MANAGEMENT PLAN FOR SEMI-NATURAL GRASSLANDS IN BORŞA AND DĂBÂCA COMMUNES (TRANSYLVANIA, ROMANIA)

MARIUS BĂRBOS[1]

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European Forum on Nature Conservation and Pastoralism

Authors' affiliation

1 Mozaic Association, Cluj-Napoca, Romania; office@mozaic-romania.org

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Mozaic Association: www.mozaic-romania.org
DBU: www.dbu.de
EFNCP: www.efncp.org

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INTRODUCTION

Semi-natural grasslands are among the most species-rich ecosystems in temperate Europe (Klimeš et al. 2000, Butaye et al. 2005). Their origins and history are related to an extensive human activity that created and maintained open and semi-open habitats (Rozbrojová et al. 2010). From succession point of view, semi-natural grasslands have replaced, long time ago, the ancient forests that have been exploited for socio-economic needs of local communities. Traditionally, they were and are used either as pastures or hay meadows but, in some cases they have mixed use – being used as hay meadow until hay cutting in the mid-summer, after that are used as pasture.

According to Cristea et al. (2004), grasslands, whether they are used as meadows or pastures, provide important ecosystem services like:

- fodder for domestic grazing animals;
- biodiversity conservation (plants and animals);
- soil protection;
- microclimate control;
- aesthetic values;
- opportunities for recreation and nature education;
- enhancement of social relations amongst farmers.

Due to the invaluable ecosystem services provided by grasslands, it is obviously that we should preserve and improve the status of our remnant semi-natural grasslands.

Our main goal is to elaborate a management plan for grasslands conservation, which can be effectively implemented by local farmers with minimal costs. This management plan meant for local farmers, which are the most important actors in the biodiversity conservation. To be a useful tool, we tried to make it as simple as possible without jeopardizing the main objectives. In its preparation we tried to identify and propose common management measures that are well known by local farmers, making its implementation easier.

I. SITE DESCRIPTION

The research area is located near 40 km north of Cluj Napoca, the largest city from Transylvania (Romania). The project has been carried out on the area of two communes (Borşa and Dăbâca), in the continental bioregion (fig. 1.1). The total area of the two communes cover 11 186.1 hectares (6162.1 Borşa and 5024 Dăbâca).

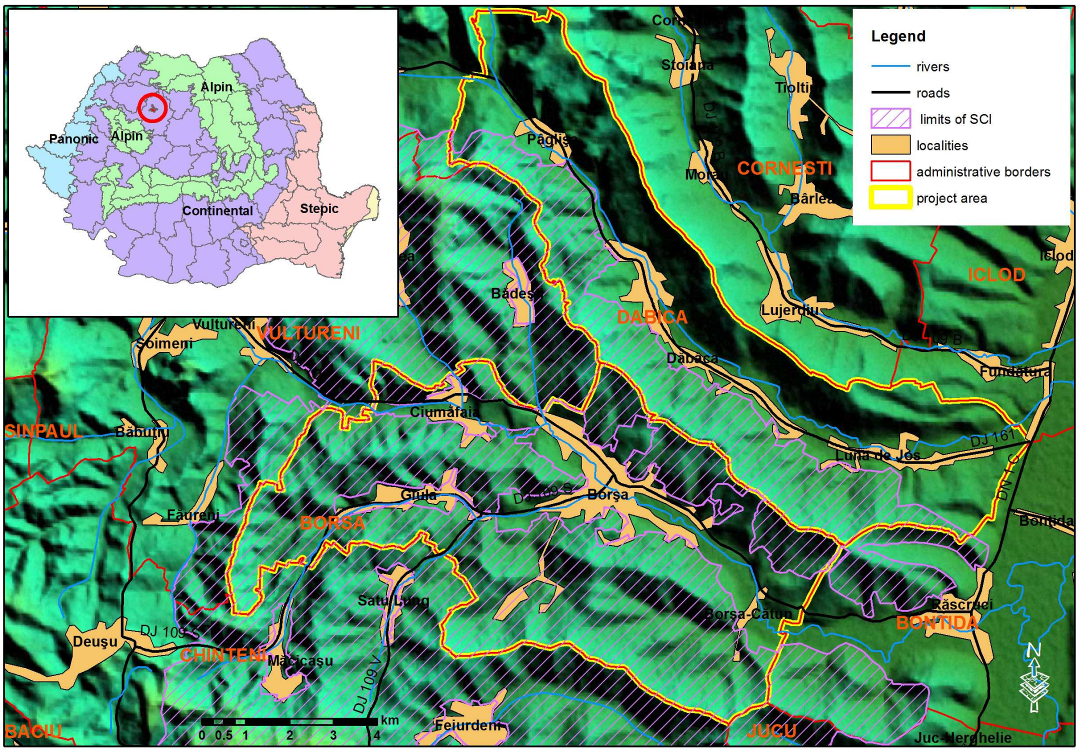

Fig. 1.1. Map of the project area

The area belongs to the so-called "Hills of Cluj" characterized by chains hills separated by valleys oriented from NW to SE. While the lowest altitude is 271 meters a.s.l. and the highest is 542 meters a.s.l., most part of the area is situated at altitude ranging between 350 and 450 meters a.s.l. (Fig. 1.2).

Even if the analysis of relationship between species richness and altitude revealed the existence of different patterns (Grytnes 2003, Bruun et al. 2006), the most commonly reported being the humped-shaped and monotonic declining patterns (Nogués-Bravo et al. 2008). The unifying prediction of this set of hypotheses is that local species richness displays a unimodal relationship with altitude, given that primary productivity and species pool size decrease monotonically with altitude (Bruun et al. 2006).

