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CHANGES OF TOPOGRAPHIC PROFILE IN DRIED VALLEY BOTTOM

A. Grzywna, S. Palys

Department of Melioration and Agricultural Building, University of Agriculture in Lublin
Leszczyńskiego 7, 20-069 Lublin, Poland

A b s t r a c t. In the present paper, on the basis of altitude measurements, changes of topographic profiles of a chosen dried valley in Elizówka on the arable land were presented. Intensity of water erosion was also studied on the unprotected loess terrain for 40 years. On the average, 22 cm of mud deposited on the tested section of the valley bottom (total area of 1.28 ha) along 500 m of the water race line, with the average width of 25.6 m. In consequence, the local erosion basis was raised and the average inclination decreased slightly. Physico-chemical properties did not significantly change within 40 years and these factors are typical of deluvial soils with unshaped profile. Their partial improvement points to reduction and stabilisation of erosion processes. That phenomenon is associated with slight thaw water run-off and the lack of larger storm precipitation.

K e y w o r d s: water erosion, topographic profile, physical properties, silting up.

INTRODUCTION

One of the symptoms of natural environment devastation is gradual soil degradation [1,5]. Changes of its physical and chemical properties as well as dynamics of requirements for water supplies cause an imbalance in the landscape. One of the reasons for soil changes is water erosion [4]. It leads to a topographic profile of a terrain through its segmentation. The main factors affecting the character and intensification of erosion processes include: level and distribution of precipitation, thaw run-offs, terrain's topographic profile, soil mechanical composition, and farming methods [2,3,7]. The aim of the present paper was to investigate the intensity of soil water erosion in the last 40 years in unprotected areas. In the paper, on the basis of altitude measurements, changes of topographic profile of a chosen dried valley were studied in the arable land.

DESCRIPTION OF THE OBJECT

A control field, property of the Agricultural Experimental Station in Elizówka was the object for the present studies (Fig. 1). It is situated in the northern part of the Lublin Upland (Wyżyna Lubelska) that is strongly threatened by water erosion processes, especially due to its rich topographic profile. Over half of the drainage area of 6.227 km^2 is inclined below 3%. Slopes with inclination of 3 to 6% constitute 37% of the area, and correspondingly with 6% to 10% inclination - 8% of the drainage area, 10 to 20% inclination - 3% of the area, and 20% inclination - 1% of the area. The average inclination of the basin is 3.6%. The slopes are long, i.e. from 50 to 400 m, and their inclination range from 10 to 20%. The soils were formed on deep loess and they are classified as brown soils. At the slope bases and in the valley bottoms where accumulation of soil material takes place, deluvial soils with undeveloped profiles can be found. Almost all the drainage area is used as arable land. The climatic conditions of the object are characterised by the average precipitation of 550 mm and the average yearly temperature of 7.3 ^{o}C. However, individual years may differ significantly [3,6]. For example, in 1974 the total sum of precipitation amounted to 822 mm, and in 1976 - to 310 mm.

METHODS

Changes in terrain topographic profile were assessed on the basis of levelling measurements taken at the points from fixed routes. Cross sections of the valley bottom were made every 20 m with the use of station poles set up every 5 m. Denser set ups were used near water race lines to establish their exact course. On the baiss differences in altitudes in 1958 and 1998, the balance of soil material was prepared (Table 1). Only the valley bottom was included in the balance, and the limit inclination of 5% value was accepted as a border between the slope and the valley bottom. Comparative studies of soil samples were done as well. Three soil pits were made and samples were taken from the characteristic horizons. The structure of the topographic profile and the depth at which the loess rock was located were determined. Granulometric composition was carried out using the Bouyoucos's method with Cassagrande and Prószyński's modification, soil permeability rate – by the apparatus of Ziemnicki. Humus content was estimated by the permanganate method, $CaCO_3$ content by the Scheibler's apparatus, and solid phase density – pycnometrically.

