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THE EFFECTS AND ENVIRONMENTAL ASPECTS OF GRASSLANDS USE CHANGE ON PLANT-SOIL-EROSION RELATIONS IN HUNGARY

EFECTELE SI ASPECTELE DE MEDIU ALE SCHIMBARII DESTINATIEI PASUNILOR ASUPRA RELATIILOR PLANTA-SOL-EROZIUNE IN UNGARIA

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Natural grasslands were observed during the researches on botany and grassland management, and laying emphasize on the maintenance of nature conservation values as well of the Transdanubian Mountain Range in Hungary. The effected areas are mainly meadows or sparse forests mixed with bushes. These were the typical vegetation types of the area in its natural state. As a result it could be stated that the dolomite slope rocky grassland is more sensitive against excess intensive grazing. Ratio of characteristic species has been decreased, giving floor for degradation tolerant species and poisonous or sticky plants not favored by animals. From a nature conservation point of view, a positive change has happened on the once mowed area converted into pasture of Hungarian Grey Cattle breed near the Balaton Lake.

***Key words**: grassland management, grazing, erosion modeling*

INTRODUCTION

Management takes place on the Hungarian natural grasslands as well. This usually means extensive activities such as mowing or grazing. The total cover of grasslands exceeds 1148000 hectares, that is 11% of the total area of Hungary, 213468 hectares of this being under nature protection. This is why harmonizing aims and tasks of agriculture and nature conservation is highly important on these areas (Ángyán 2000, Láng 1997). Observations on vegetation of pastures and its changes have got a high importance, especially in case of grass species (*Poaceae*), since it is mainly these species that ensure the most valuable forage for grazing animals (Kota

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et al. 1991, Barcsák and Kertész 1986). The other important characteristics of these areas are shallow soil depth, extreme low soil water content in summer and southern exposure. The typical agricultural activity is grazing that reflects the ecological background of the area. Overgrazing has extremely negative effects on these very sensitive soils. There are other human effects: military activity, trampling and vegetation burning etc. From our researches on the Trans-Danubian region near Balaton Lake (Penksza et al. 1998, 2003, Süle et al. 2005).

MATERIAL AND METHODS

Former (1994, 2002) and last year (2006) investigations were used for comparison of vegetation near Balaton Lake. For the coenological investigations we used the Braun-Blanquet (1951) method. We examined two types of partly vegetated and fully vegetated dolomite meadow areas: 1. where grazing ceased; 2. where there is still grazing. We analyzed the forage value of the plants found on the grasslands based on Klapp et al. (1953) who created a 10 grade scale to evaluate the important plant species in the grasslands. The most valuable species got grade 8, the worthless species or those not grazed by animals got grade 0, poisonous species got grade -1. Values and notations of grassland management categories were used following TASI (2002, 2003). The applied grass management category values follow the nomenclature of Tasi (2002): 1. important grass species in grass management, 2. important pulse species in grass management, 3. other grass species, sour grasses and monocotyledonous species, 4. indifferent dicotyledonous species, 5. poisonous species, 6. stinger species.

Erosion modeling was done on sample slopes by the Wischmeier-Smith's Universal Soil Loss Equation (USLE) (Wischmeier and Smith 1978, Centeri 2002a, 2002b). The USLE is an empirical model that uses physical factors to quantify the amount of soil loss. Its well-known equation is: $A = R * K * L * S * C * P$, where A = soil loss ($t\ ha^{-1}\ y^{-1}$); R = rainfall erosivity factor ($MJ\ mm\ ha^{-1}\ h^{-1}\ y^{-1}$); K = soil erodibility factor ($t\ ha\ h\ ha^{-1}\ MJ^{-1}\ mm^{-1}$); L = slope length (dimensionless); S = slope gradient factor (dimensionless); C = crop cover management factor (dimensionless); P = agricultural practice factor (dimensionless). The area's R factor is 175 ($MJ\ mm\ ha^{-1}\ h^{-1}\ y^{-1}$), the K factor is 0,02 ($t\ ha\ h\ ha^{-1}\ MJ^{-1}\ mm^{-1}$), LS factor is (70m long and 14% slope) 3.25, C factors were as follows: open-grazed land (0.35), closed-grazed land (0.25), open not-grazed land (0.15), closed not-grazed land (0.05) (Centeri és Császár 2003). Pedological field research was done together with the vegetation examinations. For soil analyses we used the Pürckhauer type soil core sampler (Finnern 1994). Soil laboratory analyses were done by the description of Buzás (1993).

RESULTS AND DISCUSSIONS

On the open, not-grazed grassland mono- and dicotyledonous species – indifferent from the grazing point of view – covered most of the area. Earlier monocotyledonous species were more abundant, while dicotyledonous species ruled in 2006 (Table 1.). Species with more valuable forage species grew (Table 2.) but did not alter the economical value of the association.

