

NATURAL AND ECONOMIC VALUES OF SELECTED MEADOW COMMUNITIES IN SOUTHERN POLAND

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Abstract

Changes in Polish agriculture, which contributed to transitions in land usage, e.g. meadows, started after the political transformation at the beginning of 1990s. When meadows ceased to be used agriculturally, changes in species composition in various meadow communities started to be evident. This tendency is particularly vivid in the southern part of Poland. It is because of worse conditions for agricultural production and the traditionally stressed importance of permanent grasslands. The importance of traditional meadow usage has diminished also due to a decline in herbivorous animals. On the basis of the conducted research in selected parts of southern Poland in the years 2010 – 2013, 14 plant communities which belonged to 3 phytosociological classes, were distinguished. Some of those analyzed communities were annually cut, whereas some meadows were ruled out from mowing in the last few years. The lack of land usage in the analyzed meadow communities curbed the number of vascular plant species. A disparity between the value in use of meadow communities and their environmental advantages was also observed.

Key words: meadow communities, natural values, economic values, southern Poland, biodiversity

1. INTRODUCTION

From both economic and environmental perspectives, meadow communities are considered to be crucial ecosystems. However, in our climate, these communities do not create a stable environment, but they are constantly susceptible to changes. What is more, the dynamics of meadow communities is strictly bounded up with human influence. It is said that various conditions, such as habitat conditions and anthropogenic influences, have an impact on the creation of these communities. Habitat conditions enable the production of the so-called fresh and wet communities, whereas anthropogenic influences depend on the level of pastoral agricultural practices, which in turn is related to various economic systems [Kostuch 1995, Wolański and Trąba 2007, Kuszewska and Fenyk 2010, Stosik and Krasicka - Korczyńska 2012].

In recent years, transformations in meadow communities, which are related to changes in species composition as a result of the abandonment of agricultural land usage, have been observed in Poland. These transformations are mainly evident in southern part of the country, where meadows traditionally played an important role. The importance of traditional meadow usage has diminished as a result of the worsening conditions for agricultural production and a decline in herbivorous animals. Due to the fact that a part of grassland in Małopolska Province have ceased to exist, this phenomenon has a destructive effect on the efficiency in environmental processes leading to the disappearance of mechanisms stabilizing environment and physiology of landscape, which contributes to an appearance of shrubs and certain invasive species.

It should be mentioned that structural and market changes, which have been taking place since a tumultuous economic transformation in 1989, have a considerable effect on changes within meadow communities. Deterioration of economic relations, especially in the cost of and income from agricultural production, contributes to an increase in various disagrarization processes in rural areas. This phenomenon is particularly severe in subregions with a high agrarian fragmentation, especially

evident in the southern part of Poland. It should be noted that farms with small land areas (till 5 ha) dominate in the southern part of Poland – they comprise 88,2% of all farms in Małopolska Province [Kania 2013].

Małopolska Province is characterized by being a region of secondary technological backwardness with relatively low-yield farms. Fallow as well as untilled lands are seen as a problem facing Polish agriculture, which stands in contrast with neighbouring EU countries, such as Germany, Czech Republic and Slovakia. The share of such lands is diverse in various parts of southern Poland and it fluctuates between 3 to 20%. Areas with fallow and untilled lands cover not only poor areas surrounding cities, but also urbanized ones, in which finding a job out of agriculture is easier. Excessive land fragmentation in farms from 1 to 5 ha makes agricultural lands, especially these which are far from registered farms, not particularly valuable for their owners and potential leaseholders [Musiał 2010].

The main aim of the research was valorization of natural values and evaluation of economic values of diverse types of meadow communities in Małopolska Province, that is situated in southern Poland. This analysis is an attempt at confrontation with their environmental and economic values. An answer is being seek whether economically valuable grasslands are environmentally valuable and whether environmentally valuable meadows with lower economic values have chances to be used for agriculture.

2. THE AREA OF THE STUDY

Physiographically the area of research was localized within 6 mesoregions in the southern part of Poland. They were: Wyżyna Miechowska, Pomost Krakowski, Nizina Nadwiślańska, Pogórze Wiśnickie, Gorce i Beskid Sądecki [Kondracki 2009]. In the studied area there is a clear outline of a stripped land surface which goes from uplands in the northern part of Małopolska Province, stepping down into Vistula River valleys in the eastern part and then rising again in Beskid mountainous areas in the south. It should be emphasized that in these areas, geographic environment is greatly diversified because only 9% of surface is under 200 metres above sea level, which is a unique phenomenon in a country described as lowland (fig. 1).