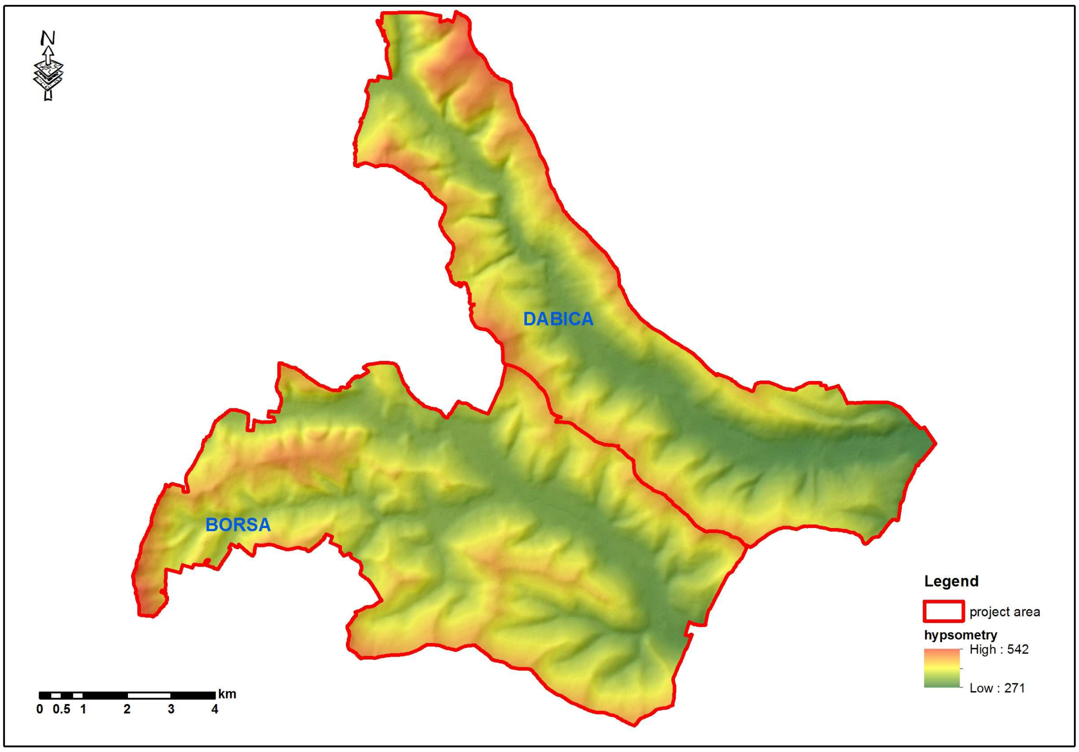

Fig. 1.2. The hypsometric map of research area

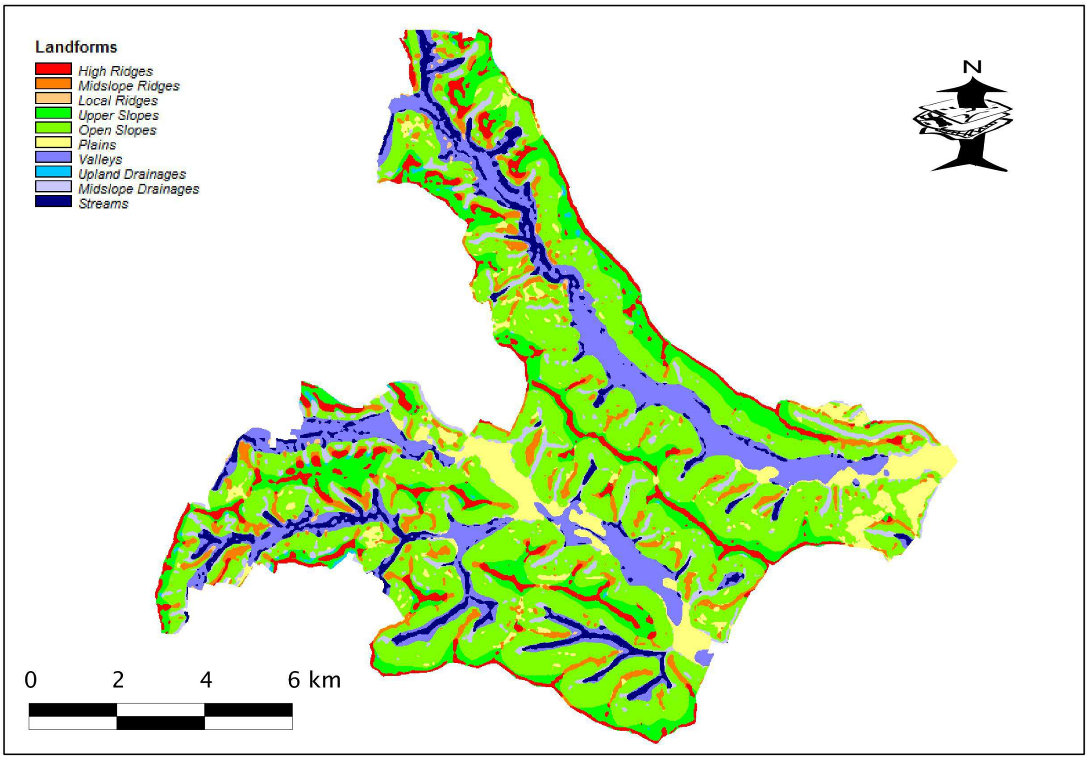

Fig. 1.3. The distribution map of different landforms

In our area, due to the relatively small variation of altitudinal range, it is very likely that the pattern of biodiversity distribution is determined by other important factors.

The various topographic features of the area determined a high heterogeneity of the local site ecological variables like (slope, terrain topographic roughness, topographic wetness, diurnal anisotropic heating, etc.) that are illustrated into figures 1.4-1.7.

Slope (fig. 1.4) is a decisive factor for soil-forming processes and many attributes of the vegetation, including species richness (Holten 1998). The slope angle, as a topographic variable, has a strong influence on soil stability and erosion, insolation, accessibility to grazing animals and vegetation cover in a given site (Dix 1958). Micro-habitats heterogeneity on slopes, which provide higher species richness, is promoted by subtratum instability and frequency of such disturbance events (Holten 1998). Klimek et al. (Klimek et al. 2007) found a positive relationship between species richness and slope angle in some managed grasslands, which is explained by the distribution of management regimes. While the mowing and hay removal is generally beneficial to general species richness as well as for the occurence of rare and endangered species (Schaffers 2002), an intensive management often leads to loss of rare taxa and dominance by few agressive species (Dornelas et al. 2009).

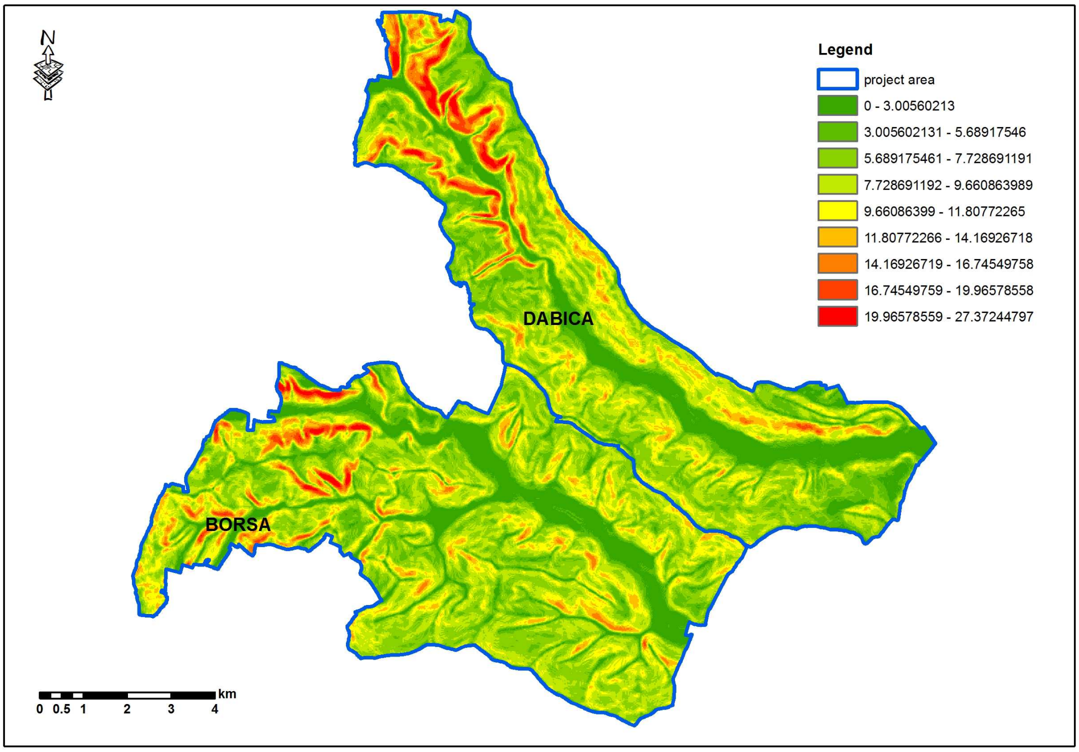

Fig. 1.4. The slope map of research area

Terrain topographic roughness is a scale depended measure of micro-relief variability that control the local sites heterogeneity. The variation of terrain roughness index (TRI) in our target area has a variation of almost 3 points and an uneven distribution (fig. 1.5).

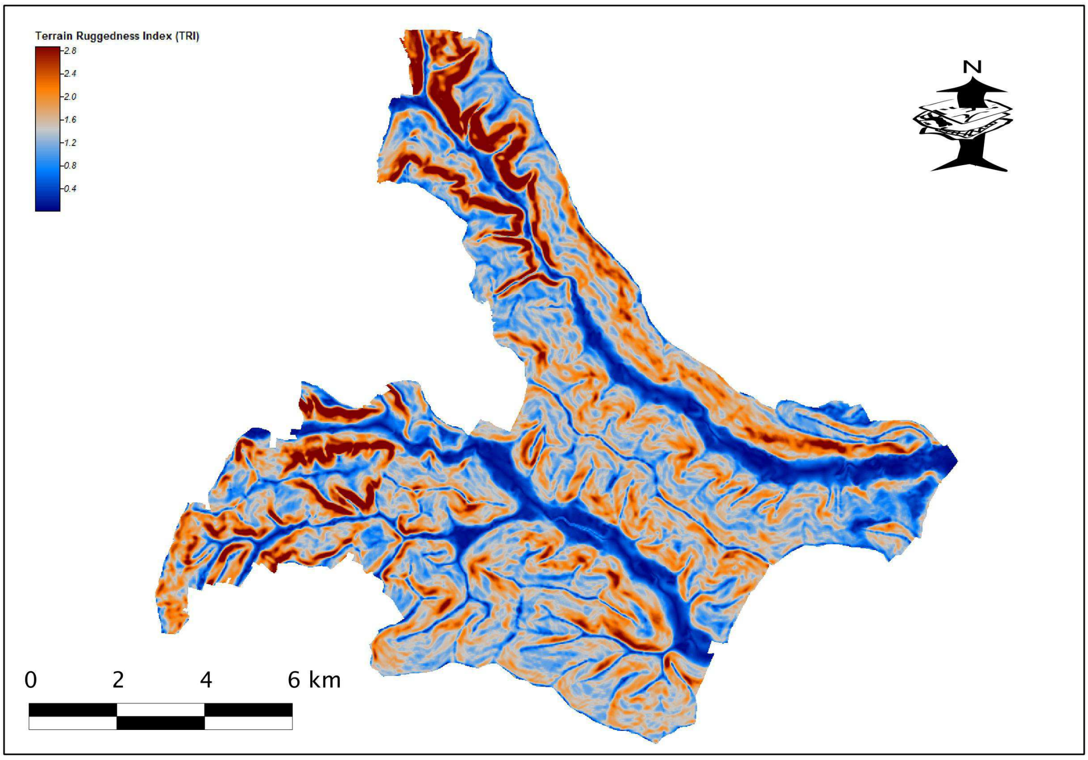

Fig. 1.5. The distribution map of the values of Topographic Roughness Index (TRI)

