively 10 in hayfields. The sum of the points in which a species is present is the *specific frequency* (*F.s.*), which ranges from 0 to 100.

The percentage ratio of the specific frequency to the sum of the specific frequencies of all the species recorded in 100 points (Σ *F.s.*) provides the *specific contribution* (Eq.1):

$$C.s. = \frac{F.s.}{\sum F.s.} \times 100 \ [\%] \qquad (1)$$

Pastoral value (*Vp*) is the main synthetic indicator for estimating the agronomic value of grasslands, being determined by the floristic composition based on its contribution to the *net biomass structure* (Σ *C.s.*), as well as by the *fodder value of the component species* (*Is*). This specific quality index of legumes, grasses, other species ranges from 0 (no value) to 5 (excellent value) – Eq.2.

Figure 3. Species recognition using the Daget –Poissonet "double meter" method for floristic composition assessment and GPS positioning of the survey using Garmin Oregon 650t receivers.

Pastoral value provides information on the grazing capacity potential and on the animal loading of the pasture without establishing the green fodder production on-site [1].

$$Vp = \frac{\sum C.s. \times Is}{5} \qquad (2)$$

Depending on the pastoral value and the corresponding grazing capacity, the forage yield and quality of permanent grasslands are appreciated from degraded to very good quality (Table 1).

Table 1. Evaluation of the quality of grasslands using the linear method (LSU = livestock unit; 1 LSU = the grazing equivalent of one adult dairy cow providing an annual quantity of 3 000 kg of milk, without adding concentrated foodstuffs).

Pastoral value computed using the linear method	Grazing capacity [LSU/ha]	Grassland quality
75-100	> 2-3	*Very good*
50-75	1-2	*Good*
25-50	0.5-1	*Average*
5-25	0.2-0.5	*Poor*
< 5	< 0.2	*Degraded*

The abundance and dominance of species were determined using the 5-point cover scale of Braun-Blanquet that takes into account the ground cover [33]. Frequency, which represents the repartition pattern of individuals of a species in a plant association, has been also estimated.

3. RESULTS AND DISCUSSION

3.1. RESULTS

The studied area is divided into two floors of natural vegetation: the beech floor and the spruce floor. In the ECO-PRACT project, we have drawn a map showing the current land cover in Fundata administrative territory (Fig. 4).

The beech floor (*Fagus sylvatica* – European beech) occupies most of the central and northern sectors of the Rucar-Bran Corridor. Here, beech forests are found on larger areas only on the northern slope of Magura Massif, as well as at west of Sirnea and near Fundata villages. In the eastern part, towards the Bucegi massif, the beech ascends up to 900 m altitude, and in the west, to the Piatra Craiului Massif, up to 1200-1300 m. In the rest of the territory, the permanent pastures of secondary origin predominate, replacing the beech forests.

The spruce floor (*Picea abies* – Norway spruce) is well outlined to the west side of the Bucegi Mountains, starting from the altitude of 900 m upwards. The lower limit of the pure spruce forests on the contact with the Bucegi Massif has a trace close to that of the 6 °C isotherm. To the Piatra Craiului Massif, the lower limit of the spruce floor corresponds to the altitude of 1200 m and approximately to the isotherm of 5 °C. Fundatica village is the only village located on the spruce floor. The rest of the human settlements are located on the beech floor.

Birch (*Betula verrucosa* – European white birch) forms compact clusters on steep slopes and versants. This species has a great regeneration capacity and reproduces in the place of former beech or spruce forests. On large and steep slopes, it is maintained for soil protection. On the pastures, it is eliminated by repeated cuts, as it reduces the useful area of the pastures and creates difficulties in the grasslands management and harvesting practices.
The birch has also a special landscape role, which is why it can be integrated into the multifunctional management system of grasslands.

Based on the field surveys, three groups of zonal grassland types were identified in Fundata territory as follows: *Agrostis capillaris* with mesophilic character on flat surfaces near villages, *Agrostis capillaris* with meso-xerophilic species on slopes, *Agrostis capillaris* and other eutrophic grasses (Table 2). Their forage potential varies from 1.7-2.1 t DM/ha (grasslands on slope and steep) to 5.7-6.2 t DM/ha (grasslands on quasi-flat lands used as hayfields). Consequently, the estimated grazing capacity ranges from 0.8-1.1 to 2.4-2.8 LSU/ha, respectively.

Table 2. Assessment of the fodder potential in Fundata grasslands.

