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EFFECTS OF LAND USE TYPES WITH DIFFERENT INTENSITIES ON SOIL EROSION, NUTRIENT LOSS AND OTHER SOIL PARAMETERS

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Abstract: The Hungarian hilly areas are characterized by water erosion. This is one of the main land degradation processes, sometimes reaching severe range on erosion-sensitive areas and under the effect of intensive agriculture. Slopes are divided into 3 sections in the Hungarian Soil Protection Information and Monitoring System: upper, middle and lower third of the slope. In order to study the water erosion processes of slope sections, sample sites were chosen in Gerézdpuszta and Novaj (Hungary). We selected an intensive (arable) and an extensive (grassy) sample area. The purpose of the investigation was to characterize and compare the slope sections and intensive versus extensive areas, based on measured basic soil parameters ($CaCO_3$, pH, TOC %, NPK). In Gerézdpuszta the $CaCO_3$ and the TOC % were good indicators of erosion processes, $CaCO_3$ and TOC content is lower on the upper third of the slope and vice verse at the bottom of the slope. The distribution of nutrients is similar to the TOC%, although on grassy areas the values didn't decrease with the altitude. In Novaj, the soil is less eroded; the $CaCO_3$ content is very low while the K content is very high. However, the P content is increasing from the upper towards the lower part of the slope on the arable land and vice verse on the grassed sample area. Overall, we found the basic soil parameters a very useful tool for characterizing the soil erosion processes.

Keywords: soil erosion processes, slope sections, basic soil parameters, land use type

Introduction

One of the fundamental elements of sustainable development is the rational management of soils (Várallyay, 1997; Demény and Centeri, 2008; Kahindi et al., 1997). In Hungary, almost 1/3 of the arable lands are affected by water erosion (Barczi and Centeri, 2005). 2/3 of the lands are consisted of loose and loess-like sediment, which are very sensitive for the mass movements and the erosion processes (Stefanovits et al. 1999; Thyll, 1992). In the present study the most important factors of all are the land use type and slope parameters. Under different land cover, various amount of soil loss occur. On hilly areas the biggest problem is caused by row crops since they have wide row space and small leaf surface, so they do not have soil protection functions (Barczi et al. 1997). So in terms of land degradation the surface and land cover have great importance, which fact have demonstrated by several studies (Kertész et al. 2001; Chen et al. 2007; Csepinszky and Jakab, 1999; Balletine et al. 2009; Martinez et al. 2000; Vacca et al. 2000; Pardini et al. 2003).

Maximum erosion occurs on upper convexities and the steepest middle parts of slopes. On a konvex slope the water erosion with the highest intensity takes place in the middle and lower third of the slope and on the concave slope in the upper and middle third.

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Accordingly we can differentiate slope sections, where on slope thirds the quantity of the soil loss can be various. This categorization can be found in several studies (Szentes et al. 2008; Penksza et al. 2009; Demény et al. 2010, Ailincai et al. 2007; Boll, 2008), where the investigation of slope thirds can help in studying the different intensity of the land use and their effect on nutrient and soil loss and on other basic soil parameters. So the aim of this paper to study the soil loss under different land use types (extensive and intensive), compare and characterize the soil erosion processes on different slope thirds based on elemental soil properties.

Materials and methods

One of our studied areas can be found in Gerézdpuszta (Somogy County) and the other in Novaj (Heves County). In case of Gerézdpuszta, the landscape is characterized by chernozems and brown forest soils. In Novaj the typical soil type is the erubase, brown forest soil with clay and chernozem brown forests soils. In both scenes we selected slopes under intensive cultivation and parallel extensive grassland. The studied slope thirds of arable land in Gerézdpuszta have 11.8 % slope category on the upper, 19 % on the middle and 14 % on the lower third of slope angle category, while the grassland has in all thirds 11.8%. In Novaj, the arable land has 6.25 % slope angle on the upper, 12.5 % on the middle and lower third of slope. The abandoned vineyard/grassland has 6.25 % slope angle on the upper and middle, while on lower third of the slope has 12.5 % slope.
Soil samples were examined in 12 points (6-6 sample point) in situ by Pürckhauer-type core sampler , where we made full soil profile descriptions (depth of layers, pH, colour, soil physical type, carbonate content, soil types were determined). For the laboratory analysis the upper (0–30cm) layer was sampled with the possible smallest disturbance. 600-600g sample was collected at the upper, middle and lower thirds of the slope. Basic soil parameters were measured from the average samples: AL-P_2O_5, AL-K_2O, pH (KCl), $CaCO_3$, and the total organic carbon (TOC%), in case of Novaj the $CaCl_2$-N_{tot}.