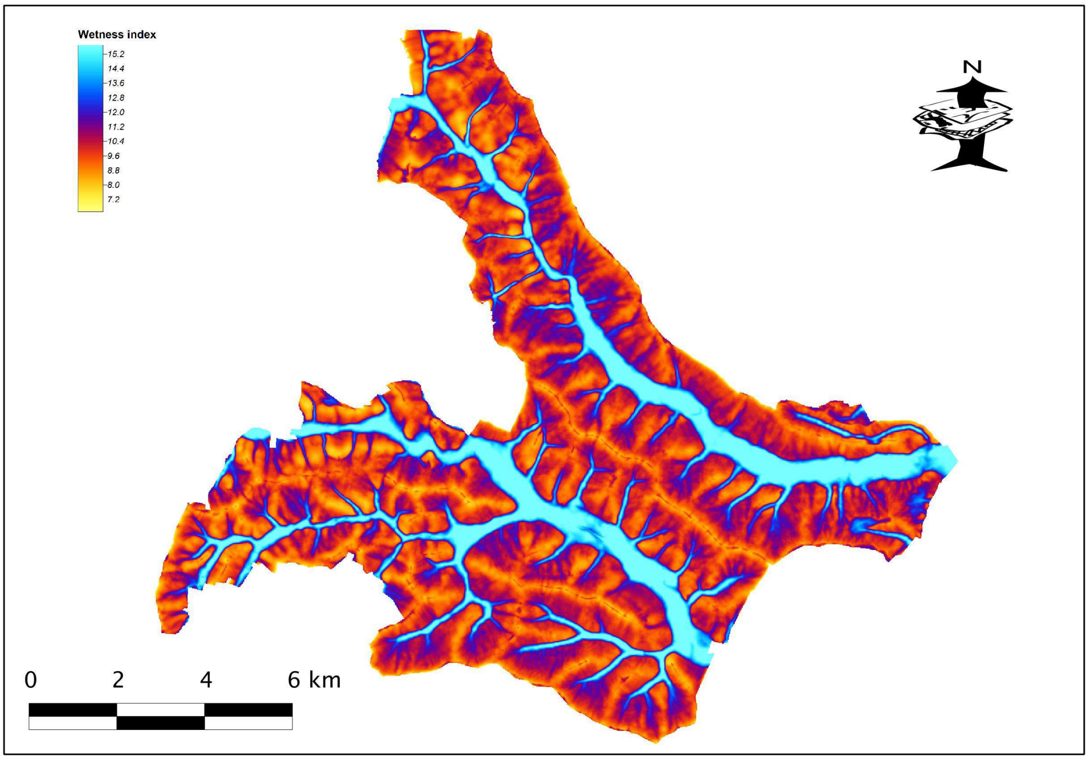

Fig. 1.6. The distribution map of the values of Topographic Wetness Index

The value of topographic wetness index (TWI) is a surrogate for distribution of the potential soil humidity, which may have a great impact on land use and biodiversity. As it can be seen in the figure 1.6, TWI has a great variability across the research area, ranging from 6.5 to 19.6 (fig. 1.6).

Another important environmental variable with a strong impact on plant physiology and also upon the specific structure, function (mainly affecting the productivity) and dynamics of grassland habitats is the diurnal anisotropic heating (DAH). This variable is influencing the evapotranspiration process in plants and thus the ability of plants to survive in a given condition. DAH is dependent on other factors such aspect, landform, slope, slope position, soil moisture etc. The variability of DAH in our research area is shown in figure 1.7.

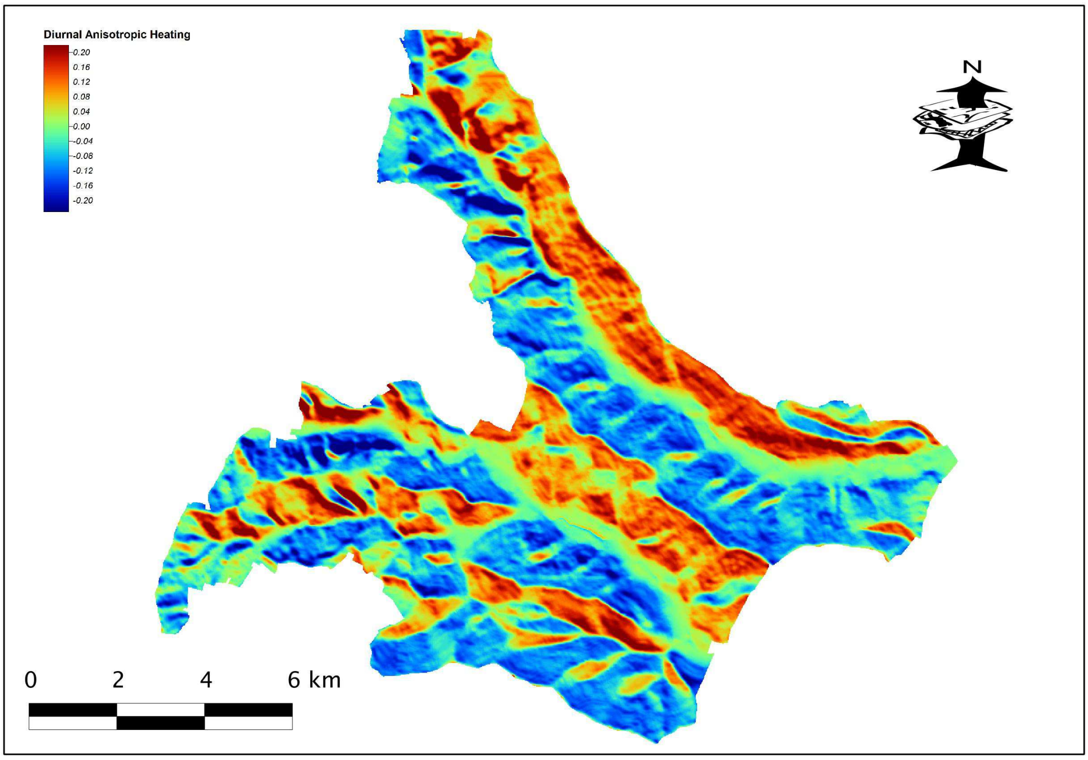

Fig. 1.7. The distribution map of Diurnal Anisotropic Heating

Due to the large variability of the main environmental variables (some of which are summarized here) is not surprising that it has been possible to allow the existence and conservation of a great biodiversity, an important issue officially recognized by the designation, in 2011, as a Site of Community Importance under the EU-Habitat Directive. Even if the designation of area as SCI was made mainly for species of the genus *Maculinea*, the only place in Europe where all five species of the genus are present in the same place, their existence would not have been possible without the heterogeneity of environmental variables.

II. GRASSLAND COMMUNITIES

Semi-natural grasslands are management-dependent, the land use history being important for their species composition. Higher species richness is generally encountered in grasslands that have been continuously managed (grazed or mown) during long periods (Cousins and Eriksson 2002), whereas lower species richness is characteristic for abandoned grasslands. However, Öckinger et al. (2006) found no differences in species richness or abundance between three grassland types (continuously managed, abandoned and restored). Proulx and Mazunder (1998) suggest that species richness declines with increasing grazing in nutrient-poor ecosystems, because the limiting available resources prevents regrowth of species after grazing. Although rare species in grasslands are affected by the management regime, it seems they are less sensitive than common species to land abandonment (Pykälä et al. 2005).

To elaborate a realistic and feasible management plan for grassland, a preliminary inventory and mapping work should be carried out. To achieve this task, during the 2010-2011 growing season, all grassland polygons have been inventoried, for each of them a list of species has been recorded.

The inventoried grasslands belong to 6 alliances, the nomenclature following Sanda et al. (2008):

Alliance *Molinion coeruleae* Koch 1926

Grasslands belonging to this alliance are characterized by vegetation growing on oligotrophic soils. Another feature of sites conditions is the high level of groundwater, this being the reason for finding many hygrophilous species. Usually, these grasslands are found in sites with small depressions. Characteristic species for this alliance are: *Molinia caerulea, Sanguisorba officinalis, Ranunculus polyanthemos, Carex tomentosa, Juncus conglomeratus, J. effussus, J. articulatus, Gentiana pneumonanthe, Serratula tinctoria* etc.

These grasslands are used especially as hay meadow, but sometimes sheep extensively grazes them. *Molinia caerulea* and *Gentiana pneumonanthe* (host plant for Maculinea spp.) have little tolerance to mowing and grazing while *Sanguisorba officinalis*, another host plant for *Maculinea*, has moderate tolerance (Landolt 2010). Due to the sensitivity to mowing of the dominant and key species, these grasslands should be used extensively and almost exclusively as hay meadow, mowed only once per year.