Grassland type	Total area [ha]	Annual yield [t DM/ha]	Grazing capacity [LSU/ha]	Observations
Agrostis capillaris near villages	1463	3.2-3.4	1.4-1.6	Grasslands without woody vegetation
Agrostis capillaris + other eutrophic grasses		5.7-6.2	2.4-2.8	Well administered hayfields in orchards
Agrostis capillaris on slopes		1.7-2.1	0.8-1.1	Woody grasslands

Table 3. Specific Quality Index (*Is*) and some ecological indicators related to humidity (I_h), pH (I_{pH}) and trophic requirement for Nitrogen (I_N) for the main species of permanent grasslands identified in Fundata area.

Name of species	I_s	I_h	I_{pH}	I_N
PERENNIAL GRASSES				
Agrostis alpina Scop.	**1**	5	5	6
Agrostis capillaris L. (*Agrostis tenuis* Sibth.)	**3**	x	x	3
Alopecurus pratensis L.	**4**	7	x	7
Anthoxanthum odoratum L.	**1**	x	5	x
Arrhenatherum elatius (L.) Beauv. ex J. et C. Presl.	**4**	5	7	7
Brachypodium pinnatum (L.) P.B.	**1**	4	7	4
Briza media L.	**1**	x	x	3
Cynosurus cristatus L.	**3**	5	x	4
Elymus hispidus (Opiz) Melderis (*Agropyron intermedium* (Host) P.B.)	2	3	8	5
Festuca pratensis Huds.	**5**	6	x	6
Festuca rubra L.	**3**	5	x	x
Holcus lanatus L.	**2**	6	x	4
Nardus stricta L.	**0**	x	2	x
Phleum pratense L.	**5**	5	x	6
Poa nemoralis L.	**2**	5	5	3
Poa pratensis L.	**4**	5	x	x
*Trisetum flavescens (*L.*) P.B.*	**4**	x	x	5
PERENNIAL LEGUMES				
Genista tinctoria L.	**0**	x	4	2
Lathyrus pratensis L.	**4**	6	7	6
Lotus corniculatus L.	**3**	4	7	4
Medicago lupulina L.	**4**	4	8	x
Medicago falcata L.	**4**	3	9	3
Trifolium alpestre L.	**2**	3	6	3
Trifolium medium L.	**2**	4	x	3
Trifolium montanum L.	**2**	3	8	2
Trifolium ochroleucon Huds.	**2**	4	7	2
Trifolium pratense L.	**4**	x	x	x
Trifolium repens L.	**4**	x	x	7
Vicia grandiflora Scop.	**3**	3	–	5
CYPERACEAE AND JUNCACEAE				
Carex ovalis Good.	**0**	7	3	4
Carex spicata Huds.	**0**	x	x	x
Juncus trifidus L.	**0**	5	5	3

Signification of the table indicators

I_s =
5 excellent fodder value
4 very good fodder value
3 good fodder value
2 average fodder value
1 mediocre fodder value
0 without fodder value

I_h =
1 – 2 species for very dry soils – xerophyte
3 – 4 species for dry soils – mezzo-xerophyte
5 – 6 species for moderate-humid soils (damp) – mezzophyte
7 – 8 species for humid soils (that are not drying) – mezzohygrophyte
x species with high ecological variability – euriphyte

I_{PH} =
1 - 2 species for very acid soils
3 - 4 species for acid soils
5 - 6 species for moderate-weak acid soils
7 - 8 species for neutral soils
x species that are not influenced by soil pH

I_N =
1 - 2 species for very low mineral N soils
3 - 4 species for low mineral N soils
5 - 6 species for moderate mineral N soils
7 - 8 species for high mineral N soils
x species that are not influenced by the mineral N soil content