Małopolska Province is characterized by a great diversity in soils. Taking the researched meadow communities into consideration, the main soils are: gley, marshy, peaty and alluvial, while for the area of Podgórze Wiśnickie and in mountainous mesoregions, they include typical brown and spodic soils. The areas where hydrogenic soils occur are seen as a usual water store in natural environment [Bednarek and Prusinkiewicz 1997, Skiba et al. 2013].

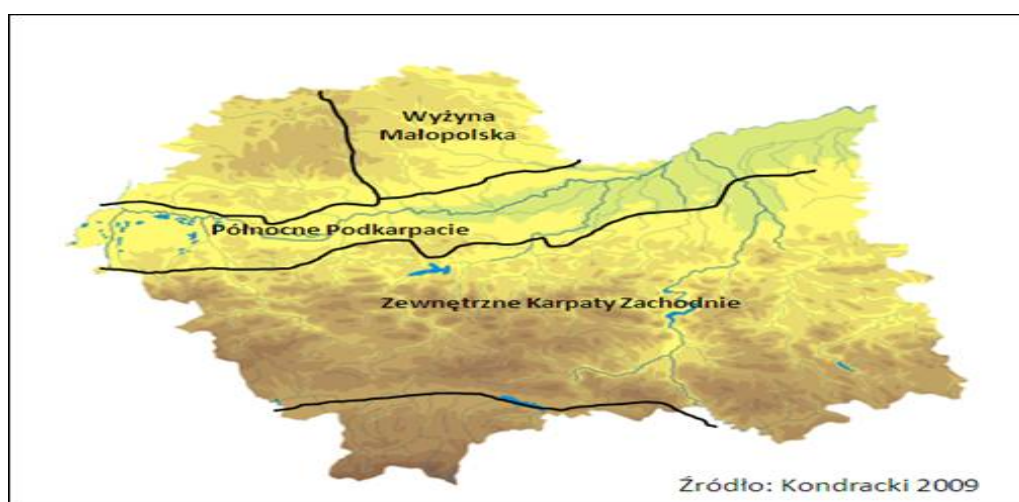


Figure 1. Distribution of analyzed mesoregions

Legend to Figure 1: Mesoregions: **I** – Miechowska Uplands (Wyżyna Miechowska), **II** – Pomost Krakowski (mesoregion in the northern part of Kraków), **III** – Vistula Lowlands (Nizina Nadwiślańska), **IV** – Wiśnicz Foothills (Pogórze Wiśnickie), **V** – Gorce Mountains (Gorce), **VI** – Beskid Sądecki (a mountain range in the Western Carpathians)

The structure of agricultural lands in Małopolska Province is varied. It can be clearly noted that districts localized in the southern part of Małopolska Province are characterized by a considerably higher share of meadows, which in turn is related to the increase in altitude above sea level, leading to more difficult conditions for agriculture. In the Carpathian Mountains, permanent grasslands consist of almost 25% of a total surface of agriculturally-used lands. In a vertical layout of Carpathian Mountains, there is a noticeable increase in the share of meadows and pastures in an acreage of agricultural lands [Guzik 1995].

3. MATERIALS AND METHODS

240 phytosociological records were carried out in the years 2010-13, in which levels of quantity expressed in percentages according to Klapp's method [1962] were seen as a base for calculations of use value of a meadow sward [Filipek 1973]. Next, the percentage share of species in each releve was transformed according to levels of quantity in Braun-Blanquet method [1964], which helped to estimate types of meadow communities. For every 6 mesoregions, there were 40 records of both cultivated (U) and uncultivated (UN) meadows.

Phytosociological affiliation of meadow communities was determined on the basis of Matuszkiewicz's work [2002]. So as to estimate natural values, not only was a floristic analysis of vascular plants made, but also Oświt method [2000] was taken into account (table 1). Filipek method [1973], which is based on the classification of meadow and pasture plants, was used to assess the use value of a meadow sward in the researched communities (table 1).