Alliance *Agrostion stoloniferae* Soo (1933) 1971

This alliance is grouping grasslands usually found on alluvial plains or near human settlements on lands with moderate humidity. This alliance consists of mesophilic to hydrophilic conenoses, which are growing on soils well supplied with nutritive elements. These grasslands, having a high productivity, are conditioned by a certain intensity of anthropogenic factor. The dominant, characteristic and frequent species are: *Festuca pratensis, Agrostis stolonifera, Alopecurus pratensis, Crepis biennis, Glechoma hederacea, Gratiola officinalis, Cirsium canuum, Dactylis glomerata* etc.

Having a good forage value, these grasslands are used to produce hay, and only occasionally they are grazed. Sometimes, due to their productivity, mowing and grazing high tolerance and regeneration capacity, are grazed early in spring and later in autumn without significantly affecting the structure and/or functions. This kind of grassland needs to be fertilized at least every 2-3 years.

Alliance *Arrhenatherion* Koch 1926

Grasslands belonging to this alliance are developing on plain terrain or light slopes near human settlements being conditioned by moderate input of fertilizers, usually organic. Having a high productivity and providing high quality forage and productivity, these grasslands are usually used as hay meadow. The dominant, characteristic and frequent species are: *Arrhenatherum elatius, Poa pratensis, Trisetum flavescens, Dactylis glomerata, Festuca pratensis, Prunella vulgaris, Salvia pratensis, Campanula patula, Pastinaca sativa, Pimpinella major, Lotus corniculatus, Knautia arvensis, Taraxacum officinale, Phleum pratense* etc.

Just like the previous grasslands, they usually have a mixt management (as pasture in early spring and late autumn and hay meadow). As hay meadow, they can be mowed 2-3 times/growing season and needs to be constantly fertilized.

Alliance *Cynosurion* R. Tuxen 1947

Grasslands assigned to this alliance have large ecological amplitude in terms of species' requirements to soil humidity, acidity and nutrients. The dominant and characteristic species are: *Cynosurus cristatus, Agrostis capillaris, Festuca rubra, Bellis perennis, Trifolium repens, Gentiana cruciata, Leontodon autumnalis, Hypochoeris radicata* etc. They are used both as hay meadows and pastures, their structure and dynamics being conditioned by the intensity of anthropic influences.

Alliance *Festucion valesiacae* Klika 1931

In this alliance xerophilous grasslands are grouped, which can be found on thermophilous slopes from low altitude. Dominant and characteristic species are: *Festuca rupicola, F. valesiaca, Dichanthium ischaemum, Stipa capillata, Linum austriacum, L. hirsutum, Muscari comosum, Medicago falcata, M. lupulina, Oxytropis pillosa, Polygala major, Adonis vernalis, Ajuga laxmannii, Salvia austriaca, S. nemorosa, Thymus pannonicus, Veronica orchidea, Scabiosa ochroleuca, Eryngium campestre, Fragaria viridis, Dorycnium herbaceum* etc.

These grasslands are mainly used as sheep pastures that are grazed the whole growing season. Despite of their low economical value (due to low forage value of dominant species), these grasslands are very important for biodiversity conservation. Dominant and characteristic species are well adapted to infertile soils with water shortage.

Alliance *Danthonio-Brachypodion* Boşcaiu 1972

These semi-dry grasslands occur on calcareous soils being used as hay meadow or extensively grazed by sheep. The dominant, characteristic and frequent species are: *Brachypodium pinnatum, Danthonia alpine, Bromus erectus, Asperula cynanchica, Carex humilis, Polygala major, Cirsium pannonicum, Centaurea scabiosa, Ranunculus polyanthemos, Prunella grandiflora, Gentiana cruciata, Veronica teucrium, Trifolium pannonicum, T. ochroleucon* etc.

Sheltering a great number of species (over 50 species/25 square meters) and an important number of rare species, these grasslands are among the most valuable in terms of biodiversity conservation.

Table 1. Summary of spatial data of grassland types

Alliance	**Total area**	**Min size**	**Max size**	**Mean size**
Agrostion stoloniferae	333	0.52	31.45	7.74
Arrhenatherion	185	0.32	46.11	8.41
Cynosurion	2908.31	0.38	360.19	50.14
Danthonio-Brachypodion	1174.82	0.69	420.82	78.32
Festucion valesiaceae	1128.87	0.5	356	38.93
Molinion	5.38	0.29	1.79	0.6
Total grassland area	**5735.38**			

In the research area we have identified 5735.38 hectares belonging to the described grassland alliances, out of 11129.08 hectares inventoried, which means 51.54% of the total area. The distribution map of grassland types is shown in fig. 2.1.

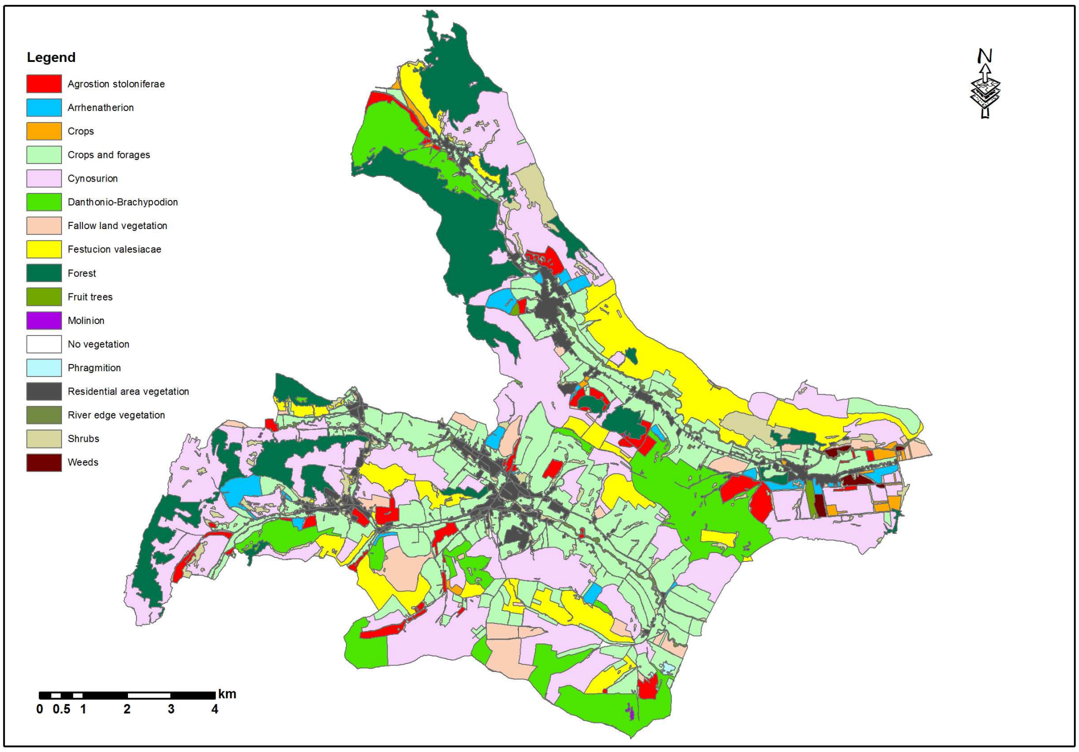

Fig. 2.1. The distribution map of grassland types

Mapping grassland types, even at alliance level, offers the base level needed for monitoring purposes, to evaluate the efficiency of undertaken management measures.

IV. THREATS AND MANAGEMENT MEASURES

4.1 Threats

Abandonment, overgrazing, weed and invasive species are among the most significant threats to the conservation of semi-natural grasslands, not only in the research area but also in the whole country. All these threaten cause important structural and functional changes that lead (sometimes irreversible) to biodiversity loss and succession to less valuable habitats. In fact, all these threaten are the results of land use changes.

4.2. Aims of management plan

The overall goal of the grassland management plan is to preserve the conservative value of the grasslands from Dăbâca and Borșa communes. In order to achieve this main goal we identified the following operational objectives (Oo):

Oo-1 – to preserve all remnants grassland in the study area;

Oo-2 – to preserve or improve the biodiversity of grasslands;

Oo-3 – to preserve or improve the specific structure of grasslands through the adequate management measures according to the socio-economical needs of the local farmers and the main ecosystem services provide by each grassland type;

Oo-4 – to preserve the landscape structure;

Oo-5 – to protect the threatened plant or animal species;

Oo-6 – to preserve and promote the traditional customs;

4.3. Management tools

Choosing the right actions to manage grasslands in order to achieve the main goal and operational objectives is a very challenging task do to the limitations imposed by both the status of declared protected area (as a Natura 2000 area) (2011a) and the constrains of agri environment scheme (2011b) and GAECs (2010). In our attempt to identify and develop a set of minimal management measures that need to be taken for grassland conservation, we used with some adaptations, apart of government's regulatory documents, some recommendations developed from agronomical point of view (Tucra et al. 1987, Marușca et al. 2010) and for Natura 2000 habitats management (Tucker et al. 2008).