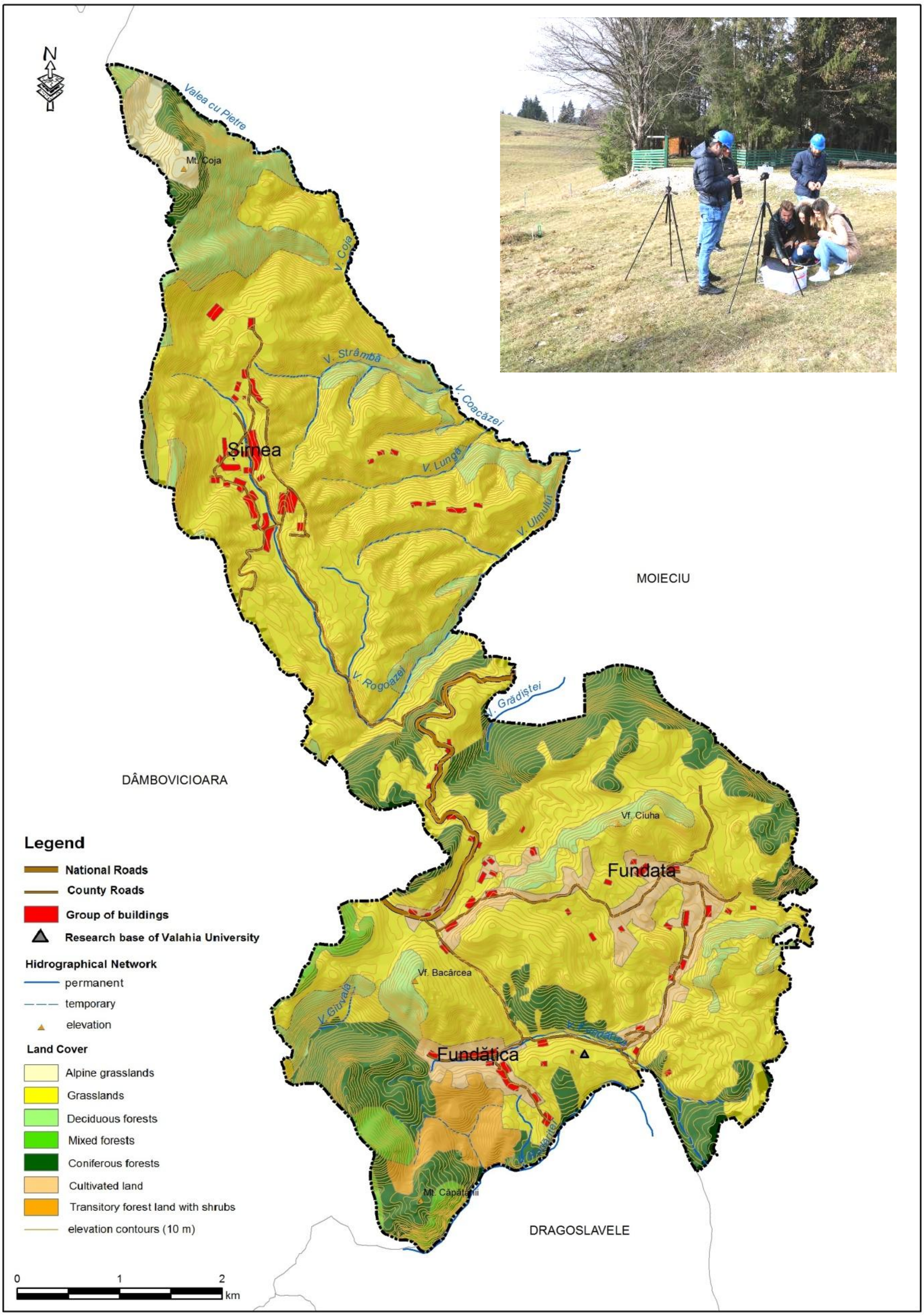

Figure 4. Map of study region showing the natural vegetation floors and distribution of grasslands obtained using field data and GIS features.

In Fundata administrative territory, many valuable species of grasses, legumes, and sedges and bulrushes might be used as ecological indicators. Table 3 presents a selection of the most representative species found in the area together with their fodder value and some indicators related to their requirements for humidity, pH and nitrogen.

The dominant species is *Agrostis capillaris* with a ground cover ranging from 20 to 50% in some areas. Other accompanying valuable grasses are *Festuca pratensis*, *Cynosurus cristatus*, *Festuca rubra*, *Phleum pratense*, *Poa pratensis*, *Trisetum flavescens*, *Arrhenatherum elatius*, and *Alopecurus pratensis*. Various associations of these grass species together with *A. capillaris* can present a ground cover between 40 and 80% in some favorable site conditions. Consequently, depending on soil fertility and moisture, some grass species can become co-dominant, forming valuable grassland subtypes.

Table 4. Pastoral value of a representative grassland type from Fundatica village (spruce floor)

Floristic composition	Participation in canopy – PC [%]	Specific Quality Index [I_s]	PC × I_s
Grass species	(77)	-	-
Agrostis capillaris	31	3	93
Festuca rubra	14	3	42
Nardus stricta	12	0	0
Alopecurus pratensis	7	4	28
Cynosurus cristatus	6	3	18
Trisetum flavescens	3	4	12
Arrhenatherum elatius	2	4	8
Anthoxanthum odoratum	1	1	1
Phleum pratense	1	5	5
Legumes	(13)	-	-
Genista tinctoria L.	5	0	0
Lathyrus pratensis L.	3	4	12
Lotus corniculatus L.	2	3	6
Medicago lupulina L.	2	4	8
Medicago falcata L.	1	4	4
Trifolium alpestre L.	+	2	0
Other species	(10)	-	-
Achillea millefolium	4	2	8
Prunella vulgaris	3	0	0
Gallium verum	1	0	0
Daucus carota	1	2	2
Potentilla erecta	1	1	1
Pteridium aquilinum	+	0	0
SUM	100	-	248
Pastoral Value	-	-	**49.6**
Grassland quality	***Average***		