Table 1. Classification according to the economic value of a meadow sward (Filipek 1973) and the natural values (Oświt 2000)

Economic values of a meadow sward		Categories of natural values	
8,1 - 10	very good	I A; II A; III A	very small to small values
6,1 - 8	good	IV B; V B; VI B	moderate to moderately large values
3,1 - 6	poor	VII C; VIII C	big to very big values
< 3	sparse	IX D; X D	unique, exceptional values

4. RESULTS

Having analyzed phytosociological records, 14 types of meadow communities in the selected parts of southern Poland were distinguished. Those groups belonged to 9 alliances, 5 orders and 3 phytosociological classes (table 2). Communities from *Molinio - Arrhenatheretea* class, which were represented by 3 orders, containing 7 alliances and 12 associations, were considered to be the most common. The other two classes, *Nardo - Callunetea* and *Scheuchzerio - Caricetea nigrae*, appeared sporadically and were expressed by single associations. They were mainly seen in mountainous areas, especially in the Gorce Mountains.

Table 2. Meadow communities in the studied mesoregions in southern Poland

Name of association	Mesoregion	Max number of species	
		U	N
I. Class: <i>Molinio - Arrhenatheretea</i>			
Order: <i>Trifolio fragiferae - Agrostietalia stoloniferae</i>			
Alliance: <i>Agropyro - Rumicion crispi</i>			
1.Association: <i>Ranunculo - Alopecuretum geniculati</i>	I	-	18
Order: <i>Molinietalia caeruleae</i>			
Alliance: <i>Filipendulion ulmariae</i>			
2. Association: <i>Filipendulo - Geranietum</i>	II	-	24
Alliance: <i>Molinion caeruleae</i>			
3. Association: <i>Molinietum caeruleae</i>			
Alliance: <i>Calthion palustris</i>	II, III	38	25
4. Association: <i>Angelico - Cirsietum oleracei</i>	I	-	29
5. Association: <i>Cirsietum rivularis</i>	I, V, VI	34	-
6. Association: <i>Scirpetum sylvatici</i>	IV	-	16
7. Association <i>Deschampsia caespitosa</i>	II	-	20
Alliance: <i>Cnidion dubii</i>			
8. Association: <i>Violo - Cnidiolum dubii</i>			
Alliance: <i>Alopecurion pratensis</i>	III	27	-
9. Association: <i>Alopecuretum pratensis</i>	I, III, IV, V	26	-
10. Association <i>Holcus lanatus</i>	IV	35	-
Order: <i>Arrhenatheretalia</i>			
Alliance: <i>Arrhenatherion elatioris</i>			
11. Association: <i>Arrhenatheretum elatioris</i>	I - IV	43	31
12. Association: <i>Gladiolo - Agrostietum capillaris</i>	V, VI	46	28
II. Class: <i>Nardo - Callunetea</i>			
Order: <i>Nardetalia</i>			
Alliance: <i>Nardion</i>			
13. Association: <i>Hieracio - Nardetum</i>	V	24	-
III. Class: <i>Scheuchzerio - Caricetea nigrae</i>			
Order: <i>Caricetalia davallianae</i>			
Alliance: <i>Caricion davallianae</i>			
14. Association: <i>Valeriano - Caricetum flavae</i>	V	-	20

Legend: Mesoregions: **I** – Miechowska Uplands (Wyżyna Miechowska), **II** – Pomost Krakowski (mesoregion in the northern part of Kraków), **III** – Vistula Lowlands (Nizina Nadwiślańska), **IV** – Wiśnicz Foothills (Pogórze Wiśnickie), **V** – Gorce Mountains (Gorce), **VI** – Beskid Sądecki (a mountain range in the Western Carpathians)

Some types of those communities were either cultivated or uncultivated, e.g. *Arrhenatheretalia: Arrhenatheretum elatioris* and *Gladiolo - Agrostietum capillaris* (table 1, fig. 2 and 3). On the other hand, *Alopecuretum pratensis* and *Cirsietum rivularis* consisted of mowed grasslands (U). Next group comprised of associations from *Molinietalia caeruleae* orders, such as *Filipendulo - Geranietum*, *Deschampsia caespitosa* and *Scirpetum sylvatici* communities. In mowed communities, species within *Gladiolo - Agrostietum capillaris* group, found in Beskid Sądecki mesoregion, were the most numerous. In a single patch of land with the surface of 100 m², 46 species of vascular plants were found (table 2). Those communities which were uncultivated were poor in species and their maximum number in a single patch of land amounted to 28. The least number of species was noted within *Hieracio - Nardetum* group (24), which comprised patches of mowed grasslands. On the other hand, within uncultivated communities, the most abundant in flora were *Arrhenatheretum elatioris* (31 species) and *Angelico - Cirsietum oleracei* (29 species), while the poorest was *Scirpetum sylvatici* association (16 species).