Results and discussion

Based on the field experiments, in Gerézdpuszta the most common soil types were humus carbonate, slope sediment, while in Novaj in case of all soil samples we found brown forest soil with clay. In Gerézdpuszta, on grassland the thickness of humic layer was greater than in case of arable land. Based on the humic layer thickness we can clearly separate the three erosion section, where on the upper third of the slope there was well-developed humic layer, the middle third was the most eroded and then the lower part of the slope were characterized by sediment. Contrarily on arable land the upper third is the most eroded, on surface the bedrock is appeared, but downhill the thickness of humic layer steadily increasing.
In Novaj, on the grassland the distribution of humic layer on slope third is more uniform, and in case of the arable land the middle third of the slope was the most eroded. On the lowest part of the slope was almost 100 cm humic layer.
In Gerézdpuszta we can say that higher $CaCO_3$ content occurred on the arable land which clearly indicate the erosion processes. Based on the distribution of the $CaCO_3$ we

can see (Table 1.) that on the arable land the most eroded third of the slope is the upper, not the middle. Parallel with it the values of the TOC % also confirm the rates of erosion, because at high $CaCO_3$ values occur with low TOC% values, which is also in correlation with the thickness of humic layers.
On grassland the highest $CaCO_3$ occurs on the upper third and it is decreasing to downhill, while the TOC% shows the opposite tendencies. In case of grassland we measured higher TOC% values, than on arable land. Phosphate and potassium supply are very low.

Table 1. The result in Gerézdpuszta under an extensive and an intensive land use type

Gerézdpuszta								
Arable land					**Grassland**			
$CaCO_3$ %	TOC %	P (mg/l)	K (mg/l)	Slope third	$CaCO_3$ %	TOC %	P (mg/l)	K (mg/l)
23,85	1,94	1,13	3,61	**Upper**	13,34	7,5	4,54	8,19
8,52	6,38	1,54	5,41	**Middle**	8,1	14,13	8,43	6,33
10	8,7	2,4	5,95	**Lower**	4,48	12,36	8,16	28,22

In Novaj the soil condition was better than in Gerézdpuszta (*Table 2.*), which results also confirmed the low $CaCO_3$ and high TOC % values.

Table 2. The result in Novaj under an extensive and an intensive land use type

Novaj												
Arable land							**Grassland**					
$CaCO_3$ %	TOC %	pH (KCl)	N (m /m%)	P (mg /kg)	K (mg /kg)	Slope third	$CaCO_3$ %	TOC %	pH (KCl)	N (m /m%)	P (mg /kg)	K (mg /kg)
0,25	7,8	8,1	0,18	355	5630	**Upper**	0,17	7,2	8,4	0,17	422	6105
0,21	7,36	8,2	0,16	440	3860	**Middle**	0,21	6,48	8,2	0,12	399	3480
0,25	7,13	8	0,24	482	5350	**Lower**	0,21	7,02	8,2	0,16	322	6010

On arable land the most TOC% occur at the upper third, which is decreasing with the altitude, while on grassland the lower values can be found on the middle third. Based on the pH, the soils are mildly alkaline. On the plot the N supply is good and the values are higher on arable land, than on grassland resulting from the fertilization. Compared the nitrogen values on the upper and the lower slope third, it is decreasing on the grassland, while on the arable land increase. In case of P, the results show higher values under arable land, where on the upper third nutrient loss, while on the lower third of the slope accumulation was observed. On the grassland the values decreased with the altitude, while on arable land continues increase to downhill. The K content was very high.

Conclusions

On the arable land of Gerézdpuszta there is high level soil degradation. The difference between the average humic layer thickness of the arable and the grassland is 11%. The arable land in Novaj has better soil facilities. The investigation of soil parameters under different land use types and on different slope thirds highlights soil erosion processes and provides insight to its dynamism and variability.

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