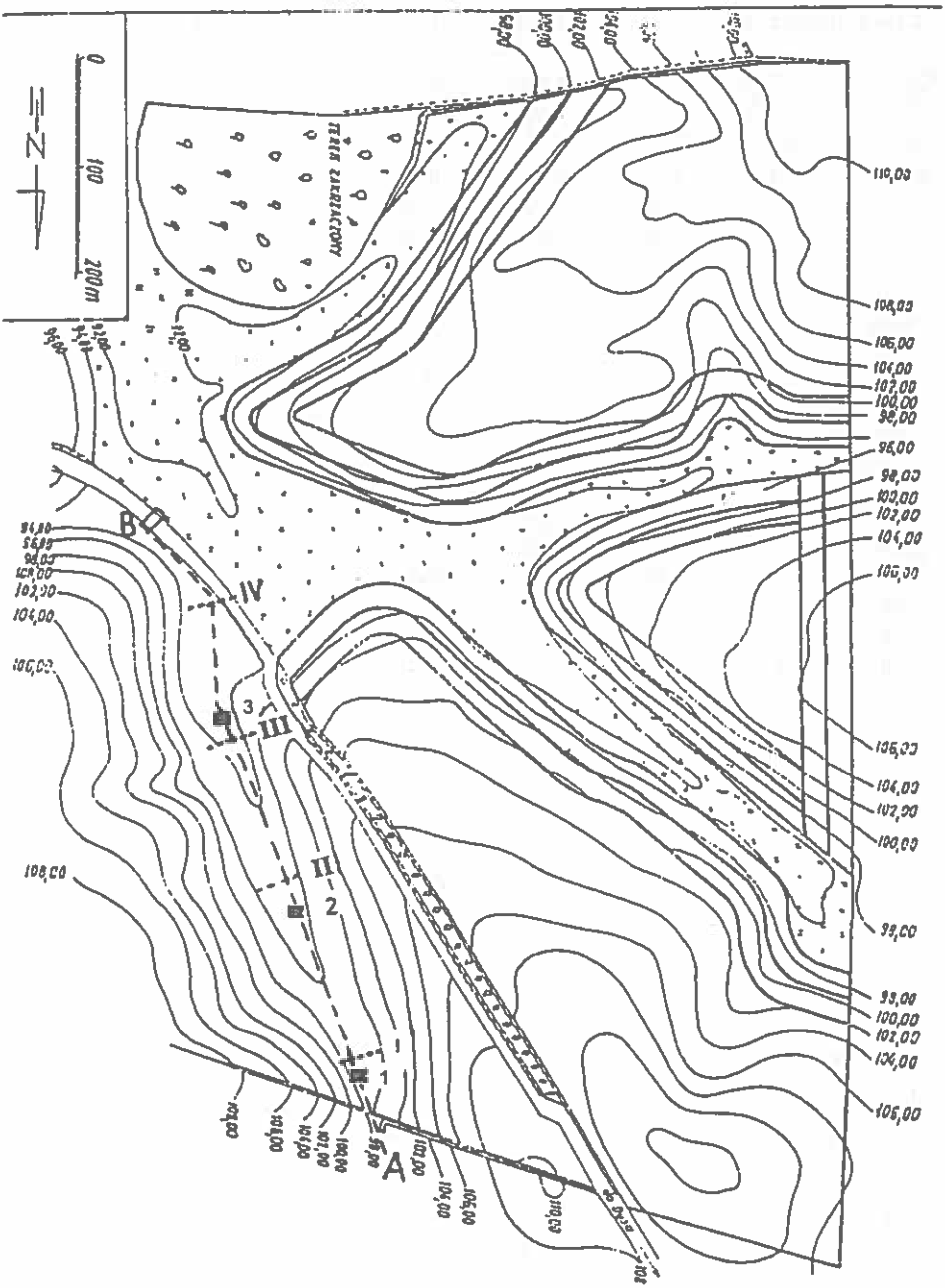

Fig. 1. Plan of the examined field in Elizówka. ■1, 2, 3, - soil profiles; A— —B - underflow lines; ————, II, III, IV - cross sections.

T a b l e 1. Balance of soil material at the bottom of AB valley in the period of 1958-1998

Section Hecto-meter	Width of the valley (m)	Surface of valley bottom (m^2)	Average silt (m)	Silting (m^3)	Drop of flow line (%)	Comments
0+00	15	1050	0.181	190.50	1.8	Farmer's land
0+60	20	300	0.190	56.90	1.5	
0+80	10	300	0.273	81.90	1.0	Control fields
1+00	20	400	0.193	77.20	1.3	
1+20	20	400	0.155	62.05	1.2	
1+40	20	500	0.128	64.00	1.5	
1+60	30	550	0.087	47.65	1.4	
1+80	25	450	0.097	43.75	1.3	
2+00	20	350	0.114	39.75	1.2	
2+20	15	450	0.086	38.50	1.1	
2+40	30	550	0.112	61.90	0.9	
2+60	25	500	0.189	94.40	1.0	
2+80	25	450	0.202	90.85	1.1	
3+00	20	400	0.186	74.62	0.9	
3+20	20	420	0.247	103.97	0.4	
3+40	22	570	0.281	160.08	0.0	Valley opening
3+60	35	650	0.240	155.98	1.6	
3+80	30	650	0.271	176.35	0.7	
4+00	35	650	0.317	205.80	0.6	
4+20	30	650	0.304	197.65	0.6	
4+40	35	880	0.316	278.30	0.5	
4+60	53	960	0.305	292.90	0.3	
4+80	43	710	0.313	222.45	0.4	From W
5+00	28					embankment
Total		12790		2817.45		
Average	25.6		0.220		0.97	