The same types of meadow communities differed in the abundance of flora in particular mesoregions on more than one occasion (table 3). Both *Molinietum caeruleae* and *Cirsietum rivularis* associations were the most abundant in flora within a patch of uplands (Miechowska Uplands and Pomost Krakowski), in contrast to other areas in which they constituted average communities. It was clearly shown that in all mesoregions, only the *Arrhenatherion elatioris* type was abounding in species diversity. However, neither Vistula Lowlands nor Wiśnicz Uphills were characterized by a great number of species richness.

Table 3. Species diversity of meadow communities in particular mesoregions

Lp	Mesoregion	I. small diversity (till 20 species)	II. average diversity (from 21 to 35 species)	III. large diversity (above 35 species)
1.	Miechowska Uplands	<i>Ran - Al gen.</i>	<i>Al. pr., An - Cir. ol.</i>	<i>Cir. riv., Ar. el.</i>
2.	Pomost Krakowski	<i>Zb. Desch caes.</i>	<i>Fil - Ger.</i>	<i>Mol caer., Ar el.</i>
3.	Vistula Lowlands	-	<i>Mol caer., Al. pr., Viol cnid dub., Ar. el.</i>	-
4.	Wiśnicz Foothills	<i>Sc. sil., Al. pr.</i>	<i>Cir riv., Zb. Hol lan., Ar.el.</i>	-
5.	Gorce Mountains	<i>Val - Car fl.</i>	<i>Cir. riv., Al. pr., Hier. - Nard.</i>	<i>Gl. - Agr.</i>
6.	Beskid Sądecki	-	<i>Cir. riv.</i>	<i>Gl. - Agr.</i>

Legend: *Ran - Al gen.* - *Ranunculo - Alopecuretum geniculati*, *Cir. riv.* - *Cirsietum rivularis*, *An. - Cir ol.* - *Angelico - Cirsietum oleracei*, *Al. pr.* - *Alopecuretum pratensis*, *Fil - Ger.* - *Filipendulo - Geranietum*, *Mol caer.* - *Molinietum caeruleae*, *Viol - Cnid dub.* - *Violo - Cnidietum dubii*, *zb. Desch caes.* - *zbior. Deschampsia caespitosa*, *Ar. el.* - *Arrhenatheretum elatioris*, *Sc. sil.* - *Scirpetum sylvatici*, *zb. Hol. lan.* - *zbiorowisko Holcus lanatus*, *Gl - Agr.* - *Gladiolo - Agrostietum capillaris*, *Hier. - Nard.* - *Hieracio - Nardetum*, *Val - Car fl.* - *Valeriano - Caricetum flavae*

Following the Oświt's method (fig. 2), natural values of the researched communities were slightly different. The highest natural values (class VII C – big values) were attributed to both a mowed community (*Cirsietum rivularis*) and an uncultivated community (*Valeriano - Caricetum flavae*). Even though both communities were characterized by small and average species richness, the species they contained were high in values, which added to their natural value. Moderate natural values were distinctive of multifarious meadow communities in the analyzed areas. *Angelico - Cirsietum oleracei* association and *Holcus lanatus* community were classified within IV B – VI B classes. However, associations: *Filipendulo - Geranietum*, *Molinietum caeruleae*, *Violo - Cnidiolum dubii*, *Scirpetum silvatici* and also partly *Alopecuretum pratensis* were attributed to IV B – V B classes. *Arrhenatheretum elatioris* and *Gladiolo - Agrostietum capillaris* communities were distinctive of small and moderate values. Moreover, small and moderate values were pinpointed in cultivated (III A class) and uncultivated communities (IV B class) respectively. Nevertheless, very small and small natural values (I A and II A classes) were noticed in unmowed meadows in the Vistula Lowlands and the Wiśnicz Foothills. While *Hieracio - Nardetum* association was ascribed to I A class, *Ranunculo - Alopecuretum geniculati* was to II A and III A classes.