For example, Table 4 shows the calculation of the pastoral value of one of the transition subtypes i.e., *A. capillaris* + *Festuca rubra* located in the spruce floor near Fundatica village. The resulted pastoral value of approximately 50 shows an average quality with a natural forage yield of 2-3 t DM/ha and 200-300 kg Crude Protein/ha (~1 LSU/ha). Another specific subtype that characterizes the region is *A. capillaris* +*Brachypodium pinnatum*, which occurs on the recent deforested lands in beech floor. Fig. 5 presents the structure of the floristic composition of this subtype identified during the field surveys.

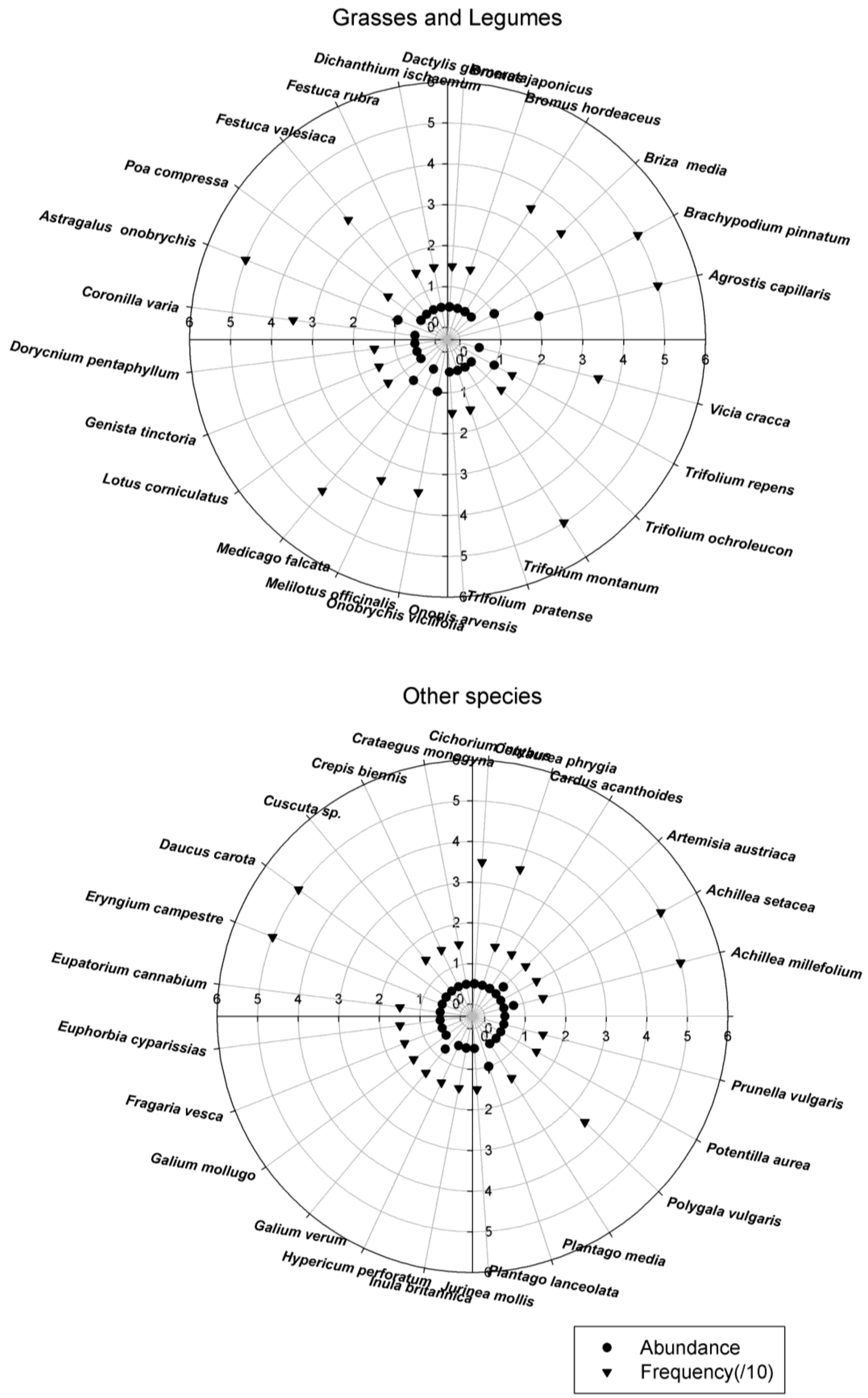

Figure 5. Floristic composition of *Agrostis capillaris + Brachypodium pinnatum* grassland type (Abundance: 1 < 5% cover, many individuals; (0.5)+ <5% cover, few (2-20) individuals); Frequency was divided by 10 for graphic scaling.