Starting from the grassland types (inventoried and mapped during 2010-2011), historical land use (information gathered from cadastral maps, local authorities and farmers) and taking into account all others constrains mentioned above, we identified a set of 5 groups of potential management measures with sub measures and options.

4.3.1. Grazing (MM-1)

Even if the plant response to grazing is hardly to be predicted, grazing could be considered as "one of the central and pivotal issues affecting grasslands, linking their maintenance, productivity, economic use and management for biodiversity" (A.R and S.J 2001).

The most important general mechanisms by which grazing affects the structure, functions and dynamics of grasslands (direct and indirect) are (Rook et al. 2004):

- creating sward heterogeneity due to dietary choices of animals through selective defoliation, altering the competition between plant species for nutrients and light;
- creating new niches for gap-colonizing species;
- altering the nutrient cycling through concentrating nutrients at dung and urine patches;
- promoting soil heterogeneity through direct and indirect mechanisms, which affect the aeration and hydrological properties of soils;
- contributing to seeds dispersal;

All these mechanisms occurs at different intensities and amplitudes with both positive and negative results (Olff and Ritchie 1998, Walsh 2003) due to the livestock used (body size and species effects), livestock size (the number of animals deployed on a giving pasture), grazing system, the duration of grazing, local site conditions (slope, slope position, soil types, soil moisture etc.) (Barthram et al. 2002, Walsh 2003, Rook et al. 2004). According to the intermediate disturbance hypothesis (Connell 1978), the highest species richness should be found at an intermediate level of grazing disturbance.

Based on the aspects presented above and in view of our operational objectives we identified the following sub measures:

MM-1.1 – Grazing according to the local traditionally practices (free range grazing)

This recommendation is meant to maintain local practices where these have created and maintained the grasslands features of conservative values with the optimal livestock type and size in the right season. There are some options regarding the season of grazing.

MM-1.1.1 – grazing in early spring and autumn (after 15-25 august)

MM-1.1.2 – grazing whole vegetation season
MM-1.1.3 – grazing after mowing of hay meadow (end of july)

MM-1.2 – Increasing or decreasing livestock rates (expressed in Livestock Unit – LU) for under-grazed or overgrazed pastures (according to the carrying support of pasture)

MM-1.3 – Changing livestock type (sheep to cattle, cattle to sheep) and/or animal breed or age

This management measure is meant to promote the diversity of grassland structure as a result of different dietary choices and feeding behavior.

MM-1.4 – Rotational grazing system

Under this system, livestock uses at least two pastures units that are alternately grazed and rested. Through this system, selective grazing by livestock is minimized and the chances to maintain species diversity for long time is maximized (Walsh 2003).

4.3.2. Mowing (MM-2)

Mowing has been used to maintain hay meadows as a source of forages for winter season. While a grassland, which is allowed to develop a high standing crop declines in plant diversity due to exclusion of less competitive species but, promotes the diversity of invertebrates, birds and small mammals (Fenner and Palmer 1998). Mowing has several advantages over other management measures, in terms of flexibility of mowing frequency and timing (Walsh 2003). Usually, in low land area hay meadows are mowed once to three times per year, depending on hay meadow structure (in terms of vegetation type). One of the greatest advantages of mowing is the possibility to be done almost any time during the vegetation season in order to meet the needs of key (target) species if there are any (e.g. host plants for important invertebrates species – *Maculinea spp*., invasive or undesirables species – *Solidago cannadensis*, target species – *Echium russicum*, etc.). Anyway, a higher diversity of plant and animal soecies can't be jointly managed through mowing as it is well documented by some studies (Fenner and Palmer 1998).

Reducing the frequency, leaving some patches unmowed or at least not mowing adjacent parcels at the same time, mowing from center of parcel toward the periphery can minimize the negative impact of mowing (Walsh 2003).

Taking into account the ecological aspects of mowing and based on the specific structure of hay meadows from our area, we identified some sub measures, like:

MM-2.1 – Traditional (manual) mowing

Mowing by hand is adequate for hay meadows that have a favorable status for conservation or which shelter some species that are sensitive to other mowing technics (mechanized mowing by small machines or tractors). This measure is meant to maintain the traditionally practices where these have created grasslands with features of conservative importance (Tucker et al. 2008).

In terms of mowing frequency or timing we have identified three options:

MM-2.1.1 – Mowing once to three times per year where the grassland types allow such frequency

MM-2.1.2 – Mowing before flowering and seed setting of some undesirable or invasive species like Solidago cannadensis, Calamagrostis epijeios, etc.

MM-2.1.3 – Mowing after flowering and seed setting of some key species (Echium russicum, Dictamnus albus etc.), measure, which promote the dispersal of seeds and increase chances of new seedlings to be established

MM-2.1.4 – Mowing after some animal key species (butterflies) has ended their biological cycles which depends of plant hosts.

MM-2.2 – Mechanized mowing by small hand held machines

Even if we do not have enough information about long-term effects of mowing by small machines (with the total mass under 400 kg), we think that this measure can be allowed until the harmful effects can be demonstrated.

MM-2.3 – Mowing adjacent parcels at different time

To provide the chances to animal species (invertebrates, birds and small mammals) to find a shelter and minimizing the mortality caused by mowing, we suggest that mowing adjacent parcels should be done in an interval of at least few days. There are no studies (or at least we do not have any knowledge of them), which can support our proposal. In the given situation, with a lot of abandoned hay meadows, we do not think that it is a good idea to propose that some parcels should be left unmowed.

MM-2.4 – Mowing from the center of parcel toward periphery

This measure is meant to avoid a high animal mortality due to mowing process and give to animals the chance to find an appropriate shelter.

4.3.3. Fertilisation (MM-3)

It is generally accepted that species richness has an unimodal relationship with soil fertility and vegetation productivity, which is explained by competitive exclusion at high resources levels (Roem and Berendse 2000, Grime 2001). Soil nitrogen is the most limiting nutrient to primary productivity in most temperate ecosystems (Reynolds and Haubensak 2008), the more nitrogen the soil contains the fewer are the species characteristic of semi-natural grasslands (McCrea et al. 2004). Many nitrogen fertilization experiments have demonstrated a dramatic decline in grassland community diversity and recovery after cessation of fertilization (Niinemets and Kull 2005, Clark and Tilman 2008). It has been well proven that the decline of species richness was mainly due to the loss of rare species (Clark and Tilman 2008) because of their narrower ecological range than common species with respect to soil biogeochemical parametres, especially ammonium in acidic grasslands (Kleijn et al. 2008).

As a management measures our proposals are:

MM-3.1 – Fertilisation control

Traditional management of grasslands (especially hay meadows) do not involve the use of chemical fertilisers but only organic manure. Artificial fertilisers are totaly prohibited. Due to the fertilisation effects on biodiversity, the use of organic should be limited to a maximum ammount of 30 kg of active nitrogen/hectar/year as is recomended in GAEC. Moreover, for the conservation purposes our proposal is that the ammount of active nitrogen/hectar should not exceed 30 kg for tree years. Organic manure should be transported and spreaded on hay meadow during winter time, preferably when the thicknes of snow layer is greater (January-February). This measure is not addressed to pastures that are grazed.

MM-3.2 – Control of sheep-pens

Usually, during grazing season, sheep are staying on pastures all the time. Sheep-pens, where animals are kept over night for a variable number of days, are a traditional way to fertilise grasslands. It is highly reccomended to keep sheep over night in the same places for up to three days, keeping them for more tha three days will determine accumulation into the soil of huge concetrantions of nitrogen and phosphorous, which will promote a luxuriant development of weeds (Carduus sp., Cirsium vulgare, Rumex sp., etc.).

4.3.4. Weed and invasive species control (MM-4)

Weeds and invasive species (whether woody or herbaceous plants) usually occur in grassland with an inappropriate management (abandoned, under or overgrazed grasslands). Callaway et al. (2005) demonstrated that some undesirable weeds (unpalatable species) play an important role in maintaining species and functional diversity of overgrazed plant communities. These “mediator species” (Spiegelberger et al. 2006) promote or reduce species richness (plants and animals) depending on land use as, in abandoned sites species richness decreases with increasing abundance of unpalatable species, whereas an opposite pattern is observed in fertilized pastures where grazing pressure is stronger. The difference between positive and negative role of weeds and invasive species is made by their local and regional abundance. Setting up a threshold value for the two antagonist effects is a very challenging task, which have to be further investigated.

Due to the limitations imposed by the agri-environmental measures and GAEC, we identified only one possible management measure.