Taking an economic value of a meadow sward into account, *Arrhenatherion* alliance with *Arrhenatheretum elatioris* association was considered to be the best. Within *Arrhenatherion* alliance, the highest use value amounting to 8,5 (a very good sward) was depicted in cultivated communities in the Miechów Uplands and the Vistula Lowlands (fig. 3). What is more, the highest use values within unmowed meadows were seen in Wiśnicz Foothills (an economic value of a meadow sward = 8,2). Both in Gorce Mountains and Beskid Sądecki, meadows of those types were represented by *Gladiolo - Agrostietum capillaris* association. The economic values of cultivated communities expressed either 7,8 or 8,4 of an economic value of a meadow sward, while the uncultivated ones – 4,6 till 5,6. *Alopecuretum pratensis* association comprised of mowed meadows, whose economic value of a meadow sward came to 5,6 – 7,7, which stressed both a poor and a good feed value of the sward. *Holcus lanatus* community, seen in Wiśnicz Foothills, was characterized by economic values within 6,9 till 7,4. *Calthion palustris* alliance with *Angelico - Cirsietum oleracei*, *Cirsietum rivularis*, *Scirpetum silvatici* associations and *Deschampsia caespitosa* community were distinguished by poorer economic values. Those values were between 1,9 for unmowed meadows and 5,9 for mowed ones.