Analyzing the floristic structure, there is a heterogeneous composition, in which together with the representative species (*A. capillaris* and *B. pinnatum*), xerophilous species are frequent such as *Festuca valesiaca*. It was noted the large number of non-valuable legumes such as *Genistella sagittalis* and *Trifolium campestre*, as well as numerous weed species that are characteristic for the recent deforestations. This grassland subtype is mainly used as hayfield or mixed pasture (respectively hayed for the first harvest and then grazed during the summer). Forage yield is low (1.0-1.2 t DM/ha) and of poor quality.

3.2. DISCUSSION

Most of the research performed on mountainous grasslands in Romania, till present, were aimed preponderantly at the influence of technological factors on fodder productivity, considered as factors with direct influence on the yield formation and less on finding out the rules between growth factors (natural and genotypic-related) and yield at the specific site conditions [23]. In this stage of the research, the results have a reduced degree of generalization, and the cropping practices applied on grasslands have a weak scientific foundation [10]. Research objectives should be oriented towards the rational grazing, habitat conservation and amplification of the multifunctional potential of mountain and alpine grasslands especially in areas affected by anthropogenic impact by employing long-term field surveys and suitable ecological modelling [34].

In Fundata, natural vegetation has been replaced on large areas with secondary vegetation, inhabited spaces, with elements of the anthropic framework mainly because of anthropogenic activities related mainly to the agro-pastoral and tourism economy. The village presents signs of rapid urbanization with direct impact also on grasslands area, typology and valuable species forming the mixed canopy (affecting net efficiency, persistence, competition capacity and viability). Various forms of environmental pollution [35] will become much present in the area affecting surrounding ecosystems [36]. Due to the recent changes in environmental conditions, *Nardus stricta*, which is a species with high phenotypic plasticity, appears more frequently in many phytosociological associations and presents significant ground cover. The forage potential of grasslands in Fundata area can be improved through a number of measures of which the most important are the improvement of herbaceous canopy with valuable forage species using optimal fertilization and overseeding (only where it is suitable), grazing rationalization, ensuring of water sources and access roads in the productive grasslands. The efficient application of these strictly necessary measures meets the goals of a functional forage system in terms of technical and economic feasibility.

Floristic composition and the fodder value of the component species are essential indicators expressing the perennial canopy utilization through grazing that substantiates the basis of animal production economic efficiency according to the concept of multifunctional utilization of the grasslands proposed by Gh. Motca [10]. In this paper, we have selected some representative insights identified during the field surveys, but this is just a small image of the complexity of grassland ecosystems existing in Bran-Rucar corridor. More continuous research programs for grassland studies are required with application on long-term basis considering climate change, background pollution and anthropogenic impacts.

4. CONCLUSIONS

Grassland forage yield depends on many technological, environmental and genetic factors that must also consider the habitat conservation. Some of the main elements that require consideration are net efficiency and persistence of the valuable forage species in the canopy, competition capacity, and viability of species. Some of the feasible grassland renovation measures are the improvement of herbaceous canopy with valuable forage species, and grazing rationalization ensuring water sources for grazing animals and access roads.

The current study identified three groups of zonal grassland types in Fundata territory i.e., *A. capillaris* with mesophilic character on flat surfaces near villages, *A. capillaris* with meso-xerophilic species on slopes, *A. capillaris* and other eutrophic grasses. Various associations of grass species together with *A. capillaris* can present a ground cover between 40 and 80% in some favorable site conditions. Consequently, depending on soil fertility and moisture, some representative grass species can become co-dominant, forming valuable grassland subtypes.

The approach had some limitations as follows: (1) using the double meter method, which was leading to the estimation of the pastoral value, involves long time to perform flora identification and complex logistics, requiring experienced operators in identifying the component species of the herbaceous canopy; (2) cover data collected by visual estimation using the Braun-Blanquet are considered semi-quantitative making the collected data unsuitable for statistical analyses. The data may also lack the resolution necessary to detect fine-scale variation in species cover over time (such as in monitoring studies) or along an environmental gradient [33].

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