MM-4.1 Hand clearing

Hand clearing of weeds and invasive species plants (woody or herbaceous) includes pulling out plants by hand or with tools or cutting plants with a brush saw, chain saw, chipper etc., or otherwise disabling the plant (Walsh 2003). This management measure should be careful implemented to not disturb the soil and create empty niches, which can be occupied by other invasive species. To prevent land sliding and/or soil erosion woody plants from areas with high risk of land sliding (area with slope greater than 180) will not be totally cleared. The removing of woody plants from pastures in these areas will be done with kipping protective bands with varying widths depending on slope degree (Maruşca et al. 2010). Landowners and/or administrators should pay more attention with hand clearing of undesirable plants (especially with woody plants) to not remove those plants, which are acting as "umbrella species" or host plants for invertebrates, due to their importance for biodiversity conservation.

All the proposed management measures can be applied alone and/or in conjunction with other measures, depending on the grassland type, land use, the presence or absence of key species, economical needs etc. All proposed management measure, with advantages and disadvantages. To be an effective tool, a management plan should be adaptive, which means that, each landowner or land administrator can change the management measures totally or just the timing and/or intensity. For the grasslands from research area we have recommended a preliminary proposal for grassland management according to the actual status of them. This proposal is summarized in table 2.

Table nr. 2. Summary of proposed management measures for each grassland type according to their land use

Grassland type	Land use	Operational objectives	Management measures															
			MM-1.1.1	MM-1.1.2	MM-1.1.3	MM-1.2	MM-1.3	MM-1.4	MM-2.1.1	MM-2.1.2	MM-2.1.3	MM-2.1.4	MM-2.2	MM-2.3	MM-2.4	MM-3.1	MM-3.2	MM-4.1
Agrostion stoloniferae	hay meadow	Oo-1, Oo-3, Oo-4, Oo-6	■		■				■	■			■	■	■	■		
Arrhenatherion	hay meadow	Oo-1, Oo-3, Oo-4, Oo-6	■		■				■	■			■	■	■	■		
Cynosurion	hay meadow	Oo-1, Oo-3, Oo-4, Oo-6	■		■				■	■			■	■	■	■		
Cynosurion	pasture	Oo-1 - Oo-6		■		■	■	■		■						■	■	■
Danthonio-Brachypodion	hay meadow	Oo-1 - Oo-6	■		■	■	■	■	■	■	■	■		■	■		■	■
Danthonio-Brachypodion	pasture	Oo-1 - Oo-6		■		■	■	■		■							■	■
Festucion valesiacae	pasture	Oo-1 - Oo-6		■		■	■	■									■	■

IV. MONITORING PLAN

To assess how the implementation of specific management measures have achieved their purpose, need periodic monitoring of the key characteristics (attributes) that can provide information about the status of the target area/grassland. Such information can identify, in advance, any problems that that have not been taken into account, initially, and help to make decisions that may correct the situation.

During the monitoring activities, the assessment of goals achievement will be based on features/attributes that have to be measurable to allow to be compared with the historical and target values.

Choosen attributes should fulfill some minimal conditions, like:

- the method of collecting data can be standardized;
- to be cost effective;
- the associated errors are minimized;
- to describe the status of feature and not the factors that influence it.

The most important attributes that can be used for monitoring, regarding the particularities of grasslands structure, functions and dynamics, can be grouped into the following categories:

- quantitative attributes (grassland extent, habitat fragmentation);
- qualitative attibutes (plant community types, dominant species, characteristic species, invasive/indesirable species, species richness, percentage of unvegetated soil, litter depth etc.);
- functional attributes (productivity, perturbations, habitat connectivity).

Acceptable limits for attributes must be made on the basis of studies on the variability of each type of grassland in part.

Grasslands are very dynamic systems which suffer structural changes from year to year or even through the same vegetation season. In this context, another important issue is about the frequency of monitoring. The frequency should be correlated with the management objective and measures but should not exceed 3 years.

All these attributes, for each grassland type identified in the research area, are summarized into tables 3 to 8.

Table nr. 3. Minimal attributes that should be monitored for grassland belonging to *Agrostion stoloniferae*

Attributes	***Acceptable limits***	***Methods of evaluation***	***Observations***
Quantitative			
Grassland extent	Increasing the total area, deacreasing more than 5% is not allowed	Grassland mapping/GIS	
Qualitative			
Plant community types	*Agrostetum stoloniferae* Ujvarosi 1941 *Poetum pratensis* Răvăruţ, Căzăceanu et Turenschi 1956 *Ranunculo repenti – Alopecuretum pratensis* Ellmauer et Mucina in Mucina et al. 1993 *Cirsio cani – Festucetum pratensis* Majovsky ex Ruzickova 1975 *Medicagini lupulinae – Agropyretum repentis* Popescu et al. 1980	Braun-Blanquet method	
Dominat species	*Agrostis stolonifera, Festuca pratensis, Alopecurus pratensis, Poa pratensis, Elymus repens*	Braun-Blanquet method	
Characteristic species	Minimum 5 species /25 square meters from the following ones: *Cirsium canum, Ranunculus repens, Geranium pratense, Lychnis flos-cuculi, Equisetum palustre, Veronica serpyllifolia, Mentha longifolia, Alopecurus pratensis, Symphytum*	Braun-Blanquet method	

	officinalis, Trifolium echinatum,		
Invasive/indesirable species	The following species should NOT cover more than 5%: *Clinopodium vulgare, Prunella vulgaris, Bellis perrenis, Lolium perenne, Arrhenatherium elatius, Centaurea spp., Festuca arundinacea, Holcus lanatus, Trisetum flavescens, Salvia pratensis, Trifoilum pretense, Medicago sativa*	Braun-Blanquet method	
Species richness	Minimum 25 species/25 square meters	Braun-Blanquet method	
Structura spaţială			
Vegetation stratification	Minimum 3-4 strata	Field observations	
Bare soil	Maximum 1% out of the total area, but no more than 0.25 m^2	Field observations	
Grosimea medie a stratului de litieră (cm)	NA	Minimum 5 samples/25 square meters	
Dynamics			
Perturbations	Data concerning the existence of perturbation	Field observations	
Productivity	> > 7-8 t dry matter/ha	Field observations	

Table nr. 4. Minimal attributes that should be monitored for grassland belonging to *Arrhenatherion*

Attributes	***Acceptable limits***	***Methods of evaluation***	***Observations***
Quantitative			
Grassland extent	Increasing the total area, deacreasing more than 5% is not allowed	Grassland mapping/GIS	
Qualitative			
Plant community types	*Arrhenatheretum elatioris* Br.-Bl. Ex Scherrer 1925 *Cerastio holosteoidis-Trisetetum flavescens* Sanda et al. 2001	Braun-Blanquet method	
Dominat species	*Arrhenatherum elatius, Trisetum flavescent, Poa trivialis*	Braun-Blanquet method	
Characteristic species	Minimum 5 species /25 square meters from the following ones: *Pimpinella major, Pastinaca sativa, Crepis biennis, Campanula patula, Trifolium pretense, Achillea millefolium, Dactylis glomerata, Leucanthemum vulgare, Rorippa sylvestris, Heracleum sphondylium, Potenstilla reptans*	Braun-Blanquet method	
Invasive/indesirable species	The following species should NOT cover more than 5%: *Clinopodium vulgare, Prunella vulgaris, Bellis perrenis, Centaurea spp., Festuca arundinacea, Medicago sativa*	Braun-Blanquet method	

Species richness	Minimum 25 species/25 square meters	Braun-Blanquet method	
Structura spațială			
Vegetation stratification	Minimum 3-4 strata	Field observations	
Bare soil	Maximum 1% out of the total area, but no more than 0.25 m^2	Field observations	
Grosimea medie a stratului de litieră (cm)	NA	Minimum 5 samples/25 square meters	
Dynamics			
Perturbations	Data concerning the existence of perturbation	Field observations	
Productivity	> > 7-8 t dry matter/ha	Field observations	

Table nr. 5. Minimal attributes that should be monitored for grassland belonging to *Cynosurion*