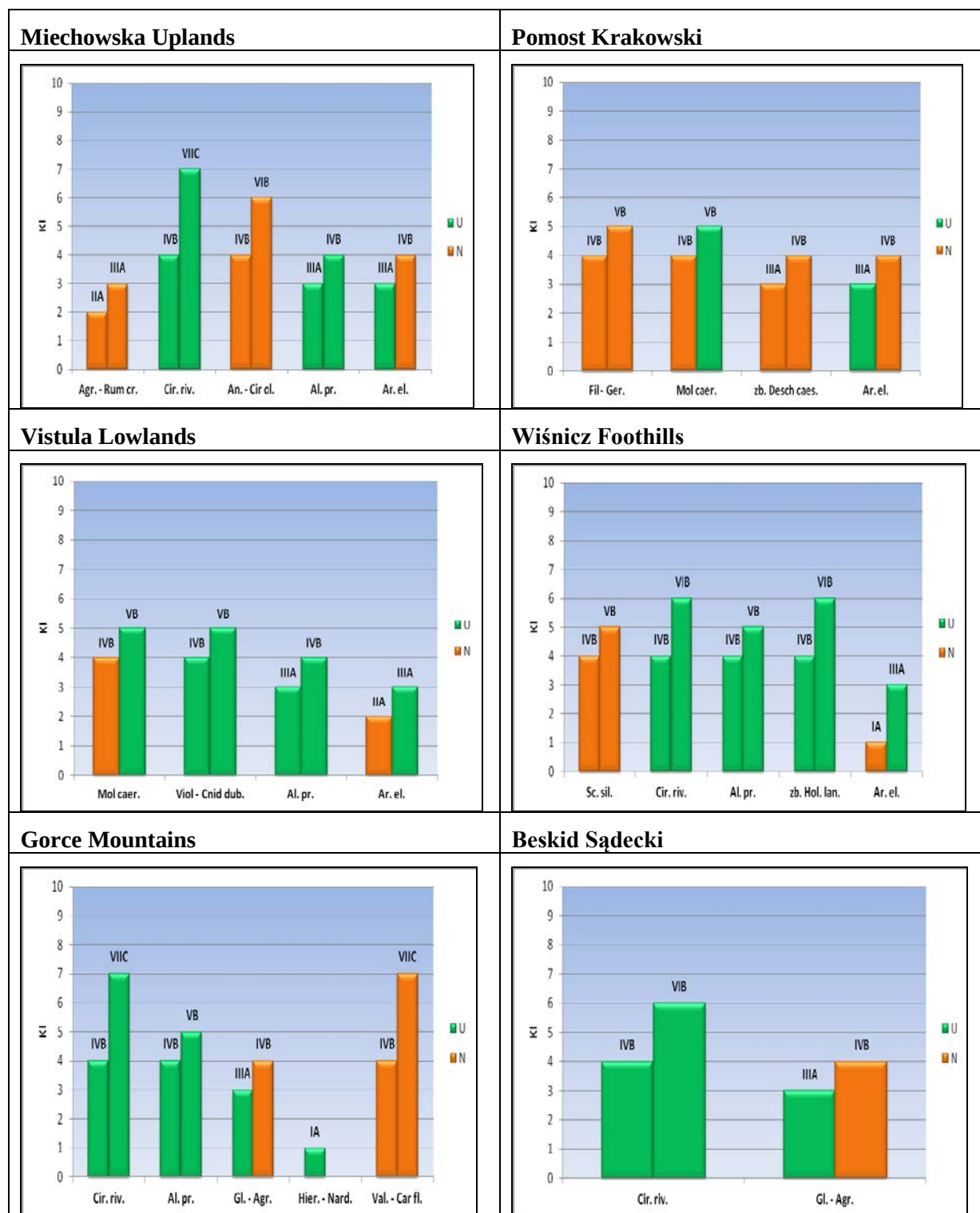


Figure 2. Natural values of meadow communities in the studied mesoregions: extreme natural values classes when cultivated and uncultivated.

Legend: Agr - Rum cr. - *Ranunculo - Alopecuretum geniculati*, Cir. riv. - *Cirsietum rivularis*, An. - Cir ol. - *Angelico - Cirsietum oleracei*, Al. pr. - *Alopecuretum pratensis*, Ar. el. - *Arrhenatheretum elatioris*, Fil - Ger. - *Filipendulo - Geranietum*, Mol caer. - *Molinietum caeruleae*, zb. Desch caes. - *zbior. Deschampsia caespitosa*, Viol - Cnid dub. - *Violo - Cnidietum dubii*, Sc. sil. - *Scirpetum silvatici*, zb. Hol. lan. - *zbiorowisko Holcus lanatus*, Gl - Agr. - *Gladiolo - Agrostietum capillaris*, Hier. - Nard. - *Hieracio - Nardetum*, Val - Car fl. - *Valeriano - Caricetum flavae*.