RESULTS

The testing period was characterised by a low intensity of erosion processes due to little surface water run-offs, mild thaw run-offs, and the lack of big storm rainfalls [3,6]. In the tested area of the AB valley, enclosed with a road embankment containing a pass with the section of 2 x 1.35 m, several typical cross-sections were presented (Fig. 2) in addition to the longitudinal section of the water race. The areas of the terrain from 1958 and 1998 were marked on them and the changes referring to the terrain's data heights were determined.

On the average, the width of the bottom, along a 500 m balanced section, amounts to 26 m, varying from 10 to 53 m. The flow line was silted up on its

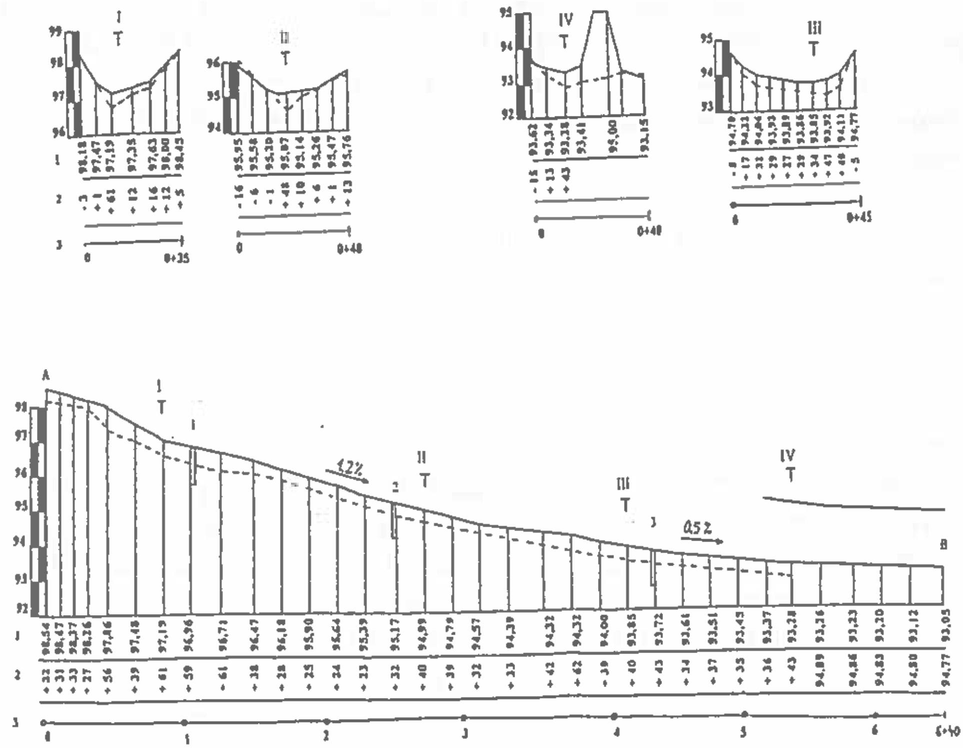

Fig. 2. Longitudinal profile and cross sections of the bottom of the AB valley. 1 – area ordinates in 1998, 2 – elevation (+) or depression (-) in cm, 3 – hectometres.

whole length, and the deposit had a thickness from 23 to 62 cm. Changes in the height of the cross-sections were bigger and ranged from 10 cm for the scour at the edges to 68 cm for the silt in the central part of the valley bottom. During a 40-year period, 2817.45 m^3 of soil was deposited in the valley bottom of 1.28 ha area. This produced an average warp layer (22 cm deep) whose sections ranged from 8.6 to 31.7 cm (Table 1). The longitudinal inclination of the water race line ranged from 0 to 1.8% end equals to 1%, on the average.

The section of the valley running from hectometre 5 + 00 to the pass under the road, along the embankment, was 10 m wide. This fragment of the valley (140 m long) was not taken into account while balancing of the soil material due to a complete change of hydrologic conditions and because of the course of the water race. This is related to the fact that it was impossible to compare data from the testing period because the road was then under construction.