Attributes	***Acceptable limits***	***Methods of evaluation***	***Observations***
Quantitative			
Grassland extent	Increasing the total area, deacreasing more than 5% is not allowed	Grassland mapping/GIS	
Qualitative			
Plant community types	*Trifolio repenti – Lolietum* Krippelova 1967, Resmeriţă et Pop 1967 *Lolio-Cynosuretum* Br.-Bl. Et de Leeuw 1936 em, R. Tuxen 1937 *Anthoxantho – Agrostietum capillaris Sillinger 1933*	Braun-Blanquet method	
Dominat species	*Agrostis capillaris, Trifolium repens, Lolium perenne, Cynosurus cristatus, Festuca rubra, F. rupicola*	Braun-Blanquet method	
Characteristic species	Minimum 10 species /25 square meters from the following ones: *Leontodon autumnalis, Bellis perennis, Phleum pretense, Carlina acaulis, Gymnadenia conopsea, Hypochoeris radicata, Primula veris, Stellaria graminea, Vicia cracca, Phleum pretense, Anthoxanthum odoratum, Gladiolus imbricatus, Briza media etc*.	Braun-Blanquet method	
Invasive/indesirable	The following species should NOT cover	Braun-Blanquet method	

species	more than 5%: *Clinopodium vulgare, Arrhenatherium elatius, Centaurea spp., Festuca arundinacea, Holcus lanatus, Trisetum flavescens, Agrostis stolonifera, Salvia pratensis, Medicago sativa, Poa annua, Urtica dioica, Rumex crispus, etc.*		
Species richness	Minimum 35 species/25 square meters	Braun-Blanquet method	
Structura spaţială			
Vegetation stratification	Minimum 3-4 strata	Field observations	
Bare soil	Maximum 1% out of the total area, but no more than 0.25 m^2	Field observations	
Grosimea medie a stratului de litieră (cm)	NA	Minimum 5 samples/25 square meters	
Dynamics			
Perturbations	Data concerning the existence of perturbation	Field observations	
Productivity	> 3-5 t dry matter/ha	Field observations	

Table nr. 6. Minimal attributes that should be monitored for grassland belonging to *Danthonio-Brachypodion*

Attributes	***Acceptable limits***	***Methods of evaluation***	***Observations***
Quantitative			
Grassland extent	Increasing the total area, decreasing more than 5% is not allowed	Grassland mapping/GIS	
Qualitative			
Plant community types	*Danthonio-Brachypodietum pinnati* Soo 1946, 1947 *Polygalo majoris – Brachypodietum pinnati* Wagner 1941 *Festuco rubrae – Danthonietum* Csuros et al. 1968	Braun-Blanquet method	
Dominat species	*Brachypodium pinnatum, Danthonia alpina, Festuca rubra, F. rupicola*	Braun-Blanquet method	
Characteristic species	Minimum 15 species /25 square meters from the following ones: *Briza media, Ononis arvensi, Polygala major, Scabiosa ochroleuca, Gentiana cruciata, Centaurea scabiosa, Helianthemum nummularium, Prunella grandiflora, Onobrychis viciifolia, Orchis tridentata, Carex humilis, Anthericum ramosum, Eryngium campestre, Asperula cynanchica, Aster lynosiris, Silene otites, Ferulago sylvatica, Chrysopogon gryllus, ornithogalum*	Braun-Blanquet method	

	pyramidale, Veronica austriaca, Stachys recta etc.		
Invasive/indesirable species	The following species should NOT cover more than 5%: *Crataegus monogyna, Rubus caesius, Rosa canina, Prunus spinosa, Pyrus pyraster, Clinopodium vulgare, Arrhenatherium elatius, Centaurea spp., Festuca arundinacea, Holcus lanatus, Trisetum flavescens, Agrostis stolonifera, Medicago sativa, Poa annua, Urtica dioica, Rumex crispus, Phragmites australis, Calamagrostis epijeios, C. arundinacea etc.*	Braun-Blanquet method	
Species richness	Minimum 40-45 species/25 square meters	Braun-Blanquet method	
Structura spaţială			
Vegetation stratification	Minimum 4 strata	Field observations	
Bare soil	Maximum 1% out of the total area, but no more than 0.25 m^2	Field observations	
Grosimea medie a stratului de litieră (cm)	NA	Minimum 5 samples/25 square meters	
Dynamics			
Perturbations	Data concerning the existence of perturbation	Field observations	
Productivity	NA	Field observations	

Table nr. 7. Minimal attributes that should be monitored for grassland belonging to *Festucion valesiacae*

Attributes	***Acceptable limits***	***Methods of evaluation***	***Observations***
Quantitative			
Grassland extent	Increasing the total area, decreasing more than 5% is not allowed	Grassland mapping/GIS	
Qualitative			
Plant community types	*Agrostio – Festucetum valesiacae Borisavljevic et al. 1955* *Medicagini minimae – Festucetum valesiacae* Wagner 1940 *Festucetum rupicolae* Burduja et al. 1956 *Botriochloetum ischaemi* (Kristiansen 1937) Pop 1977 *Stipetum capillatae* (Hueck 1931) Krausch 1961 *Elytrigetum hispidi* (Dihoru 1970) Popescu et Sanda 1988	Braun-Blanquet method	
Dominat species	*Festuca valesiaca, F. rupicola, Dichanthium ischaemum, Elymus hispidus, Stipa capillata*	Braun-Blanquet method	
Characteristic species	Minimum 10 species /25 square meters from the following ones: *Orlaya grandiflora, Thymus pannonicus, Inula germanica, Adonis vernalis, Muscari comosum, Cleistogenes serotina, Ajuga*	Braun-Blanquet method	

	laxmannii, Asparagus officinale, Artemisia austriaca, Linum hirsutum, Veronica spicata, Salvia nutans, Iris aphylla, Salvia nemorosa, Astragalus dasyanthus, Cephalaria uralensis, Eryngium campestre, leontodon hispidus, Artemisia absinthium, Dorycnium pentaphyllum ssp. herbaceum, Inula germanica,Potentilla arenaria, Fragaria viridis, Veronica teucrium, Centaurea biebersteinii ssp biebersteinii, Chondrilla juncea etc.		
Invasive/indesirable species	The following species should NOT cover more than 5%: *Crataegus monogyna, Prunus spinos, Rosa canina, Pyrus pyraster, Rubus caesius, Clinopodium vulgare, Arrhenatherium elatius, Centaurea spp., Festuca arundinacea, Holcus lanatus, Trisetum flavescens, Agrostis stolonifera, Medicago sativa, Poa annua, Urtica dioica, Rumex crispus, phragmites australis, calamagrostis epijeios, C. arundinacea etc.*	Braun-Blanquet method	
Species richness	Minimum 35-40species/25 square meters	Braun-Blanquet method	
Structura spaţială			
Vegetation stratification	Minimum 3 strata	Field observations	
Bare soil	Maximum 1% out of the total area, but no more than 0.25 m^2	Field observations	

Grosimea medie a stratului de litieră (cm)	NA	Minimum 5 samples/25 square meters	
Dynamics			
Perturbations	Data concerning the existence of perturbation	Field observations	
Productivity	NA	Field observations	

Table nr. 8. Minimal attributes that should be monitored for grassland belonging to *Molinion*

Attributes	***Acceptable limits***	***Methods of evaluation***	***Observations***
Quantitative			
Grassland extent	Increasing the total area, decreasing more than 1% is not allowed	Grassland mapping/GIS	
Qualitative			
Plant community types	*Junco – Molinietum* Preising 1951	Braun-Blanquet method	
Dominat species	*Molinia caerulea*	Braun-Blanquet method	
Characteristic species	Minimum 5 species /25 square meters from the following ones: *Juncus effussus, J. articulatus, J. conglomeratus, Galium boreale, Succisa pratensis, Gentiana pneumonanthe, Serratula tinctoria, Stachys officinalis, Epilobium palustre, Sanguisorba officinalis, Filipendula ulmaria, Cirsium palustre, Myosotis scorpioides, Galium uliginosum, Lysimachia nummularia, Valeriana officinalis, Gladiolus imbricatus, Angelica sylvestris etc.*	Braun-Blanquet method	
Invasive/indesirable species	The following species should NOT cover more than 5%: *Arrhenatherium elatius, Centaurea spp., Festuca arundinacea, Holcus lanatus, Trisetum flavescens, Medicago sativa, Poa annua, Urtica*	Braun-Blanquet method	

	dioica, Rumex crispus, Phragmites australis, Calamagrostis epijeios, C. arundinacea etc.		
Species richness	Minimum 25-30 species/25 square meters	Braun-Blanquet method	
Structura spaţială			
Vegetation stratification	Minimum 4 strata	Field observations	
Bare soil	Maximum 1% out of the total area, but no more than 0.25 m^2	Field observations	
Grosimea medie a stratului de litieră (cm)	NA	Minimum 5 samples/25 square meters	
Dynamics			
Perturbations	Data concerning the existence of perturbation	Field observations	
Productivity	NA	Field observations	

As it can be seen in the above table, to be recorded, most of attributes require a qualified staff. This obstacle could be overcome by an intensive training of the people with basic skills.

CONCLUSIONS

Based on the information summarized into this paper, without claiming to have exhausted the whole subject, we think that we have succeded to highlight some important issues underlying a successful management of grassland habitats, namely:

- semi-natural grasslands are sensitive to small variation of environmental variables;
- the management objectives should be prioritized, not all of them can be achieved in the same time (e.g. the species richness of plant species and invertebrates can't be jointly maximized);
- land use changes, abandonment, overgrazing and invasive species are the biggest threatens to grassland conservation;
- choosing the management tools (measures) should be based on a preliminary assessment of types and intensities of threatens;
- management measures should be based or derived from traditional measures and must be easy to put into practice;
- management measures should meet the ecological requirements of the (co)dominant and key species;
- any management plan should be adaptive;
- the achievement of management objective should be monitored on periodic basis which have not to exceed an interval of three years;
- further research should be carried on in order to improve the list of grassland attributes and their limits of variations.