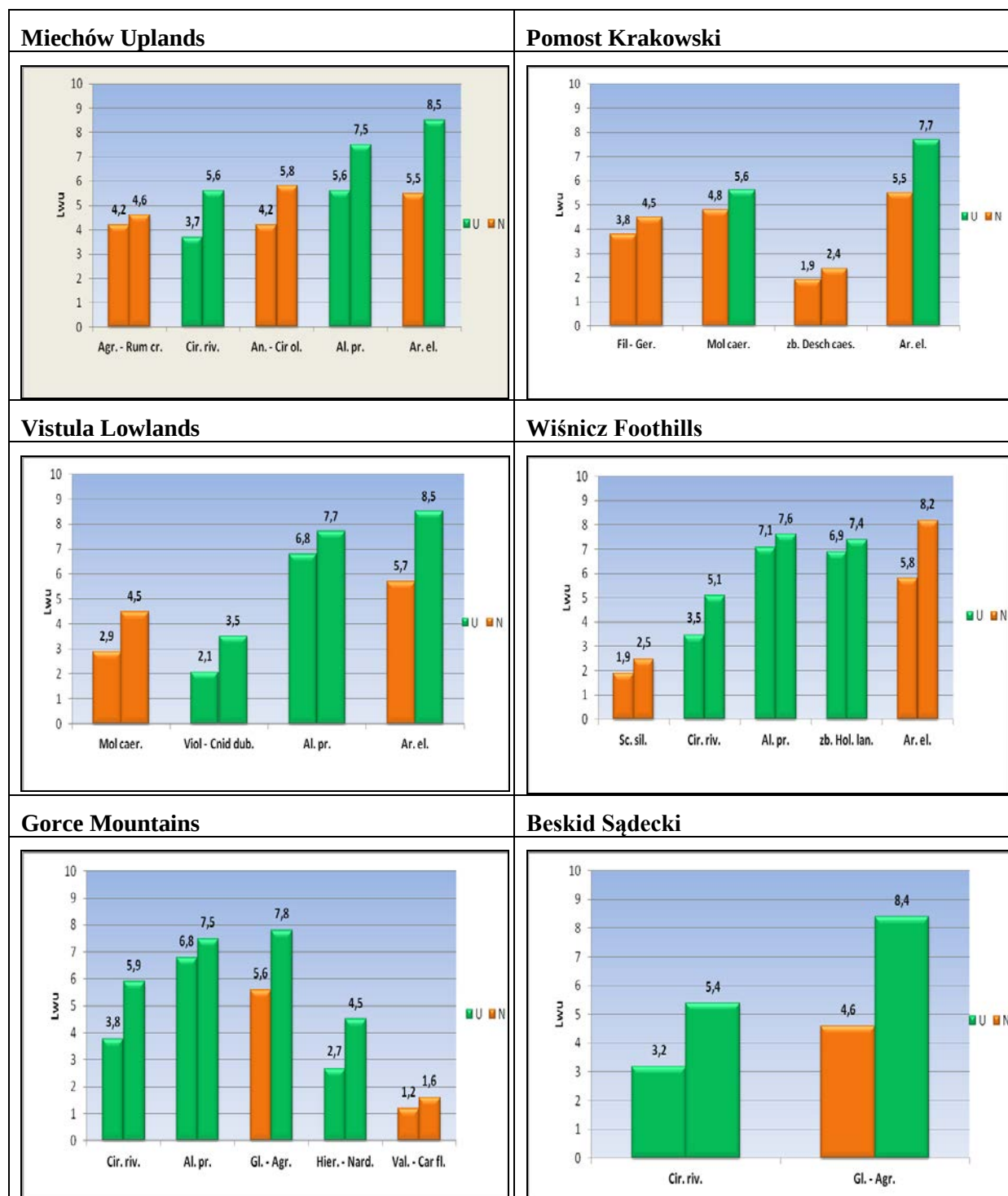


Figure 3. Economic values of meadow communities in the studied mesoregions: extreme economic values of a meadow sward when cultivated and uncultivated.

Legend: Agr - Rum cr. - *Ranunculo - Alopecuretum geniculati*, Cir. riv. - *Cirsietum rivularis*, An. - Cir ol. - *Angelico - Cirsietum oleracei*, Al. pr. - *Alopecuretum pratensis*, Ar. el. - *Arrhenatheretum elatioris*, Fil - Ger. - *Filipendulo - Geranietum*, Mol caer. - *Molinietum caeruleae*, zb. Desch caes. - *zbior. Deschampsia caespitosa*, Viol - Cnid dub. - *Violo - Cnidietum dubii*, Sc. sil. - *Scirpetum silvatici*, zb. Hol. lan.- *zbiorowisko Holcus lanatus*, Gl - Agr. - *Gladiolo - Agrostietum capillaris*, Hier. - Nard. - *Hieracio - Nardetum*, Val - Car fl. - *Valeriano - Caricetum flavae*.

Molinietum caeruleae association was characterized by poor and sparse value of a sward that amounted to 2,9 on meadows within the Vistula Lowlands and to 5,6 within the Pomost Krakowski. *Violo - Cnidietum dubii* association in the Vistula Lowlands was distinctive of poor and sparse use value of a sward. The following associations: *Filipendulo - Geranietum*, *Ranunculo - Alopecuretum geniculati*, *Hieracio - Nardetum* and *Valeriano - Caricetum flavae* were similarly classified.

5. DISCUSSION

It can be highlighted that cultivation and lack of it has a tremendous effect on the shape of meadow communities in all the analyzed mesoregions. The lack of cultivation in all the mesoregions and their meadow communities curbed the number of vascular plant species [Musiał and Kasperczyk 2011, Musiał and Kasperczyk 2013]. Taking mowed usage into account, in the Beskid Sądecki (a mountainous mesoregion), *Arrhenatherion* alliance was the most abundant in vascular plant species. Other researchers, like Medwecka - Kornaś [2006], Zarzycki [2008] and Kryszak et al. [2011] approve that there is evident species richness in meadow communities in the mountainous areas. However, they agree that mountainous communities are characterized by greater biodiversity than typical associations in the lowlands. *Gladiolo - Agrostietum capillaris* association, which constitutes an economically-vital mowed meadow community in a montane level of the western Carpathians Mountains, plays an important role in the mountains. This association is found in the areas where traditional mowing and fertilization with sheep droppings are maintained.

A certain discrepancy between the use value of communities and the natural values was observed. Cultivated communities, especially *Arrhenatherion elatioris*, were marked by higher economic values (taking feedstuff into account), but lower natural values. On the other hand, uncultivated communities had small feedstuff values, but higher natural values – it was because of the appearance of species from more humid habitats in that communities. Even though *Cirsietum rivularis* and *Valeriano - Caricetum flavae* communities found in the Gorce Mountains were marked by the highest natural values, they were not so abundant in vascular plant species. Both Oświt [2000] and Szydłowska [2009] claim that it is not the number of species in a sward, but the occurrence of naturally valuable species that determines natural high values.