Table 1.: Distribution of grass management categories in the grassland near Balaton Lake

Gmc	1994				2002				2006			
	Not grazed		Grazed		Not grazed		Grazed		Not grazed		Grazed	
	O	C	O	C	O	C	O	C	O	C	O	C
1	0.0	19.3	0.0	23.7	0.0	2.6	0.5	21.4	0.0	3.0	2.9	8.4
2	0.2	0.0	0.0	10.9	0.0	0.5	0.5	1.6	5.3	0.9	0.7	2.0
3	60.5	46.2	37.0	18.5	61.8	68.7	48.1	37.8	34.2	67.8	40.1	72.8
4	36.0	30.6	56.0	39.6	36.4	25.3	43.6	29.3	56.3	26.2	51.2	8.9
5	3.0	1.9	6.8	4.1	1.9	1.8	6.8	8.8	4.2	0.2	4.0	6.0
6	0.3	2.0	0.2	3.3	0.0	1.1	0.7	1.2	0.0	1.9	1.1	1.8

Gmc = Grass management category O = open grassland, C = closed (fully covered) grassland, values given in %

The quality of the open, grazed grasslands slowly increased between 1994 and 2006. The percentage of grass and pulse species grew, the coverage of poisonous plants decreased (Table 2.). The growth of forage values is not evident (Table 3.).

The coverage of the indifferent species of the closed, not-grazed association was 67.8%. The number of valuable species (e.g. *Festuca* *valesiaca, F. ruoicola*) decreased. The plants with zero forage value cover the biggest proportion of the land (Table 2.).

Table 2. Distribution of forage values of the meadows around near Balaton Lake

Fv	1994				2002				2006			
	Not grazed		Grazed		Not grazed		Grazed		Not grazed		Grazed	
	O	C	O	C	O	C	O	C	O	C	O	C
-1	3.6	2.4	6.6	4.7	3.5	2.9	6.8	10.1	4.2	0.0	4.0	6.1
0	20.7	29.7	3.7	5.2	6.1	35.3	5.0	16.6	11.7	52.9	9.9	46.3
1	48.0	32.1	38.7	25.1	62.5	46.1	43.8	34.3	46.4	31.5	46.5	25.4
2	14.4	11.5	22.0	13.3	15.6	10.3	12.9	14.3	22.7	10.0	18.2	10.2
3	12.7	24.2	29.0	22.9	12.1	5.0	31.4	21.7	8.0	4.4	20.4	8.7
4	0.5	0.0	0.0	0.0	0.2	0.0	0.0	0.0	1.8	0.0	0.1	0.0
5	0.2	0.3	0.0	11.7	0.0	0.5	0.2	1.6	5.3	0.9	0.7	1.6
6	0.0	0.0	0.0	2.4	0.0	0.0	0.0	1.4	0.0	0.0	0.3	1.2
7	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
8	0.0	0.0	0.0	13.8	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0

Fv = Forage value, O = open grassland, C = closed (fully covered) grassland, values given in %

On the closed, grazed grasslands the most valuable species disappeared, and grade 5 decreased by 10%, too. The biggest increase was in case of indifferent species for grazing (from 5.2 to 46.3%).

Among forage value categories, number 3 exceeds greater coverage. Rates of the three most important categories have decreased. The reason for this process can be the proliferation of narrow-leafed *Festuca* species. Although, based on species composition, forage value of the grassland has decreased during the observed years, this is compensated by the massive growth of total cover, and therefore, the value of the grassland has grown from forage value point of view as well (Table 2).

Based on the field core soil sampling, we can state that the sample area has a shallow soil cover. There are typical A-C soils (one, humus-rich A horizon above the parent material) with 5-45cm soil depth. The parent material was limestone, in some cases rocks were on the surface. The laboratory analyses of the A horizons can be found in Table 1.

Table 3. Pedological parameters of the examined areas

Plant cover	pH (H_2O)	pH (KCl)	$CaCO_3$ %	Humus %	Al-K_2O mg kg^{-1}	Al-P_2O_5 mg kg^{-1}
Closed, not grazed	7.46	6.91	1.1	12.9	490.8	68
Closed, grazed	7.23	6.96	1.2	13.9	351.79	80.07
Open, not grazed	7.62	7.09	2.3	12.7	325.29	49.8
Open, grazed	7.56	7.12	17.9	18.6	751.79	198.4

Soil parameters reflect land use and vegetation. Open grasslands have higher pH and $CaCO_3$ content because the parent material is more mixed with the soil part and there are more rock fragments on the surface, too. The high humus content of these soils originates in soil formation: long dormancy period (dry and/or cold). Soil analyses showed higher humus content in grazed lands that can be the result of manuring.

Based on the soil erosion modeling on the open grazed grasslands the average annual soil loss is 3.98 (t ha^{-1} y^{-1}), on closed grazed grasslands 2.84 (t ha^{-1} y^{-1}), on open not-grazed grasslands 1.71 (t ha^{-1} y^{-1}), on closed not-grazed grasslands 0.57 (t ha^{-1} y^{-1}). Based on estimations on yearly soil formation rate (0.2-3 t ha^{-1} y^{-1}) we can assume that on grazed land soil formation rate is no more than 1 (t ha^{-1} y^{-1}). This causes the loss of the whole soil depth (average is 30cm on the area) in 151 years on the open grazed area, and in 244 years in the closed grazed area.

Grazing must consider the nature protection values of the area, too. On the grazed areas there were extreme changes in the species composition. The number of the annual weed species increased. In the partly vegetated grasslands the typical plants were still present, often with lower coverage in spite of intensive grazing. The fully vegetated and grazed grasslands were totally degenerated, more poisonous species were wide spread, and the typical species were replaced.

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