BIBLIOGRAPHY

*******. 2010. Ordin nr. 30 din 8 februarie 2010 pentru aprobarea bunelor condiţii agricole şi de mediu în România.*in* M. A. ş. D. Rurale and M. M. ş. Pădurilor, editors. Monitorul Oficial.

*******. 2011a. Ordinul ministrului mediului şi pădurilor nr. 2387/2011 pentru modificarea Ordinului ministrului mediului şi dezvoltării durabile nr. 1964/2007 privind instituirea regimului de arie naturală protejată a siturilor de importanţă comunitară, ca parte integrantă a reţelei ecologice europene Natura 2000 în România. Pages 3-100 *in* M. M. ş. Pădurilor, editor. Monitorul Oficial.

*******. 2011b. Programul Naţional de Dezvoltare Rurală 2007-2013, versiunea consolidată iulie 2011. Pages 1-874. Ministerul Agriculturii şi Dezvoltării Rurale.

A.R, W. and O. S.J. 2001. Grasslands, grazing and biodiversity: editors' introduction. Journal of Applied Ecology **38**:233-237.

Barthram, G. T., D. A. Elston, C. P. D. Birch, and G. R. Bolton. 2002. Defoliation and site differences influence vegetative spread in grassland. New Phytologist **155**:257-264.

Bruun, H. H., J. Moen, R. Virtanen, J. A. Grytnes, L. Oksanen, and A. Angerbjorn. 2006. Effects of altitude and topography on species richness of vascular plants, bryophytes and lichens in alpine communities. Journal of Vegetation Science **17**:37-46.

Butaye, J., D. Adriaens, and O. Honnay. 2005. Conservation and restoration of calcareous grasslands: a concise review of the effects of fragmentation and management on plant species. Biotechnol. Agron. Soc. Environ. **9**:111-118.

Callaway, R. M., D. Kikodze, M. Chiboshvili, and L. Khetsuriani. 2005. Unpalatable plants protect neighbors from grazing and increase plant community diversity. Ecology **86**:1856-1862.

Clark, C. M. and D. Tilman. 2008. Loss of plant species after chronic low-level nitrogen deposition to prairie grasslands. Nature **451**:712-715.

Connell, J. H. 1978. Diversity in tropical rain forests and coral reefs. Science **199**:1302-1310.

Cousins, S. A. O. and O. Eriksson. 2002. The influence of management history and habitat on plant species richness in a rural hemiboreal landscape, Sweden. Landscape Ecology **17**:517-529.

Dix, R. L. 1958. Some slope-plant relationships in the grasslands of the Little Missouri Badlands of Noth Dakota. Journal of Range Management **11**:88-92.

Dornelas, M., A. C. Moonen, A. E. Magurran, and P. Bàrberi. 2009. Species abundance distributions reveal environmental heterogeneity in modified landscapes. Journal of Applied Ecology **46**:666-672.

Fenner, M. and L. Palmer. 1998. Grassland management to promote diversity: creation of a patchy sward by mowing and fertiliser regimes. Field Studies **9**:313-324.

Grime, J. P. 2001. Plant strategies, vegetation processes, and ecosystem properties. John Wiley & Sons, Ltd.

Grytnes, J. A. 2003. Species-richness patterns of vascular plants along seven altitudinal transects in Norway. Ecography **26**:291-300.

Holten, J. I. 1998. Vascular plant species richness in relation to altitudinal and slope gradients in mountain landscapes. Pages 231-239 *in* M. Beniston and J. L. Innes, editors. The impacts of climatic variability on forests.

Kleijn, D., R. M. Bekker, R. Bobbink, M. C. C. De Graaf, and J. G. M. Roelofs. 2008. In search for key biogeochemical factors affecting plant species persistence in heathland and acidic grasslands: a comparison of common and rare species. Journal of Applied Ecology **45**:680-687.

Klimek, S., A. R. Kemmermann, M. Hofmann, and J. Isselstein. 2007. Plant species richness and composition in managed grasslands: The relative importance of field management and environmental factors. Biological Conservation **134**:559-570.

Klimeš, L., I. Jongepierová, and J. W. Jongepier. 2000. The effect of mowing on previously abandoned meadow: a ten-year experiment. Přiroda **17**:7-24.

Landolt, E., editor. 2010. Flora indicativa. Ökologische Zeigerwerte und biologische Kennzeichen zur Flora der Schweiz und der Alpen. Edition des Conservatoire et Jardin botaniques de la Ville de Genève edition. Haupt Verlag, Bern-Stuttgart-Wien.

Maruşca, T., V. Mocanu, V. Cardaşol, I. Hermenean, A. V. Blaj, G. Oprea, and M. A. Tod. 2010. Ghid de producere ecologică a furajelor de pajişti montane. Editura Universităţii Transilvania din Braşov, Braşov.

McCrea, A. R., I. C. Trueman, and M. A. Fullen. 2004. Factors relating to soil and species diversity in both semi-natural and created meadows in the West Midlands of England. European Journal of Soil Science **55**:335-348.

Niinemets, U. and K. Kull. 2005. Co-limitation of plant primary productivity by nitrogen and phosphorus in a species-rich wooded meadow on calcareous soils. Acta Oecologica-International Journal of Ecology **28**:345-356.

Nogués-Bravo, D., M. B. Araujo, T. Romdal, and C. Rahbek. 2008. Scale effects and human impact on the elevational species richness gradients. Nature **453**:216-220.

Öckinger, E., A. K. Eriksson, and H. G. Smith. 2006. Effects of grassland abandonment, restoration and management on butterflies and vascular plants. Biological Conservation **133**:291-300.

Olff, H. and M. E. Ritchie. 1998. Effects of herbivores on grassland plant diversity. Trends in ecology & evolution (Personal edition) **13**:261-265.

Proulx, M. and A. Mazumder. 1998. Reversal of grazing impact on plant species richness in nutrient-poor vs. nutrient-rich ecosystems. Ecology **79**:2581-2592.

Pykälä, J., M. Luoto, R. K. Heikkinen, and T. Kontula. 2005. Plant species richness and persistence of rare plants in abandoned semi-natural grasslands in northern Europe. Basic and Applied Ecology **6**:25-33.

Reynolds, H. L. and K. A. Haubensak. 2008. Soil fertility, heterogeneity, and microbes: towards an integrated understanding of grassland structure and dynamics. Applied Vegetation Science **12**:33-44.

Roem, W. J. and F. Berendse. 2000. Soil acidity and nutrient supply ratio as possible factors determining changes in plant species diversity in grassland and heathland communities. Biological Conservation **92**:151-161.

Rook, A. J., B. Dumont, J. Isselstein, K. Osoro, M. F. WallisDeVries, G. Parente, and J. Mills. 2004. Matching type of livestock to desired biodiversity outcomes in pastures – a review. Biological Conservation **119**:137-150.

Rozbrojová, Z., M. Hájek, and O. Hájek. 2010. Vegetation diversity of mesic meadows and pastures in the West Carpathians. Preslia **82**:307-332.

Sanda, V., K. Öllerer, and P. Burescu. 2008. Fitocenozele din România. Editura Ars Docendi, Universitatea din Bucureşti, Bucureşti.

Schaffers, A. P. 2002. Soil, biomass, and management of semi-natural vegetation – Part II. Factors controlling species diversity. Plant Ecology **158**:247-268.

Spiegelberger, T., D. Matthies, H. Müller-Schärer, and U. Schaffner. 2006. Scale-dependent effects of land use on plant species richness of mountain grassland in the European Alps. Ecography **29**:541-548.

Tucker, G., P. Anastasiu, M. I. Bărbos, D. Gafta, P. Goriup, J. O. Mountford, M. Paucă-Comănescu, and P. T. Stănciou. 2008. Outline proposals for Natura 2000 conservation measures under the National Rural Development Programme.

Tucra, I., A. J. Kov cs, C. Rosu, C. Ciubotariu, T. Chifu, M. Neacsu, C. Barbulescu, V. Cardasol, D. Popovici, N. Simtea, G. Motca, I. Dragu, and M. Spirescu. 1987. Principalele tipuri de Pajisti din R.S. Romʃnia. Institutul de Cercetare si productie pentru Cultura Pajistilor Brasov, Redactia de Propaganda Tehnica Agricola, Bucuresti.

Walsh, A. J. 2003. Grassland Management Plan World's End Hingham, Massachusetts. The Trustees of Reservations.