The lack of mowing may contribute to a decrease in the trophism of habitats, which in turn may lead to their impoverishment and degradation. Changes within these phytocoenoses make their phytosociological classification almost impossible, and consequently communities gradually start to lose their individual qualities, which is caused by the withdrawal of typical species and the emergence of new synantrophical species [Kryszak and Grynja 2001, Matuszkiewicz 2002].

Progressing for about 15 years, reduction of the headage of herbivorous animals, especially of cattle, and little number of the headage of sheep are one of the factors negatively influencing the agricultural diversity of grasslands. The number of cattle in the dominant part of Małopolska Province is under 20 head on 100 ha, in comparison to only a few mountainous communes with 40 to 50 head of cattle. Low-profitability of manufacturing prevalent among the structure of low-scale productions of cereal crops contributes to a withdrawal of a part of farmers, who have alternative incomes, and as a result fields start to be covered with grass. Excessive and unnecessary grass is usually not mowed which causes changes in a settlement and leads to a quite rapid formation of shrubs. This phenomenon is mostly visible in either economically-valuable settlements with a great natural productivity or less economically-valuable settlements, but environmentally important [Musiał 2004, Musiał et al. 2005, Musiał 2010].

Implementation of the Common Agricultural Policy (CAP) is said to have a crucial and increasing impact on a current state of meadow development in the southern part of Poland and in the whole country. CAP highlights the most vital aspects of the protection of environmentally-valuable meadow communities. This issue is touched upon in the EU's rural development policy (Axis 2), which accentuates "improving the environment and the countryside". Farms, which are still concerned with a land usage and with a stable advancement of grasslands, are supported on the basis of a statement which is about the support of development in mountainous areas and other areas of unfavourable

development. In an activity embracing the environmental management scheme, numerous axioms concerning the land usage, especially meadows were enclosed. Supporting ecological agriculture, a protection of extensive forms of development of meadow and pasture communities is enabled [Klima 2006].

The main aim of producers and production economics is the acquisition of a large amount of feedstuffs for animals. Ecologists, on the other hand, stress the importance of sustainability of biodiversity and protection of rare and precious species, kept mainly by extensive agricultural land usage. Advisory services maintain the necessity for a search of such organizational solutions within the scope of agricultural development of productive space that will maximize agricultural land usage and adjust production intensity of grasslands to their productive potential and an economic value. The management of agricultural economy should be focused on either elimination or minimization of an abandonment of agricultural land usage, especially grasslands [Musiał et al. 2013].

6. CONCLUSIONS

1. The dominant community was *Arrhenatherion elatioris* alliance, whose appearance was seen in all mesoregions. From the Miechów Uplands till the Wiśnicz Foothills this alliance was represented by *Arrhenatheretum elatioris* association, while in mountainous mesoregions, by *Gladiolo - Agrostietum capillaris* association.
2. Uncultivated communities were distinctive of a considerably smaller number of species in comparison with cultivated communities. The lack of interest in agricultural meadow usage leads to is relatively rapid environmental degradation.
3. Between use values of communities and their natural values there was a reverse dependency. Cultivated communities were marked by greater number of use value, but lower natural values, than uncultivated ones. The greater natural values of uncultivated communities were the result of an appearance of species from humid habitats.
4. Plant succession in uncultivated communities was quite advanced. From an economic point of view, the most dominant species were those regarded as weeds, often synanthropic species. Stressing the importance of blocking the succession and maintenance of environmentally-valuable plant species, the necessity for sustainability of such grass communities is highlighted.
5. Researches show both directly and indirectly that in meadows with a lower economic values, but high agricultural valorization, agricultural production may be sustained only when supported by aid measures like an additional area or agri-environmental payments.
6. A lot of effort should be put in the areas with a large share of stable grasslands so as to sustain the livestock of herbivorous animals, including cattle and sheep, which are also breed in smaller farms, adequate to their productivity and biologic value.
7. Excessive land fragmentation and spacious field dispersal are seen as one of the most noticeable disadvantages of an agricultural land development, including stable grasslands, in southern Poland. This phenomenon curbs rational production, agricultural development of fields and hinders tenancy in a situation when their owners resign from agricultural production. Hence, land integration, especially in areas with a high share of grasslands, should be the main priority.

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