Formation of two depositional cones is characteristics for the valley under the present studies. One of them was formed in the section 3 + 60 at the mouth of the side valley at the East. The other was raised in the section 5 + 20 as a result of closing of the valley on the South-West side with the embankment that contained a pass under the road, with the bottom raised by about 50 cm over the former bottom of the water race line. This made the water run-off more difficult and resulted in the accumulation of soil material along the road embankment. It contributed to elevating of the local erosion base.

DISCUSSION

Studies on the intensity of erosion processes in the whole drainage area from 1958 to 1998 were also made. The total run-off of water, soil and salt out of the drainage area of 6.227 km^2 were determined [4,6]. The testing period, except for 1964, 1969, 1979 and 1996, was characterised by small levels of surface water run-offs resulting from mild thaw and the lack of big storm rainfalls, especially in the eighties. Throughout the whole testing period only exceptional cases of scouring could be observed. Scours of the water race line occurred in the upper section of valley's bottom, resulting mainly from thaw run-offs. Prior to the closing of the valley with the road embankment the line of erosion was quite intensive.

On the average, 22 cm of mud deposited on the tested section of the valley's bottom (total area of 1.28 ha) along 500 m of the water race line, with the average width of 25.6 m. Thus, the mean thickness of the mud layer was about 5.6 mm annually. In consequence, the local erosion basis was raised and the average inclination decreased slightly. The inclination decreased more significantly at the lower part of valley's bottom - from 0.6 to 0.5%.

Description of the soil profile of pit No. 1. Proper deluvial soil, loess below 2 m.

Ap0 – 30 cm arable humus level, gray colour, HCl(-),

W_1 30 - 95 cm gray-yellow deposits, HCl(-),

W_2 95 - 120 cm gray-brown deposits, HCl(-),

B 120 - 150 cm illuvial horizon, dark brown colour.

The grain size composition indicates a relatively small differentiation and is typical of deluvial soils formed from loess (Table 2). In pit 1 there are less fine (<0.02 mm) particles than in the corresponding levels of pits 2 and 3. Pit 1 is located in a section with a significant inclination - 1.5% and this causes that coarser particles are deposited there. Small particles are carried further and are deposited

T a b l e 2. Granulometric composition of the soil in 1998

Profile No.	Depth (cm)	Percentage of particles (mm)						Total <0.02
		1-0.1	0.1-0.05	0.05-0.02	0.02-0.006	0.006-0.002	<0.002	
	5-15	7	10	46	19	7	11	37
1	50-60	6	9	49	18	7	11	36
	100-110	5	10	44	19	9	13	41
	5-15	3	11	48	21	5	12	38
2	50-60	3	12	47	21	5	12	38
	100-110	4	11	39	23	10	13	46
	5-15	4	13	44	17	9	13	39
3	50-60	3	10	47	19	8	12	39
	100-110	4	12	41	23	8	12	43

near the silt cones where the inclination decreases below 0.5%. Insignificant differentiation occurred in the physical-chemical properties of the tested soils (Table 3). There was a general improvement of tested parameters at all levels of pit 1. There was a significant increase of porosity at the 5 - 15 cm layer from 46.4 to 52.1% and of related soil permeability rate from 0.000271 to 0.000763 cm s^{-1}. Humus content also increased, especially at the 100 - 110 cm level from 0.37 to 0.68%. $CaCO_3$ content was reduced completely.

The presented results indicate that the erosion processes slowed down both at the valley bottom and on the adjacent slopes. This was caused by a smaller degree of farming on this terrain, rare snowy winters and smaller thaw run-offs. Undoub-tedly, closing the valley with the road embankment and thereby stopping the run-off affected the intensity of line are linear erosion.

T a b l e 3. Some physico-chemical properties of the soil – profile No. 1

Year	Depth (cm)	Solid phase density ($Mg\ m^{-3}$)	Soil density ($Mg\ m^{-3}$)	Total porosity (%)	Permeability coefficient ($cm\ s^{-1}$)	Humus (%)	$CaCO_3$ (%)
	5-15	2.60	1.39	46.4	0.000271	1.74	0.00
1958	50-60	2.67	1.50	43.8	0.00064	0.94	0.04
	100-110	2.69	1.55	42.4	0.00015	0.37	0.08
	5-15	2.65	1.27	52.1	0.000763	1.77	-
1998	50-60	2.66	1.45	45.5	0.000234	1.10	-
	100-110	2.71	1.53	43.5	0.00055	0.68	-

CONCLUSIONS

1. Lower farming intensity has lead to the improvement of physical-chemical properties of deluvial soils.

2. Closing of the valley with the road embankment made the water run-off more difficult.

3. Deposited silts contributed to the flattening of the water race line and to the confined erosion.

4. Changes in the transverse of the valley bottom from triangle into a semi-circle and lowering of the flow line took place.

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